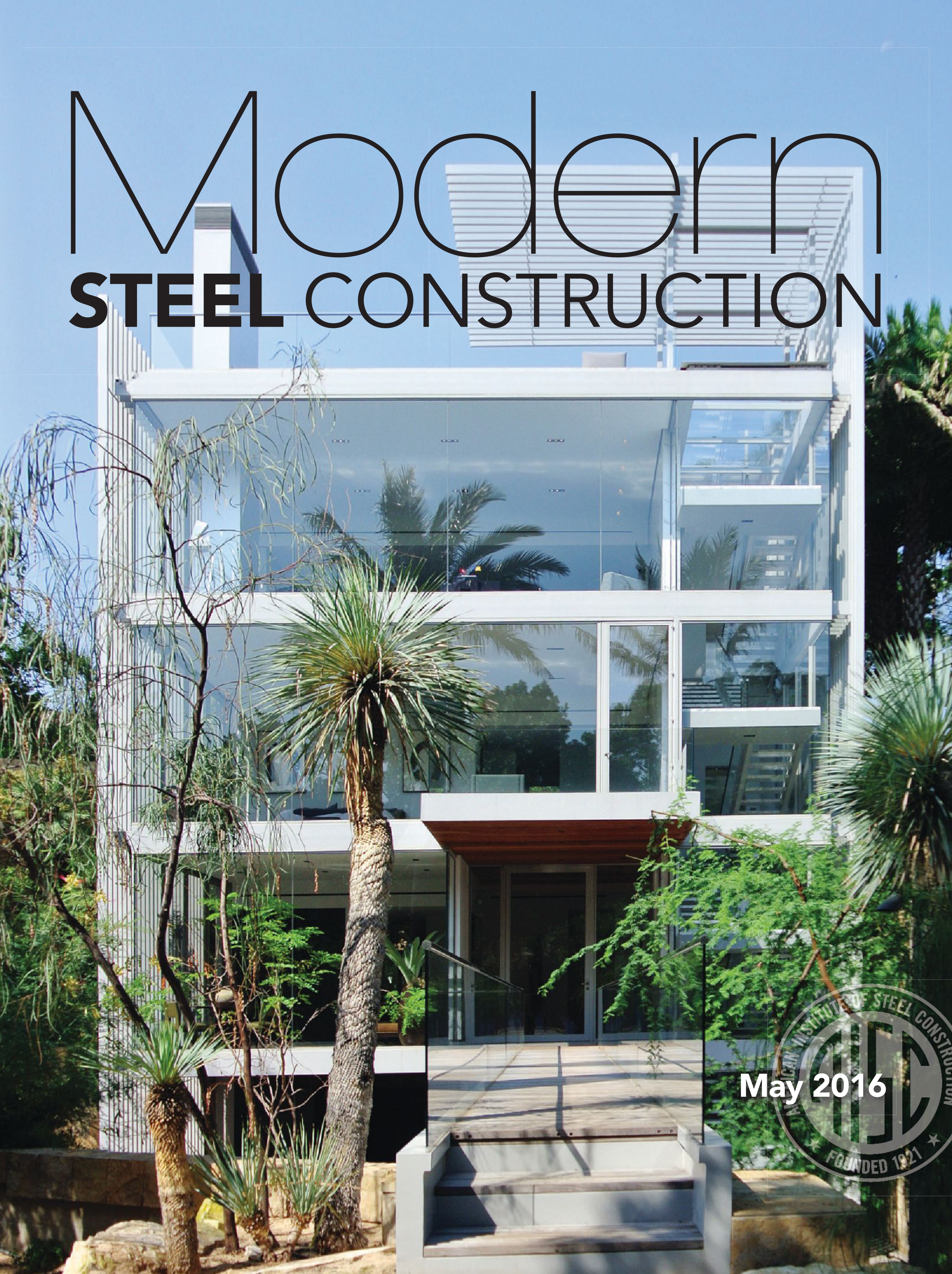
Modern STEEL CONSTRUCTION



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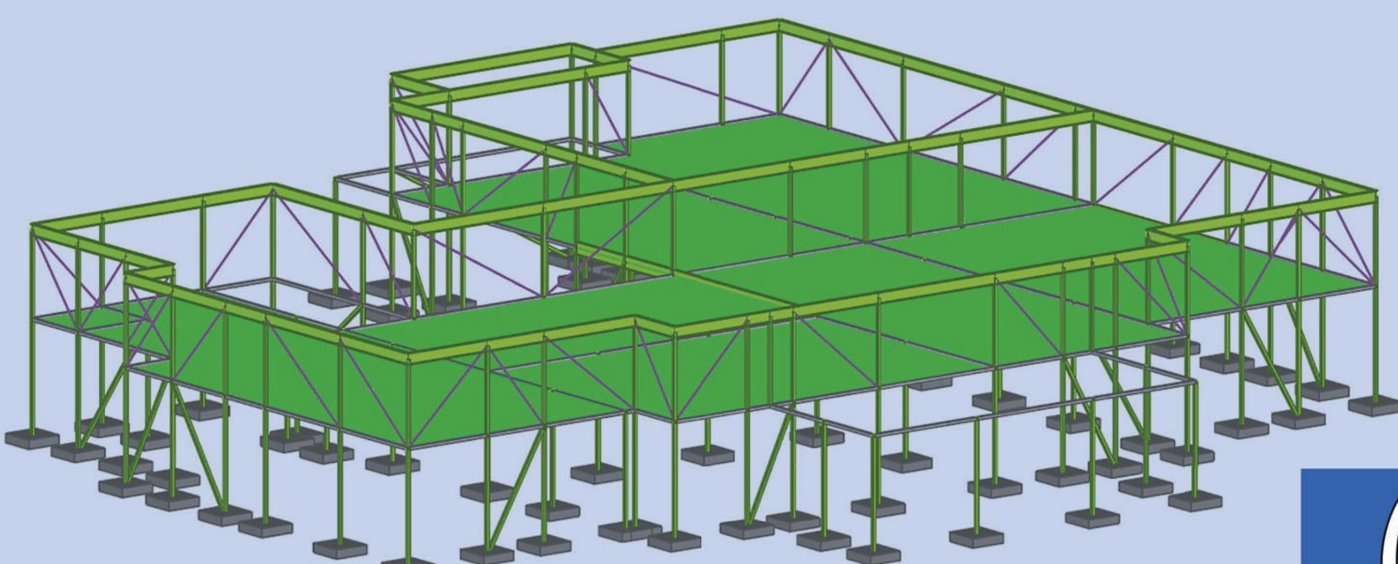

Modern
STEEL CONSTRUCTION | May 2016

columns

features

in every issue

ON THE COVER: Looking into one of Dallas' more unique houses, a 2016 IDEAS² Award winner (coverage starts on p. 28). Credit: Juan Miró

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editor's note

IF I ASK YOU TO CLOSE YOUR EYES AND IMAGINE A BRIDGE, MY GUESS IS YOU'LL SEE ONE OF THE NATION'S ICONIC BRIDGES SUCH AS THE BROOKLYN BRIDGE OR THE GOLDEN GATE BRIDGE. Or if I ask you to picture a current bridge project, you'll likely think of one of the new monumental structures currently underway, with long spans and thousands of cars crossing it every day. The Tappan Zee Bridge in New York. The Stan Musial Veterans Memorial Bridge across the Mississippi. The Gordie Howe International Bridge spanning between Michigan and Ontario.

Most people won't think about the typical 40-to-60-ft crossing in their neighborhood. A short-span bridge over a small creek or roadway. But these smaller projects make up the bulk of the bridges in the U.S. And unfortunately, for the past couple of decades, most of these have been concrete.

But I think the tide is turning—and Pennsylvania seems to be leading the way.

If you were at this year's NASCC: The Steel Conference, you may have seen a presentation on the winners of this year's Prize Bridge Awards (which will be featured in the June issue of *Modern Steel*). My favorite might be the winner in the Short Span category. The Wampum Bridge in Lawrence County, Pa., is the poster child for steel accelerated bridge construction. The goal was to create an attractive, inexpensive and functional structure with minimal disruption to the community. The simple project uses a concrete deck cast onto steel wide-flange girders. The modules are fabricated (with the deck) off-site and are then lifted into place.

For simple crossings, it doesn't get much better than this—unless you're in the mood for something completely different.

Back in September 2009, we wrote about some work Atorod Azizinamini was doing with something called a "folded steel plate girder." It looked like it was a quick, inexpensive and simple solution for short-span bridges. And now seven bridges in Pennsylvania are showing we were right. These fascinating structures are ideal for spans of 20 to 60 ft and skews up to 45°. As with the wide-flange solution, a composite concrete deck is cast on the steel folded plate girders off-site and then the system is lifted into place.

CDR Bridge Systems is spearheading the implementation of these fantastic structures. With both folded steel plate girders and the simple wide-flange structures, it looks like there are truly great solutions in steel for short-span bridges. To see even more solutions, visit **www.steelbridges.org**.

Scott Melnick

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

steel interchange

Clevises

Due to architectural considerations, I am using high-strength rods to support loads. I am being told that there is no available clevis-rod combination that meets the strength requirements per AISC *Manual* Table 15-4. I am further being told that clevis-rod combinations not included in Table 15-4 are not produced. Note that I have contacted a clevis manufacturer and have been told that they produce their products to AISC requirements.

What are the AISC requirements for clevises? Is it true that clevises not listed in Table 15-4 cannot be obtained and do not comply with AISC requirements?

My answer may surprise and possibly frustrate you. There are no AISC requirements governing clevises. Despite what you have been told it is likely that someone produces hardware that will suit your needs.

It is important to distinguish between the *Manual* and the *Specification*. The *Manual* does not provide requirements. It provides information and guidance, so the information provided in the *Manual* cannot be viewed as a requirement. Table 15-4 is provided as a convenience for our users. As stated in the table, the information must be confirmed with the manufacturer. AISC derives the information from the manufacturers. It is not generated by AISC.

However, the responses that you have received do not really surprise me. This information, though it has varied a little over time, has appeared in the *Manual* for a very long time. Though the information in the *Manual* is intended to reflect what is being done in the industry, it must be recognized that it also influences what is done in the industry. Engineers have confidence that they can get the hardware that is shown in the table, so they tend to specify this hardware instead of something else. Manufacturers respond to the volume of requests by producing the hardware shown in the table instead of some other configuration. What has been common practice continues as common practice and may appear to be an external requirement rather than the effect of market forces.

However, there is nothing in the AISC *Manual* that prevents a manufacturer from producing other configurations—or that should discourage engineers from specifying other appropriate hardware that is available. Ultimately, the engineer must evaluate the adequacy of the hardware for a given application.

Larry S. Muir, P.E.

Calculating Beam Weight

When calculating weights of beams for payment, is it correct to multiply the weight per foot by the length and not deduct for things like copes, cuts and bolt holes?

Yes. Item (a) in Section 9.2.2 in the AISC *Code of Standard Practice* applies, and the weight is calculated as the nominal weight per foot times the detailed overall length. Item (e) in Section 9.2.2 further applies: "Deductions shall not be made for material that is removed for cuts, copes, clips, blocks, drilling, punching, boring, slot milling, planing or weld joint preparation."

Charles J. Carter, S.E., P.E., Ph.D

Calculating Plate Weight

How do we calculate the weight for payment for a gusset plate that is nonrectangular?

You are somewhere between Items (b) and (c) in Section 9.2.2 in the *Code*. Item (b) states: "The weights of plates and bars shall be calculated using the detailed overall rectangular dimensions." Item (c) states: "When parts can be economically cut in multiples from material of larger dimensions, the weight shall be calculated on the basis of the theoretical rectangular dimensions of the material from which the parts are cut." Your pentagonal shape will come from a rectangular plate, and perhaps multiple pentagons will come from the same plate if they can nest. Either case gets you back to the rectangular dimensions times the thickness times 490 pcf.

Charles J. Carter, S.E., P.E., Ph.D

Filled Composite Columns

Are shear connectors required for all filled composite columns?

No. AISC Design Examples (v. 14.1) I.3, I.4, I.5, I.6 and I.7 (**www.aisc.org/examples**) all address filled composite member designs. The following statement is made in Example I.3: "Shear connection involves the use of steel headed stud or channel anchors placed within the HSS section to transfer the required longitudinal shear force. The use of the shear connection mechanism for force transfer in filled HSS is usually limited to large HSS sections and built-up box shapes, and is not practical for the composite member in question. Consultation with the fabricator regarding their specific capabilities is recommended to determine the feasibility of shear connection for HSS and box members. Should shear connection be a feasible load transfer mechanism, AISC *Specification* Section I6.3b in conjunction with the steel anchors in composite component provisions of Section I8.3 apply."

Section I6.3 addresses force transfer mechanisms and provides three options for filled composite members: direct bearing, shear connection and direct bond interaction—all options that do not involve the use of shear studs.

A 2011 NASCC: The Steel Conference presentation by Will Jacobs, N23: New Composite Design Provisions in the 2010 AISC *Specification* (**www.aisc.org/2011nascconline**), may be helpful.

Carlo Lini, P.E.

Field-Cut Holes

Several 3-in.-diameter holes need to be cut into steel beams that are already erected. Is it acceptable to thermally cut these holes?

Yes. You might ask whether there is a more appropriate method for field cutting these holes. Generally speaking, that answer is no.

Issues with field cutting tend to relate to the accuracy of the cut. The use of a mechanical guide can improve the accuracy of the cut. AISC *Specification* Section M2.2 addresses thermal cutting of steel and defers you to AWS D1.1 clauses 5.15.1.2, 5.15.4.3, and 5.15.4.4 for acceptance criteria. This information can be supplemented by AISC Engineering FAQ 2.2.6, which provides some guidance on acceptable roughness limitations for thermally cut edges, and FAQ 2.2.7, which provides some guidance on how to repair edges that do not meet those limitations. The FAQs can be found at **www.aisc.org/faq**.

To ensure you and your contractor have the same expectations regarding the field-cut openings, I would suggest you incorporate the relevant recommendations from the above references plus whatever other guidelines you feel are appropriate for your situation in your response to the contractor on how to proceed with the field cutting of the holes.

Beyond this, it becomes an engineering judgment question in which the engineer of record must decide whether the existing beam that is to be penetrated requires reinforcement due to the penetrations (in which case, I refer you to AISC Design Guide 2: *Design of Steel and Composite Beams with Web Openings*, available at **www.aisg.org/dg**). When deciding whether or not the beams require reinforcing, some consideration should be given to the fact that the holes will likely not be perfect circles and may be slightly oversized, especially if there are notches or grooves resulting from the field cut that need to be ground down or repaired. The ability of the contractor to make an accurate cut in the field may be influenced by ease of access to the member to be cut, including the presence of other items (ducts, pipes, ceiling tiles, etc.). I would suggest you discuss with your contractor how much tolerance they require on the field-cut holes based on your given circumstances so that you can incorporate these into your evaluation of the penetrated beam. Alternatively, you could specify a tolerance which, if exceeded, would require additional work.

Susan Burmeister, P.E.

Bracing Connections to Column Webs

A peer reviewer has said that our design for a special concentrically braced frame (SCBF) does not conform to the AISC *Seismic Provisions* because the bracing connections frame to column webs. The reviewer has correctly pointed out that all examples in the AISC *Seismic Design Manual* are shown to the column flange. However, I cannot find any related restrictions in the *Provisions*. Are connections to column webs permitted for SCBF?

Yes. Connections to column webs are permitted. The peer reviewer's position is a surprisingly common and persistent misconception. One reason the examples address connections to column flanges is that this permits more design considerations to be demonstrated. When connecting to the column flange, eccentricities must be accounted for that result in normal forces at the beam-to-column and gusset-to-column connections. When connecting to the web, only shears need be transferred at these connections, thus simplifying the design.

Examples to column webs are included in AISC Design Guide 29: Vertical Bracing Connections—Analysis and Design (**www.aisc.org/dg**). Again, the fact that none of these examples is designed to meet the Seismic Provisions is not intended to convey a prohibition on column web connections. The Design Guide, though nearly 400 pages long, cannot address every conceivable configuration that might be encountered in practice, and neither can the manuals.

Larry S. Muir, P.E.

The complete collection of Steel Interchange questions and answers is available online. Find questions and answers related to just about any topic by using our full-text search capability. Visit Steel Interchange online at **www.modernsteel.com**.

Larry Muir is director of technical assistance, Charles Carter is vice president and chief structural engineer and Carlo Lini is a staff engineer—technical assistance, all with AISC. Susan Burmeister is a consultant to AISC.

Steel Interchange is a forum to exchange useful and practical professional ideas and information on all phases of steel building and bridge construction. Opinions and suggestions are welcome on any subject covered in this magazine.

The opinions expressed in Steel Interchange do not necessarily represent an official position of the American Institute of Steel Construction and have not been reviewed. It is recognized that the design of structures is within the scope and expertise of a competent licensed structural engineer, architect or other licensed professional for the application of principles to a particular structure.

If you have a question or problem that your fellow readers might help you solve, please forward it to us. At the same time, feel free to respond to any of the questions that you have read here. Contact Steel Interchange via AISC's Steel Solutions Center:

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steel quiz

This month's Steel Quiz takes a look at tolerances as addressed in the AISC *Code of Standard Practice* (*COSP*).

1 **True or False:** A fabricator is permitted to correct the straightness of a W18×35 steel beam that is received and not within the ASTM A6/A6M tolerance for straightness.

2 **True or False:** For beams that are detailed without specified camber, the member shall be fabricated such that after erection, any incidental camber due to rolling or shop fabrication is downward.

3 **True or False:** A hole placed in the web of a beam that is off by ¹⁄₁₆ in. is still within tolerance per the *COSP*.

4 **True or False:** The absence of a tolerance in the *COSP* does not mean that the tolerance is zero.

5 For member lengths greater than 30 ft, the tolerance on the detailed beam length shown in Figure 1 is equal to ______ in. per Section 6 of the *COSP*.

Beam Length +/- ______ in.

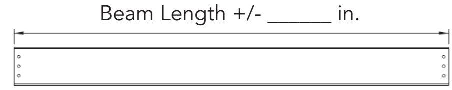


Figure 1

6 Who is responsible for locating and setting embed plates in concrete that will receive structural steel?

a. Erector
b. General Contractor/ Construction Manager
c. Fabricator
d. Concretus, god of unpredictability and ruler of RFI Kingdom

7 To account for tolerances in the *COSP*, AISC Design Guide 13: *Wide-Flange Column Stiffening at Moment Connections* (a free download for members at **www.aisc.org/dg**) recommends that for the connection detail shown in Figure 2, the thickness of the top stiffener plate be oversized by _____ in. to account for flange tilt and the thickness of the bottom stiffener plate be oversized by ______in. to account for flange tilt and beam overrun/ underrun in the beam depth.

PL thickness (top) = t_f + ______ in.

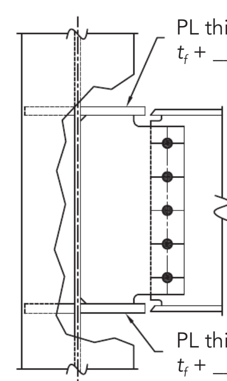


Figure 2

PL thickness (bottom) = t_f + ______ in.

