Modern Steel Construction

May 2023


PEDDIASSEMBLER VS MANUAL
TRIPLE PASS WELD 6.6 TONS OF STEEL
5 HOURS
59 MINUTES
111 TACKS
215 WELDS
45 PARTS
31 ROTATIONS
0 ERRORS
THE PEDDIASSEMBLER
13 HOURS
12 MINUTES
256 TACKS
216 WELDS
45 PARTS
35 ROTATIONS
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Modern Steel Construction

May 2023

Hadley Fruits

ON THE COVER: SoFi Stadium keeps itself grounded, thanks to its playing field being 100 ft below grade. But its high-profile roof helps it visually soar above its surroundings, p. 28. (Photo: SoFi Stadium)

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Words matter.

So do facts and figures.

And now you might be thinking, "Wow, thanks, Captain Obvious!"

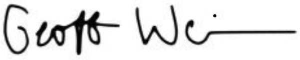
But when it comes to sustainability, some things that perhaps should be obvious aren't, and we sometimes fall for "conventional wisdom" that's really just cleverly packaged preconceived notions or that stems from outdated information and perceptions that we sometimes just can't seem to shake. Sort of like when I was in Greece a few years ago, and a local asked where I was from. When I told him I lived in Chicago, he said, "Ah, Al Capone!" and then mimicked shooting a Tommy gun, complete with sound effects. I was hoping for something closer to the present, like, "Ah, Michael Jordan!" followed by mimicking a slam dunk or jump shot, but whatever.

When it comes to sustainability and building materials, if someone says, "Wood," a common mental response might be, "Natural, renewable, or abundant," and if someone says, "Steel," a common (outdated) response might be, "Dirty or energy-intensive." But really, both occur in nature, one is made from the most abundant element on the planet (which is actually moot here in the U.S., and I'll get to that in a minute), one uses a lot of electricity in its production (and electricity production will become much less environmentally impactful as the grid and industrial firms turn more and more to renewable sources), and one isn't threatened by questionable forest management practices. I could go on, but Brian Raff has already laid out plenty of facts and figures in this month's Data Driven column on page 20.

In terms of words, you've heard AISC talk for a while now about the differences between EAF (electric arc furnace) and BOF (basic oxygen furnace) steelmaking and how the former has a lower carbon footprint than the latter—and also accounts for the vast majority of structural steel production in the U.S. Recently, one of AISC's member producers, Nucor, adopted some simple terminology to help differentiate between EAF and BOF: circular and extractive. These aren't just new buzzwords. In a word apiece, they accurately describe these two different steelmaking processes—and, frankly, do a better job of this than the technical names themselves.

In a nutshell, extractive describes a process where new iron ore is mined to create steel, while circular acknowledges the, well, circular life-cycle of structural steel—i.e., the fact that it's not a cradle-to-grave material but rather a cradle-to-cradle material that can be recycled back into the structural steelmaking process infinitely without loss of strength or properties. You'll be seeing more of these two terms in AISC publications, social media, and promotional materials moving forward, and we encourage you to adopt them. (And for a larger-scale description of the circular versus extraction concept, check out this article from the UN: **unep.org/news-and-stories/story/role-resource-extraction-circular-world**.)

Language and numbers aside, nothing is more telling than real-world examples. If you want to see some great projects that illustrate steel's resiliency, sustainability, and adaptability, check out the winners of the 2023 AISC IDEAS^2 Awards, starting on page 28. You'll see multiple adaptive reuse projects (including an excellent example of steel and wood working hand in hand). *And* you can also hear from a structural engineer, Mark Waggoner of Walter P Moore, who worked on one of this year's winners in the Field Notes section on page 22.



Geoff Weisenberger
Chief Editor

Modern Steel Construction

Editorial Offices
130 E Randolph St, Ste 2000
Chicago, IL 60601
312.670.2400

Editorial Contacts
CHIEF EDITOR
Geoff Weisenberger
312.493.7694
weisenberger@aisc.org

PUBLISHER
Keith A. Grubb, SE, PE
312.804.0813
grubb@aisc.org

GRAPHIC DESIGN MANAGER
Kristin Hall
773.636.8543
hall@aisc.org

EDITORIAL DIRECTOR
Scott Melnick
312.804.1535
melnick@aisc.org

Advertising Sales
M.J. Mrvica Associates, Inc.
2 W Taunton Avenue
Berlin, NJ 08009
856.768.9360
mjmrvica@mrvica.com

Address Changes and Subscription Concerns
312.670.2401
subscriptions@aisc.org

Reprints
Kristin Hall
hall@aisc.org

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

Single-Angle Compression Members

Are AISC *Specification* Sections E5(a) and E5(b) applicable for frame members, or are they applicable for truss members only?

If the requirements in the 2022 AISC *Specification for Structural Steel Buildings* (ANSI/AISC 360), Section E5, are met, E5(a) is applicable to "individual members." These "individual members" are not required to be part of a truss. However, E5(b) is applicable only to "web members of box or space trusses."

Bo Dowswell, PE, PhD

Evaluating Bolt Strength in Old Structures

I am evaluating an existing structure designed in the mid-1950s for new loading conditions. The 5th Edition AISC *Steel Construction Manual* includes allowable stresses for bolts that are lower than what I would expect to see today. Are there any available provisions that would allow one to determine a higher bolt strength when a structure is evaluated for new loading conditions? Additionally, is there any way to know what the bolt material is when there are no markings on the existing bolt heads?

Appendix 5, Section 5.2.6 of the 2022 AISC *Specification* states, "Representative samples of bolts shall be visually inspected to determine markings and classifications. Where it is not possible to classify bolts by visual inspection, representative samples shall be taken and tested to determine tensile strength in accordance with ASTM F606/F606M and the bolt classified accordingly. Alternatively, the assumption that the bolts are ASTM A307 is permitted..."

Section 5.3.2 states, "Forces (load effects) in members and connections shall be determined by structural analysis applicable to the type of structure evaluated. The load effects shall be determined for the loads and factored load combinations stipulated in Section B2. The available strength of members and connections shall be determined from applicable provisions of Chapters B through K and Appendix 5 of this *Specification*."

The analysis and design do not have to be completed using the method originally used. Applicable provisions of the 2022 Specification can be used. This will provide a little more strength compared to what you have been assuming.

As far as the bolt material, unless "representative samples [are] taken and tested to determine tensile strength," the bolts should be assumed to be ASTM A307.

Larry Muir, PE

Seeking Column Splice Detail Input: A Question in Two Parts

Part 1: I am working on some updates to our typical details and had some questions regarding the requirements for removing weld backing. More specifically, our current standard detail for column splices requires the removal of weld backing at complete-joint-penetration (CJP) groove welds (see Figure 1). This detail is intended to be used in high-seismic applications.

After looking into this issue, I think this requirement can be reworded, allowing the backing to stay in place as a default, but I would like your thoughts on this.

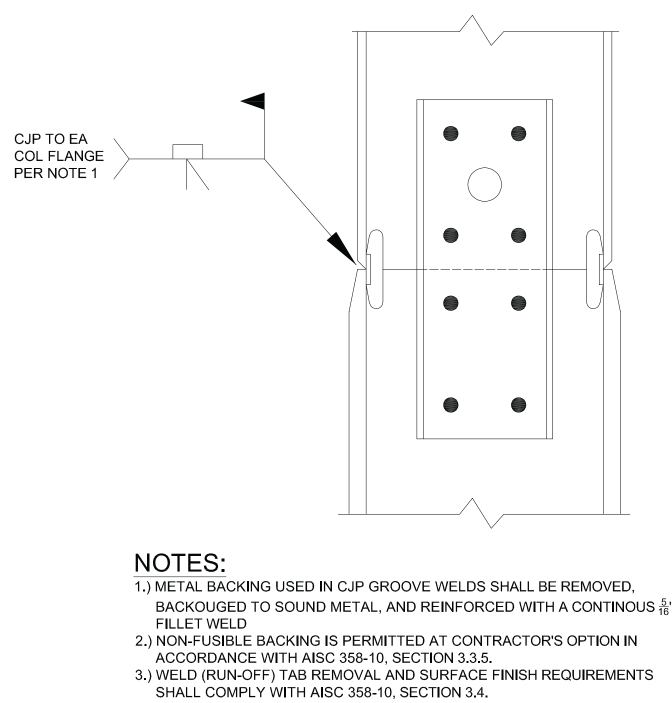


Fig. 1. Typical Column Splice – Seismic Force-Resisting System Columns
Note: Most of the information has been left off of the detail shown in order to keep the focus on the questions asked and the response provided.

Section D2.5d of the 2016 AISC *Seismic Provisions for Structural Steel Buildings* (ANSI/AISC 341) provides requirements for structural steel splice configurations and states, "For welded butt-joint splices made with groove welds, weld tabs shall be removed in accordance with AWS D1.8/D1.8M clause 6.16. Steel backing of groove welds

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

need not be removed." Contrary to Note 1, and as you suspected, the backing is not required to be removed. There are, however, cases where backing may need to be removed. The commentary to Section A4.2 in the *Seismic Provisions* states, in item (g):

> "The presence of backing may affect the flow of stresses within the connection and contribute to stress concentrations. Therefore, backing removal may be required at some locations. Removal of backing should be evaluated on a joint-specific basis based upon connection prequalification requirements or qualification testing. AWS D1.8/D1.8M provides details for weld backing removal, additional fillet welds, weld tab removal, tapered transitions, and weld access holes."

Section A4.2 in the *Seismic Provisions* provides a list of items that need to be indicated in the structural design drawings and specifications. Item (g) indicates that these documents need to note the locations where weld backing is required to be removed. Item (h) indicates that these documents need to note where fillet welds are required when weld backing is permitted to remain. However, there is no additional requirement to show the locations where backing is permitted to stay where fillet welds are not required. Since weld backing is not required, it may be better to simply remove the note altogether versus rewording it.

The February 2017 SteelWise article "Take a Moment To Consider this Moment Connection" provides a good discussion on the treatment of weld backing.

Part 2: For cases where backing needs to be removed, is it required to be back-gouged and reinforced?

Removing backing and weld root treatment is addressed in Section 6.13 of AWS D1.8/D1.8M: *Structural Welding Code—Seismic Supplement* (**pubs.aws.org**). Please consider these comments about the column splice detail shown:

1. The attached detail calls for a reinforcing fillet in Note 1. It is not clear what this fillet weld detail would look like or if it would meet the requirements in AWS D1.1. Adding a weld beyond the CJP groove weld could theoretically be detrimental. The caption to Figure 2b in the above-mentioned SteelWise article states, "Backing can remain in place at butt joints due to less uncertainty regarding stress flow." If the backing is removed and back-gouged, and then some weld metal has been added onto the outside of the CJP groove weld, it seems that we are increasing uncertainty regarding stress flow. The added weld will have some stiffness and, therefore, some stress will be drawn towards this stiffness and away from the otherwise smooth path that exists with the backing removed. Additionally, the weld could concentrate stress. This is especially true since the geometry of a fillet that exists other than at a reentrant corner is ill-defined. This note appears to be requiring extra work that could potentially be detrimental.
2. The references to AISC *Prequalified Connections for Special and Intermediate Steel Moment Frames for Seismic Applications* (ANSI/AISC 358) do not seem like the best way to meet what is likely intended by this note. *Prequalified Connections* does not address column splices; in some cases, the referenced language explicitly addresses conditions other than column splices. For example, Section 3.3.5 in *Prequalified Connections* states, "Where non-fusible backing is used with CJP groove welds between the beam flanges and the column, the backing shall be removed and the root back-gouged to sound weld metal and back-welded with a reinforcing fillet."

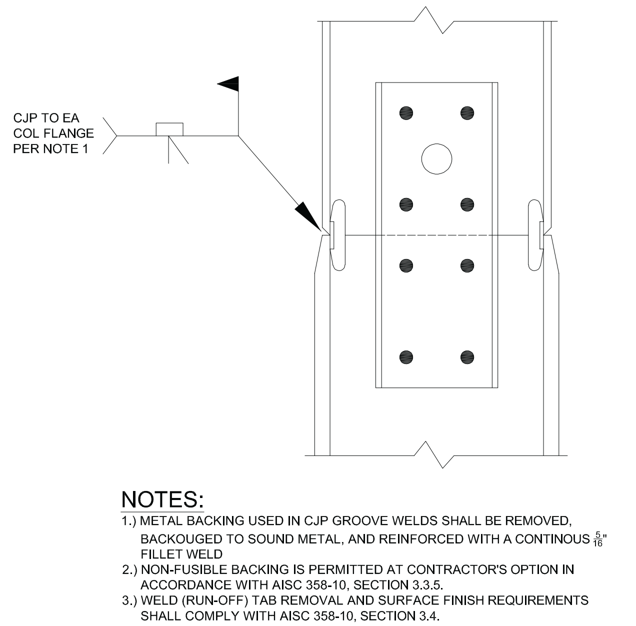


Fig. 1 (repeated for clarity). Typical Column Splice – Seismic Force-Resisting System Columns. Note: Most of the information has been left off of the detail shown in order to keep the focus on the questions asked and the response provided.

Note 2 states that non-fusible backing is permitted in accordance with Section 3.3.5. But in order to be in accordance with ANSI/AISC 358, the weld needs to be made between a beam flange and a column.

Larry Muir, PE

STEEL SOLUTIONS CENTER

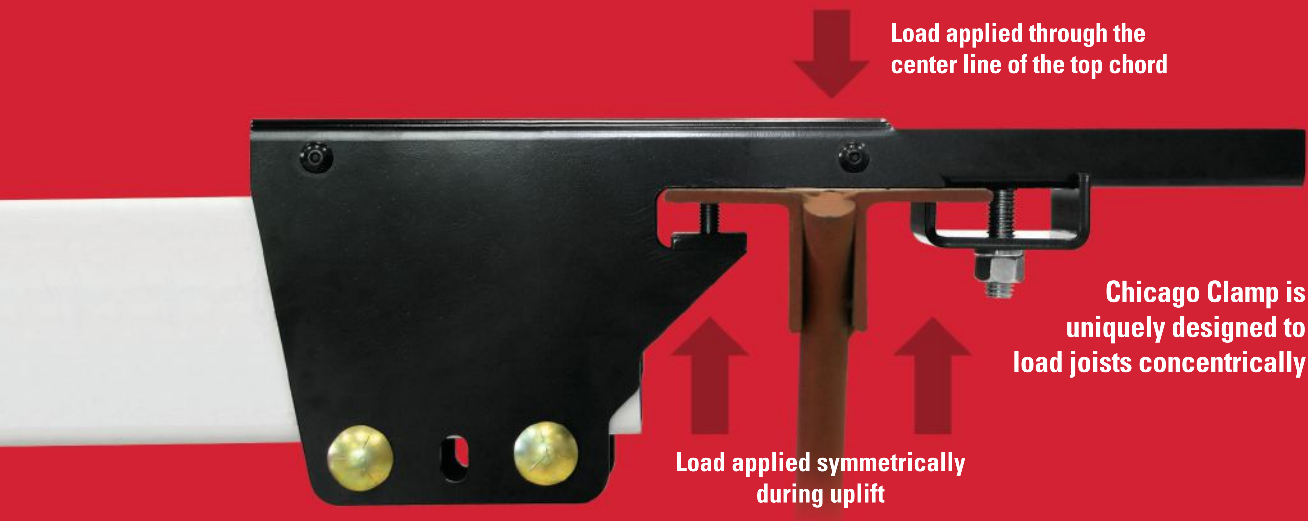
Bo Dowswell, principal with ARC International, LLC, and **Larry Muir** are consultants to AISC.

A Steel Joist Is A Beautiful Thing. Why Not Treat It Right?

"The design of open web steel joists is based on concentric loading. Asymmetrical loading can reduce joist strength."

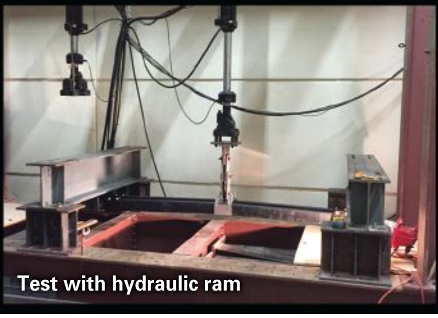
- Steel Joist Institute

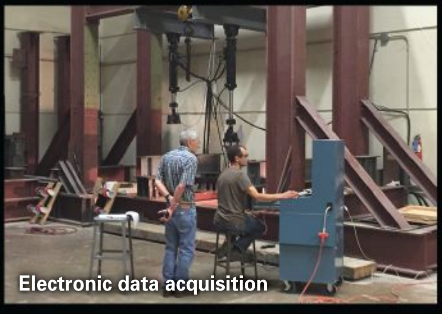
Treating a steel joist right requires loading joists in accordance with their design criteria. Loads must be applied to both chord angles without creating a torsional moment. With that fact in mind, **Chicago Clamp Company** has designed and tested their Tube Framing Clamp System.



- The clamp's strength and stiffness transfer the load vertically to the center of the joist's top chord in download and transfer symmetrically during uplift.
- Testing was performed using rocker end-attachments to avoid reliance on torsional strength of the joist chord.
- Clamping to joists avoids possible detrimental effects of welding to joists that are under stress due to loading.
- Clamping has the economic benefits of reducing labor costs, reducing installation mistakes, and reducing job delays (associated with locating and sizing curbs and openings prior to steel joist installation).


Fall protection test using rockers


Test with hydraulic ram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SJI SMACNA KEYSTONE SFA NEED FOR SPEED

steel quiz

This month's Steel Quiz focuses on design considerations and features of the various 2023 AISC IDEAS^2 Award winners (which you can read about starting on page 28). The questions and answers were developed by Brandon Presley, an AISC intern and a student at the Illinois Institute of Technology.

1 **True or False:** Weathering steel is required to be painted or galvanized for corrosion resistance.

2 **True or False:** AISC Design Guide 18 is the go-to resource for rehabilitation and retrofit projects.

3 Which of the following bend types refers to a member that is curved about a non-principal or non-geometric axis?
a. Compound bend
b. Off-axis bend
c. Reverse-compound bend
d. Standard bend

4 Which of the following curving methods is rarely used due to the higher fabrication cost and inevitable stress concentrations where the member changes direction at the miter joint?
a. Bending
b. Heat curving
c. Segmenting
d. Cutting to curve

5 **True or False:** In the evaluation of an existing structure, the strength and stiffness can only be evaluated by load tests.

6 **True or False:** Buckling-restrained braced frame systems are a special class of concentrically braced frames characterized by the brace's ability to yield in compression as well as in tension.

7 Which of the following is/are a category of general design criteria for façade and exterior wall systems on a building?
a. Envelope performance
b. Provisions for movement
c. Structural integrity
d. All the above

8 The IDEAS^2 awards showcase the innovative use of structural steel in which of the following ways?
a. The accomplishment of the structure's program
b. The expression of architectural intent
c. The application of innovative design approaches to the structural system
d. Leveraging productivity-enhancing construction methods
e. All of the above

TURN TO PAGE 14 FOR ANSWERS

All mentioned AISC publications are available at **aisc.org/publications**.

1 **False.** Steel with atmospheric resistance, commonly referred to as weathering steel (or the trade name COR-TEN, developed by U.S. Steel), does not require any coating for corrosion resistance. The surface of weathering steel oxidizes over time under normal atmospheric conditions and develops a protective patina that bonds with the surface, precluding further corrosion. Steel with atmospheric resistance can be specified for building construction as ASTM A588 for hot rolled shapes and A847 or A1065 Grade 50W for HSS shapes. IDEAS^2 Merit Award winner Michael and Quirsis Riney Primate Canopy Trails incorporates uncoated weathering steel.

2 **False.** Design Guide 15: *Rehabilitation and Retrofit* is an extensive resource for any rehabilitation or retrofit project. The guide includes historical reviews of AISC Specifications and Manuals, as well as the *RCSC Specification* and ASTM standards. The following IDEAS^2 winners all involved the rehabilitation or retrofit of existing structures: MacLac Building D (Rebirth of a Historic Paint Factory), The Eskenazi School of Art, Architecture + Design, American Family Insurance Amphitheater, Federal Reserve Building, Climate Pledge Arena, and Moynihan Train Hall.

3 **b**. Off-axis bend. For off-axis bends, also called conical rolling, the member is curved about a non-principal or non-geometric axis. Most off-axis bends are fabricated with a constant rotation relative to the plane of curvature. The various geometries available for curved members and the methods used to bend these members are discussed in Design Guide 33: *Curved Member Design.* IDEAS^2 Merit Award winner Michael and Quirsis Riney Primate Canopy Trails incorporates curved steel members.

4 **c.** Segmenting. Segmented members are fabricated by splicing several straight members together, typically using miter joints at discrete locations to approximate the geometry of a curved member. Detailed guidance and practical information on the fabrication and detailing of curved members can be found in Design Guide 33: *Curved Member Design*. IDEAS^2 Merit Award winner Michael and Quirsis Riney Primate Canopy Trails incorporates curved steel members.

5 **False.** Appendix 5 of the 2022 AISC *Specification for Structural Steel Buildings* (ANSI/AISC 360) applies to the evaluation of existing structures. Section 5.1 states, "The evaluation shall be performed by structural analysis (Section 5.3), by load tests (Section 5.4), or by a combination of structural analysis and load tests, where specified in the contract documents by the engineer of record (EOR)." IDEAS^2 Merit Award winner Moynihan Train Hall involved coupon testing of the older steels for tensile properties, chemical composition, and base metal notch toughness.

6 **True.** Buckling-restrained braced frame (BRBF) systems are a special class of concentrically braced frames addressed in AISC *Seismic Provisions for Structural Steel Buildings* (ANSI/AISC 341), Section F4. Buckling-restrained braces (BRBs) are characterized by their ability to yield in compression as well as tension. Find out more about BRBF systems in the AISC *Seismic Design Manual*. IDEAS^2 National Award winner SoFi Stadium used an advanced structural system featuring BRBs and custom viscous-damper "lock-up devices," which provide lateral strength. IDEAS^2 Merit Award winner Climate Pledge Arena also used BRBs in the lateral system design of the new bowl structure.

