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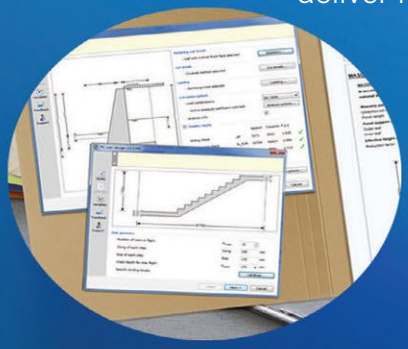

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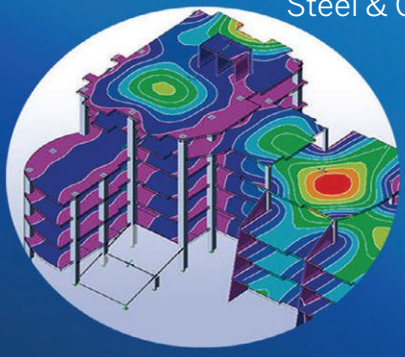

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ON THE COVER: Belgium's Vlooybergtoren is a new take on observation towers, p. 42. (Photo: ©Kris Van den Bosch)

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editor's note

FOR ANYONE OLD ENOUGH TO REMEMBER, AISC WAS A DIFFERENT PLACE IN THE 1980S.

Our staff was older, mostly men working a second career after spending most of their working life at either a steel fabricator or steel mill. When I started at the end of 1989, there were only a handful of people in their twenties, thirties and forties, and we only had one female structural engineer.

But the 1990s ushered in a new era. We began hiring bright young engineers, including Charlie Carter and Jacques Cattan. The three of us formed a radical nucleus for the association, with at least one of the old-school vice presidents frequently reminding us that in his day, we would never have made it out of the mailroom.

My, how everything has changed.

Our staff today is vibrant and active, constantly pushing for improvement and change. More than a dozen of our fantastic engineers are women.

While Jacques left AISC for a decade to work as a senior associate at Teng and Associates, he returned in 2010 as the vice president in charge of AISC Certification. I'm still the editor of *Modern Steel Construction*, but I'm also the vice president in charge of publishing, membership and IT. Charlie, who went back to school at night a few years ago to get his PhD, was promoted in 2008 to vice president of Engineering and Research and chief structural engineer. And now, Charlie has been named the new president of AISC, effective December of this year (see the news story on page 62).

Charlie is certainly well known within the steel design community and construction industry. Between his frequent lectures, informative articles and attendance at meetings on everything from bolting to HSS, it's almost a rarity to speak with someone who doesn't know, like and admire him. (Even my two boys are big Charlie fans—but I think that has more to do with his having helped them with their Cub Scout pinewood derby cars than his steel acumen.)

In the coming days, you'll be hearing a lot more about Charlie's plans for the future of AISC, but if you want a preview of his thoughts on steel, visit **www.aisc.org/charlie** to listen to his 2011 podcast. Please join me in congratulating him on this well-deserved achievement. (And if you want to drop him a personal note, he can be reached at **carter@aisc.org**.)

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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

Classifying Sections for Local Buckling

I am designing a wide-flange section in compression. I have chosen a W27×94 as a trial section. Table 1-1 indicates it is slender for compression. Table B4.1of the *Specification* indicates for an unstiffened element that $\lambda_r = 0.45\sqrt{(E/F_y)}$. For ASTM A992 steel this results in $\lambda_r = 9.89$. For a stiffened element the *Specification* indicates that $\lambda_r = 1.49\sqrt{(E/F_y)}$. For A992 steel this results in $\lambda_r = 32.8$. What I do not understand is what is meant by unstiffened and stiffened. The definition for unstiffened—"supported along one edge parallel to the direction of the compression force"—does not make sense to me. The section I am designing is 20 ft long and rigidly attached only at each end. There is no connection along either edge parallel to the direction of the compression force. Please provide guidance on the classification of this section as slender.

I think you are missing the intent. We are talking about the edges of the elements of the cross section of the shape—the web and flanges in this case.

Section B4.1 states: "For compression, sections are classified as nonslender element or slender-element sections. For a nonslender element section, the width-to-thickness ratios of its compression elements shall not exceed λ_r from Table B4.1a. If the width-to-thickness ratio of any compression element exceeds λ_r, the section is a slender-element section."

The *Specification* defines a slender-element section as, "Cross section possessing plate components of sufficient slenderness such that local buckling in the elastic range will occur."