TURN TO PAGE 14 FOR ANSWERS

steel quiz | ANSWERS

1 **True.** Section 5.1.2 of the COSP states: "When mill material does not satisfy ASTM A6/A6M tolerances for camber, profile, flatness or sweep, the fabricator shall be permitted to perform corrective procedures, including the use of controlled heating and/or mechanical straightening, subject to the limitations in AISC 360." The associated Commentary explains the background.

2 **False.** Placing the camber downward would add an unanticipated amount to the deflection. Therefore, beams are detailed so that after erection, any incidental camber is upward.

3 **It could be either true or false.** *COSP* contains no tolerance on bolt hole locations. The location of the hole is governed indirectly; the holes in the plies must match sufficiently to install the bolts. Ultimately, Section 7.12 of the *COSP* states: "The accumulation of the mill tolerances and fabrication tolerances shall not cause the erection tolerances to be exceeded." This provides sufficient control that the location of individual bolt holes need not be further regulated.

4 **True.** As stated in the commentary to Section 1.9, the absence of a tolerance means that no tolerance has been established. If a specific case or project requires a tolerance not covered in the *COSP*, it should be specified in the contract documents.

5 +/- $\frac{1}{8}$ in. per Section 6.4.1 in the *COSP*.

6 **b.** General Contractor/Construction Manager. Section 7.5.3 of the *COSP* states that embedded items and connection materials that are part of the work of other trades, but that will receive structural steel, shall be located and set by the owner's designated representative for construction in accordance with an approved embedment drawing.

7 AISC Design Guide 13 recommends increasing the top flange by $\frac{1}{4}$ in. and the bottom flange by $\frac{3}{8}$ in. Note that this is only a recommendation and that fabricators may have preferred tolerances that vary from these values based on their experience.

Steel SolutionsCenter

Everyone is welcome to submit questions and answers for 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 at **solutions@aisc.org**.

economics

ONCE UPON A TIME IN THE CONSTRUCTION MARKET

With apologies to Goldilocks.

BY JOHN CROSS, P.E.

ONCE UPON A TIME, there was a little girl named Goldilocks.

She went for a walk in the forest. Pretty soon, she came upon the home of three bears. She knocked and, when no one answered, she walked right in.

At the table in the kitchen, there were three construction market forecasts. Goldilocks was very interested in construction, so she read the first report.

"This market is too hot!" she exclaimed.

So, she read the second forecast.

"This market is too cold," she said.

So, she read the last forecast.

"Ahhh, this forecast is just right," she said happily, and she folded it up and put it in her pocket.

Like anyone who reads a market forecast, she decided she was feeling a little tired, so she went upstairs to the bedroom. She lay down in the first bed, but it was too hard. Then she lay in the second bed, but it was too soft. Then she lay down in the third bed, and it was just right. Goldilocks fell asleep.

As she was sleeping, the three bears came home.

"Someone's been reading my market forecast," growled the Papa Bear.

"Someone's been reading my market forecast," said the Mama Bear.

"Someone took my market forecast!" cried the Baby Bear.

They decided to look around some more and when they got upstairs to the bedroom, Papa Bear growled, "Someone's been sleeping in my bed,"

"Someone's been sleeping in my bed, too" said the Mama Bear.

"Someone's been sleeping in my bed and she's still there!" exclaimed Baby Bear.

Just then, Goldilocks woke up and saw the three bears. She screamed, "I just wanted to know what is happening in the construction market!" When she calmed down, she added, "And I really liked the forecast that was 'just right!'"

To which Papa Bear growled, "You silly child! In a bear market, you can't choose a forecast based on what you like!" And then the three bears launched into a long discussion of GDP growth, employment levels, consumer confidence, historic trends, demographic changes and the strength of the dollar.

In the midst of the discussion Goldilocks, screamed again, put her hands over her ears, jumped up, ran out of the room, down the stairs, opened the door and ran away into the forest. And she never returned to the home of the three bears and never again read a construction market forecast.

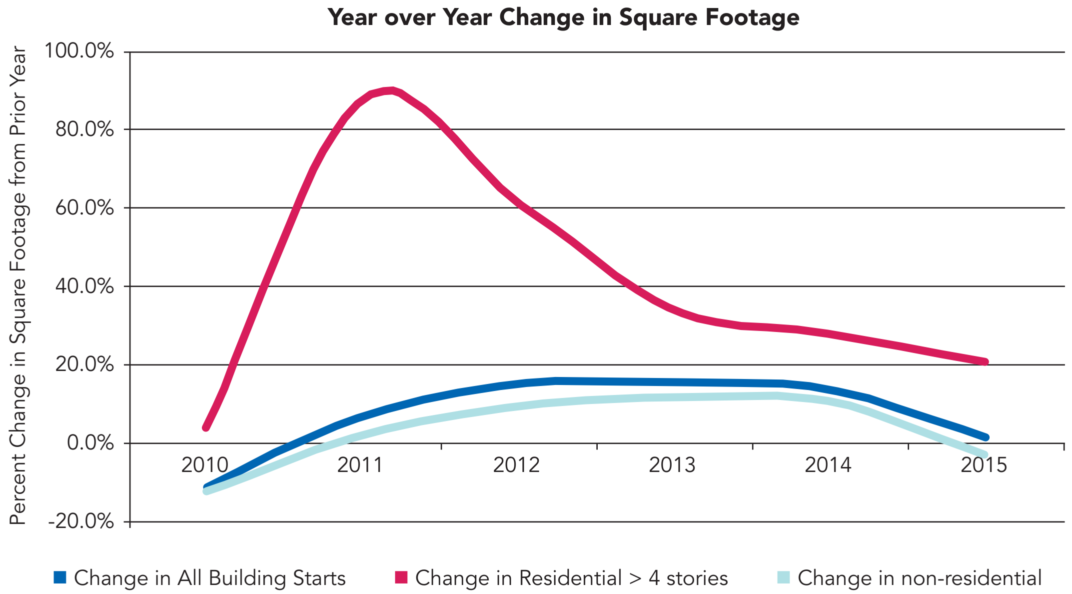
Maybe you feel a bit like Goldilocks. You like construction forecasts that are "just right" and feel like screaming and running out of the house when the details are discussed.

• • •

Since my last economics article "How Long Will the Good Times Last?" was published in the January issue (available at **www.modernsteel.com**), I've received a number of comments from readers bemoaning the statement that we should be anticipating a downturn in construction activity. The feedback has all been centered around two thoughts: "We haven't fully recovered yet from the recession, so how could the market already be shrinking again?" and "The market isn't slowing down, because I'm seeing more bidding activity."

Regretfully, the nonresidential market is already contracting. Building construction activity in 2015 was a major disappointment, with construction starts on a square-foot basis for nonresidential and multistory residential (greater than four stories) only showing a 0.5% increase over 2014. The numbers are even more sobering when you recognize that the year-over-year change in non¬residential construction was -2% and the growth in multistory residential construction was 21%. Non-residential construction starts contracted in 2015! Certainly not what was expected.

John Cross (**cross@aisc.org**) is an AISC vice president.



When did the downturn in nonresidential construction begin? Since July of 2015, the pace of nonresidential construction starts has fallen below that of 2014. Dodge Analytics is already reporting a 21% drop in nonresidential building construction starts on a per-dollar basis through February of this year. While it should be anticipated that these numbers will be adjusted upward and that construction levels will pick up in the summer, it is clearly an indication of a pullback in the marketplace.

But the real question for nonresidential construction is "Why is this occurring?"

I have reflected long and hard on this question and believe there may be several answers.

The first is that the growth in population and employment we are seeing is in urban rather than suburban or rural areas. This growth does not generate only new construction but also has a strong component of rehabilitation of existing structures for both nonresidential and residential use. The result is a reduction in construction starts for new structures.

Second, many new multistory residential projects include retail and light office space on the first floor or two of the structure. The old paradigm has been that nonresidential lags residential activity by 1.5 to 2 years. We have not seen that in the numbers; we should have had a sizeable increase in nonresidential starting in 2013. It didn't happen—or did it and the numbers didn't capture it because it was included in the square footage of the residential projects. Our data source does not have a separate category for mixed use, so if a project is majority residential it is categorized as residential.

Third, the changing work and consumer behavior of the millennial generation is more focused on smaller, open and shared office space and online purchasing.

I indicated in the January article that we should anticipate a 6% to 8% growth in the market in 2016. Is that still a legitimate expectation based on 2015 results? Probably, but not because of nonresidential growth. The growth will come from the multistory residential sector, not the nonresidential sector. The multistory residential sector is continuing to growth with 2016 tracking 12% above 2015.

So which bear was right: Papa Bear, Mama Bear or Baby Bear? Goldilocks may have liked Baby Bear's construction forecast of "just right," but Mama Bear's "too cold" forecast may be closer to reality. But unlike Goldilocks, we can't put our hands over our ears and run out of the house. Instead, we need to remember the lessons we learned during the last down cycle. Those engineering and fabrication firms that successfully survived the Great Recession had some common characteristics:

- They focused on niche markets where they had already established their reputation for quality work
- They valued collaboration, which resulted in the integration the expertise of structural steel fabricators early in the design life of the project
- They remained flexible in the management of their firms

The next several years are going to be interesting, and alertness will be key. So don't find a comfortable bed and fall asleep!

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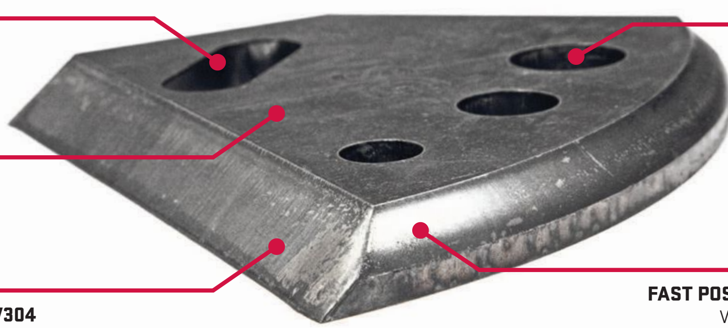

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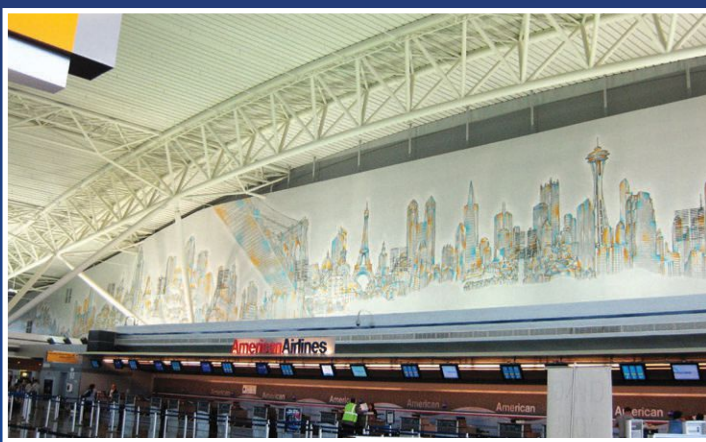
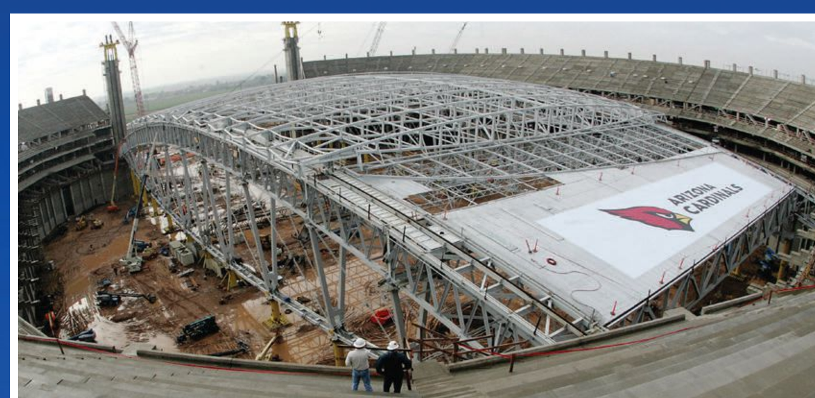
WINNERS CHOOSE CHICAGO METAL TO CURVE STEEL

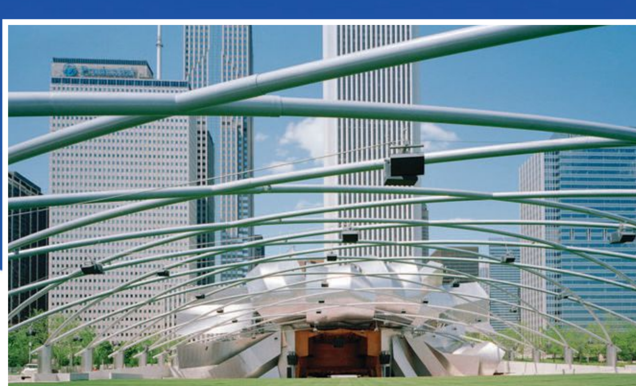
2015 IDEAS² Merit Award - 385 tons of 70 curved 8 inch sch 40 pipe for Circuit of the Americas Observation Tower. Austin, TX



2002 EAE Merit Award - 400 tons of 16 inch pipe curved for JFK International Airport Terminal 4. Jamaica, NY.



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



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

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

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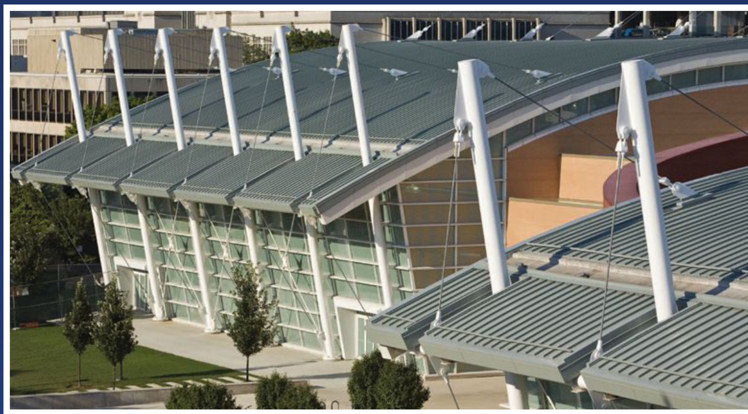

2004 EAE National Winner - 310 tons of beams bent including reverse curves for the Gerald Ratner Athletics Center. Chicago, IL.

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

2011 IDEAS² National Winner - 420 tons of rectangular tubing, pipe and beams for the roof at the Norman Y. Mineta San Jose International Airport. San Jose, CA

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

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

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

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Practical MATTERS

BY CHRISTINA HARBER, S.E., P.E.

AISC's archive of webinars provides plenty of practical advice to propel practicing engineers onward and upward in their careers.

EVERYONE FROM FRESH-FACED COLLEGE GRADUATES to veteran engineers shares a common need for continuing education.

University engineering programs typically focus on the essentials: engineering theory and basic design. But many practical subjects are never covered, so recent graduates are expected to learn on the job. As engineers gain experience, they can expect to be assigned increasingly complex projects that require new technical expertise. Thus, it is vital, no matter where you are in your career, that continuing education resources be economical and easy to access. And AISC makes it easy for engineers of all experience levels to keep on learning.

In addition to in-person seminars and live webinars, AISC offers a collection of recorded webinars that can be viewed at any time for free. This allows you to learn about a variety of steel construction topics anywhere, whether at the office, on the train or at home. Archived webinars can be accessed by going to: **www.aisc.org/educationarchives**. You can take advantage of this free resource to gain the knowledge and skills you need to succeed on the job.

There are many hidden gems in the AISC webinar vault that can help you at your job immediately. Topics include seismic design, connections, retrofit, stability, ethics, sustainability and more. These archived webinars are typically past live webinars or presentations from NASCC: The Steel Conference.

Ten to Start

There are hundreds of webinars that can be viewed on the AISC website. Before diving in, a good place to start is my personal list of the Top 10 Archived Webinars Recommended for the Practicing Engineer (in no particular order):

1. "High-Strength Bolting" by Geoffrey Kulak (1.5 hours). Connection design is often mysterious to the new engineer; few cover this topic at the college level. Geoffrey Kulak starts with the basics and focusses on bolting fundamentals and behavior. This webinar begins with an introduction to bolt material properties and moves on to the loading of bolted connections and the determination of bolt forces. Connection limit states are examined, including bolt shear, tension and combined stress, block shear rupture and bolt bearing. Kulak also covers bolts in slip-critical joints, the essentials of pretensioning, bolt installation procedures and inspection requirements. Watch this webinar and gain confidence that you are selecting suitable bolt types, properly designing your bolted connections and properly specifying installation and inspection procedures for your projects.

2. "Field Fixes" by James M. Fisher and Lawrence A. Kloiber (6.0 hours). In the real world, errors occur during construction, and some errors require the engineer to design a fix. It takes years of experience for an engineer to develop strategies to prevent construction problems through better design and to correct problems once they happen. This webinar can help an engineer without a lot of field experience to learn from the experience of others. After watching this webinar, you will be able to anticipate design decisions that are sensitive to problems during construction, as well as learn how to avoid them and have possible solutions available in case you do need to design a field fix. Construction mistakes covered in this webinar

Christina Harber (harber@aisc.org) is a senior engineer – continuing education with AISC.

include anchor rods in the wrong position, façade connections to spandrel beams, connection fit-up problems, camber problems, rooftop units at unintended locations and modifications to steel joists.

3. "Rules of Thumb for Steel Design" by Socrates A. Ioannides (1.0 hour). In order to have a feeling for initial sizing of a member or lateral system, an engineer needs to have a lot of design experience or else a mentor who will readily share their experience. This webinar gives an engineer at any experience level a bag of tricks to use for initial sizing at the schematic design phase or a way to give fairly accurate sizes while put on the spot at a meeting with clients. Take advantage of the experience of Socrates Ioannides and his colleagues as he readily shares his tips. Topics include approximation of section properties and the initial sizing of beams, truss members and columns. Construction topics are also covered, such as estimating steel tonnage, cost and construction time.

4. "Modules for Learning Structural Stability" by Ronald D. Ziemian (1.5 hours). To many engineers, the topic of structural stability brings on flashbacks of differential equations and confusion for those fortunate enough to have taken a class on this subject. Ronald Ziemian offers a hands-on tool to aid engineers in visualizing and understanding structural stability. Through free software, you can experiment with simple structures in this virtual lab to observe the effects of bracing, loading and boundary conditions on stability behavior (see Figure 1). You will develop a better understanding of elastic and inelastic flexural and lateral torsional buckling, inelastic force redistribution and second-order effects.

