Modern Steel Construction

January 2021


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Modern Steel Construction

January 2021

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ON THE COVER: Steel stretches toward the outfield at the University of Florida's new baseball stadium, p. 24. (Photo: Courtesy of Walter P Moore)

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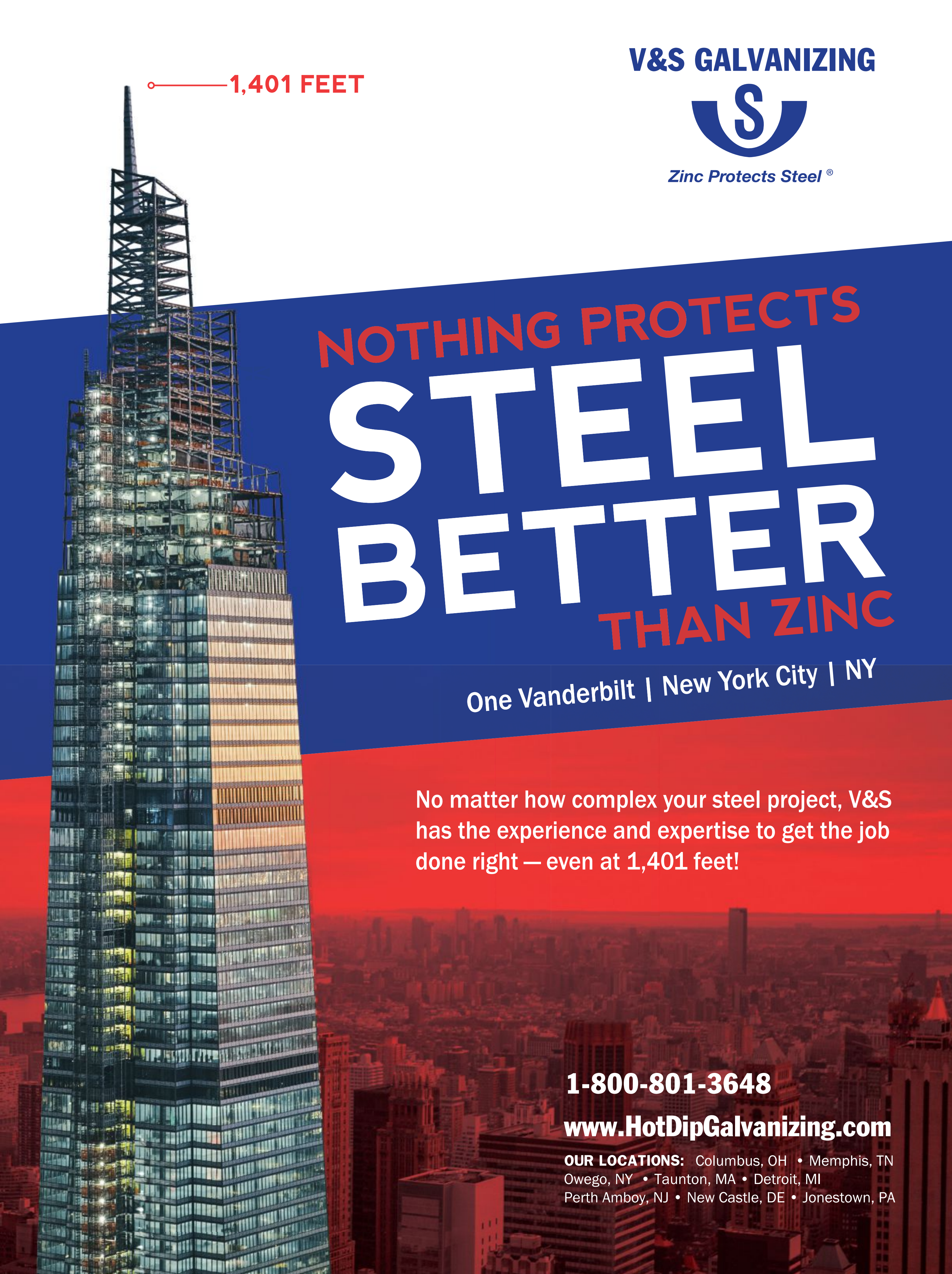
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editor's note

Year after year, ASCE issues a toothless report detailing America's crumbling bridges and roads. And every year, politicians from all ends of the spectrum pledge their support for repairing and advancing America's infrastructure. But for much of my lifetime, this has simply been empty words.

We'll soon see if President-elect Joe Biden is any different and if the Democrats and Republicans in Congress are interested in helping the country or simply obstructing the other party.

Shortly after the election, Biden stated that America needs an immediate infrastructure stimulus of roughly $300 billion and a long-term transformational infrastructure initiative of $3 trillion.

And he apparently isn't talking about the "shovel-ready" projects that we saw under the Obama administration, when billions were spent filling potholes. Instead, he's talking about important mega-projects such as the Sierra Madre and Chokecherry Wind Farm, the Texas Central High Speed Rail Project, and the Gateway Tunnel between New York and New Jersey.

But just as importantly, it's critical that we hold Biden to his promise to stress "Made in America" for his infrastrastructure projects. Biden has promised the inclusion of Buy American provisions in his infrastructure plans, he's emphasized American manufacturing, and he wants to invest $300 billion in American R&D. But as we know, talk is cheap. We need to hold him to these promises that he made: "When we spend taxpayer money, we should buy American products and support American jobs."

We also need to hold Biden to this commitment: "For decades, big corporations and special interests have fought for loopholes that redirect taxpayer dollars to foreign companies. The result: tens of billions of taxpayer dollars each year go to support foreign jobs and to bolster foreign industries. In 2018 alone, the Department of Defense (DOD) spent $3 billion on foreign construction contracts, leaving American steel and iron out in the cold, and nearly $300 million on foreign engines and vehicles instead of buying from American companies and putting Americans to work."

Let's hope that he means what he says—that he'll:

- Tighten domestic content rules
- Crack down on waivers to Buy American requirements
- End false advertising about whether products are truly made in America
- Extend Buy American to other forms of government assistance
- Strengthen and enforce Buy America
- Update the trade rules for Buy American

A strong infrastructure supporting American workers is a win-win for everyone.

Scott Melnick
Editor

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

steel interchange

All mentioned AISC codes and standards, unless noted otherwise, refer to the current version and are available at ***aisc.org/specifications****. All mentioned* Engineering Journal *articles are available at* ***aisc.org/ej****, and AISC Design Guides are available at* ***aisc.org/dg****.*

ASTM A529 Material

We have a project where the contractor submitted mill certs that conform to ASTM A529. The mill certs also include the following statement: "Also meets the requirements for F1554 S1 inclusive." Table 2-6 in the AISC *Steel Construction Manual* does not include ASTM A529 as an option for anchor rods. Is it acceptable to use ASTM A529 for anchor rods that conform to the chemistry and strength requirements of ASTM F1554?

Yes, F1554 is a configuration specification for straight, bent, headed, and headless anchor rods. This is included in the Scope statement for F1554. F1554 can be ordered as Grade 36, 55, or 105 ksi. Table 1 gives specific chemical compositions for each of those grades. Supplement S1 is required for only F1554 Grade 55 to ensure weldability. Any material meeting the specified yield strengths and chemical requirements can be used to produce an F1554 anchor rod.

A529 is a material specification for high-strength carbon-manganese steel of structural quality. It is available in Grade 55 and can be produced with a carbon equivalent of 0.55% if requested, which would make it weldable and allow it to meet the requirements for the material used for F1554 Grade 55 with Supplement S1.

For these reasons, the mill test reports for an F1554 Grade 55 with Supplement S1 anchor rod would be for the material that was used to produce the anchor rod.

Larry Kruth, PE

Bolt Holes for Bridge Projects

I believe it used to be stated that bolt holes for bridge projects had to be drilled or thermally cut and reamed. Are plasma-cut holes now acceptable when mechanically guided?

Currently, the AASHTO *LRFD Bridge Construction Specification Section* 11.4.8.1 (visit **www.transporation.org**) only allows plasma-cut holes in instances where it also allows punching full-sized holes. These instances include "holes in fillers, cross-frames, lateral bracing components, and the corresponding holes in connection plates between girders and cross-frames or lateral components."

Additional information can be found within the AASHTO/NSBA Steel Bridge Collaboration S2.1 document, *Steel Bridge Fabrication Guide Specification* (available at **aisc.org/sdocs**) section 4.6.4. It states: "Holes in secondary members or in cross-frames or diaphragm connection plates may be made full-size by drilling, punching, plasma-cutting, or water-jetting, as long as all geometric and finish requirements are met." It is also advisable to consult the local department of transportation construction and bridge specifications that may govern your specific project.

Devin Altman, PE

Combined Loading

It appears that in many of the design examples I see, Equation 10-5 from the AISC *Manual*, or some modified form of this equation, is used to address combined loading. Why is Equation 9-1 not used, and in what cases would one use Equation 9-1?

$$\frac{M_r}{M_c} + \left(\frac{P_r}{P_c}\right)^2 + \left(\frac{V_r}{V_c}\right)^4 \leq 1.0 \quad (9\text{-}1)$$

$$\left(\frac{V_r}{V_c}\right)^2 + \left(\frac{M_r}{M_c}\right)^2 \leq 1.0 \quad (10\text{-}5)$$

Equation 9-1 describes the plastic strength of a rectangular member or connection element. Equation 10-5 can be derived from von Mises' criterion (see "Plastic Strength of Connection Elements" in the first quarter 2015 issue of *Engineering Journal*), developed initially to predict the first yield load combination. Therefore, this elliptical interaction was used extensively to develop design models in the old allowable stress design (ASD) philosophy. Although the AISC *Specification for Structural Steel Buildings* (ANSI/AISC 360) is now based on strength design, Equation 10-5 is still used as an empirical estimate of the element strength. Although the equations are based on different assumptions, the resulting interaction curves are similar. It's up to the engineer to determine the appropriate method. In practice, I use both equations. If you are interested in further information, a detailed review of connection element strength under combined loads is in the above-mentioned article. As discussed in a second *EJ* article, "Stability of Rectangular Connection Elements" (fourth quarter 2016), if stability is a concern, the equations in Section H1.1 of the AISC *Specification* are more accurate.

Bo Dowswell, PE, PhD

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Bo Dowswell, principal with ARC International, LLC, is a consultant to AISC.

STEEL SOLUTIONS CENTER

Steel Beam from 1938

I am trying to identify a steel beam size and steel producer for a beam in a building constructed in 1938. The beam is marked "Trade JUNIOR Mark." The specific beam in question has a field-measured depth of $11\frac{1}{8}$ in., a flange width of $2\frac{7}{8}$ in., and a bottom flange thickness that ranges between 0.18 in. and 0.30 in. Do you have any ideas where I might find more information on this particular beam?

There are quite a few resources offered on the AISC website (**www.aisc.org**) that could help you identify the wide-flange shape size and the possible producer of that shape. When looking at some of the resources available on our website, the following items might be helpful:

A good starting place is AISC's historic *Steel Construction Manuals* (free to members), which are available at **aisc.org/publications**. Based on the year of construction, I would look at the first printing of the AISC 3rd Edition *Steel Construction Manual*. This manual contains a table that provides section properties for "Junior Beams." From the shapes listed in this table, it looks like the $11 \times 2\frac{7}{8}$ listed matches up well with the measurements taken in the field. A footnote included in the table indicates that this shape was rolled by Jones & Laughlin Steel Corp.

A second option is Design Guide 15: *Rehabilitation and Retrofit*. Table 5-3.1 in this design guide provides information for an 11-in. × 2.844-in. junior beam, designated as Jr11 on page 168. The source reference number provided in this table can help us identify more information about this particular shape's possible producer. For the Jr11 section size, the source reference number provided is 6. Table 5-3.3d provides information on the producers of junior beams on page 321 of the design guide. For reference number 6, the mill listed is Jones & Laughlin Steel Corporation (J&L), and the year is 1931. Therefore, the information provided in the table has been taken from a 1931 J&L producer catalog. While not the case for this particular beam, if multiple mills and years are listed for a particular reference number, as is the case for reference number 5 in Table 5-3.3d, this indicates that information on a shape size can be located in various producer handbooks from 1934 up through 1950.

Similar information can be found in the AISC Historic Shapes Database at **aisc.org/manualresources** (under the Shapes Database link). The same Jr11 beam is listed on excel line 15776 in the v15.0 Shapes Database. This excel line also includes reference number 6, similar to Design Guide 15. Copies of the producer reference tables in Design Guide 15 can also be found in the additional excel worksheets included in the Historic Shapes Database file.

The final option would be to look through the old producer catalogs at **aisc.org/publications/historic-shape-reference**, although this would be the least efficient approach. If you can identify the specific producer handbooks using the tables in Design Guide 15 or the Historic Shapes database, you can view these handbooks through our website if the specific version is available. Paging through old producer catalogs might be a good alternative if you seek information on steel shapes not typically used in building construction and not covered in older AISC *Manuals*.

Also, note that when evaluating existing structures, the requirements stipulated in Appendix 5 of the AISC *Specification* need to be met. In addition to the section properties, AISC Design Guide 15 also provides information on material properties, design examples, and historical reviews of the AISC *Specifications* and *Manuals* as well as the *RCSC Specification* and ASTM standards.

Carlo Lini, PE

steel quiz

This month's quiz focuses on the recently released AISC Design Guide 36: *Design Considerations for Camber*, which is available for free to members at **aisc.org/dg**.

1 What was an economical option for approaching the design of composite beams in the early days before the advance of cambering technology?

2 **True or False:** If a beam is specified to have ¾ in. of camber and is received by the fabricator with $\frac{9}{16}$ in. of natural camber, it is necessary to camber the member an additional $\frac{3}{16}$ in.

3 **True or False:** Mill camber should be considered additive to the camber specified to counterbalance some of the anticipated structural deflections.

4 In some cases, heat cambering will be the costlier option compared to simply increasing the beam's size. What is a reasonable estimate for beam weight addition in lb/ft?

a. 1 lb/ft
b. 10 lb/ft
c. 50 lb/ft
d. 100 lb/ft

5 What types of beams should *not* be cambered? Pick all that apply.

a. Spandrel beams
b. Beams with end moment connections
c. Beams longer than 25 ft
d. Cantilevered beams

6 When specifying camber on a beam, several aspects should be considered when calculating the theoretical deflection of the beam. Which is *not* one of these aspects?

a. Increased connection restraint
b. Possible deck span effect
c. Span length reduction
d. Live load effects

7 **True or False:** To conservatively account for the additional deflection that may be unaccounted for, it is generally recommended to camber members with nonuniform cross sections.

8 **True or False:** Strain hardening is not a concern for cambering beams.

TURN TO PAGE 14 FOR THE ANSWERS

STEEL SOLUTIONS CENTER

steel quiz ANSWERS

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**.

1 The design guide states in Section 1.3 that **shoring** was an economical option at the time. However, bottom flange bracing was required, and working around the shores often created on-site schedule problems.

2 **False.** The AISC *Code of Standard Practice for Steel Buildings and Bridges* (ANSI/AISC 303, **aisc.org/specifications**) states, in Section 6.4.4: "For beams that are specified in the contract documents with camber, beams received by the fabricator with 75% of the specified camber shall require no further cambering."

3 **False.** Any natural camber that exists in the member upon delivery to the fabricator from the mill is not a concern when cambering because those initial out-of-straightness variations will be superseded by the imposed camber.

4 **b.** Section 3.2 of the design guide states that a good rule of thumb for heat cambering cost of a 20-ft-long beam would be the equivalent of adding 10 lb/ft in beam weight. Check with your local fabricator on their preferred method of cambering.

5 **a, b, and d.** Section 5 of the design guide states that beams that are part of the lateral load resisting system, spandrel beams, cantilevered beams, and beams with end moment connections should not be cambered.

6 **d.** Live load effects. Section A.2 of the design guide states that when specifying camber, it is important to consider how the effect of increased connection restraint, possible deck span effect, and possible span length reduction may combine to reduce deflection when calculating the theoretical deflection of beams at the column lines.

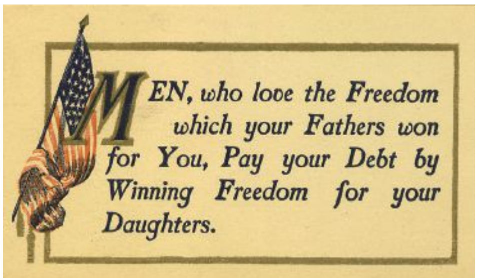
7 **False.** Section 5.9 of the design guide states that it is not recommended to camber members with nonuniform cross sections because they tend to twist when strained to yield without special procedures.

8 **True.** Section 2.1 of the design guide states: "The range of strains induced in the steel material during cambering is well below the range where strain hardening occurs."

1830 · 1840 · 1850 · 1860 · 1870 · 1880 · 1890 · 1900 · 1910 · 1920 · 1930 · 1940

1847

Seneca Falls Convention launches women's suffrage movement.

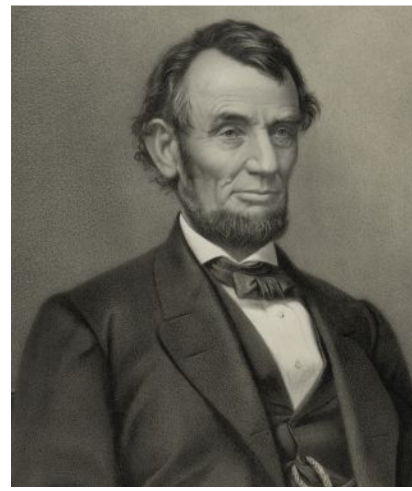


NINE STEEL BRIDGES

that are still in service today were open to traffic when it happened.

1863

President Abraham Lincoln delivers the Gettysburg address.



63 STEEL BRIDGES

that are still in use today were already open to traffic.

5,189 SUCH BRIDGES

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1933

Police drag the Charles River after a "cod-napping" in the Massachusetts State House.

At least

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steelwise

WELL-ROUNDED

BY KIM OLSON, PE

Everything you've always wanted to know about HSS, but were afraid to ask.

Kim Olson (**kim@steeltubeinstitute.org**) is the HSS technical consultant with the Steel Tube Institute.

ROUND HOLLOW STRUCTURAL SECTIONS (HSS) have a lot going for them.

Not only are they aesthetically pleasing and favored by architects, but they are also efficient structural members. With their lack of a weak axis, they are superior in compression. Their closed shape makes them preferred when torsionally loaded. When designing connections to round HSS, there are fewer limit states to consider due to the geometric nature of the section. And they can also be filled with concrete to increase compression capacity and provide fire resistance.

From bridges to transmission towers and stadium roofs to handrails and posts, HSS can be used to overcome common design challenges and expand possibilities when building and designing complex structures. In tandem with the many uses for HSS are many questions on its design potential. Here, we'll explore a few that will hopefully provide a better idea of how you can get the most out of HSS on your projects.

The fabricator on my current job requested a material substitution for A500 Grade B round shapes. What else is available, and what will the impact on my design be?

When it comes to materials, here's what engineers need to know. Currently, Steel Tube Institute (STI) producers dual-certify all of their products to ASTM A500 Grade B/C, meaning that the material meets the specification requirements for both A500 Grade B and Grade C. The AISC 15th Edition *Steel Construction Manual* (**aisc.org/manual**) contains capacity tables are calculated for A500 Grade C to reflect this as the predominant material in the marketplace. Therefore, the design community should design using Grade C, as that is what is being purchased and what has been provided for many years—not only for round sections but for all HSS.

Round sections should be specified as A500. Historically, the belief was that A53 was the most available round section and, therefore, the most cost-efficient. This is not the case. A53 is the standard specification for steel, black lacquer coated, welded, and seamless steel pipe. It is intended for use in mechanical and pressure applications as well as for use in ordinary steam, water, and air lines. ASTM A500 is the standard specification for cold-formed, welded, and seamless carbon steel structural tubing. Available in four grades, A through D, it is intended for use in construction and structural applications. Unlike A53 piping, which is only round, A500 is available in more shape options, most commonly round, square, and rectangular.

In addition to these differences in intended use between the two steel products, many additional details are critically important for engineers, especially as they relate directly to matters of cost and quality. Consider yield strength. No matter the grade, A500 material's yield strength will be greater than A53 piping. A500 Grade C round HSS specifies a minimum yield strength of 46 ksi, and A53 Grade B piping requires a minimum yield strength of 35 ksi. Although A53 was, at one time, the standard specification for round shapes, specifying A53 for columns or braces of a building results in a thicker, larger section than if using the stronger A500. Structures designed with A500 require less steel by weight; the cost-saving implications are clear.

An A500 round also has a tighter outside diameter (OD) and wall tolerances. When using an A500 round for a building column, you could specify an HSS8.625×0.322 with an outside diameter tolerance of +/-0.75% and a wall tolerance of +/-10%. The A53 equivalent, an 8-in. standard pipe, has an OD tolerance of +/-1% and a wall tolerance of -12.5%. Another word to the wise: A53 pipe is available only in lengths of 21 ft and 42 ft. A500 rounds can be produced in lengths from 20 ft to 75 ft.

When selecting section sizes for structural design, you can be assured of not only the desired cross-sectional dimensions but also the necessary straightness with A500, as producers must also adhere to a straightness tolerance specified in A500. With A53, there is no specification in the standard for how straight the pipe must be.

Here's why the external characteristics are equally important. Thus far, this discussion has focused on the structural characteristics of A53 and A500, but what happens on the outside matters just as much. When an A53 pipe is specified, part of its material cost is for the sealant that producers use to coat the outside of the pipe. In order to weld to these pipes, a fabricator must remove the sealant, creating an unnecessary cost and extra step in the fabrication process. The bare surface of the A500 tube makes it easier to paint after fabrication is complete. Also, because A53 pipe is produced to carry pressurized steam, water, or gas, the manufacturer must hydrostatically test the product, ensuring that it can withstand pressure when in use. If A53 piping is used in structural applications, the product includes the cost of those tests that a structural application does not require.

From experience, I am finding that not all HSS shapes given in the AISC *Manual* are actually produced. Is there a list of sections available?

Here are some key considerations around sizes and availability. Round HSS can be specified in a wide variety of sizes. Discerning what sizes are readily available is a little trickier. Engineers frequently wonder why there are fewer options for A53 pipe than A500 rounds. A53 pipes are designated to a nominal pipe size (NPS) referring to a "nominal" OD in inches, plus one of three scheduled wall thicknesses (standard, x-strong, and xx-strong). They are sized this way because A53 pipes—designed to carry pressurized steam, air, or water—must work with standardized fittings and valves. There is no such need with A500 tubes, which are therefore designated with much more precision and, accordingly, more efficiency. With A500 rounds, the outside diameter and wall thickness, in inches, are carried to three decimal places.

