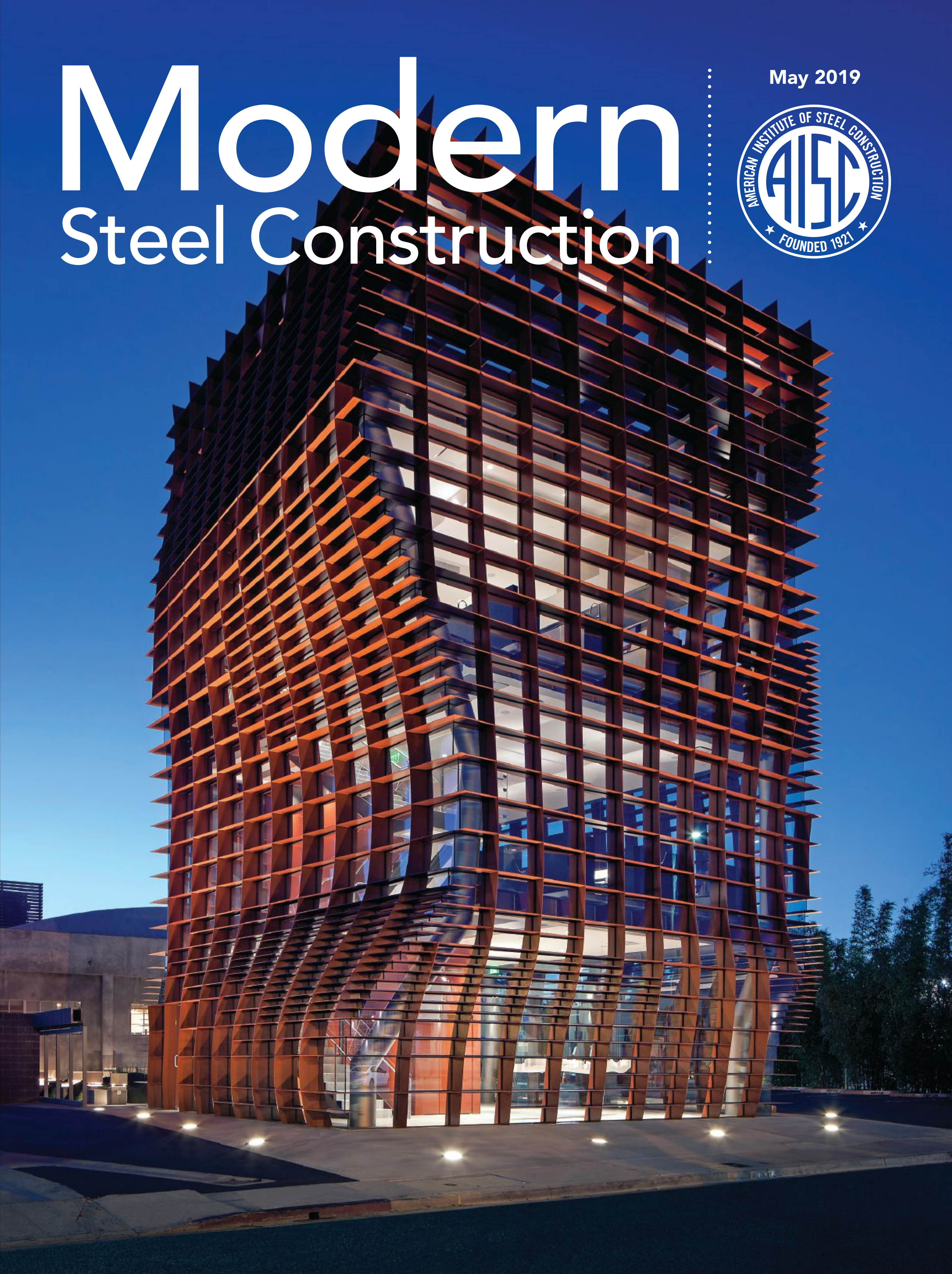
Modern Steel Construction

May 2019



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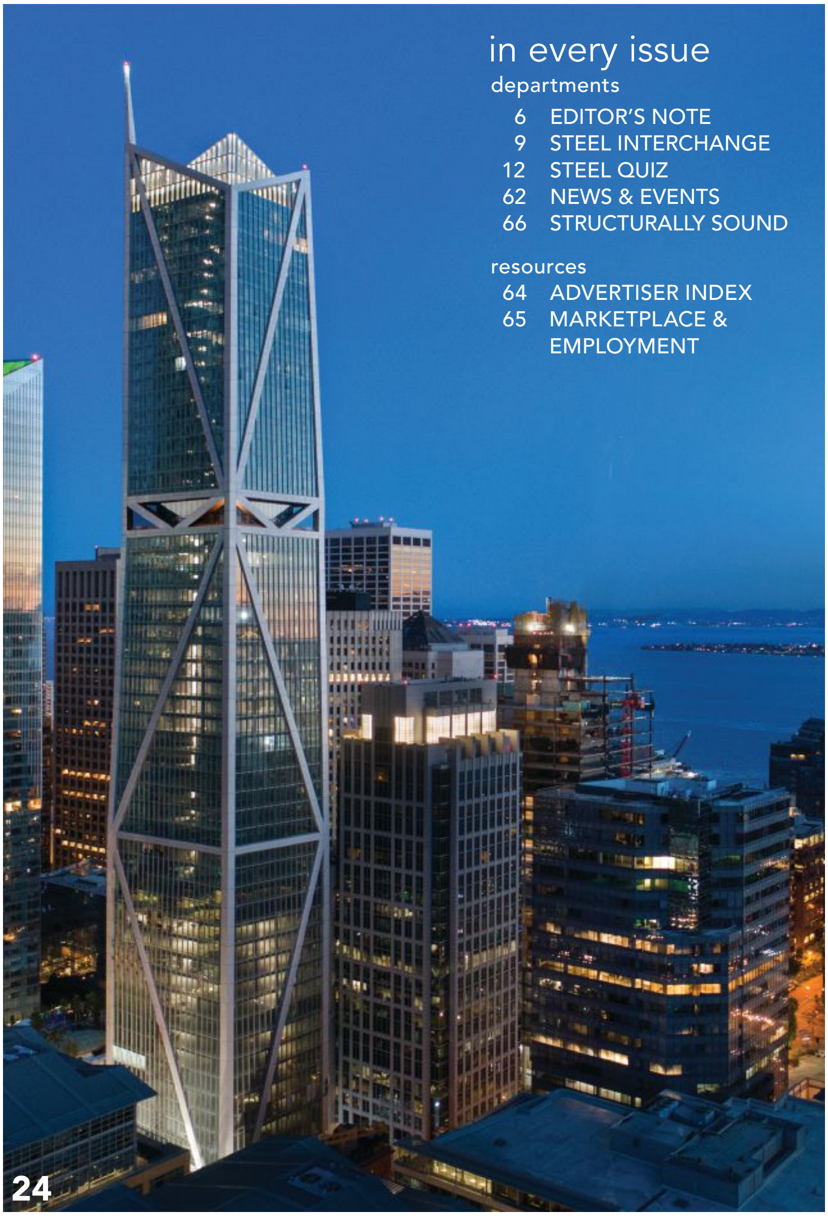

ON THE COVER: An undulating grid defines one of this year's IDEAS² Award winners. Coverage begins on p. 24. (Photo: Tom Bonner)

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editor's note

Is Bill Issler a genius or a dreamer?

Maybe he's both. I've known Bill for decades, first as the developer of CompuSteel, one of the industry's early detailing software programs, and later after he founded FabSuite, a software suite for the fabrication industry now owned by Tekla.

If there's any constant about Bill, it's that he's always looking ahead. And since "retiring," he's turned his attention from his businesses to his passion for bringing more young people to the steel industry.

A couple of years ago, Bill started talking about something he called "Industry Lift." He recognized that a career in the steel industry—as a detailer, a welder, a fitter, a fabricator—was not something many young people saw as a viable career. And in Bill's mind, the reason was two-fold: Kids didn't know the job opportunities existed and they didn't know how exciting the work could be.

When Bill first started talking about his ideas, I couldn't understand where he was headed. He held a couple of meetings and a few AISC folks were involved. But even when I talked to them, I still couldn't make heads or tails of what Bill wanted to do.

Even six months ago, when Bill really laid out his plans, I was still skeptical. But after visiting with him at this year's NASCC: The Steel Conference, I think I finally understand. And frankly, I'm impressed.

Bill is creating a virtual world that demonstrates every aspect of the steel industry. Through the use of 3D cameras and fancy VR headsets, kids can be immersed in the world of steel. Shortly, they'll be able to walk through a steel mill, a fabrication shop, or a job site. (If you've never used a VR headset such as an Oculus Rift, it's hard to explain how immersive the technology is. At the Steel Conference, Bill had users put on a headset, enter an elevator, ride it to the top of a building, and then walk out on a plank. If you have a fear of heights, you couldn't do it; the environment is simply that realistic.)

If you have access to a VR headset (you can buy cheap one, like Google Cardboard, which will convert your cell phone into a VR headset, on Amazon for $6.99 or a really good standalone product such as Oculus Go for around $200) and download various VR programs. Industry Lift is working with an app called Present 4D (you can find it at both the Apple App store or Google Play). If you want to get an early taste for what Bill is working on (it's not the full immersive experience but an intermediate step), use the portal code **fzb-fte** and download the Steel Conference files.

And if you want to find out more about Industry Lift, they're in the process of creating a website at industrylift.org. Visit and immerse yourself in Bill's dream.

Scott Melnick
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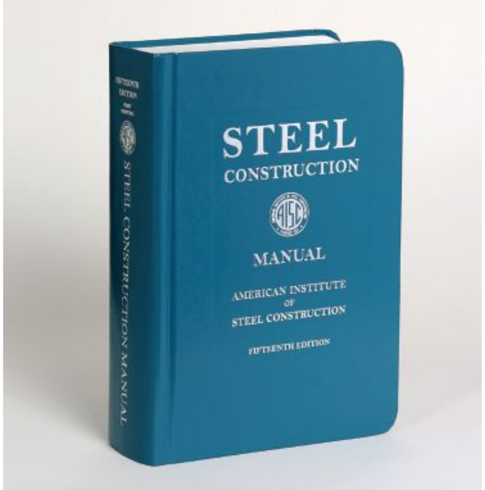

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steel interchange

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

Not Using Prequalified Material per AWS D1.1

I am specifying material that is not prequalified per AWS D1.1 Table 3.1. Am I specifying something that can be achieved?

What you have described is achievable. That said, I would not simply list the unusual material and leave it to the fabricator's estimators to catch the fact that it is not prequalified per AWS D1.1. You will likely receive better and more consistent bids if you highlight this fact in the bid documents.

Specifying material that is not prequalified for welding may tend to increase the cost of fabrication. In my experience, there will be some fabricators who simply will not bid a project where welders need to be qualified for new materials. This will reduce the number of bidders and potentially increase the costs. There is some time, effort, and cost associated with the qualification process, and this will likely be reflected in the bids. By highlighting the non-prequalified material, you may also discover that some fabricators are already qualified in this material.

Larry S. Muir, PE

Adequate Job-site Storage Space

How does one determine what would be considered "adequate storage space" for unloading structural steel on the job site?

This is addressed in Section 7.2 of the AISC *Code of Standard Practice for Steel Buildings and Bridges* (ANSI/AISC 303) which states: "The owner's designated representative for construction shall provide and maintain the following for the fabricator and the erector... (c) Adequate storage space, when the structure does not occupy the full available job site, to enable the fabricator and the erector to operate at maximum practical speed…. Otherwise, the owner's designated representative for construction shall inform the fabricator and the erector of the actual job-site conditions and/or special delivery requirements prior to bidding." This is also addressed in OSHA 1926 Subpart R – Steel Erection, which states, in 1926.752(c)(2): "A firm, properly graded, drained area, readily accessible to the work with adequate space for the safe storage of materials and the safe operation of the erector's equipment."

Of course, site conditions vary. There have been projects where steel must be erected directly from trucks. As indicated above, this sort of arrangement is unusual and the general contractor must notify the fabricator and the erector of such job-site conditions prior to bidding.

Based on the AISC *Code* and OSHA, you should be provided "adequate storage space… to enable… [operation] at maximum practical speed" unless you were notified otherwise.

Larry S. Muir, PE

Bending HSS Shapes

We are looking to curve hollow structural section (HSS) members on an upcoming project. Can you provide me with the minimum bend radii of HSS shapes?

No. Rigid guidelines on minimum bending radii are not available because they are dependent on several variables including:

- Axis of curvature
- Cross-sectional shape of the member
- Bending method used by the bender-roller
- The equipment limitations of the bender-roller
- Level of acceptable cross-sectional distortion
- Level of acceptable cold-working of the material

These limitations should be discussed with the bender-roller providing the service. You can search for AISC member bender-roller companies at **www.aisc.org/benders**.

In addition, AISC Design Guide 33: *Curved Member Design* provides some guidance on bending limits in Chapter 3. (You can also learn more about curved steel in the April 2019 article "Bending Basics," available at **www.modernsteel.com**.) But again, an accurate minimum radius for a specific condition can be provided only by the bender-roller providing the service.

Jonathan Tavarez, PE

NDT Requirements for CJP Welds

The CJP welds on a project were inspected by the quality assurance inspector (QAI) during welding. Is nondestructive testing (NDT) of the CJP welds necessary?

Yes—if NDT is required per Section N5.5b of the AISC *Specification for Structural Steel Buildings* (ANSI/AISC 360). Even if the CJP weld is witnessed by the QAI, NDT will still need to be performed when required. In accordance with *Specification* Section N6, NDT of welds completed in an approved fabricator's shop is permitted to be performed by that fabricator when approved by the authority having jurisdiction (AHJ). It is generally recommended to size welds for the actual demand and not based on the strength of the joined parts. Fillet welds do not require NDT. In cases where a fillet weld would suffice, the use of CJP groove welds increases the cost of fabrication and erection due to several factors, including additional inspection and the logistics associated with the additional inspection.

Larry S. Muir, PE

steel interchange

Jonathan Tavarez is a staff engineer with AISC's Steel Solutions Center. **Bo Dowswell**, principal with ARC International, LLC, and **Larry Muir** are both consultants to AISC.

Clearances for Slotted HSS Braces

For slotted HSS braces, we typically provide a clearance of 1 in. to 2 in. beyond the edge of the gusset plate. Is there a limit on how much clearance can be provided?

There is no limit on the amount of clearance that can be provided. Slots are typically fabricated with a 1-in. minimum clearance beyond the edge of the gusset plate. Because a 1-in. clearance is often inadequate for the required erection clearance, many fabricators prefer to use a clearance of 2 in. However, there are cases where the 2-in. clearance will not be sufficient for the brace to be maneuvered into its final position. Therefore, the slot length should be carefully evaluated by the detailer. Thornton and Fortney, in the third quarter 2012 *Engineering Journal* article "Satisfying Inelastic Rotation Requirements for In-Plane Critical Axis Brace Buckling for High Seismic Design," noted that the required clearance dimension could be as high as 6 in. Because the HSS wall is an unstiffened element over the non-welded portion of the slot length, it is more susceptible to local buckling than the other segments of the member. Therefore, especially for seismic applications, the slot length should be limited to a reasonable distance.

Bo Dowswell, PE, PhD

Fit-up of Bearing Stiffeners

Is there a general fabrication procedure for bearing stiffeners?

No. Note that if the stiffeners serve as reinforcement of a member, it is typically more economical to upsize the member and avoid the use of stiffeners altogether.

The AISC *Specification* and AWS D1.1 provide fit-up tolerances that must be satisfied but do not define a fabrication procedure. Milling and/or grinding may be used. In some cases, I suspect the application of heat is also used to satisfy the fit-up tolerances.

Given the difficulty of achieving the proper fit-up, many fabricators will opt to use bigger welds sized to transfer the full compressive load and neglecting the bearing strength altogether.

Larry S. Muir, PE

Wrapping Welds for Braces in an SCBF System

Is it possible to meet the brace effective net area requirements in Section F2.5b.(c) of the AISC *Seismic Provisions for Structural Steel Buildings* (ANSI/AISC 341) without having to provide reinforcement on the braces?

Yes. Section F2.5b.(c) states: "The brace effective net area shall not be less than the brace gross area. Where reinforcement on braces is used, the following requirements shall apply…" The phrase "Where reinforcement on braces is used" indicates that reinforcing is not always required. This permits the use of a detail such as the one mentioned in Commentary Section F2.5b., which states: "Braces with two continuous welds to the gusset wrapped around its edge (instead of the more typical detail with four welds stopping short of the gusset edge) performed adequately in the tests by Cheng. However, this practice may be difficult to implement in field conditions; it also creates a potential stress riser that may lead to crack initiation."

Until recently wrapping of welds was prohibited in AWS D1.1. However, this has been changed. The other hurdle involves the calculation of the effective net area. Shear lag factors, U, are provided in *Specification* Table D3.1. Case 5 includes conditions where $U = 1.0$ for round HSS. There is no similar case in Case 6 for rectangular HSS. Therefore, the detail can only be used with round HSS.

Wrapping the welds as described in the Commentary would seem to be an option to avoid the use of reinforcement for round HSS braces. You would have to weigh the cost savings of eliminating the reinforcing versus the issues related to wrapping the weld.

Larry S. Muir, PE

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steel quiz

This month's Steel Quiz is all about bolted connections and references the 2016 AISC *Specification for Structural Steel Buildings* (ANSI/AISC 360) and 2014 *RCSC Specification for Structural Joints Using High-Strength Bolts*, both available at **www.aisc.org/specifications**.

1 When designing a single-plate shear connection, the maximum plate thickness (or beam web thickness) is limited to half the bolt diameter plus $\frac{1}{16}$ in. in some cases. Is this a design requirement? What is the reasoning behind this limitation?

2 **True or False:** ASTM A325 and A490 structural bolts no longer exist.

3 Explain why bolt tensile strength is based on nominal unthreaded body area rather than net tensile area.

4 **True or False:** Mean slip coefficients differing from Class A or B are prohibited for use in slip-critical joints.

5 **True or False:** When calculating the effective net area for the flange-plated tension connection found in Figure 1, a shear lag factor *U* need not be less than the ratio of the gross area of the two flanges to the member gross area.

6 **True or False:** The nominal standard hole diameter has been revised in the AISC *Specification* to be $\frac{1}{8}$ in. larger than all bolt diameters.

7 **True or False:** A minimum bolt spacing of three times the diameter is required by the AISC *Specification*.

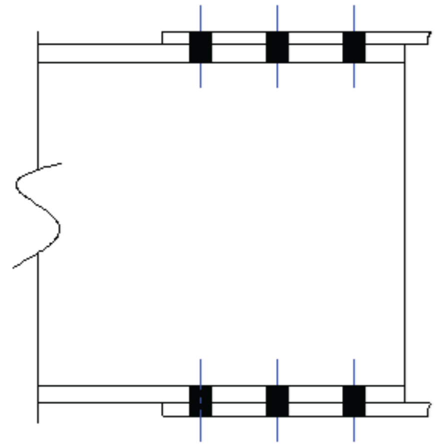

Fig. 1.

TURN TO PAGE 14 FOR THE ANSWERS

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—Charlie D. Pug

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1 This limitation is found in the AISC *Steel Construction Manual* (**www.aisc.org/manual**) and thus is not a requirement. Single-plate shear connections tend to be rotationally stiff relative to other beam end connection types. This plate thickness limitation allows bolt bearing to occur (either in the plate or beam web) before bolt shear. Bolt plowing into the plate or connecting beam web allows the beam to rotate, justifying the assumption of a simple connection as defined by Section B3.4a of the *Specification*.

2 **Trick question!** The A325 and A490 classifications are now included as grades of the ASTM F3125 structural bolt standard. F3125 consolidates the A325, A490, F1852, and F2280 bolt designations. So the proper designation would be ASTM F3125 Grade A325, A490, F1852, or F2280. Note that this change was implemented in 2015 after the latest *RCSC Specification* was published, but was integrated in the 2016 AISC *Specification*.

3 The Commentary in Section J3.6 states: "The nominal tensile strength values in Table J3.2 were obtained from the equation $F_{nt} = 0.75F_u$." It also states: "The factor of 0.75 included in this equation accounts for the approximate ratio of the effective tension area of the threaded portion of the bolt to the area of the shank of the bolt for common sizes. Thus, A_b is defined as the area of the unthreaded body of the bolt, and the value given for F_{nt} in Table J3.2 is calculated as $0.75F_u$."

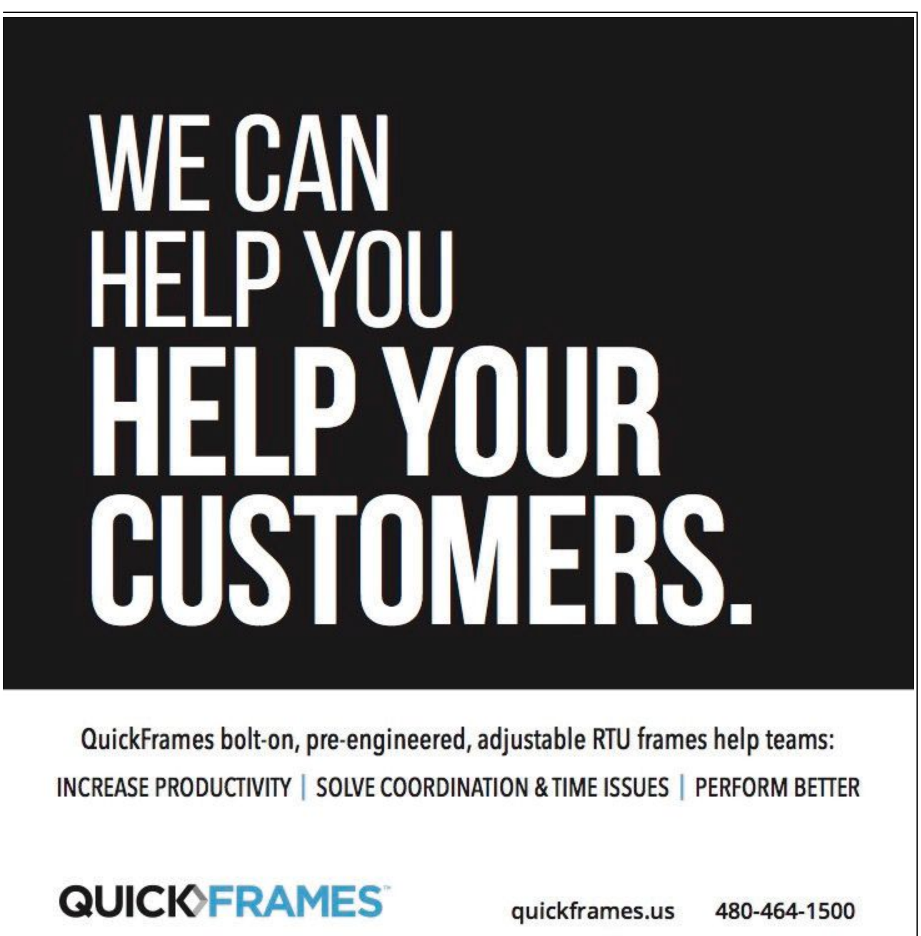
4 **False.** Section 3.2.2 of the *RCSC Specification* states that when approved by the engineer of record, coatings that provide a mean slip coefficient differing from Class A or B are permitted when (1) the mean slip coefficient is established by testing in accordance with the requirements in Appendix A and (2) the design slip resistance is determined in accordance with Section 5.4 using this coefficient but limiting it to 0.5.