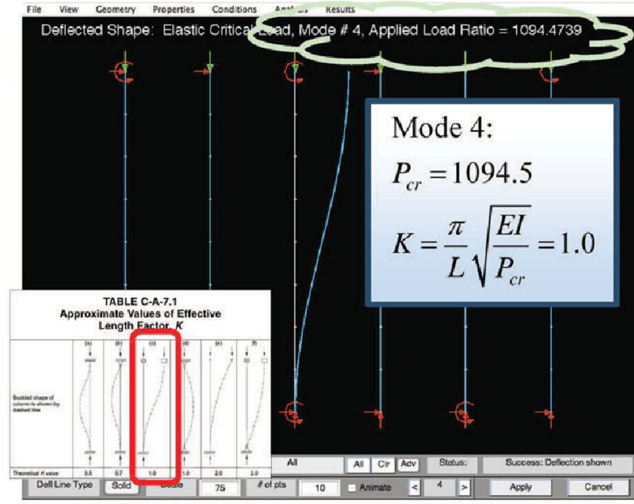

Figure 1. A virtual lab from the "Modules for Learning Structural Stability" webinar.

5. "Load Path! The Most Common Source of Engineering Errors" by Carol Drucker (1.5 hours). As a highly experienced connection design engineer, Carol Drucker has seen her share of structural drawings. While load paths in design seem like common sense, it is an area that is often overlooked. This webinar is an opportunity for you to look at real examples of both good and absent load paths. Drucker highlights details for gravity load transfer, collectors, truss connections, bracing connections, moment connections, detailing for thermal expansion and design for davits. She also encourages designing with erection in mind in order to eliminate potential load path problems.

6. "A New Approach to Design for Stability" by R. Shankar Nair (1.0 hours). This webinar highlights a major change made in the 2005 *Specification* regarding design for stability. While 2005 seems like a long time ago, these provisions still are current, having been only modestly improved in more recent editions. First, the webinar takes a stroll down memory lane to review how we were designing for stability before 2005. Problems with pre-2005 stability design included calculated moments that were too low, incorrect and un-conservative. The effective length factor, *K*, had to be determined, which can be tricky in some real-world conditions. This led to the development of changes which debuted in the 2005 *Specification*. The preferred method, the direct analysis method, include both initial imperfections (through notional loads or direct modeling of initial imperfections) and inelasticity (through reduced member stiffness) in the second order analysis. Therefore, a *K*-factor of 1 can be used in the determi-

Meet the Speakers

- **Geoffrey Kulak** is Professor Emeritus at the University of Alberta's Department of Civil Engineering and the author of AISC's Design Guide 17: *High Strength Bolts—A Primer for Structural Engineers*.
- **James M. Fisher** is the vice president emeritus of Computerized Structural Design and a member of the AISC Committee on Specifications.
- **Lawrence A. Kloiber** is the retired vice president of engineering at LeJeune Steel Co. and an emeritus member of the AISC Committee on Specifications.
- **Socrates A. Ioannides** is the owner of Structural Affiliates International, Inc.
- **Ronald D. Ziemian** is a professor of civil and environmental engineering at Bucknell University and a member of the AISC Committee on Specifications.
- **Carol Drucker** is a principal with Drucker Zajdel Structural Engineers and a member of the AISC Committee on Specifications.
- **R. Shankar Nair**, senior vice president of exp US Services, Inc., is an emeritus member of the AISC Committee on Specifications.
- **Rafael Sabelli** is a seismic design expert at Walter P Moore's San Francisco office and a coauthor of Design Guide 20: *Steel Plate Shear Walls*. He is also a member of the AISC Committee on Specifications and Committee on Manuals.
- **Duane K. Miller**, manager of engineering services with the Lincoln Electric Company, is the author of AISC's Design Guide 21: *Welded Connections—A Primer for Engineers*. He is also a member of the AISC Committee on Specifications.
- **Charles Carter** is AISC's chief engineer and vice president of engineering and research.
- **Terri Meyer Boake** is a professor of architecture at the University of Waterloo in Waterloo, Ontario, Canada, and an AESS expert.

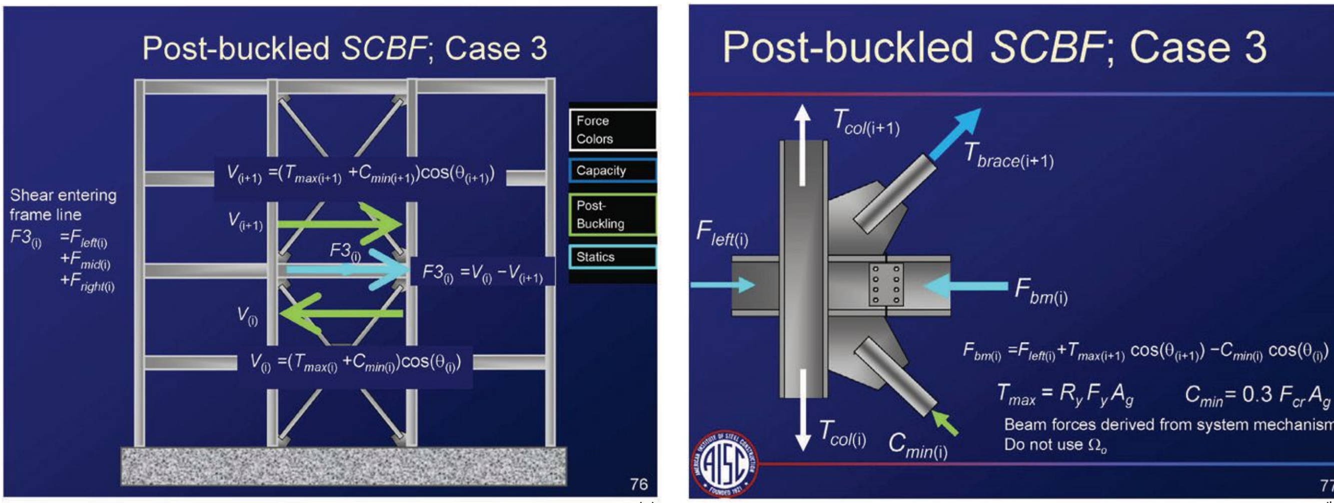

Figure 2 (a and b). Determination of post-buckled SCBF connection forces from the "Where Did that Force Come From?" webinar.

nation of member capacity which eliminates any confusion associated with determining *K*. This webinar will ensure that you understand the approach to stability design that was introduced in 2005 and is still applicable today.

7. "Where Did that Force Come From?" by Rafael Sabelli (1.5 hours). In seismic design, combining diaphragm and braced-frame forces is not a straightforward process. When a vertical force distribution due to wind load or seismic load in an R = 3 system is applied to a braced frame, every part of the structure is in equilibrium. There are some situations, however, that are not so straightforward, and the engineer will need to make adjustments to certain member forces. One such situation arises in a mechanistic analysis assuming a post-buckled state in a special concentrically braced frame (SCBF). In Figure 2a, forces in the braces at level i and i+1 are the expected tensile strength and the expected compression post buckling strength. The connections at level i, shown in Figure 2b, are not in equilibrium unless a chord force is assigned at the floor level i. This force is determined through statics. At this point, you may start to wonder where all these forces came from and how best to achieve equilibrium. There is no one correct way to handle these situations. Rafael Sabelli dives into this force balancing quandary by examining rational ways to determine forces in this situation.

8. "Weld Details – Good, Bad and Ugly" by Duane K. Miller (1.5 hours). Engineers need to understand connections, and welds are no exception. When engineers incorrectly specify welds, the welds end up resisting undesirable forces for which they were not designed. This even includes prequalified welds when used under the wrong conditions. Duane Miller, the expert on welding, offers a list of good weld criteria and counters it with examples of bad and ugly welds. The tips given in this webinar can be applied to welds in any situation. Be prepared to use the information that you learn immediately, regardless of where you are in your career.

9. "SteelDay 2015: Steel and the Phantasmagoria" by Charles J. Carter (1.0 hour). Don't be fooled by the enigmatic title: This one is full of very specific resources and commonsensical advice. Engineers often waste precious time searching for resources and reinventing the wheel when they encounter a design problem that is new to them. Charles Carter of AISC discusses the many resources available to engineers such as AISC manuals, design guides, design examples, specifications, codes, standards and relevant articles.

10. "Architecturally Exposed" by Terri Meyer Boake (1.0 hour). This Top 10 AISC Webinar list is no beauty pageant, but if it were, this webinar would be the winner. Terri Meyer Boake explains the rise of architecturally exposed structural steel (AESS) and the fabrication techniques used to accomplish aesthetically pleasing steel structures. Most of the photographs in this webinar were taken by Boake herself. You will be inspired by the unique structures she presents and understand how the engineering and economy of these structures relies heavily on fabrication techniques.

You can watch and learn from these 10 selected webinars—or any other of the hundreds of other recorded webinars offered by AISC—for free. These programs give you insights from the experts into real-world design and construction techniques, opportunities and solutions. Take advantage of this vault of resources to broaden your engineering knowhow. Happy viewing and learning!

Credit where Credit is Due

All of the webinars mentioned in the Top 10 list can be viewed for PDH credit at **www.aisc.org/educationarchives**. For licensed engineers seeking professional development hours, some of the archived webinars can be watched for credit. After watching the webinar, purchase the quiz for that webinar. After taking and passing the quiz, you will receive a PDH certificate.


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2016 IDEAS² awards

INNOVATIVE DESIGN
in ENGINEERING and
ARCHITECTURE
with STRUCTURAL STEEL

MODERN STEEL CONSTRUCTION IS PROUD to present the results of AISC's annual IDEAS² Awards competition, which recognizes Innovative Design in Engineering and Architecture with Structural Steel. Awards for each winning project will be presented to the project team members involved in the design and construction of the structural framing system, including the architect, structural engineer of record, general contractor, owner and AISC member fabricator, erector, detailer and bender-roller. New buildings, as well as renovation, retrofit and expansion projects, were eligible, and entries were asked to display, at a minimum, the following characteristics:

- A significant portion of the framing system must be wide-flange or hollow structural steel sections
- Projects must have been completed between January 1, 2013 and December 31, 2015
- Projects must be located in North America
- Previous AISC IDEAS² award-winning projects are not eligible

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

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

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

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

National honors were awarded in all three categories, merit awards were given in two categories and a Presidential Award of Excellence in Engineering was also given. In addition, this year's jury recognized steel's important role in public art by selecting an outstanding sculpture project.

Meet the Jury

William D. Bradford, owner juror. William is an assistant director/project manager with the University of Illinois at Chicago's Office for Capital Programs, which manages the major planning, design and construction projects for the campus. He currently is overseeing the restoration of the exterior façade of University Hall and the 28-story Administration Building; major remodeling projects for the Outpatient Care Center, Human Resources Building and Stevenson Hall classrooms; and planning for a new Advanced Chemical Technology Building for chemistry, physics and biological sciences. Prior to joining UIC, William was in private practice for over 30 years, designing facilities for various institutions of higher education. A licensed architect in five states, he holds a Master of Architecture from the University of Illinois at Urbana-Champaign, has served as president of the Chicago Chapter of the American Institute of Architects and the Illinois State Council of the AIA, and is a past recipient of the AISC Design Excellence Award.

Roger E. Ferch, AISC staff juror. Roger, AISC's president since 2005, has been active in the steel construction industry for more than 40 years. He began his career as a Naval Civil Engineer Corps officer then joined the steel construction industry with The Herrick Corporation in 1974, where he supervised various departments during his 30 years with the company. He was promoted to vice president in 1989 and was responsible for managing the purchasing and engineering departments as well as the firm's major projects. Some of the noteworthy buildings he's worked on include the Boeing 777 Assembly building, the San Francisco Airport International terminal and the Frank Gehry-designed Walt Disney Concert Hall in Los Angeles. Roger's education includes a Bachelor of Science in civil engineering from the University of Washington and a Master of Business Administration from the University of California, Berkeley. A licensed civil engineer in California, he served on AISC's Board of Directors from 1998 to 2005 and also served as vice chairman of the AISC Specification Committee.

Kem Hinton, architect juror. Kem is a founding principal of Tuck-Hinton Architects in Nashville, whose most prominent projects include the Country Music Hall of Fame and Museum, the Tennessee Bicentennial Capitol Mall, the Frist Center for the Visual Arts, Middle Tennessee State University Sports Hall of Fame, the Tennessee World War II Memorial, Nashville Public Square and the Music City Convention Center. Kem received his Bachelor of Architecture from the University of Tennessee and his Master of Architecture from the University of Pennsylvania. He is the author of *A Long Path, the Search for a Tennessee Bicentennial Landmark and contributor to The Work of Tuck-Hinton Architects: 1984-2014*.

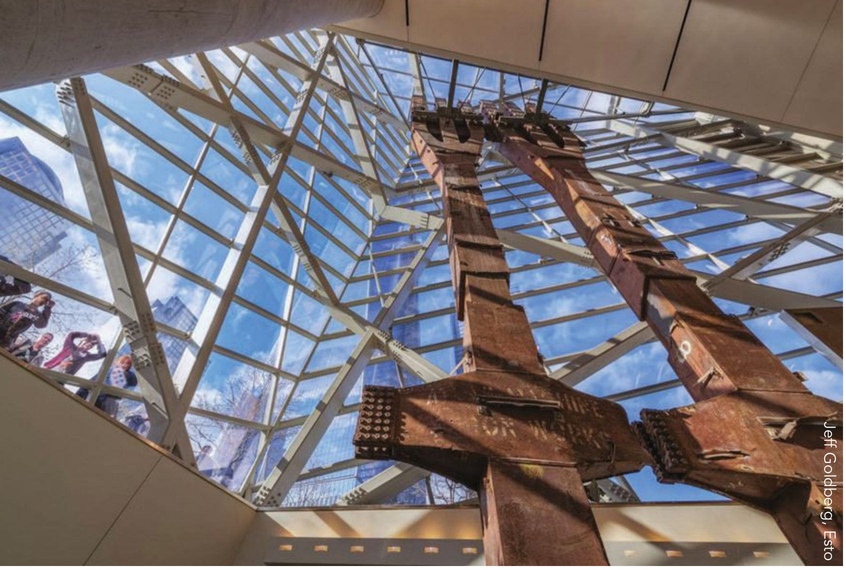
Wanda Lau, trade media juror. Wanda is the senior editor of technology, products and practice for *ARCHITECT* and *Architectural Lighting* magazines, and has a decade of AEC experience. She holds a Bachelor of Science in civil engineering from Michigan State University, a Master of Science in building technology from MIT and Master of Arts in journalism from Syracuse University.

Paula Pritchard, general contractor juror. Paula is a partner, construction manager and vice president of Plant, where she has worked since 2000. She has over 25 years of construction experience, building a variety of projects including new construction, high-rise residential, tenant interiors and remodels of occupied spaces throughout the United States and Canada. She joined Plant after relocating to the Bay Area from Portland, Ore., where she was a project manager in charge of construction of Nike's NikeTown stores. Paula is a licensed civil engineer in California and received her Bachelor of Science in civil engineering from the University of the Pacific.

Colter Roskos, engineering student juror. Colter is a Ph.D. student in the University of Texas at Austin's Department of Civil, Architectural and Environmental Engineering's Ferguson Structural Engineering Laboratory. He has earned a Bachelor of Science and a Master of Science in civil engineering from Montana State University. Colter worked for two years as a project engineer for Eclipse Engineering, focusing heavily on designing light-gauge truss/fabric structures and structural steel connections for steel fabricators. His current project at UT, "Partial Depth Precast Panels on Curved Bridges," involves the development of a method to connect precast panels to the top flanges of I-girders and tub girders so that the panels can be relied on for stability bracing of the girders during construction of the bridge.

Jason B. Stone, P.E., structural engineer juror. Jason is a senior associate at Leslie E. Robertson Associates (LERA) and is currently the project manager for the Hyundai Global Business Center—a large mixed-use development in Seoul, Korea—in addition to several projects in New York. Some past projects that he has been involved with include the New Academic Building– CUNY John Jay College, World Trade Center – Tower 4, the Shanghai World Financial Center and the William Jefferson Clinton Presidential Center in Little Rock, Ark. He is an associate adjunct professor of architecture at Columbia University and holds a Master of Science in structural engineering from Stanford University and a Bachelor of Science in civil engineering from the University of Illinois at Urbana-Champaign.

Brian Wessel, steel fabricator juror. Brian is the general manager of Cives Steel Co.–Mid-West Division, located in Wolcott, Ind., an AISC Member and Certified fabricator, where he began his career in 1997 as a project engineer. Since then, he has steadily risen through the ranks, being promoted to project manager in 2001, estimating manager in 2008, operations manager in 2014 and his current position—in which he oversees all plant operations—last year. Some of Cives Mid-West's current projects include the River Point high-rise in downtown Chicago, the Detroit Event Center (the new home of the Detroit Redwings) and the McCormick Place Event Center in Chicago. He is a graduate of Rose-Hulman Institute of Technology in Terre Haute, Ind.