A good rule of thumb is to specify an HSS member that is equivalent to the NPS sizes. These are listed in Table 1 with the corresponding callout for an HSS. If deviating from those listed, it is best to check the STI Capability Tool at **www.steeltubeinstitute.org** to see if the section specified is domestically produced and, therefore, commonly available. This can also be done for rectangular sections. You can also search for HSS shape availability in the "Who makes the shapes you need?" search box at **www.aisc.org**.

If I'm working on a handrail design, what sections should I be looking at?

Table 2 lists the sections commonly available in ASTM A500 Grade B/C for handrail construction.

Table 1: Commonly available round HSS and corresponding NPS designations.

HSS Designation	Standard Pipe
HSS3.5×0.216	3 in. STD pipe
HSS3.5×0.300	3 in. STRONG pipe
HSS4×0.226	3½ in. STD pipe
HSS4.5×0.237	4 in. STD pipe
HSS4.5×0.318	4 in. STRONG pipe
HSS5.563×0.258	5 in. STD pipe
HSS5.563×0.375	5 in. STRONG pipe
HSS6.625×0.280	6 in. STD pipe
HSS6.625×0.432	6 in. STRONG pipe
HSS8.625×0.322	8 in. STD pipe
HSS8.625×0.500	8 in. STRONG pipe
HSS10.75×0.365	10 in. STD pipe
HSS10.75×0.500	10 in. STRONG pipe
HSS12.75×0.375	12 in. STD pipe
HSS12.75×0.500	12 in. STRONG pipe

Table 2: Commonly available handrail sections.

HSS1.9	×0.180
	×0.145
	×0.125
HSS1.66	×0.140
	×0.134
	×0.125
HSS1.315	×0.133
	×0.125

When sourcing smaller sections, can ASTM A513 be substituted if A500 is "not available"?

This is a multi-step answer. First, challenge the question of availability. Check the Capability Tool and contact STI for assistance. Second, the answer to the substitution request is, "It depends." ASTM A513 is a mechanical tubing specification intended for applications where dimensional tolerances are critical, but the strength of the member is not paramount. ASTM A513 has no physical requirements (minimum yield, tensile, or elongation), and often A513 material is not provided with a material test report (MTR) indicating these properties. Therefore, if a substitution is requested, it is essential to first perform coupon testing or review the product's MTR to ensure that it meets the physical requirements you assumed in your design.

I need large round sections for my design. What is available domestically?

The availability of these sections should be a concern when considering specifying them. ASTM A500 is limited to sizes with peripheries less than or equal to 88 in. Anything larger than a 28-in.-OD round section cannot be specified as A500. However, rounds even that large are not produced to the A500 specification domestically. Currently, the largest A500 sections made in the U.S. are 20-in.-OD. It is worth noting that, by the end of 2021, there will be a new domestic mill producing sections up to 28-in. OD. In addition to the periphery limits, A500 also has a limit on the wall thickness. The maximum thickness of an A500 member is 1 in.

If a project requires members that exceed what is currently produced in A500, there is piping produced for other industries that can be used in structural applications, with caution. Most commonly, products that meet specifications like ASTM A252: *Standard Specification for Welded and Seamless Steel Pipe Piles*, which is used for pipe pile foundations, or API 5L, for the oil and gas industries, can be procured in diameters up to 80 in.

What are some of the notable differences between API 5L and ASTM A500?

- API 5L products come in many grades, denoted by "X65" or "X70," which refers to the yield strength (i.e., X65 has a yield strength of 65,300 psi).
- While API 5L is produced in very large diameters, the thicknesses of domestically produced pipes are limited to 1 in. Imported material, especially from Asia, is available with walls exceeding 1 in. in thickness, although the availability of such products is often challenging to nail down.
- As API 5L is intended for use as pipelines in the transport of petroleum and natural gas, the tolerances and finishes that are expected for building products do not apply to API 5L products. API 5L is similar to ASTM A53 as both are hydrostatically tested. However, API 5L material is of a much higher quality as it is expected to withstand higher pressures and much higher temperatures than A53 pipe is.
- API 5L is not an approved material per the AISC *Specification for Structural Steel Buildings* (ANSI/AISC 360, **aisc.org/specifications**), as specified in Section A3.1a. However, the Commentary to this section states: "Other materials may be suitable for specific applications, but the evaluation of those materials is the responsibility of the engineer specifying them." It is the engineer of record's (EOR) responsibility to prove the material used conforms to an ASTM *Specification* specifically listed in AISC 360-16, Section A3. (The three "Unlisted Materials" articles in the October, November, and December 2018 issues, available at **www.modernsteel.com**, may prove useful here.)
- API 5L has two product specification levels: PSL 1 and PSL 2. PSL 1 provides a standard quality level for line pipe. PSL 2 includes additional requirements for chemical composition, fracture toughness, a maximum yield strength, and additional nondestructive testing.
- Today, the most common grade of API 5L pipe available for structural applications is Grade B or X42 (PSL 1); however, there are 40 other grades given in API 5L, many of which may be available.
- One of the additional requirements PSL 2 stipulates a yield-to-tensile-strength ratio of 0.93 maximum for Grade B and X42 up to X80. This is important, as some of the connection strengths given in Chapter K of AISC 360-16 are rooted in the ductility of the material that produces the anticipated connection deformation. The maximum yield-to-tensile ratio for the materials used in the development of AISC 360-16, Chapter K, is 0.80.
- If a large section is required, but the stringent chemical and testing requirements of the API 5L specification are not, it may be prudent to call out the section as "ASTM A500 Grade C or approved equivalent." This allows a mill that has not gone through the rigorous certifications necessary to obtain an API license to produce the material needed for a construction application and may save significant project costs.

Is the substitution of ASTM A252 for ASTM A500 OK?

ASTM A252 is a material specification for steel pipe piles for foundations, where the steel either acts as the permanent load-carrying member or as the form for cast-in-place concrete piles. STI does not recommend the substitution of ASTM A252 for ASTM A500 unless extreme care is taken. A few items of note follow:

- ASTM A252 can be specified in one of three grades. Yield strengths vary from 30 to 45 ksi, and tensile strengths vary from 50 to 66 ksi.
- There are no chemical composition requirements in ASTM A252.
- Although A252 is frequently produced in large sections, the specification does not speak to the tolerance for sections exceeding 24 in. in diameter and/or ½ in. thick.
- The tolerances in A252 are more lenient than A500 for wall thickness, and it has no tolerance for straightness.
- Similar to API 5L, ASTM A252 is not an approved material per AISC 360-16.

If A252 is substituted, the EOR should account for its thinner wall, the lower yield strength, and the variable chemistry that may affect the members' weldability.

What are the key considerations concerning the fabrication of round HSS?

When considering the total cost of a structure, the fabrication is a significant portion of the steel package cost. The handling of the material during fabrication is a contributor to the overall fabrication cost. It should be noted that round HSS can be more challenging to handle in the shop as they have a tendency to roll. Marking and adding pieces to quadrants at 90° to each other on a round piece is not quite as easy as it is on a rectangular section. Additionally, when connecting a round section to another round section, like in the truss shown in Figure 1, the cut necessary to connect the branch member to the chord is complex. This fabrication step has been simplified with the implementation of lasers into fabrication shops. However, without lasers, it can be quite complicated. While round sections are often the most efficient per weight, it may be more cost-effective to use a square or rectangular section to aid in the fabrication costs.

What are the key considerations concerning weldability?

The requirements for the chemical composition of the commonly specified structural steels and, in particular, the limiting values of carbon equivalents have been selected to facilitate weldability. The American Welding Society's AWS D1.1: *Structural Welding–Steel*, in Table 3.1, lists prequalified steel materials and grades that have been selected because they have historically displayed good weldability. ASTM A53, A500, A1085, and API 5L Grade B, X42, and X52 are all listed as approved base metals for prequalified WPS (welding procedure specifications). Steel grades not listed in Table 3.1 may be new and have simply not been incorporated into D1.1 or, as is the case for ASTM A252, have been excluded because their mechanical properties and chemical compositions are not sufficiently defined. For these materials to be used, a special qualification test is required.

Fig. 1. Complex end profiling.

What do I need to know about weld seams?

ASTM A500 round sections are produced with a straight seam weld, with the outside weld bead scarfed, or cut smooth with the outside surface. Specifiers should be aware that other specifications for round sections, particularly large pipes, are also produced with a spiral weld. In a spiral weld, the weld seam wraps around the member like a spiral. This is of particular importance if the member is to be used in an architecturally exposed condition as an architectural element (AESS). In that case, it is likely necessary that the member should be specified on the contract documents that it shall be "straight-seam welded." (Note that spiral-welded HSS shapes are not common in building construction and may not be readily available.)

Fig. 2. Spiral weld pipe.

What about the tolerances of these various materials?

All of the materials mentioned in this article have different tolerances innate to their specifications (Table 3). As noted above, it is vital to ensure that assumptions made about the material in the development of the code meet or exceed what is provided in the actual member to be used. Additionally, there are other requirements, such as straightness, that may be worth investigating if an alternate material is sourced for a project.

There are countless questions about all aspects of HSS. Hopefully, the ones we've covered here will give you more clarity on the nuances and benefits of designing with HSS—and possibly spark more questions. If the latter occurs, email me! ■

Table 3. Summary of tolerances.

Summary of Tolerances							
	ASTM 500	ASTM A252	API 5L			ASTM A513	ASTM A53
	Grade C	Grade 3	B	X42	X52	cold rolled, as welded	Grade B
intended use	structural tubing for welded or bolted construction of bridges and buildings and general structural purposes	steel pipe piles for foundations	pipeline transportation systems for petroleum and natural gas industries			mechanical tubing	mechanical and pressure applications; also acceptable for ordinary uses in steam, water, gas, and air lines
minimum yield strength	46 ksi	45 ksi	35.5 ksi	42.1 ksi	52.2 ksi	no requirement	35 ksi
% elongation in 2 in.	21	20	based on cross-sectional area of test piece (same as A53)			no requirement	based on cross-sectional area of test piece (same as API 5L)
Tolerances							
OD	+/– 0.75%	+/– 1%	for 2.375 in. < OD < 24 in., +/– 0.75% (0.125 in. max) for 24 in. < OD < 56 in., +/– 0.5% (0.16 in. max)			ranges from +/– ¼ to ½ %; see ASTM A513	+/– 1%
wall thickness	+/– 10%	–12.5%	for 0.157 in. < t < 0.984 in.,–12.5% for t > 0.984 in., max of –12% or –0.1t			ranges from +/– .001 to .009; see ASTM	–12.5%
weight	no requirement	–5%, +15%	–3.5%			no requirement	+/– 10%
straightness	0.125 in. per 5 ft of length	no requirement	max deviation from straight line 2% of pipe length			0.03 in. per 3 ft of length	no requirement

field notes

A STRONG CAST

INTERVIEW BY
GEOFF WEISENBERGER

The founders of Cast Connex have turned a structural castings dream into strong, inspiring realities around the world.

De Oliveira and Gray at Toronto's Queen Richmond Centre West. To read about the project, see "Jacks of All Trades" in the March 2014 issue, available at **www.modernsteel.com**.
Photo: Neil Ta

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**.

CARLOS DE OLIVEIRA AND MICHAEL GRAY, co-founders of AISC member Cast Connex, forged a partnership as students that evolved into a company that is a global leader in steel castings for structural applications. They talk about how they met, how their student research became a steel construction phenomenon, their favorite Toronto buildings, and their company's humble beginnings—complete with a road trip to NASCC.

Let's start from the beginning. How did you two meet?

Carlos: We met when we were both co-op students at a structural engineering firm in Toronto. We were sitting beside each other and were tasked with similar projects.

Michael: Yeah, we got to know each other working side by side, and there were two things that stood out for me from our first day working together. First, he told me he was going to start his own firm. And second, he tried to sell me a CD from his rock band.

Carlos: He did buy it, although that's a bit of a point of contention now because he has threatened to play it for all of our employees.

You haven't made good on that threat yet?

Michael: It's the nuclear option. I don't want to go there unless I have to. So anyway, by the end of the work term, Carlos said, "We should start our own business," and I was thinking to myself, "This guy is nuts."

Carlos: During this co-op work term, I was applying to grad schools and I was considering going to the U.S.—both Michael and I were born and raised in Toronto—and at the time, Michael was studying at the University of Toronto and he suggested that I look into going there for my master's degree. He really pitched the University of Toronto to me, talking about the excellent professors and the incredible structures laboratory and test facilities, and so I applied and I was accepted. I ended up working with professors Jeffrey Packer and Constantin Christopoulos—Dr. Packer, of course being well-known

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for tubular connections and HSS and Dr. Christopoulos for seismic design of structures—and my master's thesis topic was to study seismic-resistant braced-frame connections, looking at how we might be able to leverage casting manufacturing to simplify those types of connections for HSS brace members. So the topic of my thesis was really the nexus of our business.

A year into my thesis, my advisors encouraged me to change my master's thesis to a PhD, and I turned them down. I obviously had other aspirations! And so they came to me one day and told me since I turned them down, they'd need to get another student to continue my research, and they had a great one in mind. "He's really bright and intelligent," they told me. "You might know him. His name is Michael Gray." Of course, it was funny to me because unbeknownst to my supervisors, Michael and I were best friends, and I thought it was really fitting that Michael would be continuing my research. And that research eventually led to the creation of our business.

Tell me about the early years of the business. I recall a road trip story when we spoke at NASCC a couple of years ago.

Michael: Yes, that was our first trip to NASCC. We founded Cast Connex maybe a year earlier and we had put a lot of effort into getting our products developed and doing some testing, and this was going to be our big launch. The two of us were in a rented van, driving from Toronto to Nashville, with prototype castings rolling around in the back and a few pop-up posters for our exhibit booth. We didn't know what we were doing. Halfway down there, we realized we hadn't even painted the castings and they were rusting, so we pulled over at a hardware store and bought a wire brush, and we were really trying to clean the samples as much as possible.

Carlos: We were bootstrapping for sure. We were a company with one full-time and one part-time employee—Michael was finishing up his PhD—and we were just trying to get our materials down there and set it all up ourselves and try to look somewhat professional.

The only thing that could have made that story even better was if the van had broken down.

Carlos: Well, scrubbing rusty castings in the parking lot of a Walmart is pretty epic.

Michael: Those first few years of trade shows, I think I went to a hardware store in every city we visited to fix one thing or another.

Can you talk about the first connection you developed?

Carlos: Our company's first product was our High Strength Connector, our steel casting for use at the end of HSS bracing in special and ordinary concentric braced frames, and that one was actually developed as part of my master's thesis work. The first use of that product came about because we were clever enough to engage a very important steel fabricator in Canada, Canam Group, to build our lab test specimens when we were doing full-scale testing at École Polytechnique at the University of Montreal with professor Robert Tremblay. We had the company fabricate our test specimen because we thought if we could get our High Strength Connectors in the hands of a big steel fabricator, they would appreciate how they can simplify fabrication, and this might pave the way for something in the future. And sure enough, they were actually the first company to use our connection in a building. They were building a four-story office building in an empty lot beside their fabrication shop, and they leveraged our connectors. That turned out to be our company's first commercial sale.

Michael: There is one engineer in particular at Canam Group that we will be forever grateful for, and that is Pierre Gignac. He recognized the value of our High Strength Connectors and was instrumental in putting them into structural service for the first time.

Can you tell me about another memorable project early in your company's history?

Michael: I'd say the Queen Richmond Centre West in Toronto. The team there was tremendously supportive in helping us get our start. It's a huge project for us. If it weren't for Stephenson Engineering, Sweeny &Co Architects, and Walters, the steel fabricator, we wouldn't have gotten a shot at it.

Carlos: The building is a remarkable structural feat. Each of our castings is carrying 20 million lb of force in supporting something like 12 stories of reinforced concrete office tower 70 ft in the air atop these seemingly purely sculptural forms. It's a tremendous project and such a great way to leverage casting manufacturing.

Let's take a step back before you met. Were you both always interested in buildings and construction?

Carlos: Like most structural engineers, if you ask a lot of us this question, you'll hear people say, "Well, I used to play with Legos and Tinker Toys growing up," and it's the same for me. I was always into math and sciences and really driven to create and build and invent and design things. I have very fond childhood memories of going to Ontario Place, which features the Cinesphere, a spherical theater structure. I always remember looking at the structural framing of that building, which is actually on its outside, and being fascinated and thinking about how it was put together. And lo and behold, 20 years later we're designing and engineering and supplying gigantic cast steel nodes for what I believe will be the world's largest spherical structure, which is under construction right now in Las Vegas.

Michael: It's kind of full circle on that as well for me. I guess the first building I remember making me feel some kind of inspiration was Brookfield Place in Toronto and its atrium designed by Santiago Calatrava. It's got some really beautifully complex AESS arches supporting the roof.

As lifelong Torontonians, what are some of your favorite things about the city?

Michael: I'd have to start with the diversity. There are cultures from all around the world living together in reasonable harmony. Lots of great restaurants and places to go. And as a business operator, it's great because it's enabled us to have a very diverse team with lots of ideas and different backgrounds, which I think helps keep our company really healthy and innovative. So we love it. We couldn't imagine calling anywhere else home.

Carlos: Although the winter sometimes makes me wonder about that. ■

*To hear more from Carlos and Michael, including their thoughts on the Maple Leafs and Carlos' college band, visit **modernsteel.com/podcasts**.*

WORKING ON TEAMWORK

BY DAN COUGHLIN

Take the team seriously, don't take yourself too seriously, and know when to say when.

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

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

TEAMWORK IS CRITICALLY IMPORTANT to improving the results of any group or organization.

Teamwork happens when the people in the group or organization consciously and proactively work together to support one another's efforts toward fulfilling a meaningful purpose and achieving positive outcomes.

It can also happen as a result of collectively dealing with a crisis, being called together to fulfill a significant purpose, or wanting to raise the bar in meeting the needs of an important cause.

Teamwork is something to take seriously, but it's important to be careful that you don't take *yourself* too seriously. When your personal agenda conflicts with what's best for the team, you can inadvertently begin to ruin your organization's collective efforts. Here are some factors that can cause you to put yourself before your team—and tactics to keep you from doing so.

Emotions

Intense emotions can include tremendous joy, unbridled optimism, deep-seated worry, and fiery anger. When you experience extremely positive or extremely negative emotions in a team setting, it's beneficial to trace the source of those emotions.

Are you feeling positive or negative emotions because you got or did not get what you wanted on a personal level?

Are you feeling positive or negative emotions because the team did or did not fulfill a meaningful purpose or achieve its important desired outcomes?

Are you feeling positive or negative emotions because of how you've seen people within the team treat one another?

Take anger, for example. Let's say you're working with your team and something happens that brings out your anger. Why do you feel that way?

You could be angry because you didn't get the recognition that you thought you deserved or you felt ignored, laughed at, or controlled by other people. In that case, your anger is about you.

You could be angry because your team did not fulfill its purpose or achieve its desired goals, and your emotions are overwhelming you. This is about your attachment to the outcome.

You could be angry because you feel members of the team have mistreated other members of the team. This is about perceived mistreatment within the organization.

If the source of your anger is you, then I suggest you work not to take yourself so seriously. Remember: It's not about you. Don't take comments from other people as an attack on you personally. They are just sharing their opinions and making decisions. If this is becoming a major issue for you, then I encourage you to do things to lighten and improve your mood. Read a book for enjoyment. Watch a comedy. Go for a long walk or bike ride. Volunteer to help other people. Above all, recognize that part of the reason that you're angry is that you're taking yourself too seriously.

If the source of your anger is a shortfall in results, then ask yourself what you and your team can do to improve outcomes in the future. Put together a new plan and move into action.

If the source of your anger is what you perceive to be the mistreatment of some teammates by others, then talk with the latter party. See if you can have an impact on how they treat other members of the team. They might not even be aware they're doing it, and engaging them will bring them awareness. Or they might be doing it intentionally, and engaging them will let them know that they can't get away with it without notice. And of course, if the mistreatment is extreme enough, you need to go beyond the team altogether and report it to the appropriate people in your organization.

Apathy

Apathy is another issue. It often manifests as a short-term "solution" to anger that leads to a long-term problem. One way to stop your anger is to stop caring about the team. Since all three sources of anger I mentioned are connected to caring about your perceptions of the team (their opinion of you, the team's results, and the behavior of team members), you can cut out that source by simply not caring about the team.

And at first, it can seem like a good idea. If you truly stop caring about the team, then you won't have any need to be angry about anything related to it. You attend meetings and events, but you do so with a very apathetic attitude. If someone says something offensive, you don't become angry because you don't care. If the team doesn't fulfill its purpose or achieve its goals, you don't become angry because, again, you don't care. If the team members are really rude to each other and treat each other in a mean-spirited way, you don't become angry because—well, you get the picture.

You are still part of the team, but you are not emotionally invested in it. You become like a zombie walking around in a trance. The good news is you no longer get angry.

The bad news is you are wasting your life. You show up in name and body, but your passion is gone. You don't contribute. You don't complain. You are just a blob of purposeless matter.

Apathy feels good for a little while. You no longer get worked up over anything. You just sit there.

Know When to Walk Away

Sometimes, apathy is short-lived or can be worked past. But if you've gotten to a point where the only way to be part of the group is to be apathetic, then it's probably time to move on. If you feel members of the team mistreat other members and you have done everything you can to try to improve those behaviors, and nothing has worked, then I encourage you to leave the team. Move on.

In the book *Maslow on Management*, Abraham Maslow says, "Ultimately, real self-esteem rests on a feeling of dignity, of controlling one's own life, and of being one's own boss." Rather than being permanently angry over the mistreatment of other people, sometimes you need to move to a different part of the organization or a different organization altogether. Being a good worker or team member doesn't mean that you have to permanently remain in an unhealthy situation just to show your grit or commitment. Sometimes the healthiest thing for the team and for yourself is to remove yourself from the group.

This can be very hard to do, especially if you have been a part of the team for several years. However, in doing so, you give yourself an opportunity to be a part of a new group where people can pull together and support one another toward fulfilling a meaningful purpose and achieving positive outcomes.

Remember: While teamwork is certainly important, in the end, it's your life and it's your call. When working in a team environment, learn to recognize when you might be taking things too personally, whether apathy is something that can be worked past or appears to be permanent, when it's time to step in and stand up for team members who are being mistreated, and when it might be time to look elsewhere. And then you can make the decision that is appropriate for you and the team. ■

An integrated delivery process keeps the new University of Florida Baseball Stadium project on track and within budget.

No Extra Innings Needed

BY DYLAN S. RICHARD, PE AND STEPHEN E. BLUMENBAUM, PE

Rather than displacing the Gator baseball team for an extended period by rebuilding on the same site, the athletic department decided to move the team to a new home on the University of Florida campus near the softball complex.

all images courtesy of Walter P Moore

WHEN THE UNIVERSITY OF FLORIDA baseball team opens its 2021 season, it will have already hit at least one proverbial home run.