5 **True.** Section D3 states: "For open cross sections such as W, M, S, C, or HP shapes, WTs, STs, and single and double angles, the shear lag factor, *U*, need not be less than the ratio of the gross area of the connected element(s) to the member gross area." Case 7 would apply to this condition with three fasteners in line in the direction of loading. Note that Case 2 would also apply to this condition, and the larger value of the three is permitted to be used.

6 **False.** The nominal standard hole diameter is $\frac{1}{8}$ in. larger than the nominal bolt diameter for bolts 1 in. and larger. The $\frac{1}{16}$-in. clearance is still applicable for bolts with diameters less than 1 in. The *Specification* Commentary provides the reason: "To accommodate manufacturing process tolerances and provide fit and rotation capacity proportional to the size of connections typically using large diameter bolts, the size of standard holes for bolts 1 in. in diameter and larger was increased to $\frac{1}{8}$ in. over the bolt diameter. The sizes of standard holes in S.I. units already provided sufficient tolerance and were not increased."

7 **False.** The three-times-the-diameter spacing is included as a recommendation in a User Note in Section J3.3. User Notes are non-mandatory and are intended to provide concise and practical guidance in the application of the *Specification* provisions. The *Specification* requires a minimum spacing of $2\frac{2}{3}$ times the nominal diameter.

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



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steelwise

PREQUALIFIED UPDATE

BY MARGARET MATTHEW, PE

A new supplement to AISC 358 includes three prequalified connection updates: a revision, an expansion, and a whole new connection.

Margaret Matthew (**matthew@aisc.org**) is a senior engineer with AISC and editor of *Engineering Journal*.

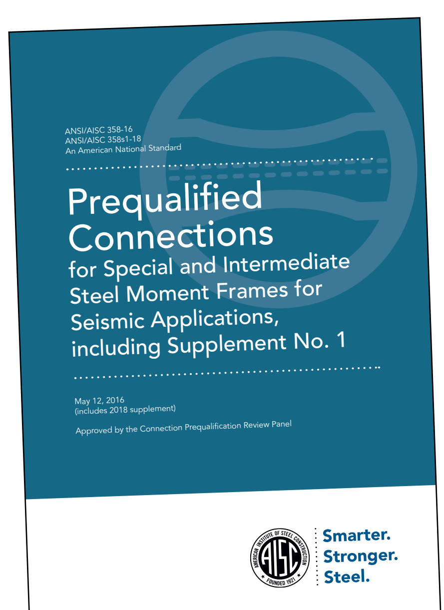
ENGINEERS HAVE LONG RELIED ON ANSI/AISC 358 *Prequalified Connections for Special and Intermediate Steel Moment Frames for Seismic Applications*—the most recent version of which was released in 2016—for guidance on seismic design.

AISC 358 specifies the design, detailing, fabrication, and quality criteria for connections that are prequalified in accordance with the AISC *Seismic Provisions for Structural Steel Buildings* (AISC/ANSI 341) for use with special moment frames (SMF) and intermediate moment frames (IMF). In short, AISC 341 contains performance and testing requirements that have been shown to produce robust moment connections, and AISC 358 details connections that meet those criteria.

And AISC has just released Supplement No. 1, which includes three significant updates to AISC 358-16:

- Chapter 10, which covers the ConXtech ConXL moment connection, has been revised to address a manufacturing safety issue.
- The SidePlate moment connection in Chapter 11 has been expanded to include hollow structural section (HSS) columns and permit bolted connections.
- A new prequalified moment connection has been added, the SlottedWeb Moment Connection, covered in Chapter 14.

Following is a brief summary of these updates.



ConXtech ConXL Moment Connection

The update to the ConXtech ConXL moment connection in Chapter 10 includes revisions to four figures. The revision to Figure 10.7 corrected an oversight in ANSI/AISC 358-16, and slight revisions to dimensions were made to Figures 10.11, 10.12, and 10.19 as the result of a manufacturing safety issue.

SidePlate Moment Connection

The SidePlate moment connection in Chapter 11 is now prequalified for both field-welded and field-bolted connections. Both types are fully restrained connections. The field-bolted option, the SidePlate PLUS connection, does not require any welding in the field and comes in two configurations, referred to as configuration A (standard) and configuration B (narrow); see Figure 1.

The beam in the field-bolted connection can be a rolled wide-flange, HSS, or built-up I-shaped section conforming to the requirements of Section 2.3. Rolled and built-up wide-flange beam weight is limited to 400 lb per ft.

Columns can be any of the rolled shapes, built-up box, HSS, or built-up I-shaped sections meeting the requirements of Section 2.3. Rolled shape column depth is limited to a W44, and the built-up box column width can be as much as 33 in. There is no limit on column weight per foot. Note that the testing program included two full-scale specimens with HSS columns subjected to a substantial axial load to investigate the impact of the larger width-to thickness ratio on the HSS columns; more details are given in the Commentary to Chapter 11.

In addition, bolts must be pretensioned high-strength bolts conforming to ASTM F3125 Grade A490/A490M or F2280. Bolt diameter is limited to 1½ in. maximum, and bolt holes can either be standard or oversized depending on the connecting parts and can be made by drilling, thermally cutting with grinding, or sub-punching and reaming.

The extension of the side plates beyond the face of the column is limited to 0.65d to 1.7d, where d is the depth of the beam. Beam-to-column connections need to satisfy the limitation b_{bf} + 1.0 in. ≤ b_{cf} where b_{bf} and b_{cf} represent the beam and column flange width, respectively, as shown in Figure 2.

SlottedWeb Moment Connection

The new SlottedWeb moment connection in Chapter 14, an addition to the publication, is a proprietary connection developed by Seismic Structural Design Associates, Inc. (SSDA) and features slots in the web of the beam that are parallel and

Fig. 1.

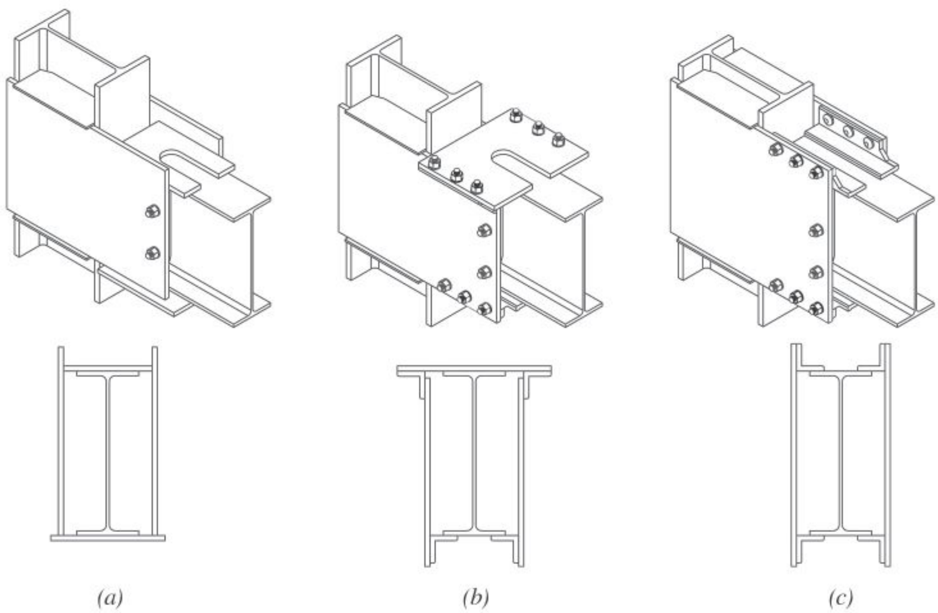


Fig. 11.3. SidePlate field-welded and field-bolted connection comparison: (a) typical field-welded connection; (b) typical field-bolted standard connection (configuration A); and (c) typical field-bolted narrow connection (configuration B).

Fig. 2.

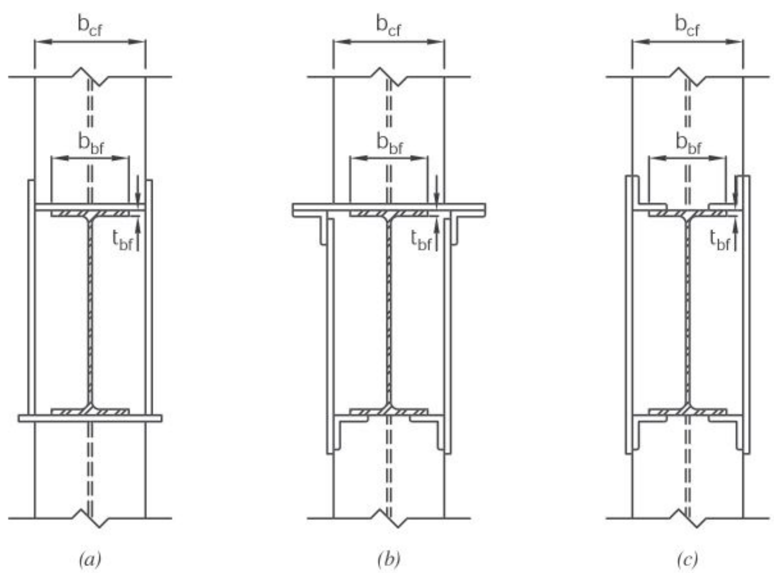


Fig. 11.9. Geometric compatibility (a) field-welded connection; (b) field-bolted standard connection (configuration A); and (c) field-bolted narrow connection (configuration B).

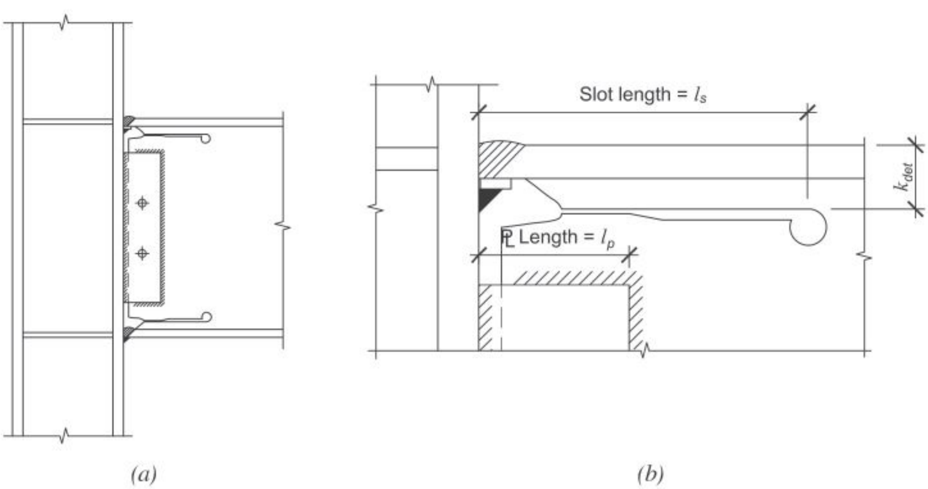


Fig. 3. *Fig. 14.1. SW Beam-to-column moment connection.*

adjacent to each flange, as shown in Figure 3. Inelastic behavior is expected to occur through yielding and buckling of the beam flanges in the region of the slot, accompanied by yielding of the web in the region near the end of the shear plate.

The SlottedWeb connection is prequalified for use in SMFs and is a fully restrained connection. Beam sections permitted are either rolled wide-flanges or built-up I-shaped members conforming to the requirements of Section 2.3, with a beam depth limited to W36 and beam weight limited to 400 lb per ft.

Columns in the connection can be any of the rolled shapes or built-up sections as permitted in Section 2.3. Rolled shape column depth is limited to W36 while built-up box columns are limited to a depth of 24 in. There is no limit on the weight per foot of columns.

In the SlottedWeb connection, the beam web is welded to the column flange and also to the shear plate to give the web both shear and moment capacity. The beam flanges are welded to the column flanges using complete-joint-penetration (CJP) groove welds, which are considered demand-critical. By separating the beam flanges from the web in the region of the connection to the column, essentially all the beam shear is resisted by the beam web.

The narrow slot width over the shear plate is designed to inhibit beam flange buckling near the face of the column and force the major beam flange buckling to occur over the wider part of the slot. The beam web slots are made using thermal cutting or milling of the slots and holes or by drilling the holes. These slots, which start at the end of the beam and are typically one-third to one-half the nominal beam depth in length, are terminated at a round stress relief hole, and punched holes are not permitted. The slot widths and tolerances are shown in Figure 4.

Fig. 4.

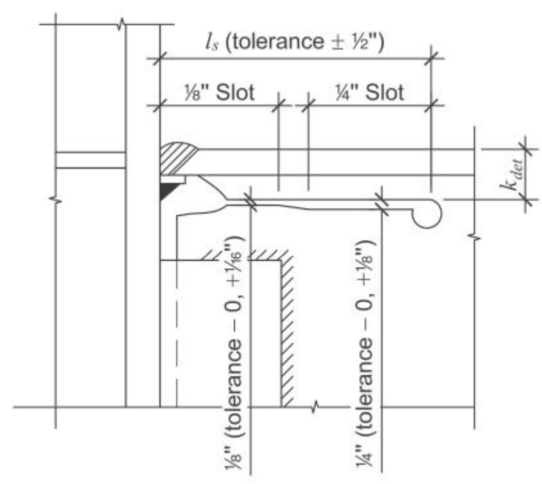


Fig. 14.3. Slot widths and tolerances.

More Choices

Prequalified moment connections are structural steel moment connection configurations and details that have been reviewed by AISC's Connection Prequalification Review Panel (CPRP) and incorporated into the AISC 358 standard. The criteria for prequalification are spelled out in AISC's *Seismic Provisions* (both publications are available as free downloads at **www.aisc.org/specifications**).

The first version of AISC 358 was released in 2005, with subsequent major releases in 2010 and 2016. Supplements are typically issued in between versions as new prequalified connections are added to the standard, as is the case with Supplement No. 1. With the addition of the SlottedWeb connection in Chapter 14, AISC 358 now contains ten prequalified moment connections, providing designers with many choices for beam-to-column moment connections in SMFs and IMFs. As only a few brief highlights have been previewed here, you should peruse the supplement for complete details and requirements for these and other prequalified connections. And remember that designers are not restricted to only using prequalified connections; AISC 341 also permits connections in SMFs and IMFs that have been qualified by testing but have not necessarily been prequalified.

And looking ahead, the second supplement to AISC 358-16 is currently under development and is expected to be published next year. It will expand the prequalification scope of the SidePlate and Simpson Strong-Tie connections. ■

business issues

A LETTER TO/FROM THE NEW ENGINEER

BY AARON KOSTRZEWA

Advice from a new engineer to those entering the workforce—and also those that mentor, manage, and work with them.

Aaron Kostrzewa (akostrzewatc@gmail.com) is a junior structural engineer with Permasteelisa North America.

EVERY COLLEGE STUDENT wonders where their education will take them in life the first day they sit down in class their freshman year.

As their final year rolls around, the next step is even more daunting. For those pursuing a career immediately after college, there is much uncertainty. I was lucky enough to begin my career at a company that did an excellent job assisting me in the transition from college to the professional world. My intent here is to remind experienced engineers what it's like to be a new engineer and to remind new engineers that the struggles they are experiencing aren't unique to them, but rather something that most of us have gone through.

Good First Impression

I graduated with honors from Michigan Technological University with a degree in civil engineering. When it came to the job search, I was able to whittle my choices down to two companies in the Twin Cities. Both proposed similar offers and the work seemed engaging. What gave me clarity on my decision was the interview process with Permasteelisa North America (PNA), a structural façade contractor. The interview lasted six hours, and multiple candidates were applying at the same time. Half the engineers from the structural department conducted several hours of interviews before taking us all to lunch. Having the time to interact with my potential coworkers in a casual setting allowed me to feel comfortable, despite the professional environment. To finish the day, I took a technical exam and said farewell. Fortunately, I received offers from PNA and another company. I chose PNA because of the friendliness of the employees and the sense of community I felt. I knew I would fit in well.

Once I started work, a senior engineer was assigned to be my trainer; he also was my desk mate, so it was easy to ask him questions. He was busy with his own tasks but gave me his full attention without hesitation when I needed assistance. We fostered a strong balance between my independence and his teaching. Week by week, I learned more about the technical specifics of curtain walls while building my confidence as a designer. My first month concluded and I submitted a complete building submittal for a dummy project that new hires have to complete. I had to perform this project on my own with minimal guidance, and then review my process with my mentor (the AISC *Steel Construction Manual* was one of the publications I spent the most time analyzing). Some of the calculations took me a few days to complete, which was a struggle but ultimately beneficial. Like many companies, the engineers had built templates to accelerate the common calculations that were performed. While it is challenging to perform an unfamiliar calculation on my own, taking the time to do calculations from the ground up was nothing but a good thing. It's all too easy for a young engineer to rely solely on design aids or templates, but the ability to completely understand a condition and analyze it properly is an invaluable skill.

Next came the real thing. I was confident in the material I learned from the classes I took, but college could have never prepared me for the unique industry of curtain wall engineering. After one month of training, my first project assignment

> Perhaps the best way to make someone feel respected in an office is to genuinely ask what they think about some matter.

was a 61-story building in San Francisco. Some of the challenges I encountered were the real-life considerations of construction tolerances, seismic loading, and constructability—topics I had minimal experience with at school. Fortunately, the training I was provided with in my new job couldn't have helped me more. The engineers in my department were and are instrumental in my professional development. I strongly encourage managers and experienced engineers to implement thorough onboarding procedures like extensive training so new hires can promptly adapt to their fledgling careers.

Never Stop Asking Questions

During my time at my company, I've been continually encouraged to ask questions, take the time to fully understand the calculations I'm performing, and challenge the long-standing conventions used by the company. Early on, when I wanted to advance as fast as I could, my lack of experience could only take me so far. Even when I put forth my best work, I would often forget to do the most basic checks. Yet over time, those mistakes were minimized. Further, beyond trying to do the engineering work, I had to also implement formatting required in a design firm. Despite the ups and downs of being a new hire, I was making exponential progress day by day. I'd encourage fellow young engineers not to be dismayed if they experience the same sentiments and to take a minute each day to reflect on how far they've come since their first day. Likewise, for the mentoring engineer, patience and a teacher's spirit will provide the tools for the new engineer to succeed.

Perhaps the best way to make someone feel respected in an office is to genuinely ask what they think about some matter. When someone asks their superior for their opinion, it is expected, yet it still shows respect. When a superior asks a subordinate for their opinion, it shows teamwork and the utmost respect for the individual. This is the norm at PNA, and I feel respected whether I have a good idea or make a novice mistake.

Energized to Improve

Six months into the job, I headed up an important submittal for a project I was working on. What seemed like a manageable workload quickly escalated as deadlines got changed, designs were updated, and my novice mistakes caused the need for correction after correction. The experience led to exponential learning on my end; it was easy for me to feel like my skills were outpacing my experience. I made good progress on my calculations but would often forget my fundamental skills of drawing a free body diagram, validating assumptions, and practicing good problem-solving management skills.

The week before the submittal, everything felt like it was coming together smoothly. I was handling my workload well and providing the necessary information to the appropriate parties. However, up until this point, all calculations and assumptions were run solely past the lead engineer on the project, not the professional engineer who would be stamping the design documents. The professional engineer would have to agree with all assumptions and calculation procedures. Just two days before the submittal was slated to be sent out, the professional engineer finally had time to look at the calculations and drawings. He pointed out many concerns he had and additional structural checks that needed to be verified. It wasn't the kind of news I wanted to hear just as I was getting ready for the weekend. Yet, in structural engineering, one can never justify finalizing work when there is excess uncertainty in the analysis. So, we got to work doing everything we could to meet our deadline.

In the end, the submittal was completed and sent out to the reviewing consultant. It was a relief to have completed this work. However, reflecting on how poorly the process went was painful for me, especially since I had felt so confident in the week leading up to the due date. Yet I wasn't dismayed by the underwhelming performance. Rather, I was energized to improve myself! The hardest part about the entire process was that I had given it my all to ensure I was meeting deadlines. However, in engineering, complete work isn't always enough; it has to be correct as well. The root problem ended up being poor communication among the engineers involved in the submittal. Since we have a team mentality in the office, we all took the blame for how much of a letdown the submittal was. Fortunately, the workload slowed down afterward so I was able to reflect on the process with my superiors. This time proved to be extremely beneficial to solidify my learning on the topics that I had spent so many hours studying. It also gave me the chance to review the incorrect assumptions and mistakes with the lead engineers. I learned one lesson for certain: All of the time the lead engineers spent mentoring me will pay off many times over as I know I've gained exponentially more knowledge from reflecting on the experience. Let this story be a reminder to the experienced engineer to be gracious to the novice and to take the time to teach, explain, and reflect. After all, don't you wish someone had done that for you (and if they did, don't you feel fortunate)?

Make the Time to Take the Time

One of my favorite sayings is "Your schedule allows for the tasks at hand"—in other words, you will never have time to do the things you don't have to do unless you make time. And as it turns out, everything else can typically still be completed. So even though you may not feel like you have time to instruct the new engineer,

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make the time. To the new hire, don't be dismayed by your poor results in the beginning. No one is expecting you to be perfect right out of college, but they do expect to learn as much as you can and try your best. Maintaining a positive attitude will only serve you well in the long run. It's all too easy to come out of college thinking you know all there is to know about engineering and that you'll be the CEO by next year. The reality is that no one wants to work with a know-it-all right out of college.

The new engineer has to realize that "A" student work is no longer adequate; 100% accuracy is what is required while also being professional, timely, and precise. I thought I was off to a good start by having a successful college career, then I realized that everything reset when I became a practicing engineer. The classroom taught me that engineering problems always had one solution, but my professional experience thus far has shown me that the solution to a problem is only as good as how well you are able to interpret and apply the results. There are no perfect solutions in the real world. All the codes and textbooks structural engineers are responsible for knowing are based on assumptions about materials, probability and statistics, mechanics, and so on. These assumptions need to be fully understood and consistently reevaluated to determine their implications. Another favorite quote of mine is the "definition" of an engineer: "Someone who does precision guesswork based on unreliable data provided by those of questionable knowledge." Such a quote is humbling to read when you get caught up wondering if you should take your results from two or three decimal places.

Support Systems Matter

The process of transitioning from a university setting to the workforce is daunting. There are no more professors to grade or Internet searches to find the exact answer to a problem. Yet in my time as a practicing engineer in training, I've grown more than I ever imagined. There's definitely still a struggle, but the concerns I had about starting a new job were alleviated when I realized the people I worked with care about my professional advancement and personal wellbeing.