Jeff Goldberg, Esto

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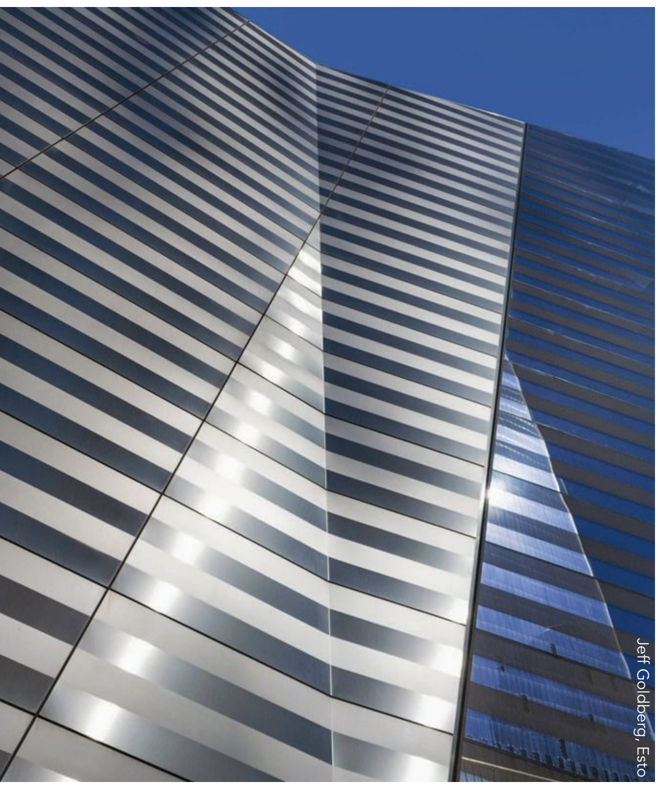
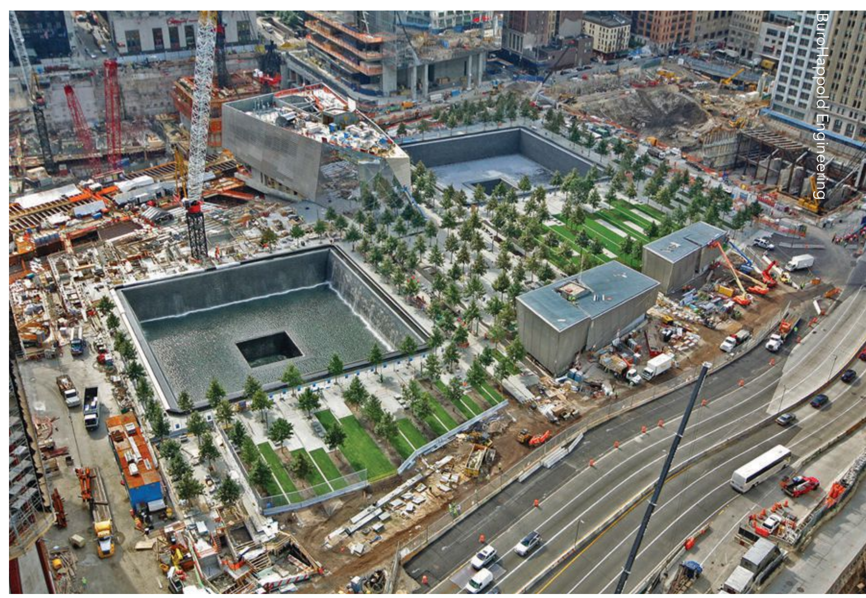


Jeff Goldberg, Esto

NATIONAL AWARD Over $75 Million
National September 11 Memorial Museum Pavilion, New York



BuroHappold Engineering

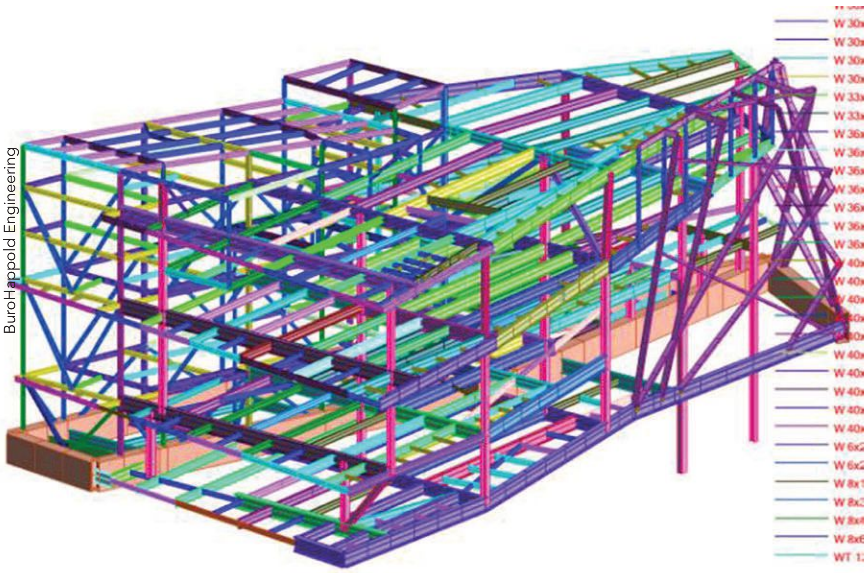
THE NATIONAL SEPTEMBER 11 Memorial Museum Pavilion is a striking presence on the memorial site not only because of its dramatic, angular structure and prominently displayed steel tridents, but also because it is the only above-ground portion of the museum.

While it protrudes four stories into the air, the remainder of the facility, including the two pools that represent the footprints of the original World Trade Center towers, are all below-grade. The 47,600-sq.-ft cultural facility orients visitors within the memorial grounds, acting as an entry point to the museum and belying the complexity of the site.

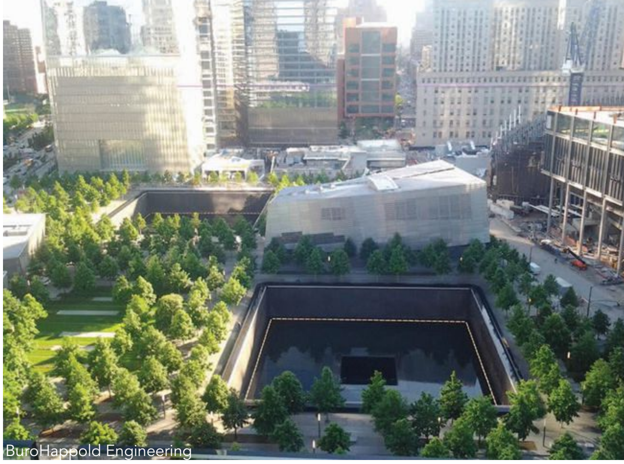
Overcoming the many constraints of a site that is situated in dense urban environment and that has been continually transforming since September 11, 2001, required rigorous coordination and interplay among architect, engineer and other project teams working on site. Integrated structural systems, both above and below grade, impacted the building's design as well. The team had to take into consideration support for the museum below and other underground infrastructure when calculating structural loads.

The majority of the pavilion is supported over the PATH (Port Authority Trans-Hudson) train station and tracks while the remainder sits atop the museum. Analysis of these below-grade structures, the memorial pools and surrounding infrastructure identified, in addition to the pavilion's concrete core, limited the supports capable of carrying the loads of the pavilion. A full-story-tall steel truss extends from the pavilion's core to effectively cantilever the building over the PATH station hall.

While the concrete core provides lateral stability for the pavilion, its location above the PATH tracks and station hall complicated the transfer of lateral forces to the ground. To solve this issue, the pavilion is ringed with steel and reinforced-concrete composite drag beams that transfer the forces to the museum's shear walls. To construct the pavilion shear walls over the tracks, erection trusses support the full weight of the four-story pavilion's walls.



BuroHappold Engineering



BuroHappold Engineering

Jeff Goldberg, Esto

Jeff Goldberg, Esto

Jeff Goldberg, Esto

"Wow! The design team got it right on this one. A powerful and humbling project." —Brian Wessel

One of the most Pavilion's most striking features is the pair of 80-ft-tall artifacts known as the tridents, which originally formed the iconic outer structural support of the original towers. The tridents are housed in a full-height steel and glass atrium that also extends one story below grade. The atrium steel support is a complex configuration of HSS20×8 and HSS20×12 clad with a uniform rectangular curtainwall system set at an angle. Due to their size, the tridents were installed prior to the installation of the atrium's structural steel framing system—and they were protected as the atrium and remainder of the pavilion were constructed. Within the atrium, the pavilion's freestanding, HSS-supported grand stair is 30 ft tall and widens as it descends, bringing visitors within close proximity of the tridents. The stair has limited support points, creating the appearance of floating within the space.

For more on the National September 11 Memorial Museum Pavilion, see "Monument of Perseverance" in the "What's Cool in Steel" feature in the August 2015 issue, available at ***www.modernsteel.com****.*

Owner
National September 11 Memorial and Museum at the World Trade Center

Architects
Snøhetta, New York
Adamson Associates International, New York

Structural Engineer
BuroHappold Engineering, New York

General Contractor
Bovis Lend Lease, New York

Steel Fabricator, Erector and Detailer
AFCO | W&W Steel, Oklahoma City, Okla.

THE MARIPOSA LAND PORT OF ENTRY in Nogales, Ariz., is one of the busiest land ports in the United States.

Processing over 2.8 million northbound vehicles each year and serving as the entry point to 37% of the produce imported to the U.S. from Mexico, it was in need of modernization and expansion due to the growth in trade since it was built in the 1970s. Completed in 2014, the updated 55-acre site now contains 270,000 sq. ft of buildings, inspection facilities and kennels for both south- and northbound traffic. The total cost for the LEED Gold-certified project was $187,000,000.

The circulation design consists of four parallel zones: a southbound traffic zone, a northbound privately owned vehicles (POV) zone, the "oasis" and a northbound commercial traffic zone. The oasis is the central spine of the port, a desert garden that runs the length of the main buildings and uses landscaping to provide respite from the harsh Sonoran climate and the day-to-day stress of security and border protection. The Sonoran Desert experiences huge amounts of rainfall during the monsoon season. Therefore, the pavement and roof structures throughout the Mariposa campus are designed to collect the rainfall and convey it to a 1 million-gallon underground storage tank use for landscape irrigation. The large steel scuppers throughout the project celebrate the collection of rainwater. The inspection canopies, trellises and roof structures are constructed of weathering steel, adding to the visual richness of the port as it develops a natural patina over time.

The most distinguishing feature of the Mariposa Land Port of Entry is the large amount of exposed structural steel throughout the site. The most prominent of these structures is the large shade canopy spanning across the entry to the port. The canopy's trusses provide shade from the desert sun, facilitate overhead inspection of vehicles by way of a continuous catwalk and create the dynamic red, white and blue entry threshold to the United States.

In addition to the entry canopy, the two main buildings (both over 1,000 ft long) have large structural steel overhang trellises. These shade structures as well as the roof overhang structures all consist of long-span, custom designed steel trusses carefully articulated to direct rainwater movement. The trusses were designed and detailed in the structural engineer's office for each span and loading condition as the architecture required different steel shapes than those in typical pre-fabricated trusses. In addition, all steel connections are expressed and custom detailed.

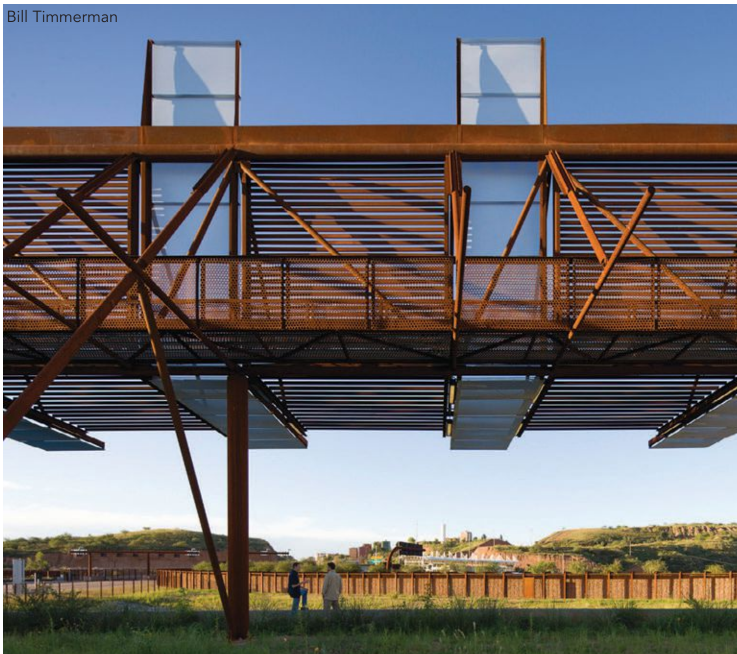
The trusses along the largest canopy structure span 64 ft on average with additional 18-ft cantilevers at each end. The trusses are spaced as much as 15 ft on center and support 3-in., 18-ga. steel decking and HSS while accommodating vehicular movement below. The trusses bear on deep custom steel joist girders, and the girders span 38 ft and are supported on high-strength HSS columns. These girders are nearly 1,000 ft long, transitioning from the inspection

Bill Timmerman

Bill Timmerman

MERIT AWARD Over $75 Million
Mariposa Land Port of Entry, Nogales, Ariz.

Brian Farling



Bill Timmerman

canopy to the interior of the main processing lobby and back to exterior canopy.

The majority of the custom trusses consist of HSS for the top and bottom chords and a combination of HSS and channel sections for the web members. A large portion of the HSS was required to be high-strength steel due to the large internal stresses induced, and some of the longer-span trusses were assembled on-site.

Another unique element of the port is the set of serpentine shade structures for pedestrian crossing at the international border. These structures consist of rigid steel bents spaced at approximately 10 ft o.c. and made of wide-flange sections and steel channels. Smaller HSS members are used as infill to create a unique shade pattern.

Construction of the Mariposa Port occurred over four phases spanning 58 months. The new facility was constructed in the footprint of the previous facility, and the team knew from day one that there could be no interruption of port operations at any point during construction. The orchestration of multiple tenant moves became an art unto itself as temporary facilities wove between the new buildings and other elements as they were being constructed. These efforts were further complicated by the reality of needing to keep thousands of semi-trucks rolling through the facility without obstruction. Conceptual phasing plans were developed by the design team and refined and implemented by the contractor, and the site team worked closely with the port's directors to ensure that it remained operational at all times while not impeding construction activities. Staying on schedule was facilitated by port liaisons, who participated in weekly project meetings with the project team. Not only was the project delivered on time, (and some portions were even completed early), but the building team was also able to accommodate and integrate more than $20 million in tenant-requested added scope without any time loss on the project.

Owner
General Services Administration, Region 9, San Francisco

Owner's Representative
GSA - Design + Construction, San Francisco

Architect
Jones Studio, Phoenix

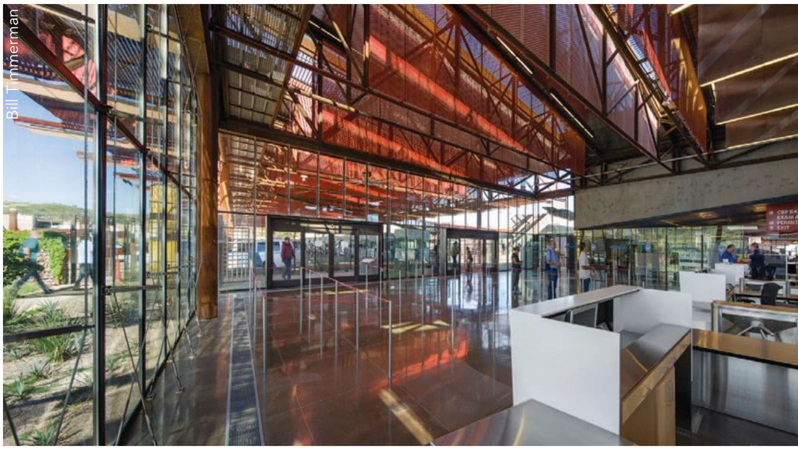
Structural Engineer
Bakkum Noelke Consulting, Phoenix

General Contractor
Hensel Phelps, Phoenix

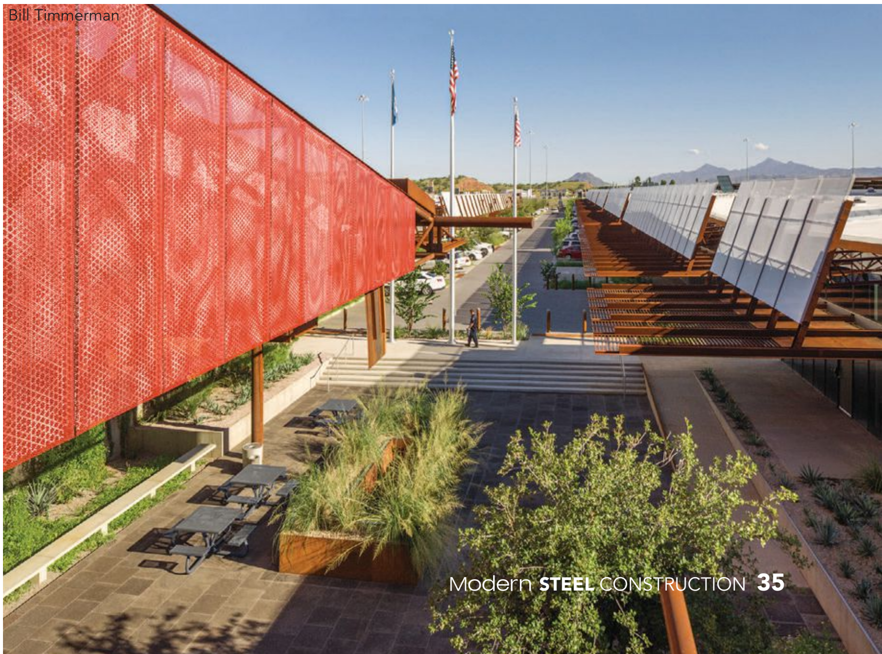
Steel Fabricator and Erector
S&H Steel, Gilbert, Ariz.


Bill Timmerman

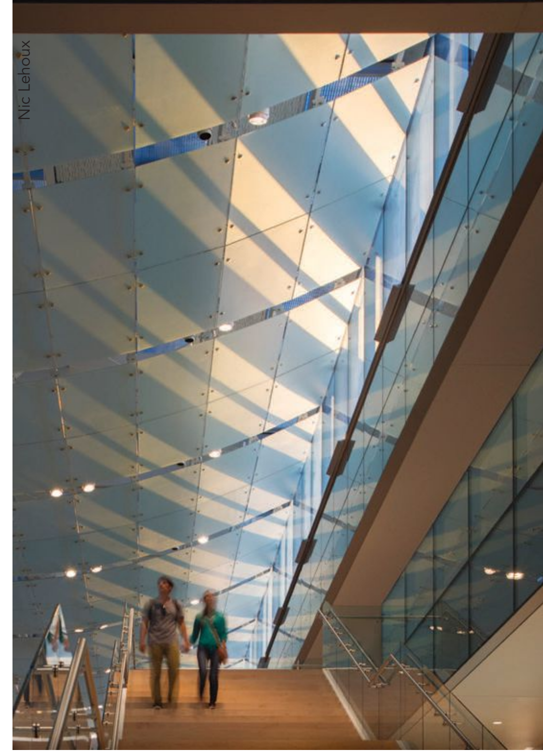
"Simple materials beautifully detailed. The design fits the desert location."
—William Bradford


Bill Timmerman


Bill Timmerman

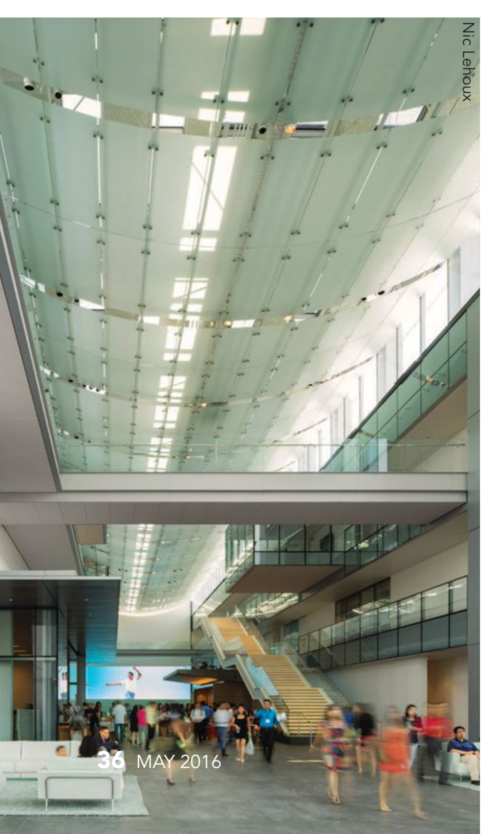

Bill Timmerman

Nic Lehoux



Nic Lehoux

Nic Lehoux



Nic Lehoux

“The design is sleek and the cantilevered conference rooms are wonderful.”
—Paula Pritchard

Bohlin Cywinski Jackson

Bohlin Cywinski Jackson

Bohlin Cywinski Jackson

NATIONAL AWARD $15 Million to $75 Million
Nu Skin Innovation Center, Provo, Utah

THE NU SKIN INNOVATION CENTER transforms Nu Skin Enterprises' corporate campus in Provo, Utah, into an inspiring new headquarters that reflects the modern sensibilities of a global company.

The new $74 million, 170,000-sq.-foot facility houses research laboratories, conference spaces, two cafés, a retail storefront, a fitness center, three floors of executive offices and a data center in a series of elegant, light-filled spaces that reflect the aspirational qualities of the Nu Skin brand and its line of anti-aging products.