7 **d.** All of the above. Design Guide 22: *Façade Attachments to Steel-Framed Buildings* groups general design criteria for façade and exterior wall systems into three categories: structural integrity, provisions for movement, and envelope performance. Chapter 2 of Design Guide 22 describes the design criteria for attaching façades, noting that details to accommodate one criterion will often conflict with other criteria, and it is important to balance all the competing needs for a successful attachment design. National Award winner Orange County Museum of Art overcame challenges with the design of the façade support system requiring full structural integration of the primary structural system and secondary façade system.

8 **e.** all of the above. The Innovative Design in Engineering and Architecture with Structural Steel (IDEAS^2) Award program recognizes projects that illustrate the exciting possibilities of building with structural steel. Learn more about the award program, and find out how to submit a project for the 2024 competition, at **aisc.org/ideas2**.

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


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Seismic Shift

BY JOHN HARRIS, SE, PE, PHD, AND CONRAD PAULSON, SE, PE

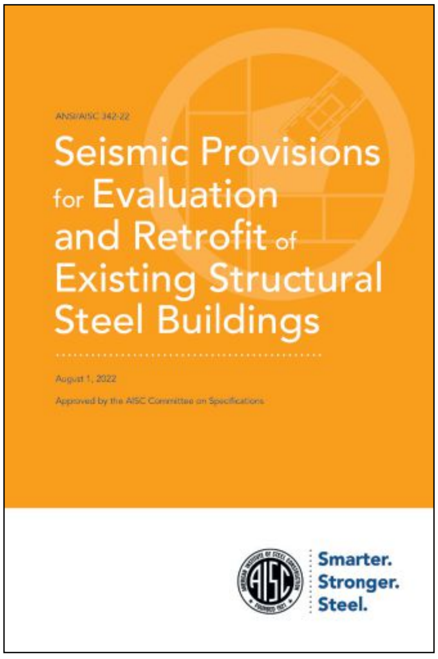
Designers now have a new AISC specification focused on the seismic evaluation and retrofit of existing steel buildings.

AISC HAS ALWAYS BEEN forward-thinking when it comes to seismic design but is now also taking a look back—at existing buildings.

Over the past seven years, the AISC Committee on Specifications (COS) and its task committees have worked to develop a new standard, AISC *Seismic Provisions for Evaluation and Retrofit of Existing Structural Steel Buildings* (ANSI/AISC 342-22). And it will be available this month at **aisc.org/specifications**.

Seismic Retrofit History

So how did it come to be? First, a little history on guidance for seismic retrofits. Engineers have long followed ASCE/SEI 41: *Seismic Evaluation and Retrofit of Existing Buildings* (ASCE/SEI 41-17) to evaluate the seismic performance of an existing structural steel building. This standard represents the current state-of-the-practice in seismic evaluation and retrofit of existing buildings and is considered a first-generation performance-based methodology. It and its preceding editions are referenced for use by the *International Existing Building Code*, the *California Building Code*, federal government building standards and guidelines—e.g., *Standards of Seismic Safety for Existing Federally Owned and Leased Buildings: ICSSC Recommended Practice 10 (RP 10-22)*—and mandatory seismic retrofit ordinances for several local jurisdictions. It provides analytical procedures and performance criteria for evaluating buildings and designing retrofits based on a defined performance objective.



In this context, seismic *evaluation* is defined as a methodology for evaluating deficiencies in components of a building that prevent the building from achieving the selected performance objective. Seismic *retrofit* is defined as the design of measures to improve the seismic performance of structural or nonstructural components of a building by correcting deficiencies identified in the seismic evaluation relative to the selected performance objective. ASCE/SEI 41-17 does not mandate the performance objective to be used in the evaluation. Instead, performance objectives are established in the policy of federal, state, or local jurisdictions or by the building owner.

ASCE/SEI 41-17 provides several analytical procedures to the engineer to determine the seismic demands on building components, classified as Tier 1, Tier 2, or Tier 3. Each tier differs in analytical complexity, and the selection of a particular tier will depend on what is being evaluated or retrofitted. The most detailed procedure is Tier 3, requiring the engineer to construct a model of the building and then subject that model to earthquake loading, similar to what would be done when designing a new building. ASCE/SEI 41-17, in Chapter 9, contains all the information needed to evaluate structural steel components. Three primary characteristics are given for various types of components: 1) stiffness, 2) strength, and 3) acceptance criteria; the latter is a measure of the capacity of the component measured against the performance objective.

Transitioning Seismic Requirements to AISC

The information provided in Chapter 9 of ASCE/SEI 41-17 was introduced in 1997 in FEMA 273: *NEHRP Guidelines for the Seismic Rehabilitation of Buildings* and subsequently updated over the course of two decades—and will be updated again this year in ASCE/SEI 41-23.

Over the same timeframe, AISC has been directly involved in developing seismic design provisions for structural steel components in new buildings. Today, the practice is to use ASCE/SEI 7: *Minimum Design Loads and Associated Criteria for Buildings and Other Structures* (ASCE/SEI 7), the AISC *Specification for Structural Steel Buildings* (ANSI/AISC 360), and the AISC *Seismic Provisions for Structural Steel Buildings* (ANSI/AISC 341) for seismic design of new buildings.

Prior to these last seven years, AISC had not been directly involved in the seismic aspects of *existing* buildings, though some AISC committee members did sit on the respective FEMA project committees, the ASCE 41 main committee, and the ASCE 41 steel subcommittee. For the most part, Chapter 9 of ASCE/SEI 41-17 references the AISC *Specification* for component strengths and other characteristics. However, it became apparent that its update cycle was not happening as quickly as that of other seismic standards, such as the AISC *Seismic Provisions*.

After ASCE/SEI 41-13 was published, it was decided that AISC would develop companion provisions with the goal that they would be used as the resource document for new technical provisions in Chapter 9.

A memorandum of understanding between AISC and ASCE provided a pathway for this to occur, and the effort started as a work item for a subcommittee under AISC COS Task Committee 9—Seismic Systems, with the objective of preparing existing building seismic provisions as an appendix in AISC 341. It subsequently became a major work item for COS Task Committee 7—Evaluation and Repair, which took over and developed a completely new standard, the *Seismic Provisions for Evaluation and Retrofit of Existing Structural Steel Buildings*. This development effort was completed in early 2022, and the ASCE 41 Committee recently approved that Chapter 9 of the ASCE/SEI 41-23 standard will reference this new AISC standard for structural steel requirements rather than reprinting these provisions in Chapter 9 (which avoids a circumstance where the exact requirements appear in two separate documents conforming to the distinct editorial formats of both AISC and ASCE). With this arrangement set, it is essential to recognize that the new *Seismic Provisions for Existing Structural Steel Buildings* is to be used with ASCE/SEI 41, similar to how the AISC *Seismic Provisions* standard is used with ASCE/SEI 7 for new building design—i.e., *Seismic Provisions for Existing Structural Steel Buildings* is not a "standalone" document.

A Brief Overview

Engineers familiar with Chapter 9 of ASCE/SEI 41-17 will notice that the *Seismic Provisions for Existing Structural Steel Buildings* is formatted similarly to other AISC standards and that the layout between the two is very different. First, *Seismic Provisions for Existing Structural Steel Buildings* was set up to follow a workflow that engineers would most likely follow in practice. The standard starts with the information needed to conduct a condition assessment of the building and gather information pertinent to the development of the building model and analysis, such as material properties and information about components (members and connections). It has also extracted all component-related requirements from the sections on structural systems (moment frames and braced frames) and put these requirements into one chapter. This format minimizes cross-referencing of components between systems and maximizes flexibility for modeling and evaluating the entire structural system that resists seismic forces and deformations (this was done in recognition of the fact that existing buildings may not contain a "designated" seismic force-resisting system). The chapter on components is broken down by type: beams, columns, braces, panel zones, connections, etc. Future editions may expand this chapter to include new components or rearrange components—e.g., columns and buckling braces separated into separate subsections. The last few chapters deal with system-level requirements—e.g., eccentrically braced frames—that reference individual components when applicable. A high-level "mapping" between the major sections of the new specification and Chapter 9 of ASCE/SEI 41 17 is given in Table 1.

This inaugural edition of the *Seismic Provisions for Existing Structural Steel*

TABLE 1:
AISC *Seismic Provisions for Existing Structural Steel Buildings* sections and their equivalent in Chapter 9 of ASCE/SEI 41-17

AISC: *Seismic Provisions for Evaluation and Retrofit of Existing Structural Steel Buildings*	**ASCE/SEI 41-17, Chapter 9**
A General Provisions A1 Scope A2 Referenced Specifications, Codes, and Standards	9.1 Scope
A3 General Requirements A4 Document Review and Condition Assessment A5 Material Properties A6 Subassembly Tests	9.2 Material Properties and Condition Assessment
B General Requirements of Components	9.3 General Assumptions and Requirements
C Component Properties and Requirements	[No corresponding section in ASCE/SEI 41-17, Chapter 9. Component requirements were relocated from Section 9.4 and 9.5.]
D Structural Steel Moment Frames	9.4 Steel Moment Frames
E Structural Steel Braced Frame and Steel Plate Shear Wall Requirements	9.5 Steel Braced Frames
F Structural Steel Frames with Infills	9.6 Steel Frame with Infills
G Diaphragms	9.10 Diaphragms
H Structural Steel Pile Foundations	9.11 Steel Pile Foundations
I Cast and Wrought Iron	9.12 Cast and Wrought Iron

Buildings includes some technical improvements from ASCE/SEI 41-17. Some of the significant changes are as follows:

- The provisions on condition assessment, material properties, and existing welds received a thorough overhaul, and provisions for making new welds to existing steel have been added
- All beam types are consolidated into one section, and provisions for shear-controlled beams in a moment frame and shear-controlled beams in an eccentrically braced frame are in the same section
- The biaxial axial force-bending moment interaction equations were advanced to focus on the deformation-controlled action (i.e., flexure), which also aligns with ASCE/SEI 41-17, Chapter 7
- Provisions for fully restrained and partially restrained moment frame connections are improved and supplemented with new data
- Provisions for column splices were incorporated
- Provisions for braced frames with buckling braces and their connections were improved based on current research

Future Plans

With the first edition of the *Seismic Provisions for Existing Structural Steel Buildings* now complete, the COS and Task Committee 7 have turned their attention to the next development cycle, with the next edition planned for 2029. Future development of this standard is expected to match the ASCE/SEI 41 development cycle, which has typically been published one year after ASCE/SEI 7. This will also allow the development cycle of the AISC *Specification* and the AISC *Seismic Provisions* to be concluded in the prior year to facilitate referencing those provisions in the *Seismic Provisions for Existing Structural Steel Buildings*.

The publication of ANSI/AISC 342-22 marks the culmination of a multi-year effort by AISC to become technically established in the seismic evaluation and retrofit of existing structural steel buildings. The relationship between AISC and ASCE will undoubtedly enhance the usability and strength of ASCE/SEI 41, resulting in more efficient seismic evaluation and design of existing buildings.■

Conrad Paulson is a principal in structural engineering at Wiss, Janney, Elstner Associates, Inc., and Chair of AISC Task Committee 7. **John Harris** is is the acting director, and a research structural engineer, of the National Earthquake Hazards Reduction Program at the National Institute of Standards and Technology and Vice-Chair of AISC Task Committee 7.

Sustainability By the Numbers

BY BRIAN RAFF

The numbers say it all: Steel is part of the solution, not the problem.

I'M ALWAYS AMAZED when I talk with sustainability practitioners about the sustainable aspects of steel.

More often than not, I find that these folks, like many of us, have been influenced by some misleading headline that paints U.S. structural steelmaking as a dark and messy industry. The truth is that while global steel production has historically been seen as environmentally unfriendly, the American steel industry is the cleanest and most energy-efficient of the leading steel industries in the world–and it's actually been that way for decades.

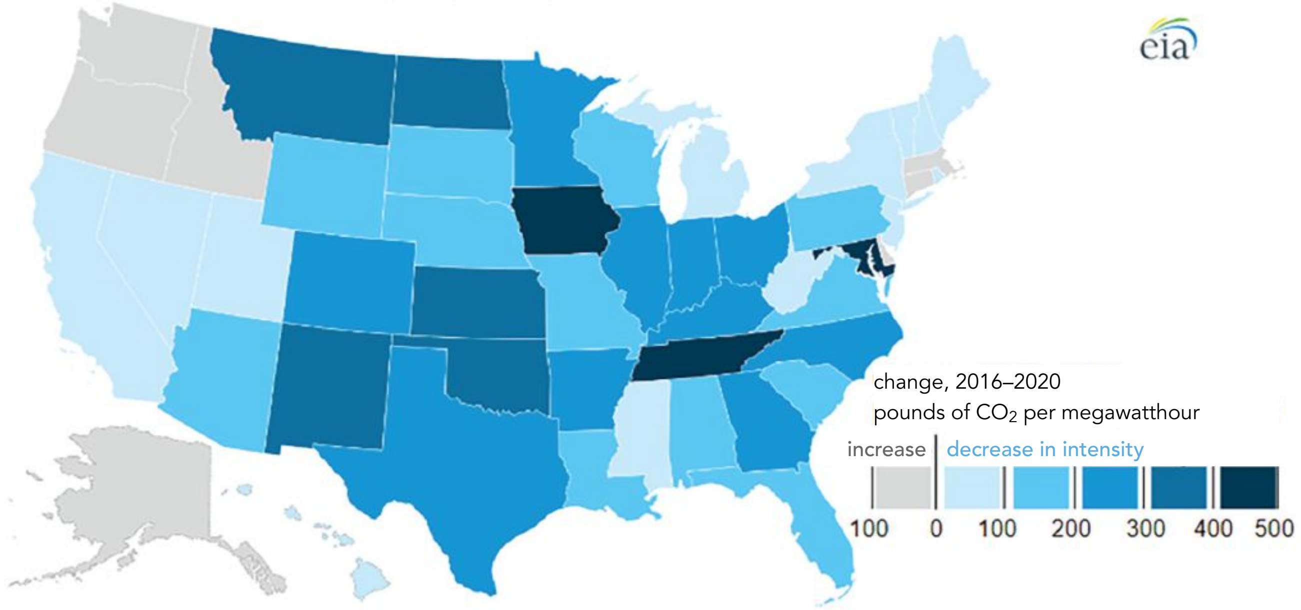
In fact, of the seven largest steel-producing countries, the U.S. has the lowest CO_2 emissions per ton of steel produced and the lowest energy intensity. By contrast, Chinese steel production creates CO_2 emissions that are almost 2.5 times higher—and uses 50% more energy compared to the U.S.—per ton of steel produced, according to a study sponsored by Global Efficiency Intelligence.

All structural steel shapes produced in the U.S. are made in electric arc furnaces (EAFs), which use electricity to melt cars, refrigerators, decommissioned bridges, and other scrap into new steel without any loss of quality. The average new member contains 93% recycled steel, and EAF steelmaking has 75% less emitted CO_2 than basic oxygen furnace (BOF) steelmaking.

Steel producers in the U.S. have also announced recent projects that employ renewable energy to supply all or most of a facility's energy requirements, and additional research is underway to assess the use of carbon-capture technology in the steelmaking process. As a result of these and other advancements in steelmaking and energy efficiency, the U.S. steel industry has reduced its energy intensity by 35% and CO_2 emissions intensity by 37% per ton of steel shipped since 1990, according to the American Iron and Steel Institute (AISI). Furthermore, Environmental Protection Agency (EPA) data indicates that the production of iron, steel, and metallurgical coke in the U.S. amounted to less than 1% of national CO_2 emissions when compared to the global scale of total CO_2 emissions from steel, which is nearly 7%. And on the fabrication side, some AISC members, such as Lexicon and SteelFab, have invested heavily in solar power for their facilities (for an article on the latter, see "Solar Steel," in the February 2020 issue at **www.modernsteel.com**).

The numbers don't just look back but also forward, and industry innovations will continue to decrease the CO_2 intensity of steel produced in the U.S. The structural steel industry is serious about decarbonization—and its

Fig. 1.
Change in Carbon Intensity of Power Generation by State (2016–2020)



footprint will continue to decrease as the U.S. power grid becomes less dependent on fossil fuels. According to the Energy Information Administration (EIA) Power Plant Operations Report, 43 states have decreased their carbon intensity of power generation between 2016 and 2020. Iowa and Tennessee are both leading the charge, reducing their carbon intensity by more than 500 lb CO_2 per megawatt-hour over that time period (Figure 1).

But American structural steel mills aren't waiting for the power grid to catch up. They're making their own public commitments to reduce greenhouse gas emissions or intensity:

- Nucor has pledged to reduce greenhouse gas intensity by 35% by 2030
- Steel Dynamics has pledged to go carbon neutral by 2050
- Cleveland-Cliffs has pledged to reduce greenhouse gas emissions by 25% by 2030
- Gerdau just launched an 80-megawatt solar farm to generate clean, renewable electricity for its production line in Midlothian, Texas

When choosing a sustainable structural material, you need the full story. AISC works with some of the largest mills in the country to develop accurate industry-average environmental product declarations (EPDs) that consider a number of environmental impacts related to the manufacture of steel, including global warming potential, ozone depletion, acidification, eutrophication, and ozone creation.

Other materials' documentation excludes important carbon emission sources, like decomposing harvest waste and the release of embodied carbon at the end of a product's service life. Steel "waste" goes right back into the supply chain, avoiding landfills completely. With steel, you get the complete picture. Learn more at **aisc.org/epd**.

When we say that American structural steel is part of the solution, that's not a meaningless platitude. It's a fact backed by solid numbers. ■

Brian Raff (**raff@aisc.org**) is AISC's vice president of market development, marketing communications, and government relations.

Powerful Percentages

How does domestically produced hot-rolled structural steel stack up sustainability-wise?

- 93% recycled content
- 98% recycling rate
- 95% of U.S. production is represented by facility-specific environmental product declarations (EPD)
- 75% is produced via electric arc furnace (scrap-based)
- 41% reduction in global warming potential can be achieved if the U.S. grid became 100% renewable tomorrow–and that's only from Scope 2 emissions reductions (i.e., indirect emissions from the generation of purchased electricity, steam, heating, and cooling consumed by the reporting company)

Covering the Super Bowl(s)

INTERVIEW BY GEOFF WEISENBERGER

Mark Waggoner's experience designing long-span steel roofs has led to his working on multiple massive stadiums, including several that have hosted the Super Bowl in recent years.

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

MARK WAGGONER makes no little plans when it comes to his designs.

That's not to say he doesn't consider the small details. It's just that he happens to have designed long-span roofs for more than a dozen professional sports stadiums, including SoFi Stadium, a winner of this year's AISC IDEAS^2 Awards program.

Here, he discusses his work on some of these projects, as well as texts, travels, and experiences early in his career that put him on the path to being a long-span design leader.

When you were younger, were there certain buildings or structures that influenced you to get into the field?

I would say that came a little bit later when I was in college. You take a lot of classes where you learn how to design a beam and those kinds of things, but they don't do a lot of teaching in terms of, 'Hey, here's how you come up with, say, the Hancock Building or something like that.' At one point, I read David Billington's *The Tower and the Bridge: The New Art of Structural Engineering* and devoured a lot of those kinds of books. When I was in grad school, that was pretty influential, just seeing what people were doing out there in the real world and how innovative and creative they could be, and also seeing the kind of stuff that's possible. Perhaps the culmination of that for me was when I finished up grad school at UT [University of Texas at Austin], someone from SOM came to campus and pitched this great opportunity. They were doing a structural engineering traveling fellowship every year where they would provide money to travel and see some of these kinds of amazing structures. I was fortunate enough to get to do that the summer after I finished grad school and before I started work at Walter P Moore. I traveled around Europe and got to see a lot of the buildings that I'd learned about in the books I'd read. That was quite an experience.

I can imagine. Obviously, there are countless examples of great architecture and structural engineering in Europe. Was there one city or building in particular that wowed you more than any other?

Munich Olympic Stadium, which was built for the 1972 Olympics. It's one of the first structures to use steel cables on a large scale to stabilize the roof and was a very influential building. That one certainly stood out.

It is a beautiful stadium. And clearly struck a chord since stadium roofs are now your specialty. Once you started working at Walter P Moore, were there any projects that served as important lessons early in your career or that perhaps changed some of your preconceived notions about designing buildings?

Early on, I worked on NRG Stadium in Houston—previously Reliant Stadium—when it was replacing the Astrodome. I came in when that one was already underway and the design had been going for a little while. But my second project after that was what's now called State Farm Stadium for the Arizona Cardinals—previously Cardinals Stadium and University of Phoenix Stadium. And I worked on that one all the way through. I'd say it was pretty formative for me, seeing the whole process and also realizing that we do a lot more than just design stuff. We have to be very aware that we're an integral part of getting something very complicated built. So working with the builders and understanding how that interaction goes really set the stage for a lot of other things that I've done since.

I'll bet! So you go to work on State Farm Stadium, which just hosted this year's Super Bowl, as well as SoFi Stadium, which hosted the Super Bowl last year. That's pretty cool.

Yes, and when it came to State Farm Stadium, we had to check the roof for all of Rihanna's platforms that were going up and down. That was interesting.

Indeed. When that performance started, I was just hoping she wouldn't fall!

I'm sure she was tethered, but I can definitely say that the roof was capable of handling the platform loads.

That's good to hear! Speaking of stadiums, it seems like we're starting to hear a lot more about ETFE (ethylene tetrafluoroethylene) being used for the roofs. What's your experience been like with that material? Are there special considerations when designing with it?

We've done several ETFE projects recently. Before that, we designed quite a few retractable roof stadiums with these big giant moving panels, especially for NFL stadiums. When we do that, the idea is obviously that they can open up the roof and have the game open to the elements and basically make it an outdoor stadium. But we've seen that the teams and the fan bases, for whatever reason, for those buildings tend to keep the roof closed and not open them nearly as much as we all talked about when we were designing the buildings. So that's been part of a shift to find a simpler way to have fans be connected to the outside. For example, with the Minnesota Vikings' stadium—U.S. Bank Stadium [which hosted the Super Bowl in 2018]—we had some early involvement in that project before the final design. But the team indicated that if the design were to incorporate a retractable roof, it wasn't likely that it would be open very much during the games. But there was still the desire to have the stadium feel open to the sky. And the architect, HKS, suggested ETFE since it provided a lot of natural light and a connection to the sky but without all the moving parts and maintenance concerns that came with an operable roof. So ETFE eventually became somewhat of a go-to system for the last several stadiums, including SoFi Stadium. We do a lot of tensile structure design, and I chair ASCE/SEI Committee 55-16, which covers their *Tensile Membrane Structures* standard, so I'm very familiar with that part of the industry. I can say that designing with ETFE is a little bit different than designing with, say, PTFE (polytetrafluoroethylene) fiberglass fabric, but it's kind of in the same ballpark. There are a lot of little ins and outs of putting together the steel system for at ETFE roof, but it's something we've done on quite a few projects now.