So the intent is to check if any element of the section will buckle before the overall section buckles. If it does, then only a portion of the section is effective. Based on this, the classification of stiffened or unstiffened is related to the element, not the overall section as you indicate near the end of your question. Since the flange is supported only at one (unloaded) edge, at the web, it is unstiffened. Since the web is supported at both (unloaded) edges, at each flange, it is stiffened. In the case of the W27×94, the flange is nonslender, but the web is slender. The flanges will be fully effective, but the web will not.

The cases you refer to from Table B4.1a, Cases 3 and 8, address more general conditions. The flanges and web of a wide-flange section are check more appropriately using Cases 5 and 1.

Larry S. Muir, PE

More Classifying Sections for Local Buckling

What limiting width-thickness ratio for compression elements should I use for rectangular bars? My software uses $\lambda_r = 1.49\sqrt{(E/F_y)}$, which is indicated for a stiffened element. Why would a rectangular bar be considered a stiffened element instead of an unstiffened element?

This question comes up with some regularity. It would be interesting to have the software company explain how they arrived at their decision.

Let's first look at the definitions of stiffened and unstiffened elements.

Stiffened element: "Flat compression element with adjoining out-of-plane elements along both edges parallel to the direction of loading."

Unstiffened element: "Flat compression element with an adjoining out-of-plane element along one edge parallel to the direction of loading."

If you have only a rectangular plate which is free between the supports (which are also the loaded ends), then you have an element that is neither stiffened nor unstiffened since there is no out-of-plane element between the supports.

The *Specification* defines a slender-element section as, "Cross section possessing plate components of sufficient slenderness such that local buckling in the elastic range will occur." In essence a slender-element section is a section where some part of the section will buckle before the entire section buckles. This does not apply to a rectangular plate for which local and global buckling are the same. Depending on how you look at it, either you cannot have a slender element rectangular plate or you always have a slender element rectangular plate. Nonsense, right?

This discussion highlights how important it is for engineers to examine and understand the assumptions made in the software they are using. In this case the consequences of performing this check are likely minor since essentially a check is being performed that is unnecessary. It might result in a plate that is thicker than necessary and only a slight increase in overall cost. However, it also abuses basic structural mechanics and the intent of the *Specification*. Ultimately, this is why it is the engineer of record who is responsible for all design decisions.

Larry S. Muir, PE

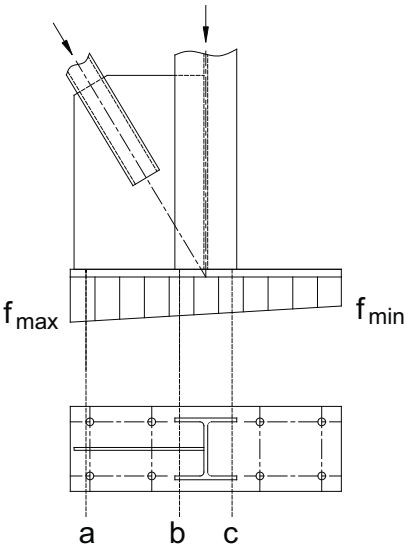
Base Plate Models

AISC Design Guide 1: *Base Plate and Anchor Rod Design* (a free download for members from www.aisc.org/dg) describes methods that can be used to design column base plates. How should these procedures be modified when the connection includes longitudinal plates such as stiffeners or gusset plates for bracing elements as shown above?

The base plate with gusset attached to the left side is subjected to axial compression loads in both the column and the brace. Assuming the triangular distribution solution from Appendix B in AISC Design Guide 1, a bearing pressure is generated below the entire plate with f_{max} and f_{min} at opposite ends. To check the bending strength of the plate due to bearing pressure, bending moments should be calculated about bending lines. For this connection, since there is bearing pressure on both sides of the column (no tension in anchors) we need to check the strength of the plate for both sides.

For the right side, where there base plate is not stiffened, the critical section is at "c".

The critical section for the left side is less clear. If I consider the section at "b," I am neglecting the stiffening effect of the gusset plate. Which is the critical section?



In practice, the presence of the gusset plate is typically neglected in the base plate design.

If the base plate is centered on the column, f_{max} and f_{min} will be equal. In this case, the right side of the base plate will control the design. However, this assumes an infinitely stiff base plate. Although this is a reasonable assumption for typical base plates, extremely long plate cantilever lengths can be a source of significant error caused by a highly nonlinear bearing pressure distribution. Using a uniform or linearly-varying bearing pressure across the full width will result in a conservative base plate thickness and a non-conservative concrete/grout bearing pressure. It may be more accurate to assume a shorter effective plate width in the calculations.