A final word of advice is to make connections in the workplace. Step outside of the bubble that is engineering awkwardness and make friends at work. Hang out with them after hours so that this early stage in your professional life can be more than just satisfying work and a paycheck. The most reassuring comment I got from my boss before I started work was that he hired me for a reason. He knew what I was capable of. Remember: You were hired for a reason and you are capable of great things—especially if you make an effort to learn and grow as much as possible. ■

WHAT DO A GLASS BOX with a massive laptop for a roof, a restaurant building encased in a mind-bending red grid, and a trio of giant foliage-filled bubbles all have in common? Not only are they all iconic steel-framed structures, but they're also winners of 2019 AISC IDEAS^2 Awards!

Why "IDEAS^2?" Because the program recognizes **I**nnovative **D**esign in **E**ngineering and **A**rchitecture with **S**tructural **S**teel. Awards for each winning project are presented to the project team members involved in the design and construction of the structural framing system—including the architect, structural engineer of record, general contractor, owner, and AISC member fabricator, erector, detailer, and bender-roller.

New buildings, as well as renovation, retrofit and expansion projects, are eligible, and entries must meet the following criteria:

- A significant portion of the framing system must be wide-flange or hollow structural sections (HSS)
- Projects must have been completed between January 1, 2016 and December 31, 2018
- Projects must be located in North America
- Previous AISC IDEAS^2 award-winning projects are not eligible

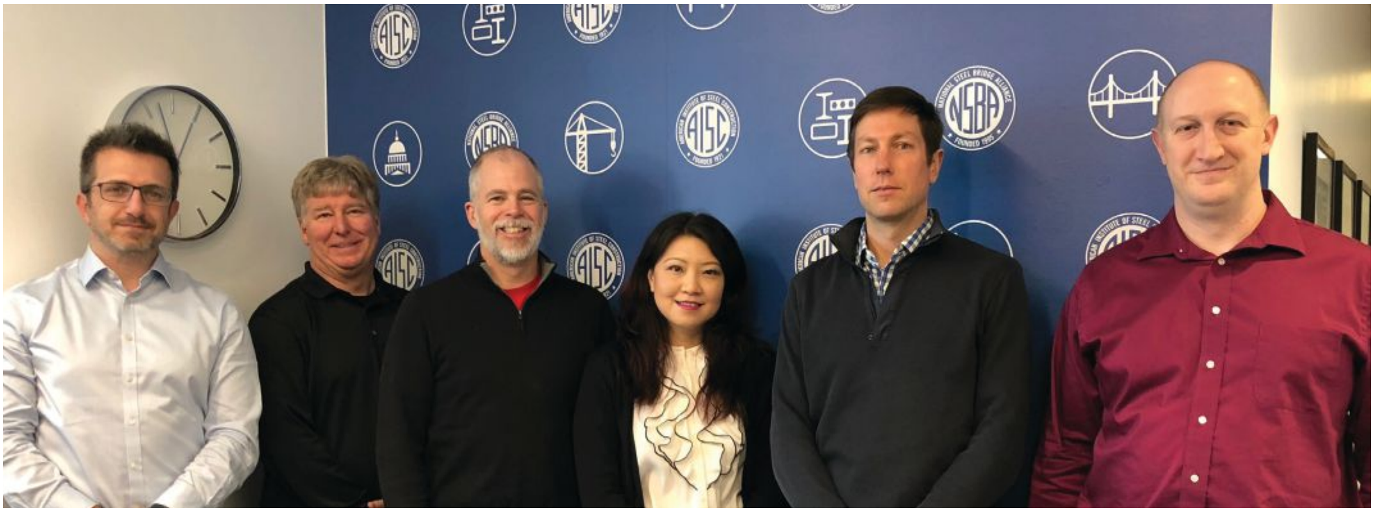
This year's six judges considered each project's use of structural steel from both an architectural and structural engineering perspective, with an emphasis on:

- Creative solutions to the project's program requirements
- Applications of innovative design approaches in areas such as connections, gravity systems, lateral load-resisting systems, fire protection, and blast protection
- The aesthetic impact of the project, particularly in the coordination of structural steel elements with other materials
- Innovative uses of architecturally exposed structural steel (AESS)
- Advancements in the use of structural steel, either technically or in the architectural expression
- The use of innovative design and construction methods such as 3D building models, interoperability, early integration of steel fabricators, alternative methods of project delivery, and sustainability considerations

A panel of design and construction industry professionals judged the entries in three categories, according to their constructed value in U.S. dollars:

- Under $15 million
- $15 million to $75 million
- Over $75 million

National and Merit honors were awarded in all three categories and two Presidential Awards of Excellence were also given: one for Erection Engineering to Facilitate Adaptive Reuse and one for Excellence in Fabrication. A Scultpure/Installation/Non-building Structure winner was also chosen.



The 2019 judging panel, from left to right: Filo Castore, Craig Wehrmann, Matt Johnson, Maggie Kwan, Eric Wills and Devin Huber.

Filo Castore, AIA
Division Vice President – Director of Client Engagement, Buildings, and Infrastructure – Americas, JACOBS

Filo has more than 20 years of experience in shaping many of Houston's buildings, businesses, and communities through stakeholder collaboration and innovative design. As a leader in the growth of national architectural practices in Houston, Filo establishes relationships with clients, developers, architects, engineers, and contractors. Filo has been involved with the American Institute of Architects (AIA) at the local, regional, and national levels for more than 15 years. His AIA involvement extends to local and national leadership positions including AIA Houston board member and AIA National Chair of the Committee on the Environment (AIA COTE). He currently serves as vice president of communications for the Texas Society of Architects (TxA) and he is on the board of directors of CoreNet Houston and Houston Tomorrow. Filo earned his BA in architecture from the University of Houston.

Devin Huber, PE, PhD
Director of Research, AISC

Devin joined AISC as the director of research this past fall. Prior to that that, he spent ten years in the private sector working for ExxonMobil (eight years) and Barton Malow (two years) where he worked in a variety of roles in the civil and structural disciplines within the oil and gas/industrial sector. Devin attended Michigan State University, where he received a BS in civil engineering, and then attended Purdue University, where he received his PhD in civil engineering.

Matt Johnson
Principal, Simpson Gumpertz & Heger

Matt is the Structural Engineering Division head for Simpson Gumpertz & Heger's Chicago office, leading a diverse team that designs, investigates and rehabilitates buildings and infrastructure, structurally complex building enclosures, and nontraditional structures. He brings a multidisciplinary approach to design and construction, combining a passion for innovation with a focus on value and client results. Matt and the Chicago office continually seek opportunities to implement industry-leading computational methods, pushing the traditional boundaries of the architecture, engineering, and construction industry. He is a graduate of Ohio University, where he received both his BS and MS.

Maggie Kwan
Senior Vice President Civil and Structural Engineering, AECOM Tishman

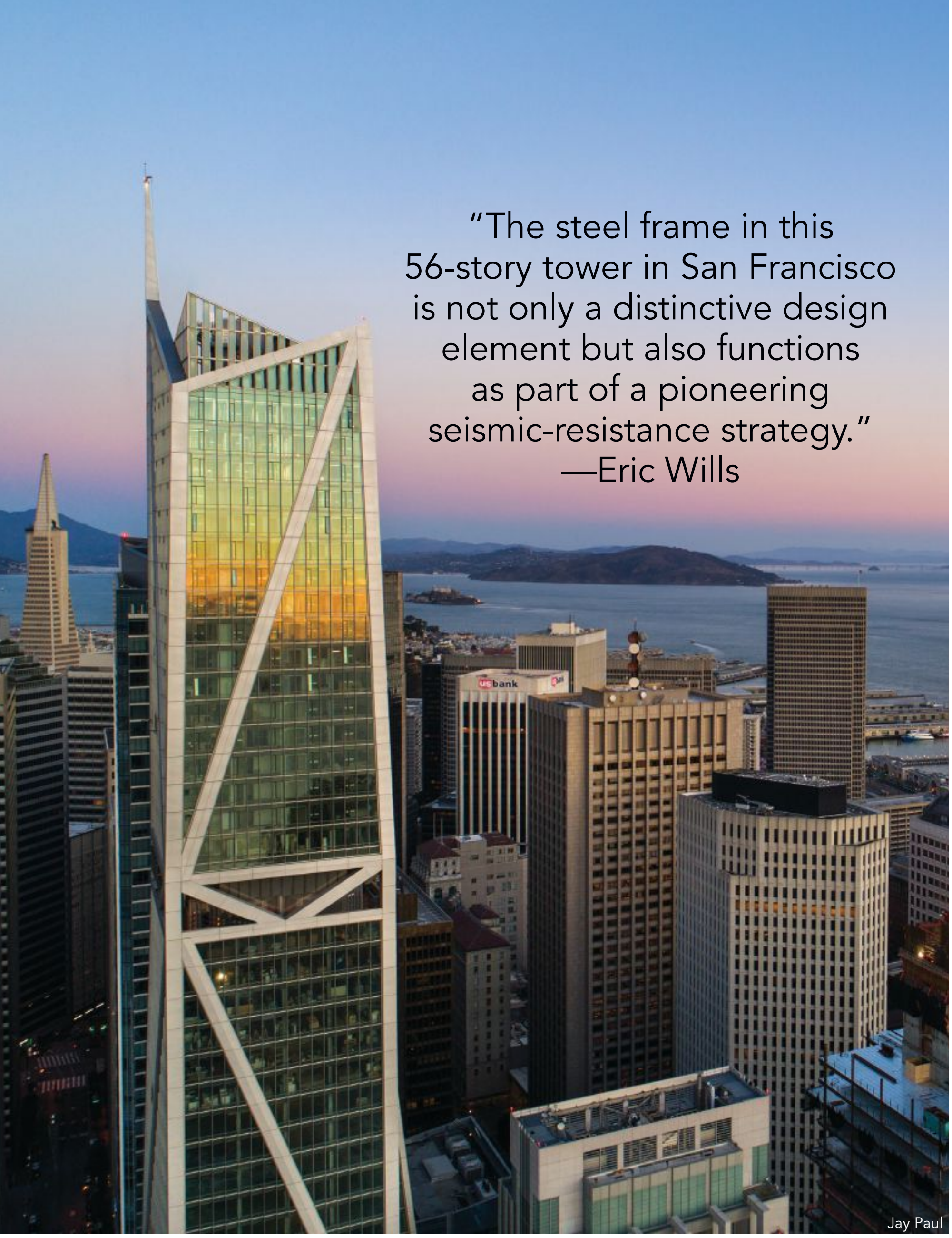
Maggie has 23 years of experience in the construction industry, including more than 20 years with AECOM Tishman. Her areas of responsibility include client relations, preconstruction analysis, purchasing, estimating, scheduling, budgeting, construction, design-assist programs, steel detailing programs, and special third-party construction engineering and equipment programs. Maggie is an acting second vice president on the executive board for Concrete Industry Board of New York and a member of the Structural Engineering Association of New York, Professional Women in Construction (PWC), and the American Society of Civil Engineers. Additionally, she sits on the New York City Department of Buildings Construction and Demolition Safety Code Revision Advisory Committee. She earned her BS in civil and environmental engineering, with a minor in architectural engineering, from Clarkson University.

Craig Wehrmann
General Manager, Gateway Company of Missouri

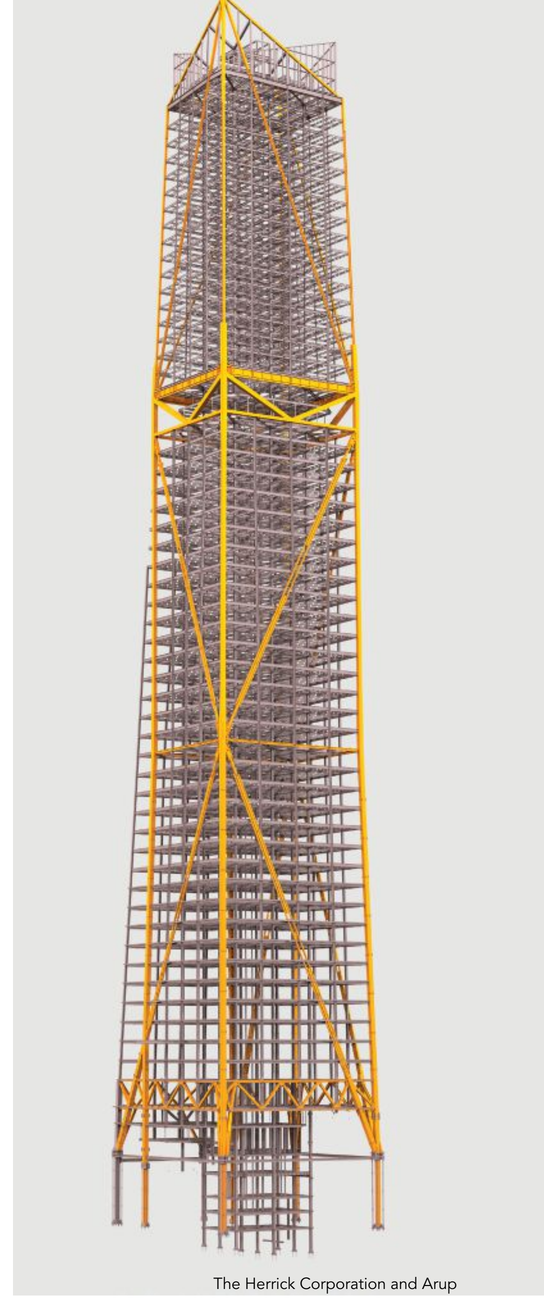
Craig currently serves as general manager of AISC member and certified fabricator The Gateway Company of Missouri, LLC, where he specializes in the fabrication of complicated structures. Craig is a board member of the BiState Fabricator Association as well as a representative for BiState on the Fabricator Connection Committee. He is a graduate of Washington University's civil engineering program.

Eric Wills
Senior Editor, *Architect* Magazine

Eric Wills has 20 years of journalism experience and currently serves as senior editor at *Architect* magazine in Washington, D.C. Eric has been with *Architect* for eight years, where he edits feature stories and criticism. Eric's work has been nominated for and/or won numerous awards, including a National Magazine Award. Previously, Eric served as an editor at *Preservation* magazine, where his writing was cited in Best American Essays.



Jay Paul



The Herrick Corporation and Arup

NATIONAL AWARD Greater than $75 Million

181 Fremont, San Francisco

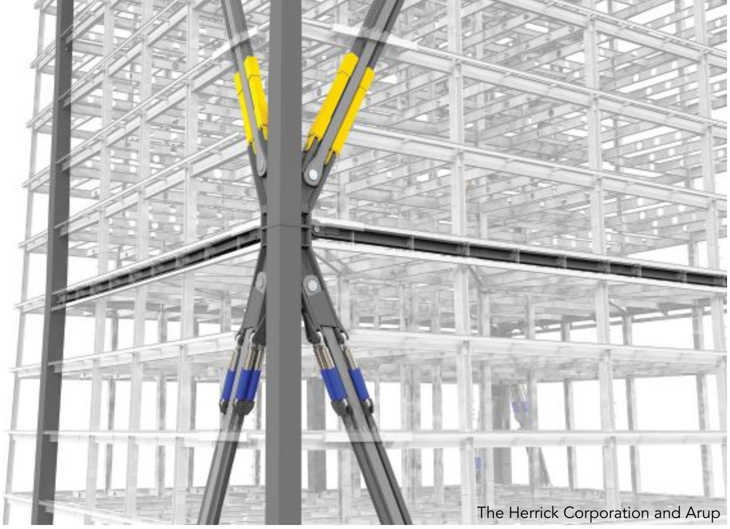
181 FREMONT TOWER adds a striking new focal point to the San Francisco skyline.

The tallest mixed-use building in the city, the 802-ft-tall tower is also arguably the most resilient tall building on the West Coast and is designed to remain essentially elastic and achieve immediate reoccupancy following a 475-year earthquake. After recognizing that the seismic performance objectives in current building codes did not align with its goals, the building's owner chose to pursue an innovative design to deliver "beyond code" seismic resilience.

The architectural design of the building, which has achieved LEED Platinum, features a faceted, tapering façade that highlights an integrated mega-frame structural system. A visual recess between the commercial and residential levels provides a residential amenity floor with a double-height open terrace made possible by 8-ft-deep perimeter transfer girders. Similarly, transfer trusses between levels 2 and 3 carry load to corner mega-columns to create a column-free ground-floor lobby.

The design team selected a steel-only lateral force-resisting system (LFRS) instead of a more traditional concrete core to preserve floor space inside the slender tower. At the commercial levels, damped mega-braces span 200 ft to 250 ft between mega-nodes, with perimeter moment frames to carry lateral load from each floor up or down to nodal levels. The damped mega-brace design facilitated a reduction in building stiffness to decrease seismic demands while also improving occupant comfort for wind-induced vibration. This eliminated the need for a tuned mass damper at the roof, which freed the penthouse level for a luxury condominium. The design saved approximately 3,000 tons of steel from the framing package, a roughly 25% reduction in weight compared to a more conventional steel system.

The mega-brace design uses an innovative combination of established technologies. Built-up box primary braces connect to mega-nodes at both ends, with parallel secondary braces on opposite sides, and the stiff secondary braces drive deformation into vis-



The Herrick Corporation and Arup

Jay Paul

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cous dampers at one end of each secondary brace. The combined system performs like a giant shock absorber to limit building drift and reduce floor accelerations. Buckling-restrained braces (BRBs) in both the primary and secondary brace frames act as fuses in the event of maximum considered earthquake (MCE) shaking, preventing damage to the dampers and mega-columns. The largest of these BRBs is composed of four units with a total 5,000-kip capacity. The mega-braces are restrained laterally at each floor to prevent buckling but slide freely along their length against polytetrafluoroethylene (PTFE) bearing pads attached to a steel mount cast in each floor slab.

Corner mega-columns carry load into the foundation through steel cruciform sections embedded in pilasters within the basement walls. The mega-columns are designed to remain elastic in a MCE, employing built-up box columns as large as 36 in. by 36 in. using 5-in.-thick plate. To limit tension demands in the tower and foundation, the mega-columns are designed to uplift slightly at their base and are anchored at ground level by 3-in.-diameter 150-ksi pretensioned rods extending to the bottom of the five-story basement foundation. The anchor force is tuned to prevent uplift in wind or smaller earthquake events but also to allow approximately 1 in. of uplift in a MCE.

For more on this project, see "Braced for the Future" in the April 2016 issue, available at ***www.modernsteel.com****.*

Owner
Jay Paul Company, San Francisco

General Contractor
Level 10 Construction, San Francisco

Architect
Heller Manus Architects, San Francisco

Structural Engineer
Arup, San Francisco

Steel Fabricator and Erector
The Herrick Corporation, Stockton, Calif. AISC CERTIFIED FABRICATOR & ERECTOR

NATIONAL AWARD Greater than $75 Million

Superior Court of California, San Diego

SAN DIEGO'S NEW Central Courthouse brings boldness and beauty to the realm of civic buildings.

The 700,000-sq.-ft, 25-story structure, which consolidates three previous courthouses into one facility, addresses the security needs of a modern court building while also presenting an uplifting and welcoming image. The new building connects with the adjacent Hall of Justice at the third level via a steel pedestrian bridge, which required complicated planning, engineering, and logistics as it passes over the catenary lines for the San Diego Metro line below and is designed so as not to load the Hall of Justice. The 85-ft cantilever span with an 80-ft back-span is supported in the center by a single tapered column that fits within the sidewalk.

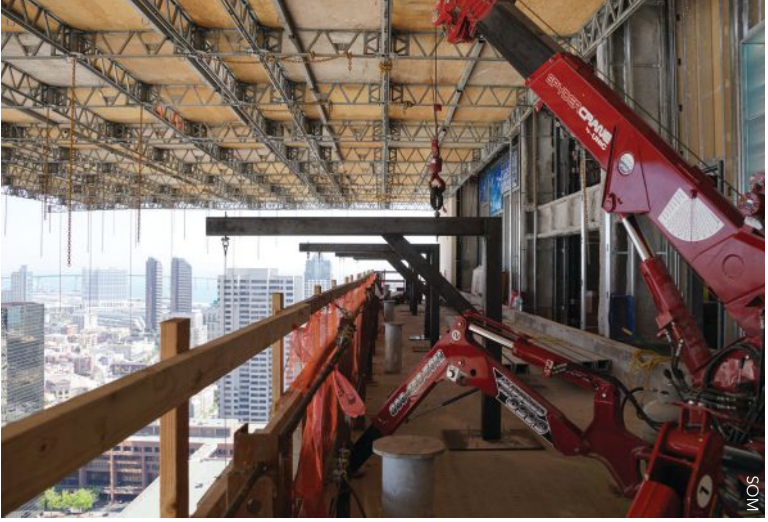
All high-volume activities are located on the first four levels of the building, including security, arraignment courts, business offices, the jury assembly hall, the cafeteria, and the bridge. These program elements are linked in section by a naturally lit, three-story great hall, which incorporates a cascading escalator linking the first four levels of the building. To allow for future flexibility, the design of the family, probate, and civil courts is identical to the criminal trial courts except for the jury box. The business offices in the podium have large, open floor plans to allow for future programmatic evolution. The unique geometry of the trusses at level 4 enabled a flexible layout at the podium levels. These trusses support not only the level 5 frame above but also a hanging cafeteria below.

Above the four-story podium, the remainder of the building is organized in plan, using two pairs of courtrooms with a holding core in between. The courthouse features a distinctive soffit at its crown, clad with shaped aluminum panel sections, that shades the building during morning hours and also captures and dynamically reflects southern and western light back onto the underside of the structure's surface.

The building consists of a steel-framed superstructure with two-way lateral special moment frames (SMFs) using ductile

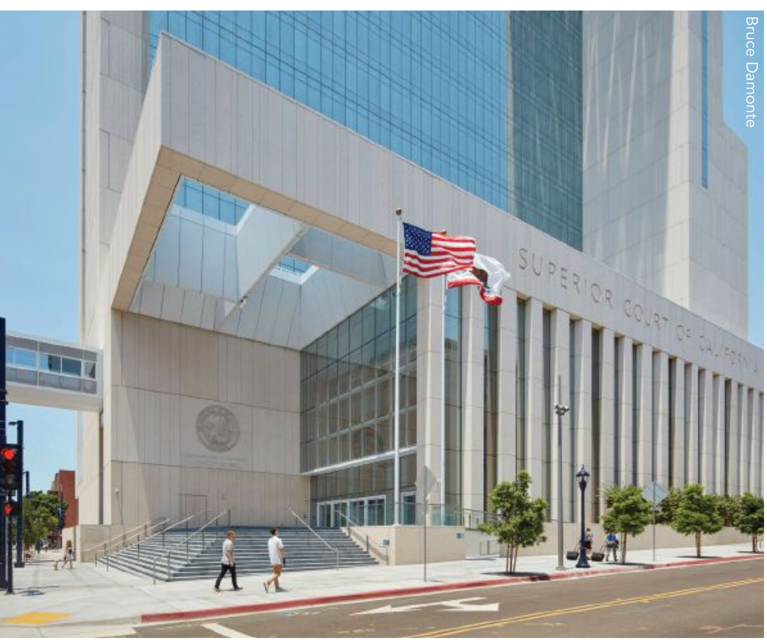
Bruce Damonte

SOM



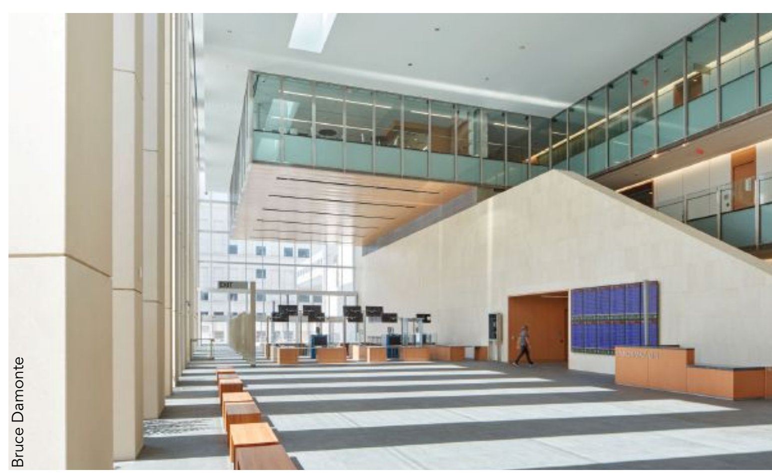
SOM

"Raising the bar on courthouse design by adopting an innovative and contextual resolution to complex and demanding program requirements!" —Filo Castore



Bruce Damonte

Bruce Damonte



Bruce Damonte

reduced beam section (RBS) connections with wide-flange cruciform and built-up box column sections. The steel moment resisting frames incorporate 106 nonlinear viscous damping devices (VDDs) in the slender transverse direction to provide a distributed supplemental energy-dissipating damping system over the height of the structure. This system reduces seismically induced building story shears, story drifts, floor accelerations, and inelastic rotational demands on moment frame beam-column joints. The VDDs were also effective in providing damping for wind loads.