Interesting. So ETFE became a new approach for stadium roofs when it comes to achieving the open feel, and SoFi Stadium is really a new approach to stadium roofs in terms of the shape. The overall look is very striking and really puts a new twist on stadium design. I'm just curious, what was your first impression when you saw the architectural vision for this project?

We were fortunate enough to be involved from the very early stages—and on this type of project, you really have to be—and early on, there were some other options on the table in terms of the roof that we were looking at when deciding the best path moving forward. And being involved from the very start and having my eyes on the project for such a long period made it sort of difficult to distinguish an initial reaction. The impression evolved over time as we worked on the design, but the desire for an open feel and the decision to go with a lightweight, semi-transparent roof were there from the beginning. In terms of the project as a whole, the parameters included a height limit, given that the project's site location in Hollywood Park is right by LAX [Los Angeles International Airport] and had to factor in flight patterns. The site was formerly a horse racetrack, so it was fairly open, but we had to push the building into the ground to account for the planes approaching LAX. That was a really interesting challenge to be involved with from the start. ■

*This column was excerpted from my conversation with Mark. To hear more from him, including his thoughts on living in Austin, his next big stadium project, and the Astrodome, check out the May 2023 Field Notes podcast at **modernsteel.com/podcasts**.*

And you can read more about SoFi Stadium and its various design challenges and solutions in this month's coverage of AISC's IDEAS² Awards, starting on page 28.

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

Gather and Grow

BY LAURIE GUEST

Refill your team's energy tank with these four steps.

THERE'S NEVER A PERFECT TIME to pause your day-to-day work and focus on the internal team, but when you do make the effort, the dividends are immediate.

Setting aside an hour, a half-day, a two-day retreat, or anything you can manage as a team will provide the opportunity to gather together, grow as a team, and refill your collective energy tank in order to bust out of service fatigue and return to delivering excellent service in every interaction.

Refill the Team's Energy

Your first step to regaining the capacity to do your work at your fullest potential is to heighten self-awareness and lean into the responsibility that you must refill your tank. Just like a video game avatar who seizes every opportunity to grab more energy for the harrowing journey ahead, you also need to seek out and embrace the chance to replenish yourself wherever you find it.

The good news is there are easy, actionable ways to find and create more energy for yourself and your whole team. It starts with committing to a "gather and grow" mentality that brings a team together (virtually or in person) and facilitates the kind of growth that fills your team's energy tank and returns your business to a thriving state in the marketplace.

This four-step G.R.O.W. process will show you exactly how.

G – Game On! Gaming at work might not be an intuitive way to encourage your team to spend their time. But gaming on the job is an easy way to bring hearts and minds together in pursuit of your common professional goals. Friendly competitions, staff meetings with moments of levity, and experiential outings with your team are all impactful ways to bust out of service fatigue.

To take your workplace gaming to the next level, consider uniting over a cooperative strategy that can break the boredom or monotony of a day. You can boost teamwork qualities through games that bring a team around a collective purpose and goal. These types of efforts are shown to reduce stress and help participants cope with work-related fatigue.

R – Rule Reminders. It seems every business needed to adjust rules, policies, and offerings over the last two years to accommodate the global crisis. Process procedures changed for everything from hotel housekeeping to checking out books from your local library. Frequent change without strong internal communication leads to trouble. Making time to "accuracy audit" will help your team find their footing again when it comes to customer instruction.

Conducting an accuracy audit is easier than it sounds, and it's the perfect agenda for the next time the team gathers together. Does your website match the current offerings? Do all members of the team know the current rules, even if they only work a few hours a week? Is everyone clear on the current processes of your organization, both internally and externally? Francis Ford Coppola, the famous film director, was once asked what his secret to success was. He answered, "The first thing I do is make sure that everyone on set is making the same movie." You are the director of your workplace set. Get all the characters on the same page.

O – Optimism. The dedication to sincerely working toward a better tomorrow is imperative for personal and professional growth. That's not to say that finding the silver lining in every situation is easy. Far from it. However, when a crowd gathers, its members can feed off each other's attitudes, mindsets, and perceptions, the good and bad vibes quickly bouncing from one person to the next. For example, observe any boat rocker on staff who starts a rumor laced with a little over-the-top emotion and see how fast the fire spreads ill will among the team. Disaster follows.

But as Smokey the Bear always told us, only you can prevent forest fires! Take the time to gather regularly (even if in a virtual format) and stay in positive communication to decrease the chance of an unnecessary negative spark. Strive to provide frequent updates and truthful status reports, and lead by example with your own optimistic attitude.

W – Warm Welcomes. The odds are good that when your team gathers the next time, there will be new faces on board. Don't underestimate the power of a warm welcome. No one likes the feeling of being the "new kid in school," and your compassion and kindness (regardless of your position at the company) can go a long way to get new staff off to a great start with the team. Remember to share those unwritten rules everyone else knows about (like "Use any coffee mug except the purple one with the smiley face. That's Sandy's, and you'd be wise not touch it.") Consider assigning a first-week mentor to each new team member to help shave the learning curve and make them feel at more at home.

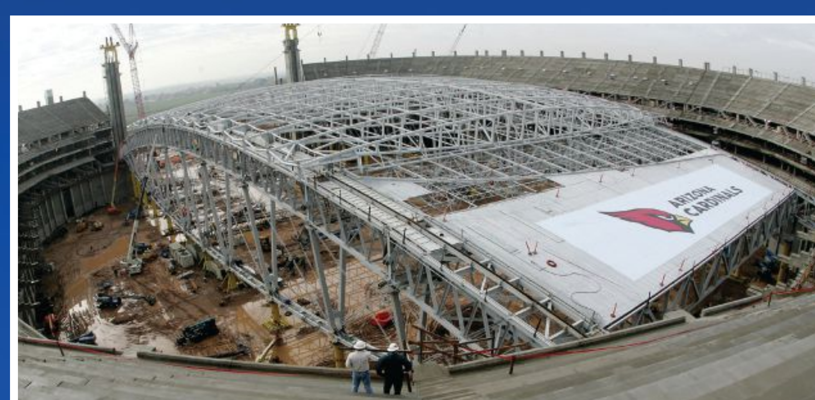
Making the time to G.R.O.W. will help reboot your organization's energy tank and make sure that everyone is working at full power and with a positive outlook. ■

Keynote speaker and author **Laurie Guest** is an authority on customer service excellence. Laurie blends real-life examples and proven action steps for improvement. She is the author of two books and is writing a third on the topic of service fatigue. To learn more or connect with Laurie, visit **www.laurieguest.com**.

Winners Choose Chicago Metal TO Curve Steel

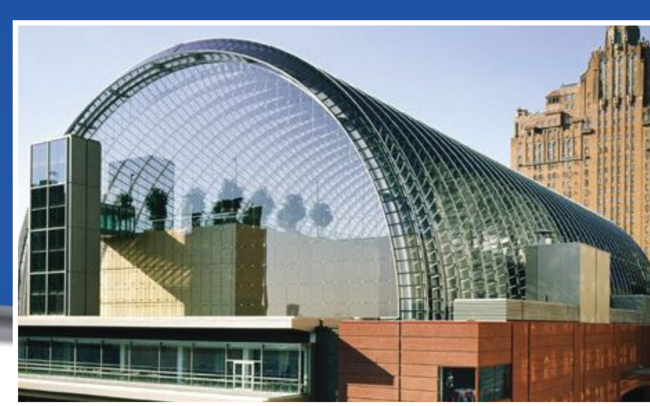
2015 IDEAS² Merit Award - 73 pieces of curved 8" sch 40 pipe totaling 35 tons for Circuit of the America Observation Tower. Austin, TX

2014 SEAOI Best Project - Elliptically curved trusses rolled from 5" and 8" diameter AESS pipe for Institute of Environmental Sustainability at Loyola University. Chicago, IL



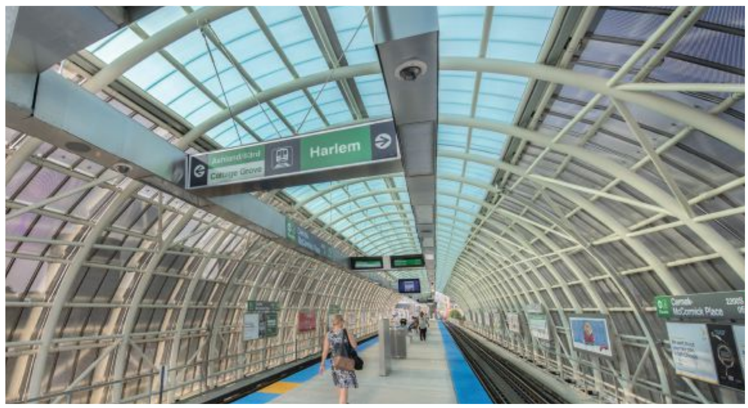
2007 IDEAS² National Winner - 400 tons of 12" square tubing curved for the retractable, lenticular room trusses at the University of Phoenix Stadium. Phoenix, AZ

2005 EAE Merit Award - 570 tons of 12", 14", 16", 18" and 20" pipe curved for the Jay Pritzker Pavilion. Chicago, IL



2003 IDEAS² National Winner - 300 tons of 5" square tubing curved 45° off-axis for the Kimmel Center. Philadelphia, PA

Call us at 866-940-5739 to make *your* next project a winner!



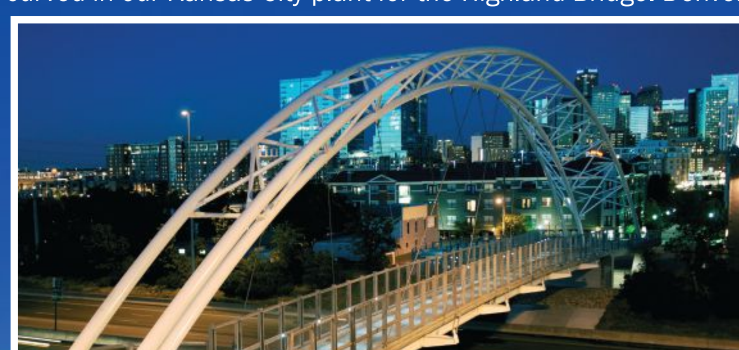
2015 AIA Distinguished Building Award - HSS 8" pipe featuring an ellipse curvature with multi-radius bends for the structural ribs for CTA Cermak-McCormick Place Station. Chicago, IL

2012 IDEAS² Merit Award - 133 tons of 16" pipe curved for the Rooftop Tiara of the Great American Tower at Queen City Square. Cincinnati, OH

2020 IDEAS² National Winner - 920 pipe members rolled from 1300 tons of 14" pipe creating 38 super-trusses for the iconic canopy at Hartsfield-Jackson Atlanta Intl Airport. Atlanta, GA

2013 IDEAS² Merit Award - 3600 pounds of pipe each curved with multiple radii for a solar canopy to recharge batteries on electrical vehicles. Chicago, IL

2007 NSBA Special Purpose Prize Bridge Award - 152 tons of 18" pipe curved in our Kansas City plant for the Highland Bridge. Denver, CO



2010 NCSEA Award Winner - 200 tons of beams, channels and angle for the roof of the University of Illinois at Chicago Forum. Chicago, IL

PERFECT TEN

A concert venue that raises the roof, a 1950s Mies van der Rohe design built seven decades after its creation, an art museum whose structural form is itself a work of art, and more comprise the winners of this year's AISC IDEAS^2 Awards.

IT'S A PERFECT TEN!

That's the number of projects that have been named winners of the 2023 Innovative Design in Engineering and Architecture with Structural Steel (IDEAS^2) Awards!

Presented annually by AISC, these awards recognize projects that illustrate the exciting possibilities of building with structural steel and highlight the many ways steel can help express architectural intent while harnessing its unique advantages for both simple and complex structural systems.

The awards showcase the innovative use of structural steel in:

- the accomplishment of the structure's program
- the expression of architectural intent
- the application of innovative design approaches to the structural system
- leveraging productivity-enhancing construction methods

All entries must meet the following criteria:

- New buildings, expansions, and renovation projects (major retrofits and rehabilitations) are eligible. There is also a category for sculptures, art installations, and nonbuilding structures.
- Building projects in the 2023 competition must be located in the U.S. and must be completed between Jan. 1, 2020, and Sept. 30, 2022.
- A significant portion of the framing system of a building must be wide-flange or hollow structural steel sections (HSS).
- The majority of the steel used in the project must be domestically produced.
- The project must have been fabricated by a company eligible for AISC full membership. Projects with a unique or distinctive feature fabricated by a company eligible for AISC full membership will also be considered.
- Pedestrian bridges entered in the competition must be an intrinsic part of a building and not standalone structures. We encourage members of project teams for standalone bridges to enter the 2024 National Steel Bridge Alliance's Prize Bridge Awards.

National and merit winners were awarded in four categories according to constructed value in U.S. dollars:

- Less than $15 million
- $15 million to $75 million
- $75 million to $200 million
- More than $200 million

In addition, one Sculpture/Art Installation/Nonbuilding Structure Winner was named.

This year's winners are an intriguing mix of adaptive reuse and brand-new structures. Two of the winners—Seattle's Federal Reserve Building and a brick industrial space in San Francisco—needed substantial work to bring their seismic systems up to code. On the opposite coast, steel turned a 20th-century post office into a 21st-century transportation icon in New York.

Also in Seattle, steel allowed for a near-total demolition of the interior of Climate Pledge Arena—while keeping the roof and façade in place—and in Milwaukee, steel kept the music playing at an aging but beloved lakeside concert venue by literally raising the roof.

Bridging the gap between old and new, another winner brought a 1952 Ludwig Mies van der Rohe design to life in a brand-new building on the Indiana University campus, seamlessly bringing the striking design into compliance with modern building requirements. In Inglewood, Calif., steel allowed a massive new stadium to feel light while also allowing movement in the event of seismic activity.

Down the coast in Orange County, steel served as an inspiring canvas for an art museum—and it gave visitors to St. Louis' zoo a lemur's-eye view of the world. Finally, steel landed at a new terminal at Dallas-Ft. Worth International Airport in large, modular sections, creating a modern new space and enhancing the airport experience for passengers.

This year's jury consisted of:

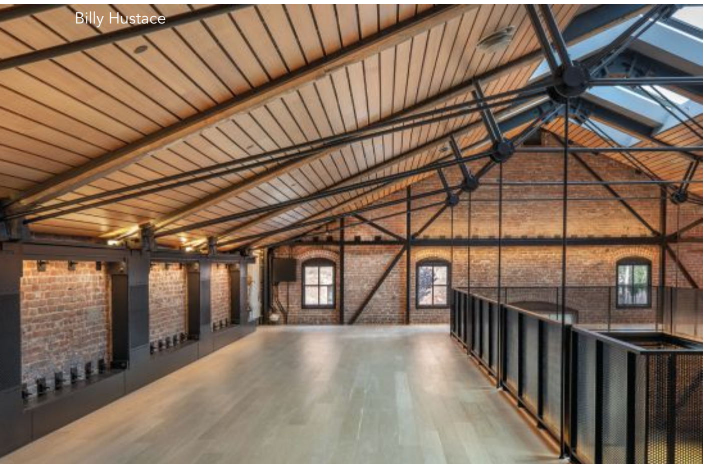
- David Horowitz, executive vice president with Tishman Construction
- Jim Foreman, SE, PE, senior project engineer with Martin/Martin Consulting Engineers
- Mark Trimble, PE, senior vice president with AISC
- Anders Lasater, AIA, CEO, principal architect with Anders Lasater Architects
- Helen Torres, SE, PE, president and founder of Helen Torres and Associates Structural Engineers

Trimble, Lasater, and Torres have all been subjects of *Modern Steel*'s monthly Field Notes interview column and podcast. (You can listen to their interviews at **modernsteel.com/podcasts**.) In addition, this month's Field Notes column (on page 22) highlights Mark Waggoner, a structural engineer with Walter P Moore that helped design SoFi Stadium, one of this year's winners.

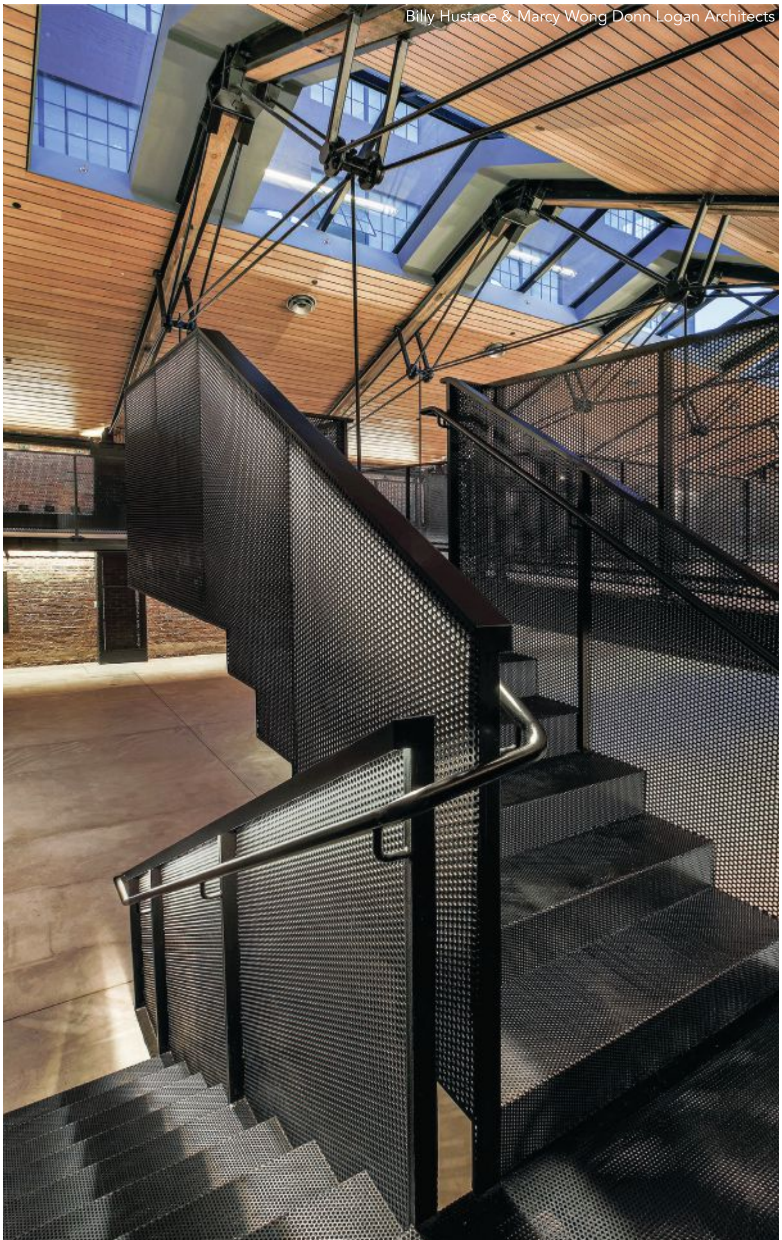
Read on to learn more about and see fantastic images of all this year's winners!

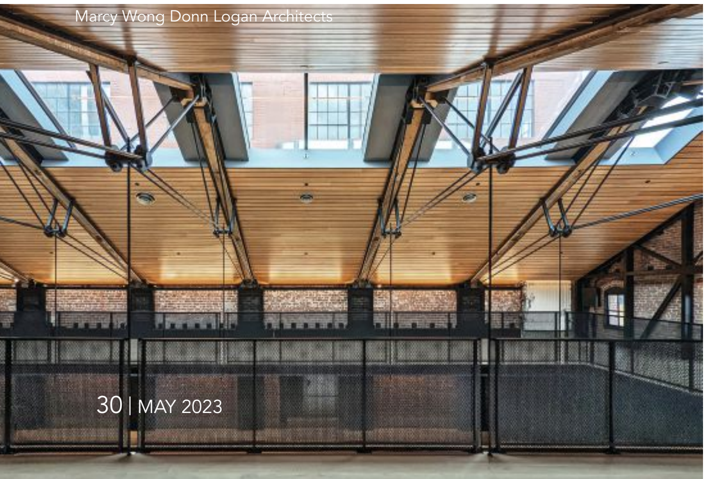
2023 IDEAS^2 AWARDS


Billy Hustace


Billy Hustace

"A thin, sleek design—something you could only have done in steel that completely lets your eye pass to the historic pieces of the building that remain."
—Jim Foreman


Billy Hustace & Marcy Wong Donn Logan Architects


Marcy Wong Donn Logan Architects

RHC Construction

RHC Construction

LESS THAN $15 MILLION National Award

MacLac Building D (Rebirth of a Historic Paint Factory), San Francisco

AIRY STEEL TRUSSES and a new mid-height structural mezzanine add state-of-the-art seismic resistance to an unreinforced brick factory from 1906—preparing it for another century of service.

This rebirth of this historical building—with its newly unveiled, lofty interior volume made possible by the use of structural steel in the retrofit—is now ideal for functions that are in accordance with the City's PDR ("Production Distribution and Repair") zoning, which includes a showroom, restaurant, office, retail, light manufacturing, arts-related and design-related establishments.

The classically gabled, industrial brick edifice initially functioned as part of a lacquer and paint manufacturing complex and was known as Building D. The MacLac moniker reflects the previous owner's name (R. J. McGlennon) combined with the word lacquer.

At the outset of the project, the building's condition was akin to a rat maze, resulting from a century-plus accretion of ad hoc partitions, random levels, obsolete industrial equipment installations, and a surfeit of detritus. The solution was to raze the maze, exposing the previously hidden, magnificent volume of the historic building and the original construction materials of brick, wood, and steel. The architectural and structural design team's plan was to highlight these historical elements with 21st-century steel architectural and structural upgrades. The rejuvenation introduces crucial new steel seismic elements, accentuates the symmetry of the original building with an open second level whose footprint provides geometric reinforcement, introduces abundant daylight through ridge skylights extending the length of the structure, and provides architectural lighting that highlights the new structural steel architecture and elements. In addition, the original brick walls are reinforced by new steel braces and structural diaphragm elements that reduce the unsupported height of the brick walls.