The team's new baseball stadium, Florida Ballpark at Alfred A. McKethan Field, in Gainesville, Fla., is just one part of the University Athletic Association's Facilities Master Plan designed to enhance the overall experience of Florida Gator players and spectators in their facilities. The state-of-the-art $55 million, 7,000-seat (4,200 fixed), 135,000-sq.-ft stadium features all of the modern amenities a fan could imagine, including a 360° open concourse and seating, allowing fans to walk around the venue without losing sight of the action on the field.

Rather than displacing the Gator baseball team for an extended period by rebuilding on the same site, the athletic department decided to move the team to a new home on the University of Florida campus near the softball complex. The new location not only provides a convenient location for the baseball team, but also makes room for construction of a new football training complex on the old baseball stadium site.

Tying Back to History

Having a longstanding relationship with the University of Florida, Walter P Moore (WPM) was proud to be the structural engineer for the new baseball stadium. Additionally, the company continued its working relationship with Populous and Walker Architects, the prime and local architects for the venue.

During the early conceptual phase of the project, both steel and concrete were considered for the structural system. However, it was important to the design team that the ballpark tie back to the collegiate gothic style that defines the University of Florida's architecture. Structural steel was the clear choice to accomplish this goal, and the project used 933 tons of steel in all.

"One of the ways we made that connection was through the expression of the structural steel and steel detailing of the seating bowl, scoreboard, and ballpark canopy," said Zach Allee, associate principal at Populous. "By cantilevering the structural steel of the roof, we were able to shade the upper-level seats, while using that deck to shade the seating below for ultimate fan comfort throughout the ballpark."

Dylan S. Richard (drichard@walterpmoore.com) is a principal and senior project manager, and **Stephen E. Blumenbaum** (sblumenbaum@walterpmoore.com) is a principal and director of construction engineering, both at Walter P Moore.

above: The new $55 million, 135,000-sq.-ft stadium can seat 7,000 fans. It was important to the design team that the ballpark tie back to the collegiate gothic style that defines the school's architecture, and steel was the clear choice to accomplish this goal.

above and below: There was a desire to express as much of the structural steel as possible in all portions of the stadium, including the batter's eye structure in center field, which uses 30 tons of steel.

Models and Drawings and Documents, Oh My!

As 3D modeling in steel design and construction evolves, so must the language that describes it. In an effort to keep everyone on the same page, so to speak, the latest version of the AISC *Code of Standard Practice* (ANSI/AISC 303-16, **aisc.org/specifications**) now includes several updated terms.

You may notice two of these newer terms in this article: *approval documents* and *fabrication documents*. Approval documents are defined as "the structural steel *shop drawings*, *erection drawings*, and *embedment drawings*, or, where the parties have agreed in the contract documents to provide digital model(s), the *fabrication model* and *erection model*." Fabrication documents are defined as "the *shop drawings*, or, where the parties have agreed in the *contract documents* to provide digital model(s), the *fabrication model.*"

For more details on these and other terms related to 3D model-based workflows, see "Speaking the Same Language" in the April 2017 issue, available at **www.modernsteel.com**.

Approximately five months before construction began in 2019, the cost estimates on the stadium's initial design were higher than expected, so the owner, design, and construction teams spent two months carefully reviewing, adjusting, and finalizing the design to be in line with the budget. However, the university could not afford a slip in the final delivery date for the stadium, as its completion was necessary to allow demolition of the old baseball stadium and begin construction of the new football training complex. Thus, the challenge was to regain two months of the project schedule to maintain the original completion date.

Integrated Delivery Process

The solution to the schedule challenge came in the form of WPM's integrated delivery process. The firm's construction engineering team joined the project to simultaneously prepare a steel fabrication (LOD400) model as the structural design work was completed. This process contrasts traditional delivery, where 2D design documents are handed off to a steel fabricator for interpretation and implementation after the design documents are completed.

"When WPM approached me with the idea of using their construction engineering services for structural steel detailing on the baseball project, I was initially skeptical. It was a different approach, and I had a lot of questions," said Adam Cowan, operations manager at Brasfield and Gorrie, the general contractor for the project.

But after several conversations with WPM and the athletic department, Cowan became more comfortable with the idea as a way to streamline the steel detailing process and improve the schedule. Because structural steel detailing took place concurrently with the structural design, it enabled the mill order model to be given to steel fabricator GMF Steel Group on the day it was awarded the project, and steel was ordered the next business day.

"The direct collaboration between WPM and GMF Steel Group allowed for quicker connection design preferences, as well as our means and methods to be incorporated into the steel detailing," said Jason Hall, executive vice president at GMF Steel Group, the project's steel fabricator and erector. "This streamlined process ensured that our standard of quality was upheld, while also saving weeks off the schedule compared to a typical process."

This reformatted process yielded several benefits to the design and construction of the stadium. First, it allowed the project team to coordinate and finalize the design before securing the steel mill order. WPMs integrated services eliminated the need to order steel from early structural documents before completion of the architectural, mechanical, electrical, and plumbing documents. Second, this method allowed a more thorough understanding of the design intent by prospective fabricators, which helped reduce uncertainty and risk. The fabrication model communicated to the subcontractor's precise material quantities, connection requirements, and the like versus having to estimate material takeoffs from 2D paper drawings. Finally, this nearly eliminated review comments required on the approval documents from the design team, with corresponding reductions in processing time from the architect, builder, fabricator, and detailer.

Elimination of RFIs

On a job of this size and complexity, and using traditional delivery methods, RFIs are common. But thanks to the ongoing, model-based communication between the design team, Brasfield and Gorrie, and GMF, the project had zero RFIs when it came to the steel package.

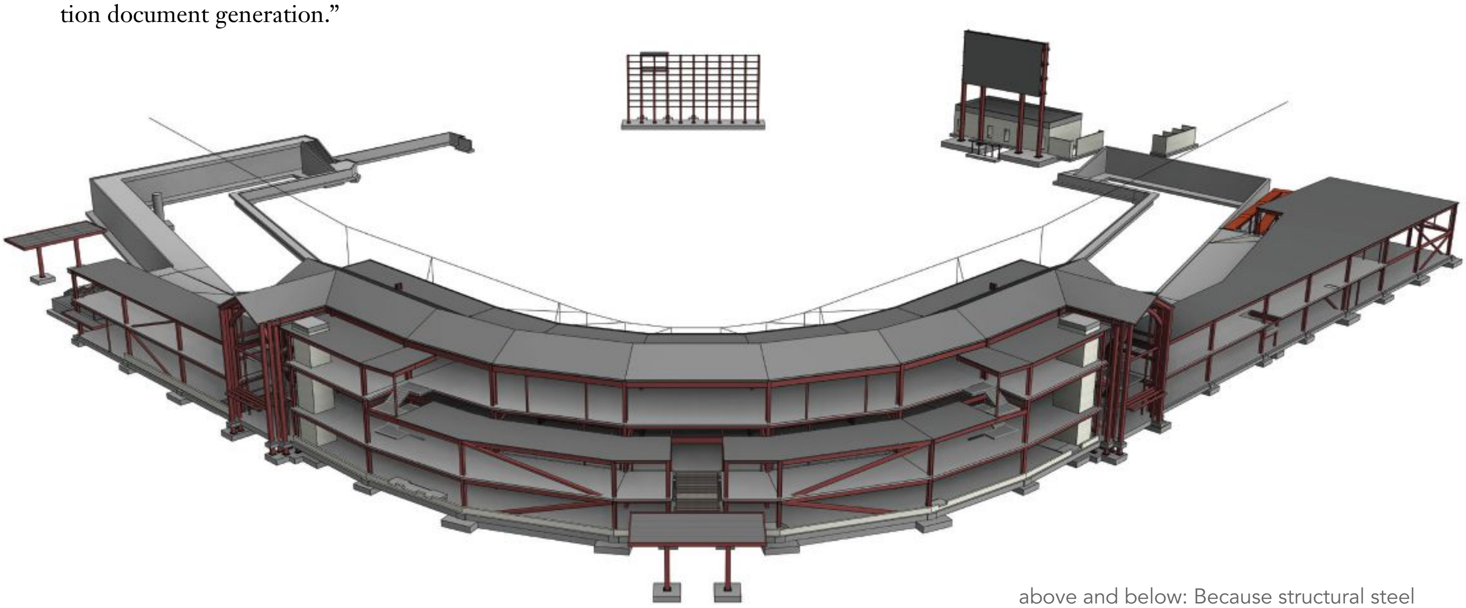
"Another main benefit we noticed was the elimination of a lot of back-and-forth and RFIs during the detailing process," Cowan said. "WPM's detailers were working hand-in-hand with their designers, so questions were answered before and during fabrication document generation."

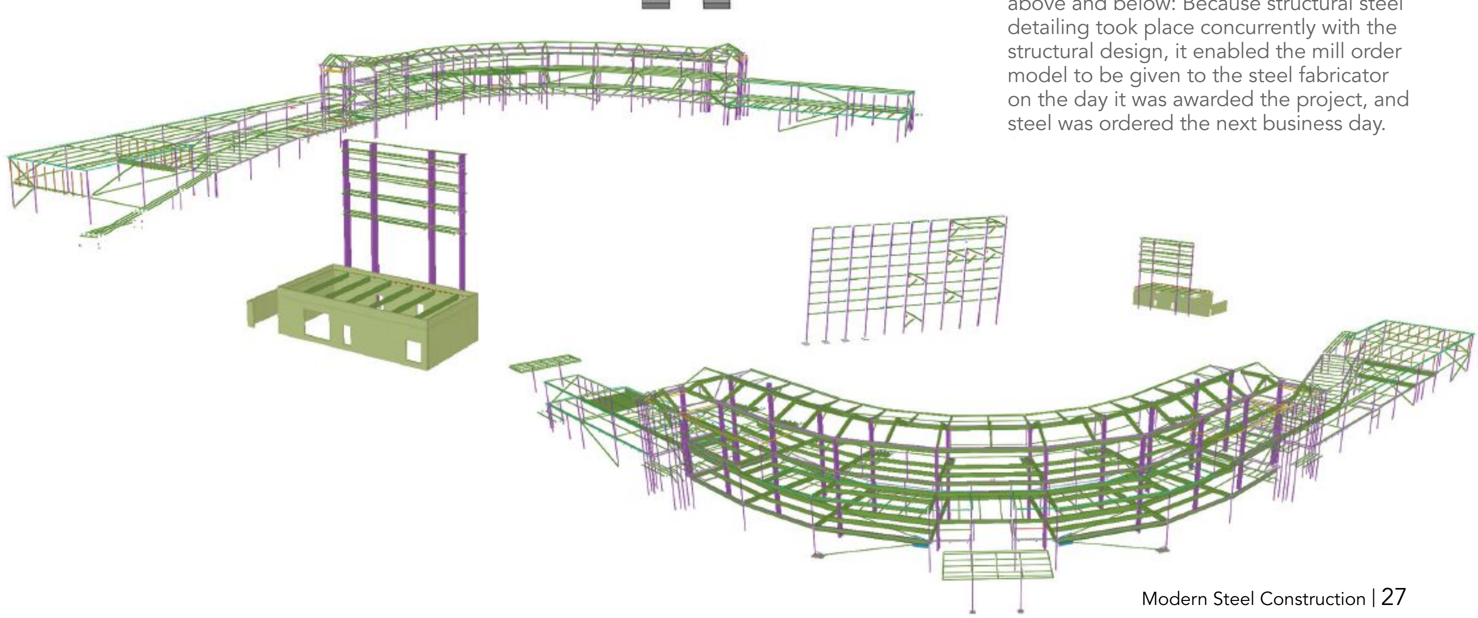
"The coordinated execution plan resulted in the delivery of steel on-site early and completing erection three weeks ahead of schedule, attributable to the quality of detailing, fabrication, and erection," Hall added. "This project delivery method with WPM adds value for the owner and is our preferred approach to providing quality steel fabrication and erection with an expedited schedule."

Production of the LOD400 model during the design phase also proved valuable to the precast seating unit subcontractor. The team had adequate time to coordinate the interfaces between the steel and precast in a virtual environment, which brought further schedule gains in the field compared to traditional methods.

In addition, open sharing of the BIM models between WPM, GMF, and precast subcontractor Gate Precast played a key role in the successful construction of the upper bowl and helped find several small but important vertical and horizontal discrepancies early. Furthermore, constructability considerations during the design stage allowed the steel sections to have enough stiffness to accommodate the temporary unbalanced conditions that occur when installing precast stadia.

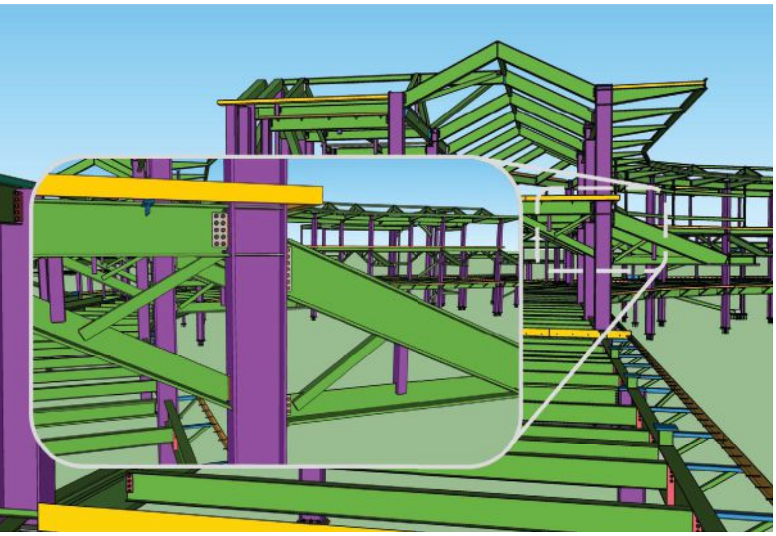
"The early design coordination and attention to detail resulted in UF Baseball being one of the smoothest running stadium projects Gate Precast has ever built," said Richard Pope, project manager at Gate Precast.



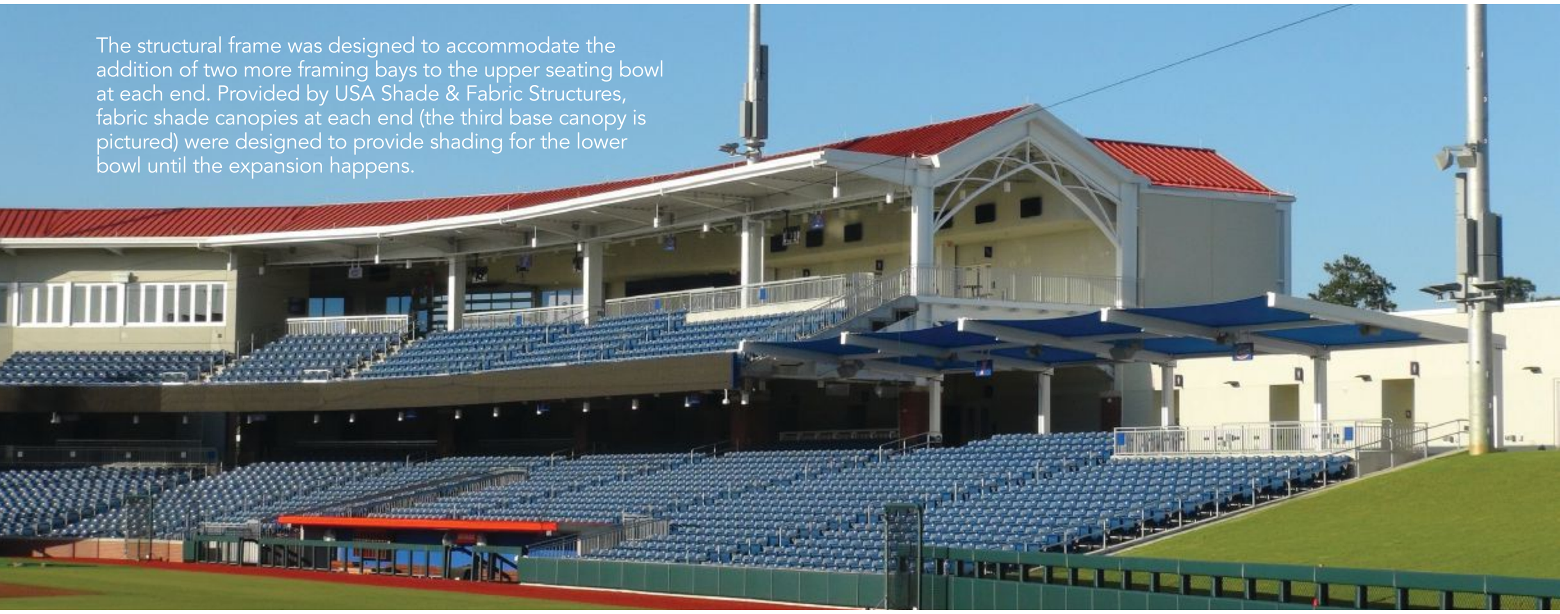


above and below: Because structural steel detailing took place concurrently with the structural design, it enabled the mill order model to be given to the steel fabricator on the day it was awarded the project, and steel was ordered the next business day.

above: By cantilevering the structural steel of the roof, the team was able to shade the upper-level seats, while using that deck to shade the seating below for ultimate fan comfort throughout the ballpark.



left and above: Production of the LOD400 model during the design phase also proved valuable to the precast seating unit subcontractor. The team had adequate time to coordinate the interfaces between the steel and precast in a virtual environment, which brought further schedule gains in the field compared to traditional methods.



The structural frame was designed to accommodate the addition of two more framing bays to the upper seating bowl at each end. Provided by USA Shade & Fabric Structures, fabric shade canopies at each end (the third base canopy is pictured) were designed to provide shading for the lower bowl until the expansion happens.

A model of a stairwell and concourse framing (above) and actual steel in the field (below).

below: The stadium is completed and ready for Florida's team to take the field when the 2021 baseball season starts.

Achieving the Vision

Despite the time constraints associated with the stadium, construction finished on time in July 2020 and within budget.

"The schedule was complicated at the end, but WPM dipped into their resources to still deliver the stadium on time," said Joe Walker, principal in charge at Walker Architects.

The design team used a reformatted delivery process to help achieve the owner's vision for the new stadium, and integrated services helped bridge the gap between design and construction, providing a more seamless transition from concept to reality.

"The ability to create and customize the detailed steel fabrication documents was the single most powerful item that saved the project budget and schedule," Walker said. "WPM's efforts saved approximately $800,000 on bid day."

Conventional delivery methods likely would not have solved the project schedule's challenges without introducing higher levels of risk in terms of cost, field durations, or both. The team success on the Florida Ballpark at Alfred A. McKethan Field provides reasons to expect further innovations in project delivery.

"The 3D model can be the new deliverable, but only if designers create their models accurately and pack them with information so that they can be trusted by the downstream users," said Aaron White, principal and director of digital practice at WPM. "At the same time, 2D construction documents will only go away when design, construction, and owner teams are willing to leverage digital tools and try something new."

There is only one thing left to do: Play ball! ■

Owner
University of Florida Athletic Association, Gainesville, Fla.

General Contractor
Brasfield and Gorrie, Jacksonville, Fla.

Architects
Populous, Kansas City
Walker Architects, Gainesville

Structural Engineer, Connection Designer, and Detailer
Walter P Moore, Tampa, Fla.

Steel Fabricator and Erector
GMF Steel Group AISC CERTIFIED FABRICATOR & ERECTOR, Lakeland, Fla.

Winning Past, Winning Future

BY DAVID BIBBS, SE, PE, AND JOHN ROACH, SE, PE

A steel-framed renovation and expansion project recognizes proud tradition and creates a promising future for University of Maryland athletics.

David Bibbs (**dbibbs@cannondesign.com**) is a structural engineer with the Chicago office of CannonDesign and was the project's engineer of record. **John Roach** (**jroach@cannondesign.com**) is a structural engineer with the Buffalo office of CannonDesign.

TRADITION RUNS DEEP at the University of Maryland, College Park, where athletic achievement has long been an important part of the school's culture.

That sense of history is tangible across the campus athletic complex, and perhaps no building holds more sentimental value than the William P. Cole, Jr. Student Activities Building. Colloquially known as Cole Field House, the facility was the home of the Maryland Terrapins men's and women's basketball teams and has hosted countless campus events from its completion in 1955 until a new arena (now called the Xfinity Center) opened in 2002.

For several years after that, Cole Field House was used for intramural sports and other activities and also housed office space. But in 2015, the university partnered with architecture and engineering firm CannonDesign to create a first-of-its-kind human performance and academic research facility—a living laboratory where entrepreneurs, scientists, clinicians, trainers, and athletes can work together to advance the practice of sports medicine. This 400,000-sq.-ft endeavor involved reimagining Cole Field House as a modern football practice facility, as well as the creation of an adjacent Center for Sports Medicine and Human Performance.

Fit for the Future

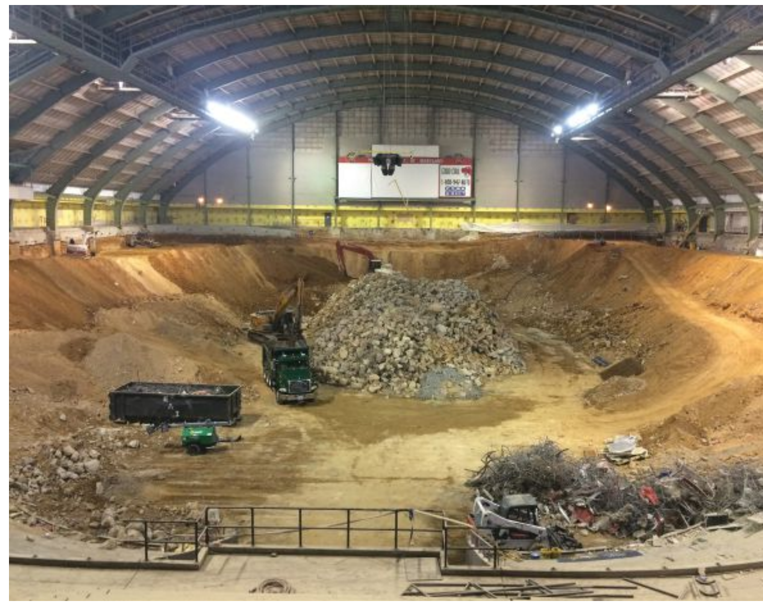
The success of the entire project was predicated on resolving a hefty challenge: how to fit a football practice field into Cole Field House while maintaining the historic fabric of the former basketball arena, particularly its landmark vaulted roof. Comprised of 15 steel arches spanning the full 250-ft width of the 80,000-sq.-ft building, the roof structure ultimately provided the key to repurposing the building.

Rising 92 ft above the arena floor, the existing steel arches provided adequate clear height to accommodate the new football practice facility. Building on this feature, CannonDesign structural engineers developed a strategy to expand the width and length of the arena bowl while maintaining the structure above.