The new facility is the culmination of three components: a three-story building to the north, a six-story steel-framed building to the south and a four-story steel-framed atrium. A canopy on the south elevation that extends the interior spaces into the landscape is supported by 18-ft-tall, 6-in.-diameter HSS columns, and an airfoil-shaped mechanical penthouse tops the south building.

Typical framing for this building is composed of structural steel columns supporting composite steel beams and floor slabs. One of the first-floor meeting rooms needed to be column-free, so six tower columns are transferred at the third floor and are supported by two 67-ft-long built-up steel plate girders in the north-south direction and two 85-ft-long story-deep trusses spanning east-west.

The atrium is the heart of not only the two new buildings, but the Nu Skin campus as a whole. The glass roof is supported by steel girders that span between the north and south buildings, along with intermediate steel beams and tension bracing. The translucent glass ceiling is hung from delicate trusses, which are in turn suspended from the roof girders. The 10-ft, 6-in.-wide feature stair rises 29 ft between levels 1 and 3 and runs 93 ft continuously along the atrium; the stringers and treads and both fabricated with steel channels.

*For more on the Nu Skin Innovation Center, see "Extreme Makeover" in the February 2016 issue, available at **www.modernsteel.com**.*

Owner
Nu Skin Enterprises, Provo, Utah

Architect
Bohlin Cywinski Jackson

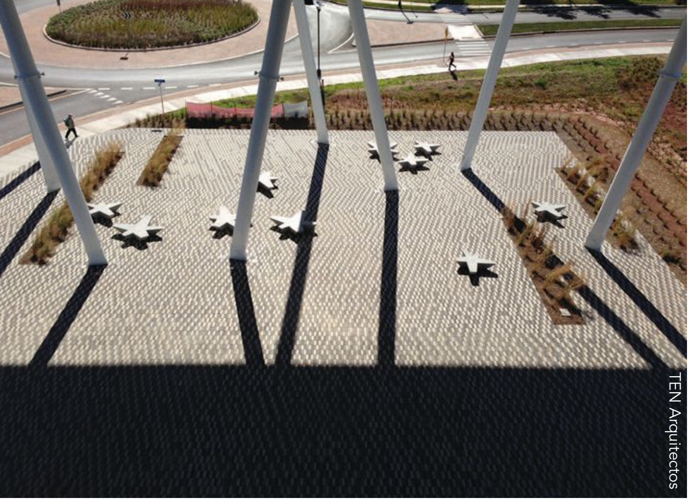
Structural Engineer
Magnusson Klemencic Associates, Seattle

General Contractor
Okland Construction, Salt Lake City, Utah

Steel Team

Fabricator
Tech-Steel, Clearfield, Utah

Bender-Roller
Paramount Roll & Form, Santa Fe Springs, Calif.



TEN Arquitectos

TEN Arquitectos

NATIONAL AWARD $15 Million to $75 Million
Rutgers University School of Business, Piscataway, N.J.

THE 150,000-SQ.-FT RUTGERS BUSINESS SCHOOL is more than just an academic building; it also serves as the gateway to Rutgers University's Livingston Campus in Piscataway, N.J.

Organized into three layers—classroom, office and public spaces—the building consists of two towers connected by a "floating" L-shaped portion that features a 92-ft, column-free span (made possible by 60-in.-deep built-up plate girders) This connector portion is supported 60 ft above ground level by 12 exposed 65-ft-long, 36-in.-diameter round sloping columns. These columns are filled with self-consolidating concrete and coated with intumescent paint.

Due to the open nature of the building, numerous openings in the floor diaphragms were required. Along with the L-shaped building mass connecting the two towers, these openings spurred the team to carefully follow the load paths of the wind- and seismic-induced loads into the building's exposed X-brace framing. In order to mitigate vibration issues in the floating L-shaped portion of the building, the design team created a finite element model was created to study human induced vibrations for floating L-shaped portion, and a time history analysis, following the AISC Design Guide 11: *Floor Vibrations Due To Human Activity* recommendations, was also performed. Fortunately, the studies confirmed that human-induced vibrations would be considerably less than the acceptable vibration levels defined in the guide.

The building, like all new construction at Rutgers, is LEED Silver equivalent. Solar panels located above the adjacent parking lot provide power, and cooling and heating needs are augmented by neighboring geothermal bore fields built below the quad. All storm water is managed through bioswales and retention ponds on-site. In addition, the atrium provides high levels of daylighting, and the mechanical system is optimized for lower energy use.

For more on the Rutgers University School of Business, see "Elevating Business" in the January 2016 issue, available at ***www.modernsteel.com***.

Owner
Rutgers University, Piscataway, N.J.

Owner's Representative
Structure Tone, New York

Design Architect
TEN Arquitectos, New York

Executive Architect
Richard Bienenfeld AIA, New Rochelle, N.Y.

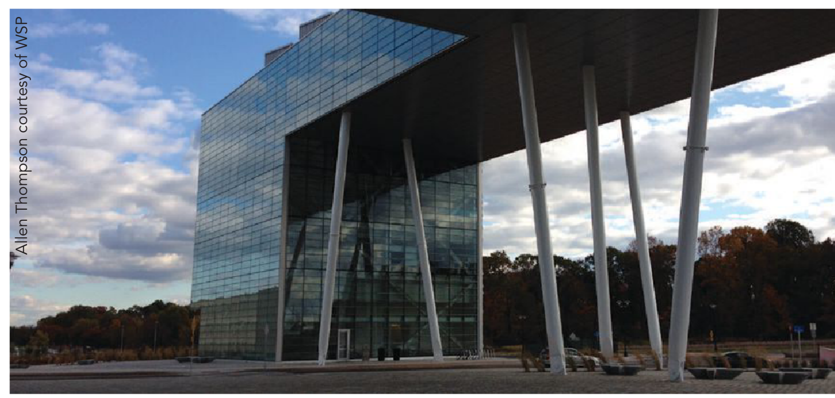
Structural Engineer
WSP, New York

General Contractor
Century 21 Construction, River Edge, N.J.

TEN Arquitectos

Allen Thompson courtesy of WSP

"A project that invites you in and begs you to touch and wonder at it. It's easy to forget that it's a functioning building and not just a wonderful piece of sculpture." —Jason Stone



Allen Thompson courtesy of WSP

THE AMERICAN PHYSICAL SOCIETY'S (APS) newly renovated headquarters in Ridge, N.Y., is somewhat of an object lesson in physics.

Founded in 1899, the nonprofit organization's objective is to "advance and diffuse the knowledge of physics," and its new facility does just that with its new addition. Because the Long Island Pine Barrens Preservation Act prohibited expanding the building's footprint, the building had to expand upward. The result is an 18,000-sq.-ft level atop the original one-story 30,000-sq.-ft building.

The team was tasked with meeting the project's $6 million construction budget without interrupting the operation of the office—which eliminated the option of leasing temporary space and temporarily relocating APS' 150 employees—so all construction was achieved with the building fully occupied.

The existing structure—footings, columns, roof framing and lateral system—did not have the capacity to support the second story loads. The long-span design with a column grid as large as 38 ft by 62 ft resulted in a spacious, column-free and architecturally flexible interior with minimal penetrations through the existing ground floor. The majority of the perimeter columns were located outside the walls of the existing building, forming an exoskeleton in the courtyard.

The W12 columns of the new frame are situated 5 ft to 9 ft outside the perimeter of the existing structure, which eliminated any interference with the existing foundation and allowed most of the foundation work to be done outside the building. Only six columns penetrate the interior of the existing building, and these columns and footings were installed one at a time, with limited impact to the occupied building. The new second floor is elevated 4 ft over the existing roof, with the interstitial space housing mechanical services. In addition, the existing roof served as a working platform for the erection of the addition.

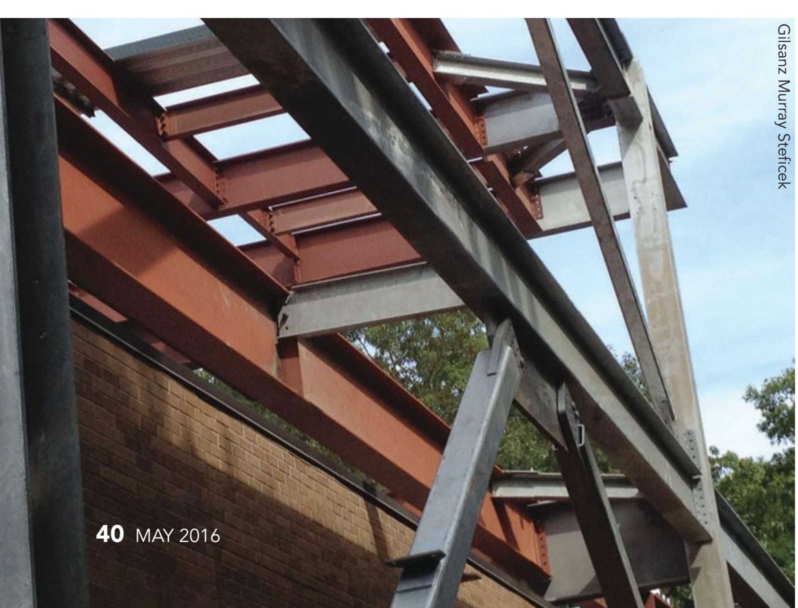
The thermal analysis of the exoskeleton accounts for the differential expansion and contraction created by the temperature differences between the interior and the exterior of the building. All members that penetrate the building envelope are insulated for the first 8 ft as they enter the building. A series of skewed W8×24 members brace the exterior beam-column connections to not only resist lateral loads but also to dissipate the increased stresses caused by the temperature differentials.

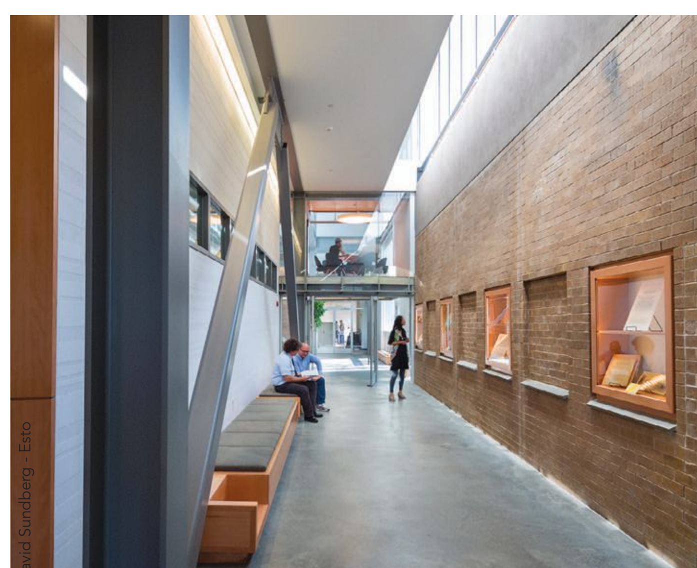
The long-span design took into account the deflection, vibration and construction of the steel members. The 57-ft-long W24 filler beams span north to south between W30 to W36 east-west girders, which in turn frame into columns at the interior. At the north side, the girders are offset from the columns, serve as spandrels beams and are located within the building envelope. These spandrels frame into 62-ft-long W30 beams at the north-south column line that extend through the envelope and connect to the exoskeleton columns.

The building's lateral system consists of eight braced frames,

NATIONAL AWARD Under $15 Million
American Physical Society, Ridge, N.Y.

David Sundberg - Esto


Gilsanz Murray Steficek


David Sundberg - Esto

which use diagonal HSS8×8 braces that frame at three locations around the perimeter of the exoskeleton, two locations within the existing single-story section of the structure and three visually exposed locations at the new double-height interior atrium. The existing one-story building was laterally upgraded by tying it to the new two-story structure so that both behave as one.

Floor slabs consist of 2½-in. normal-weight concrete on 3-in. metal deck. To moderate deflection that occurs in long-span frames, the concrete was placed from the center of the diaphragm outward. The design called for slip joints at the top of all interior partition walls so that deflection under snow loads or other live loads would not cause interior partitions to buckle.

The exoskeleton supports an eco-mesh made of 0.135-in. woven wire mesh with a unique bridge wire for stabilization and framed on four sides with 16-ga metal channel. These "green screens" carry native vines, enveloping the complex in a green blanket and mitigating solar heat gain from the building's façade.

The exposed portion of the existing roof was converted into a light-weight green rooftop, over which shorter green screens are supported by HSS6×6 "eyebrows" that cantilever from the new second-floor roof. A new second-floor terrace was designed to accommodate possible future expansion within that area, and a new mezzanine level over the western portion of the atrium is suspended from the upper structure using W6 and W8 hangers. Interior steel was left exposed and fire-protected with intumescent paint.

This project was developed using Revit, and a BIM consultant facilitated coordination between the design team and contractors from the outset and reduced the duration of design development by avoiding any major unanticipated interference. This process also enabled the structural engineer to verify the alignment of steel members within the construction documents and confirm the connections and load transfers. The collaboration between the architect's talent for aesthetic emphasis and the engineer's innovative structural design resulted in a state-of-the-art, high-performance and cost-effective facility.

Owner
American Physical Society, Ridge, N.Y.

Owner's Representative
LePatner & Associates, New York

Architect
Marvel Architects, New York

Structural Engineer
Gilsanz Murray Steficek, New York

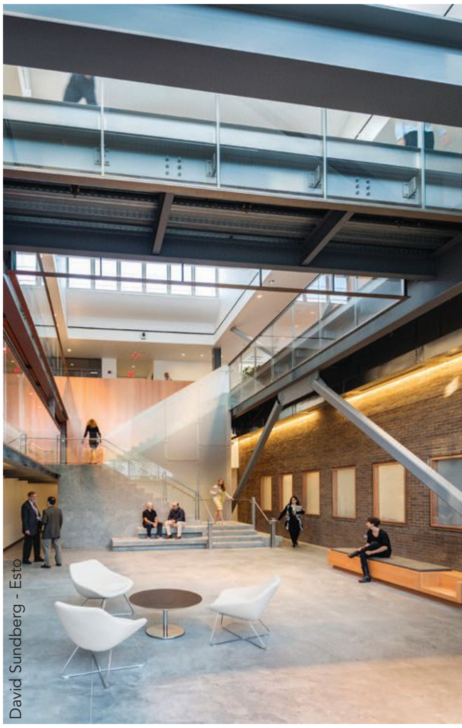
General Contractor
T.G. Nickel & Associates, Ronkonkoma, N.Y.

Steel Fabricator and Detailer
STS Steel, Schenectady, N.Y. AISC CERTIFIED FABRICATOR

David Sundberg - Esto

David Sundberg - Esto

"An honest project that celebrates the existing building and steel expansion structure without overwhelming you." —Jason Stone



David Sundberg - Esto

Gilsanz Murray Steficek

Gilsanz Murray Steficek

Juan Miró

Juan Miró

Juan Miró

Juan Miró

Juan Miró

NATIONAL AWARD Under $15 Million
Vertical House, Dallas, Texas

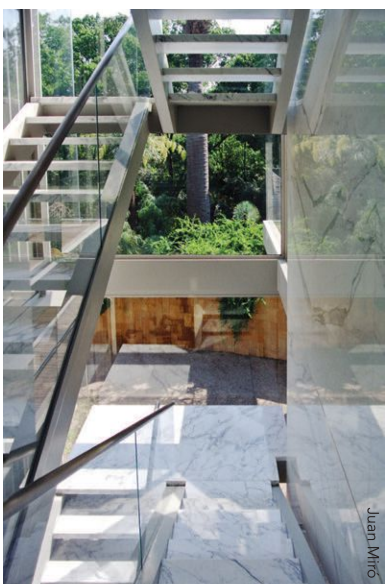
IN A METRO AREA known for sprawl, this Dallas house bucks the trend.

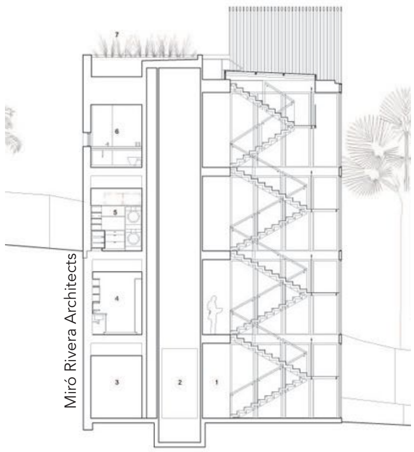
Located on one of the highest sites in the city, the vertical volume of the five-story residence rises 58 ft above the surrounding landscape and is rotated from the adjacent neighborhood grid to capture views of the downtown skyline.

The compact footprint of the project is sectionally integrated into the site via a carved spiraling entry drive that allows for an almost subterranean experience, while the verticality of the two exterior screen walls accents the home's slenderness and height. This curvilinear geometry emanates from the master suite and extends out into the landscape. Visitors to the house arrive at natural grade and then cross over the excavated area via an internally stabilized architecturally exposed structural steel footbridge to the front entry. The 4-ft-wide foot bridge is framed with a pair of C15×50 edge stringers, each spanning 43 ft. Vertical and horizontal diaphragm cross-bracing is provided in panel bays of 4 ft, 3½ in., with a steel grating floor accented by thin strips of glass flooring on the edges.

The house is conceived as two interlocking oppositional volumes: one highly transparent and oriented toward distant views and one solid and oriented towards the site. The taut transparent volume is delicately flanked at either end by a vertical steel screen of HSS6×2 columns spaced at 6 in. on center, which simultaneously and elegantly shades and structurally supports this portion of the house.

The interior elevated floor framing consists of a series of very shallow wide-flange beams with shear studs, supporting a 1½-in.-deep composite metal deck filled with 2¾-in. concrete above the deck flutes. Wide-flange floor framing ranges in size from W10×17 to W10×100, and each beam is connected via welded moment connections to a stiff C15×50 steel channel along the perimeter walls, which distributes the vertical loads from the conventionally spaced interior beams to the closely-spaced exterior screen columns. The steel HSS curtain, which provides vertical support for the floors, is set 1 ft, 4 in. clear of the floor edge. This visual break between the floor and supporting screen of columns was critical to the ar-





"I want to live there!"
—Paula Pritchard

chitectural effect. Each screen column, positioned proud of the exterior walls, is connected to the perimeter channel via a vertical ¾-in.thick steel plate at each floor level; each plate not only transmits the dead and live loads to the columns, but also provides the required stability bracing against weak axis flexural buckling of each 58-ft-tall screen column via weak-axis bending of the cantilevered plate. The stresses in the connection system were relatively small when compared to the nominal capacities, as the structural design of each plate was materially governed by the flexural stiffness requirements for nodal bracing.