Structural steel was the ideal material for this project, thanks to its high strength and ductility, providing seismic resistance crucial to the survival of the very building in a high-seismic area. Moreover, it provided the perfect solution for an industrial heritage adaptive reuse project, as it harkens to the roots of the building's history and is a visually outstanding complement to the old brick walls and new floors.

An innovative steel king post truss system and structurally suspended cross-laminated timber (CLT) mezzanine floor structural design visually highlight the building's geometry, original wood, and masonry while providing seismic safety and additional column-free ground floor leasable floor area. The team repurposed the top chords of the original heavy timber trusses as spacers between the steel channel top chords of the symmetrical king post trusses on each side of the existing trusses, allowing the new steel channel to encapsulate these top chords while leaving the bottom surface exposed. The system was prefabricated in two identical pairs of trusses, a center node, and two rods, which helped ease transportation and erection in the exiting building and resulted in no field welding. Once the rods joining the two sides were installed, they could be tightened to adjust the height of the ridge and assisted with aligning and leveling the old roof, and then existing web members and bottom chords of the trusses could be removed, leaving the light and elegant new trusses. The CLT floor mezzanine is suspended by hanger rods dropped down from the king post nodes on the roof trusses, leaving a column-free lower level with an open center area that allows light from a new skylight to reach the entire lower level. The "bonus" floor area of the mezzanine adds 2,555 sq. ft to the ground level area of 3,784 sq. ft, for a total interior area of 6,339 sq. ft.

The seismic-resisting system for the rejuvenated building is an ultra-stiff moment frame system consisting of deep steel columns and beams formed with hollow structural sections (HSS) acting as flanges and perforated steel plate acting as webs. This design accommodates the punched windows on the long sides of the buildings and works in tandem with stiff concentric braced frames on the gabled ends of the building. Thanks to the strength and workability of steel, a cantilevered steel landing at the mezzanine level supports a scissors stair whose only structure is the folded perforated steel plate forming the treads and risers, the perforated steel plate guard rails, and the perforated steel plate sandwich landing, all of which forms a torsionally stiff stressed-skin structure.

Owner
Comstock Realty Partners, Los Angeles

General Contractor
RHC Construction, Oakland, Calif.

Consultant
Mark Hulbert Preservation Architecture, Oakland, Calif.

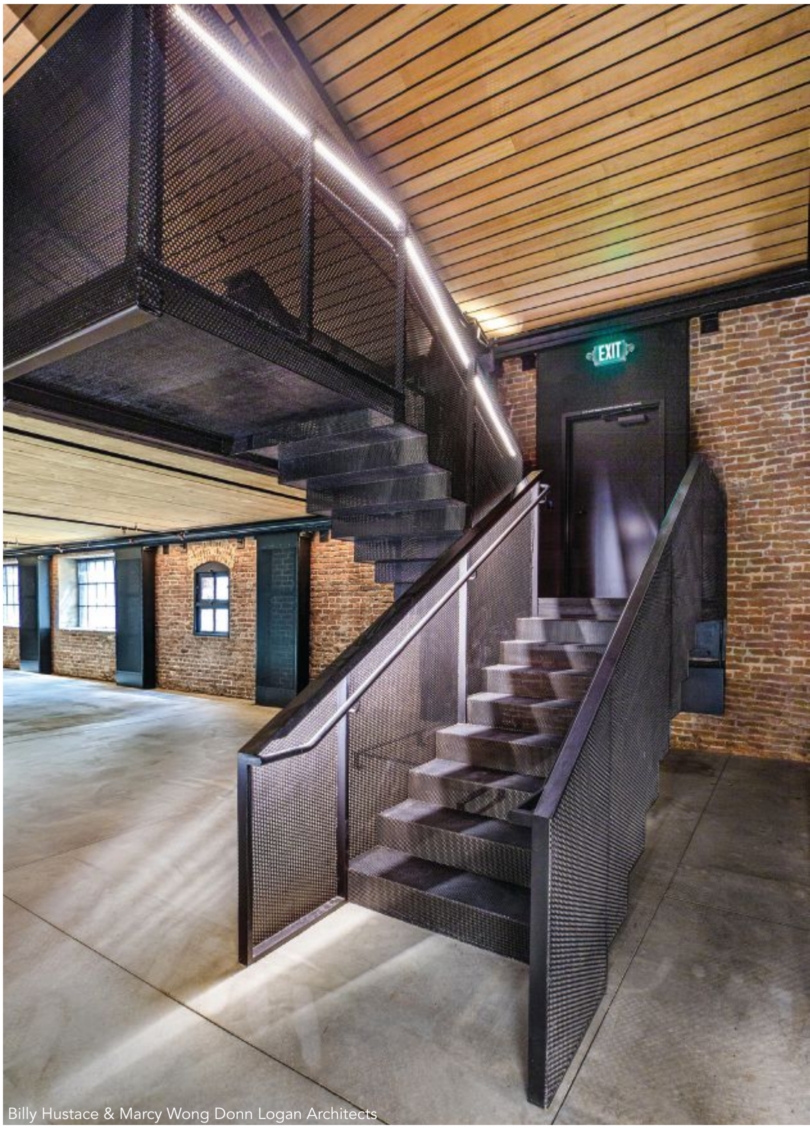
Architects
Marcy Wong Donn Logan Architects, Berkeley, Calif.
Peter Logan Architecture + Design/PLAD, New York

Structural Engineer
Gregory P. Luth and Associates, Inc., Santa Clara, Calif.

Let There Be Daylight

Meeting LEED v.4 C+S Gold Certification requirements was a goal for the design team, and the lighting system—including abundant daylighting—was a major contributor. The electrical lighting is grouped into different zones that correspond to primary and secondary daylight harvesting zones. The light fixtures have full-range dimming drivers and are connected to dimming controls, and daylight sensors located throughout the various spaces trigger the drivers to adjust the lighting to compensate for the amount of daylight penetrating the zone. As the daylight conditions change, the system responds to adjust the overall balance of light to appropriate ratios, allowing maximum energy efficiency to be attained at any given time.

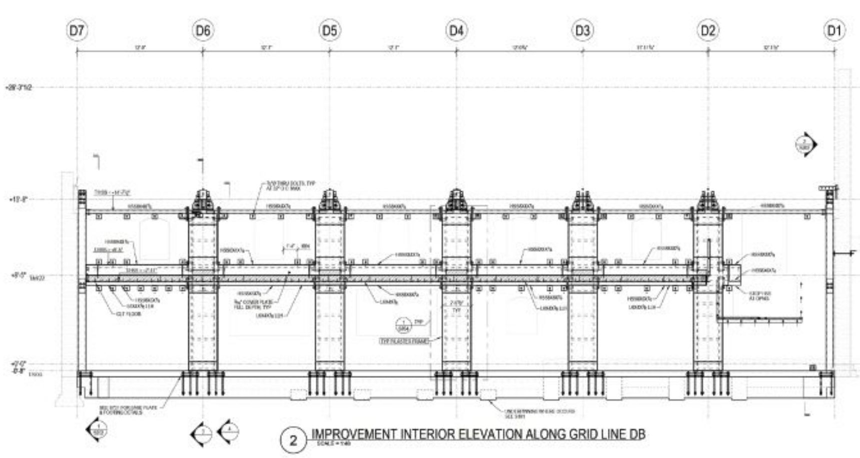

Marcy Wong Donn Logan Architects

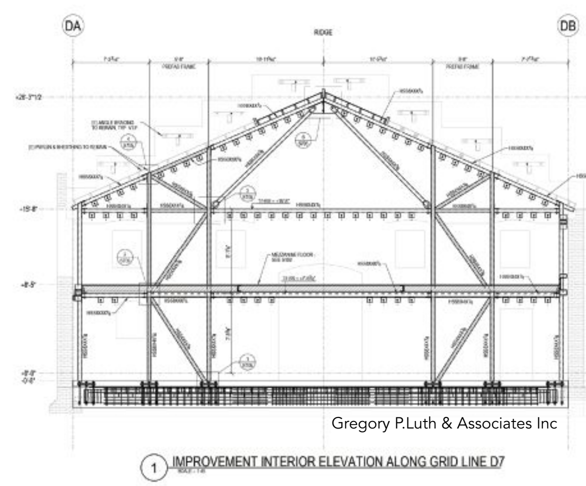


Billy Hustace & Marcy Wong Donn Logan Architects

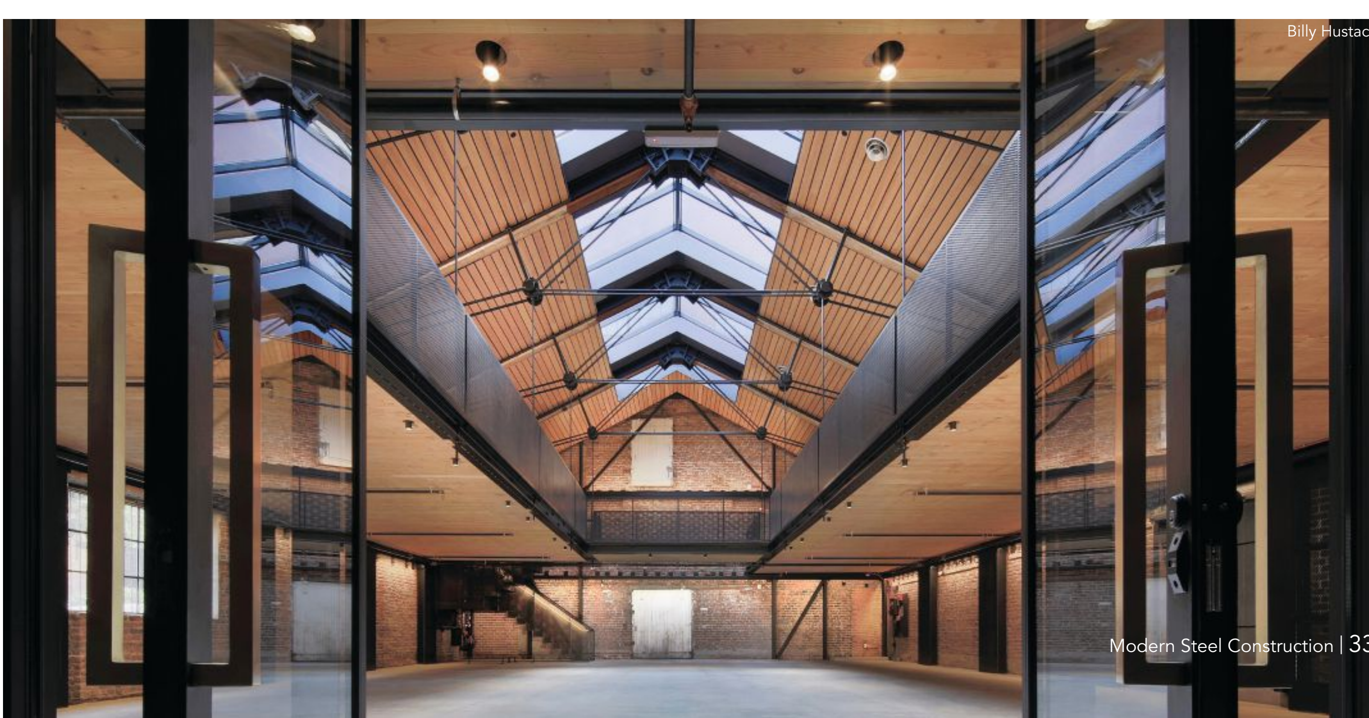

RHC Construction

RHC Construction





Gregory P.Luth & Associates Inc



Billy Hustace

LESS THAN $15 MILLION Merit Award

The Eskenazi School of Art, Architecture + Design, Bloomington, Ind.

IN 1952, Ludwig Mies van der Rohe designed a house for the Pi Lambda Phi fraternity on the main campus of Indiana University in Bloomington, but funding cuts relegated the plans to the MoMA archives. Exactly 70 years later, students now get to enjoy that space—not as a fraternity house but rather as a design school.

The newly completed Eskenazi School of Art, Architecture + Design is a modern revival of van der Rohe's design. The new/old building was brought back to life through a recent collaboration between architect Thomas Phifer and Partners and structural engineering firm Skidmore, Owings and Merrill (SOM). The team studied the original plans, drawings, construction details, and calculations while comparing them to similar van der Rohe buildings of the time. The team also gathered all available notes from the famed "less is more architect," including the original structural calculations for a similar building by Myron Goldsmith, formerly of SOM and van der Rohe's offices. A key challenge was to stay true to the original design intent while simultaneously aligning the project with current building codes and environmental considerations.

The two-story, nearly 10,000-sq.-ft building, which officially opened in April 2022, features a lecture hall, offices, and meeting rooms for faculty and staff. The ground floor is mostly open, while a central square atrium carves the upper level. The design brings abundant light to the interiors with a white-painted steel frame and floor-to-ceiling windows. The original design was followed with only minimal alterations to the visible architecture. Changes to the ground level included the reconfiguration of the stairs to comply with current safety codes, in addition to an expanded mechanical room, and other modifications included the addition of a hydraulic elevator and changing the glazing from a single pane to high-performance insulating glass. The second floor of the original design remained largely intact, repurposed from bedrooms to offices.

Since the structure was a recreation of an original design in steel, steel was the only viable option. Then as now, it provided a crisp aesthetic to the defined edges of the columns and mullions and also allowed for a thinner floor slab, providing more space for the MEP services in the 15-in. ceiling sandwich.

Hadley Fruits

Hadley Fruits

"You can't separate the idea of steel and the idea of that building; steel is the only thing that could make that building work." —Anders Lasater

Anna Powell Denton

Hadley Fruits

The primary structural challenges included engineering the steel mullions to accommodate insulating glass, wind loads, and building movements with minimal changes to the mullion profile of a typical van der Rohe design; coordinating MEP services through the 10-in. beams—in particular, locating and engineering the relatively large openings in the beams for air-conditioning ductwork, which the original design did not have; and creating structural details with no visible welds or bolts while simultaneously having all site connections bolted to facilitate erection provided some adjustability to maintain the very tight tolerances.

The solution for the mullion challenge was to use steel bars for the structural core of the mullions with glazing stops screwed to the steel bar core. The steel bar had the center machined to a ⅜-in. web to create a 1-in. glazing pocket, which was the dimension required to accommodate tolerances and frame wind load racking and vertical floor deflections. For mullion deflection calculations, the glazing stops were included in the mullion stiffness properties. The machining and careful selection of mullion stop screw size and spacing resulted in the absolute minimum mullion size.

There was a total of 15 in. available for the slab, steel framing, insulation, services, and ceiling for the MEP services, a depth that was dictated by the perimeter spandrel channel size, which was the same as the original design. The team specified a 2-in. slab over one ½-in. metal deck to achieve this extremely thin sandwich. The slab also had embedded radiant heat pipes, which required careful engineering and coordination of the slab system. For the building services, the second-floor beams had 220 openings in the steel girders varying in size from 3-in. round to 20-in. by 6-in. rectangular, with the latter openings requiring in-depth calculations to validate their strength.

All beams and girders on column lines were designed considering the connections as partially restrained for lateral load resistance and minimized deflections. Flush bolted end plates were used at the beam-to-column connections, and the built-up girders ran over the columns with end plate splices near the cantilever back-span inflection point. The channel spandrels also had bolted end plate connections near the inflection points (two on each façade) with corners shop welded. The end plate connections were subsequently seal welded and ground flush to provide the appearance of a continuous member. Beam-to-perimeter columns were bolted to studs welded to columns to eliminate the requirement for any welding on the exterior with the connection configured so the channel could be erected and bolted first, followed by the end plate connected beam.

Hadley Fruits

Hadley Fruits


Hadley Fruits

In addition to resisting wind loads on the glazing system, the vertical steel mullions also provide part of the second-floor gravity system. This is required since the second-floor channel spandrel at 15 in. was not adequate to span 30 ft, nor was it adequate for deflections of the 10-ft cantilevers. The vertical steel mullions are, therefore, rigidly bolted between the roof and second-floor spandrels, allowing part of the second-floor load to be shared by the roof spandrels, which have less load than floor spandrels. Also, rigidly connecting the spandrels together eliminates differential vertical deflection between the roof and floor, allowing a smaller glazing pocket than required.

The individual mullion elements are bolted to the structural frame with countersunk bolts in the glazing pockets. Horizontal mullions are attached to the vertical mullions with screws. The end plate connection of the vertical mullions is contained within the glazing pocket, so it is not visible from the exterior. By containing all fasteners within the glazing pocket, no fasteners were visible, and no welds were required, which allowed for crisp corners and edges for all the mullion elements without the need for grinding welds. Although integrating mullions in the structural system is not necessarily a new idea (as a matter of fact, the original design used this concept), connecting the glazing system with only screws and bolts, with the only visible fasteners being those attaching the glazing stops, was developed in a very innovative way.

Owner
Indiana University, Bloomington, Ind.

General Contractor
CDI Inc., Terre Haute, Ind.

Architect
Thomas Phifer and Partners, New York

Structural Engineer
Skidmore, Owings and Merrill (SOM), Chicago

Steel Fabricator and Detailer
MAK Steel Services, LLC, Seymour, Ind.

$15 MILLION TO $75 MILLION National Award

Orange County Museum of Art, Costa Mesa, Calif.

Jasmine Park

THE ORANGE COUNTY MUSEUM OF ART (OCMA) is a central component of the OC art scene. With a focus on 20th- and 21st-century art by artists with ties to California, the institution's focus has always been to educate and inspire the community.

In the mid-2000s, as OCMA was contemplating an expansion beyond its space within a high-end commercial mall, it identified a suitable new home: a portion of the Segerstrom Center for the Arts in nearby Costa Mesa, a massive campus of performance venues and public spaces.

The museum's new form is that of a flowing, irregular structure housing intimate small galleries, a reconfigurable main exhibition space, and a rooftop terrace for large-scale sculptural works. Located adjacent to the 3,000-seat Segerstrom Hall, it also serves as the final component of what was envisioned as a multi-disciplinary arts campus. With nearly 25,000 sq. ft of exhibition galleries—approximately 50% more than in the previous location—the new 52,000-sq.-ft space allows OCMA to organize major special exhibitions alongside spacious installations from its collection. The design complements and responds to the undulating façade of the neighboring concert hall and supports an outside-in and inside-out experience, and also features an additional 10,000 sq. ft for education programs, performances, and public gatherings, as well as administrative offices, a gift shop, and a café.

Visitors approach the new structure via an at-grade plaza punctuated by the 66-ft Connector sculpture by Richard Serra, and at the far end of the terrace is a sweeping staircase that looks over the entryway and central campus walkway, intended as a lounging and meeting place. The three primary gallery spaces within the flowing, irregular mass all required uninterrupted site lines, and the long-span spaces are arranged in complex configurations. The nonorthogonal architectural element—that, in places, cantilever more than 30 ft off the primary structure—and highly visible public spaces below a cantilever-trussed classroom wing required a structural material that could meet the aesthetic and functional needs of the design, endure the seismic forces of Southern California, and offer a sustainable, economically fabricated option. A high-bearing-strength material was also required for the necessary reduced column section below the massive girders that span the ground floor gallery. As such, structural steel was envisioned from the outset by the design team as the material of choice since it met all of these primary needs. The structure does employ concrete shear for the shear walls, but using it for floor framing would have been prohibitively heavy—and due to the sheer size of the members required, it would not have supported the architectural proportions desired for the galleries and public space elements.

The museum's design provides flexible and functional spaces over four levels, including a mezzanine and mechanical level. The main floor is dedicated to 60-ft-long open, reconfigurable internal and street-front galleries that can accommodate temporary and permanent exhibits. Maintaining the architectural clarity while supporting

Mike Kelley

Jasmine Park

"The architect and the structural engineers really understand the unique qualities and material capabilities of structural steel and found ways to use it to their design advantage."
—Anders Lasater

Mike Kelley

these long-span spaces was a significant challenge, made more difficult by the requirement that the soffit maintain a consistent elevation throughout, which limited the depth of steel beams and girders. This was solved in the ground floor gallery by adding a 700-lb-per-ft plate girder that spans roughly 68 ft at the terrace, with ten beams framing into it, and has a self-weight of roughly 24 tons.

A spacious roof terrace, equivalent in size to 70% of the building's footprint, serves as an extension of the galleries, with a sculpture garden and reconfigurable open-air spaces. In order to maintain column-free spaces at the indoor-outdoor threshold of the terrace, a full-story steel truss was cantilevered off of a concrete elevator core.

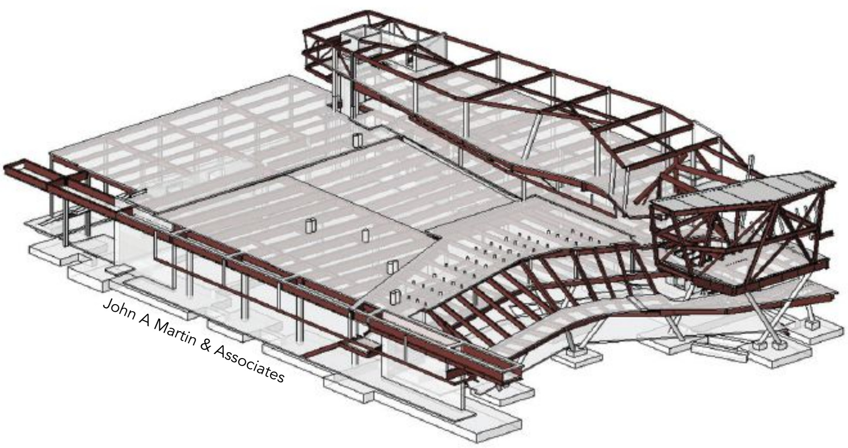
Further supporting the irregular geometries are two 5-ft-deep built-up plate girders that support the cantilevered planter, known as the "plantilever," on the northeast side of the terrace. These girders have a cantilever of roughly 40 ft, and one of them is supported by another cantilevered beam underneath it. The tip of one of these girders was cambered upward 3.5 in. to meet the project deflection criteria.