The effect of the gusset plate is typically neglected for the following reasons:

- If the gusset plate provides a stiff support to transfer loading into the base plate, the base plate bend lines will probably extend diagonally (actually curved) from near the column flange tip to near the gusset edge. However, due to the column web bending flexibility at the gusset-to-column interface, it is doubtful that a stiff support can be assumed.
- Presumably, the column design would typically be based on axial load alone. The assumption that the gusset plate alters the bending strength of the base plate would induce a moment in the column (which would be transferred through the gusset-to-column interface). This situation can be alleviated by using stiffeners on both sides of the column web.
- The gusset plate would need to be designed for the additional loads induced by the bearing pressure at the bottom edge of the gusset plate.
- The gusset interface connections, including the local strength of the column web, would need to be designed for the additional loads induced by the bearing pressure at the bottom edge of the gusset plate.

Neglecting the presence of the gusset plate is also consistent with the implicit assumptions made in Section 4.3 of AISC Design Guide 29: *Vertical Bracing Connections—Analysis and Design* (a free download for members from www.aisc.org/dg) where only shear is transferred at the base-plate-to-gusset connection.

If the gusset plate is considered in the base plate design, it is not clear where the critical section would occur. Ultimately, you must use your own judgment to determine what is appropriate for your situation. I have suggested a simple and common design model. More complex models are possible.

Bo Dowswell, PE, PhD

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 at AISC. Bo Dowswell is a consultant to AISC.

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steel quiz

The Steel Quiz made its first appearance in the November 1995 issue of *Modern Steel Construction*. This month's Quiz takes a look at some of the best questions from 1996.

1 To prevent sag and vibration in long, light tension-only diagonal bracing members, they are sometimes fabricated short. This practice is known as inducing:
a. shortening **b.** stretch **c.** draw **d.** full tension

2 True or False: The maximum fillet weld size that can be placed along the toe of a channel flange is equal to 1/16 in. less than the tabulated flange thickness.

3 When using heat to camber or straighten members made from ASTM A992 steel, what maximum temperature must be imposed?

4 True or False: An ASCE 60-lb crane rail weighs 20 lb per ft.

5 What two characteristics define an HP-shape?

6 Which of the following is true?
a. A steel lintel embedded in a masonry wall is considered to be structural steel in the AISC *Code of Standard Practice*.
b. For payment purposes, the weight of high-strength bolts is calculated based upon the tabulated weights in the AISC 14th Edition *Steel Construction Manual*.
c. ASTM A529 covers steel that offers atmospheric corrosion resistant properties.
d. AISC 14th Edition *Manual* and AISC *Specification* cover the design of cold-formed steel members.

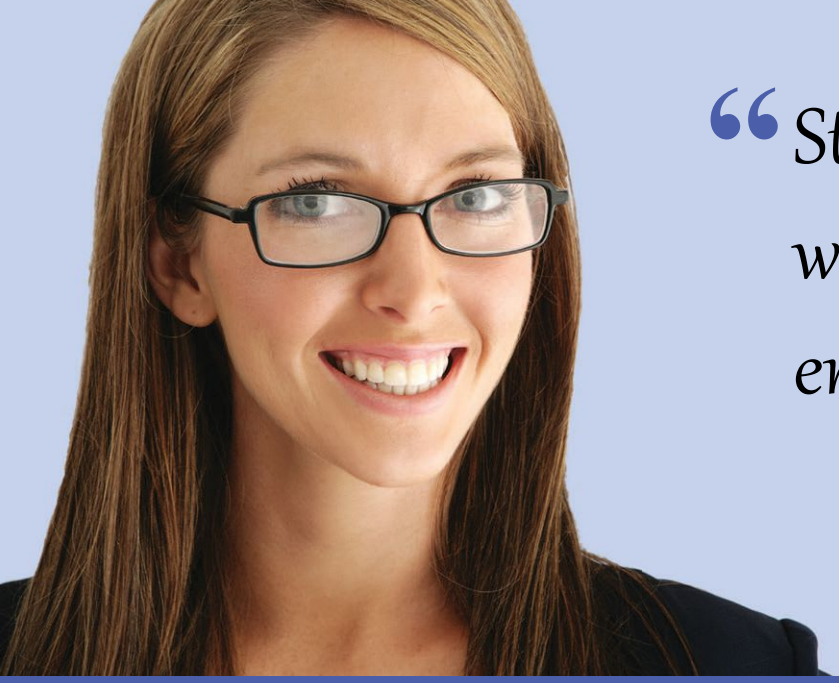
7 Which of the following limit states is not solely serviceability related?
a. deflection of a girder in a floor system under gravity load
b. building drift under wind loading
c. ponding of a roof system due to the accumulation of rainwater
d. floor vibration induced by the operation of mechanical equipment

8 True or False: In 1942, the War Production Board sanctioned the use of a 24,000-psi allowable tensile stress instead of the then AISC-specified 20,000-psi, as well as a proportionate increase in allowable shear stress.