During early design development phases, seismic risk and life-cycle assessments were completed to assist with selecting alternative structural systems, leading to cost-effective "enhanced" seismic performance objectives. Simplified nonlinear capacity (pushover) curves in each principle direction were used to estimate economic losses, resulting in expected mean annual loss, cost-benefit ratios, and return on capital investment based on a 25-year life-cycle over the baseline SMF "normal" or code-minimum performance objective.

Owner
Judicial Council of California Administrative Office of the Courts, San Francisco

General Contractor
Rudolph and Sletten, Inc., San Carlos, Calif.

Architect and Structural Engineer
Skidmore, Owings & Merrill, LLP, Chicago

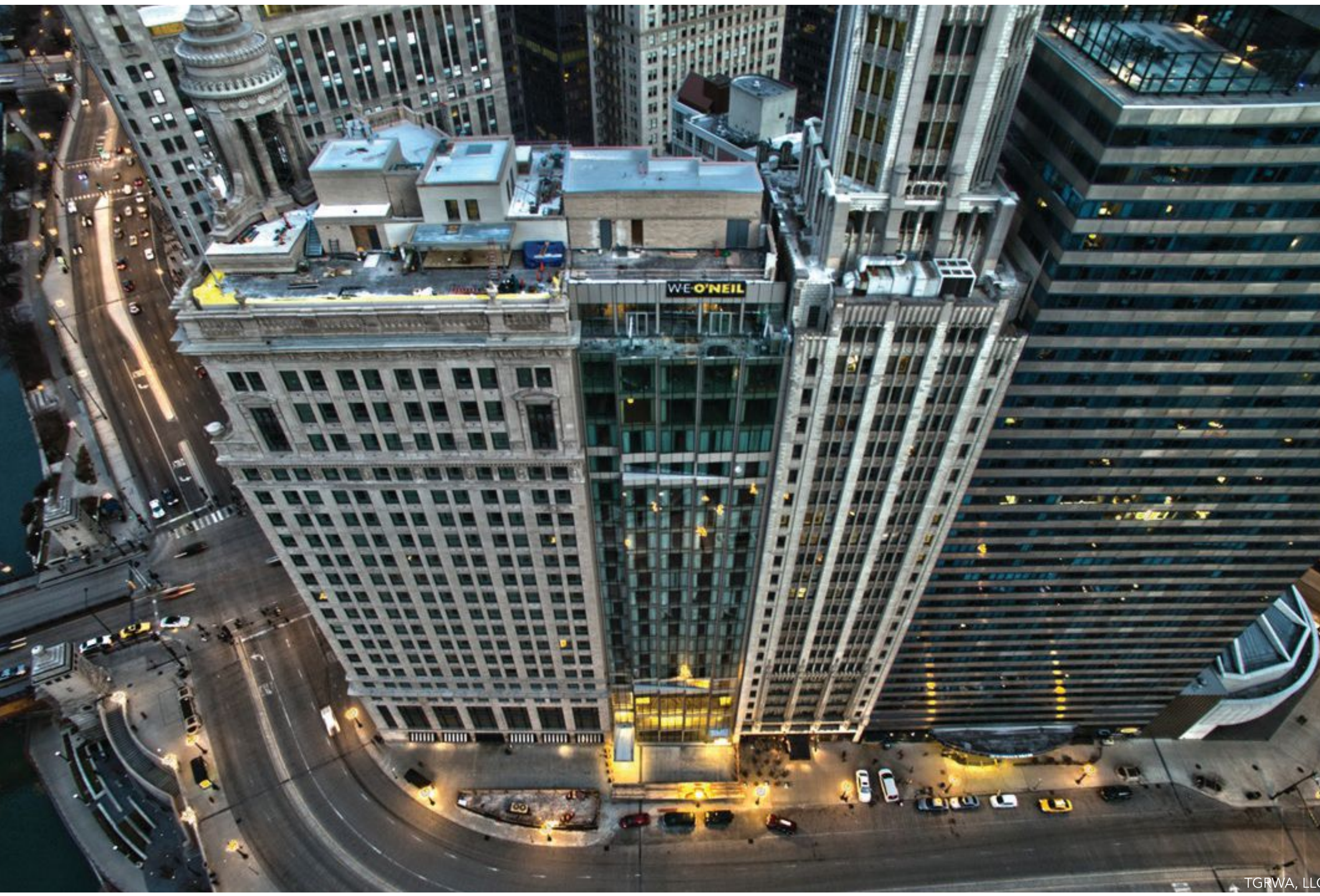
Steel Team

Fabricator and Erector
The Herrick Corporation, Stockton, Calif.

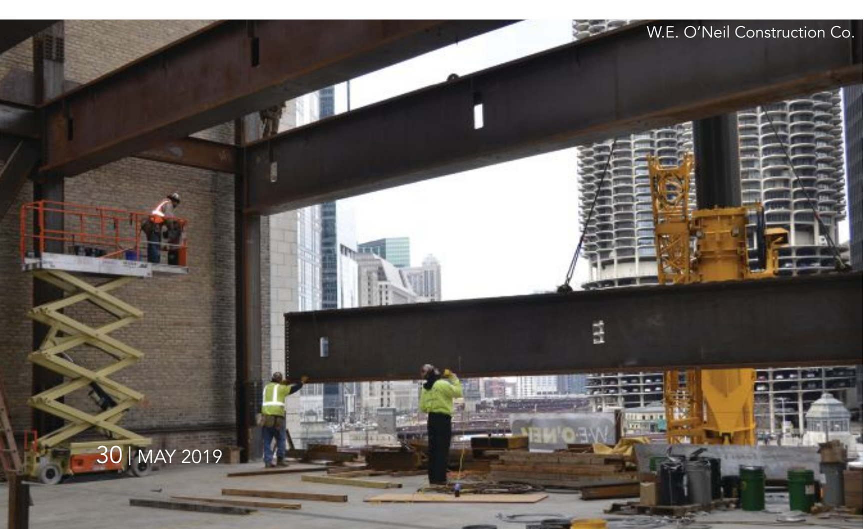
Detailer
SNC Engineering, Inc., Norwalk, Calif.


Goettsch Partners, Inc.


TGRWA, LLC



TGRWA, LLC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—Filo Castore

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TGRWA, LLC

MERIT AWARD Greater than $75 Million

LondonHouse Hotel, Chicago

THE LONDONHOUSE HOTEL sits at a prominent intersection on the edge of Chicago's Loop central business district, overlooking the "Magnificent Mile" of Michigan Avenue and the Chicago River.

The project involved the renovation of the landmarked 280,000-sq.-ft London Accident and Guarantee Building, originally constructed in 1923, into a modern hotel, as well as the addition of a new, attached 22-story, 70,000-sq.-ft steel framed tower, which filled in the only open parcel on the block (its footprint previously served as a street-level parking lot).

One structural challenge was to create a column-free open space to accommodate a large ballroom in the new addition. Structural engineer TGRWA's solution was to design double-webbed plate girders framing to a single wide-flange column, which provided the maximum amount of usable space possible without the need to eliminate prime hotel rooms. Site constraints limited the lifting capacity of the contractor's crane, requiring the plate girders to be divided into two lighter sections in parallel, which were connected together in the field.

When it came to the lateral system for the new addition, TGRWA developed a hybrid system to address wind loading, which is the controlling lateral criteria per the local building code. For north-south wind loading, concentric steel braced frames were implemented, which provided drift performance to accommodate concerns of differential lateral movement of the joint between the new and existing buildings. For the east-west wind loading, the building's program did not allow for a conventional lateral system of shear walls or steel braced frames due to the new addition not having an elevator core or consistent stair tower. A such, the solution was to use the steel moment frame lateral system of the existing building to withstand east-west wind loading.

Because the new steel structure was laterally tied to the existing building's lateral system in one direction only, while allowing slip in the perpendicular direction, a specially designed expansion joint was required between the new and existing structures. The load was transferred from the diaphragm of the new structure to the existing structure using a specialized drag strut system. At several locations on each floor, new steel members extended from the new structure to the existing structure and distributed the load through the existing clay tile diaphragm. This innovative hybrid approach greatly reduced the required material and labor costs of an independent lateral system and worked with the unique building program. This hybrid lateral system provided a tremendous cost savings to the owner since the construction time, labor, and steel required were greatly reduced compared to a conventional moment frame solution. It also provided the architect with much more usable space in the structure compared to a braced frame solution.

For more on this project, see "Tight Quarters" in the October 2017 issue, available at ***www.modernsteel.com.***

Owner
Oxford Capital Group, LLC, Chicago

General Contractor
W.E. O'Neil Construction Co., Chicago

Architect
Goettsch Partners, Inc., Chicago

Structural Engineer
TGRWA, LLC, Chicago

NATIONAL AWARD $15 Million to $75 Million

Spectrum IV, San Diego

SPECTRUM IV, the new base of operations in San Diego for Vertex Pharmaceutical, Inc., is inspired by the company's own work.

The V-shaped building form, with people, light, and air passing through a common lobby, is reminiscent of the trachea and the lobes of the lungs, targets for the cystic fibrosis medications Vertex develops. The facility, which is anticipating LEED Gold certification, consists of 170,000 sq. ft of state-of-the-art laboratory, office and collaboration spaces above two levels of underground parking in the heart of San Diego's Torrey Pines life-science cluster.

For the structural frame, the integrated design team selected a stepped-grade steel framing concept comprised of two rectangular wings interconnected by a high-volume through lobby. The wings are at right angles to each other, resulting in the V-shaped design. The building's seismic force-resisting system consists of steel special moment-resisting frames in each of the wings, arranged orthogonally to reduce building torsion and allow for predicable ductile behavior during future earthquakes.

Structural steel was the ideal material for both the superstructure and the subterranean parking structure. It was able to efficiently span uninterrupted interior lab spaces and provide the adaptability and flexibility required to meet Vertex's current and future needs with relatively shallow shapes, thus allowing the project team to fit three stories of program within the local height limit. Further, at strategic locations the steel floor framing was carefully tuned to minimize the dynamic-loading-induced floor vibrations that are incompatible with the high-powered optical lab equipment used to develop the company's pharmaceuticals.

The integrated architecture and structural engineering team collaborated closely on several prominent building features designed to showcase the versatility and beauty of exposed structural steel. One of these is a steel halo that rings the perimeter of the building, cantilevering up to 25 ft from the façade. At the rear of the building, the halo is supported by sloping bundles of tilted weathering tube steel columns that pass through an expansive outdoor deck.

Taking advantage of the area's moderate climate, the design blurs the boundaries between indoors and outdoors, while maintaining the controlled laboratory environment within. Thanks to the inherent openness of steel-framed buildings, 100% of the occupied interior space is able to take advantage of natural light, and the solar heat gain into the building is minimized by perforated steel sunshades, building overhangs, and vertical and horizontal louvers.

For more on this project, see "A Living, Breathing Building" in the February 2019 issue, available at ***www.modernsteel.com****.*

Owner
Alexandria Real Estate Equities, San Diego

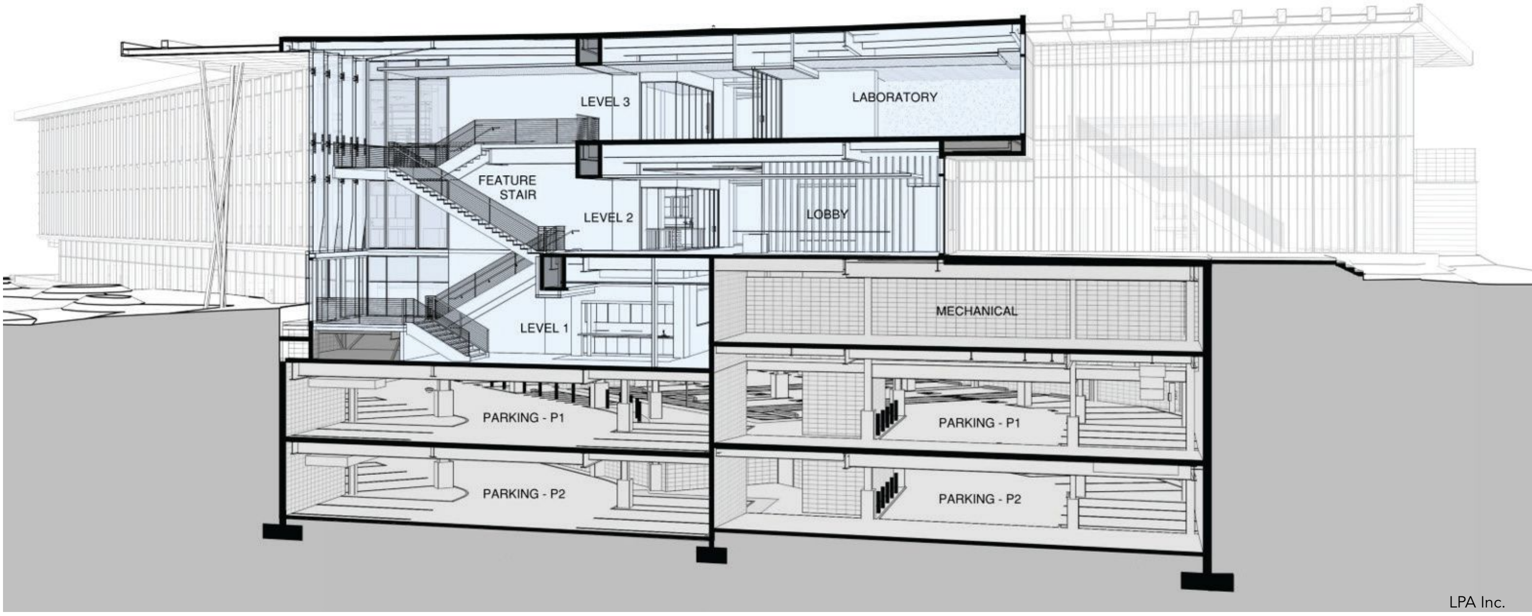
General Contractor
BNBuilders, San Diego

Architect and Structural Engineer
LPA, Inc., Irvine, Calif.

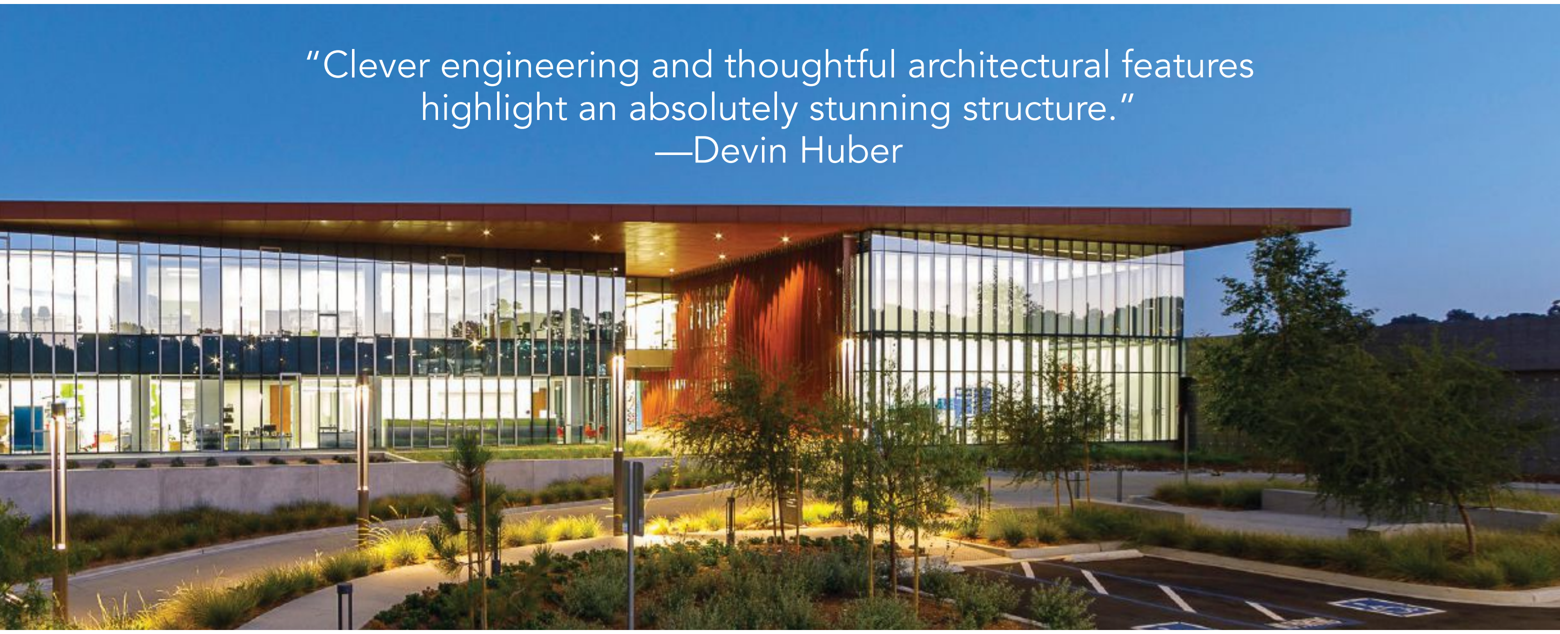
Steel Team

Fabricator and Erector
Rossin Steel, Inc., San Diego

Detailer
Dowco Consultants, Ltd., Langley, B.C., Canada



LPA Inc.



Costea Photography Inc.

Aislinn Weidele

Jeff Ervin

Aislinn Weidele

NATIONAL AWARD $15 Million to $75 Million

UT Austin Engineering Education and Research Building Atrium, Austin, Texas

WHEN PLANNING WAS UNDERWAY for the University of Texas at Austin's Engineering Education and Research Center (EERC), Deans Greg Fenves and Sharon Wood, both structural engineers, made it clear from the start that engineering ingenuity should be on display throughout the building.

The new facility, part of UT's Cockrell School of Engineering, is comprised of two nine-story towers with research and teaching space, joined by a central atrium. It is in this steel-framed atrium where the most dynamic and exciting structural engineering is displayed.

Rather than performing structural feats as follies, the steel features work together as a symphony of exposed structural steel to accomplish four objectives: (1) publicly display the genius of the engineering community at work inside, (2) inspire users and visitors by celebrating the beauty of great engineering, (3) connect people physically and visibly to promote collaboration and interdisciplinary research, and (4) manage daylighting and heat gain.

Entering the atrium from the west, on the third floor, visitors are treated to the expanse of the grand foyer containing the connector bridge, V-column, and three-story spiral stair. The stair's treads cantilever out from a 48-in.-diameter central steel pipe made of ¾-in.-thick plate displaying pattern of diamonds that gradually elongate as they go up the pipe. Above that, the west bridge connects the two research wings at levels 5 through 8, with the upper shade canopy floating atop the space between the wings.

MGM National Harbor Casino Baltimore, MD

132 tons of steel rolled by Chicago Metal Rolled Products throughout the entire structure. The focal point of the casino includes an elliptical & domed skylight that required a box welded beam constructed from segments of elliptically rolled ¾" Grade 50 plate. The skylight ribs constructed of parabolic arching Hollow Structural Sections and Wide Flanged Beams take on a 3rd dimension, adding even more space to the interior entrance of the casino and doming the skylight.