The solid volume, clad in locally abundant limestone, is tectonically differentiated from its butt-glazed counterpart with inset windows, providing a pronounced shadow line at penetrations. A glass and steel "floating stair," along with an adjacent elevator core, provide the primary vertical circulation of the residence. The steel stair is comprised of 1-in. × 4-in. steel plate stringers oriented in a zig-zag geometry that follows the pattern of the tread and riser plates. The stair terminates at an inviting fifth-level open-air roof terrace that provides breathtaking 360° views of the city; the terrace is shaded from the afternoon sun by an extension of the HSS6×2 screen columns, which folds at the roof level to form a horizontal roof trellis. The intermediate stair landings are cleverly suspended via two disguised thin steel rods; each rod hangs from the screen-turned-trellis, created a "floating stair" aesthetic. Captured rain water from the roof will is used throughout the site as supplement to surrounding landscaping.

Owner's Rep and Architect
Miró Rivera Architects, Austin, Texas

Structural Engineer
Datum Engineers, Austin, Texas

THE SCOPE of the Hillary Rodham Clinton Children's Library and Learning Center is, like its namesake, rather ambitious.

The new facility is based on experiential learning, where children are educated through hands-on activities that teach life skills needed to become responsible adults. Referred to as a "community-embedded, supportive learning center," this library offers not only books, but also a performance space, a teaching kitchen, a greenhouse, a vegetable garden and an arboretum. The challenge from the library's director was to create a playground without equipment, where nature and imagination combine to create grand adventures on a six-acre site in the heart of Arkansas' capital city.

Sited adjacent to Interstate 630, which bisects the city, the project incorporates the sustainable principals of protecting and restoring habitats, storm water quality and control and heat island mitigation. The site filled a significant hole identified in a neighborhood planning study, which concluded that a community center was greatly needed in the area. The architecture speaks to the the technical nature of construction, expressing all connections and systems, much like an Erector Set or Tinker Toys. The steel structure's honest expression and craft of its detailing allowed every column, beam, bolt and connection to be exposed in functional fashion. The great reading room's roof lifts to the north in response to the idea of "lifting expectations," and the entire upper library becomes loft-like, with tree house study rooms cantilevered and floating in balance over educational spaces below. Like a barn, the space is a physical, flexible container where objects can be rearranged as needed, and the steel spans were facilitated minimal columns (four).

The upper library sits at the level of the elevated Interstate, allowing kids to watch traffic zoom through the trees. Just as importantly, traffic can see the entire open floor of the library. By contrast, at the ground level the sound of rustling water overcomes the highway noise. The building's base reaches out and touches the water with "reading steps." Vertical interstitial spaces where the square upper library plan and broader building parallelogram overlap become visual and physical connectors to education programs below and the landscape beyond. Both open stairs physically extend outside the building envelope proper, giving the feeling of being out in the site. The auditorium reading steps serve as monumental stair, hang-out space and a movie/performance theater traditional seats.

The west façade's 15-ft-deep porch and fritted glazing minimize heat load while maximizing light and views. The roof directs water to large scuppers, flowing as waterfalls to spillways, expressively feeding the wetland. The Tinker Toy-like sculptural tube structure draws pedestrians into the site, leading to the plaza and amphitheater beyond. Extended steel beams at southern roof edges are capped with galvanized steel grates, expanding sun protection. The building's main use is expressed in a simple, colorful gesture: the giant letters "r-e-a-d." The steel letters were made to be climbed on and have become a favorite family photo opportunity.

Owner
Central Arkansas Library System, Little Rock, Ark.

Architect
Polk Stanley Wilcox Architects, Little Rock

Structural Engineer
Engineering Consultants, Inc., Little Rock

General Contractor
East Harding Construction, Little Rock

Timothy Hursley

MERIT AWARD Under $15 Million
The Hillary Rodham Clinton Children's Library and Learning Center, Little Rock, Ark.

Timothy Hursley

Timothy Hursley

Timothy Hursley

Timothy Hursley

Timothy Hursley

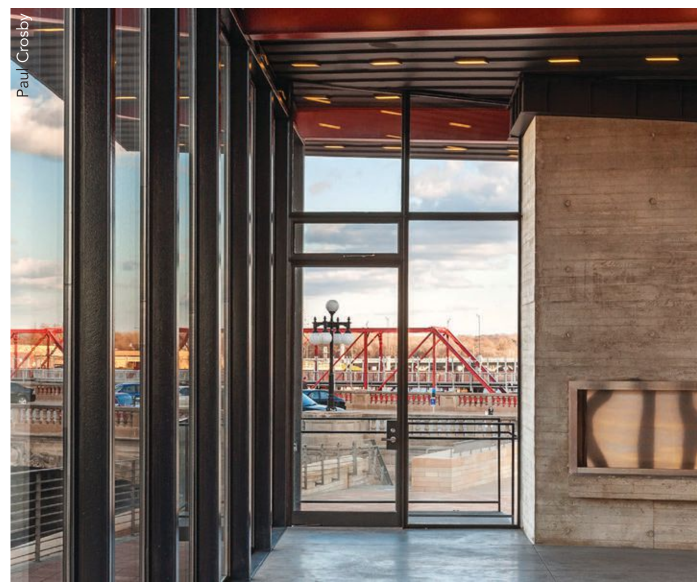
"With a community-driven mission,
the library showcases steel in its purest form and use
in a whimsical but purposeful manner." —Wanda Lau

PSW Architects

Timothy Hursley

"The sleek metal roof cuts through the sky like the razorblade." —Colter Roskos

MERIT AWARD Under $15 Million
Principal Riverwalk Pavilion,
Des Moines, Iowa



THE PRINCIPAL RIVERWALK PAVILION is one piece in a plan to encourage Des Moines residents and visitors to take advantage of the Iowa capital's scenic riverfront.

Situated next to a new recreational trail and waterfront promenade and riverfront promenade at the west end of the historic Court Avenue Bridge, the triangular 2,200-sq.-ft pavilion was designed to mimic the prow of a boat. The $1.2 million angular space is clad with a folded black zinc skin and roof. The west façade is "louvered" to allow for views upriver to the north while blocking the harsh, western sun. To accomplish this visual effect, an exposed steel frame was used to support the zinc skin, and steel tube sections are concealed within the skin itself. This structure discretely accommodates the multiple cantilevers and reduces the apparent thickness of this folded plane.

A moment frame system supports the gravity loads and resists the lateral loads imposed on the building. A row of W14×30 columns along the west side of the building spaced at 16 ft on center support one end of the W14×30 roof beams spaced at the same dimension, and a welded moment connection was used at the top of the column-and-beam intersections.

The W14×30 beams were cantilevered on the east side of the building over the top of a series of built-up column sections that acted as the prop. These welded built-up column sections consisted of back-to-back C6×13 with a ½-in. steel plate sandwiched between them. The plate extended 2½ in. past the flanges of the channels to provide support and a place to fasten the window glazing system. This detail allowed the columns to appear as a part of the glazing system while still allowing it to be a continuous plane from the exterior; the profile also allowed for the desired unobstructed views of the river and river walk.

For more on the Principal Riverwalk Pavilion, see "Back to the River" in the November 2015 issue, available at www.modernsteel.com.

Owner
City of Des Moines, Des Moines, Iowa

Architect
Substance, Des Moines

Structural Engineer
Charles Saul Engineering, Des Moines

General Contractor
Covenant Construction Services, Waukee, Iowa

Scott Adams

Scott Adams

Scott Adams

Scott Adams

> "Interactive steel allows the Gourd to be more than just a sculpture. Children will enjoy this one for many years to come." —Brian Wessel

Scott Adams

Patrick Winn

SCULPTURE Jury Recognition
The Gourd, San Antonio, Texas

EVER WONDERED WHAT IT'S like to hang out in a birdhouse? Head to San Antonio and seek out the Gourd.

Built for the San Antonio Botanical Gardens' human-sized birdhouse competition, the Gourd is a testament to working for and with community, and offers a playful platform in which to contemplate the complex relationship between humans and the natural world through expressed structure.

The Gourd is built out of 70 plates of 12-ga weathering steel that are wrapped around a robin's egg blue internal octahedron structure. More than 1,000 holes dot the sculpture, each of them fitted with a Ball Mason jar that brings light to the interior. Each steel plate, unique in shape and size, emulates the pattern of a dragonfly wing. The entire thing is held above the ground via schedule 80 pipe legs and is accessible via a thin metal stair. The three legs attach to concrete spread footings that are connected via underground tension cables and turnbuckles that prevent each footing from splaying in the direction of the angled leg.

The steel octahedron structure is fabricated from rolled arcs of schedule 40 pipe connected with custom laser-cut and bent steel hubs. Each hub is designed around an X-shaped disk with four rounded arms, laser cut from ½-in. steel plate, and then bent 15° inward. On the upper end of the Gourd, these disks have a 3-in. extension pipe connecting a round bolt plate for fastening the steel skin. At the lower three connection hubs, the extension pipe is fastened on both sides of the X-shaped disk and is gusseted with ½-in. plate for additional transfer of lateral loads to the legs.

Bent by hand through the process of assembling each faceted plate together, the steel skin becomes a self-supporting tensile balloon once fully assembled. As each plate flexes inward, the skin self inflates while also providing the tensile support to lift the neck of the bottle gourd into its cantilevered position.

*For more on the Gourd, see "Small Space, Big Imagination" in the "What's Cool in Steel" feature in the August 2015 issue, available at **www.modernsteel.com**.*

Owner and Architect
Overland Partners, San Antonio

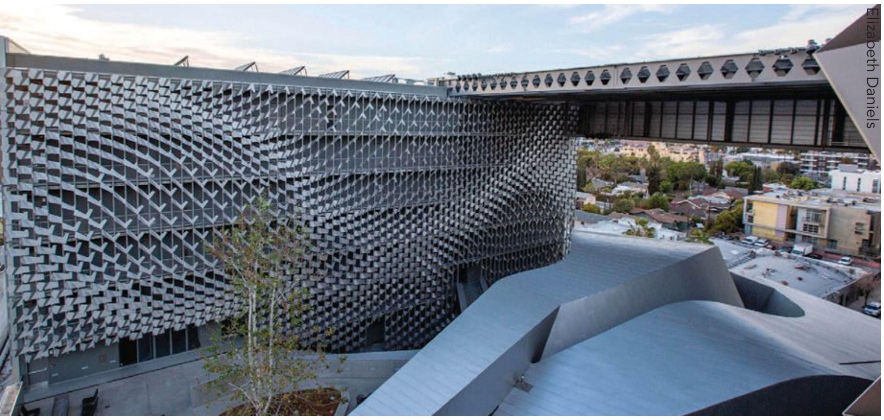
Structural Engineer
Datum Engineers, San Antonio

General Contractor
Overland Workshop, San Antonio

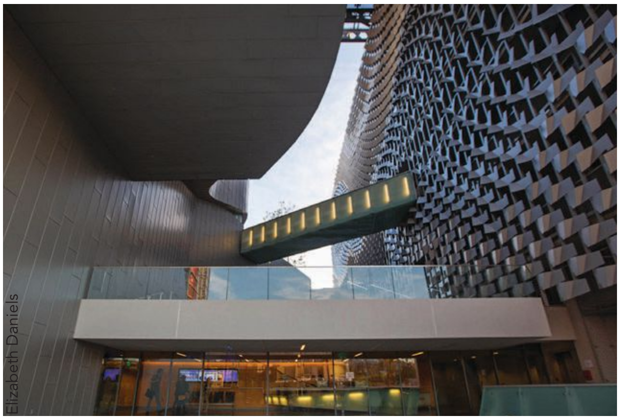
Elizabeth Daniels

Photekt

PRESIDENTIAL AWARD OF EXCELLENCE IN ENGINEERING
Emerson College Los Angeles



Elizabeth Daniels



Elizabeth Daniels

EMERSON COLLEGE LOS ANGELES brings the East to the West.

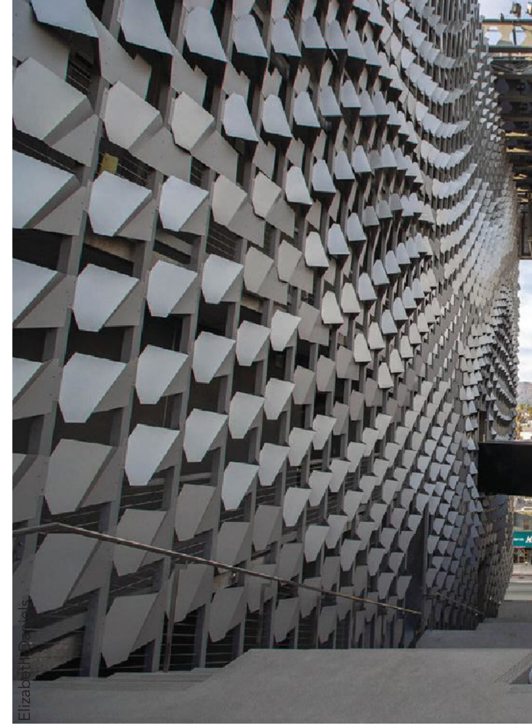
Located in Hollywood, the $85 million building, which serves as the West Coast home of Boston-based Emerson College, is a small-scale university campus containing below-grade parking, classrooms, performance space, offices and student housing. Located on Sunset Boulevard, the facility adds a dynamic new focal point to the neighborhood while serving as a conduit for Emerson students to intern in the nearby entertainment industry during a work/study semester in Los Angeles. The complicated forms and interconnecting spaces required creative structural problem solving to maintain efficiency of material and constructability while upholding the architect's vision.

The virtually square footprint of the building is based three stories below grade and rises in that shape up to the third level. Above that, the square shape of the building is broken into two separate pieces: the eastern tower, a slender rectangular floor plate housing residential units; and the western tower, a combination of academic space and administrative offices in an irregularly shaped slab adjoined with residential units. The two towers continue to climb, with the western tower's shape continually changing, until the sixth level, where the western tower reduces to a near-mirror image of the eastern tower. The towers terminate at the 11th/roof level, where they are connected by a helistop spanning over the academic structure below.

Mild reinforced concrete slabs are the gravity framing system for the parking, administrative and office spaces. The residential towers are framed using post-tensioned concrete slabs, and the academic form is supported by steel framing and composite deck. Interconnectivity of the multiple systems was addressed by careful detailing and consideration of the construction sequence. The amorphous shape of the academic building presented further structural challenges because of the two intertwining forms and varying floor-to-floor heights between residential and academic program areas. The academic building features a hanging boardroom, simultaneously reinforcing the architect's desired massing and providing a column-free entry pavilion at the second level. To support the academic forms, multiple cantilever elements were outfitted with steel cantilever trusses, one supported by the concrete elevator core walls and the other supported off of steel columns terminating at concrete transfer girders. Discontinuous special concentric braced frames and discontinuous steel moment frames were used to transfer lateral forces from the roof of the academic building down to the supporting concrete transfer diaphragm at level 3.

The helistop that connects the two towers is supported by eleven 120-ft-long, 5-ft-deep castellated beams. These beams add structural load capacity and stiffness without adding weight.

John A. Martin & Associates, Inc.



Elizabeth Daniels

John A. Martin & Associates, Inc.

"A jaw-dropping, monumental accomplishment in structural expression and architectural gusto. This is quite unlike anything I have ever seen."
—Kem Hinton

Elizabeth Daniels

The connection of the two towers, at both the roof and bridges at levels 5 and 6, created structural challenges accommodating the differential deflection of the separated elements. To minimize the movement of the towers, which tended toward deflection amplified by torsional effects, the helistop was ultimately used as a diaphragm to control the torsional deflection of the residential towers. This allowed separation joints between elements to be minimized and provided reduced deflection criteria for the sensitive curtain walls and scrims cladding the towers' exteriors.

A singular and complicated design like Emerson College is best created and explained using three-dimensional models. Multiple building information modeling (BIM) platforms were used by the design teams but were combined to coordinate the structure with the architecture. In developing the structural model for the academic form, multiple iterations of geometry refinement were coordinated with the architect's model. The thickness of the exterior assembly was determined by the factory-assembled panel system, including tolerance and connection details, and the structural shape was set using a 3D shell created by offsetting the architect's exterior shape. Through close collaboration, both the aesthetic and functional intentions of the architecture were used to aid in shaping the appropriate structural systems and geometry. ■

Owner
Emerson College, Los Angeles

Owner's Representative
Silverman Associates, Newton, Mass.

Architect
Morphosis, Culver City, Calif.

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

General Contractor
Hathaway Dinwiddie Construction Co., Los Angeles

Steel Team

Fabricator and Detailer
Schroeder Iron Corp., Fontana, Calif.

Erector
Bragg Crane & Rigging, Co., Long Beach, Calif.

FRENCH Connection

BY BRIAN MCELHATTEN S.E., P.E., AND CHELSEA ZDAWCZYK, P.E.

The new home for an international school in Chicago integrates structural value with architectural vision while keeping future expansion in mind.

LAST FALL MARKED the start of Lycée Français de Chicago's 20th academic year—and its first in its new home.

Founded in 1995, the school has seen significant growth over years, expanding from an initial student population of less than 150 students to its current enrollment of more than 700. In addition to growing in size, the organization has matured over the years, developing a strong connection to the city and solidifying its mission of providing a multicultural, bilingual education with an emphasis on civic-mindedness and cultural engagement.

Having outgrown its space in Chicago's Uptown neighborhood near the lakefront, the school established an ambitious vision for the development of a new urban campus. Its top priorities included satisfying an immediate need for additional student capacity, creating an environment that reflects its mission in a unified and modern architectural language and developing a master plan for future expansion of the campus. These ambitious goals were met by an equally ambitious budget: $28 million for total construction costs (including site work but not land purchase).

With the completion of its new 3.8 acre campus in the city's Ravenswood neighborhood, roughly two miles from its original location, the school now has a state-of-the art facility that solidifies its position in the academic and cultural fabric of Chicago and empowers the organization to achieve its vision for educating future generations. The new 85,000-sq.-ft building, spread over two wings, incorporates space for as many as 800 pre-K through 12th-grade students. The four-story west wing houses classrooms, labs, a library and central atrium, and the two-story east wing includes a cafeteria, additional administrative offices and a full-size gym. Future growth is accommodated with plans for a 40,000-sq.-ft two-story expansion to the east wing.

Adding Value

With a tight construction budget of $28 million, it was clear from the start that all aspects of structural design would be weighed against the value they added to the overall project and that no decision could be taken for granted, especially the choice of the primary structural system. Early in the schematic design phase, several structural options were examined, including a precast solution. However, based on initial calculations and discussions with the architect and contractor, a steel gravity system had clear advantages given the desired architectural expression of the façade, the tight budget, the presence of numerous cantilevers, shallow floor-to-floor heights and the need to be able to add on to the structure at a future time.

The overall gravity system in the west wing typically consists of steel columns supporting composite metal deck on steel beams and girders. The structural bay dimensions of approximately 25 ft by 30 ft are easily spanned by W16 beams and W24 girders. In the east wing, a similar system is used; however, larger spans required the use of W18 beams and W30 girders. At the gym, 36-in.-deep steel open-web joists are used for the 70-ft roof span. For the lateral system, the west wing uses exposed concrete core walls in the three stair cores, while the east wing uses steel braced frames.