9 Which of the following applications are covered by the RCSC *Specification*?
a. a bolted expansion joint detail with a slip pad between the steel plies
b. a column base with four headed anchor rods embedded into concrete
c. a girt connection made with ASTM A307 bolts
d. none of the above

10 True or False: Composite beam design flexural strength is unaffected by whether the construction is shored or unshored.

TURN TO PAGE 14 FOR ANSWERS



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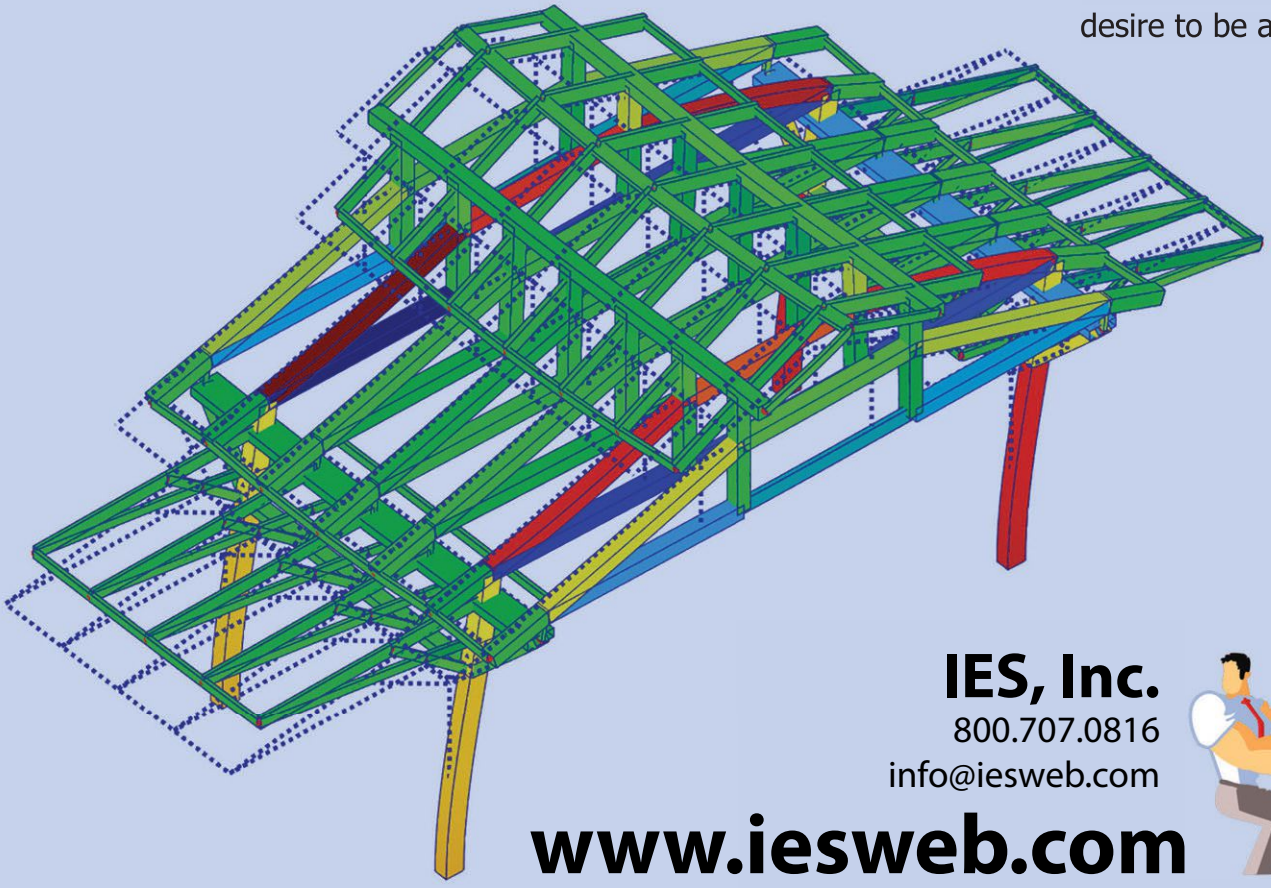

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steel quiz | ANSWERS

1 **c.** Intentionally fabricating light braces short is known as inducing draw. Bonus trivia: This guidance predates AISC and can be traced back to at least 1918. It was contained in the *Structural Engineers' Handbook: Data for the Design and Construction of Steel Bridges and Buildings* by Milo S. Ketchum.