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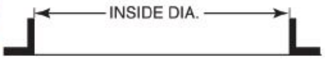
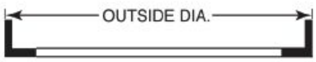


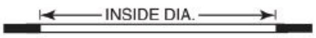
10" x 10" x 1" Angle

2 Angle Leg In



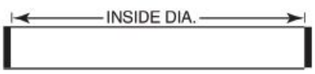
10" x 10" x 1" Angle

3 Flat Bar The Hard Way



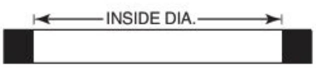
24" x 12" Flat

4 Flat Bar The Easy Way



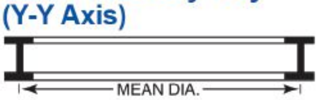
36" x 12" Flat

5 Square Bar



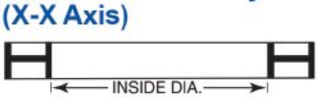
18" Square

6 Beam The Easy Way (Y-Y Axis)



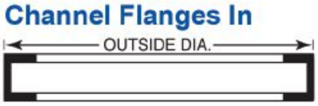
44" x 335#, 36" x 925#

7 Beam The Hard Way (X-X Axis)



44" x 285#

8 Channel Flanges In



All Sizes

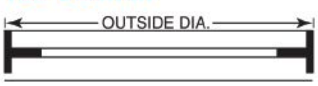
9 Channel Flanges Out

All Sizes

10 Channel The Hard Way (X-X Axis)

All Sizes

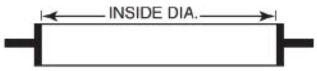
11 Tee Stem In



22" x 142 1/2# Tee

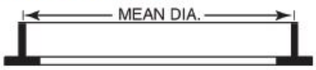
We bend ALL sizes up to:

12 Tee Stem Out



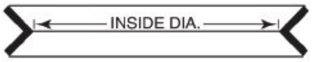
22" x 142 1/2# Tee

13 Tee Stem Up



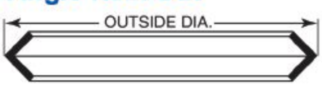
22" x 142 1/2# Tee

14 Angle Heel In



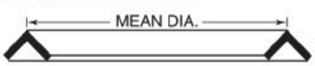
8" x 8" x 1" Angle

15 Angle Heel Out



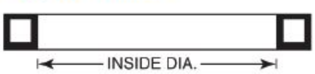
8" x 8" x 1" Angle

16 Angle Heel Up



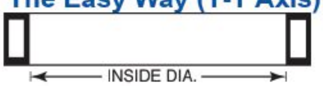
8" x 8"x1" Angle

17 Square Tube



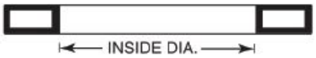
24" x 1/2" Tube

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



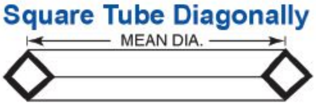
20" x 12" x 5/8" Tube

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



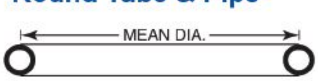
20" x 12" x 5/8" Tube

20 Square Tube Diagonally



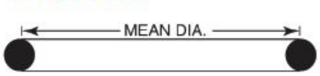
12" x 5/8" Square Tube

21 Round Tube & Pipe



24" Sched. 80 Pipe

22 Round Bar



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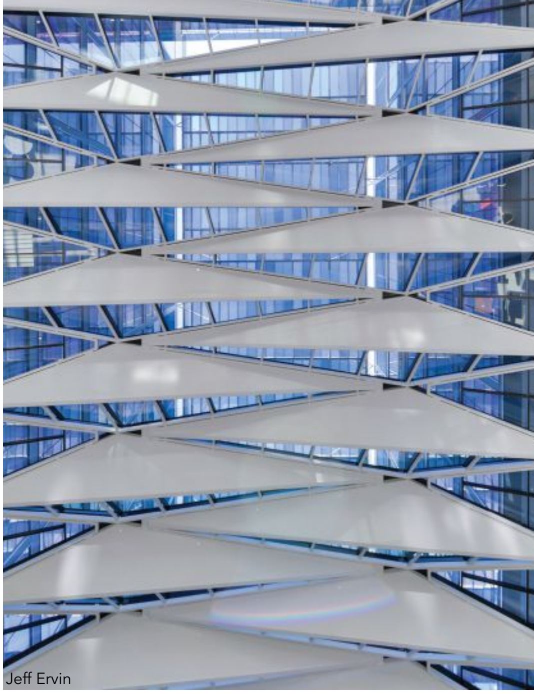

Jeff Ervin

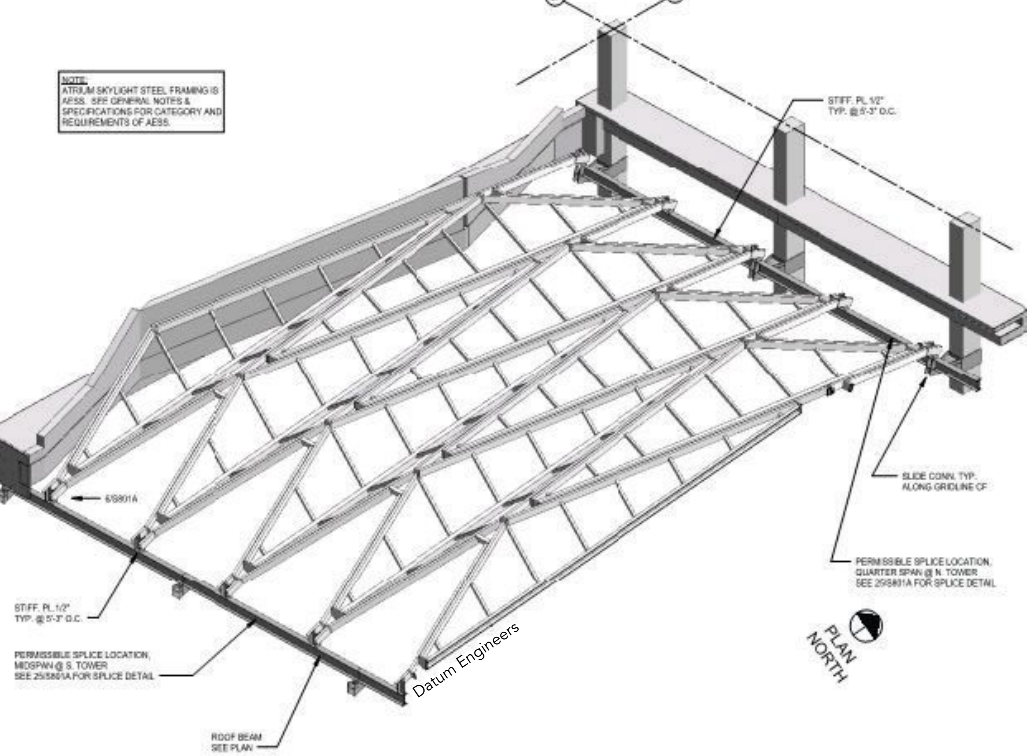

Kelly Thibodeaux

A faceted, pleated skylight roof spans 150 ft by 70 ft and the westward facets are filled with zinc panels to manage light and heat gain. The unique, complex geometry demanded an ingenious engineering approach as the alternating truss frames are interrupted 17 ft short by an opposing truss springing from the other side.

In response, structural engineer Datum devised a unique 3D "raft-truss" solution. Much like a wooden raft is built by lashing logs together, the alternating truss frames of the atrium roof are stitched together side-by-side to help each other finish the span on either end. Datum was also able to delete diagonal web members from the frames, creating a more elegant design. The trusses were detailed so the modular frames could be prefabricated, erected, and infilled with smaller "puzzle pieces," speeding erection and reducing cost. The roof was assembled at fabricator Patriot Erector's shop for practice, then broken down and shipped to the site for assembly.

The bowstring connector bridge was built with a twist—literally. The two bottom chords swoop in toward one another at midspan without touching. The twist is that the web members from each top chord connect across to the opposite bottom chord, creating a unique woven look. The bridge was detailed and fabricated with clean shop welds and erected in one piece. The built-up steel V-column, which supports a concrete ribbon stair, is comprised of two tapered steel plates, 1 in. by 8 in., joined together by 3-in. spacers, and expressive pin assemblies at the top and bottom.

The four-story west bridge connects the two towers, shades the atrium and is highlighted by an X-truss configuration. Two key details make this striking structural element stand out. First, the use of steel castings at the nodes provided an efficient way to build the trusses to stand out from the chords and the rest of the bridge, emphasizing the truss form. Second, the diagonals are not continu-

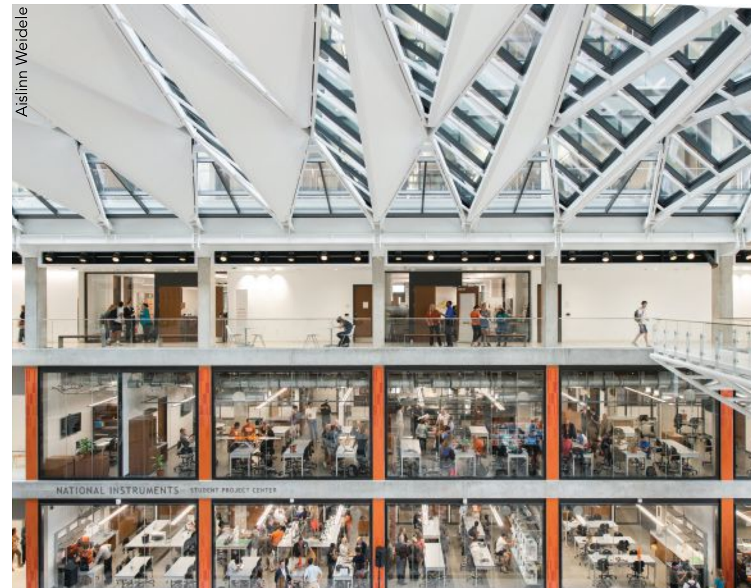


Datum Engineers


Aislinn Weidele


Jeremy Klahorst


Patriot Erectors



Aislinn Weidele

> "This project's central atrium, with its skylit roof, pedestrian bridge, and spiral staircase that winds around a plasma-cut column, is practically an ode to steel construction."
> —Eric Wills

ous between floors. Rather, they swoop in waves halfway above and below each floor, meeting in what appears to be a hinge in the middle. The "hinge," however, was designed and built (as a casting) to avoid buckling in compression and distribute the loads more evenly.

The upper canopy shades the atrium and towers. An iterative parametric model determined the optimal shading density to balance daylighting with heat gain, allowing the glazing of the towers facing the atrium to be completely transparent—crucial for providing visual connectivity across the atrium. The thin structure seems to float above the space between the towers, thanks to minimal attachments, and was designed to move vertically as the towers move independently.

The EERC has been a huge success in providing a collaborative, cross-disciplinary home for the Cockrell School, created opportunities for interdisciplinary research and been a boon to recruiting. The integration of structural steel elements to inspire, bring people together, and shade the building demonstrates that engineering can be beautiful as well as functional and sustainable.

Owner
University of Texas at Austin Cockrell School of Engineering, Austin, Texas

General Contractor
Hensel Phelps, Austin

Architects
Ennead Architects, New York
Jacobs, Fort Worth, Texas

Structural Engineer
Datum Gojer Engineers, Austin

Steel Team

Fabricator and Erector
Patriot Erectors, Dripping Springs, Texas (AISC Certified Fabricator & Erector)

Detailer
Tectonix Steel, Mesa, Ariz. (AISC Detailer)

MERIT AWARD $15 Million to $75 Million

Apple Michigan Avenue, Chicago

APPLE MICHIGAN AVENUE advertises its wares via the building itself.

The tech giant's new retail store, situated prominently along the Chicago River and North Michigan Avenue, appears as a light, open-span glass box—with a laptop for the roof.

Due to its versatility and strength, structural steel was at the center of each creative solution to the project's program requirements—particularly exemplified in the steel roof frame, the four columns, and the balcony framing.

The store features an extremely thin carbon-fiber-reinforced-polymer (CFRP) roof, resembling a MacBook, supported on a tightly integrated structural steel frame of built-up steel box sections approximately 24 in. square. Tapered structural steel plate "fins" cantilever to the glass line, from which point the CFRP ribs cantilever the remaining distance to the edge of the roof canopy. Together, the steel fins and the CFRP ribs cantilever 27 ft, 4 in. to the south, 24 ft, 3 in. to the north, and 30 ft, 4 in. to the east and west.

The four steel box columns—with drain pipes concealed inside—provide the entire lateral and vertical support for the roof. The two south columns are finished in stainless steel and are unbraced for the full height of the store, while the two north columns are clad in stone and support the roof, the cantilever mezzanine balcony, and a portion of the plaza.

A single, giant steel torsion box girder (nicknamed the "Miracle Girder") supports the south line of reactions from the plaza beams and simultaneously supports the cantilevered mezzanine balcony.

Nigel Young Foster + Partners

Foster + Partners

Nigel Young Foster + Partners

This element is a built-up steel box measuring 3 ft, 8 in. wide by 4 ft, 4 in. tall and weighing approximately 1,100 lb per ft. The girder simultaneously supports the steel plaza beams, forms the frame that stabilizes the north pair of columns, and supports the cantilevering mezzanine balcony.

The structural steel roof frame uses a combination of flexure and torsion to resist gravity, wind, and snow loads. Numerous optimization studies revealed torsion boxes as the most compact and efficient solution. The use of torsion as a primary structural action resulted in a unique and innovative solution that freed the ceiling space for other essential program elements. The torsional beams permitted the exceptionally tight structural depth to be achieved. Similarly, the Miracle Girder uses torsion significantly to support the entire cantilever balcony. The south two box columns are architecturally exposed structural steel (AESS), with welded stainless steel cladding plates that were milled and brushed while on the column, an innovative approach to AESS design.

The extensive use of torsion as a primary structural action was another innovation for structural steel design. Rather than eschew torsion, the team embraced its use—both in the steel roof frame and the Miracle Girder—for its efficiency and its compactness. It was postulated that torsion makes full use of the cross section, compared to alternative solutions.The dynamic response of the lightweight steel cantilevering mezzanine balcony was analyzed for the expectations of heavy pedestrian foot traffic. A shallow tuned mass damper, tucked inside the shallow balcony framing, was provided to improve the vibration response.

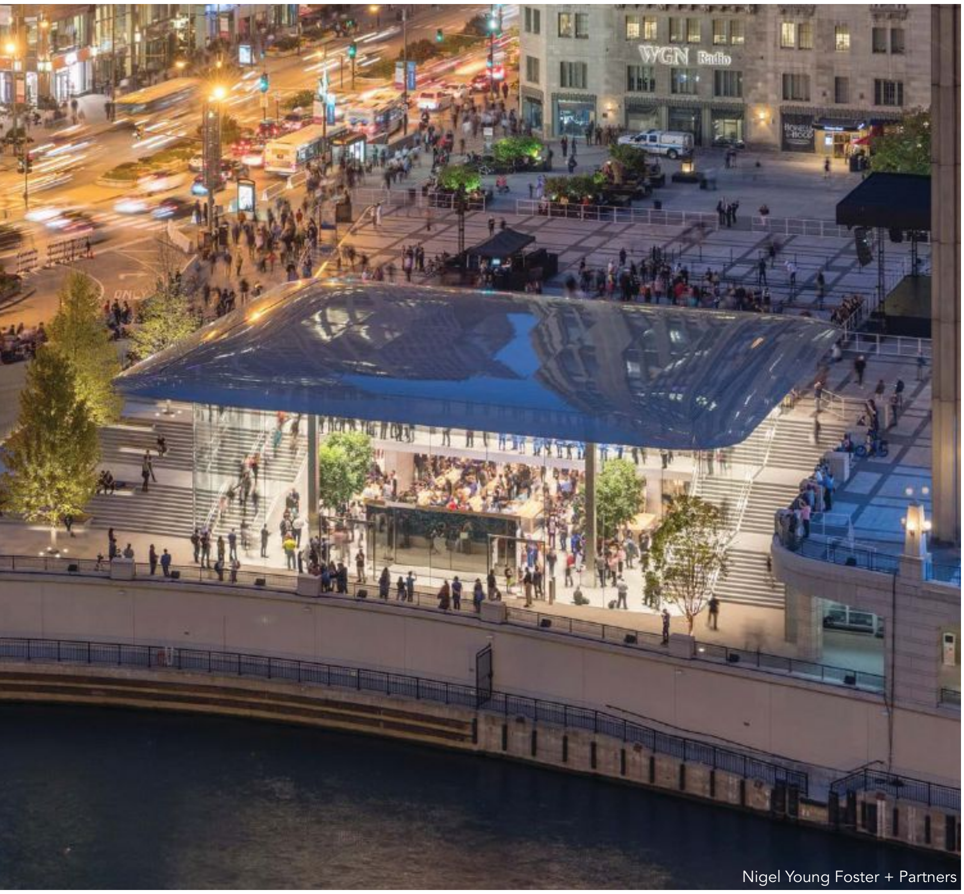
The new F3125 Grade 2280 twist-off bolts were used in the steel connections to resist combination loading effects. Also, Dacromet-coated F3125 Grade A490 bolts were used at the façade line where high strength and corrosion resistance were required. Structural steel bolted connections were also used in an inventive way to clamp the cantilever CFRP ribs.

Foster + Partners

Nigel Young Foster + Partners

“A well-concealed built-up steel box beam does a lot of heavy lifting in the structural system and allows for customers to take in the beautiful yet relatively minimalistic architecture of the building.”
—Devin Huber

Foster + Partners



Nigel Young Foster + Partners

The existing plaza slab at adjacent Pioneer Court was retained through a creative strengthening scheme involving pairs of heavy wide-flange beams (W36×487) spanning more than 50 ft and straddling the existing columns. The beams were cleverly designed and sequenced to replicate the same support conditions as the original structure, thereby allowing removal of the existing columns.

In addition to erecting the steelwork, erector Chicago Steel Construction was commissioned to erect the CFRP roof panels. Due to site limitations resulting in a shortage of laydown space, a barge was moored in the Chicago River, from which point the panels were assembled and lifted into place.

The client recognized the need for a collaborative process with a sophisticated steel fabricator and employed Zalk Josephs early in the design process, resulting in a highly coordinated steel framing plan. A 3D Tekla model was the basis for the final coordination, shop drawings, and fabrication. Zalk Josephs fabricated the cantilever balcony beams in large sections in an effort to reduce the number of pieces handled in the field.

Structural steel also enabled the long, cantilevering roof canopy, which shades the southern face against unwanted solar heat gain in summer while still capturing low-angle winter sun for passive heating. In addition, the grand steel stairs are tightly integrated with the displacement ventilation system.

Nigel Young Foster + Partners

Owner
Apple, Inc., Cupertino, Calif.

General Contractor
Power Construction, Chicago

Architects
Foster + Partners, New York
Ross Barney Architects, Chicago

Structural Engineers
Simpson Gumpertz & Heger, Chicago
Foster + Partners, London

Steel Team

Fabricator
Zalk Josephs Fabricators, LLC, Stoughton, Wis. (AISC Certified Fabricator)

Erector
Chicago Steel Construction, LLC, Merrillville, Ind. (AISC Associate, AISC Certified Erector)

Detailers
Ken Boitz Associates, Bloomington, Ill. (AISC Detailer)
Computerized Structural Design, S.C., Milwaukee

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MERIT AWARD $15 Million to $75 Million

The Exchange at 100 Federal Street, Boston

AN ANGULAR plate steel and glass prism, inspired by a folded piece of graph paper, makes quite the entrance for the 100 Federal Street office building in the heart of Boston's Financial District.

Known as The Exchange at 100 Federal Street, the entry pavilion is a sharply faceted form with an exposed steel structure whose main rib plates form the main lateral load-resisting system.

Several steel options were considered for the structure and its design requirements of achieving 75-ft main spans via steel members less than 6 in. wide. W-shapes, hollow structural sections (HSS), built-up box girders, and cable truss options were all considered, but none could be cost-effectively sized to achieve these design goals. But thanks to guidance from the steel fabricator, Cives, the design team of architect Perkins+Will and structural engineer McNamara Salvia produced a final design using solid plate members with exposed bolted connections.

Though not as weight-efficient as rolled W-shapes or tubes, solid plate steel presented an opportunity to significantly reduce fabrication costs over the built-up shapes that might have satisfied aesthetic requirements. The plate shapes did present a challenge for structural stability in that they required frequent lateral bracing, a problem that was solved by adding sufficient additional steel bracing plates and matching the panel spacing of the curtain-wall system, thereby eliminating additional aluminum mullions in the process.

Typically, a steel detailer would begin the modeling process with fully dimensioned drawings and a Revit model from the architect and engineer. However, the exposed, mitered shop connections and the fact that the steel would serve as the curtain wall mullions meant that many tweaks needed to be made to the steel geometry before finalizing the steel locations and orientations. To simplify the workflow, the structural drawings provided member sizes, but member locations were determined solely through 3D model coordination.

McNamara Salvia issued a Revit model with member sizes and approximate member positions while Perkins+Will simultaneously supplied a precise Rhinoceros model of the curtain-wall system and mitered steel joints, which was imported through Revit into the SDS/2 steel model. Cives then located and oriented all plate members to accurately maintain the 5⅜-in. offset required by the curtain wall system. Where the vertical rib members were not oriented perpendicular to the plane of the glass, outside plate edges parallel to the glass plane were chamfered.

For more on this project, see "Functional Folds" in the January 2018 issue, available at ***www.modernsteel.com****.*

Owner
Boston Properties, Boston

General Contractor
Turner Construction Company, New York

Architect
Perkins+Will, Chicago

Structural Engineer
McNamara Salvia Inc., Boston

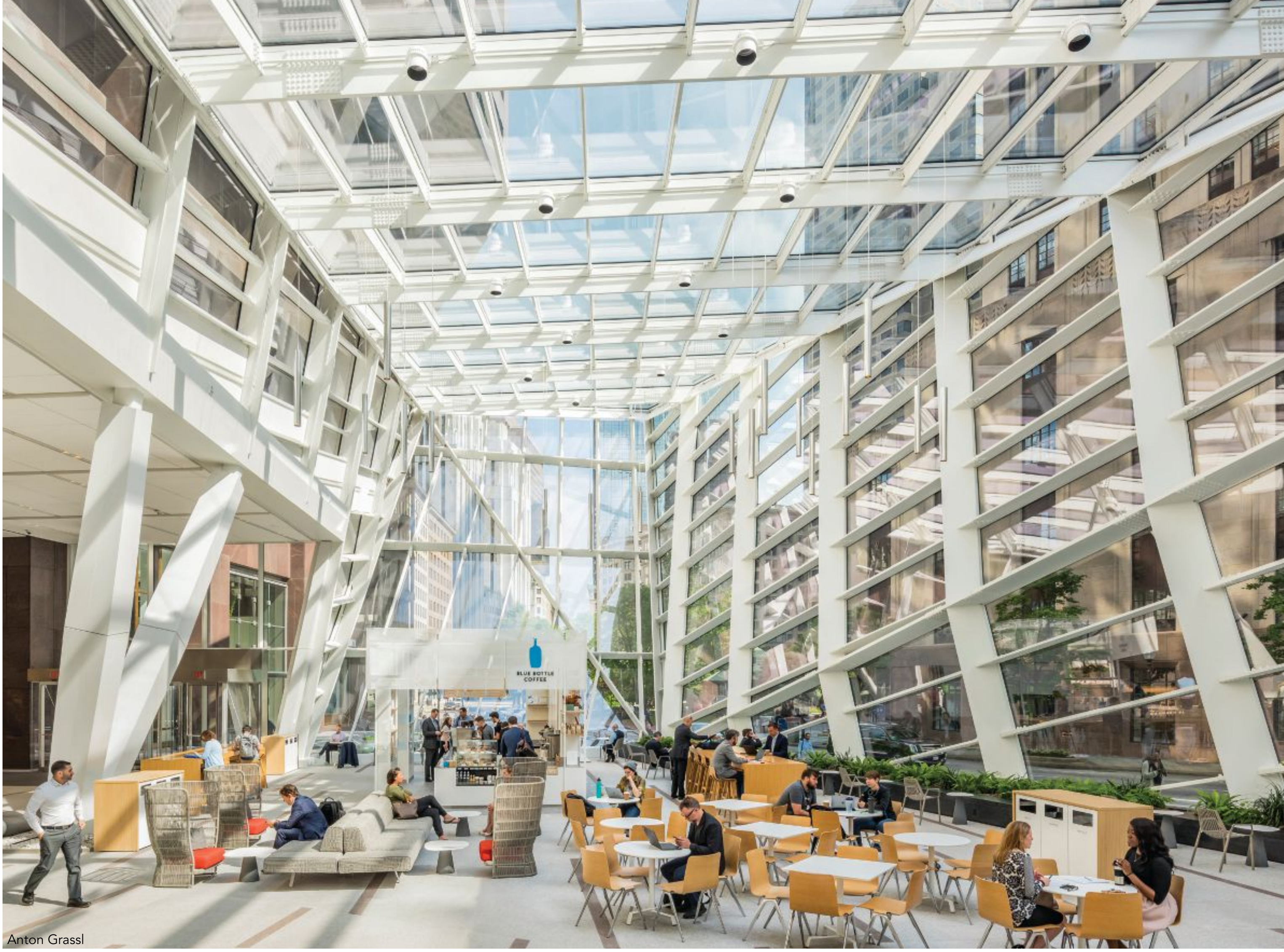
Steel Fabricator
Cives Steel Company–New England Division, Augusta, Maine