University of Maryland Archives

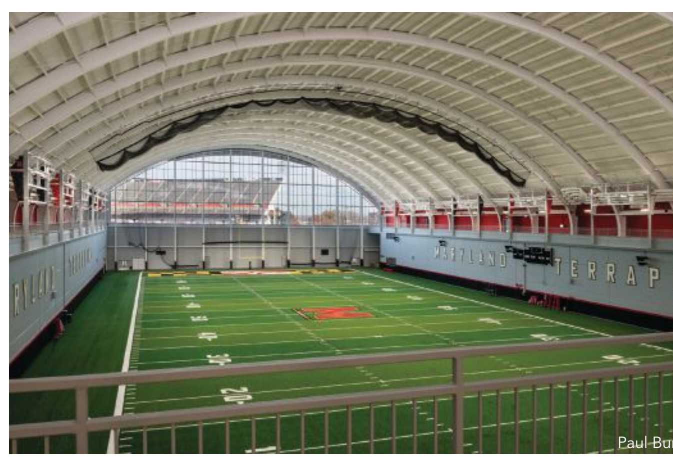
left: Cole Field House as it appeared upon completion in 1955. The original seating bowl for the arena was carved into the site from the at-grade concourse level.

below: The arena seating bowl was demolished and excavated to accommodate the new football practice field.



opposite page and above: The bays added to the end of the building were designed to closely match the construction of the existing steel arches that support the roof.

right: The completed football practice facility at Cole Field House.



Paul Burk

To accommodate the required length of the indoor practice field, the north end of the building was demolished, and three new structural bays were added. Each new bay features an exposed steel arch designed and detailed to be indistinguishable from those in the original structure. The new arches were constructed from five curved W36 beams, each supported by a pair of W36×160 columns at both ends. Bolted splices transfer shear and moment between members along the span and into the support columns, where pairs of braced frames resist the outward thrust.

The arena seating bowl, which was carved 33 ft into the ground below the concourse level, was demolished to provide the necessary width for the practice field. Because the existing roof arches were supported by concrete thrust blocks at grade, a new foundation system was required before excavation could begin. To avoid undermining the existing foundations, the original arches were re-supported with more than 100 micropiles that transfer the roof loads and lateral thrust to a new bearing stratum below the proposed finished floor. Soil nails were provided at the perimeter of the interior excavation to serve as the permanent earth retention system, and a 33-ft-tall reinforced concrete foundation wall was constructed to serve as the finished interior surface.

As this extensive earthwork continued below the roof structure, the original Tectum roof deck was removed and replaced by galvanized B-Deck fastened to the existing purlins. New diaphragm bracing was added to resist lateral loads, and the original steel was cleaned and painted to match the new construction.

A 50-ft-high curtain wall along the upper portion of the new north end brings natural light deep into the practice facility. To provide a sufficiently stiff backup structure, W36×182 columns span between the field and the bottom of the arch, and exposed hollow structural section (HSS) girts brace the columns at regular intervals and support the bottom of the curtain wall above portals that connect the practice field to a new strength training center.

Celebrating Terrapin Culture

While the Cole Field House reconstruction featured a deliberate weave of new construction and preservation, the Center for Sports Medicine and Human Performance is entirely new construction. More than 2,261 tons of steel were used in this 320,000-sq.-ft portion building, where structural efficiency and Terrapin culture are seamlessly intertwined and boldly expressed through architecturally exposed structural steel (AESS).

To provide a column-free space within the strength training center, seven pairs of steel trusses fabricated to AESS 2 span 100 ft across the facility and support a landscaped roof terrace above. Echoing the steel arches of the adjacent Cole Field House as well as the geometry of a terrapin shell, the bottom chord of each truss consists of a curved W12×79 member field bolted to W24×146 columns at each end. Rather than align with a straight span across the training center, each pair of trusses is skewed to intersect at the midpoint. Viewed from below, this array of trusses and diagonal web members creates a diamond pattern that serves as an homage to both the state flag of Maryland and the natural patterns found on a terrapin shell.

Crystal Steel fabricated each truss in two halves at its Delaware facility. The team benefited from the large, open nature of the project site, where the free end of each section was temporarily shored while the chords at the opposite end were bolted to wide-flange stubs welded to the W24 columns. After alignment, the four truss segments were spliced using a fully welded, intersecting pair of wide-flange beams with bolted end connections.

above: The Center for Sports Medicine wraps around a pair of practice fields and serves as an extension of Cole Field House, whose arched roof can be seen at upper-right.

below: The two facilities occupy a prominent location on the University of Maryland Campus.

Creating Connections

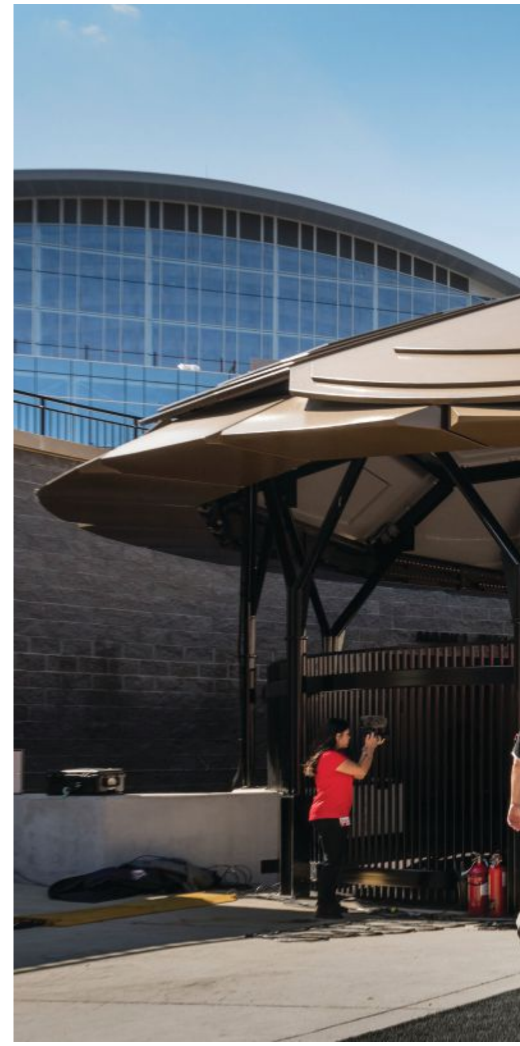
Just as the Cole Field House reconstruction provides a symbolic bridge between the proud past and exciting future of Maryland Athletics, the project as a whole is designed to strengthen physical connections between the athletics facilities and the surrounding campus. Important public spaces and circulation corridors adjacent to Cole Field House and the Center for Sports Medicine and Human Performance are aligned with adjacent roads, pathways, and campus landmarks. To emphasize their distinctive role within the complex, these multi-story spaces are clad with curtain walls rather than the masonry veneer that defines the rest of the exterior.

At the north end of the complex, a four-story "glass box" projects 7 ft from the face of the Center for Sports Medicine and points toward adjacent Maryland Stadium. Within this volume, ornamental steel stairs provide circulation between each level of the atrium. At the glass box, exposed HSS members protected with an intumescent coating support 65 ft of canted curtain wall. To reduce field labor and mitigate potential quality issues, the entire HSS curtain wall support frame was welded together in the shop and bolted to the primary structure in the field. This approach allowed the design team to achieve a visually acceptable result without the need to specify an AESS finish.

above: An homage to important campus symbols, intersecting groups of arched trusses support the rooftop terrace above the strength training room. The renovated Cole Field House can be seen in the background.

right: Exposed steel supports a multi-story canted curtainwall that looks toward the football stadium.

left: More than 2,261 tons of structural steel were used to construct the Center for Sports Medicine and Human Performance.



Fear the Turtle

While sculpted forms of steel and glass imbue public areas of the performance and innovation center with a sense of drama, the portions of the complex reserved for student-athletes are more subdued. Many of these areas are transitional spaces—passages or team corridors that provide a link between one public space and another. This is especially true of the long underground tunnel that was constructed to connect Cole Field House with Maryland Stadium. To give teammates a final, private moment before emerging into a stadium filled with cheering fans, CannonDesign created a 45-ft-long terrapin shell canopy to shelter the end of the tunnel.

While a variety of materials were considered for the terrapin shell, the team quickly determined that using steel fabricated to AESS 4 (showcase elements) would be the most effective method for balancing aesthetics with constructability (for more information on the various AESS levels, see "Maximum Exposure" in the November 2017 issue, available at **www.modernsteel.com**). Due to the complex geometry of the terrapin shell and its support structure, CannonDesign worked closely with steel fabricator Shickel Corporation to refine the connection details. The terrapin shell is an assembly of built-up steel plates welded together and mounted to a structural frame comprised of HSS members. Eight pairs of round HSS columns splay outward 4 ft below the shell to add visual depth and further reinforce the diamond motif found throughout the complex.

below: Within the "glass box," ornamental steel stairs provide circulation between each level of the atrium.

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15	Angle Heel Out	OUTSIDE DIA.	8" x 8" x 1" Angle
16	Angle Heel Up	MEAN DIA.	8" x 8"x1" Angle
17	Square Tube	INSIDE DIA.	24" x $\frac{1}{2}$" Tube
18	Rectangular Tube The Easy Way (Y-Y Axis)	INSIDE DIA.	20" x 12" x $\frac{5}{8}$" Tube
19	Rectangular Tube The Hard Way (X-X Axis)	INSIDE DIA.	20" x 12" x $\frac{5}{8}$" Tube
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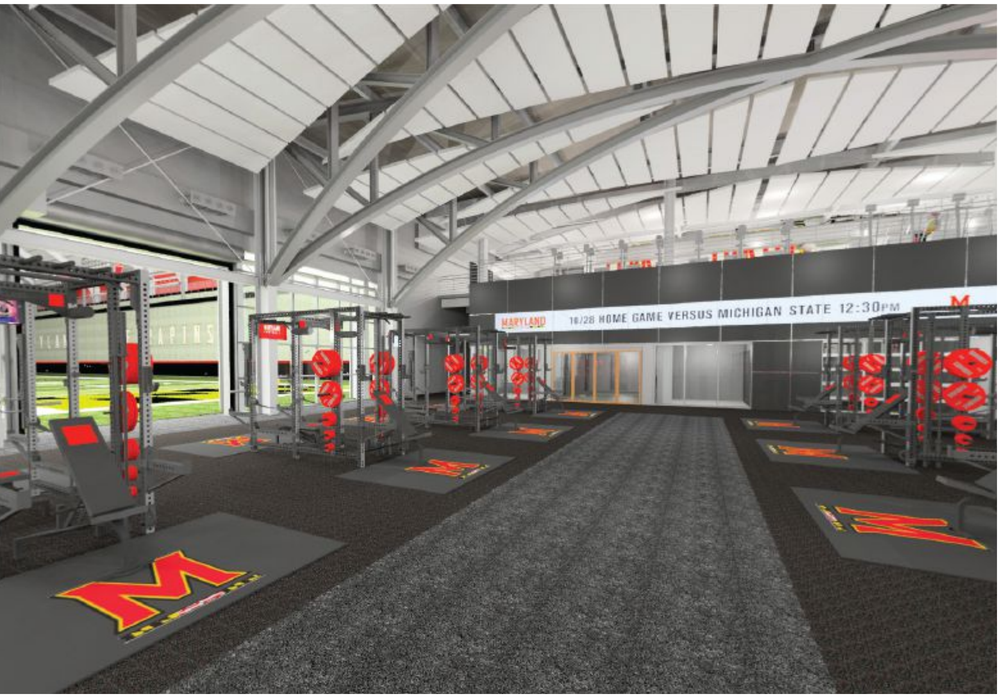
Players enter the field from beneath the terrapin shell, which consists of built-up steel plates supported by splayed HSS columns.

Paul Burk



Like Cole Field House, the strength training center also incorporates steel arches.

Each welded connection was finished to NOMMA #3 (partially dressed weld with spatter removed) and all members received SSPC-SP 7 (brush-off blast cleaning) surface preparation. For constructability purposes, the entire structure was segmented into a series of modules that were bolted together in the field. Prior to final erection, Shickel verified member fit-up by assembling the entire structure in its shop.

Preserving the Past, Preparing for the Future

With a projected 2021 completion, the Center for Sports Medicine and Human Performance will serve as an unrivaled beacon for sports excellence, innovation, and campus pride. By integrating a revitalized Cole Field House into the new facility, CannonDesign leveraged the versatility of steel to preserve an important piece of campus history and avoid the waste of demolishing a serviceable structure. Today, the Maryland Terrapins have a state-of-the-art football practice facility, and the proud legacy of Cole Field House carries on, in a new form, to the next generation of Terrapin student-athletes. ■

Owner
University of Maryland, College Park, Md.

Construction Manager
Gilbane Building Company, Baltimore

Architect
CannonDesign, Arlington, Va., and Baltimore

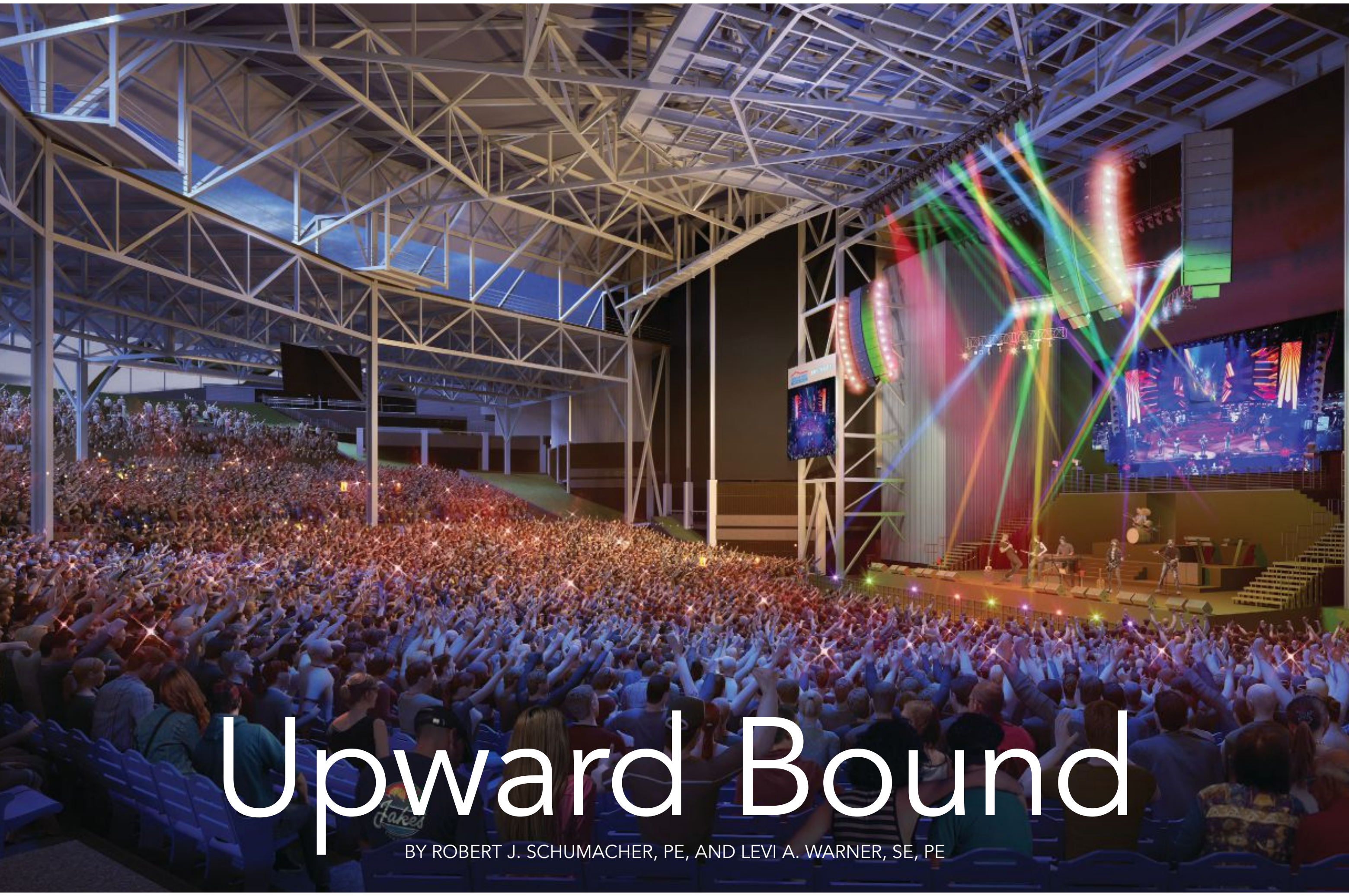
Structural Engineers
CannonDesign, Chicago
Columbia Engineering, Columbia, Md. (tunnel and Human Performance Center foundations)

Steel Team

Fabricators
Crystal Steel Fabricators, Inc., Delmar, Del. (superstructure, also detailer)
Shickel Corporation, Bridgewater, Va. (terrapin shell)

Erectors
Memco, LLC, A Division of Banker Steel, Lynchburg, Va.
L.R. Wilson and Sons, Inc., Gambrills, Md.

Bender-Roller
WhiteFab, Inc., Birmingham, Ala.



Upward Bound

BY ROBERT J. SCHUMACHER, PE, AND LEVI A. WARNER, SE, PE

MILWAUKEE'S SUMMERFEST Presented by American Family Insurance has long been recognized as the "World's Largest Music Festival," even being officially certified as such by the Guinness Book of World Records.

Every year, the 75-acre Summerfest grounds, located on the shores of Lake Michigan in downtown Milwaukee, hosts hundreds of performances and a carnival over a nine-day run in late June and early July, often attracting upwards of one million visitors.

But even the biggest music festival on the globe needs to grow here and there. Due to a 39-ft clear height limit within Summerfest's primary music venue, the covered 23,000-seat American Family Insurance Amphitheater (AFIA), a recent Paul McCartney show was forced to leave one-third of its video screens and special features "in the trucks," thus eliminating a montage that would typically be part of the show.

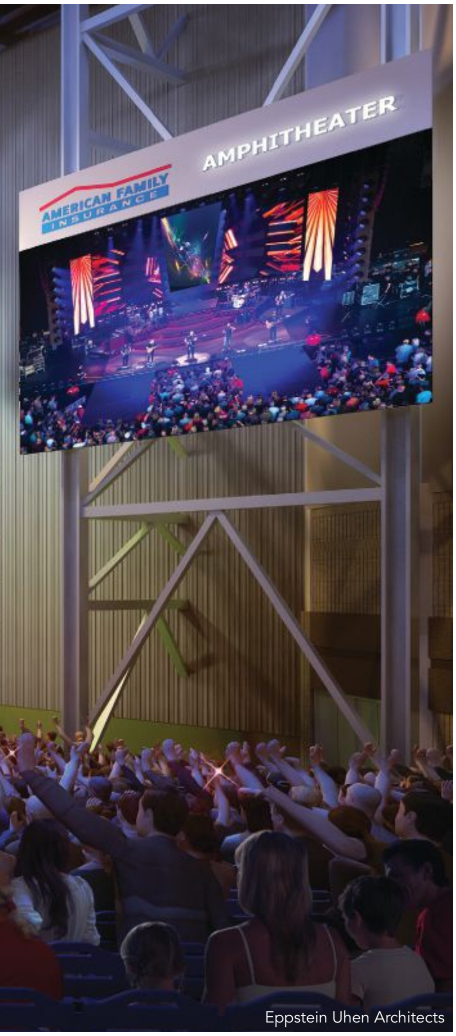
Thus, the Milwaukee World Festival (MWF), the nonprofit agency that oversees Summerfest and the amphitheater, chose to raise the central 25,000-sq.-ft, 300-ton portion of the steel-framed roof 26 ft, creating a vertical clearance of 65 ft. Doing so would allow the venue to accommodate the largest and most extravagant shows that might potentially be lost to larger, newer venues, particularly the Milwaukee Bucks new Fiserv Forum arena.

"The roof lift was one of the most complex elements of the building project, and one of the most important, as it will allow us to host the world's largest tours," said Don Smiley, president and CEO of MWF. "The Amphitheater has seen its share of legends over the years, and by raising the roof, we will continue to attract top talent, ensuring Summerfest remains a driver of economic impact and tourism for Wisconsin."

Existing Roof, Existing Team

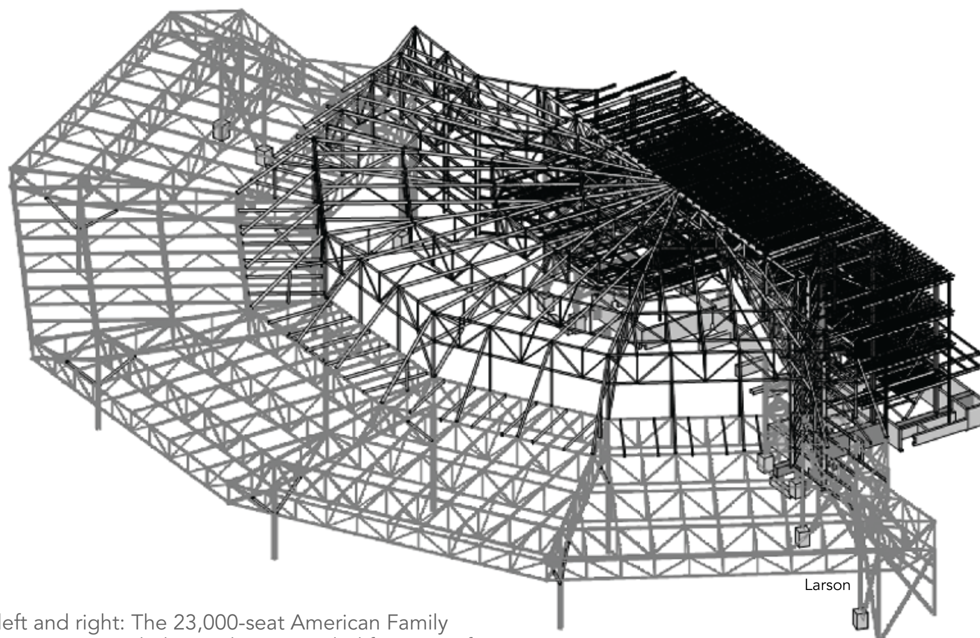
The existing structure was framed with 12-ft-deep hollow structural section (HSS) trusses spanning 240 ft from the stage over two columns to the outer seating area; these radial trusses form five 15° wedges. Transverse trusses span between them at about 24-ft spacing, and the roof deck is supported on 12-in.-deep HSS purlins spaced at 12 ft. The six radial trusses are supported by a 16-ft-deep, 120-ft-long "proscenium" HSS truss directly over the stage. The roof structure is braced by chevron bracing towers at the stage and X-brace frames flanking the seating areas. A 70-ft by 100-ft theatrical hanging grid was integrated into the trusses over the stage and was designed to support over 300 kips of sound equipment, lighting, and props suspended above the stage. In addition, a four-story steel- and CMU-framed dressing room area behind the stage was integrated with the truss bracing.