Finally, the unusual geometry of the museum's classroom component presented highly specialized superstructure and secondary structural design challenges. This public element is supported via a 36-in.-deep cantilevered truss with roughly a 68-ft span that simultaneously cantilevers and slopes up past the columns all the way to the front of the classroom. The truss is supported on 20-in.-diameter sloping columns that work in pairs to resist competing forces that develop as a result of their sloped geometry. Collectively, the element had a unique shape, sloping walls, special concentric braced frames, full-story-seep trusses, and a cantilever east end, which created multiple nodes where some or all of these elements intersected. Aligning these elements with architectural, MEP, and other systems required near-constant 3D model integration with the team, and drafting details created in collaboration with the steel detailer and erector also facilitated constructability and efficient fabrication.

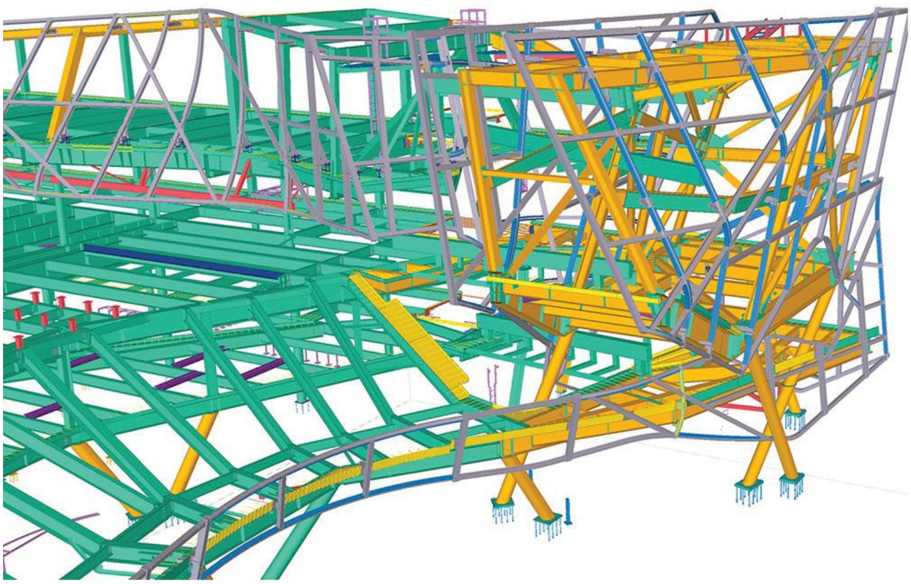
The structural system used special concentric braced frames with bolted connections designed to buckle in the plane of the frame, allowing for quick erection and reducing the size of the SCBF gusset plates. Because these elements were bolted and not welded, the gusset plates were smaller, allowing more architectural freedom.

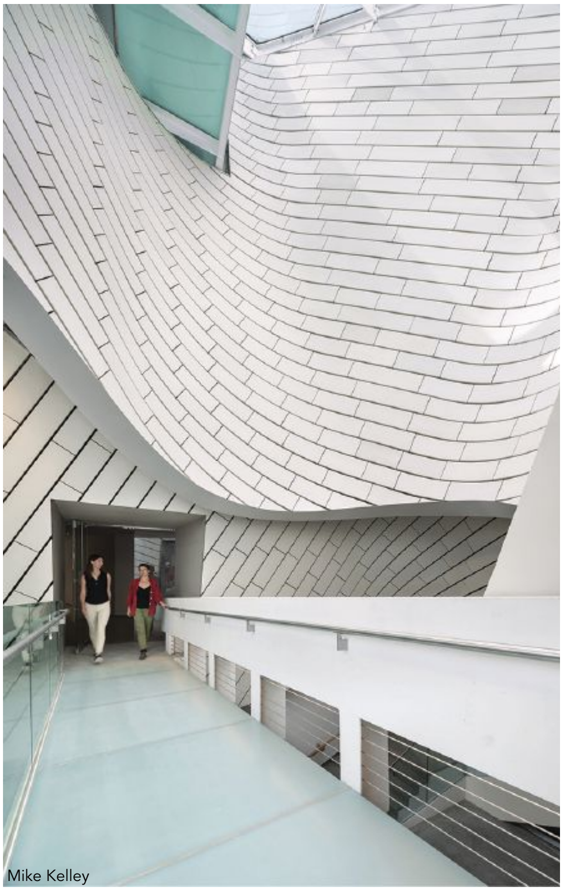
While primary systems were designed at the same time, secondary systems were not determined or designed until much later in the production process. One such instance was with the façade, a series of differentially angled planes with radially curved surfaces connecting the various planes, all of which are clad with a terra-cotta rain screen system. Structurally, this required a geometrically complex secondary steel system that would support the façade and the long-span glazing system. That secondary system also required full structural integration that would be compatible in terms of loads and movements between the systems and eliminate independent support structures for each. The primary structure anticipated large, eccentric loading from the façade's secondary steel frame long before any specific load magnitudes or locations were available. The structural


John A Martin & Associates


John A Martin & Associates


John A Martin & Associates


Anatomic Iron Steel Detailing


Mike Kelley

team used historical experience with these systems to design secondary steel frames that could inform loading assumptions for the primary structure.

At the outset of the design process, the team developed a BIM execution plan to lock in geometries and collaboratively establish guidelines that allowed the steel design to remain efficient and reduce complexity in detailing. These structural "rules" offered designers the freedom to massage geometries to meet conceptual or aesthetic goals, but they also established reasonable load paths in the structural system to support those elements.

As questions arose, the guidelines also allowed the engineering team to consistently distill issues into fundamental parts while maintaining an understanding of the overall load paths—a necessity to meet the rigorous seismic requirements in an area known for high seismic activity. This was highlighted as the project moved from design to construction and design models were combined in a BIM environment with fabrication models. For the review of shop drawings, the structural team would review 3D drawings in Tekla in tandem with 2D drawings to verify conditions. Work points were pulled from the architect's Rhino model by the engineering team and translated into the fabricator's Tekla model, ensuring a level of accuracy that nearly eliminated cost overruns due to coordination.

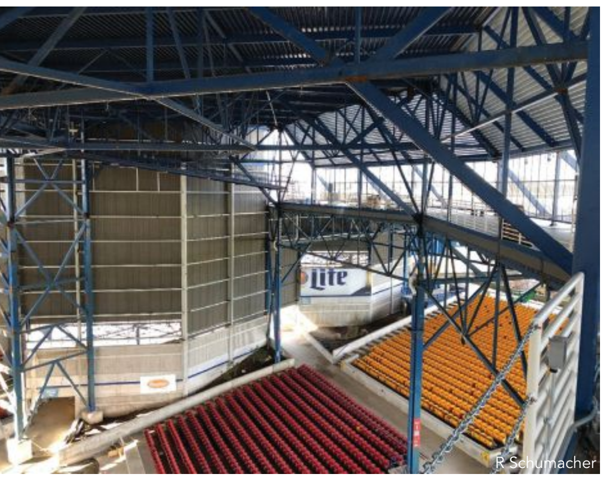
Owner
Orange County Museum of Art, Costa Mesa, Calif.

General Contractor
Clark Construction Group, Irvine, Calif.

Architect
Morphosis Architects, Culver City, Calif.

Structural Engineer
John A. Martin and Associates, Inc., Los Angeles


R Schumacher



R Schumacher


Eppstein Uhen Architects

$15 MILLION TO $75 MILLION Merit Award

American Family Insurance Amphitheater, Milwaukee

MUSIC LOVERS have raised the roof at Summerfest's permanent venue in Milwaukee for decades. With modern stage acts requiring more vertical space, the project team had to raise the roof, too—to the tune of 26 ft higher.

Summerfest is an annual music festival that has been held in downtown Milwaukee along the shore of Lake Michigan since 1968. This destination event drove the need for a permanent concert venue, and after much planning and fundraising, the original 23,000-seat amphitheater (now called American Family Insurance Amphitheater) was completed in 1987. Over the years, performers grew accustomed to modern facilities that were able to accommodate elaborate stage shows that well exceeded the 39-ft clear height limit of the aging existing roof structure. To keep attracting the best talent to Summerfest, the steel-framed amphitheater needed to raise the roof from 39 ft to 65 ft to accommodate more modern stage shows.

And it did just that. The renovation was staged in two phases so that the premier concert venue could be available for performances in the prime summer festival season while construction work could take place in the colder months. Under a tight schedule and trying weather conditions, the lift was successfully completed safely without a single injury, and the upgraded venue hosted concerts a few short months later.

The existing roof structure and new framing were modeled and analyzed using RISA 3D, and the nearly identical 15° wedges allowed for modeling one wedge and replicating it with minor adjustments to complete the full model. This resulted in a model that used over 3,000 members and 3,000 nodes based on the 1987 shop drawings. The model included the new stage building with an extension of the braced bays at either side of the stage extended to three braced bays to resist the significant added wind loads and higher overturning forces. In addition, the existing columns in the seating area had knee braces added below to provide moment resistance and additional lateral stiffness.

The exposed steel followed the existing form of the amphitheater, and the lift frames were mounted to the top of the extended columns so that no significant other temporary structures were needed to support the lifted roof during the lift. The lift frame beams cantilever a couple of feet over the lifted roof with back spans to the adjacent columns or panel points, and the associated framing and added loads from lifting were modeled and analyzed, revealing that no additional reinforcing was required. Lifting lug plates were designed and welded to the frame with provisions to be removed after the lift.

Construction began with the demolition of the stage building and the removal of all siding and girts. Stage building foundation construction took place at the same time that crews were reinforcing the roof truss and connections. In order to lift the roof, the purlins connected to truss T-5 needed to be cut, so temporary

"It's a great example of what can be done with steel in these adaptive reuse situations."
—David Horowitz


R Schumacher


R Schumacher


R Schumacher

steel beams were required to support the purlins and span between radial trusses. The whole and cut trusses were modeled, as were the new extended steel columns, and rotation and displacement values were calculated and compared. When cutting the truss member for the lift, a larger gap needed to be provided for clearance during the lift and to align with the final lifted position.

The lift contractor used 200-ton-capacity hydraulic strand jacks mounted to lifting beams to pull up the roof. The jacks were interconnected at the control room, where the progress of the lift was monitored to ensure uniform lifting. The weight of the roof portions at each jack needed to be calculated carefully to ensure uniform lifting. By the time the lift beams and equipment arrived on site, the support steel was erected and the temporary steel and lifting lugs were installed. Simultaneously, the stage, which had been demolished, was being reconstructed. A 300-ft-boom crane was used to install the lift beams and jacks.

Once the lift beams and jacks were installed and interconnected at the control room, the strand jacks were loaded to 90% of the anticipated load so the lugs could seat and any lift issues addressed. The lift took place the next day when the morning temperature reached a low of -10° F. The jacks were loaded to the anticipated weight, and the roof trusses and purlins were cut loose. The member cuts were widened to the anticipated rotation of the trusses following a loss of continuity from the cuts, and then the lift proceeded. The stroke of the hydraulic jacks was 18 in., allowing for length adjustments between strokes to ensure a uniform lift. The lift stopped at points where the lower chord of the lifted trusses needed to clear the top chord of the remaining trusses to grind portions of the cut ends for clearance, and the operation proceeded for about six hours to reach the 26-ft level when the jacks were secured for the night.

Reattachment of the trusses to the new upper frame began the next morning. The main trusses and lift jacks were set at eight locations to reattach the roof as quickly as possible, and the lifted roof was fully re-supported within two days, with most main connections completed in about a week.

For more on the American Family Insurance Amphitheater project, see "Upward Bound" in the January 2021 issue, available at ***www.modernsteel.com***.

Owner
Milwaukee World Festival, Inc. (Summerfest), Milwaukee

General Contractor
Hunzinger Construction, Brookfield, Wis.

Architect
Eppstein Uhen Architects, Milwaukee

Structural Engineer
Larson Engineering, Inc., Wauwatosa, Wis.

Consultant
Mammoet (formerly ALE Heavy Lift), Rosharon, Texas

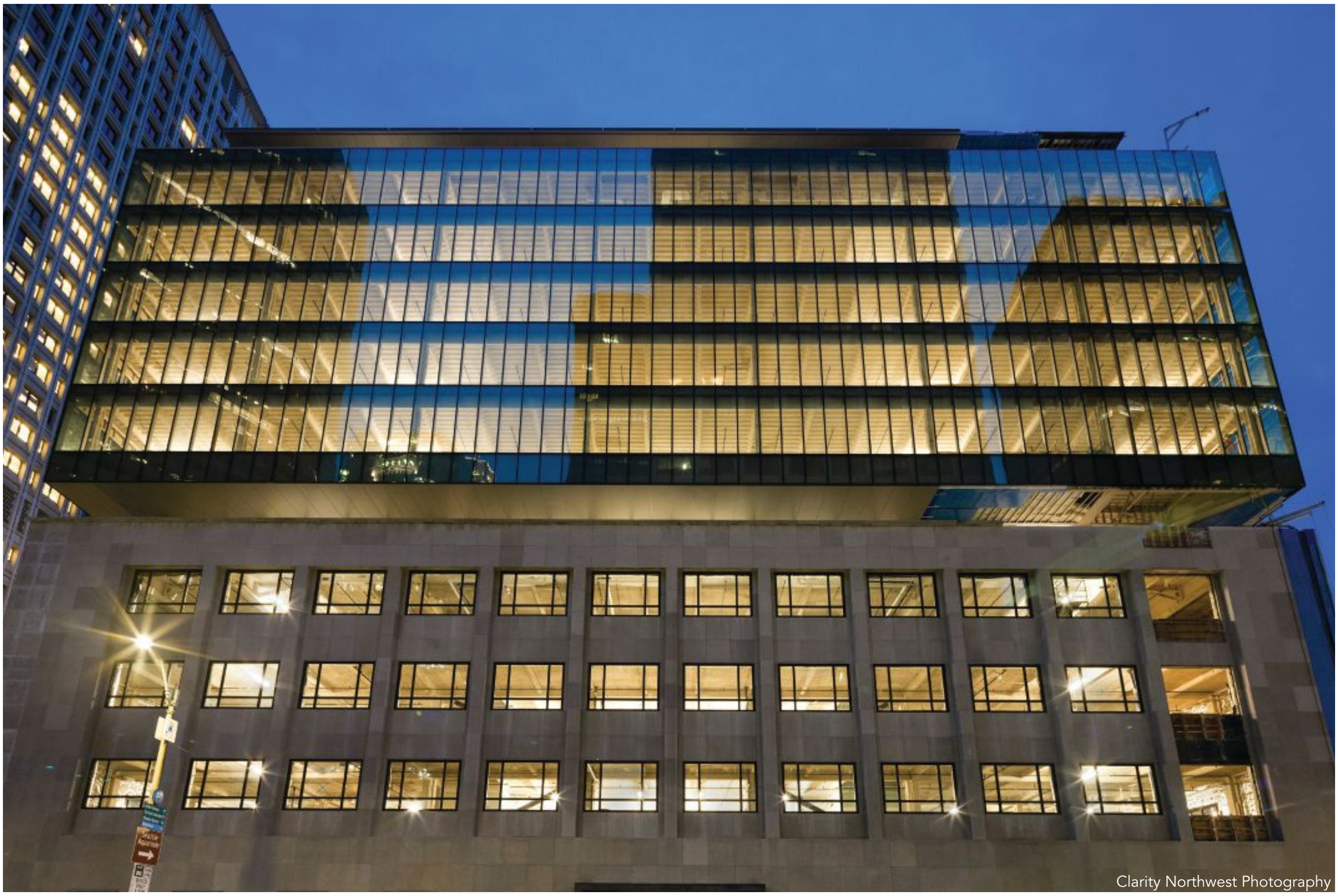
Steel Team

Fabricator
Ace Iron and Steel, Inc., Milwaukee

Erector
SPE, Inc., Little Chute, Wis.

$75 MILLION TO $200 MILLION National Award

Federal Reserve Building, Seattle



Clarity Northwest Photography

BUILT IN 1949 and retired in 2014 due to its outdated security features and minor damage sustained during the 2001 Nisqually earthquake, the Federal Reserve Building in Seattle now reaches for the sky with a vertical expansion, a new seismic system, and new steel.

The landmark building has been converted into a 204,000-sq.-ft Class A office space thanks to an updated design featuring seven beautifully restored existing floors along with seven brand-new floors, with the latter encased in a glass jewel box structure providing stunning views of Seattle's new waterfront. In addition to the seven added stories on top of the original structure, the entire building was strengthened to comply with modern lateral building codes that have significantly changed since the original construction. Many unique challenges required innovative solutions, including providing a new seismic system while preserving the existing system, fabricating new steel framing, and incorporating a near-indestructible five-million-pound vault in the basement into the new building structure.

The framing for the original historic building was provided by Bethlehem Steel in Pennsylvania, and steel was identified as the clear solution for the new framing from the earliest design phases of the expansion and renovation project. In addition to making connections to the existing structure easy, the light weight of a steel framing system reduced the forces on the existing building, as well as the amount of strengthening required throughout.

In order to support the seven-story addition, new steel columns are woven through the existing structure to new foundations below. While the new and existing portions of the building have largely separate gravity systems, they share a lateral force-resisting system because the existing concrete wall system was found to be stiff but weak. Buckling restrained steel braces were installed at each level up the height of the building to provide lateral stability and are visible from the exterior of the building. The existing concrete walls at the lower level were cut away from the building so that they supported their own weight for in-plane forces, but they are supported by the new lateral system for out-of-plane movements. Because the new steel was woven through the existing steel that was placed on an orthogonal grid pattern, the new steel needed to be placed off the original gridlines, which resulted in new framing that did not often meet at right angles. The 3D fabrication model was instrumental in creating accurate shop drawings and identifying conflicts between the new and existing framing for this complicated structure.

To create design separation between the new and existing building, a one-story column-free "hyphen" was created at the perimeter above the roof of the existing structure. In order to accomplish this, a cantilevered plate girder was used above the setback that supports the entire weight of the perimeter columns from the added seven stories above. The design team created a full 3D model of the gravity framing to analyze the vertical deflections and vibrations of the building to make sure that the performance of the plate girders is within acceptable limits.

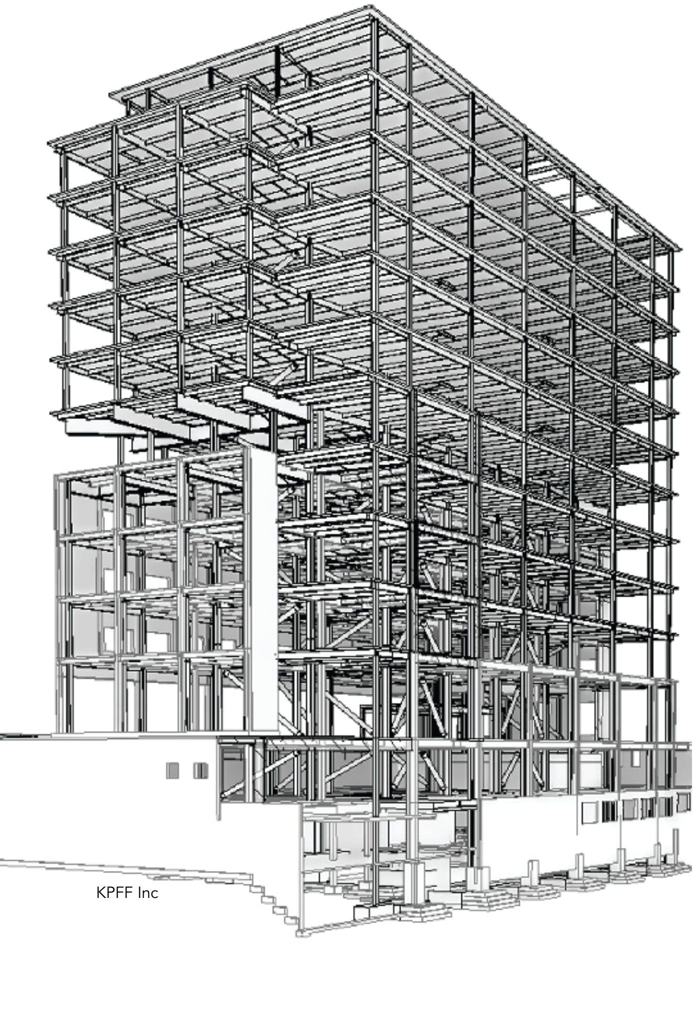
Clarity Northwest Photography

KPFF Inc

Clarity Northwest Photography

"The project showcases where steel has a truly unique ability to be connected and modified into an adaptive reuse of a building that otherwise could not be brought up to current codes."
—David Horowitz

Clarity Northwest Photography



KPFF Inc

Down in the basement, the original 55-ft by 54-ft by 27-ft vault occupies a significant plan area of the building and prevents the addition of foundations in this space. Original construction photos show that the steel security mesh in the vault was so thick that it wasn't possible to see through. The base of the vault was found to be adequate for gravity and downward seismic loads but not seismic uplift loads due to attachment restrictions. To provide uplift resistance, a bearing plate attachment in the middle of the clear span vault lifts up on the underside of the vault lid, and the vault has enough capacity to support its full weight from this one point of support. Eliminating the need to demolish the vault to construct new foundations saved significant time and material for the project.

The historical status of the building resulted in many design challenges, one of which occurs at the corners of the building where a seismic joint is needed, but the limestone panel cladding of the building can't be modified. In order to create a joint while also leaving the exterior of the building intact, a joint was cut vertically through the perimeter-backing concrete walls at the corners but not through the historical panels. The panels were anchored to stainless steel frames that are supported from one side of the joint and reach across the joint to support the entire panel. Fiber-reinforced polymer (FRP) was adhered to the backs of the limestone panels and anchored into the panel thickness to keep the panels from breaking into pieces if there is significant movement at the joint. In the final condition, the corners of the building look unmodified from their original condition.

Because of the original construction tolerances, and the movement of the 70-year-old building with time, the existing steel is close but not exactly in the locations shown in the original construction documents. In order to fabricate the steel correctly, a full 3D scan was taken of the interior of the existing building, and the resulting point cloud was compared to the fabrication model. Where the new steel framing attaches to the existing structure, the dimensions and detailing of the new framing were altered during fabrication to perfectly connect with the existing structure. Additionally, after the framing was installed, 3D scans were taken again and compared against the fabrication model to provide quality control and to verify that the framing was installed in the correct location.