AISC CERTIFIED FABRICATOR

"This unique design and skillful construction demonstrates an effective use of structural steel plate material."
—Maggie Kwan

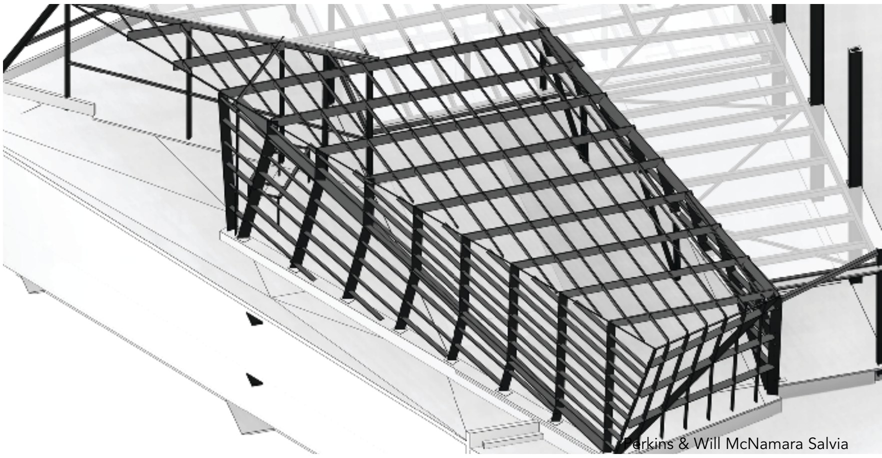

Anton Grassl


Anton Grassl



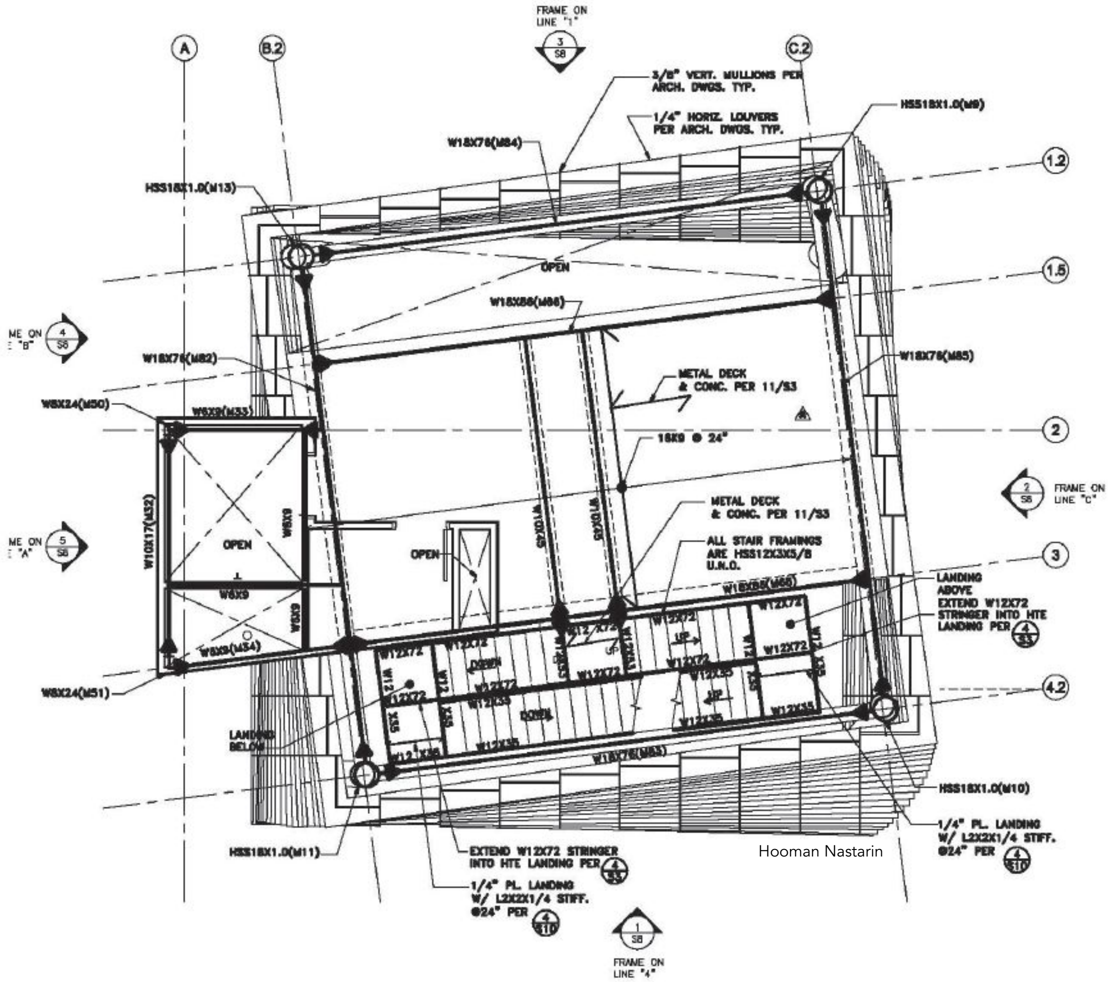
Anton Grassl

Anton Grassl

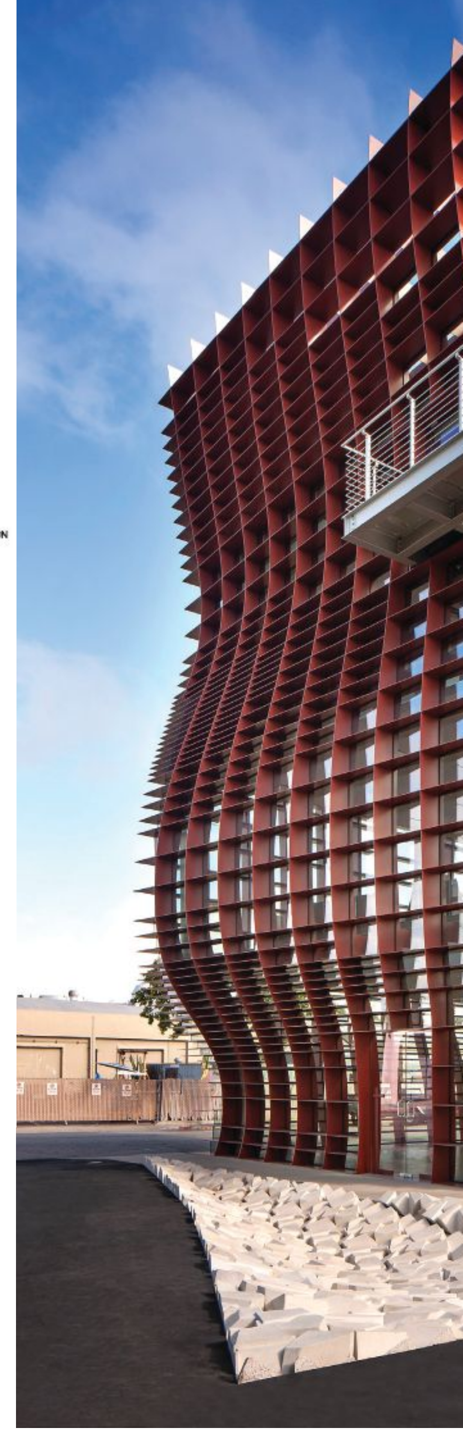


Perkins & Will McNamara Salvia

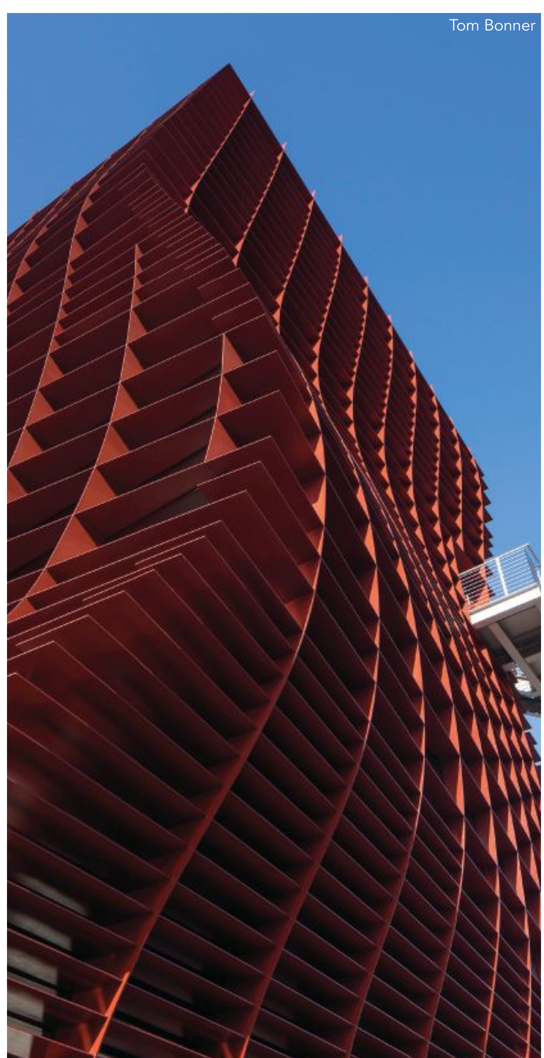
Jonathan Bayreuther



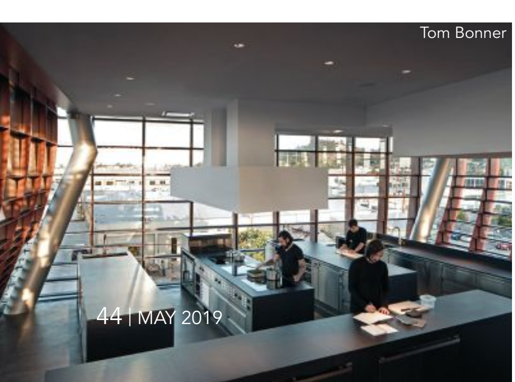
Hooman Nastarin



“This surrealist looking building looks as though it could go for a walk if it wanted to, with structural columns that kink and undulate in and out of plane freely. While aesthetically unique, the structural system is also robust.”
—Devin Huber


Tom Bonner


Tom Bonner


Tom Bonner

Tom Bonner

Hooman Nastarin

NATIONAL AWARD Less than $15 Million

Vespertine, Culver City, Calif.

IF STRUCTURAL STEEL BUILDINGS were common in Lewis Carroll's Wonderland, they might look like the Vespertine building.

The four-story building, which is currently home to a modern restaurant (also called Verspertine) stands out thanks to a gently curving surface sculpted by vertical and horizontal steel fin plates—⅜ in. thick and ¼ in. thick, respectively—painted red.

At each of the building's four corners are silver steel pipe columns, twisting and bending with precise fabrication accuracy, as they follow the undulating pattern of the exterior surface in careful harmony. These four columns provide a majority of the structural support for the floating three levels above the ground level.

The shell's crate-like geometry added a new level of complexity to the deflectional computation of the building and its performance. Each side of the shell is flexible in plane yet highly rigid in the out-of-plane direction, posing a great challenge to the supporting building, which itself is flexible in an uneven direction. In addition, the horizontal planes pivot along the building's height more aggressively as it reaches from the top toward the bottom while maintaining a square shape in the plan view.

The conceptual design demanded multi-directional frames with circular columns at each corner. The four columns are 18 in. in diameter with a ⅝-in. wall thickness. Bottom fixity is provided by welded reinforcement bars through the walls of the columns doweled into concrete grade beams within the foundation. To achieve the desired slope of the northeast column, an internal 9-in.-diameter steel sleeve was inserted within the column and had to follow the complex bending of the column up to the top of the second-level connection. Internal doughnut-shaped continuity plates inside the columns at each connection and bend provided wall stiffness. The perimeter beams provided out-of-plane rigidity for the shell connections and were required to be reduced beam sections (RBS) at the connection to the pipe face so as not to overpower the pipe walls. Additional vertical external continuity plates were added to help stiffen and stabilize the pipe walls at the point of connection.

The challenge of the exterior shell was not limited to the directional stiffness. While the building was expected to rotate as construction progressed, the steel shell—to be installed as separate panels—posed a new heavy load after the fact. Also, due to the slenderness of the fins, each component had to remain in tension under all load conditions. The vertical fins are supported via gusset plates to the face of perimeter beams on the third level, whereas the connection points at the levels below are carefully tuned slip connections.

One of the critical directives of the project was that the final alignment of the fins needed to create perfectly vertical lines aligned with the perfectly horizontal plates after construction. Careful deflection studies were performed with numerous construction phases to locate the connection point at each level for the final at-rest horizontal location of the connection plates, since all the levels rotated in deferring directions as the shell panels were to be loaded onto the building core. On the other hand, specific tolerances were allowed at each connection, diverting the overall movement to the face of elevator shaft to accommodate daily thermal expansion of the shell plates. The exterior shell is intricately configured and connected to the tower structure for maximum flexibility and minimum deflection during extreme seismic acceleration. The delicate stiffness and support relationship between the core and the shell help maintain the free-flowing shape of the building.

Owner and General Contractor
Samitaur Constructs, Culver City, Calif.

Architect
Eric Owen Moss Architects, Los Angeles

Structural Engineer
NAST Enterprises Corp., Los Angeles

Steel Fabricator, Erector, and Detailer
Plas-Tal, Santa Fe Springs, Calif.


Fredrik Brauer


Fredrik Brauer

Fredrik Brauer

NATIONAL AWARD Less than $15 Million

Caddell Building, Atlanta

THE GEORGIA INSTITUTE OF TECHNOLOGY'S Caddell Building project transformed a 1950's-era Naval Reserve motor pool building into the campus' new School of Building Construction. The overall strategy was to promote maximum visibility, campus engagement, and energy reduction through the use of a whole-building shading structure and interior daylighting.

What was previously a diminutive background structure has become an engagingly transparent and high-efficiency example of contemporary reuse in an urban campus setting. While the functional assignment was to create a 10,600-sq.-ft facility with flexible-format teaching areas, collaborative spaces, and faculty offices, the larger ambition was to create a building "that excels in collaboration, sustainability, and technology."

Taking advantage of its unique function and location on the campus—a facility focused on making buildings, directly alongside a major pedestrian thoroughfare—the design prioritizes visibility and performance as a progressive vehicle for the more functional attributes of the program. Where the building was once entirely closed and concealed, it is now revealed by the removal of the exterior enclosure and the placement of a new full-height structural silicone glazed curtain-wall system. Every space on the interior is visible to and from the exterior, including faculty offices, conference rooms, and collaborative workspaces—a strategy that supports the concept of an "open campus" that facilitates interdisciplinary work, student-faculty engagement, and a collective community.

This primary material strategy of "reveal and reuse" puts the original building's hybrid concrete-encased steel frame—with 36-in.-deep girders under the second floor and steel angle trusses at the roof—on display. During selective demolition, everything except these steel and concrete elements, floor and roof slabs, and portions of the exterior brick assembly were removed. As part of the LEED Platinum goal for the project, waste was managed, diverted, and recycled to the highest degree possible.

The renovation started from a conceptual framework of building back only what was needed, without excess or ornament, to promote the larger goals of transparency, connectivity, and sustainability. The perimeter is defined by a new curtain wall to maximize daylighting. Interior walls are framed with drywall only where needed for acoustical separation and privacy; otherwise, glass partitions and transoms allow for "borrowed" light. In the primary flexible format teaching space, moveable partitions are hung from the original steel girders instead of fixed walls and doors. New elements such as stairs and railings are detailed to reinforce their tectonic relationship to the existing steel structure, and the benches in the lobby are even made from excess steel sections from the project.

While choices of materials and expenditures were strongly guided by these sustainable factors, it would be misleading to say that the architecture is simply a result of these efforts. There was a specific material and tectonic agenda developed to emphasize both the lateral transparency of the building and the delicacy of the overhead shading structure. The design team considered the building as a community asset, one that would be noticed on the way to class more than it might ever be entered. The material choices, density, color, and reflectivity of the shading canopy were manually and digitally modeled and mocked up to ensure that the performance of the shading could be rigorously met without sacrificing the experiential lightness of the structure itself.

The most significant architectural element of the project has its roots in an agenda of sustainability. The new east-facing façade is remade with 100% glazing but is almost entirely shaded with a whole-building steel-framed shading canopy. This canopy shades both the new window wall and, equally importantly, the primary campus pathway that passes by the east side of the building. Cantilevering 28 ft beyond the building face, it transforms the path into a porch-like space, drawing passersby into a closer association with the interior program.

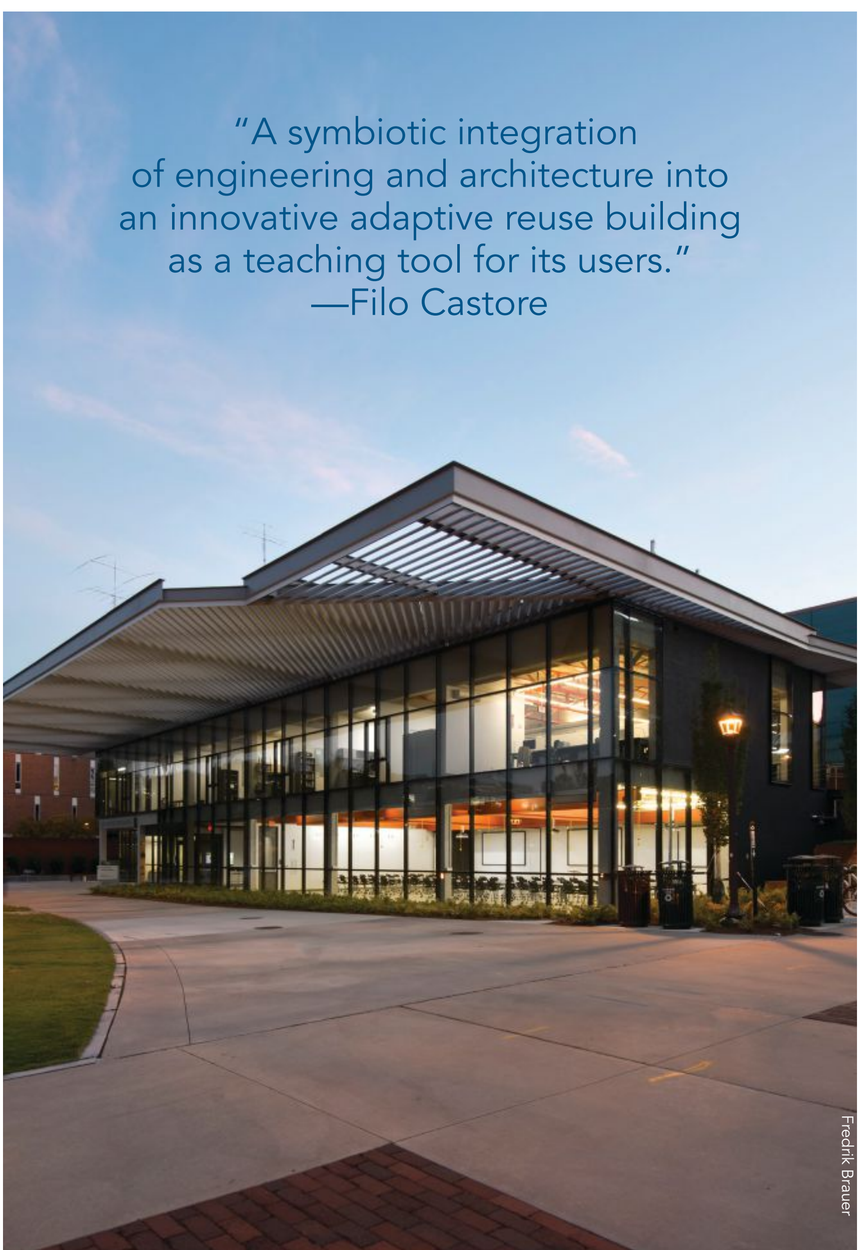
Owner
Board of Regents, University System of Georgia, Atlanta

General Contractor
Evergreen Construction, Atlanta

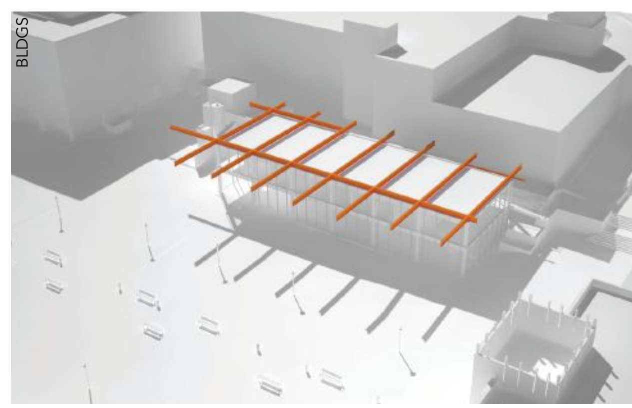
Architect
BLDGS, Atlanta

Structural Engineer
CFD Structural Engineering, Roswell, Ga.

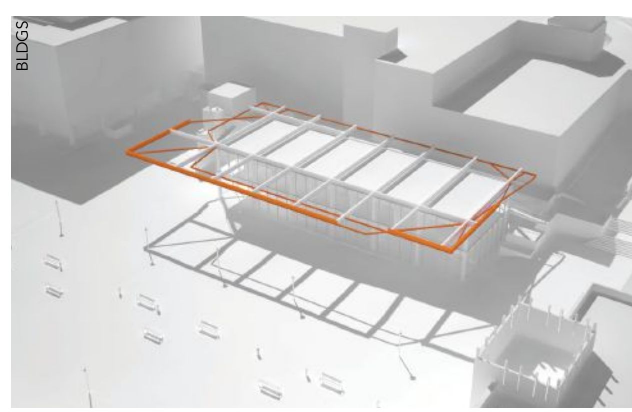
Steel Fabricator and Erector
King Steel Company, Inc., Lawrenceville, Ga. AISC CERTIFIED FABRICATOR & ERECTOR



Fredrik Brauer



BLDGS



BLDGS

BLDGS

MERIT AWARD Less than $15 Million

Saxum Vineyard Equipment Barn, Paso Robles, Calif.

THE SAXUM VINEYARD Equipment Barn is quite the departure from the typical notion of what a barn should look like.

Located in the Templeton Gap area of West Paso Robles, Calif., this simple agricultural storage structure rests at the toes of the 50-acre James Berry Vineyard, with the adjacent Saxum Winery sitting just over 800 ft away. Designed as a modern pole barn using reclaimed oil field drill stem pipe, the structure's primary objective is to provide an armature for a photovoltaic roof system, which offsets more than 100% of the winery's power demands, as well as covered open-air storage for farming equipment, workshop, and maintenance space and storage for livestock supplies.

Designed to harness the local climate and maximize cross ventilation, daylight, and solar energy, the recycled oilfield pipe structure holds a laminated glass photovoltaic roof system that produces one-third more power than needed (roughly 87,000 kWh per year) eliminating the dependence of grid-tied power for the winery and its vineyard irrigation wells through net metering. By using the laminated glass solar modules as both the actual primary roof and the renewable energy generator, any additional costs to construct an additional roof with separately mounted crystalline solar panels were offset.