The design team for the renovation included a handful of people that were involved in designing the original structure more than three decades earlier: Greg Uhen, CEO of Eppstein Uhen Architects, then a staff architect; Joel Becker, vice president of construction for Hunzinger Construction, then the site superintendent; and Bob Schumacher, structural project manager for Larson Engineering, Inc., then a project engineer.



Eppstein Uhen Architects

The largest venue at the "World's Largest Music Festival" wasn't large enough for some of the world's largest live performances. Luckily, there was no way to go but up for the steel-framed roof.



Larson

left and right: The 23,000-seat American Family Insurance Amphitheater has upgraded from a 39-ft vertical clearance to 65 ft.

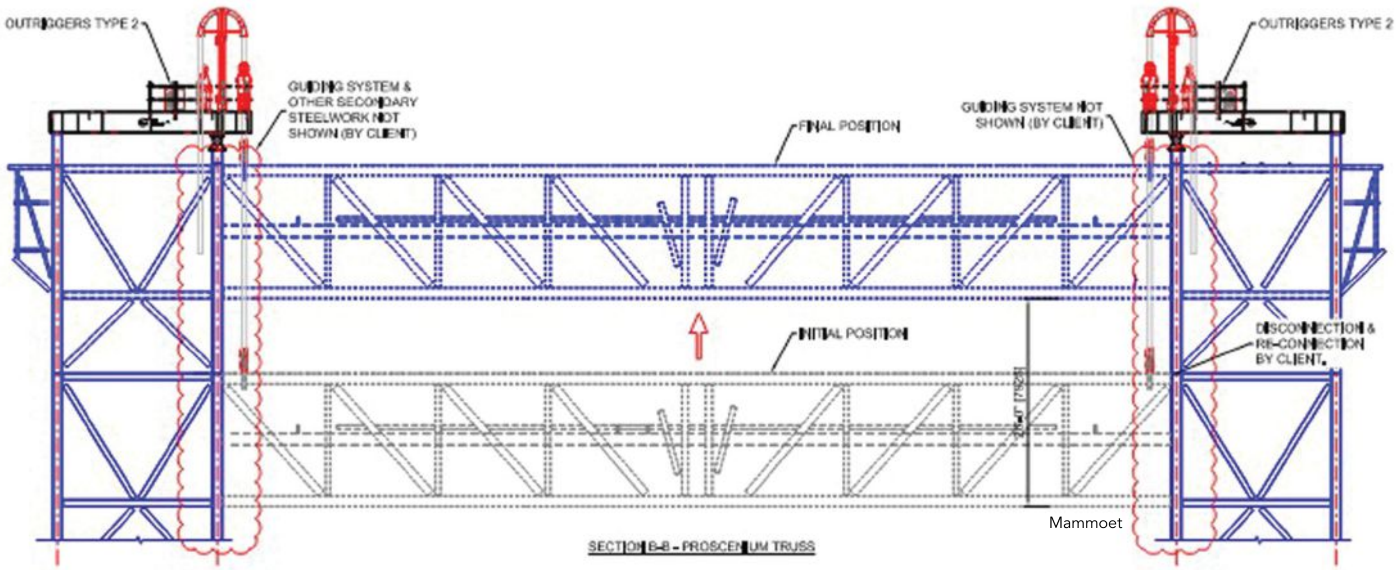
Going Up

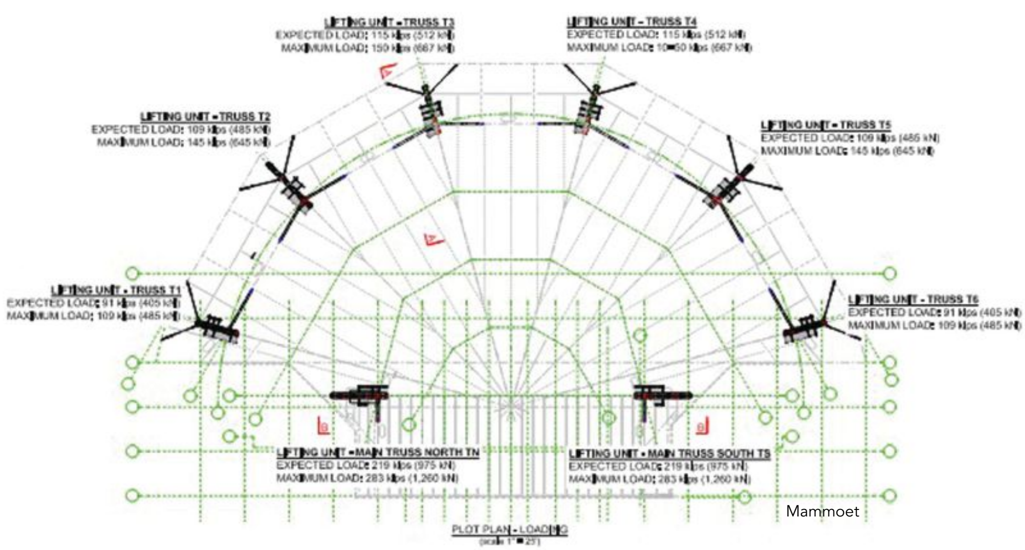
The good news was that the plan to raise the roof aligned well with renovations that MWF was already planning, which included replacing the wall panels and rebuilding the stage/dressing room building. As this demolition and replacement work would have required the roof to be raised or replaced anyway, a portion of the cost for the roof would already be covered.

While MWF did consider demolishing and replacing the roof structure, after considering cost, schedule, sustainability, and feasibility of raising the roof versus rebuilding it, the raising option was deemed the better choice. The renovation could also be staged in two phases, allowing the venue to be available for performances during the warmer months (it hosts performances throughout the summer, not just for Summerfest) and the work to be performed during the colder months. The mostly HSS steel trusses could easily be reinforced and modified for the new configuration and allowed for detachment, lifting, and reattachment over the winter as long as cold weather provisions for welding were maintained (which they were).

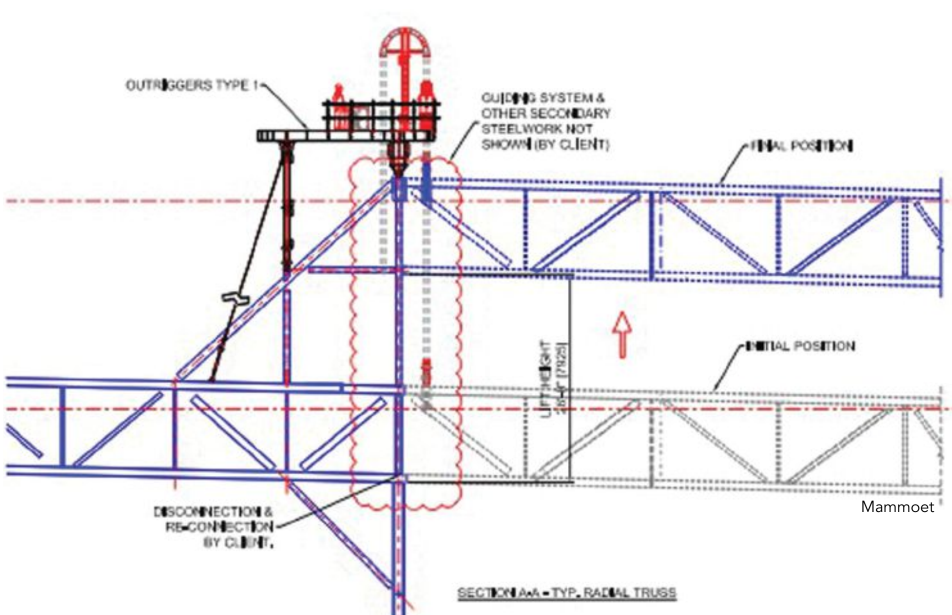
Once the decision to raise the roof was finalized, the question became, "How?" One plan involved raising the entire roof and removing and replacing columns while the roof was suspended in the air. However, the additional wind load and overturning moments would also require significant additional lateral resistance in the form of vertical trusses or composite "mega" columns as part of moment frames. This scheme would also involve adding a dozen or more helical piers to the foundation in the seating area, as well as a large pile cap that would need to be compatible with the existing column pile caps and future enlarged column groups. Additional bracing around the stage would also be needed, and the proscenium truss at the stage would need to be lifted and reconnected to columns and bracing extended to the new height ahead of the lift.

Robert J. Schumacher (**rschumacher@larsonengr.com**) is a senior project manager (and was with a previous firm during the design of the original project), and **Levi A. Warner** (**lwarner@larsonengr.com**) is a project engineer, both with Larson Engineering.





The lift plan, indicating the portion of the roof to be lifted and the lifting frames.



The team eventually settled on an option that involved raising only the center portion of the roof adjacent to the inner columns in the seating area and connecting to new framing preinstalled above the existing outer roof. The stage truss would be lifted as described in the first option above, and additional bracing would be added within the new stage building construction. In the chosen option, all of the columns and foundations could remain in place, and the raised roof could be immediately welded to the new steel instead of being suspended for a long duration while the new columns were erected from below on the new foundations.

While roof raises are typically designed as a routine part of the framing and erection plan for new stadiums and arenas, the segmented fan shape of AFIA's roof made for a more complicated situation than lifting, say, rectangular sections. Careful coordination and communication throughout the two-year project made it happen, as did the decision to lift the roof from outriggers on the existing columns.

New Steel

Once the lifting concept and plan were decided, the new steel needed to support the upper steel was designed. The roof was designed to be cut and raised at the inner columns, which are at tangential truss T-5. A new truss, similar to T-5, would be installed at the upper level to receive the purlins, which needed to be cut for the roof raise. The raised roof and the new upper T-5 would be supported on a vertical extension of the existing columns, with the vertical chord member of the truss being reinforced for the added local drift load and an HSS8×8 extended upward to receive the upper roof. A diagonal HSS12×8 chord would be extended at about 45° to the lower top chord at the panel point where the next tangential truss (T-6) joins the radial truss. Additional diagonals were designed for the third points of the new T-6 for added continuity and to support the new purlins supporting the new sloped extension of the upper roof. The end bays over the outer bracing were sized for the added wind loads from the raised portion. All existing truss members over the bracing needed reinforcing, and the stage's vertical bracing was extended 26 ft vertically to accept the raised proscenium truss.

right: Tangential roof support steel in place.

below: Stage bracing and proscenium truss support steel in place, with some lift beam assemblies installed.

The amphitheater with the stage building demolished and all siding removed.

R Schumacher

New framing to support the lifted roof.

below: New support steel in place, with lift equipment installed and ready for lifting the next day.

right: Roof lift proceeding near the top, with the roof soon to be reattached to the new framing.

R Schumacher

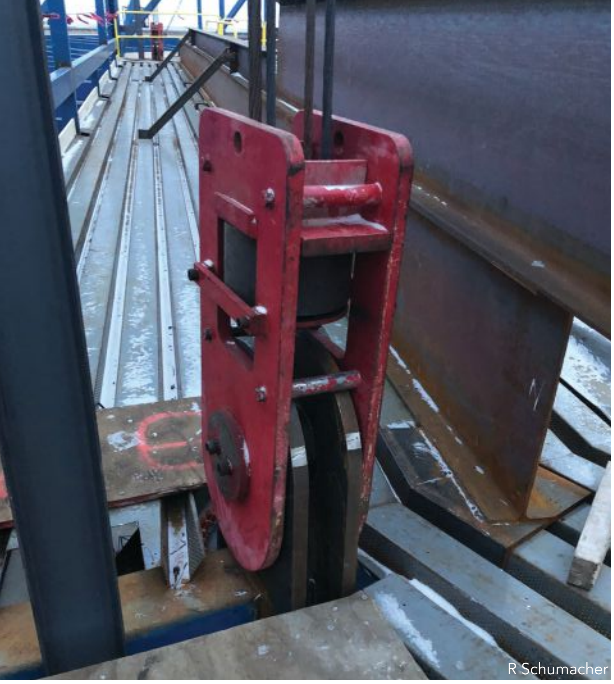
R Schumacher

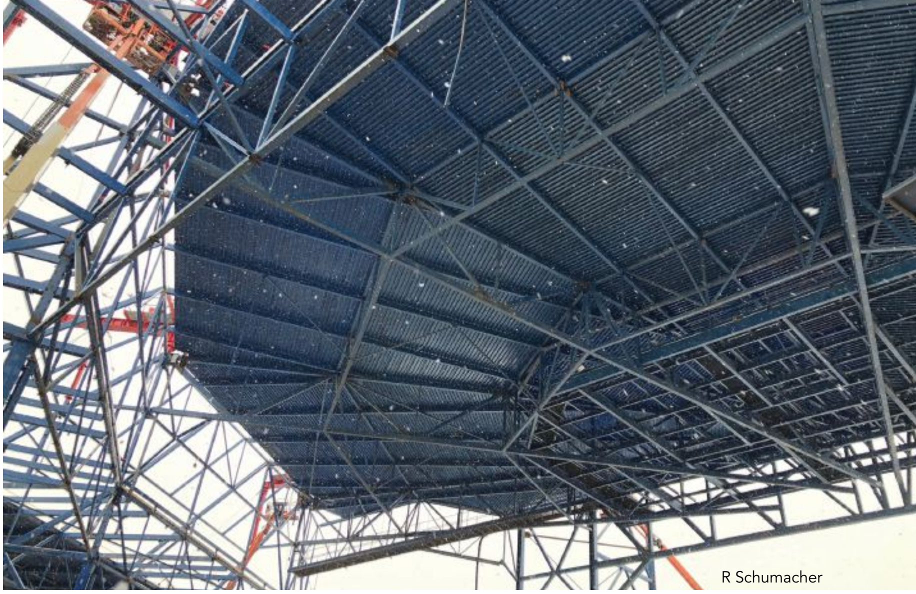
Roof Analysis

Following the accepted concept, the existing roof structure and new framing were modeled and analyzed. The roof was modeled using RISA Structure and encompassed more than 3,000 members and 3,000 nodes. The model included the new stage building with the braced bays on either side of the stage being extended to three bays to resist the significant added wind loads and higher overturning forces. In addition, knee braces were added to existing columns in the seating area to provide moment resistance and additional lateral stiffness.

For the most part, the existing structure was adequate to support the renovated roof. The existing columns resist essentially the same dead and live loads plus the additional snow drift created by the height change (added capacity was realized when the 12-psf stone roof ballast was removed as part of a roof replacement 15 years prior). The existing pile foundations were also found to be adequate, though some radial truss web diagonals needed reinforcement and the tangential truss at the height change required chord and web reinforcement for the added snow drift. Purlins were also added between trusses T-5 and T-6 midway between the existing purlins to support the snow drift created from the upper roof to the lower roof.

Steel members were reinforced by placing steel plates on each side of the HSS verticals and diagonals and stitch welding them as needed. Ends were welded to chords as needed to transfer loads; fortunately, the chords were 8 in. wide and accommodated the reinforcement of the 6-in.-wide web members. All truss connections were checked for the new loads, and some of these connections required reinforcement even if the members themselves were adequate. This reinforcement was provided via additional welding and the introduction of plates at the ends of member webs to transfer the additional load.





R Schumacher

R Schumacher

left: Attached lifting lug and temporary steel.

above: A view from below immediately following the roof lift.

below: The temperature was -10 °F the morning of the roof lift.

R Schumacher

Lateral Resistance

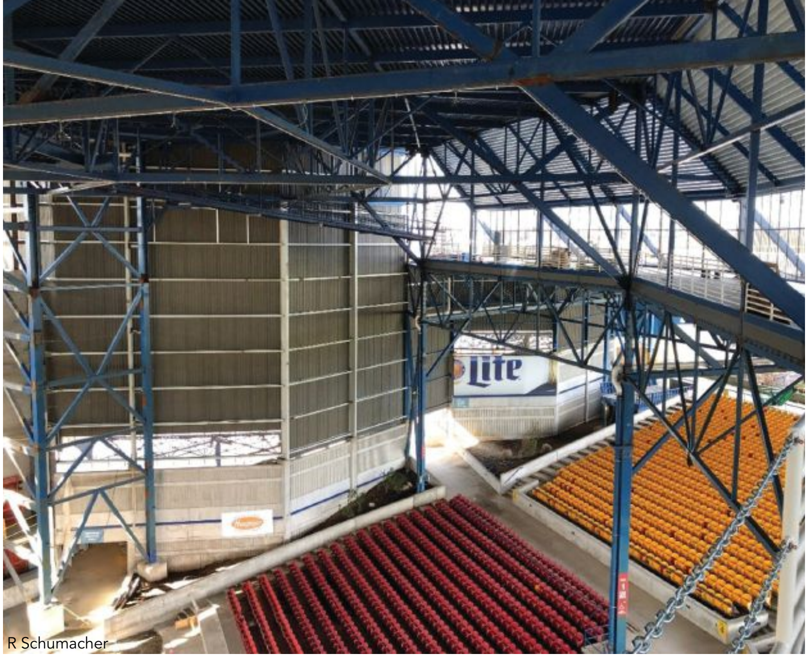
The now-taller roof added over 7,000 sq. ft of wall area, which in turn added over 240 k of shear 70 ft above grade, causing major overturning forces to be resisted by the lateral system. In addition to the three bays of added bracing at the stage, the existing X-bracing flanking the seating areas required some reinforcement. The bolts connecting the bracing columns to the pile caps were overstressed with net uplift in excess of 200 k, so concrete collars were placed around the columns, 16 headed studs were welded to each column, and collar-reinforcing steel was epoxy-doweled into the pile caps.

When it came to truss connections, the lifted roof was field welded to the new upper steel columns and existing raised truss using cheek plates. These long plates allowed for up to 2 in. of vertical and horizontal offset in the final alignment.

Lift Analysis

The lift frames were designed to be mounted to the tops of the extended columns, with the lift frame beams cantilevering 2 ft, 6 in. over the lifted roof and back spans reaching to the adjacent columns or panel points. The lift frames and added loads from lifting were modeled and analyzed, and no additional reinforcing was required. Lifting lug plates were designed and welded to the frame with provisions to be removed after the lift.

In order to lift the roof, it was determined that the purlins connected to truss T-5 would need to be cut, requiring temporary steel beams to support the purlins and span between radial trusses since the existing frames would lose continuity once cut. The whole and cut trusses, as well as the new extended steel columns and frames, were modeled and rotation and displacement values were calculated and compared. The model determined that when cutting the truss member for the lift, a larger gap would be required for clearance during the lift and to align with the final lifted position. Based on this finding, a schedule of truss cut gaps and a cutting order were provided to the general contractor.

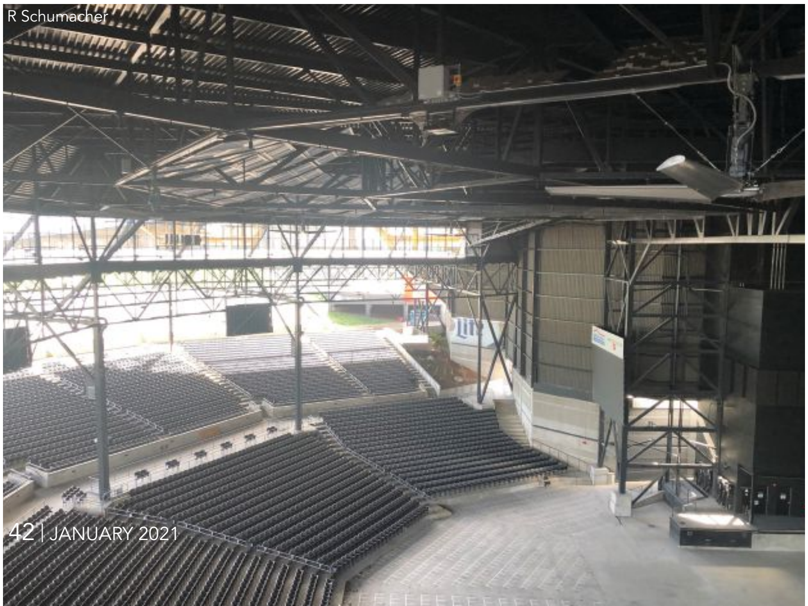

R Schumacher

above: The bi-level reattached roof adjacent to the now-taller walls and siding.

below: Erection of the stage building and installation of the walls and siding.


R Schumacher

below: Completed renovation of the amphitheater's interior from a spotlight position on the low roof.


R Schumacher

Construction

Construction began with demolition of the stage building and removal of all siding and girts. Installation of the roof truss and connection reinforcing took place while the stage building foundation was being constructed. In order to facilitate erection of the new upper truss frames on the outer portion of the roof, the roof deck in the 26-ft-wide bay at the new truss frame was removed to allow lifts to pass through to facilitate erection and welding of the new frame from the ground.

The construction team, including the construction manager, lift contractor, steel fabricator, steel erector, and design engineers, held weekly meetings to review and coordinate the lift with overall construction progress, resulting in a lift that was executed with minimal issues. 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 lift progress was monitored and loads at each jack were calculated to ensure uniform lifting. By the time the lift beams and equipment arrived at the project site in December 2018, the support steel was erected and the temporary steel and lifting lugs installed. Simultaneously, the stage that was demolished in September was being reconstructed. A 300-ft boom crane was used to install the lift beams and jacks. Following the lift and reattachment, the stage building was erected, and a 500-ton crane with a 115-ft-long main boom and a 220-ft-long mega-wing attachment was used to remove the lift beams and temporary steel.

Once the lifting beams and jacks were installed and interconnected at the control room, the strand jacks were loaded to 90% of the anticipated load so that the lugs could be seated and any lift issues could be addressed. The lift took place the next day in late January 2019, and the temperature was -10 °F that morning. 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 loss of continuity from the cuts. The stroke of the hydraulic jacks was set to 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. The lift proceeded for about six hours to reach the 26-ft level, and then the jacks were secured for the night.

Reattachment of the trusses to the new upper frame began the following morning, with lift jacks being placed at eight locations on the main truss. Eight welders and man lifts were used at each location to reattach the roof as soon as possible, and eight weld inspectors were on-site to verify that preheat requirements were met and to observe and test welds. The lifted roof main trusses were fully re-supported within two days, and most main reattachment connections were completed in about a week, after which the lift equipment was removed from the roof.

R Schumacher

above, right, and below: The structure was fully erected and functional by June 2019. After the 2019 concert season, the second phase of the renovation took place: sandblasting and repainting the entire roof structure. All 15,000 amphitheater seats and bleachers were removed and replaced, and the concourses were enlarged by 15,000 sq. ft of space on three levels to match the existing grid.