Clarity Northwest Photography

In order to make efficient use of construction materials while also respecting the structure's history, the existing slab-on-deck floor plates were reused wherever possible. Demolition of portions of the existing floor plates only occurred at bays with new stairs and where required for the movement of materials during construction. The archaic concrete-slab-on-metal-deck system was not positively attached to the structural framing, and where beams and girders required strengthening for vertical loads, attachment to the deck was used to reduce the unbraced length of the framing and to increase the capacity instead of adding to the structural section. Performing strengthening via this method saved material and reduced the need for installation labor, including abatement.

Owner
Martin Selig Real Estate, Seattle

General Contractor
Lease Crutcher Lewis, Seattle

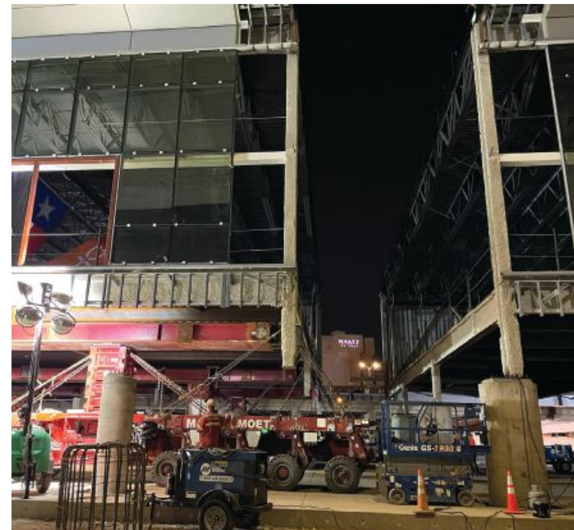
Architect
Perkins&Will, Seattle

Structural Engineer
KPFF Consulting Engineers, Seattle

Steel Fabricator and Detailer
Metals Fabrication Co. (AISC Certified Fabricator)
Airway Heights, Wash.

$75 MILLION TO $200 MILLION Merit Award

DFW High C Gates Demolition and Replacement – Core and Shell, Dallas



MODULARIZATION BROUGHT a new 80,000-sq.-ft concourse in for a speedy landing on a challenging site at Dallas-Ft. Worth International Airport (DFW).

The project involved the demolition and replacement of four gates, known as the High C Gates, at DFW's Terminal C. The new 80,000-sq.-ft concourse consists of six individual modules, roughly 84 ft by 84 ft, constructed roughly one mile away using conventional steel framing that were then moved to the terminal site using SPMTs (self-propelled modular transporters) and set on concrete columns. Once the modules were set in place, additional steel framing was erected to fill in the gaps between a few of the modules. This method allowed for the modules to be constructed while the existing buildings were demolished and foundations and supporting columns were installed, reducing the schedule by 22%.

Each module was designed to be structurally sufficient when freestanding at the fabrication yard, during transport on the SPMTs, and as part of the overall concourse at the terminal site. For this design concept to work, the system for lateral forces and the system for gravity forces required creative solutions. Laterally, each module was stabilized using a combination of braced frames and moment frames to create freestanding modules. The modules were then stitched together at the terminal site so the individual lateral systems could work in conjunction. At both the fabrication yard and the terminal site, a traditional gravity load path was followed, with all loads ultimately being transferred from the deck to beams, then to the columns that transfer the loads to the foundations.

Some columns at the terminal site could not be installed until after a module had been moved into place because they were in the direct path of the SPMTs, which could only support a module at the terminal site for a set amount of time before they had to be returned to the fabrication yard to transport the next module. Because of the time constraint, the team created a composite column concept, with the steel portion of the column designed to support the module when it was on the SPMT. Once the steel column was placed and the transporter released the module, concrete was poured around the steel column to create a composite column that could support full lateral and building service loads.

In addition to designing concourse girders that could support the weight of the module during transport, the team also analyzed possible overturning moments due to wind and the acceleration or deceleration of the SPMTs. Friction at the surface where the concourse girders were in contact with the SPMTs helped prevent the modules from sliding off during transport.

To further expedite the project schedule, the roof, exterior walls, metal panel system, and curtain walls, along with some mechanical shafts and pipes, were installed on the modules at the fabrication yard. This required additional coordination with the manufacturing of those systems and further analysis of the structure to ensure that any unintended deflections that might occur when the modules were being transported or transitioned would not damage the metal panel system or the glass in the curtain walls.

Owner
DFW Airport, Dallas

General Contractor
The Walsh Group, Chicago

Architect
PGAL, Addison, Texas

Structural Engineer
Henderson Rogers Structural Engineers, LLC, Houston

Consultant
Mammoet, Rosharon, Texas

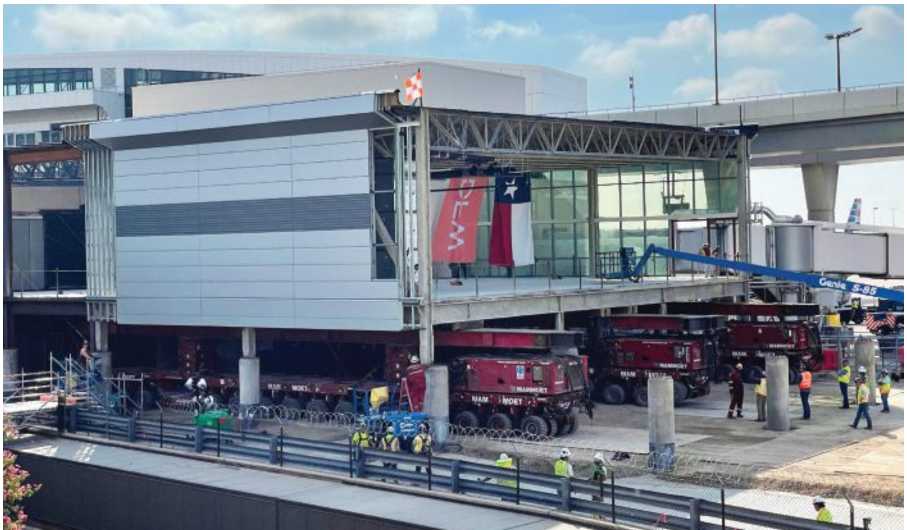
Steel Team

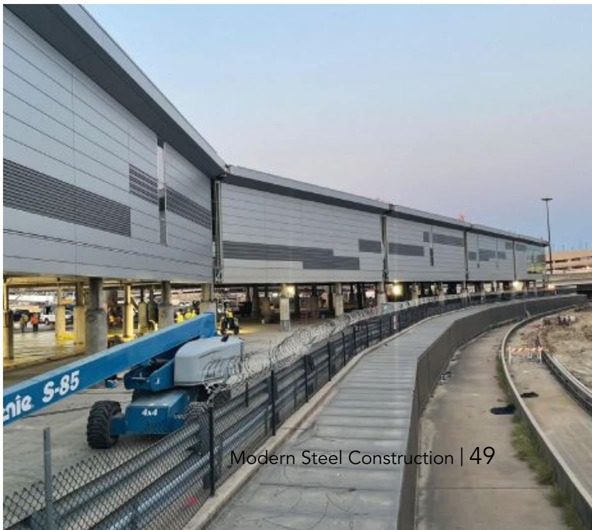
Fabricator and Detailer
Miscellaneous Steel Industries (AISC Certified Fabricator), Kyle, Texas

Erector
Acero Construction Services (AISC Certified Erector), Kyle, Texas

"This modular installation is a great way to showcase the efficiency of using steel in a tightly constrained site."
—David Horowitz

All photos: Henderson and Rogers Structural Engineer, LLC





GREATER THAN $200 MILLION National Award

SoFi Stadium, Inglewood, Calif.

IT TAKES TRUE INNOVATION to make a below-grade structure surrounded by a 100-ft-tall, mechanically stabilized earth wall feel light, but the SoFi Stadium project team did just that.

Home to the Los Angeles Rams and Los Angeles Chargers of the NFL, the 3.1 million-sq.-ft stadium seats 70,000 and can be expanded to 100,000. It sits in close proximity to the Newport-Inglewood fault and also in between flight paths to Los Angeles International Airport (LAX), just three miles away. Due to its proximity to LAX and the subsequent FAA requirements, the playing field was driven 100 ft into the ground, and a record-breaking 100-ft-tall mechanically stabilized earth wall created a moat around the entire stadium, giving it room to safely move during a seismic event. In addition, an advanced structural system featuring buckling-restrained braces (BRBs) and lock-up devices provides needed lateral strength.

The stadium realizes a grand vision that redefines what a venue can be, transcending NFL football to include a wide range of entertainment events, including Super Bowl LVI, the College Football National Championship Game in 2023, and the Opening and Closing Ceremonies of the Olympic Games in 2028. It's topped by a sinuous, semi-transparent roof canopy, which is supported by the largest double cable-net system in the world. The canopy includes micro-operable panels to help maintain climate certainty for events, and the ethylene tetra-

"There's a lightness to it that really elevates the spirit. It's a dramatic experience."
—Anders Lasater

all photos by SoFi Stadium

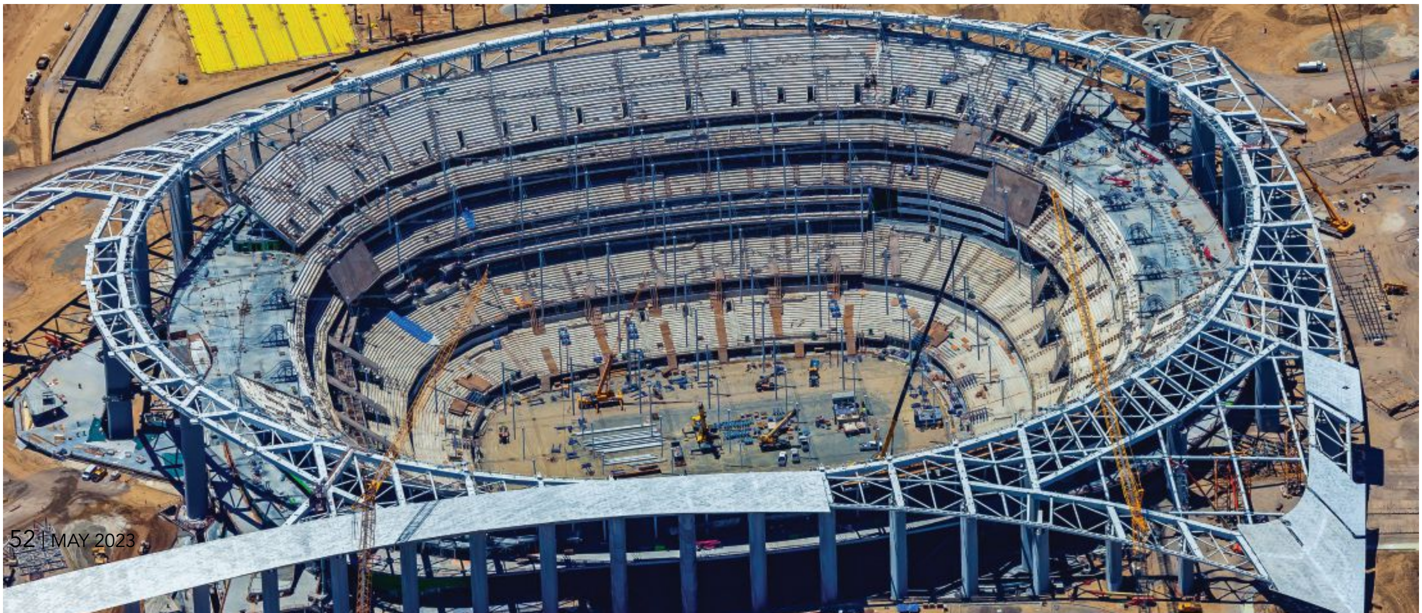
fluoroethylene (ETFE) roof canopy columns are supported on a complex soil-isolated foundation system that extends outward from the stadium.

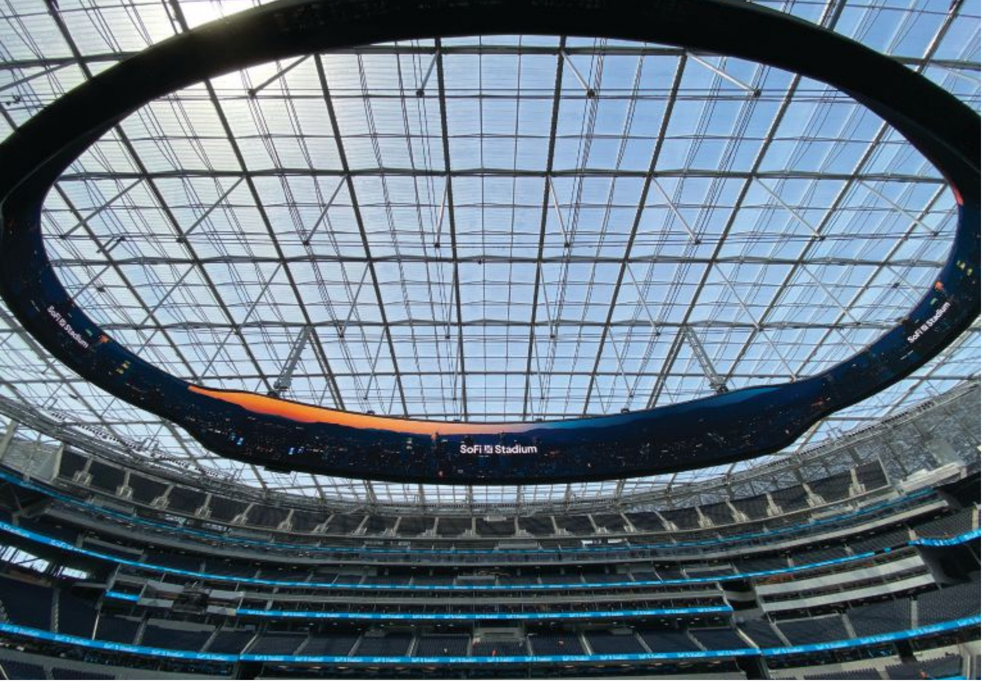
Steel was the right material for this project. Lightweight and strong, with excellent ductility, steel helps minimize seismic activity while providing excellent resistance. Just as the lightweight roof enabled the efficient spanning of the new stadium, the lightweight framing structure allowed efficient seismic resistance in a near-fault location. The cable net ETFE roof canopy and supporting steel frame with columns were designed with aesthetics in mind and driven by the indoor-outdoor nature of the stadium. They also support the Infinity Screen by Samsung, a circular video screen that hangs above the playing field.

The long-span roof canopy demanded a design that maximized material efficiency and lowered tonnage, resulting in seismic isolation and greatly reducing the roof accelerations, permitting a lighter and more elegant design. The use of isolation on a form so different from traditional buildings necessitated performance-based engineering with nonlinear dynamic analysis of the structural elements under numerous seismic ground motions. The roof canopy cable net structure was analyzed under a variety of support conditions, including superimposed loads from the 1,100-ton suspended video screen using 3D seismic acceleration. Additionally, an independent geotechnical analysis of the soil behavior under those same ground motions was performed to validate the final design, ensuring adequate decoupling of behaviors of the roof canopy, perimeter shell, column supports, grandstand, and MSE wall systems.

The stadium bowl was achieved by optimizing the 1,000+ discrete BRBs in the main grandstand and the surgical placement of 48 discrete custom viscous-damper "lock-up devices" (LUDs).


SoFi Stadium





These custom LUDs securely link the lower seating bowl levels during the potential occurrence of seismic activity while allowing the structure to expand and contract under normal thermal loads typical of an outdoor stadium. This required large-scale use of thermal analysis and lock-up devices with buckling-restrained braced frames (BRBFs) to permit partial-height thermal joints, allowing uninterrupted concourses at upper levels by elimination of upper-level seismic joints.

The ETFE roof canopy is supported by the largest known double cable-net system at 1.3 million sq. ft. The cable net rests on a massive asymmetric steel compression ring that is, in turn, supported atop a system of 38 150-ft-tall segmental precast concrete columns located outside of the MSE wall. The compression ring is seismically isolated atop the columns with triple pendulum isolators. In another first, the roof canopy includes 46 operable mechanical panels that draw outside air from the sides and promote passive air circulation throughout the building. The canopy columns are supported on a complex soil-isolated foundation system extending outwardly from the stadium.

Nestled under the same roof canopy as SoFi Stadium is YouTube Theater, a 6,000-seat performance venue, and the 2.5-acre American Airlines Plaza. On the southwest side of the stadium is Lake Park, which features a six-acre lake that functions as a novel water recycling system by collecting 70% to 80% percent of the stormwater runoff from around the site, filtering it through natural wetlands and mechanical systems, and then using it to irrigate the surrounding parkland.

Owner
Hollywood Park, Inglewood, Calif.

General Contractor
Turner Hunt Joint Venture, Inglewood, Calif.

Architect
HKS Architects, Inc., Dallas

Structural Engineer
Walter P Moore, San Francisco

Steel Fabricator, Erector, and Detailer
SME Steel Contractors (AISC Certified Fabricator & Erector), West Jordan, Utah (stadium bowl)

Mortenson, Photographer: Anna Halstead

Mortenson, Photographer: Anna Halstead

Mortenson, Photographer: Anna Halstead

GREATER THAN $200 MILLION Merit Award

Climate Pledge Arena, Seattle

THE NEW HOME of the Seattle Kraken scores a hat trick: It involved the near-total demolition of the existing structure and construction of a largely below-grade arena while keeping the landmarked façade and iconic roof intact, it was completed in time to meet NHL scheduling requirements, and it was designed to be the first net-zero certified arena in the world.

The resulting facility, Climate Pledge Arena, is a major transformation of the former KeyArena, once home to the NBA's Seattle SuperSonics. The $930 million renovation and expansion has created an 800,000-sq.-ft, mostly below-grade venue that holds more than 17,000 fans.

The transformation required near-total demolition of the old structure and construction of a new one, all while keeping the landmarked façade intact and the 22,000-ton roof supported above. The arena is in a high-seismic zone, requiring a roof and column retrofit as well as extensive excavation and shoring to build the new facility under the existing roof. Tuned mass dampers provide vibration control for a 275-ft-long press level bridge using two trusses, a composite steel beam floor system is used throughout the structure, and steel rakers support precast concrete stadia units at seating areas. In addition, an expansive rigging grid supports more than 100 tons of loading.

From the initial phases of the project, a steel structure was the clear structural system of choice for the complicated below-grade bowl structure and the press level bridge. While the temporary roof support system was not fully designed and coordinated until the latter part of the design process, the design team envisioned an extensive temporary steel structure that would be required to be removed and disassembled after the permanent structure was in place. A temporary system using concrete was not feasible, and the temporary roof support system would also require an independent lateral system designed to resist any potential temporary seismic forces. A structural system that could be woven in and around the temporary roof support steel elements won out over a permanent concrete structure that required challenging formwork and shoring conditions. Other factors tipping the scales towards a steel structure included a reduction in self-weight to reduce the seismic forces by minimizing the weight of the floor system.

The steel and concrete structure that now covers the arena was designed by Paul Thiry in the late 1950s and constructed in 1961, and in 2017, the Seattle Landmarks Preservation Board classified Key Arena as a local landmark. This distinction required that the roof, curtain wall, and exterior concrete elements be preserved as part of the renovation with virtually zero impacts on their aesthetics. The central challenge became how to support the existing roof while work continued below it.

Since the new foundations and 55-ft-below-grade event level would undermine all of the existing roof supports, the engineering team designed a temporary system entailing 3,700 tons of temporary steel framing to uphold the majority of the roof's gravity load and resist wind and lateral seismic forces during twenty months of construction. The historic roof had to be supported in the air during the demolition of the remaining structure without incurring damage while also allowing sufficient access and clearance to remove 680,000 cubic yards of soil and install the permanent structure around the temporary structure.

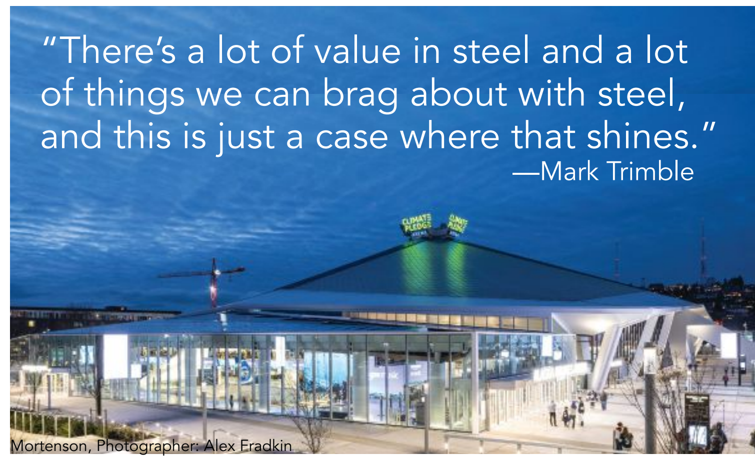
The team performed a seismic retrofit of the existing roof to ensure that it would resist the seismic demands of modern

Mortenson, Photographer: Alex Fradkin

Mortenson, Photographer: Alex Fradkin

Mortenson, Photographer: Alex Fradkin

"There's a lot of value in steel and a lot of things we can brag about with steel, and this is just a case where that shines."
—Mark Trimble



Mortenson, Photographer: Alex Fradkin

codes, using a computationally demanding performance-based design process that relied on realistic ground motions based on site-specific seismicity and accounts for the structure's nonlinear behavior. Using these advanced analysis techniques allowed the team to significantly reduce the number of steel roof members requiring retrofitting.

The project team also employed strategically placed seismic fuses to minimize retrofits in the exposed concrete elements and preserve the aesthetics of the landmarked structure. To limit seismic demands on the existing Y-shaped columns supporting the roof, the team seismically isolated them from the upper levels of the new bowl structure using low-friction slider connections. One of the primary existing lateral bracing elements, the south buttress, was cut back above its foundation to allow for the construction of a new below-grade parking garage. The team employed selective hydro demo techniques to preserve the existing reinforcing in the buttress and supported it in the permanent condition using an 8-ft-thick shear wall on a large pile cap.

The new bowl structure lateral system consists of buckling-restrained braces (BRBs) in the elevator cores and concrete shear walls at the perimeter basement walls and strategically located at the interior. BRBs also brace a new catwalk and a 100-ton-capacity rigging grid to the existing roof structure to control the forces between the new and existing structures. In addition, tuned mass dampers control vibrations in the long-span floor system, and slide bearings between the new elevator core steel and the existing roof structure seismically isolate the roof from the new bowl structure below.