Minimalistic materials were selected to withstand the particularly dry climate, based on regional availability, to achieve long-term durability and to minimize the need for maintenance. The primary column and roof structure is constructed of welded Schedule 40 reclaimed drill stem pipe, in 2-in., 3-in., and 3.5-in. diameters, left to weather naturally. The lateral force-resisting system (LFRS) consists of diaphragm rod cross-bracing and vertical tension-only cross-braced frames. Laminated glass solar modules, serving as both the solar system and the roofing, are supported on wood and WT steel flitch purlins welded to the pipe trusses. An 8-in.-diameter Schedule 40 half-pipe gutter is situated at the low end of the roof to accommodate future rainwater harvesting. In addition, weathering corrugated perforated steel panels provide shading and filtered privacy to the equipment bays, and the barn doors are clad in weathered steel cutoffs that were saved for reuse from the adjacent winery shoring walls, reused in a "calico" pattern to mesh the oddly shaped panels to the tube steel-framed door leafs.

Standing sentry as the foremost structure upon entering the vineyard lined property, the barn and its renewable energy system speak to the winery's commitment to sustainability and subservience to the natural landscape. The barn is completely self-sufficient and operates independently from the energy grid, maximizing the structure's survivability and resilience.

Owner
Saxum Vineyards, Paso Robles, Calif.

General Contractor
Rarig Construction, Inc., San Luis Obispo, Calif.

Architect
Clayton & Little Architects, San Antonio

Structural Engineer
SSG Structural Engineers, San Luis Obispo, Calif.

Casey Dunn

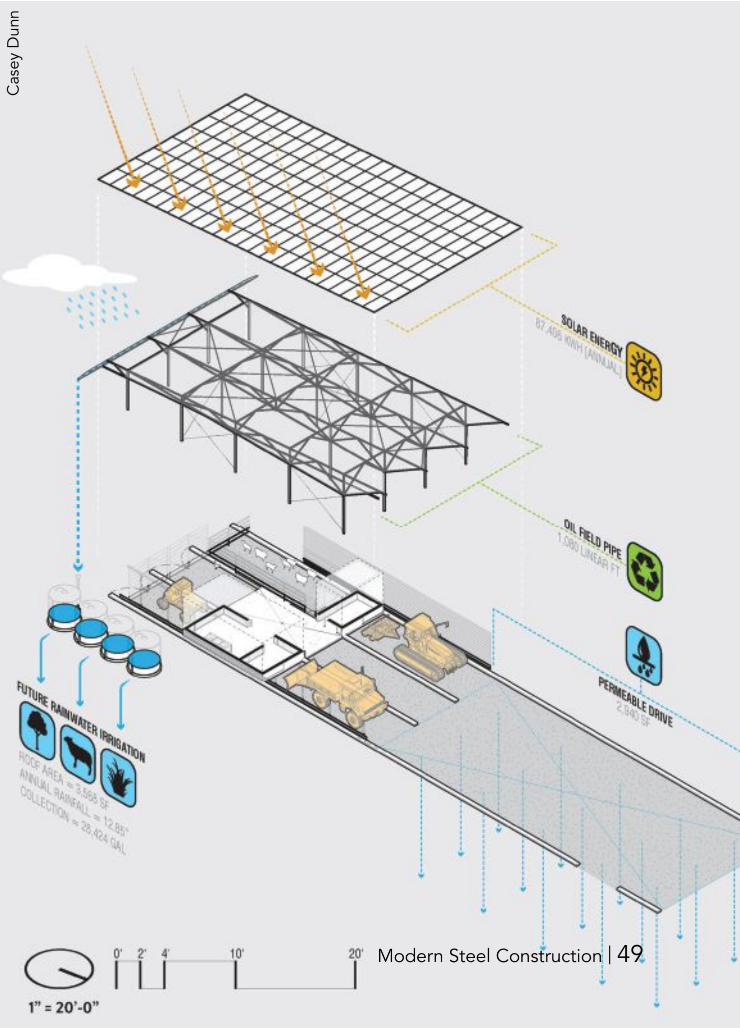
"Sustainability meets natural beauty in this one-of-a-kind building nestled in the scenic vista of wineries and olive gardens. This structure is much more than just a canopy, as its solar roof panels perched upon its minimalist steel frame convert beautiful California sunlight into useful electricity."
—Devin Huber

Casey Dunn

Casey Dunn

Casey Dunn

Casey Dunn



Casey Dunn


Bruce Damonte


Mathias Krause


Dave Campbell

SCULPTURE/INSTALLATION/NON-BUILDING STRUCTURE

Helen Diller Civic Center Playground, San Francisco

THE HELEN DILLER Civic Center Playground, a design collaboration between Andrea Cochran Landscape Architects and Endrestudio, feature three expressive steel-framed play structures inspired by the often mercurial weather patterns of San Francisco: Fog Valley lopes slowly along the ground, Lenticular Cloud creates a layered world of blue mesh nets, and Sky Punch spirals up above the park in an open helical sweep.

The structures emerged through a synthesis of parametric form exploration, circulation strategy, and fundamental geometric principles. In this way, the forces are resolved through form rather than solely relying on strength of materials. To facilitate the aggressive project schedule and simplify assembly, a bolted splice connection was designed that could be used with a range of curvatures for each structure.

At night the park's focus shifts to the nearly 70 "pixel poles"—stainless steel posts with built-in LED display caps that are centrally controlled and fully programmable. The poles glow, flicker, and dance, joining in the hum and buzz of an evening at the Civic Center.

> "Learning while playing through real-life 3D structural diagrams! I will not see playgrounds the same way again."
> —Filo Castore


Luke Downen

Owners
The Trust for Public Land, San Francisco
City of San Francisco Parks and Recreation Dept., San Francisco

General Contractor
Bothman Construction, Santa Clara, Calif.

Architects
Endrestudio, Emeryville, Calif.
Andrea Cochran Landscape Architecture, San Francisco

Structural Engineer
Endrestudio, Emeryville, Calif.

Consultant
Anticlockwise Arts, Oakland, Calif.

NBBJ Sean Airhart

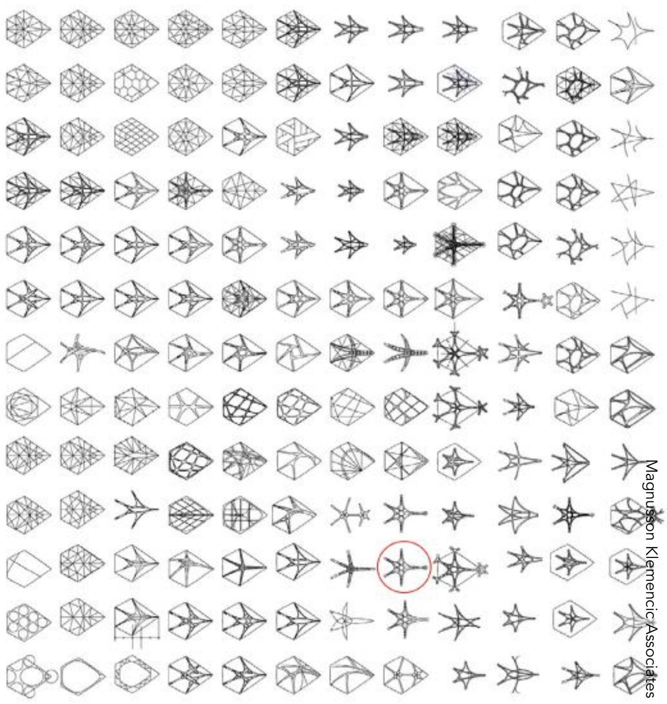
"The Spheres are simply amazing to behold. They are part bio-dome, part gathering area, and fully spectacular."
—Devin Huber

NBBJ Sean Airhart

Magnusson Klemencic Associates

NBBJ Sean Airhart

Magnusson Klemencic Associates



Magnusson Klemencic Associates

Magnusson Klemencic Associates

Bruce Damonte

PRESIDENTIAL AWARD FOR EXCELLENCE IN FABRICATION

The Spheres, Seattle

IF YOU'VE VISTED downtown Seattle recently, you may think that you have stumbled upon a giant's terrarium.

In reality, you've discovered The Spheres, three intersecting steel-and-glass orbs housing five, freestanding floors of unorthodox workspaces for Amazon employees—as well as more than 40,000 exotic plants from 30 countries.

Magnusson Klemencic Associates (MKA) collaborated with architect NBBJ to construct this iconic, city-altering structure. The first-of-their-kind spheres were built from intricately shaped steel sections whose highly organic appearance reflects their interior use—a space cohabited by nature and people. Spanning as an independent structure around the interior floors, the exterior skeleton is comprised of curved tube steel members and nodes fabricated from curved plates.

Deriving from a 60-sided shape, a pentagonal hexecontahedron, the structure's principal advantage is repetition; each of the 60 sides are the same pentagon, allowing for efficient fabrication. The pentagons join at their edges in different ways, yielding an organic final form. The repeating piece, dubbed a "Catalan," honors the 19th Century mathematician who first defined this shape. A total of 105 Catalans, 620 tons of steel and 3,045 panes of glass form The Spheres.

The engagement of the architect, contractor, structural engineer, and steel fabricator/detailer/erector team at project inception was essential to realizing the complex geometry, analysis, fabrication, and erection. The collaboration yielded many improvements to the project, such as imperceptible rationalizations of the initial architectural geometry of the Catalan that allowed for standard hollow structural sections (HSS) thus reducing the number of members built from steel plate. The team was also able to establish architecturally exposed structural steel (AESS) standards through building mock-ups of critical welding details, then selectively apply these standards depending on occupant proximity to the steel.

In addition, the team was able to streamline the documentation, detailing, and shop drawing process for a "mass customization" fabrication approach where each piece used the same base parts and fabrication jigs but had variable amounts of welding and internal stiffeners appropriate to individual structural demands. And the collaborative process also helped the team identify the detail and splice locations for fabricating the largest transportable pieces in the shop, thus speeding up the erection process. The integrated design team workflows were exceptionally efficient, requiring only 18 sheets of structural drawings for the Catalan structural steel.

Perhaps most importantly, integrating steel fabrication/erection constraints into the design at the earliest stages ensured that NBBJ's vision was executable within the owner's challenging schedule and budget requirements. Prefabricating the structural steel components at fabricator Supreme's Portland, Ore., facility made the final product seamless; erection took only six weeks.

Owner
Amazon, Seattle

General Contractor
Sellen Construction Company, Seattle

Architect
NBBJ, Seattle

Structural Engineer
Magnusson Klemencic Associates, Seattle

Steel Team

Fabricator
Supreme Steel Portland, Portland, Ore. AISC CERTIFIED FABRICATOR

Bender-Roller
Albina Co., Tualatin, Ore. AISC ASSOCIATE

PRESIDENTIAL AWARD FOR ERECTION ENGINEERING TO FACILITATE ADAPTIVE REUSE

75 Rockefeller Plaza, New York

WHEN THE 34-STORY 75 Rockefeller Plaza was built in 1947, it was the tallest completely air-conditioned building in New York and the first skyscraper at Rockefeller Center.

Located on 51st Street between Fifth and Sixth Avenues in Midtown Manhattan, the steel-framed building totals 623,000 sq. ft, with typical floor plates ranging from 14,000 sq. ft to 30,000 sq. ft. The building has recently undergone a major repositioning, including restoration of the façade and base metalwork, retail, and lobby enhancements and new mechanical infrastructure.

Every aspect of the updated building, which anticipates LEED Gold certification, has been meticulously reinvented to provide a building worthy of its stature and location. The street-level façade is reinstated with tempered monolithic glass, bronze mullions, and Deer Isle granite. A new private terrace overlooking 51st Street and Rockefeller Plaza—home of the annual Rockefeller Center Christmas tree—invokes the original design of 75 Rockefeller Plaza. The revitalized streetscape features a distinctive, bronze curvilinear entrance, an architectural detail that also serves as a focal point for new retail space.

One of the most significant structural updates included reconfiguring the lobby into a double-height, 24-ft-high space connecting 51st and 52nd Streets. The former black granite at the lobby's interior has been replaced with white marble walls and terrazzo floors. The same Indiana limestone that clads the exterior of the building is also used for two walls of the interior. The lobby includes a skylight and gallery space that will exhibit revolving public art. The main lobby finishes continue to the ground-floor elevator lobbies, where artist-designed bronze elevator doors open to reveal refurbished elevator cabs.

The lobby renovation required the removal of four columns at the ground floor, three of which supported existing transfer girders. Multistory transfer trusses and removal of each column from the top down were among the schemes considered before the final design of a composite steel box girder was selected. While the multistory truss would have obstructed too much leasable space, column removal and transfer floor by floor would have provided a large column-free area across all floors—but was prohibitively expensive.

Courtesy of RXR Realty

Courtesy of RXR Realty

Gilsanz Murray Steficek

Courtesy of RXR Realty

The unique box girder solution (as opposed to a pair of built-up wide-flange beams) coordinated nicely with the planned sculpted lobby ceiling, which required the transfers to be as narrow and shallow as possible. The composite box girder had to be carefully specified, as this configuration and method are typically applied to bridges rather than buildings. As such, both the AISC *Specification for Structural Steel Buildings* (ANSI/AISC 360, available at **www.aisc.org/specifications**) and AASHTO bridge specifications were consulted. Other design challenges included eccentrically reinforcing existing columns and modifying the existing partially restrained wind frame. Of particular note were the constructability challenges of erecting and preloading a new steel box girder around the existing transfer girders to effectively extend these transfers to the next column line. A scaled 3D model was printed to help communicate the design concept and erection/preloading procedures to the steel fabricator and the owner.

To preload the girders, a solution was developed that maintained redundancy throughout the entire loading procedure and did not require any temporary structure or shoring. This method, involving a yolk system with 500-ton jacks, pushes the girder and pulls the below column up, loading the girder in flexure without any significant displacement. At that point, the final connections are completed and the existing column removed.

Effects of column shortening and resistance from the steel moment frame above were all considered during the loading process. Maintaining the building's lateral stiffness was a primary focus throughout the project. The building was originally designed under New York's 1938 building code, which included no wind or seismic requirements and therefore accounts for a small amount of lateral stiffness relative to modern buildings. Careful attention was paid to reinforcing connections and keeping the relative increase in member loads to a minimum. ■

For more on this project, see "Playing to the Base" in the February 2018 issue, available at ***www.modernsteel.com****.*

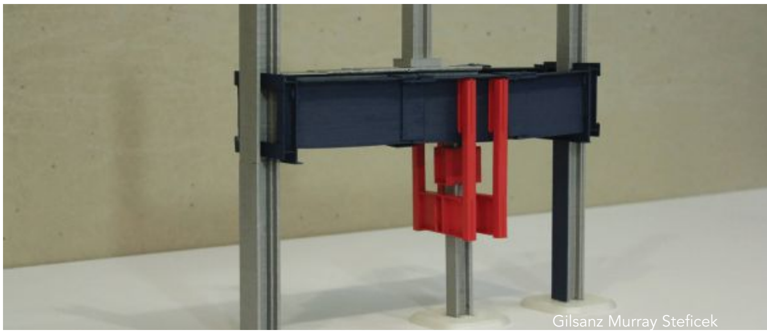
Owner and General Contractor
RXR Realty, New York

Architect
Kohn Pederson Fox, New York

Structural Engineer
Gilsanz Murray Steficek, New York

Steel Fabricator, Erector, and Detailer
Orange County Ironworks, Montgomery, N.Y. AISC CERTIFIED FABRICATOR & ERECTOR

Gilsanz Murray Steficek



Gilsanz Murray Steficek

"The adaptive reuse of the 1947 building shows the long-term viability of a steel structure and the endless possibilities of structural modifications."
—Craig Wehrmann

Courtesy of RXR Realty

Managing Management Review

BY ANNA PETROSKI

Management review is a valuable component of AISC certification—and it doesn't need to be painful.

Anna Petroski (anna@atema.com) is president of Atema, Inc., a quality management consultant specializing in large infrastructure project construction.

"MANAGEMENT REVIEW. Didn't we just do one of these *last* month?"

"There's nothing wrong, our customers keep on ordering!"

"When are we going to get back to real work?"

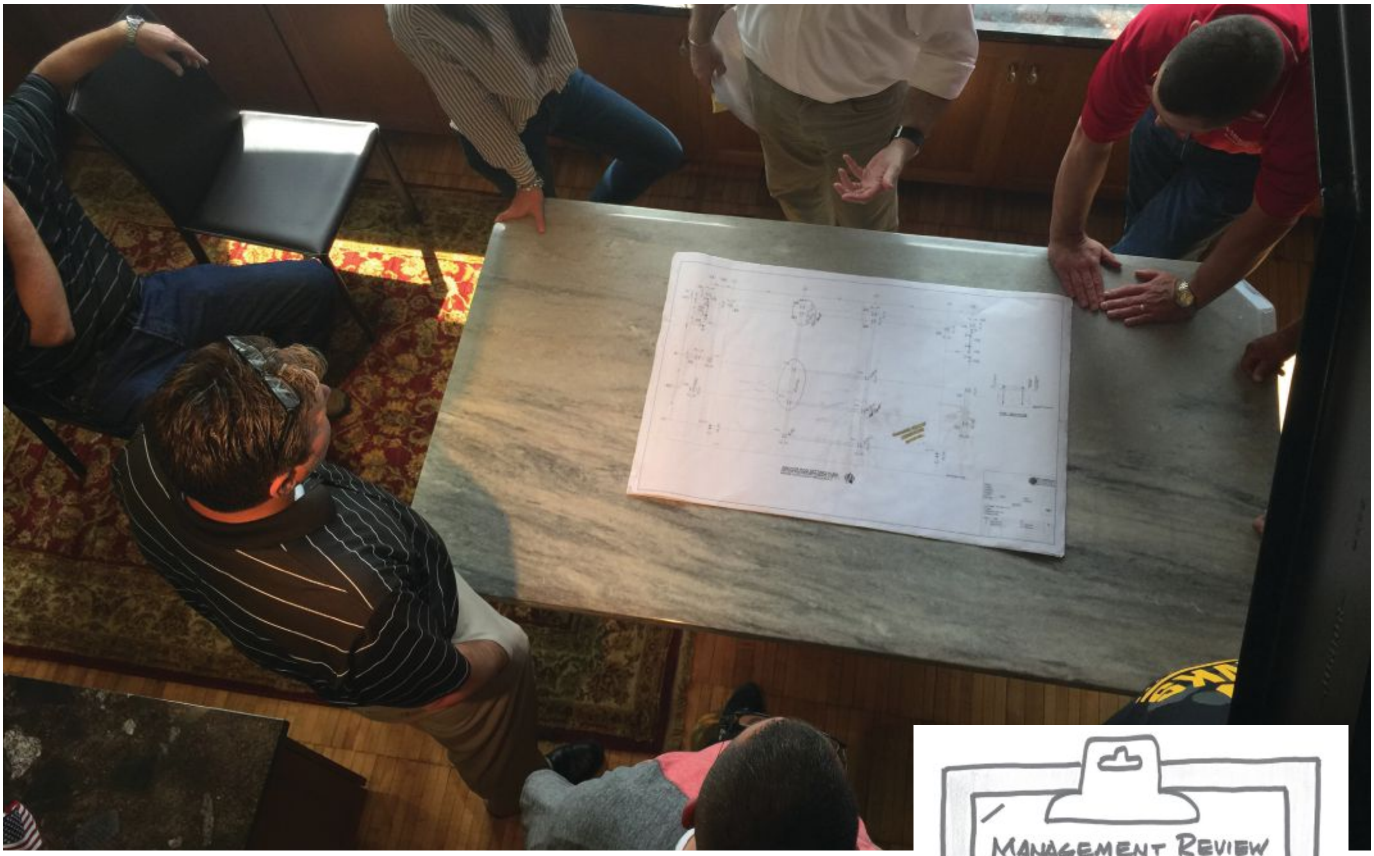
Sound familiar? These are the types of reactions you might hear as you schedule a management review if you're the quality manager in charge of getting your team ready for your upcoming AISC certification audit. You think you've got it covered. You've conducted a deep internal audit this year and found some real areas where you can work to protect the company from making errors in the next contract. Now comes the management review process, which is meant to check the effectiveness of your quality management system and plan for future needs and improvements.

Maybe your team already meets weekly to discuss schedule and production. They are great at firefighting when a problem comes in from the field or the owner has their tenth unreasonable request of the week. However, long-term solutions are never discussed and similar problems keep happening. Goals that were discussed and set six months ago have no promised data collected and haven't been reviewed since. You know that the whole team can benefit from talking about the quality system, yet getting them together for a management review is consistently a challenge.

We hear this story all the time. It's not unique to fabricators, erectors, or general contractors. Regardless of the size or type of work you do, meaningful management reviews are sometimes difficult to conduct, especially if your team has yet to buy into the value of a quality culture. Working quality discussions into regular production meetings or conversations is a gradual way to change company culture and can lead to more enthusiastic involvement. More comprehensive and regular meetings are still a necessity, and gathering multiple personalities and working styles together for one or more meetings can get intense.

The Right Environment

In a respectful and open environment focused on process not people, management reviews give the team a chance to safely raise issues they may not have felt comfortable voicing before. When presented in the right way, with issues aired in a facilitated group



above: Making sure your management review process is in order can transform what is often seen as a chore into a business-positive event.

right: A sample management review meeting checklist.

and focused on requirements and factual data—not a perceived personal failure—a productive environment is created, one that keeps the emotional temperature low. The greatest satisfaction is seeing the aha moments when mangers who adamantly say they talk to each other every day suddenly visualize the effect of their action or lack of information sharing on a department, and realize that they can improve their group's workflow and productivity with a small change.

When changes are made (or need to be made) the ripple effect of the change is not always clear when it's discussed only at one level. A group review explores that effect and encourages adoption.

Rating Severity

The current version of AISC's *Certification Standard for Steel Fabrication and Erection, and Manufacturing of Metal Components* (AISC 207-16, available at **www.aisc.org/specifications**) does not prescribe a way of execution for management reviews, but it does require methods for tracking nonconformances. The addition of "severity" indicates that executive management (or someone in the company assisting executive management) must create a means of ranking or classifying all nonconformances, showing how serious/severe the item is. (Note: While erectors are already familiar with tracking severity to some degree, this is a new approach for those in other AISC certification categories.)

A management review is more than merely going through a checklist of items. More importantly, its interactive nature can increase a sense of trust and accountability among all team members, set the tone for productive future reviews, and ensure that your facility is meeting all of its quality objectives in the near and long terms—and positively impact your company's bottom line.

For more on how AISC certification audits work, see "Don't Fear the Auditor" in the July 2018 issue, available at ***www.modernsteel.com****.*

The 2019 NASCC: The Steel Conference session "What Does 'Management Review' Really Mean?" discussed the basics of conducting a management review and also featured a fictional "management review gone wrong" scenario—with an interactive portion that gave advice on how to turn around a meeting that's headed south. In addition, topics such as how to meet AISC requirements, scheduling (all at once or broken up through the year), how to capture audit results, and how to address action items or nonconformances were all discussed. If you missed the conference or session, not to worry: You can view a recording of the presentation approximately 45 days after the show at **www.aisc.org/2019nascconline**.