All photos: © STL Architects

As with many projects, the aim of the overall structural scheme was simplicity and general uniformity, allowing for economy through repetitive use of details. However, specific architectural design elements in various parts of the building necessitated specific and unique structural solutions. In response to the Lycee's community-centric ideology, a modified double-loaded corridor scheme was used for the west wing layout. Classrooms are pushed to the north and south edges of the plan, taking in direct natural light and engaging the external environment. At the center of the plan, a light-filled atrium between Level 1 and the roof, surrounded by open corridors, strengthens the sense of internal community by creating a visual connection between all academic levels (pre-K at the bottom, high school at the top). Gathering spaces at each end provide further opportunities for planned and ad-hoc interaction within the building. To keep these spaces as open as possible, the column lines are held back approximately 7 ft from the edge of the atrium opening (aligned with and hidden in the classroom walls), and steel cantilevered beams (typically W16 sections) support the corridors surrounding the atrium.

At the east end of the atrium, a feature stair between the first and second floor creates a focal point and provides a visual screen between the busy main entrance and the academic areas. The stair is a hybrid structure, an exposed concrete slab suspended from the third floor by eight slender steel rods. Architecturally detailed clevis connections transfer the weight of the slab into the rods, and the lightness of the steel suspension structure provides a visually striking contrast to the heavy solid form of the concrete stair slab.

▲▼ The new 85,000-sq.-ft Lycée Français de Chicago, spread over two wings, incorporates space for as many as 800 pre-K through 12th-grade students.

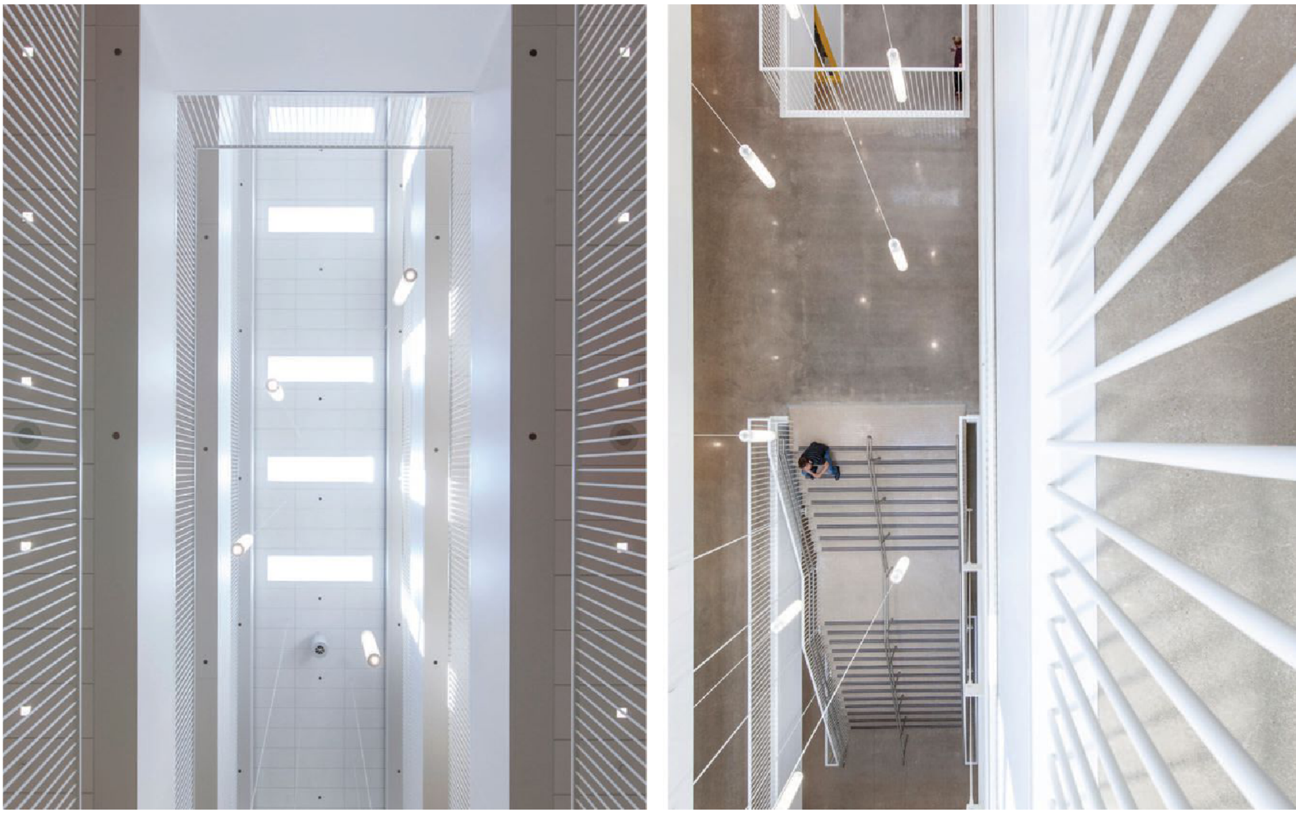
Brian McElhatten is an associate principal and **Chelsea Zdawczyk** is a senior structural engineer, both with Arup's Chicago office.

Future growth is accommodated with plans for a 40,000-sq.-ft two-story expansion to the east wing.

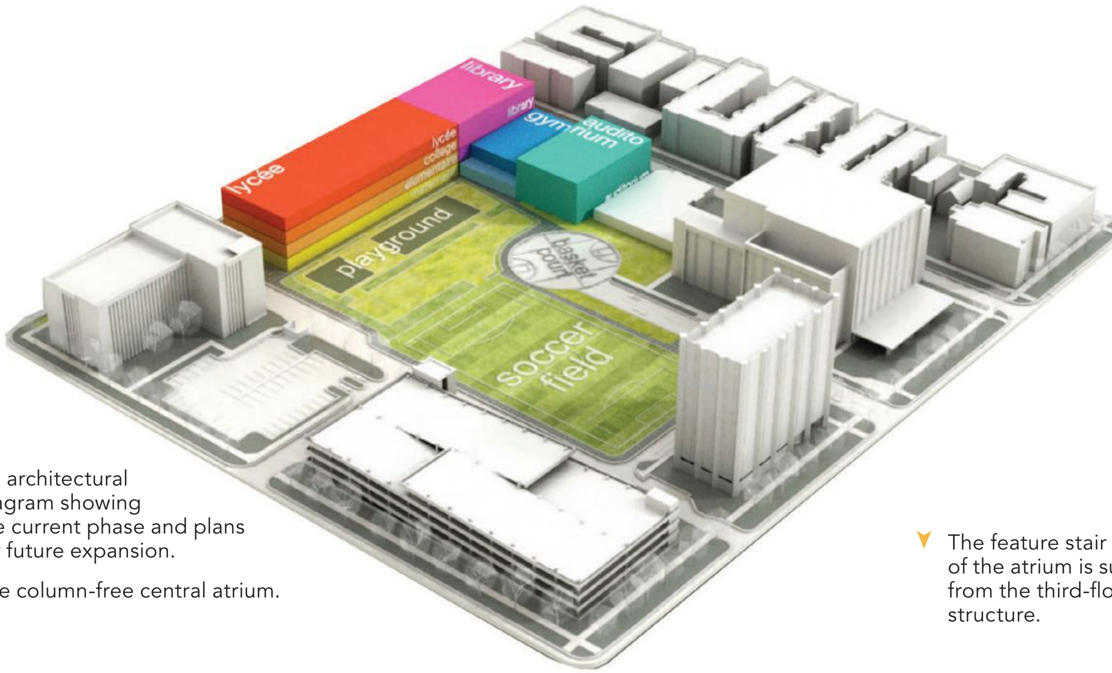
The setback at the main entry in the east wing required transferring braced frame forces.

In contrast to the sense of openness and verticality in the west wing, the east wing presented significant challenges due to the constraints of the relatively short floor-to-floor heights coupled with the need for deeper beams due to larger spans at the cafeteria. W30 beams were required for the spans, but these did not allow sufficient space for routing MEP services from the rooftop mechanical equipment. As a result, large beam penetrations were incorporated using guidance provided by AISC Design Guide 2: *Design of Steel and Composite Beams with Web Openings*. In addition, the existence of a large setback at the northeast corner, which creates a recessed and column-free exterior entry area, required that the second floor be cantilevered approximately 13 ft beyond the first floor perimeter column line. Combined deflections at the tip of the cantilevered floor framing were an initial concern, but the heavy W30 beams were able to satisfy the requirements.

In relation to the lateral system, these same architectural features, as well as the location of future programmatic elements, limited potential locations for braced frames in the east wing. Additionally, due to the offset at the northeast corner, it was not possible to create a vertically continuous frame on the north side of the east wing. Forces from above must transfer through horizontal steel bracing at the Level 2 to an adjacent frame between Levels 1 and 2.



Looking up and down through the atrium.



An architectural diagram showing the current phase and plans for future expansion.

The column-free central atrium.

The feature stair at the end of the atrium is suspended from the third-floor structure.

Overall 3D view of the structural Revit model.

Future Expansion

The master plan for the new facility includes provisions for future expansion, including the addition of two floors on top of the east wing. Although the budget was tight, the school had the foresight to invest in upgrading the structural design now to support the future loads as opposed to taking on costly and disruptive strengthening work later. Columns, bracing and foundations were upsized as necessary to deal with the additional forces and stiffness requirements, and future connections also needed to be thought out in order to minimize the need for future field modifications to the existing structure. The use of steel simplified the design since unobtrusive detailing could be incorporated to facilitate future column splices and beam connections. In numerous locations, end plate connections were anticipated to prevent the detailing from protruding outside the building envelope.

During the design process, the project scope grew to include the full design (through permit drawings) of a potential 300-seat multipurpose auditorium space, which would allow for expansion of the school's arts program pending additional fund raising efforts. The siting of the auditorium will be directly adjacent to the gym and connected to the gym and main academic areas by a future corridor on the west side.

The auditorium design uses a "box-in-box" design to provide acoustic separation for the performance space; an exterior steel gravity structure with steel braced frames on all four sides allows the auditorium to be fully independent from the gym and east wing. The interior box is formed by full-height concrete masonry unit walls on three sides and a concrete circulation core at the rear of the auditorium, and the balcony seating will be supported by cantilevering steel raker beams from embedded connection plates in this core wall. These beams will support precast panels to form the stepped seating. The spans over the auditorium are similar to those of the gym, but the roof structure must also resist concentrated loads from catwalks and rigging. As such, 48-in.-deep steel open-web joists and a metal deck diaphragm were incorporated to provide a cost-effective, lightweight and structurally simple means to carry these loads to the perimeter columns.

The design for the school's new campus presented numerous design challenges. However, the adaptability of steel meant that solutions could be found that fit a tight budget and short timeline and facilitated the realization of the client's vision for the project. The result is a new and inspiring academic environment for educating the next generation of global citizens. ■

Owner
Lycée Français de Chicago

General Contractor
Bulley and Andrews

Architect
STL Architects

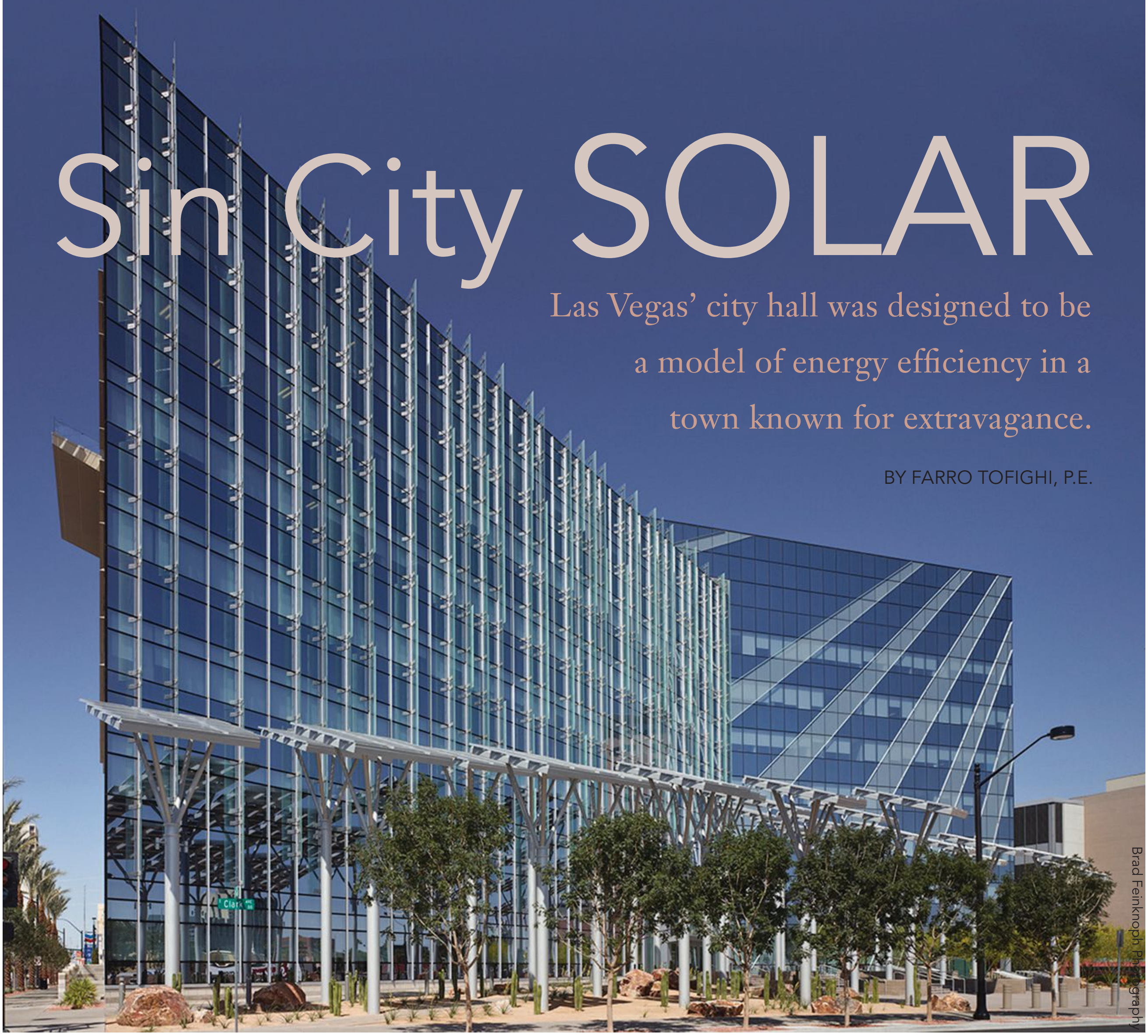
Structural Engineer
Arup

Steel Fabricator and Detailer
Scott Steel Services, Inc. AISC CERTIFIED FABRICATOR

Sin City SOLAR

Las Vegas' city hall was designed to be a model of energy efficiency in a town known for extravagance.

BY FARRO TOFIGHI, P.E.



Brad Feinknopf Photography

WHAT COMES TO MIND when someone mentions Las Vegas?

Extravagant casinos? Fancy nightclubs? World-class restaurants and shops? None of these would be surprising, considering that Las Vegas is renowned for catering to the pleasures of the millions of tourists that descend upon Sin City every year.

Contrary to its reputation as a land of excess, however, Las Vegas has become home to a large number of LEED projects in the past decade. Its water utility pioneered water management practices to conserve and reduce its total water intake from Lake Mead and more recently, the city has become a hotbed for solar activity. So it should come as no surprise that when Las Vegas began planning a new city hall, the design team focused on creating a premier sustainable development to showcase Las Vegas in a new light.

Downtown Renewal

Located on Main Street between Bonneville and Clark Avenue, the seven-story building serves to anchor and build upon the urban renewal program seeking to revitalize the downtown Union Park neighborhood. The steel-and-glass City Hall facility boasts a modest area of approximately 300,000 sq. ft, which includes 70 underground parking spaces. The LEED Gold-rated facility houses a 500-seat council chamber, a public exhibit area and 250,000 sq. ft of governmental offices.

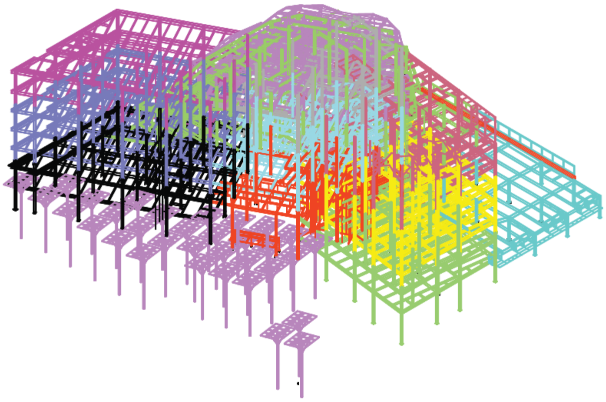
The primary structure is an angled, two-section seven-story tower immediately adjacent to a low-rise council chamber with a partial mezzanine, and there is one level of below grade parking under the entire plaza level. The plaza level floor framing, the perimeter basement walls and the supporting columns are constructed with cast-in-place reinforced concrete, but structural steel was selected for everything above grade to accommodate the architectural design intent, column grid irregularities long spans and speed of construction. The project used 2,900 tons of structural steel in all.

The tower's structural system is composed of wide-flange steel beams and girders supported by steel columns. To accommodate the building's open nature, typical moment frames were used in both directions for the lateral system. Slotted web (SW) moment connections designed by Seismic Structural Design Associates were chosen for the moment frame connections in an effort to provide maximum ductility under seismic loads; SW is a post-Northridge moment connection technology whose design allows for a ductile beam-column joint connection. In a capacity designed moment frame, it keeps the plastic hinge in the beam and away from the column joint, and tested SW moment connections have achieved rotations up to 5 and 6 radians while under very high shear demands. Perimeter spandrel beams were designed to receive the glass façade and window walls.

The primary structure is an angled, two-section seven-story tower immediately adjacent to a low-rise council chamber with a partial mezzanine. The project used 2,900 tons of structural steel in all.

The solar "trees" are made of round HSS.

A structural model of the courthouse.



The council chamber building, adjacent to the office tower, is also supported at the plaza level but separated from the tower with an seismic expansion joint above the plaza level near the skylight so that the two structures move independently above the plaza level. While the façade of this portion of the building is curved, it was achieved with straight steel assemblies. Long-span trusses were used for the council chamber's gravity and lateral system and support the high roof above the council chamber.

Solar Forest

One of the feature green elements of this highly sustainable building is also framed with steel: The 40,000-sq.-ft public plaza contains 33 energy-producing photovoltaic "trees" that also serve as pedestrian lights. The trees, which vary from 40 ft to 60 ft in height, are constructed from round hollow structural steel (HSS) sections. Each tree consists of four 8-in. HSS branches that sprout from a 12-in. HSS trunk and support a rectangular HSS grid frame that in turn supports the photovoltaic panels.