R Schumacher

Eppstein Uhen Architects

While ALE erected its red lifting platforms, erector SPE, Inc., performed steel erection work for all permanent and temporary steel (including large lifting lugs) for the lifted roof support frames and reinforcement for the existing roof structure. The company also erected the four-story stage building and all the steel for the bar/food service areas, restrooms, red plate accent framing on the fourth level, stairs, and miscellaneous steel. When it came to erection staging, the seating area east of the stage prevented crane setup and material lay-down there, and existing structures on the other sides of the site made for some long crane reaches. As such, materials deliveries were coordinated and staged by SPE to optimize use of the limited lay-down area.

The structure was fully erected and functional by June 2019 for the summer festival season. After the 2019 concert season, the second phase of the renovation took place: sandblasting and repainting the entire roof structure. All 15,000 amphitheater seats and bleachers were removed and replaced, and the concourses were enlarged by 15,000 sq. ft of space on three levels to match the existing grid. A four-story elevator was added for ADA compliance, restrooms and other amenities were gutted, renovated, and enlarged. The work included new steel-framed roofs over six bar and food service areas, as well as a 240-ft-long steel-framed signage and architectural feature.

All renovations for AFIA were ready for concertgoers in time for Summerfest 2020, with the two-year project completed without a single lost-time accident. However, like so many things in 2020, the unveiling of the dramatically enhanced venue was put on hold until 2021. The economic impact of canceling Summerfest due to the COVID-19 pandemic was estimated at nearly $200 million in lost tourism revenue to businesses in Milwaukee. When the amphitheater can safely reopen, it will be a key part of the local economy's recovery. ■

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

General Contractor
Hunzinger Construction, Inc., Brookfield, Wis.

Roof Lift Contractor
Mammoet (formerly ALE Heavy Lift)

Architect
Eppstein Uhen Architects, Milwaukee

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

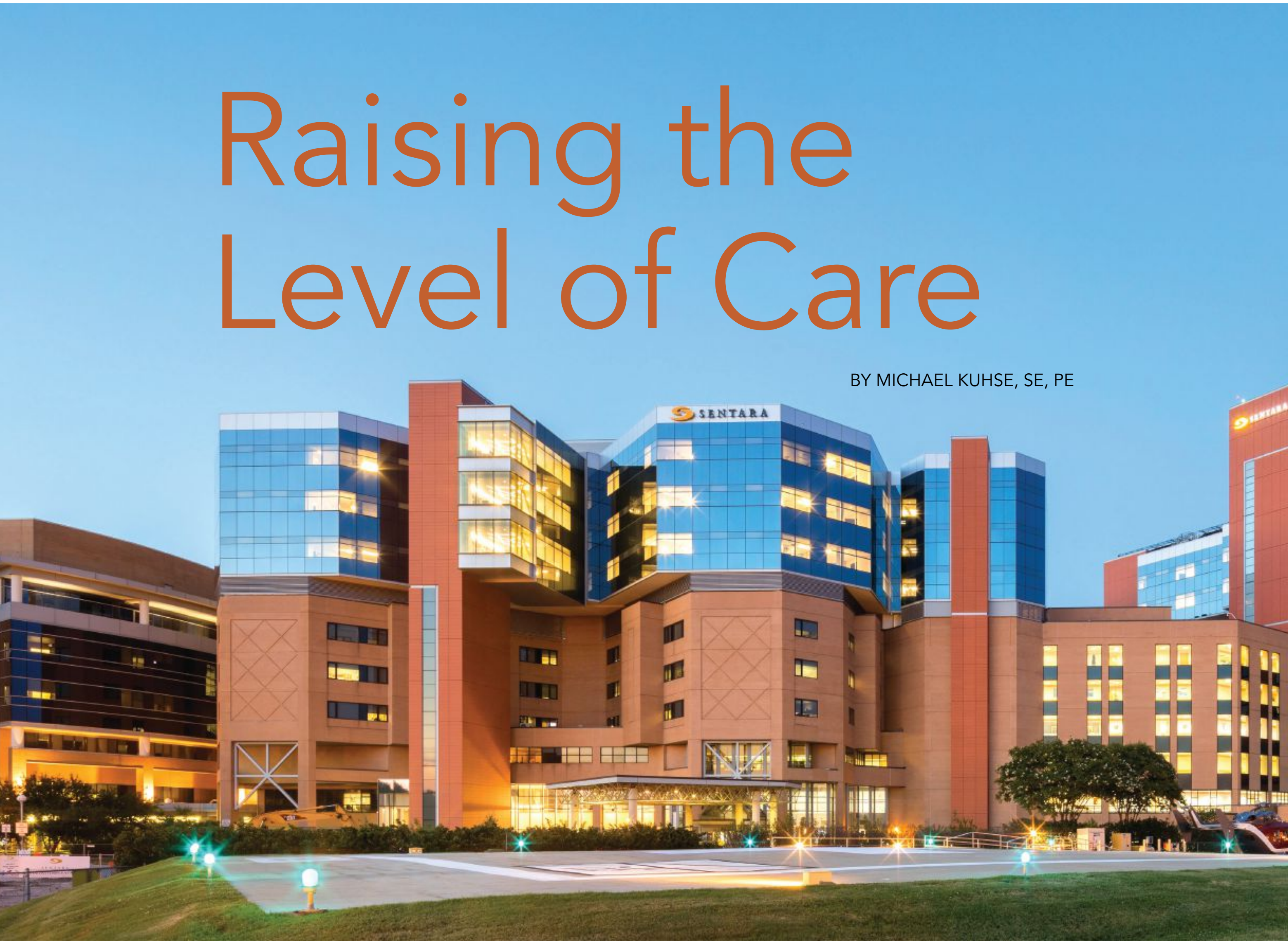
Steel Team

Fabricator (roof and lift)
Ace Iron and Steel Corporation (AISC), Milwaukee

Erector
SPE, Inc. (AISC ASSOCIATE), Little Chute, Wis.

Raising the Level of Care

BY MICHAEL KUHSE, SE, PE



Michael Kuhse recently retired after working over 40 years as a senior structural engineer for HDR in Omaha, Neb., specializing in large-scale healthcare projects but also working on numerous project types all over the United States.

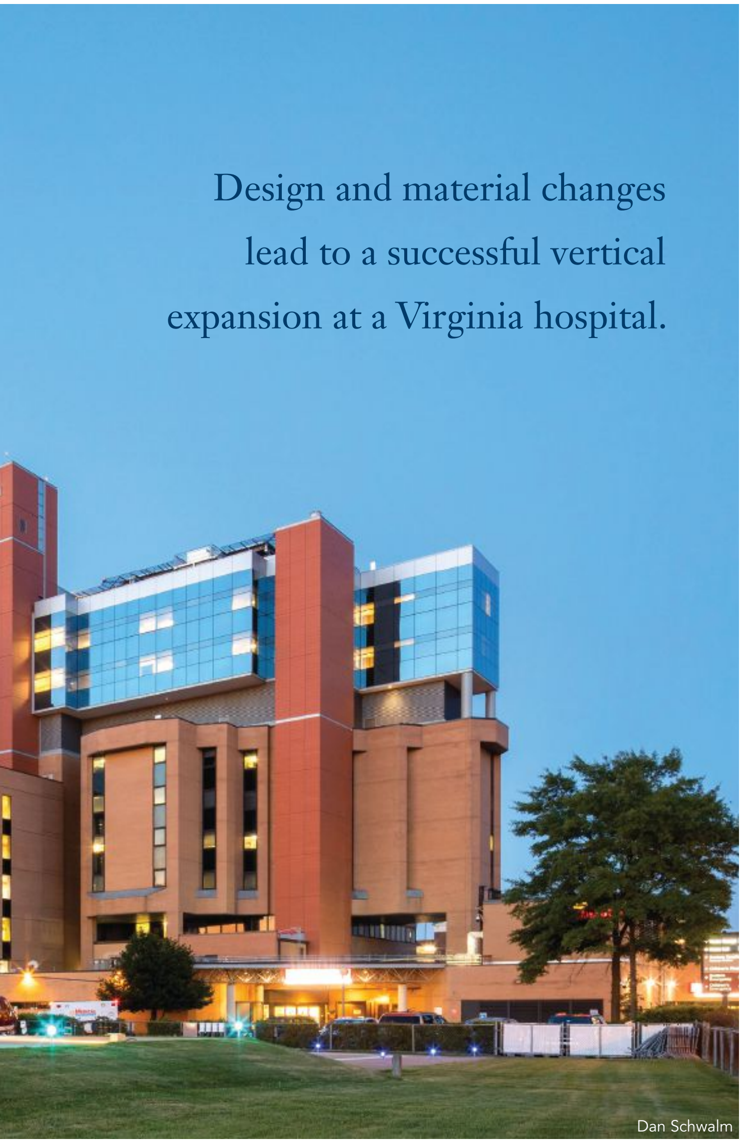
BUILDING ON TOP of an occupied building is never easy. Building on top of a functioning hospital without interrupting its day-to-day operations is especially difficult.

Over three decades ago, the River and Kaufman Pavilions at Sentara Norfolk General Hospital in Norfolk, Va., were designed as five- and six-story concrete buildings, with provisions for eventual expansion in the form of two additional concrete-framed floors. By 2015, the hospital reached the point where the expansion became necessary to add much-needed patient rooms. And while the building was "expansion ready," hospital leadership preferred a different floor plan than the existing buildings. Desired changes in the new patient room floor plans dictated that the footprints of the two vertical expansions would *not* match the footprints of the floors below. In fact, the new floors of River Pavilion would need to extend beyond the existing walls of the below building.

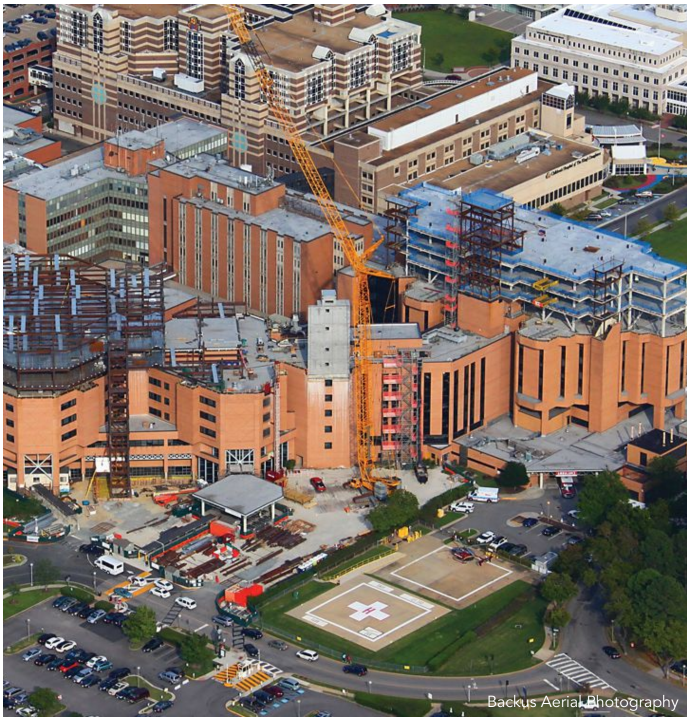
A Change in Plans

This change in floor configuration also led to a change in framing material—from concrete to steel. Because the new floors extended beyond the existing floors—and were also six stories in the air—forming the concrete in space would have been extremely difficult. In addition, a steel framing system would not require any shoring down to the existing roof. And while the roof was designed to carry the weight of the shoring load from the future floors, thus making load capacity a nonissue, if concrete had been used for the expansion, the shores sitting on the existing roof would have increased the likelihood of leaks into the hospital space below.

Design and material changes lead to a successful vertical expansion at a Virginia hospital.


Dan Schwalm


Backus Aerial Photography


Backus Aerial Photography


Backus Aerial Photography

above and right: The River and Kaufman Pavilions at Sentara Norfolk General Hospital in Norfolk, Va., were designed for future vertical expansion, which recently came in the form of new steel-framed levels on top of both.

Steel also brought benefits in terms of gravity design. By using composite floor framing with a 3½-in. topping on 3-in. metal deck for a total slab thickness of 6½ in., the Kaufman Pavilion expansion could be increased to three additional floors from the original design of two additional floors. The typical gravity framing uses W16 purlins spaced at approximately 10 ft on center, supported by W21 and W24 girders. The project used nearly 1,300 tons of structural steel for both pavilions.

For lateral load resistance, the original buildings use shear wall cores around stairs and elevators for lateral load resistance. Extending the shear walls upward for the new addition would have required the main elevators to be taken out of service for the duration of construction—obviously creating enormous operational problems for the staff. This led the structural team at HDR to choose a steel moment frame as the primary lateral load-resisting system for the vertical expansion.

Initially, HDR employed a traditional design for these frames, but to meet inter-story drift criteria, the bases of the columns needed to be fixed at the top of the existing structure. Due to the existing column geometry and the rebar layout, it became apparent early on that fixing the bases of the columns would be difficult, if not impossible. The columns could be pinned at the base to eliminate the column moment, but pinning the steel columns increased the story drift. However, the columns were getting large and heavy, which was adding to the construction costs.

Collaborative Moment

In a fortunate turn of events, early in the structural design, the HDR structural team attended a design seminar presented by AISC associate member SidePlate, which featured the company's new all-bolted moment connection. This connection had the benefits of increasing the overall stiffness of the connection joint and eliminated a large amount of field welding.

SidePlate performed preliminary analyses of the buildings and found that with the increased stiffness of its moment connection, the column bases could be pinned on the two-story addition without a significant increase in steel weight. For the three-story addition, braced frames were used at the lowest level of steel framing, with SidePlate moment frames above. Since the connection is a proprietary design, the design team discussed the option with both the construction manager, Whiting-Turner, and the steel fabricator, North State Steel. As a group, there was agreement that the SidePlate solution with a pinned base was the best approach to providing lateral load resistance. With this problem solved, the team proceeded with the bolted moment connections.

HDR worked collaboratively with SidePlate throughout the project, creating and sharing a gravity analytical model in Ram Structural System. SidePlate determined locations, optimized frames, provided construction documents, and checked fabrication documents for the moment frames—which use W18 columns and W21 and W24 girders—thus freeing up time for HDR's structural team to focus on designing and detailing the remainder of the gravity structure and miscellaneous steel. With the project's aggressive schedule and early steel packages, this division of work sped up the structural design and the overall construction schedule.

above and below: A change in floor configuration led to a change in framing material, from concrete to steel.

above: The project used nearly 1,300 tons of structural steel for both pavilions.

below: A helipad was added to the top of Kaufman Pavilion by extending the W14 building columns above the roof and providing cap plates at the tops of the columns, on top of which the helipad framing was installed.

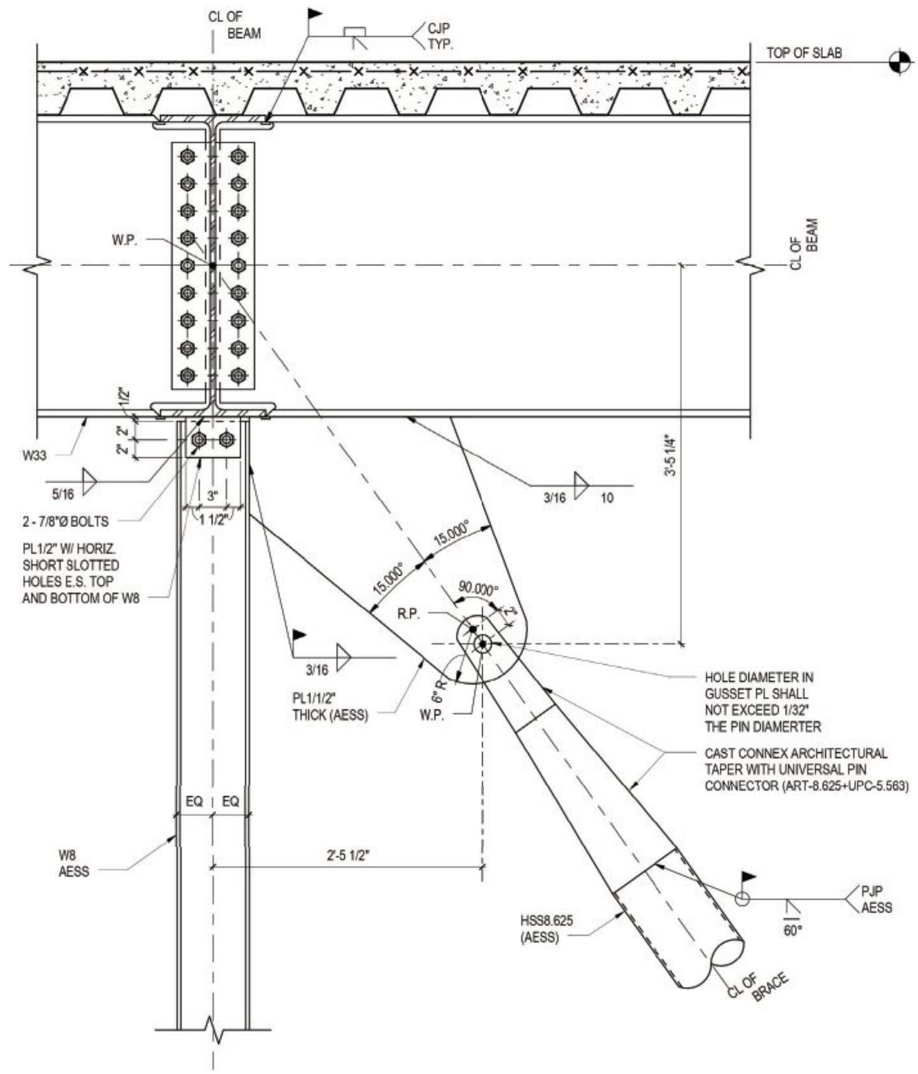
below: Steel erection progressing on both towers at Sentara Hospital.

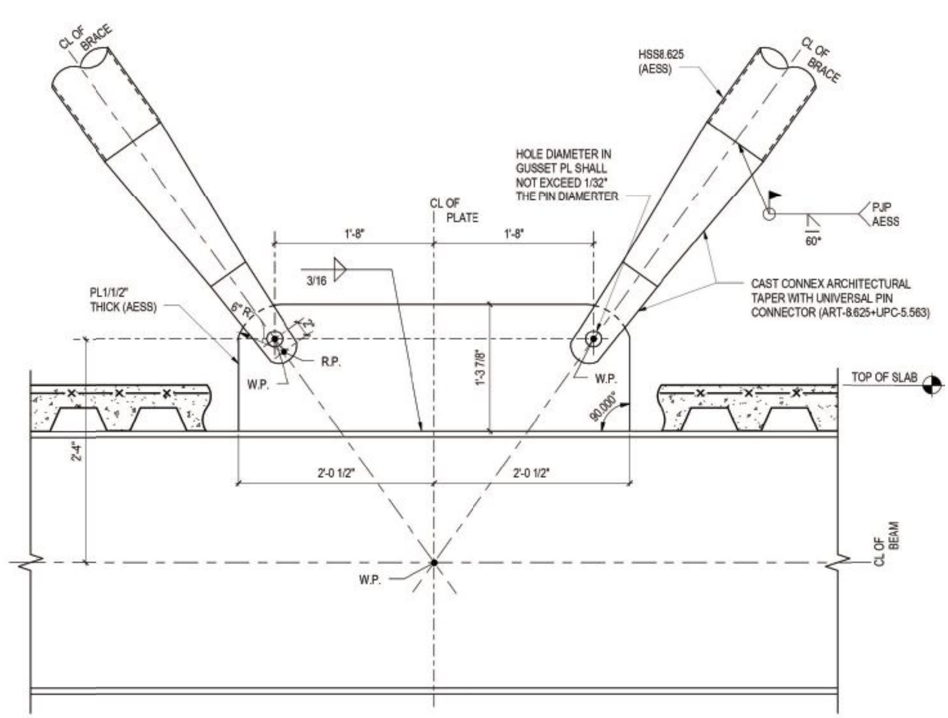
Elevating the Project

One of the most noticeable elements of the expansion is the addition of a new elevator tower for River Pavilion. The floor plan for the patient rooms required that the existing passenger elevators not continue up through the new floors, thus requiring an elevator tower to be added outside of the footprint of the existing building. This exterior elevator tower is 23 ft by 15 ft, 8 in. and is 138 ft tall. Framed with steel, it uses braced frames on three sides to provide lateral load resistance. The columns are W14×211, and the braces are HSS6×6×¼ and HSS6×6×5⁄16.

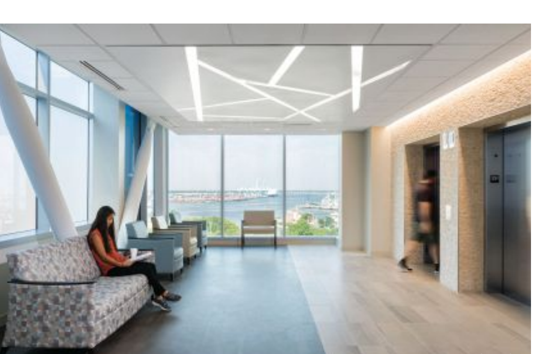
To avoid existing building foundations and site conditions, the elevator tower is placed 16 ft away from the existing building. It is also offset in plan from where the elevator lobby meets the new hospital floor plates. At levels eight, nine, and ten, W33×118 beams cantilever 16 ft, 8 in. off of the elevator tower to support the elevator lobby floors. An additional 16 ft of floor framing was required to close the gap between the elevator lobbies and the hospital floors, with a 2-in.-wide expansion joint provided between the elevator lobby and the patient tower to accommodate differential movement between the elevator tower and the hospital.

To help resist wind loads on the cantilevered elevator lobbies, a braced frame was added between levels eight and ten. This assembly, left exposed in the elevator lobby and coated with Hilti Fire Finish intumescent paint, is constructed of round HSS8.625×0.250 and Cast Connex castings at the connections to the gusset plates.



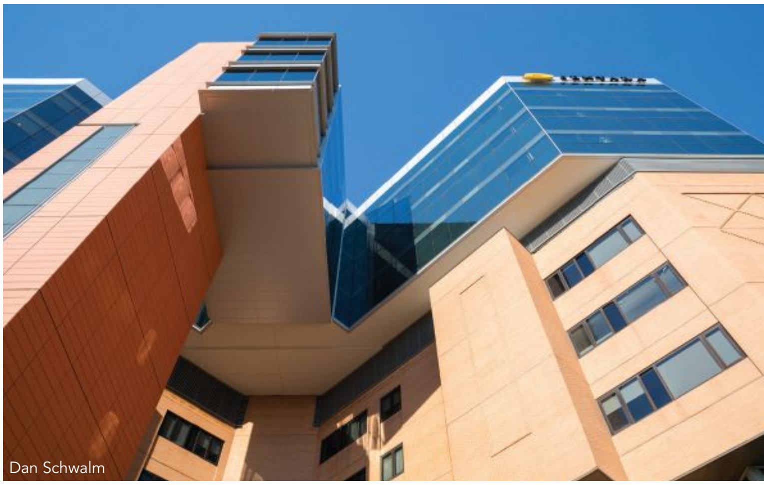


right and below: The new elevator lobby at the top of River Pavilion features an exposed braced frame made of round HSS with Cast Connex castings at the ends.



below and right: River Pavilion's new exterior elevator tower is 23 ft by 15 ft, 8 in. and 138 ft tall, and uses braced frames on three sides to provide lateral load resistance.