Rewriting the Book on Parking Structure Design

BY JOHN HORST, PE

As Nashville's population shoots skyward, the parking structure for the city's main library follows suit with a multistory steel expansion.

NASHVILLE IS ONE OF AMERICA'S current boomtowns. Census data indicates that the city gained nearly 100 residents per day in 2018, and the Metro Planning Department estimates Middle Tennessee will add one million new residents by 2040. As the city booms, space—specifically in terms of parking—is at a premium in the urban core.

Due to the surge in business, tourism, and convention traffic (the city has played host to NASCC: The Steel Conference twice since 2008!) the Nashville Downtown Partnership and Metro Nashville Government saw the need for more parking and called on structural engineer Gresham Smith to expand the city's main library parking structure vertically by three levels. The garage itself, which is operated by SP+ and maintained by Block by Block, is used by downtown employees, daily visitors to the library and nearby attractions, and guests at the Renaissance Hotel across the street.

While all involved parties wanted to accommodate Nashville's growth, each had their own set of goals. The Downtown Partnership wanted additional spaces, the library needed to improve the entrance and general safety in the garage, and SP+ hoped to improve the garage's flow and efficiency. Block by Block wanted to reduce maintenance, the Renaissance Hotel needed to keep the garage operational throughout construction, and Metro Planning wanted the project delivered on time and on budget with at least 350 new parking spaces. Gresham Smith worked with the contractor, Messer Construction, to address each party's goals, then set to work on design.

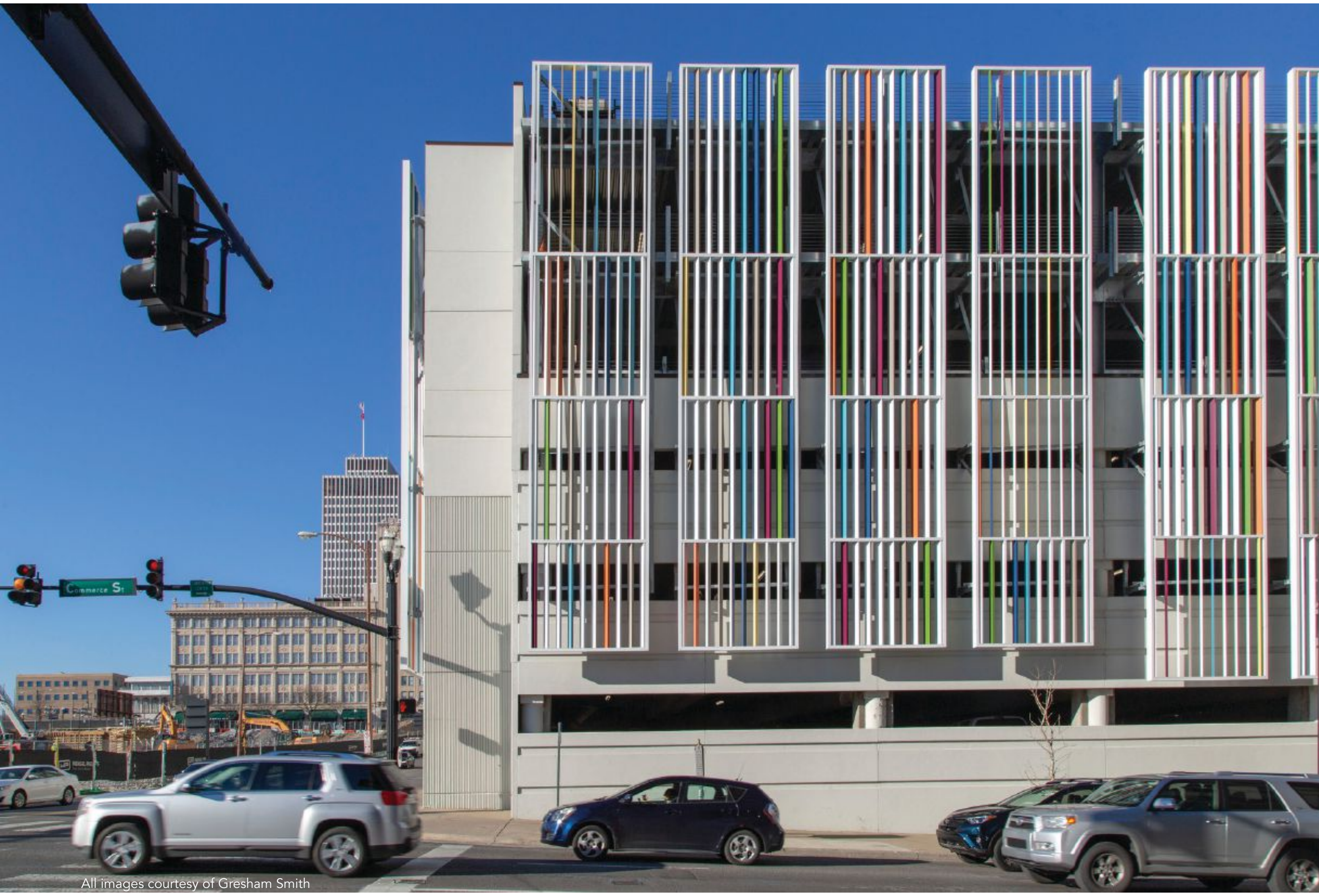
Figuring out Feasibility

Due to the site's long history and many uses—it was once home to Nashville's original Jewish synagogue, then a shopping mall and then the main library (as of 2001)—there wasn't much documentation on the site except for basic floor plans. The structural team needed to learn all they could about the site's structural condition before determining if a vertical expansion was even possible, and worked with multiple geotechnical firms to conduct a multi-phased forensic analysis, which provided enough information at each phase to determine feasibility before undertaking the next phase.

During the investigation, the team discovered there were at least three different existing structural systems for the existing four-story garage: cast-in place conventionally reinforced concrete on the first three elevated floors, cast-in place post-tensioned concrete on the top floor, and composite structural steel infill on portions of the roof. It also appeared that the structure had previously been altered on at least three separate occasions. After performing a year of testing on the site's bedrock and the garage's foundation and concrete structure, the team gathered the information they needed to confidently move forward with the design to expand the garage vertically.

Thinking Outside the Concrete Box

Working without existing drawings and on a tight, active urban site, the team elected to use structural steel (660 tons in all) rather than concrete to frame the expansion. Thanks to being much lighter



Colorful new panels were added to Nashville's Main Library garage as part of a vertical expansion that provides three new steel-framed parking levels.

than concrete and possessing a high strength-to-weight ratio, structural steel avoided overloading the existing foundation and structure. The design employed a composite floor system, which limited the amount of concrete needed and resulted in sections of the floor being poured in a single day without concern for cold joints. Additionally, steel allowed for smaller columns, which improved interior visibility and circulation for drivers. (Typical girders are W30×99, infills are W14×22, and columns are W14×120, W14×176, and W18×106.) And since the steel is exposed, direct inspection and maintenance is much easier for management staff to achieve.

The team opted for SidePlate, a specialized steel frame connection system, rather than traditional welded steel frames. In addition to reducing the overall steel tonnage, this system allowed the structure to be supported laterally, without diagonal bracing or shear walls. The construction team was also able to build the additional levels quickly and efficiently within the 60-ft spans since the connections are simply bolted in the field. And thanks to the overall moment frame stiffness that the system achieves, the designers were able to pin the column bases to the existing roof. This removed the need for a complicated base connection to the existing structure as well as the need to deal with different column conditions for each base.

One of the biggest challenges with the vertical expansion was determining how to create a ramp from the existing fourth floor through the existing roof. Not only did the ramp's installation require demolition of a large area of the roof structure, but areas of the fourth floor slab at the base of the ramp also had to be removed to accommodate the ramp's structural depth. Again, thanks to its lightness, structural steel allowed the team to support portions of the ramp on the fourth floor without overloading the existing concrete beams. Due to multiple retrofits on the roof of the existing structure, several of the new ramp beam connections had to be adjusted in

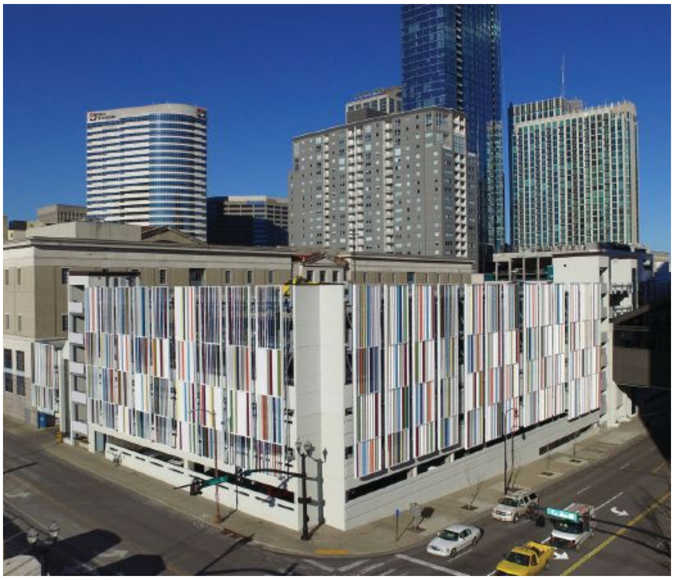
John Horst (john.horst@greshamsmith.com) is a project manager with Gresham Smith.

above: A SidePlate moment frame system was employed for the new parking levels.

below: A rendering of the original garage, with the new levels shown in red.

the field to make the design work, occasionally including attachments to concrete, steel, or both.

When it came to protecting the exposed steel framing, the team considered both paint and galvanizing, ultimately settling on the latter, which they felt provided the greatest longevity and lowest maintenance requirements for the value. Additionally, the team reinforced the slab to limit the number of construction joints and potential locations for moisture intrusion. In addition to mild steel reinforcing, macro-fiber reinforcing, shrinkage compensating admixtures, and a crystalline admixture were all employed to both reduce initial shrinkage of the concrete and minimize cracking.



above: The steel-framed addition to the garage brings 350 new parking spaces to booming downtown Nashville.

below: The steel framing was galvanized for corrosion protection.

Exterior Overhaul

While the goal of adding 350 additional parking spots was achieved thanks to the vertical steel expansion, the garage's outward appearance was also elevated. Working with Centric Architecture, the team designed a Tubelite curtain wall system using colorful aluminum slats installed at alternating angles to create an immediately recognizable façade. The colorful solution conceals the existing, worn precast concrete panels while also providing enough space between the slats to bring natural ventilation into the garage. Structural steel framing attached to the existing concrete frame supported the new façade without having to attach to

The colorful exterior panels conceal the existing, worn concrete façade while also being open enough to provide natural ventilation.

the precast panels or deal with the uncertainties of the existing precast connections' capacity.

By using steel, an uncommon choice for parking structure projects, Nashville's main library garage was expanded into a structurally sound space that is as attractive as it is functional. Downtown Nashville now has more parking for library patrons and other visitors to the area in the form of a vibrant structure whose new façade makes it nearly impossible to forget where you parked. ■

Owner
Metro Nashville Government

General Contractor
Messer Construction, Nashville

Architect
Centric Architecture, Inc., Nashville

Structural Engineer
Gresham Smith, Nashville

Steel Team

Fabricator
Wylie Steel Fabricators, Inc., Franklin, Tenn. AISC CERTIFIED FABRICATOR

Detailer
Structural Detailing, LLC, Brentwood, Tenn. AISC DETAILER

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SSBC

Student Steel Bridge Competition to Take Place at Southern Illinois University

The finals for this year's annual Student Steel Bridge Competition (SSBC) are set.

Forty teams, comprised of the top few finishers from 17 regional competitions—which just wrapped up in late April—are moving on to the 2019 National Finals at Southern Illinois University in Carbondale, Ill., on May 31 and June 1.

Sponsored by AISC, the annual competition challenges college and university teams to design and fabricate a scale-model steel bridge, then assemble it as quickly as possible. 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 structural requirements and construction speed but also on aesthetics, economy, lightness, stiffness (a combination of lateral and vertical loading tests) and efficiency. Lafayette College was the overall winner at last year's competition, hosted by the University of Illinois at Urbana-Champaign, with California Polytechnic State University, San Luis Obispo, taking second place and École de technologie supérieure, back-to-back champions in 2016 and 2017, coming in third. You can view a list of this year's 40 finalists as well as past results at **www.aisc.org/ssbc**.

Preparation typically starts during the fall semester and can involve thousands of hours for design, fabrication, and practice assembly. The latter often takes place right up to the last minute, as finalists are often spotted practicing their bridge assembly the night before the construction speed portion.

Every year, the goal for the competition is put forth in a problem statement of a theoretical real-life situation. This year's statement is as follows:

"In an effort to rebuild infrastructure destroyed during recent volcanic flows and earthquakes associated with the Kilauea Volcano and make Hawaii Volcanoes National Park accessible, the National Park commission is interested in paying tribute to the historic Hawaiian steel railroad bridges in the replacement and development of new bridges for the park. A feasibility study is being conducted that includes a competition to identify the best design for a limited-access, short-span bridge to cross a river near recent and past lava flows. The bridge must have the ability to support bicycles, pedestrians, park vehicles, and emergency vehicles while prohibiting private motor vehicles. Models will be erected under simulated field conditions and will be tested for stability, strength, and serviceability using standardized lateral and vertical loads. Structural cost, construction cost and duration, and aesthetics are important considerations. Virtual costs are assigned to critical features, including a sliding scale for material that promotes robustness without wastefulness. Engineers associated with the park will judge the competition and will award the design-build contract to the company whose model satisfies specified requirements and best achieves project objectives."

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.

People and Companies

- **Richard Garlock, PE**, has been named a partner of New York-based **LERA Consulting Structural Engineers**. Garlock, who has been with LERA since 1994, currently leads many of LERA's residential, mixed-use, and office developments in the Northeast and internationally. Other recent LERA promotions include **Antonio Rodriguez, PE**, to associate partner and the following employees to senior associate: **Halle Doenitz, PE**, **Michael Hopper, PE**, **Thomas Kelleher, PE**, and **Alfonso Oliva**.

- **Cives Steel Company**, an AISC full member fabricator, recently purchased 25 acres of land in El Mirage, Ariz., with plans to establish a new fabrication facility. With the addition of this new location, the company will have eight fabrication locations across the country. As six of these plants are located in the eastern U.S., the new El Mirage facility will focus primarily on serving the Southwest portion of the country.

- **SteelFab, Inc.**, announced that it has acquired a majority interest in L&M Industrial fabrication. Both companies are AISC member fabricators. The acquisition will expand Charlotte, N.C.-based SteelFab's capabilities to better serve clients on the West Coast. L&M is located in Tangent, Ore., where its more than 75 employees fabricate structural and miscellaneous steel for commercial, industrial, and specialty projects.

SAFETY

AISC Names 2018 Safety Award Winners

AISC has recently honored more than 60 structural steel fabrication and erection companies with AISC Safety Awards for their excellent safety performance records in 2018. Awards are given in the categories of "Fabricator" and "Erector" and include the Safety Award of Honor—AISC's top safety award, presented for a perfect safety record of no disabling injuries—as well as the Safety Certificate of Merit and the Safety Certificate of Commendation.

All AISC full member fabricators and associate member erectors are eligible and asked to participate, and data for the program is solicited annually. In order to facilitate data collection and to make statistics meaningful in terms familiar to safety professions, the program uses data that companies also report to the Occupational Safety and Health Administration (OSHA). The program recognizes performance in terms of Days Away, Restricted, or Transferred Rate (DART), a measure of the number of recordable lost work cases per 200,000 man-hours worked. Only the number of cases (not days) that are required to be reported on the OSHA 300A form and that cause a lost workday, as defined by OSHA, are reported to AISC, along with the hours worked in the year.

"Nobody has a stronger commitment to safety than the steel industry," explained AISC's president, Charlie Carter. AISC Safety Awards are given for perfect records (Honor, DART = 0), excellent records (Merit, 0 < DART ≤ 1) and commendable records (Commendation, 1 < DART ≤ 2).

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

For more information about the program, as well as safety resources available to the fabricated and erected structural steel industry, please visit **www.aisc/org/safety**. This year's winners are as follows:

2018 SAFETY AWARD ★★★

Fabricator Honor Award
American Steel Fabricators, LLC
B&B Welding Company, Inc.
BENCHMARK Fabricated Steel
Center Point Contractors, Inc.
Chesapeake Bay Steel, Inc.
Cianbro Corporation
Cianbro Fabrication & Coating Corporation
Clark Steel Fabricators, Inc.
Cooper Steel
DeAngelis Iron Work, Inc.
Eddy's Welding, Inc.
Epic Steel Company
Fiedeldey Steel Fabricators, Inc.
G2 Metal Fab, Inc.
Garbe Iron Works, Inc.
The Gateway Company of Missouri, LLC
Gerace Construction Co., Inc.
GMF Industries, Inc.
GT Grandstands, Inc.
Hercules Steel Company, Inc.
Industrial Constructors/Managers, Inc.
Industrial Fabricators, Inc.
Irwin Steel
J.R. Hoe and Sons
K&T Steel Corporation
Larwel Industries
Lyndon Steel
Moore & Morford, Inc.
NOVA Group, Inc.
Phoenix Fabrication & Supply, Inc.
Pikes Peak Steel, LLC
Process Systems Incorporated Construction Company
Ramar Steel Sales, Inc.
Reno Iron Works
Rochester Structural, LLC
Shickel Corporation
Steel Erectors, Inc.
Steel Service Corporation
Steward Steel, Inc.
Structural Steel of Carolina, LLC
S.W. Funk Industrial Contractors, Inc.
Systems Fab & Machine, Inc.
Trinity Fabricators, Inc.
Tubal-Cain Industries, Inc.

Erector Honor Award
Ben Hur Steel Worx, LLC
Black Cat, LLC
Chesapeake Bay Steel, Inc.
Clark Steel Fabricators, Inc.
Cooper Steel
Douglas Steel Fabricating Corporation
Eddy's Welding, Inc.
Industrial Constructors/Managers, Inc.
JPW Structural Contracting, Inc.
Peterson Beckner Industries, Inc.
Process Systems Incorporated Construction Company
Ramar Steel Sales, Inc.
Reno Iron Works
Rochester Structural, LLC
San Joaquin Steel Co., Inc.
S.W. Funk Industrial Contractors, Inc.
Systems Fab & Machine, Inc.
Tubal-Cain Industries, Inc.

2018 SAFETY AWARD ★★

Fabricator Merit Award
Covenant Steel Warehouse, Inc.
Industrial Mechanical, Inc.
Southwest Ironwork, Inc.
PKM Steel Service, Inc.
Prospect Steel, a Division of Lexicon, Inc.

Erector Merit Award
Ideal Contracting
Kraemer North America
LPR Construction Co.
Williams Erection Co., Inc.

2018 SAFETY AWARD ★

Fabricator Safety Commendation
The Arthur Louis Steel Company
Ben Hur Steel Worx, LLC
Custom Metals, a Division of Lexicon, Inc.
Douglas Steel Fabricating Corporation
Environmental Air Systems, LLC
Ford Steel, LLC
Geiger & Peters, Inc.
High Industries
Hillsdale Fabricators, a Division of Alberici Constructors
North Alabama Fabricating Company, Inc.
Slay Steel, Inc.

Erector Safety Commendation
Lee's Imperial Welding, Inc.
Stonebridge, Inc.

correction

TRICK QUESTION?

It has been brought to our attention that the calculation in the answer for Question 5 of the March 2019 Steel Quiz was incorrect. The correct calculation is as follows:

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., $n = m = (N - 0.95 \times d)/2$ = (10 in. – 0.95 × 6 in.)/2 = 2.15 in., therefore l = 2.15 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:

$$t_{min} = l\sqrt{\frac{2P_u}{\phi F_y BN}} = 0.36 \text{ in.}$$

Use a ½-in. plate thickness, as recommended on page 3 of the Design Guide.

advertiser index

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

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

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

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

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

Controlled Automation DRL344 CNC Beam Drill Line, Hem WF140 Saw, Tandem Line, 2008 **#24937**

Ficep Gemini 324PG Plate Processor, 10′ x 40′, 15 HP Drill, HPR260XD Plasma Bevel Head, (1) Oxy, 2014 **#28489**

Peddinghaus 623-0 CNC Angle Line, 6″ x 6″ x 5/8″ Capacity, 75 Ton Punch, 230 Ton Shear, Siemens CNC Ctrl, 2006 **#29317**

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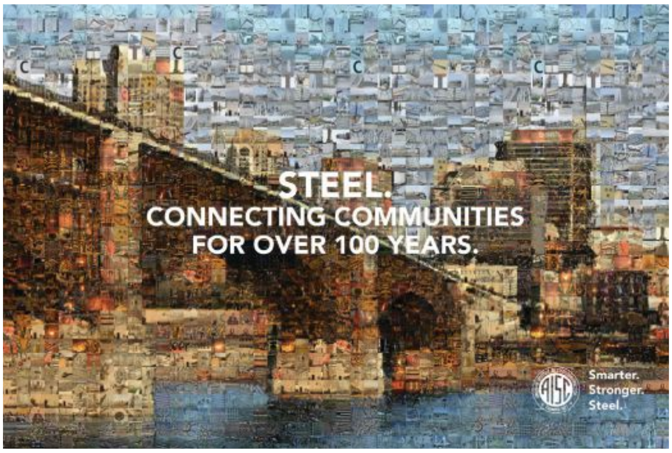
Ronald Semmick

A CENTURY (AND THEN SOME) OF STRENGTH

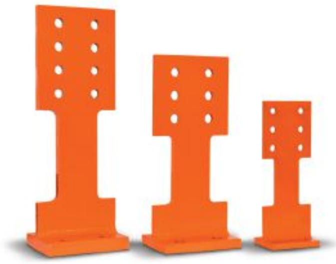
NEARLY A CENTURY before St. Louis' Gateway Arch opened in 1965, another arch—or rather, set of arches—served as an icon for the city: the Eads Bridge.

Opened in 1874 and named for its designer and builder, James Buchanan Eads, the steel-framed arch structure was the first bridge to be built across the Mississippi River south of the Missouri River, as well as one of the first large-scale uses of steel as a structural material. Comprised of three steel arches—the longest being the center arch, at 520 ft—the total length of the 46-ft-wide bridge, including approach spans, is 6,442 ft. Originally built as a railroad bridge, it currently carries pedestrian and automobile traffic—more than 8,000 vehicles per day—as well as the St. Louis MetroLink light rail train across the Mississippi between St. Louis and East St. Louis, Ill.



The bridge is one of the best, most enduring examples of how steel bridges can provide a century of service—and in this case, nearly a century-and-a-half and counting. It was also celebrated in the form of a photo mosaic at last month's NASCC: The Steel Conference in St. Louis, where attendee photos were stitched together to form an image similar to the one above.

If you missed the conference—or were there but didn't get to all of the sessions you'd hoped—you can view recordings of the presentations approximately 45 days after the show at **www.aisc.org/2019nascconline**. And remember to mark your calendars for next year's conference, taking place April 22–24 in Atlanta!



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