Using steel allowed for these structures to maintain a slim profile and create a look reminiscent of a hi-tech silicon forest. Each tree generates 50 kW of electricity, which, complemented by the 7,000-sq.-ft roof-mounted photovoltaic panel system, dramatically reduces the building's energy costs. The new city hall stands as a testament of Las Vegas' newfound environmental pragmatism and serves an expression of its commitment to a sustainable future. ■

Owner
City of Las Vegas

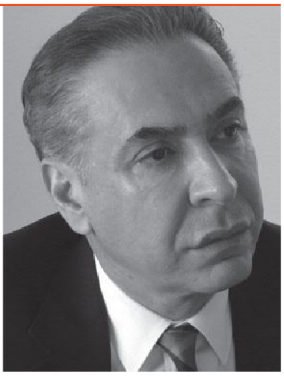
General Contractor
The Whiting-Turner Contracting Company

Architects
Elkus Manfredi
JMA Architecture Studios

Structural Engineer
DeSimone Consulting Engineers

Steel Fabricator, Erector and Detailer
SME Steel Contractors, Inc.

Farro Tofighi (farro.tofighi@de-simone.com) is a managing principal with DeSimone Consulting Engineers in Las Vegas.



SAFETY

Revised Labeling Requirements for Chemicals to take Effect June 1

June 1 marks a critical date for users of the 2012 *Hazard Communication Standard* (OSHA 1910.1200 and OSHA 1926.59). This is the deadline for requiring all alternative labeling for secondary chemical containers to be in place in fabrication and other manufacturing facilities, as well as on job sites. For example, if a chemical, such as paint or thinner, is transferred from a large container to a smaller container, the new labeling must communicate to employees the hazards of the chemical in the smaller container. In addition, each facility's hazard communication program must be revised to fully comply with the standard, including Globally Harmonized System (GHS) provisions, and all employees must be trained in the new hazard communication program. Lastly, signage in fabrication shops and on job sites must be enhanced with more descriptive warnings about the hazards present in order to be in compliance with the standard. This will include signage for items such as flammable liquids (1910.106, 1926.52), spray finishing using flammable and combustible materials (1910.107) and welding, cutting and brazing chemicals (1910.252). All of these items must be addressed by June 1.

For more information on the 2012 *Hazard Communication Standard*, see "Altering Alerts" in the February 2013 issue (available at **www.modernsteel.com**), the AISC safety webinar "Hazard Communication and the Globally Harmonized System (GHS) for Fabricators and Erectors" (**www.aisc.org/ghs**) and OSHA's "Hazard Communication" (**www.osha.gov/dsg/hazcom/standards.html**).

CERTIFICATION

Certification Standard Available for Public Review

The current draft of the 2017 AISC *Certification Standard for Steel Fabrication and Erection, and Manufacturing of Metal Components* (AISC 207-17) is now available for public review.

The standard, along with the review forms, is available for download at **www.aisc.org/publicreview**. Copies are also available (for a $35 nominal charge) by calling 312.670.5411. Please submit comments via the online forms to Max Puchtel (**puchtel@aisc.org**) by May 16 for consideration.

CERTIFICATION

AISC Issues Certification Bulletin for Erector Participants

To help keep participants informed about program updates and changes, AISC Certification has released Certification Bulletin 2016-1: *Current Participant Conversion to Standard Based Erector Certification Program*. The bulletin is available at **www.aisc.org/certification**.

This bulletin provides information required to convert certified erectors with certifications expiring in September 2016 or after to the new requirement-based AISC certification program, which is mandatory for all participants.

The new requirement-based AISC certification program supersedes the former erector checklist criteria and existing categories (Certified Steel Erector and Advanced Certified Steel Erector). The updated program is designed to ensure participants have quality procedures in place and demonstrate that they are following them, which serves as an effective way for participating companies to communicate their commitment and capability with respect to quality.

For questions or concerns regarding the bulletin, please contact **erectorconversion@aisc.org**.

People and Firms

- **Thornton Tomasetti** recently announced the opening of its first Canada office in Toronto. The move is the initial phase of the firm's strategic plan to strengthen and expand its Canadian presence, and it now has 38 offices around the globe. The new Toronto office is intended to allow Thornton Tomasetti to better support its long-standing clients and partners in Canada. The firm has been collaborating with Canadian architects, developers and consultants for more than 30 years on more than 50 projects involving nearly each of its 10 practices.

- **J. Brandon Davis** has joined **The Austin Company** as vice president and general manager of the company's Cleveland operations. In this role, Davis will have overall responsibility for Austin's largest operation, which includes consulting, design, engineering, planning, construction and design-build operations. Davis previously served as senior vice president of **AECOM**'s industrial group.

- **ecoScorecard**, the environmental BIM rating system for **Revit** and **Sketchup**, has been 100% acquired by **VIMtrek, LLC**, as well as **SmartBIM**, the parametric smart object developer. While the two companies have been working together for two years to fully integrate the smart objects and the environmental rating system into the visualization platform the shareholders felt it strategically appropriate to acquire 100% of the shares.

IN MEMORIAM

Fernando Friás, IMCA President, Dies at 90

Fernando Friás, longtime president of the Mexican Institute of Steel Construction (IMCA), passed away in March at the age of 90.

"As the driving force behind IMCA, Friás was instrumental in establishing positive relationships between IMCA and AISC," said Roger Ferch, AISC's president. "In addition to his success as a steel fabricator, he helped grow and advance the fabricated structural steel industry in Mexico, including translating the AISC *Specification*, and he was a frequent participant at NASCC: The Steel Conference."

Friás served as an advisory member on the AISC Specification Committee and in 1998, he initiated IMCA's collaboration with AISC's annual Steel Conference. In 2005 he received the AISC Honorary Member Award and in 2010 was honored with the AISC Lifetime Achievement Award.

Friás received his bachelor's degree in civil engineering from the University of New Mexico and his master's degree from the National University Autonoma in Mexico. He began his career as the director of FESA, a steel fabrication shop he founded in 1958, and was also one of the founders of Sociedad de Fabricantes de Estructuras Metálicas A.C. (FEMAC), where he served as president from 1980 to 1984.

Friás was a founding father of IMCA, which formed in 1983. The following year he was elected president, and he served in that role for more than 30 years until his passing. During his tenure he promoted a wide variety of activities in education and standard practice for complex steel construction designs. He was also the primary advocate and promoter of the IMCA *Steel Construction Manual* since its first publication in 1984, up until the most recent (5th) edition, which was published in 2014.

ENGINEERING JOURNAL

Second Quarter 2016 *Engineering Journal* Now Available

The second-quarter 2016 issue of AISC's *Engineering Journal* is now available at **www.aisc.org/ej**, where you can view, download and print the current digital edition. Articles in this issue include:

➤ **Design of Horizontal Life Lines in Personal Fall Arrest Systems**
Thomas S. Dranger, S.E., Ph.D.
Personal fall arrest systems have become common in construction, maintenance, and many other activities including recreation. Many use a horizontal lifeline (HLL), often a steel cable. Their design is governed by Occupational Safety and Health Administration (OSHA) regulations that require "supervision by a qualified person" and a factor of safety of at least two. This paper gives a summary of regulations, a reiterative method of analysis, a discussion of the limit states, and some appropriate modifications in the case of unacceptable behavior. The effects of assumptions used in the analysis are discussed in the conclusion.

➤ **Tensile Strength of Embedded Anchor Groups: Tests and Strength Models**
David A. Grilli and Amit M. Kanvinde
Steel column bases in seismically braced frames and other similar structures must be designed for high uplift or tensile forces. A common detail for this connection involves anchors embedded in the footing with a plate at their lower end, also embedded in the footing. This paper presents tension tests on two full-scale specimens featuring this anchorage detail. The tests are evaluated against three strength models, including the ACI 318 Appendix D method, the ACI 318 punching shear equation and the concrete capacity design (CCD) method. The latter shows the most promise, even considering the limitations of the study.

➤ **Cross Section Strength of Circular Concrete-Filled Steel Tube Beam Columns**
Mark D. Denavit, Jerome F. Hajjar and Roberto T. Leon
Closed-form expressions for the cross-section strength of steel-concrete composite beam-columns according to the plastic stress distribution method are tabulated in the AISC *Seismic Design Manual* and the AISC *Design Examples*. Approximations have been used in the derivation of these formulas, most of which do not significantly affect the accuracy of the results. However, an approximation in the equation for the axial strength of circular, concrete-filled steel tubes that are simultaneously subjected to flexure at one of the key points on the interaction curve (designated as Point E) leads to results that are unconservative. The derivation of the equation is reviewed and a more accurate expression is proposed.

➤ **Design for Deconstruction with Demountable Composite Beams and Floor Systems**
Judy Liu
Sustainable design, or building "green," includes consideration of resources (e.g., energy, raw materials) but also construction and demolition waste. The statistics on waste are motivating shifts in structural design. Ongoing and recently completed research on deconstructable steel-concrete composite beams and floor systems for steel frame buildings is presented. This research includes demountable beam-slab connectors, deconstructable composite floor systems with precast concrete planks, and lightweight modular two-way steel flooring systems.

SAFETY

AISC Names 2015 Safety Award Winners

More than 70 structural steel facilities are being honored with an AISC Safety Award for their excellent records of safety performance in 2015. Awards are given in the categories of "Shop and Office" and "Field Erection" and include the Safety Award of Honor, AISC's top safety award, presented for a perfect safety record of no disabling injuries, as well as the Safety Certificate of Merit and Safety Certificate of Commendation.

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

The AISC Safety Awards program is open to all AISC Member fabricators and erectors. For more information about the program as well as safety resources available for the fabricated and erected structural steel industry, please visit www.aisc.org/safety.

Here is the list of winners:

➤ Shop and Office Category Honor Awards

2-K Steel Products, Inc., Ashville, Ala.
Anderson Steel Supply, Inc., Great Falls, Mont.
B&B Welding Company, Inc., Fort Howard, Md.
Bowen Engineering Corporation, Indianapolis, Ind.
Cianbro Fabrication and Coating Corporation, Pittsfield, Maine
Cold Steel, Inc., Farmington, N.M.
Cooper Steel, Shelbyville, Tenn.
CSE, Inc., Madison Heights, Va.
Cubic Designs, Inc., New Berlin, Wis.
Custom Metals, Little Rock, Ark.
Douglas Steel Fabricating Corporation, Lansing, Mich.
Eddy's Welding, Inc., Ellicott City, Md.
Gibson Industrial Inc., Richmond, Va.
Gremp Steel Company, Posen, Ill.
Grunau Metals, Oak Creek, Wis.
GT Grandstands, Inc., Plant City, Fla.
Hercules Steel Company, Inc., Fayetteville, N.C.
Highway Systems Incorporated, Sumterville, Fla.
Hillsdale Fabricators, J.S. Alberici Construction, St. Louis, Mo.
LeJeune Steel, Minneapolis, Minn.
LMC Industrial Contractors, Dansville, N.Y.
LPR Construction Company, Loveland, Colo.
Midland Steel Company, Wathena, Kan.
Miscellaneous Steel Industires, Inc., Kyle, Texas
National Steel City, LLC, Plymouth, Mich.
NOVA Group, Inc., Napa, Calif.
Padgett, Inc., New Albany, Ind.
Phoenix Fabrication & Supply, Inc., South Chicago, Ill.
Pikes Peak Steel LLC, Colorado Springs, Colo.
RAI Industrial Fabricators, LLC, Athens, Ga.
Scott Steel Services, Inc., Crown Point, Ind.
Simko Industrial Fabricators, Hammond, Ind.
Steelcon, LLC, New Waterford, Ohio
Stinger Bridge & Iron, Coolidge, Ariz.
Stud Welding, Inc., Centerville, Tenn.
The Arthur Louis Steel Company, Geneva, Ohio
The Haskell Company, Jacksonville, Fla.
Tyler Steel Company, Tyler, Texas
Unlimited Welding, Inc., Winter Spring, Fla.
V&M Erectors, Pembroke Pines, Fla.
XLE Metals, Inc., Prospect Park, Pa.

➤ Field Erection Category Honor Awards

B&B Welding Company, Inc., Fort Howard, Md.
Cold Steel, Inc., Farmington, N.M.
Douglas Steel Fabricating Corporation, Lansing, Mich.
Eddy's Welding, Inc., Ellicott City, Md.
Gibson Industrial, Inc., Richmond, Va.
JPW Structural Contracting, Inc., Syracuse, N.Y.
LMC Industrial Contractors, Dansville, N.Y.
National Steel City LLC, Plymouth, Mich.
North Alabama Fabricating Company, Inc., Birmingham, Ala.
Peterson Beckner Industries, Inc., Houston, Texas
RAI Industrial Fabricators, LLC, Athens, Ga.
Reliance Steel, Inc., Colchester, Vt.
S.W. Funk Industrial Contractors, Inc., Chester, Va.
Steelcon, LLC, New Waterford, Ohio
Stinger Bridge & Iron, Coolidge, Ariz
Unlimited Welding, Inc., Winter Spring, Fla.
XLE Metals, Inc., Mendenhall, Pa.

➤ Shop and Office Category Merit Awards

Goff Communications, Sarasota, Fla.
W&W/AFCO Steel, Okalahoma City, Okla.

➤ Field Category Merit Awards

CSE, Inc., Madison Heights, Va.

➤ Shop and Office Category Commendation Awards

Dave Steel Company. Inc., Asheville, N.C.
Ford Steel, LLC, Porter, Texas
Kwan Wo Ironworks, Inc., Hayward, Calif.
North Alabama Fabricating Company, Birmingham, Ala.
Prospect Steel Company, Little Rock, Ark.
Shickel Corporation, Bridgewater, Va.
Steel Service Corporation, Jackson, Miss.
Systems Fab & Machine, Inc., El Dorado, Ark.
Vigor, Clackamas, Ore.

➤ Field Category Commendation Awards

Cooper Steel, Shelbyville, Tenn.
Grunau Metals, Oak Creek, Wis.
LPR Construction Company, Loveland, Colo.

CORRECTION

In an unintentional April Fools joke, the lettered choices in April's Steel Quiz were ordered incorrectly. An updated version of the quiz, with the choices in the correct order, is posted in the Archives section of www.modernsteel.com.

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SteelDay is an annual event sponsored by the AISC and hosted by its members and partners.

SteelDay is the industry's largest educational and networking function, with events occurring all over the country.

It's an opportunity for individuals from various professions to see how the structural steel industry contributes to building America.

STEEL REVOLUTION

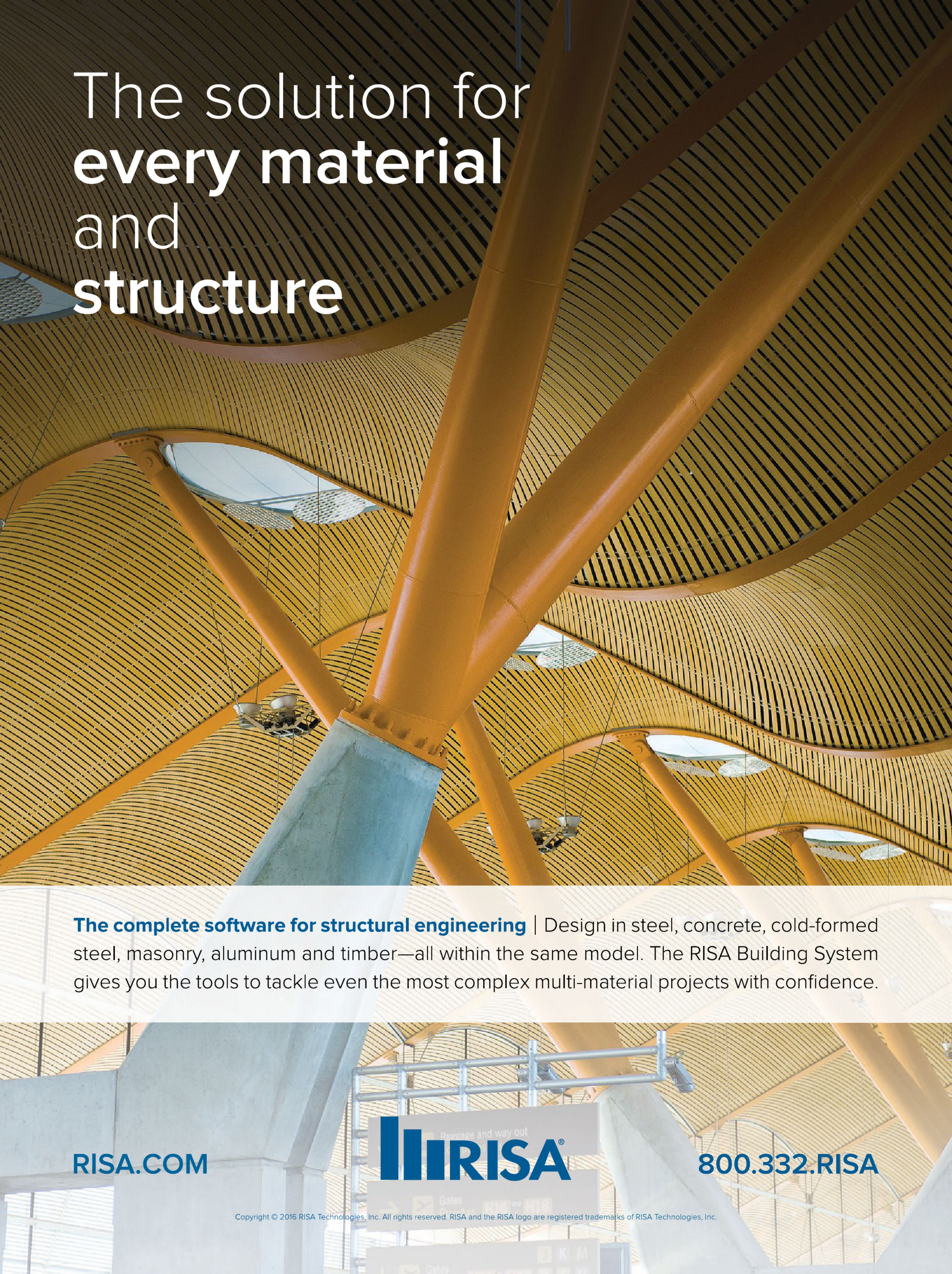
Jeffrey Totaro

THE MONMOUTH BATTLEFIELD STATE PARK Visitor Center in Monmouth County, N.J., welcomes visitors to the site and educates them on the Battle of Monmouth. The June 28, 1778 battle is considered a critical turning point in the American Revolution and is cited as one of General Washington's brilliant political strategies, one that led to the eventual colonist victory and his ascension to the presidency.

The landscape of the battlefield is its most powerful and enduring artifact, and the building sits atop Combs Hill, which overlooks the area where the battle took place. However, the existing concrete and brick brutalist building effectively blocked the view of the battlefield from visitors, so ikon.5 architects designed an adjacent, visually open steel-framed renovation that frames the views and sits delicately on the historic site.

Conceived as a modern-day primitive hut, the visitor center is a simple one-story flat-roofed structure that orients visitors toward the battlefield and features an exterior "steel sky" of exposed wide-flange members and metal mesh that creates a solar shade for reducing heat gain and protecting the exhibits inside. A portion of existing 1976 structure was removed to make way for the new structure, and another section was converted into a multipurpose classroom and archeological lab space.

Designed by structural engineer Thornton Tomasetti and fabricated by AISC member and certified fabricator Arnold Steel Company, the framing system consists of thin columns and cantilevered beams; the columns are custom-fabricated structural tees that are set back from the exterior enclosure to give the feel of a floating building.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