Randy Schroeder



Dan Schwalm

On top of Kaufman Pavilion, provisions were made to support a helipad—designed and built by FEC Heliports—by extending the W14 building columns above the roof and providing cap plates at the tops of the columns, on top of which the helipad framing was installed. The elevators were also extended up to the floor elevation of the helipad to provide dedicated service.

Although the construction was complex, close coordination between the design team, contractor, fabricator, and erector resulted in a project that caused minimal disruption to the hospital during construction and provided the facility with 180,000 sq. ft of much-needed new space. ■

Owner
Sentara Healthcare, Norfolk. Va.

General Contractor
Whiting-Turner, Roanoke, Va.

Architect and Structural Engineer
HDR, Omaha, Neb.

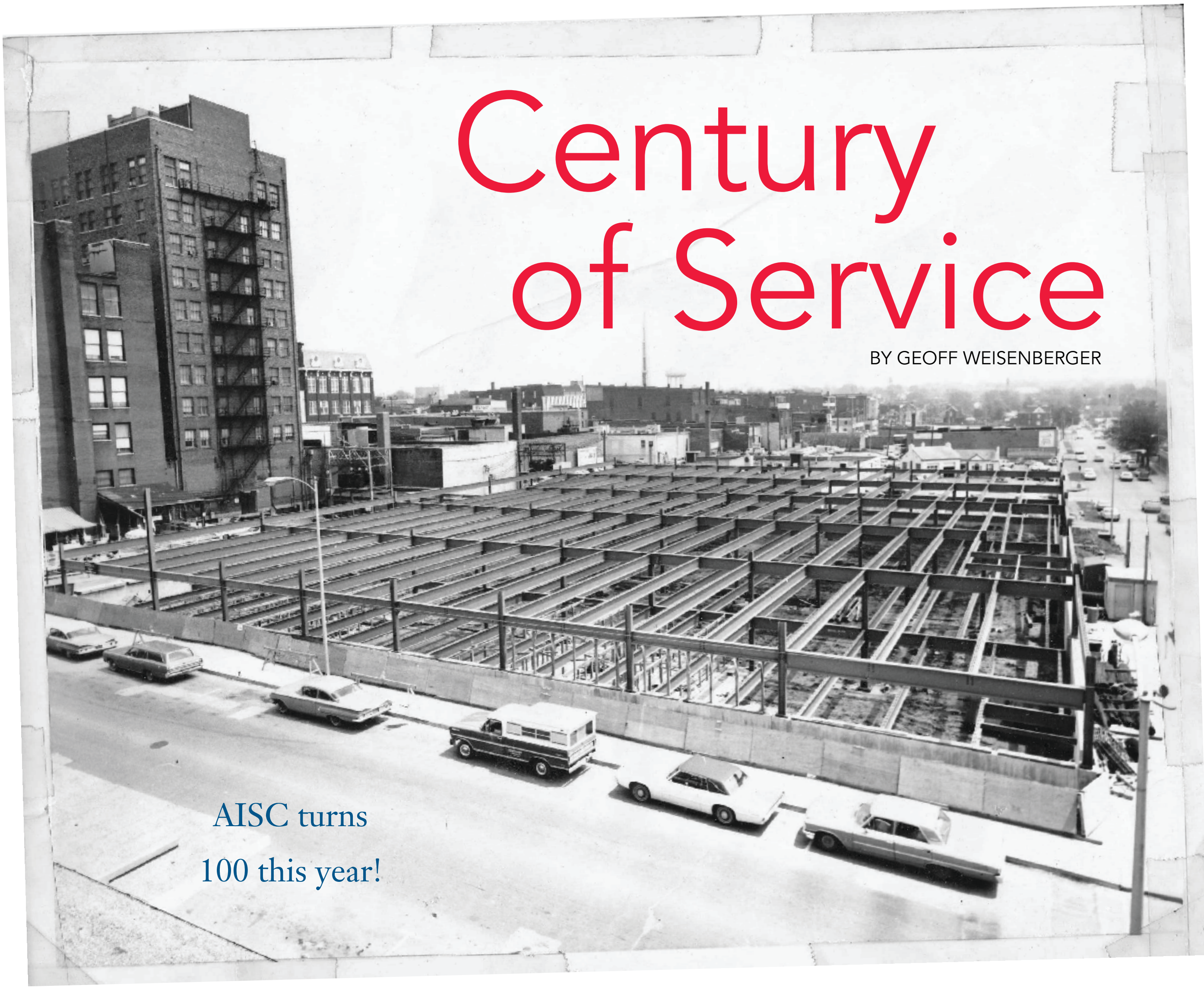
Steel Team

Fabricator
North State Steel (AISC Certified Fabricator), Greenville, N.C.

Detailer
Cistron Technologies (AISC Detailer), Mooresville, N.C.

Century of Service

BY GEOFF WEISENBERGER



AISC turns 100 this year!

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

CELEBRATING 100 YEARS 1921–2021

AMERICAN INSTITUTE OF STEEL CONSTRUCTION AISC FOUNDED 1921

AISC IS NOW IN THE CENTURY CLUB.

Established in 1921 to serve the U.S. structural steel design community and construction industry, AISC turns the big 1-0-0 this year. And in the spirit of making this a year-long celebration, we will include multiple articles related to this milestone throughout 2021 (and will post them in the "100 Years of AISC" section at **www.modernsteel.com**).

To kick off the new year, we're highlighting a member fabricator that's been in existence even longer than we have (and we'll feature other century clubbers throughout the year).

Answers provided by Laura Gerdes Ehrhart, president of ***Michelmann Steel Construction Company*** *in Qunicy, Ill.*

How and when did your company start?

Our company was started in 1865 by my great-great-grandfather, J.H. Michelmann. He came to the U.S. from Prussia at age 23 and started working in Evansville, Ind., for a boilermaker named Valentine Stegemueller. Stegemueller moved to Quincy, Ill., in 1855 and J.H. moved with him. In July of 1865, J.H. bought a small boiler and tank shop from Stegemueller. J.H.'s son Henry joined him in the business, which was called the Michelmann Boiler Company, marking the beginning of the present-day Michelmann Steel Construction Company. J.H.'s son-in-law, William F. Gerdes, Sr., joined the company in 1903, bringing with him ten years of experience with Union Iron and Foundry in St. Louis. Under Gerdes' direction, the company switched its focus from boilers to fabricated structural steel and was incorporated and changed its name to reflect the new line of business. I am the fifth generation of the founding family to run the business (and the first woman).

Michelmann has been able to weather challenges for well over a century. How has this helped you weather the current pandemic?

I think past experiences have been a great help to us in weathering the COVID-19 pandemic. Personally, I think the economic downturn of 2008-2009 taught me the most about weathering a crisis. We changed our whole business model at that time to focus more on relationships that brought us work we didn't have to bid on rather than bidding in the competitive open market. And we focused on quality, on-time delivery, customer service rather than trying to be the lowest price. We didn't let any employees go, but we didn't hire any new ones either, and at one point we went from 30-plus employees to only 18. We learned to work together to get the job done, whatever it took. So I think the economic downturn taught us to be flexible and adaptable. And that lesson has served us well during the pandemic.

What's the best business advice you've received from, or an anecdote involving, past leadership at the company?

Our favorite anecdote has to be J.H. Michelmann's work rules (see "Built to Last" in the September 2016 issue), which are a bit antiquated and fun to read by today's standards. I think the most important thing my dad (William F. Gerdes III) taught me was to focus on the people—employees, customers, vendors. Everything else takes a back seat to people. If you have good people and good relationships with those people, everything else will come together. Another thing Dad liked to stress was "thinking outside of the box." He even had a little award made up for it. He valued creativity, ingenuity, and trying to find new and better ways of doing things. He was also very frugal. If you left your desk for even five minutes, you would come back to find your desk lamp and other things turned off.

How long has your company been involved with AISC and taken advantage of its resources?

The company became a member in 1924. We have certainly been involved with AISC for my whole career, which started when I worked at the company during the summers in the early 1980s. We have always found AISC to be a valuable ally and a great cheerleader for the business of fabricated structural steel. ■

opposite page: A parking garage fabricated by Michelmann and built in Quincy, Ill., in 1969.

below: The recently opened Blessing Hospital Medical Office Building, another Michelmann project in Quincy.

A Century (and then some) of Service

These AISC member fabricators have been in business for a century or longer. If you happen to know of another 100-year-old fabricator, email Carly Hurd at **hurd@aisc.org**.

- A Lucas and Sons, Peoria, Ill.
- ArcelorMittal Plate, Coatesville, Pa.
- Art Iron, Inc., Toledo, Ohio
- Atlas Iron Works, St. Louis
- Buffalo Structural Steel Construction Corp., Amherst, N.Y.
- Central Texas Iron Works, Waco, Texas
- Garbe Iron Works, Inc., Aurora, Ill.
- Geiger and Peters, Inc., Indianapolis
- Herrick Steel Stockton, Calif.
- Huntington Steel and Supply, Huntington, W.V.
- LaSalle Iron Works, St. Louis
- LB Foster Fabricated Bridge Products, Pittsburgh
- McGregor Industries, Inc., Dunmore, Pa.
- Michelmann Steel Construction Company, Quincy, Ill.
- Paxton and Vierling Steel Co., Carter Lake, Iowa
- Ralph H. Simpson Company, Elmhurst, Ill.
- Reno Iron Works, Reno, Nev.
- Romak Iron Works, Benicia, Calif.
- Salem Steel, Winston-Salem, N.C.
- Sioux City Foundry Co., Sioux City, Iowa
- Standard Iron Works, Scranton, Pa.
- Stein Steel, Atlanta
- Stupp Bros., Inc., St. Louis
- The Tarrier Steel Company, Columbus, Ohio
- The Berlin Steel Construction Co., Kensington, Conn.
- Woerner Wire Works, Omaha
- Wyatt Resources, Inc., Fulshear, Texas
- Zalk Josephs Fabricators, LLC, Stoughton, Wis.

Complexity, Simplified

BY TERRI MEYER BOAKE

How do you keep a complex exposed steel project from becoming overly complicated? Go back to the basics.

Terri Meyer Boake (**tboake@uwaterloo.ca**) is a professor in the School of Architecture at the University of Waterloo in Waterloo, Ontario, Canada.

THERE IS AN INTRINSIC CONNECTION between advances in computing technology and the evolution of complexity in architectural design.

This encompasses all facets of design, drawing, calculation, and production. So it's no surprise that the increase in complexity of steel structural systems has followed along quite tightly with the evolution of computing systems since the last five decades.

The majority of these more complex steel structures are aesthetically driven. If a visual product is the end goal, then we can begin to entertain a variety of means to achieve this. Recalling the primary driving factor behind the methodology for specifying architecturally exposed structural steel (AESS)—the distance factor—we can begin to formulate modified fabrication strategies to reach a satisfactory solution. And we can achieve the goal of a complex, attractive project without driving the budget over the top.

Complex Typologies

Complexity can be defined as the state or quality of being intricate or complicated. By applying this notion to steel structures, we are referring to those systems that deviate from the standard orthogonal structural systems that typified most 20th century buildings. The perception of complexity has changed over time—from complex in appearance (high-tech) to complex in actual configuration (deconstructivism)—as has its relationship to structural steel design.

Complex steel structures can be examined as typologies that can lead to more cost-effective methods for aesthetically satisfying solutions. These would include structures with a focus on multiple member types, angularity (eccentric loading), curvature, chaos, castings, and a high level of custom fabrication.

Economically Driven Strategies

Here, we'll look at a range of strategies that could be classified as AESS 2 (feature elements not in close view) or AESS 3 (feature elements in close view) approaches. As indicated, these include "feature" steel at varying viewing distances but exclude AESS 4 (showcase elements) projects that require high levels of weld remediation and contour blending of custom fabricated members intended to be viewed at a very close distance. (See "Maximum Exposure" in the November 2017 issue, available at **www.modernsteel.com**, for more detail on the various AESS levels.)

The distance factor. The overall strategy behind the category system for specifying AESS is to allow the distance to view to soften the fabrication requirements for the steel. If a surface or element is situated further than 20 ft from view, it is unlikely that the viewer will either be able to see or appreciate fastidious detailing. This distance applies in all directions and holds true for multi-story atrium spaces, for instance—and this can be advantageous when designing complex structures, as there is no need to design beyond AESS 2 when detailing atrium roof structures. While AESS 3 should be used for the supporting elements that are close to view, giving the impression to the viewer of a more fastidious overall level of detailing, the detailing of the systems at height can be softened and might include standard hollow structural sections (HSS) or wide-flange members, simpler bolted connections, and un-remediated welds.

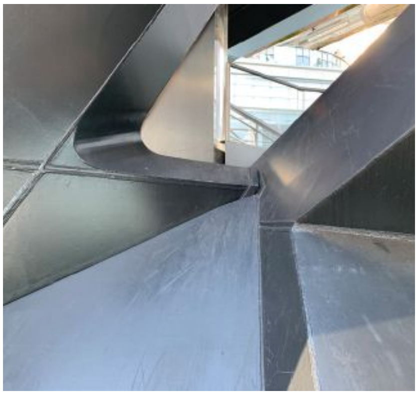

All photos: Terri Meyer Boake

The complex steel structure at Tokyo Midtown applies a hierarchical system of detailing. The tree-like columns use custom bending combined with the use of plate steel to create the tapering branches. A close view of the upper-level truss reveals that the member selection of the lower (white) portion of the truss makes use of discreet bolted and typical space frame nodal connections. The temporary bolt tabs at the tops of the branches have been cut tightly to the tubes but not remediated because of the distance to view. Dark gray-painted steel supports the skylight, making use of standard orthogonal connection details.

Semi-exposure and the use of screen elements. The idea of layering via the use of screens or semi-transparent membranes located in front of the structural system is an approach that can achieve a unique presentation of complex steel. The structure is viewable through the screen, albeit often in a near-silhouette situation. The fabrication and material requirements for the screen and the structure can be clearly separated. The limited exposure of the steel allows for a reduction in the AESS fabrication requirements. The detailing of the primary support structure sitting behind the screen can be substantially softened. Even if in partial view, there is little point to fabricating beyond AESS 2. This will preclude extensive on-site welding and favor more simple bolted connections. In exterior applications, the attachment systems must be designed for corrosion resistance and to preclude places for water and snow to puddle. Clean lines in the overall finished form become that much more important.

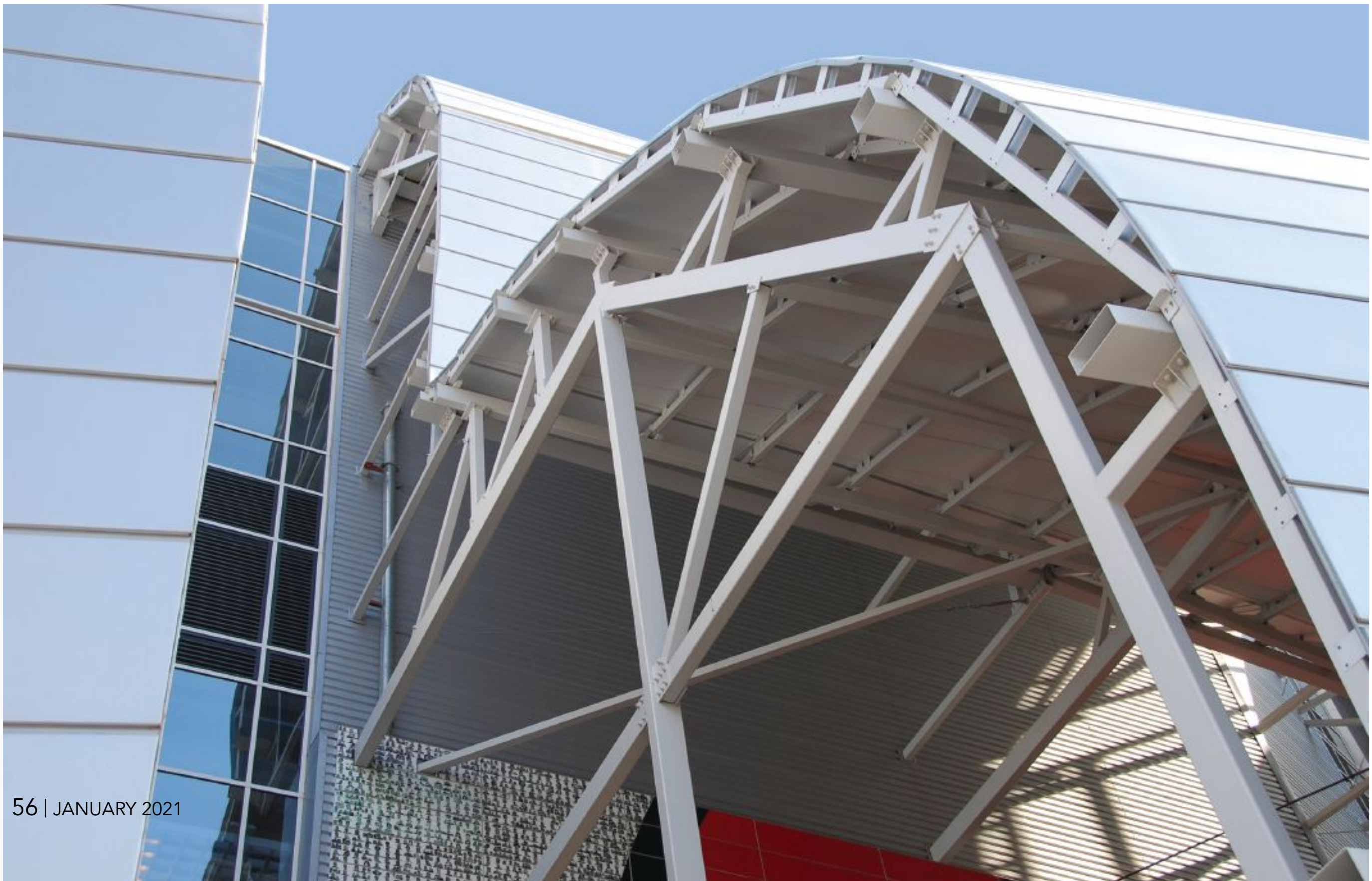
A fine aluminum screen covers the galvanized steel frame at Caltrans District 7 Headquarters in Los Angeles, providing shading for the façade. The silhouette of the steel can be seen and in certain places, the screen is removed to completely expose the rugged steel frame. Here, the system is manipulated to create an oversized street number as iconic signage for the building. The overall design of the frame has clean, organized lines, but the connection detailing doesn't need to exceed AESS 2.

Making the steel recede. In a similar vein to the idea of using screens, adjacency to other elements may be used to shift the focus away from exposed supporting steel, thereby allowing its fabrication detailing to be softened. The viewer's eye will be drawn to a more finely detailed and polished part of a project to the point where the structural support system, though clearly visible, takes a visual back seat. This is different from the "distance to view" strategy, as the steel may actually be very near to view and touch.



There is no denying the important role that the modular steel support system plays in the creation of the iconic Vessel at Hudson Yards in New York. However, it is the reflective copper cladding on the exterior, not the steel, that takes center stage. Even though much of the interior view is comprised of the gray walking surfaces and the steel frame, the frame itself is hidden in the shadows and recedes from view. This has allowed for the use of extensive unremediated welds, as well as exposed bolts in some areas. Given its nearness to view and use of welding, custom plate steel, and curved steel, the structure did not need to be completed to AESS 4 requirements.

Although State Farm Stadium (formerly University of Phoenix Stadium) in Phoenix, home to the Arizona Cardinals, gives an impression of curvature when viewed from a distance, in actuality there is not a single curved member in the project. The main structural frame is comprised of straight elements, and smaller sections are used to build the frame out to approximate a curve. This has allowed the use of a flat cladding system that easily follows horizontal lines of implied curvature, thereby creating economy in the structure and the cladding system. (The project was a 2007 AISC IDEAS^2 winner; see the May 2007 issue at **www.modernsteel.com**.)

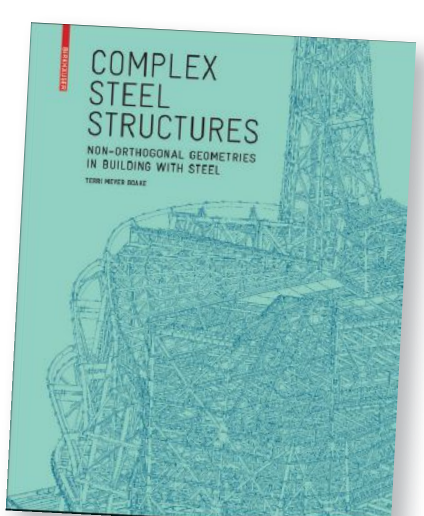


Faking the curve. Bending and curving steel remains a largely hand-crafted process, adding to the cost of the contract. When curving becomes central to the aesthetics of the project, it is sometimes necessary to question whether or not the viewing distance, sheer scale, or nature of the project requires actual curvature, or whether the elements can be faceted. (And to be clear, there are plenty of situations where curved steel members can and should be used.)

Recalling that the design is driven by aesthetic intent, it may be possible to use straight segments of structural steel to achieve an impactful impression of curvature. The overall scale of the form, surface, or structure may be large enough or distant enough to effectively use straight members to create segmented or approximated curves. This can also allow the use of planar cladding materials as these, too, tend to be more expensive if manufactured and installed with true curvature.

As you can see (regardless of viewing distance) it is possible to break down the aesthetic aims of complex steel structures in a way that supports the overall project intentions—often and perhaps ironically—by addressing simple factors like viewing distance, building scale, and intended use. In short, you *can* keep your complex structures simple. ■

This article summarizes information in Terri's new book *Complex Steel Structures: Non-orthogonal Geometries in Building with Steel*, published by Birkhauser. The book also provides extensive information on more refined approaches to designing curved, angular, and chaotic structures, as well as a closer look at the impact of nodes and castings on contemporary complex steel design.



Design-Assist: What It Is, Why It's Beneficial

BY EDWARD SEGLIAS

A new paper created by AISC and AIA clarifies newer approaches to project delivery, such as design-assist, that can result in more efficient steel projects.

Edward Seglias (**eseglias@cohenseglias.com**) is an attorney with Cohen Seglias and is AISC's general counsel.

WE LIVE IN A WORLD of ever-increasing complexity, and there is little prospect of that changing.

As such, adaptation, innovation, and collaboration are essential to producing more favorable outcomes in virtually every commercial activity.