An integrated approach to solving challenges was critical to the project's overall success. The structural engineer provided its Advanced Project Delivery (APD) services, which helped to achieve considerable schedule and cost efficiencies, and the construction engineering and structural design teams worked in parallel with the steel team to provide a fully coordinated and connected Tekla model for the 8,700 tons of permanent steel for the arena and parking garage while also producing full shop drawings for the 3,700 tons of temporary roof shoring structural steel.

For more on the Climate Pledge Arena project, see "Inside Job" in the April 2021 issue, available at ***www.modernsteel.com****.*

Owner
Oak View Group, Los Angeles

Owner's Representative
CAA ICON, Denver

General Contractor
Mortenson, Kirkland, Wash.

Architect
Populous, Kansas City, Mo.

Structural Engineer
Thornton Tomasetti, Inc., Kansas City, Mo.

Civil Engineer
DCI Engineers, Seattle

Steel Team

Fabricators
LeJeune Steel Company (AISC Certified Fabricator), Minneapolis
Corebrace, LLC/SME Steel Contractors, Inc. (AISC Certified Fabricator), West Jordan, Utah (BRBs)

Erector
Danny's Construction Company, Inc. (AISC Associate, AISC Certified Erector), Shakopee, Minn.

Detailer
LTC, Inc. (AISC Detailer), Onalaska, Wis.

GREATER THAN $200 MILLION Merit Award

Moynihan Train Hall, New York

NEW YORK ONCE AGAIN has a grand rail entrance, thanks to the transformation of an early-20th-century postal building into a 21st-century transportation hub.

Moynihan Train Hall expands New York City's Penn Station across Eighth Avenue and into the landmarked James A. Farley Post Office, designed by McKim, Mead and White in 1912 as a sister to their original Pennsylvania Station. Five decades after the demolition of that Penn Station and 30 years after the plan's conception, the 255,000-sq.-ft Moynihan Train Hall once again provides visitors with a grand entrance to New York City. Its central feature—the 30,000-sq.-ft, skylit main boarding concourse—increases public space at America's busiest transit hub by 50%.

For decades, the Farley Building served as Manhattan's General Post Office. The building's location over the railroad tracks greatly facilitated the distribution of mail to and from the rest of the country, and operations there increased through the late 20th century. As long-distance delivery transitioned from rail to truck, however, the Postal Service shifted work to other facilities. In 1992, Amtrak proposed a move into the then mostly vacant building. The idea was championed by U.S. Senator Daniel Patrick Moynihan of New York, in whose honor the facility was eventually named.

The Farley building's historical designation was a direct result of Penn Station's demolition and the onset of a preservation movement that is still active today. As a landmark, the Beaux-Arts exterior and retail post office could not be altered in any way. However, as a steel-framed structure—one that represents an almost encyclopedic history of the early-20th-century American steel industry, with contributions from Carnegie Brothers, U.S. Steel, and Bethlehem Steel, among other notable shops—Farley was readily adaptable. Reinforcement of roof trusses, reconfiguration of concourse girders framing over live railroad tracks below, and concealed framing within the landmarked walls helped transform the building from a mostly functional 20th-century postal building into a 21st-century transportation hub while maintaining its outward elegance.

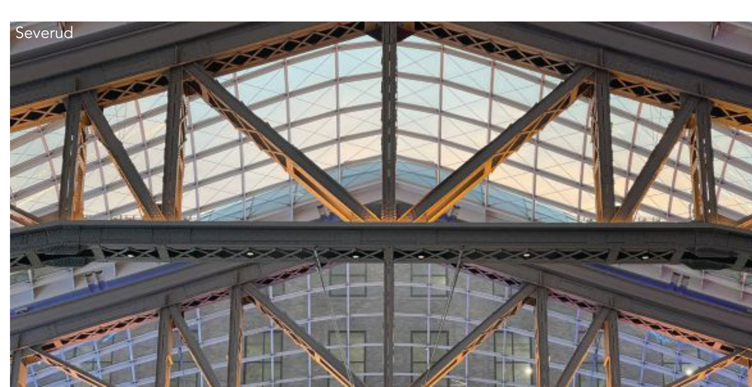
Structural steel was the natural choice for redeveloping the Farley building. The original Eighth Avenue building, constructed in 1912, and the Annex, which was built in 1933 and extended Farley all the way west to Ninth Avenue, are framed almost entirely in steel. The original engineers would have chosen steel for its ability to span over multiple railroad tracks—up to 70 ft—while also transferring loads from five levels of framing above. Similarly, the strength of steel allowed the original engineers to use a generous 32-ft by 40-ft column spacing in the Annex. Given the original building's age, the engineering team cut coupons from portions of the existing steel and tested them for tensile properties, chemical composition, and base metal notch toughness and determined that they typically met or exceeded current standards. In all, 1,000 tons of the building's existing steel were removed, 4,000 tons were modified, and 6,000 tons of new steel were added. Together, the improvements add station entrances, track access points, and interconnectivity between rail, subway, and street-level modes of transportation.

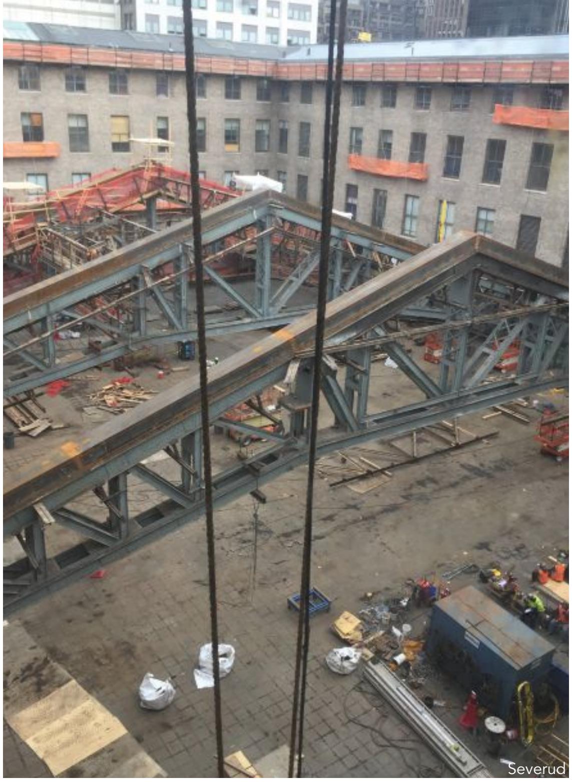
Aesthetics also played a role in the use of structural steel for Moynihan Train Hall. Steel trusses that span across and enclose the former mail sorting room are now exposed to view. Their latticed members add an extra sense of lightness that could not be attained with another material and establish a modern aesthetic while dis-

Dave Burk
Empire State Development–SOM

"It shows the resilience of steel. You can take that 110-year-old truss and still keep it working."
—Helen Torres

Severud





Severud

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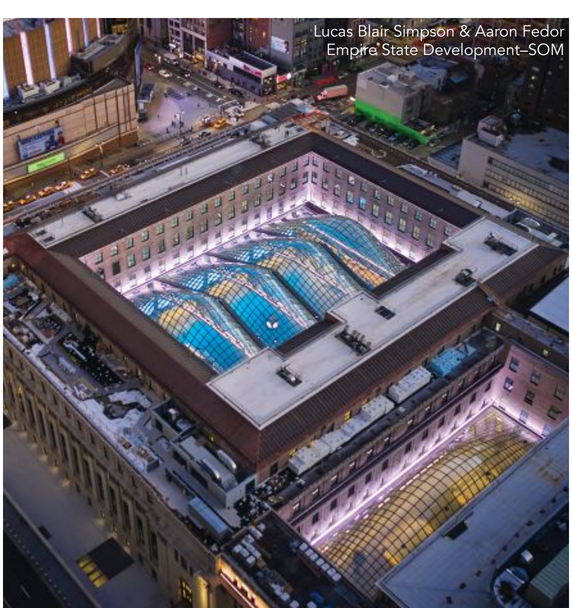


Lucas Blair Simpson & Aaron Fedor
Empire State Development–SOM

playing neoclassical workmanship. Boxes of steel plate, compact and concealed between the top chords and skylights, do nothing to detract from this aesthetic.

Moynihan Train Hall's central feature is the main boarding concourse. Located in Farley's former mail sorting room, the 150-ft by 200-ft space is column-free due to three existing steel roof trusses—invisible a century ago—that were uncovered and reinforced to become a significant focal point of the design. Their latticed configuration and riveted connections are reminiscent of framing in the old Penn Station and add delicacy of detail and a sense of lightness, despite their large scale.

The existing trusses had sufficient capacity to carry a new roof. However, all existing framing between the trusses had to be removed to maximize the skylight's function and appearance. This left them unbraced at their ends and for the full length of their gabled top chords. Restoring the trusses' stability was, therefore, a central component of the structural design plan.

Each truss is composed of two identical and parallel bents, spaced about 3 ft apart, initially to form an observation gallery for postal inspectors. The bents are tied together with diaphragm plates and latticed straps that terminate about six feet above the bottom chords. A box beam 36 in. wide by 24 in. deep, composed of 3.5-in.-thick steel plates and located along the top of each truss, provided sufficient lateral support while remaining concealed beneath the skylights. The box beams also deliver lateral loads to the ends of the trusses and eliminate the need for bracing between them.

The skylights themselves were designed as four independent modules, 50 ft by 150 ft, and arched in cross section, which follow the top truss chords and enclose the concourse. The structures are lightweight grids of steel tees of varying depths spaced with 3 ft to 4 ft between them. The frameworks are internally braced with in-plane diagonal cables and transverse "spiderwebs" of cables at the existing truss third points.

The trusses required additional reinforcements to maintain stability under the skylight loading. Diaphragm plates were welded between each pair of existing truss bents, at the top of the top chords and just below them, and then diagonal bracing plates were welded to the diaphragms to prevent rotation where the bracing cables connect. Finally, plates were welded to tie together pairs of truss bottom chords at each panel point as a replacement for framing elements that were removed.

Existing double-bent trusses also frame the perimeter of the train hall, supporting the low roof between the skylights and Farley building office wings, and are now exposed to view. With a uniform horizontal profile but located at about the main truss bottom chord level, the perimeter trusses are too low to support the new skylights directly. So instead, existing columns were extended up to the box beam elevation, and new framing was installed between them. At the ends of the box beams, steel tube diagonals were welded from each side down to the first perimeter truss panel point to prevent rotation and transfer lateral loads into the building frame.

For more on the Moynihan Train Hall project, see "Station to Station" in the August 2021 issue, available at ***www.modernsteel.com****.*

Owner
New York State/Empire State Development, New York

General Contractors
Vornado Realty Trust, The Related Companies, and Skanska, East Elmhurst, N.Y.

Architect
Skidmore, Owings and Merrill, New York

Structural Engineer
Severud Associates Consulting Engineers, PC, New York

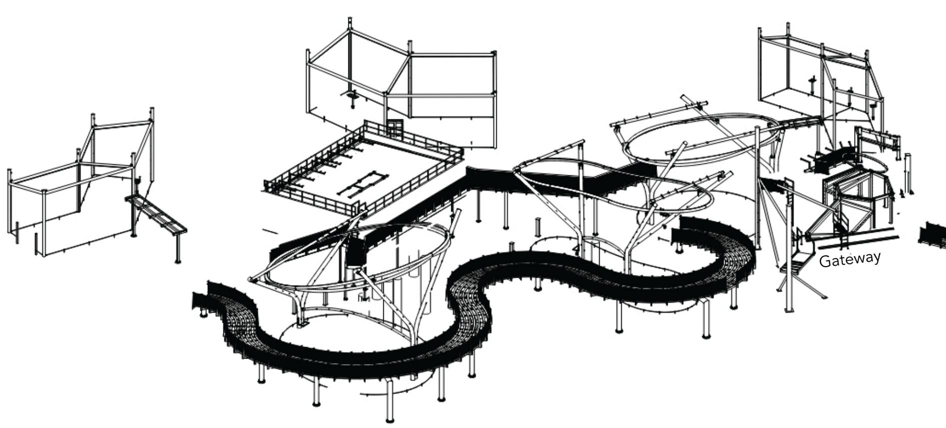
Steel Team

Fabricators
Crystal Steel Fabricators/Crystal Metalworks, Delmar, Del. (primary)
L & M Fabrication and Machine, Bath, Pa. (plate reinforcement)

Detailers
Anatomic Iron Steel Detailing, North Vancouver, B.C., Canada
International Design Services, Inc., St. Louis

Brian Tulgetske

Brian Tulgetske



Emi Lampman

"I don't think this project could have been made with anything other than steel. The way the paths are nestled through the trees seems almost natural."
—Mark Trimble

Emi Lampman

Emi Lampman

Brian Tulgetske

Emi Lampman

SCULPTURE/ART INSTALLATION/NON-BUILDING STRUCTURE Merit Award

Michael and Quirsis Riney Primate Canopy Trails, St. Louis

THE PROJECT TEAM behind the Michael and Quirsis Riney Primate Canopy Trails weren't monkeying around when it came to seamlessly interweaving steel paths and climbing structures with live trees and other natural elements to give visitors a treetop experience—but the real star of the show is uncoated weathering steel, which can gracefully withstand the seasonal changes of the Midwest.

This one-of-a-kind interactive outdoor primate exhibit offers Saint Louis Zoo a unique experience within its 35,000-sq.-ft space, allowing visitors to walk through the forest floor via a see-through tunnel framed in steel and float through the treetops via an elevated winding steel boardwalk. It features eight different steel-framed habitats for primates—including Old World monkeys, New World monkeys, and lemurs—that contain enrichment play areas as well as shelters for the animals.

Climbing structures of steel intertwine with live trees to create a habitat that showcases industrial steel interwoven beautifully with nature. The boardwalk is supported by a round HSS spine that winds through the exhibit. In the three largest habitats, painted round HSS structures are interwoven between sycamore and blue ash trees that create additional climbing and enrichment activities for the animals. Above this is an assembly of weathering steel that holds in place the netting that encloses the habitats. Sixteen steel shelter boxes throughout the habitats, fabricated from weathering HSS, provide the animals with a place to find shade in the summer, heat in the winter, or just a place to hang out when not swinging around the steel and natural treetops.

The project's design included multiple complex curves and elevation changes throughout. The boardwalk had to be fabricated in fifteen separate pieces, with each section having a unique curve and elevation. The curved HSS that made up the spine required the fabricator to hand torch the ends to the correct pitches and angles, with each cut being unique to each piece of the boardwalk and each end. This was achieved through extensive manual calculations in the fabrication shop as well as continued communication between the detailer and the fabricators. The handrail and mesh panels that lined each boardwalk piece were also hand calculated in the fabrication shop to ensure the straight panels could follow the curve and pitch of each section of the boardwalk. An added challenge was the egg shape that the tubes took on after being rolled. While this a common hurdle to overcome with any rolled member, it was an added complexity within an already complex project.

Along with the challenges that were presented with the boardwalk, there were also the curved members that made up the steel trees in three of the habitats. The fabrication shop had certain coordinates that they had to keep constant for the rolled members to hit, and each bracket attached to the curved members needed to be custom fabricated by hand to match the curve of the tube. An additional challenge involved the three steel halos that were attached to hold a mesh netting that encloses the habitat. Each of these halos is a different size and shape and had to be fabricated at a specific radius. The brackets attaching them to the curved steel trees had to be hand calculated for the proper angle to ensure erection in the field could be performed without hitting the existing sycamore and blue ash trees.

One of the largest challenges with connecting the trees to the halos involved the ball that sat in the halo pipe, which had to be hand cut at the correct angle for erection in the field. In addition, the ironworkers were tasked with erecting these pieces among trees that could not be touched or damaged, so each angle and radius had very little room for movement. ■

*For more information on the Michael and Quirsis Riney Primate Canopy Trails project, see "What's Cool in Steel" in the December 2022 issue, available at **www.modernsteel.com**. Note that Joe Nicoloff (deceased) of Nicoloff Detailing was also a steel detailer on this project.*

Owner
Saint Louis Zoo

General Contractor
Tarlton Corporation, St. Louis

Architect
PGAV Destinations, St. Louis

Structural Engineer
Leigh & O'Kane, Kansas City, Mo.

Animal Enclosure Consultant
A Thru Z Consulting, Tucson, Ariz.

Steel Team

Fabricator
The Gateway Company of Missouri, Berkeley, Mo.

Erector
Acme Erectors Inc., St. Louis

Detailer
Pan Gulf Technologies

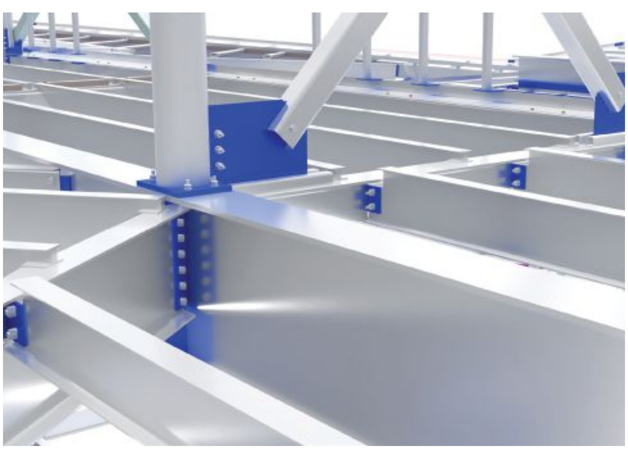
Bender-Roller
Max Weiss Company, Milwaukee

new products

This month's New Products section features updates to fabrication and detailing software packages, as well as an off-the-shelf bracing solution designed with efficiency in mind.

Tekla PowerFab 2023

Steel fabrication management software suite Tekla PowerFab 2023 offers new functionalities that help fabricators manage changes in their projects efficiently to minimize errors. In the latest version of Tekla PowerFab, subscribers can gain quick and easy access to visual production dashboards and a shipping calendar. The mobile tool Tekla PowerFab Go provides new time-saving functionalities. To support sustainable material sourcing, Tekla PowerFab now features improvements for tracking the origin of raw materials. For more information, visit **www.tekla.com**.

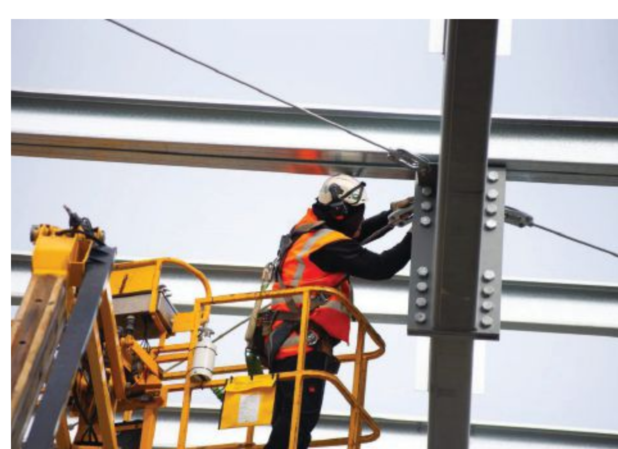


SDS2

SDS2 by ALLPLAN is the ultimate solution in steel detailing, covering all your project needs in structural and miscellaneous steel and automated connection design, along with seamless BIM integrations to enhance your workflows from estimating to fabrication and delivery. Our latest release delivers even more power to help you maximize efficiency with new features and enhancements in modeling, detailing, fabrication integrations, and more. In SDS2 2023, you'll see new tools and enhancements in everything from modeling, drawings, connections, the API, and more. Tackle unique design challenges with modeling enhancements for material fit operations and other specialized elements. Add more valuable data to your model—including surface finishes—to feed your fabrication management systems and share design data more clearly with new display options for the model and drawings. For more information, visit **www.sds2.com**.

Donovan Group

DonoBrace is a new high-strength, easy-to-use bracing system. While bracing is a small aspect of the building design, it is also a crucial one. The design and engineering process needs to consider all possible forces that a building can experience, and bracing plays a key role in maintaining the structural integrity of the building. To support structures in a range of high-load environments, bracing systems should be designed for increased ductility, strength, and security. Moving towards better efficiency for bracing isn't just about material usage; it's also about streamlining processes for construction professionals and making everyone's life in the value chain easier and more cost-effective. As an off-the-shelf product, DonoBrace helps streamline the work for everyone involved, from structural engineers to fabricators to installers. For more information, visit **www.donobrace.com**.



ENGINEERING JOURNAL

Second Quarter 2023 *Engineering Journal* Now Available

The second quarter 2023 issue of AISC's *Engineering Journal* is now available. It includes papers on designing for shear at brace and diagonal member connections, thermal loading and steel plate composite walls, electroslag welding applications, and slotted hidden gap connections. To access this issue and all past issues of *Engineering Journal*, visit **aisc.org/ej**.

Design for Local Member Shear at Brace and Diagonal Member Connections: Full-Height and Chevron Gusset
Original paper by Rafael Sabelli and Brandt Saxey, discussion by Paul W. Richards

The paper "Design for Local Member Shear at Brace and Diagonal-Member Connections: Full-Height and Chevron Gusset" (Sabelli and Saxey, 2021) develops equations for checking local member shear demands using a Concentrated Stress Method (CSM) and presents a design example. This discussion presents results from a finite element (FE) model, based on the design example in the paper, to quantify the accuracy of the proposed design equations in predicting beam yielding.

Effects of Accident Thermal Loading on In-Plane Shear Behavior of Steel-Plate Composite Walls
Saahastaranshu R. Bhardwaj, Kadir C. Sener, and Amit H. Varma

Structural walls in safety-related nuclear facilities are required to be designed for seismic and accident thermal (due to postulated high-energy pipe break events) loading combination. Current U.S. and international codes provide limited guidance for the analysis and design of walls for this loading combination. This paper describes the experimental results and observations from tests conducted on a laboratory-scale (1:4 to 1:5) test unit representing steel-plate composite (SC) walls subjected to combined in-plane (seismic) and accident thermal loading. The test unit was subjected to surface temperatures of up to 450 °F in combination with cyclic in-plane loading. Results of similar experiments recently conducted in Japan are also summarized (with surface temperatures up to 570 °F). Surface heating combined with the low thermal conductivity and high specific heat of concrete resulted in nonlinear thermal gradients through the thickness of the specimens. These nonlinear thermal gradients and the associated self- or internal restraint led to extensive concrete cracking. This concrete cracking reduced the initial and secant stiffness of the specimens. The initial stiffness of the heated specimens was reduced to 30% to 40% of the initial stiffness of the control (unheated) specimen. The secant stiffness of the heated specimens reduced up to 50% of the secant stiffness of the control (unheated) specimen. However, the in-plane shear strength of the heated SC specimens was still approximately 10% to 30% greater than the nominal in-plane shear strength that was calculated for the limit state of steel plate von Mises yielding using ANSI/AISC N690 equations and measured material properties.