In the construction industry, one of those efforts is the addition of design-assist to the list of contracting delivery formats. But as with many innovations, the initial roll-out of the design-assist concept did not come with a playbook or even a meaningful definition of the term. Instead, the industry had only a vague idea of what design-assist entailed and how it worked.

Collaborative Effort

My friend and predecessor as AISC's general counsel, David Ratterman, Esquire, with Stites and Harbison, was early to recognize this gap and recommended to his counterpart at the American Institute of Architects (AIA) that they form a task group to develop written materials to delineate the concepts of design-assist and delegated design. The idea was to provide a better understanding of the duties and responsibilities of interested parties under these two important project delivery formats and how they differ in both application and expectation. It took a few years, but David's leadership on this effort has now materialized into a comprehensive and important paper recently published jointly by AIA and AISC: *Design Collaboration on Construction Projects Part I: Delegated Design, Design Assist, and Informal Involvement—what does it all mean?* The paper not only provides clear descriptions of design-assist and delegated design (as well as informal involvement) but also identifies specific responsibilities between design professionals and collaborating constructors to minimize areas of contention that may later arise due to erroneous assumptions about who owns what responsibilities, or worse, who is liable for a loss or failure.

So what is design-assist, and what does it mean for a steel fabricator? Under Part 1 of the paper, design-assist is described as "a form of collaboration where a contractor provides information to assist a design professional's design, typically before pricing for the work has been agreed upon or before the work has been awarded."

The paper further states that while the design professional typically will have a separate written contract with the owner, the contractor still may incur contractual liability (whether to an owner or GC) for the information it provides. But the concept of design-assist also holds that the design professional is ultimately responsible for incorporating the contractor's information into its design, and that it maintains professional responsibility for the overall design. So although there is a clear obligation to the contractor or steel fabricator to provide accurate information for the benefit of the project design, it also is true that if the information so provided is used by the design professional to inform its design, the design professional is still responsible for integrating the information into the design and resolving any design conflicts that may occur.

Contractor Insight

Now that the scary part of design-assist has been addressed, let's consider its core benefit. A key underpinning is that contractors possess a wealth of experience planning and implementing the construction of systems, building materials, and other tangible forms of design on multiple types of projects. And design-assist allows you to take advantage of that experience in the pre-construction phase, where the design is still being developed and costs are not yet being incurred. While this makes good business sense and the paper acknowledges this benefit, it also recognizes that the collaborating contractor must be compensated for its design input under a written agreement, with the expressed recognition that design-assist is not a delegation of design responsibility.

The paper also identifies the types of services that might be included in such a written agreement. For example, a collaborating contractor may:

- evaluate alternative design solutions and constructability
- collaborate with the design team to suggest improvement to design elements
- suggest modifications to the specification
- prepare cost estimates for a specified scope of work
- prepare scheduling requirements
- validate the proposed design from a construction standpoint
- assist the design professional in developing a design that brings the highest value

While these services are somewhat general given the nature of the paper, there is currently one form document written by the Consensus Docs Coalition (541 Design-Assist Addendum) to coordinate efforts of design professionals, construction managers, and trade consultants in the design development phase. Other project-specific templates have been written by practitioners to identify the services sought in the pre-construction design phase. But a careful review of such documents is always required to ensure that they reflect the expectations of the parties as clearly and expressly stated.

Currently, a committee within AISC is preparing a draft of Part 2 of the design-assist publication, which will specifically address circumstances involving the work of structural steel fabricators. But until that effort is completed, Part 1 will ably serve our industry's interest by providing guidance and advice on the evolving concept of design-assist, determining whether it's right for an upcoming project, and, if so, how to effectively implement it. ■

If you want to learn more about design-assist and its benefits, you can access Design Collaboration on Construction Projects Part I: Delegated Design, Design Assist, and Informal Involvement—what does it all mean? *for free at* ***aisc.org/design-collaboration-aia****. And if you have any questions about it, email me!*

new products

Welcome to *Modern Steel's new* New Products page! Every month, we'll feature a handful of product, tool, machine, service, and software offerings for the steel design and construction industry. This month's products focus on material labeling, bolt capping, and worker comfort.

InfoSight PermaFlex

PermaFlex™ is the newest metal identification tag in the PermaLabel™ family of scratch-proof metal tags. It combines all of the durable properties and resistance of PermaLabel with the added benefit of a flexible tag that can conform to curved surfaces. Since the tags retain their shape once curved, they can be attached to curved surfaces as small as 1-in. in radius. Tag sizes are 3 in. wide and range from 0.75 in. to 6 in. long and can be printed with InfoSight's mill duty LabeLase™ Laser Metal Tag Printers.

For more information, visit **www.infosight.com**.

Typhoon Performance Products Bolt Caps

Bolted connections in multistory steel frames and structures have been an Achilles heel when it comes to fire resistance. Bolt caps have displayed consistently high performance in testing against common fire threats. The bolt cap with a mechanical tap on the fixing is available as the standard product, and bolt caps with a screw-fix system are also available. A further variant, currently in development, will incorporate anti-corrosive properties in addition to fire protection. The cap provides a quick-fit engineered solution and indefinite shelf life, and bolts require no special preparation before application and can be installed in any weather.

For more information, visit **www.typhoonproducts.com**.

NoSweat Hard Hat Liners

NoSweat is a disposable moisture-wicking hard hat liner whose patented SweatLock Technology is engineered to instantly absorb sweat, keeping it out of the wearer's eyes and allowing them to focus on their work without the need to constantly wipe sweat away. It also reduces fogging in glasses, face shields, and other protective eyewear, helps prevent sweat stains on headwear, reduces odor, and is comfortable and hypoallergenic.

NoSweat performance liners easily stick inside any hat, visor, helmet, or hard hat. Application is easy: peel it, stick it, no sweat!

For more information, visit **www.nosweatco.com**.

AISC NEWS

AISC Announces Two New Vice Presidents

Brian Raff has been named AISC's new vice president of market development, and Carly Hurd has been promoted to vice president of operational engagement.

"I'm excited to recognize Carly and Brian, who have made key contributions to advancing AISC's mission to increase the use of domestically fabricated structural steel," said AISC president Charles J. Carter.

Raff will lead a team of steel building and bridge specialists located throughout the U.S. to help architects, engineers, contractors, and structural steel fabricators in their work designing and building steel structures. From facilitating communication between designers and fabricators to helping to educate the A/E/C community about innovative steel systems, AISC's market development group is focused on increasing steel's share of the construction market.

Raff first joined AISC in 2005 as manager of certification business development and was later promoted to marketing director of the National Steel Bridge Alliance (NSBA). He left AISC in 2014 to take a job with the Canam Group but returned to AISC in 2017 as director of government affairs and later added director of communications to his resume. He also previously worked as a structural engineer at OWP/P (now CannonDesign) and Thornton Tomasetti.

"AISC has been my North Star with respect to steel design and construction, and I hope to make it the same for everyone that interacts with us as an organization," said Raff.

Hurd, formerly AISC's director of membership, has been promoted to the newly created position of vice president of operational engagement. "Carly's new role will help advance the steel industry by building stronger connections within the work we do for our industry and the design community and also to our members, volunteers, and the entire A/E/C community," Carter explained.

Hurd, a graduate of Western Michigan University, joined AISC in 2006 as a membership services assistant, rising up to membership services manager before becoming director of membership in 2008. She has been responsible for developing and managing AISC member recruitment and retention efforts, as well as membership administrative functions, full member education, and the sponsorship program for the Student Steel Bridge Competition. She also acts as a liaison between AISC and regional fabricator associations.


Brian Raff


Carly Hurd

"I'm excited for this opportunity to help strengthen our organization and industry," she said. "I know cooperation and coordination can help us achieve amazing things."

IN MEMORIAM

Lewis Burgett, Former AISC Associate Director of Education, Dies at 92

Lewis "Lew" Bradford Burgett, whose career at AISC spanned nearly three decades, passed away on November 6 at age 92. Born in Guntersville, Ala., Burgett played football at East Mississippi Junior College, then graduated from Auburn University with a degree in civil engineering. He went on to earn his master's degree from the University of Tennessee, worked at the TVA for a few years, and met and married JoAnn Noah. In 1958, he joined NASA, where his projects included launch pads and the Vertical (now Vehicle) Assembly Building at Kennedy Space Center.

Burgett began his career at AISC in 1970. His first role was as a regional engineer in Syracuse, N.Y., followed by stints in Memphis and Charlotte. Next, he served as AISC's southern regional engineer and southeast regional manager in Atlanta before becoming associate director of education. In the latter position, which he held until his retirement in 1998, he was responsible for preparing and presenting lectures on steel design, and answering technical questions. He averaged more than 30 presentations per year, traveling at least twice per month. It was that direct contact with practicing engineers that he found most rewarding.

"The challenge of this job is the preparation and presentation of lectures that will convey some ideas and methods to the practicing engineer that will improve him or her as a professional," he said upon his retirement. (For more on Burgett's career, see his retirement announcement in the June 1998 News Briefs, available in the Archives section at **www.modernsteel.com**.)

"At home, he coached T-ball, led Boy Scouts, and taught us how to ride a bike, hit a baseball, and throw a football," recalled his daughter, Amy. "But most of all, he loved our mom."

Burgett is survived by his children, Amy and Bradford, and his grandchildren, George, James, Todd, JoAnn, and Molly Jean Hughes.

SCHOLARSHIPS

AISC Awards Emergency Scholarships to 39 Students

Since the spring, AISC has been hearing about how the Coronavirus pandemic has affected students and the extreme financial challenges they have been facing. The stories are all too often the same: carefully planned budgets that were turned upside down, paid internships and campus jobs that disappeared, parents who lost their jobs and could no longer contribute to their children's educational expenses, savings accounts that have been depleted, and new, unexpected expenses like at-home high-speed internet or upgraded computers to run sophisticated design and analysis programs since computer labs are closed. All of this is being shouldered by students that already face skyrocketing tuition costs.

AISC made a plan to help. In September, on behalf of the AISC Education Foundation, a fundraising campaign was launched to raise money that could be immediately provided to students in the form of emergency scholarships. By the end of October, a total of $83,500 was raised to be awarded in time for the 2020-2021 winter/spring term.

AISC offers our sincere thanks to all of those who donated and provided support to students in their time of profound need. The AISC Education Foundation continues to accept donations in order to expand our scholarship programs for the upcoming 2021-2022 academic year to further help with these ongoing challenges. If you wish to contribute, please visit **aisc.org/giving**.

Congratulations to the following 39 deserving AISC Scholarship recipients for the January 2021 term.

$500 Award Recipients

- Tayoshe Aluko, *Senior*, Johns Hopkins University
- Elizabeth Laughlin, *Junior*, Clarkson University
- Awoenam Mauna-Woanya, *Master's*, Stanford University
- Cooper Morris, *Senior*, University of Memphis
- Trinity Schaefer, *Junior*, University of Texas at San Antonio
- Niyam Shah, *Master's*, University of Texas at Austin
- Natasha Vipond, *Master's*, Virginia Tech

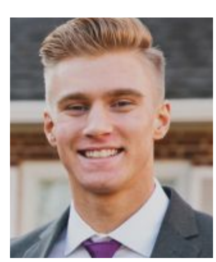


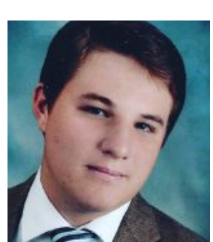




$2,500 Award Recipients

- Amanda Anderson, University of Massachusetts Amherst
- Zachary Baker, University of Minnesota – Twin Cities
- George Beck, Illinois Institute of Technology
- Casey Boyle, Cal Poly, San Luis Obispo
- Spencer Browne, University of Arizona
- Luke Calabrese, Rose-Hulman Institute of Technology
- Nichole Criner, University of Cincinnati
- Michael DePiero, University of California, Berkeley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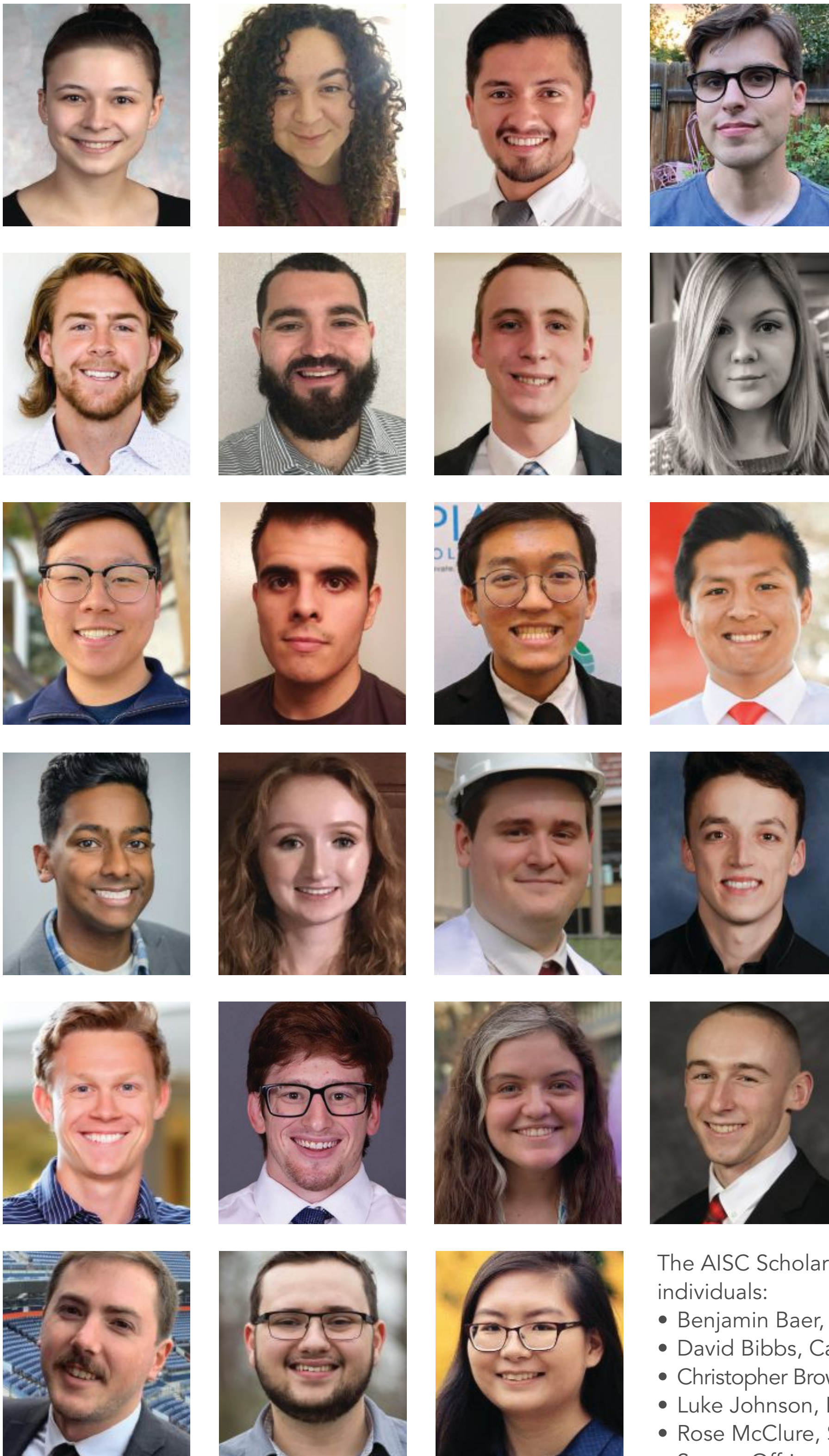
$2,500 Award Recipients



- Kathryn Ebert, Milwaukee School of Engineering
- Emma Fuentes, Angelo State University
- Roberto Furlan, University of California San Diego
- Benjamin Garrett, Metropolitan State University of Denver
- Thaddeus Hansen, Utah State University
- Anthony Kantzabedian, Colorado School of Mines
- Bryce Katen, John Brown University
- Katrina Knudsen, City College of New York
- Ezra Lee, University of California San Diego
- Iran Mejia, University of Texas at Arlington
- Elton Nguyen, Georgia Institute of Technology
- Adrian Porras, University of Utah
- Wakil Pranto, University at Buffalo
- Elisabeth Roberts, Marshall University
- Markus Rocca *(not pictured)*, University of California San Diego
- Devin Schmidt, Santa Clara University
- Vlad Slivkov, Oregon State University
- Mark St. Pierre, Jr., University of Arkansas-Little Rock
- Jake Stogdill, Colorado School of Mines
- Julia Szabla, Northeastern University
- Zachary Tate, Rose-Hulman Institute of Technology
- John Wood, Metropolitan State University of Denver
- Marc Woods, John Brown University
- Alexandra Zhao, University of California, Berkeley

The AISC Scholarship jury consisted of the following individuals:

- Benjamin Baer, Baer Associates Engineers, Ltd.
- David Bibbs, CannonDesign
- Christopher Brown, formerly of Skidmore, Owings & Merrill, LLP
- Luke Johnson, ECS Limited
- Rose McClure, Simpson Gumpertz & Heger
- Steven Offringa, EXP
- Kristi Sattler, AISC
- Matthew Streid, Magnusson Klemencic Associates

news & events

ENGINEERING JOURNAL

First Quarter 2021 *EJ* Now Available

A new year means a new quartet of AISC *Engineering Journals*, and the first quarter issue is now available. (You can access this issue, as well as past issues, at **aisc.org/ej**.)

Discussion: Investigation on the Performance of a Mathematical Model to Analyze Concentrically Braced Frame Beams with V-Type Bracing Configurations
Charles W. Roeder, Dawn E. Lehman, Qiyang Tan, Jeffrey W. Berman, and Andrew D. Sen

AISC Provisions for Web Stability under Local Compression Applied to HSS
Fei Wei and Jeffrey A. Packer

The relevant limit states for local compression loading on the webs of a rectangular HSS member are reviewed, and the Chapter J provisions in the 2016 *AISC Specification for Structural Steel Buildings* (ANSI/AISC 360, **aisc.org/specifications**) are adapted from their normal application to the single web of a W-shape or I-section to this case. Two recent laboratory tests on matched-width, rectangular HSS-to-HSS cross-connections are described to illustrate the behavior of such connections under branch axial compression. The data from these tests are supplemented by experimental results from a further 76 cross-connection tests, with the branches being either welded plates or welded HSS.

Critical Temperature of Axially Loaded Steel Members with Wide-Flange Shapes Exposed to Fire
Ana Sauca, Rachel Chicchi, Chao Zhang, and Lisa Choe

This paper presents closed-form equations that were developed to evaluate critical temperatures of structural steel compression and tension members exposed to fire. The deterministic approach involved a parametric study using finite element simulations in order to identify influencing factors—for example, mechanical properties of steel, member slenderness, and axial load ratios. Statistical models were employed to develop closed-form equations representing the best fit of numerical results.

Design for Local Member Shear at Brace and Diagonal-Member Connections: Full-Height and Chevron Gussets
Rafael Sabelli and Brandt Saxey

Large local member shear forces develop in beams in chevron-braced frames due to the delivery of brace forces to beam flanges, which are at a distance from the beam centerline (Fortney and Thornton, 2015, 2017; Hadad and Fortney, 2020). Using the "lower bound theorem" (Thornton, 1984), Sabelli and Arber (2017) developed design methods to address this local member shear by optimizing the internal stress distribution and thus maximizing the resistance used in design.

NASCC

NASCC To Go Virtual for Second Straight Year; Registration Opens Soon

The 2020 NASCC: The Steel Conference didn't go quite as expected—but it was still a success. Like everything else in 2020, the conference went online.

AISC has made the difficult decision to hold the 2021 conference—taking place April 12–16—online as well. While it is disappointing to miss an in-person NASCC for the second year in a row, the good news is that last year's online version went as well as could be expected, and we all made the most of it. The 50-plus online sessions were packed, some of them bringing in more than 1,500 attendees.

Online or in person, NASCC is your once-a-year opportunity to learn from leading experts in the steel community and earn PDHs. Also included are multiple conferences within a conference: the World Steel Bridge Symposium, QualityCon, the NISD Conference in Steel Detailing, and Architecture in Steel. One low registration fee gains you access to all of these conferences/sessions, the keynote sessions, and the (virtual) exhibition hall.

For more information and to register, visit **aisc.org/nascc**. We hope to see you this coming April—online!

People & Companies

Walter P Moore's board of directors has appointed three new senior principals and nine new principals to the company's leadership team. The new senior principals are: **Lee Anne Dixon**, director of operations/Infrastructure in the company's Houston office; **Abhijit Shah**, country managing director with Walter P Moore India; and **Aaron White**, director of digital practice/Structures in the Tampa office. The new principals are: **Santiago Bonetti**, design Manager/Structures in the Washington, D.C., office; **Heather Guillen**, team director/Infrastructure, in the Houston office; **Al Hajka**, director of civil engineering/Civil Engineering Martinez Moore Engineers in Austin; **Jonathan Hurff**, project manager/Structures in the Atlanta office; **Soheil Mohammadi**, senior specialty structural engineer/Structures in the Los Angeles office; **Matthew Rechtien**, general counsel in the Houston office; **Melissa Shea**, project manager/Structures, in the Washington, D.C., office; **Susan Turrieta**, managing director/Infrastructure in the Austin office; and **Tom Yost**, project manager/Structures in the Denver office.

Lincoln Electric Holdings, Inc., announced that **Steven B. Hedlund** will serve as executive vice president and president of both the Americas Welding and International Welding segments. Regional presidents in the Americas, EMEAR, and Asia Pacific will report directly to him. In this newly expanded role, Hedlund will lead the welding segments' Higher Standard 2025 Strategy initiatives to advance growth and enhance margin and return performance.

marketplace & employment

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STRONG SUPPORT

A POINT-SUPPORTED CURTAIN WALL at the new UCHealth orthopedic and sports medicine center in Englewood, Colo., mimics the strength and tension testing that takes place at the facility.

The left portion of the entrance to the steel-framed building—which houses an advanced orthopedic clinic, physical therapy and rehabilitation spaces, imaging services, training and technology areas, and a surgery center—features an open-air roof supported by HSS12×6×¼ beams spaced at 5 ft O.C. spanning through the opening. The members are clad with metal panels, allowing for more light to pass through the glass at the main entrance and atrium. The point-supported glass around the curved atrium façade added significant point loads to the roof framing due to the tension in the wall system's vertical cables, thus requiring considerable coordination between structural engineer Stewart, architect BSA, glass manufacturer Novum, general contractor Haselden, and AISC member steel fabricator Puma Steel. Thanks to this effort, the team was able to locate the beams above the cable supports and provide sufficient stiffness for the cables once they were tightened. Had adequate stiffness not been provided, significant deflection could have resulted in insufficient tension in the cables—an "injury" that would potentially require the building to undergo its own rehabilitation.

Want to learn more about the project? Watch for next month's issue, available February 1, at **www.modernsteel.com**. ■