Electroslag Welding Applications for Steel Building Construction in Japan: A State-of-the-Art Review
Yukihiro Harada, Jun Iyama, Yuka Matsumoto, Kazuaki Suzuki, and Koji Oki

Electroslag welding (ESW) is advantageous for the improvement of the efficiency of welding thick steel plates, and the application of ESW has been gradually spreading to civil structures such as steel bridges and steel building structures. This paper presents a review of state-of-the-art ESW applications for steel building structures in Japan.

Steel Structures Research Update: Slotted-Hidden-Gap Connections and Intentional Eccentricity for Steel Brace Members
Judy Liu

Research on alternatives for steel brace members and their connections is highlighted. These studies are a collaboration between Dr. Colin Rogers, Professor and Acting Chair at McGill University, and Dr. Robert Tremblay, Professor at Polytechnique Montreal. Research on braces with intentional eccentricity (BIEs) is motivated by improvements in seismic performance compared to concentrically loaded brace (CLB) members. A brief summary of the background, motivation, and research objectives is presented.

People & Companies

The **Steel Bridge Task Force**, comprised of the **American Iron and Steel Institute (AISI)**, **NSBA**, and the **American Association of State and Highway Transportation Officials (AASHTO)** T-14 Technical Committee for Structural Steel Design, announced that it selected **Ryan J. Sherman, PE, PhD**, assistant professor in the School of Civil and Environmental Engineering at **Georgia Institute of Technology**, as the recipient of the 2023 Robert J. Dexter Memorial Award Lecture. Sherman will present a lecture on his research findings at the next meeting of the Steel Bridge Task Force on September 21, 2023, in Denver.

Instituted by the Steel Bridge Task Force in 2005 in memory of the late **University of Minnesota** associate professor **Robert J. Dexter**, an internationally recognized expert on steel fracture and fatigue in bridges, the program provides an opportunity for early-career structural engineers to present their research to the Steel Bridge Task Force.

Sherman is involved in several research projects that are advancing the steel bridge industry. His research areas include large-scale structural experimentation, structural health monitoring, material characterization, finite element simulation, fatigue and fracture, and additive manufacturing for civil engineering infrastructure. Sherman's research for the **Federal Highway Administration Transportation** Pooled Fund resulted in a proposed methodology to set rational inspection intervals using high-toughness steel and an integrated fracture control plan, and his role in NCHRP Project 10-74 resulted in a new fatigue design load for high-mast lightning towers that AASHTO adopted into its *LRFD LTS Specification*.

Sherman is a member of the World Steel Bridge Symposium Planning Committee and **AISC's** Partners in Education committee. In 2022, AISC recognized Sherman with the Terry Peshia Early Career Faculty Award.

SAFETY

AISC Announces Safety Award Winners

AISC is pleased to honor more than 130 structural steel fabricators and erectors for their outstanding safety records in 2022.

"The dedicated people who work in fabrication shops and on job sites across the country are what really sets domestically fabricated structural steel apart," said AISC senior director of engineering Tom Schlafly. "AISC is proud to recognize those who truly put safety first to protect our industry's greatest asset: talented, passionate workers."

Most of this year's winners have earned the Institute's top safety award, the Safety Award of Honor, which is presented for a perfect record of no disabling injuries (DART=0—see below for more info about DART data).

"A culture of workplace safety only works if everyone in the organization, from top to bottom, actively participates and commits to looking out for one another," said AISC Safety Committee Chair John Schuepbach. "When leaders take ownership and make safety a top priority, it encourages employees at all levels of the company to do the same—and it's a lot of work on everyone's part. This year's Safety Award recipients deserve a lot of credit for their dedication to safety in the field and in the shop."

AISC relies on information that companies also report to OSHA to determine Safety Award recipients: their Days Away, Restricted, or Transferred (DART) rates. The DART measures the number of recordable lost work cases per 200,000 labor hours worked. AISC bases the awards on cases (not days) as reported to OSHA on the 300A form, along with the hours worked in the year.

AISC presents a Safety Award of Honor to fabricators and erectors with perfect records (a DART of zero). Those with excellent records ($0<DART\leq1$) earn a Safety Award of Merit, and Safety Commendations recognize companies with DARTs greater than one and less than or equal to two.

The awards program is open to all AISC member fabricators and erectors, and applications for the program are solicited annually. Awards are issued separately for fabrication and erection companies. In order to be eligible to win an award, the member company must submit a copy of their OSHA 300A form for verification purposes.

For more information and resources on safety for the fabricated and erected structural steel industry, visit **aisc.org/safety**.

2022 SAFETY AWARD

Safety Award of Honor (DART = 0) Fabrication

- AF Steel Fabricators, Chandler, Ariz.
- Alamo Structural Steel, Waco, Texas
- Alpha Iron, Ridgefield, Wash.
- Apollo Steel, LLC, Jaffrey, N.H.
- Associated Steel Fabricators, Inc., Tomball, Texas
- B & B Welding Company, Inc., Fort Howard, Md.
- BENCHMARK Fabricated Steel, Terre Haute, Ind.
- C & F Steel Company, Inc., Hamilton, Texas
- Chesapeake Bay Steel, Inc., Norfolk, Va.
- Cianbro Fabrication & Coating Corporation, Pittsfield, Maine
- Continental Steel Works Inc., Butte, Mont.
- Crowder Industrial Construction, Spartanburg, S.C.
- Delta Steel Inc., Saginaw, Mich.
- Diversatech-Metalfab LLC, Gridley, Ill.
- Dixie Southern Industrial, Inc., Polk City, Fla.
- Eddy's Welding, Inc., Ellicott City, Md.
- F.A. Wilhelm Construction Co. Inc., Indianapolis
- Fiedeldey Steel Fabricators, Inc., Cincinnati
- Florida Structural Steel, Gibsonton, Fla.
- Fresno Fab-Tech, Inc., Sanger, Calif.
- G2 Metal Fab, Inc., Livermore, Calif.
- George's Welding Services, Inc., Miami
- Gibson Industrial Inc., Richmond, Va.
- Gira Steel West, Columbia, S.C.
- GMF Industries, Inc., Lakeland, Fla.
- Gremp Steel Company, Posen, Ill.
- Hall Industries, Inc., Ellwood City, Pa.
- High Plains Steel Services, LLC, Windsor, Colo.
- Hillsdale Fabricators, a Division of Alberici Constructors, St. Louis
- Iowa Engineered Processes Co., Independence, Iowa
- J.R. Hoe and Sons, Middlesboro, Ky.
- Jonquil Steel and Construction Inc., Mableton, Ga.
- Larwel Industries, Bedford, Texas
- Lee's Imperial Welding Inc., Fremont, Calif.
- Levan Associates Inc., Emmaus, Pa.
- LMC Industrial Contractors, Avon, N.Y.
- Lyndon Steel Company, Winston-Salem, N.C.
- M & J Steel LLC, Trussville, Ala.
- Maccabee Industrial Inc., Belle Vernon, Pa.
- Mast Farm Service, LTD, Millersburg, Ohio
- McClean Iron Works, Everett, Wash.
- McCombs Steel Company, Inc., Statesville, N.C.
- New Industries, LLC, Morgan City, La.
- NOVA Group, Inc., Napa, Calif.
- Ogeechee Steel, Inc., Swainsboro, Ga.
- Penn Steel Fabrication, Inc., Bristol, Pa.
- Phoenix Fabrication & Supply, Inc., Peotone, Ill.
- Pioneer Erectors, Grand Rapids, Mich.
- Premier Fabrication, LLC, Congerville, Ill.
- Prospect Steel, a Division of Lexicon, Inc., Armorel, Ariz.
- RCC Fabricators, Inc., Paterson, N.J.
- Resolute Performance Iron, Inc., Tempe, Ariz.
- Rochester Rigging & Erectors, Inc., Bloomfield, N.Y.
- Rochester Structural, LLC, Rochester, N.Y.
- Rocky Mountain Steel, Inc., Olathe, Colo.
- Sanpete Steel Corporation, Moroni, Utah
- Schuff Steel Company, Humble, Texas
- Schuff Steel Company, Ottawa, Kan.
- Shure Line Construction, Kenton, Del.

2022 SAFETY AWARD ★★★

- Steel Fabricators of Monroe, Monroe, La.
- Steel Service Corporation, Jackson, Miss.
- Steel Specialty, Inc., Belmont, N.C.
- Stinger Bridge & Iron, Coolidge, Ariz.
- Stud Welding, Inc., Centerville, Tenn.
- Talley Metal Products, Inc., Hagerstown, Md.
- The Arthur Louis Steel Company, Geneva, Ohio
- The Gateway Company of Missouri LLC, St. Louis
- The Haskell Company, Jacksonville, Fla.
- Tipton Structural Fabrication, Tipton, Iowa
- Tipton Structural Fabrication, Cedar Rapids, Iowa
- Triad Fabricators, LLC, Evansville, Ind.
- Trinity Fabricators, Inc., New Albin, Iowa
- Troy Industrial Solutions, Brewer, Maine
- United Weld Services, LLC, York, Pa.
- USA Structural Steel & Foundations, Sarasota, Fla.
- Welding Works, Madison, Conn.
- Zimkor LLC, Littleton, Colo.

Safety Award of Honor (DART=0) Erection

- AF Steel Fabricators, Chandler, Ariz.
- Black Cat LLC, Cheyenne, Wyo.
- Building Zone Industries, Kanarraville, Utah
- Delta Steel Inc., Saginaw, Mich.
- Derr & Gruenewald Construction, Henderson, Colo.
- Eddy's Welding, Inc., Ellicott City, Md.
- F.A. Wilhelm Construction Co. Inc., Indianapolis
- Fresno Fab-Tech, Inc., Sanger, Calif.
- Gibson Industrial Inc., Richmond, Va.
- Gremp Steel Company, Posen, Ill.
- High Plains Steel Services, LLC, Windsor, Colo.
- Jonquil Steel and Construction Inc., Mableton, Ga.
- Lee's Imperial Welding Inc, Fremont, Calif.
- McClean Iron Works, Everett, Wash.
- North Alabama Fabricating Company, Inc., Birmingham, Ala.
- Ogeechee Steel, Inc., Swainsboro, Ga.
- Peterson Beckner Industries, Inc., Houston
- Pioneer Erectors, Grand Rapids, Mich.
- Resolute Performance Iron, Inc., Tempe, Ariz.
- Rochester Structural, LLC, Rochester, N.Y.
- Shure Line Construction, Kenton, Del.
- Stinger Bridge & Iron, Coolidge, Ariz.
- Structural Services, Inc., Albuquerque, N.M.
- The Arthur Louis Steel Company, Geneva, Ohio
- United Weld Services, LLC, York, Pa.
- USA Structural Steel & Foundations, Sarasota, Fla.
- XLE Metals Corporation, Prospect Park, Pa.

2022 SAFETY AWARD ★★

Safety Award of Merit (0<DART≤1) Fabrication

- Custom Metals, a Division of Lexicon, Inc., Little Rock, Ark.
- Integrated Structural Engineering, LLC, Cedarburg, Wis.
- Prospect Steel, a Division of Lexicon, Inc., Little Rock, Ark.
- Schuff Steel Company, Phoenix
- Schuff Steel Company, Bellemont, Ariz.
- Thompson Metal Fab, Inc., Vancouver, Wash.

Safety Award of Merit (0<DART≤1) Erection

- Davis Erection (Omaha), Gretna, Neb.
- Integrated Structural Engineering, LLC, Cedarburg, Wis.
- Williams Erection Co., LLC, Smyrna, Ga.

2022 SAFETY AWARD ★

Safety Commendation (1<DART≤2) Fabrication

- Able Steel Fabricators, Inc., Mesa, Ariz.
- Alamo Structural Steel, Victoria, Texas
- Cooper Steel, Shelbyville, Tenn.
- DIS-TRAN Steel, LLC, Pineville, La.
- Garrison Steel Fabricators, Inc., Pell City, Ala.
- Gayle Manufacturing Company, Caldwell, Idaho
- Metal Pros, LLC, Wichita, Kan.
- North Alabama Fabricating Company, Inc., Birmingham, Ala.
- Schuff Steel Company, Stockton, Calif.
- Schuff Steel Company, Eloy, Ariz.
- Schuff Steel Company, Lindon, Utah
- Summit Steel Works Corp, San Jose, Calif.
- Tampa Tank/Florida Structural Steel, Tampa, Fla.
- Thomas Steel, Inc., Bellevue, Ohio
- Western Slope Iron & Supply, Inc., Grand Junction, Colo.

Safety Commendation (1<DART≤2) Erection

- Cooper Steel, Shelbyville, Tenn.
- Dixie Southern Industrial, Inc., Polk City, Fla.
- Garrison Steel Fabricators, Inc., Pell City, Ala.
- ROC Steel, LLC, Suffolk, Va.
- Stonebridge Inc., South Plainfield, N.J.
- Ideal Contracting, Detroit

T.R. HIGGINS AWARD

AISC Seeks Nominations for 2024 Higgins Lectureship Award

AISC is seeking nominations through July 2, 2023, for the prestigious T.R. Higgins Lectureship Award, which includes a $15,000 cash prize. Presented annually by AISC, the award recognizes a lecturer-author whose technical paper(s) are considered an outstanding contribution to engineering literature on fabricated structural steel. The winner will be recognized at the 2024 NASCC: The Steel Conference, March 20–22, in San Antonio, Texas, and will also present their lecture, upon request, at various professional association events throughout the year.

Nominations should be emailed to AISC's Martin Downs at **downs@aisc.org**. Or, if you'd prefer to mail your nomination, contact Martin for mailing information. Nominations must include the following information:

- Name and affiliation of the individual nominated (past winners are not eligible to be nominated again)
- Title of the paper(s) for which the individual is nominated, including publication citation
- If the paper has multiple authors, identify the principal author
- Reasons for nomination
- A copy of the paper(s), as well as any published discussion

The author must be a permanent resident of the U.S. and available to fulfill the commitments of the award. The paper(s) must have been published in a professional journal between January 1, 2018, and January 1, 2023. In addition, the winner is required to attend and present at the 2024 Steel Conference and also give a minimum of six presentations of their lecture on selected occasions during the year.

The award will be given to a nominated individual based on their reputation as a lecturer and the jury's evaluation of the paper(s) named in the nomination. Papers will be judged for originality, clarity of presentation, contribution to engineering knowledge, future significance, and value to the fabricated structural steel industry.

The current T.R. Higgins Lecturer is Jennifer McConnell, PhD, who received the award for her paper titled "Performance of Uncoated Weathering Steel Bridge Inventories: Methodology and Gulf Coast Region Evaluations," as well as for her outstanding reputation as an engineer and lecturer. If your organization is interested in hosting a T.R. Higgins lecture, please contact Christina Harber, AISC's director of education, at **harber@aisc.org**.

The award is named for Theodore R. Higgins, former AISC director of engineering and research, who was widely acclaimed for his many contributions to the advancement of engineering technology related to fabricated structural steel. The award honors Higgins for his innovative engineering, timely technical papers, and distinguished lectures. For more information about the award, visit **aisc.org/higgins**.

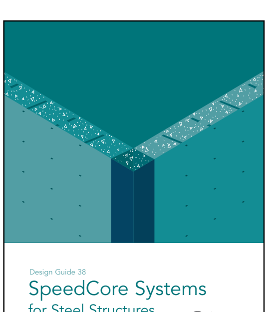
SPEEDCORE

AISC Releases Design Guide on Revolutionary SpeedCore System

AISC has added a new design guide to its library, and it's all about speed!

Design Guide 38: *SpeedCore Systems for Steel Structures* gives designers everything they need to take advantage of the non-proprietary concrete-filled composite steel plate shear wall core system that shaved a whopping ten months off the erection schedule of Seattle's 58-story Rainier Square. Digital and print versions are available at **aisc.org/dg**.

The guide (authored by Amit H. Varma, PhD; Morgan Broberg, Soheil Shafaei, PhD, and Ataollah Anvari Taghipour) covers coupled and uncoupled systems in planar, C-shaped, and I-shaped configurations. It also includes critical information about designing for wind, fire, and seismic considerations, along with extensive design examples.



"SpeedCore is a game-changer when it comes to the rapid design and erection of steel buildings because there's no waiting for concrete to cure," said AISC vice president of engineering and research Christopher H. Raebel, SE, PE, PhD. "It's possible to build four floors in a week, which translates into shorter construction time, substantial cost savings, and earlier occupancy. The new Design Guide provides a complete toolkit to harness the potential of this innovative structural system."

In addition to being, well, speedy, SpeedCore provides extraordinary strength and stability, which is one reason it's being used in seismic zones like Seattle and California. It also offers superior impact and blast resistance, and its predictable structure with no hidden reinforcing bars makes it great for future adaptive reuse.

Letter to the Editor

Big, but Not Quite Biggest

It was great to see an article on the use of castellated beams for the Ace Hardware Distribution Center ("Going Big with Castellated Beams," January 2023, **www.modernsteel.com**). However, I am not sure this is the largest known castellated beam project. When I was in a previous role, we partnered with another fabricator on a castellated beam project, a new multi-level parking garage for the Wind Creek Bethlehem resort and casino in Bethlehem, Pa., that was over 4,000 tons and over 1.1 million sq. ft. *[Editor's note: The Ace Hardware project used just over 2,600 tons of castellated beams and had approximately the same square footage as the Wind Creek project.]*

—Tim Bradshaw, PE
Vice President, Project Delivery
Owen Steel Company, Inc.

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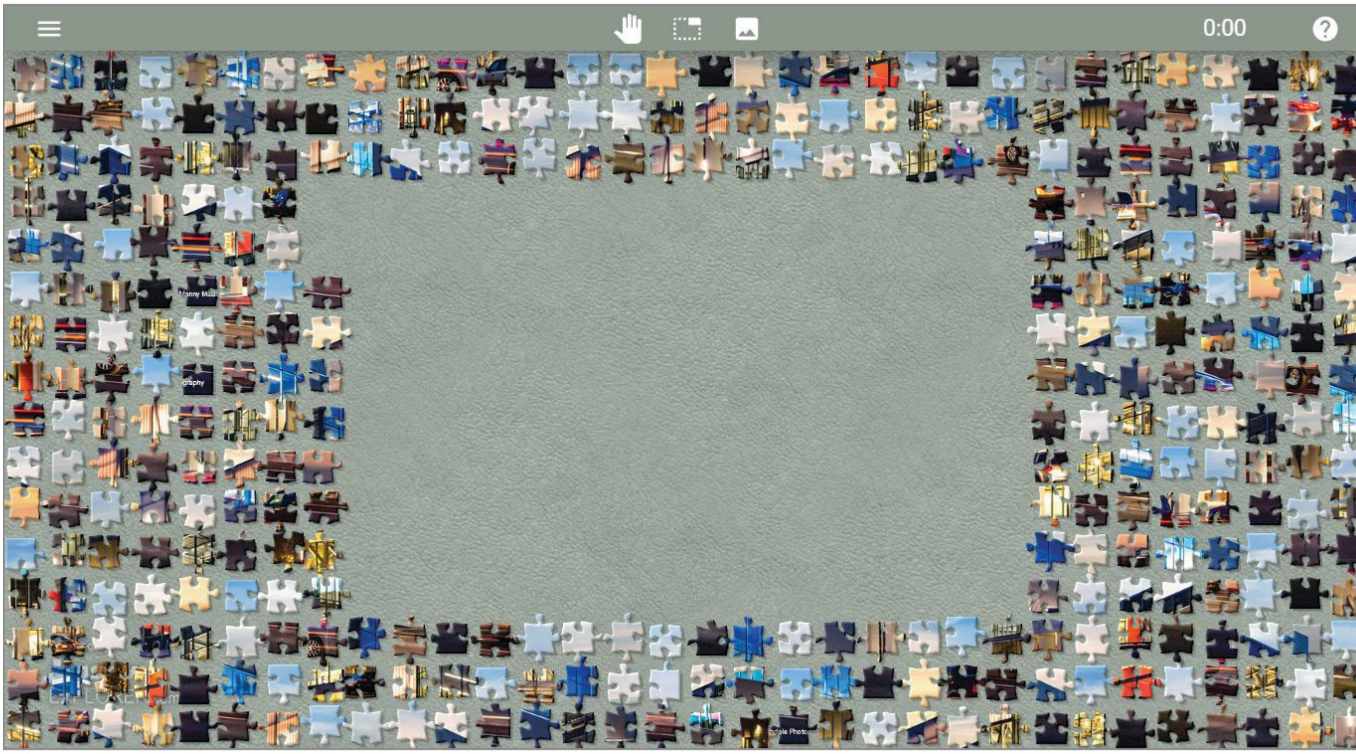

Go to Pieces—in a Good Way!

THERE ARE PLENTY of online activities out there, many of which are designed to keep you glued to your screen and, frankly, waste your time.

But rather than doom-scrolling, suffering from FOMO, or getting caught in an endless loop of cringe-worthy dance videos, why not pick something that's meditative and provides a sense of accomplishment? Something like, oh, I don't know, a puzzle?

If you haven't already noticed, we've been posting digital puzzles on the AISC website for quite some time now. In fact, we've got an archive of more than 100 just waiting to be completed.

The puzzles came about in the early days of COVID in response to the popularity—and subsequent scarcity—of (analog) jigsaw puzzles while everything was shut down. They became our way of featuring stunning shots of steel projects and concepts, showcasing prize-winning bridges and buildings, upcoming events, and, occasionally, neat historical tidbits, and providing a nice way to clear the mind on a Friday afternoon (or at 3:00 a.m.). And since they're digital, they can be tailored to steel fans of all ages! You can set the piece count from six all the way up to 1,024.

A new puzzle goes live every Friday. Visit **www.modernsteel.com** or **aisc.org/puzzles** to see the most recent one, as well as the entire puzzle archive. Have fun!