2 **False.** Because channel flanges are not parallel, the toe of the flange is less thick than the average flange thickness tabulated. To comply with Section J2.2b in the AISC *Specification*, which generally limits the maximum weld size to 1/16 in. less than the thickness of the edge of the connected part, this reduced thickness must be considered.

3 According to AISC *Specification* Section M2.1, the temperature may not exceed 1,200 °F.

4 **True.** Crane rails are designated by their nominal weight per yard. Therefore, an ASCE 60-lb crane rail weighs 20 lb per ft.

5 As defined in the ASTM A6/A6M Section 3.1.2.4, HP-shapes (commonly used as bearing piles) are "wide-flange shapes… whose flanges and webs are of the same nominal thickness and whose depth and width are essentially the same."

6 **b.** AISC *Code of Standard Practice* Section 9.2.3 indicates that "items for which weights are shown in tables in the AISC *Steel Construction Manual* shall be calculated on the basis of tabulated weights shown therein." Because high-strength bolt weights are so tabulated, they fall under this provision. Choices a, c and d are false: A steel lintel embedded in a masonry wall (i.e., not attached to the structural steel frame) is not structural steel as defined in the AISC *Code of Standard Practice* Section 2.2; ASTM A588 (not A529) covers weathering steel; and AISI produces the *Cold-Formed Steel Design Manual* and the *North American Specification for the Design of Cold-Formed Steel Structural Members.*

7 **c.** Although ponding results progressively from the incrementally increasing deflection of a flat roof system as rainwater accumulates, the roof system must possess adequate strength to carry the load of the rainwater it retains. For this reason, ponding, as a limit state, is both strength and serviceability related.

8 **True.** The following is quoted from *AISC: The First 60 Years*: "In 1942, [the War Production Board] issued temporary national emergency specifications for the design of structural steel. To conserve material [during wartime] the WPB specification committee, on which AISC was represented, sanctioned [the aforementioned increases in allowable stress] but no increase in column stress." Bonus trivia: AISC members can download a free PDF of these temporary national emergency specifications at the Historic Standards link at **www.aisc.org/epubs**.

9 **d.** As stated in Commentary Section 1.1 of the RCSC *Specification*, "This specification deals principally with two strength grades of high-strength bolts, ASTM A325 and A490, and with their design, installation and inspection in structural steel joints. These provisions may not be relied upon for high-strength fasteners of other chemical composition, mechanical properties or size. These provisions do not apply when material other than steel is included in the grip—nor are they applicable to anchor rods."

10 **True.** Because the nominal flexural strength is achieved after the composite beam has been loaded into the inelastic range (i.e., where stress is no longer proportional to strain), initial stresses in unshored construction need not be considered for the final composite cross section. Note that the steel beam is checked under the wet weight of the concrete separately—and also that total deflection can change for unshored construction.

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WHAT IS SNUG, ANYWAY?

The answer is simple, though not necessarily brief.

BY CHARLES J. CARTER, SE, PE, PHD, AND THOMAS J. SCHLAFLY

THE RESEARCH COUNCIL ON STRUCTURAL CONNECTIONS (RCSC) addresses three types of bolted joints: snug-tightened, pretensioned and slip-critical.

These joints are defined in the RCSC *Specification for Structural Joints Using High-Strength Bolts*, which is a free download at **www.boltcouncil.org**. Supporting information also is available in the *Guide to Design Criteria for Bolted and Riveted Joints*, 2nd Edition (also free as a download from RCSC). RCSC defines these joint types and provides guidance for their use. Nonetheless, there remains some confusion about what snug-tightening is.

The formal definition of a snug-tightened joint is given by RCSC as:

> *A joint in which the bolts have been installed in accordance with Section 8.1. The snug tightened condition is the tightness that is attained with a few impacts of an impact wrench or the full effort of an ironworker using an ordinary spud wrench to bring the plies into firm contact.*

The intent is to provide for great simplicity, but perhaps definitions can get in the way. Breaking it all down, here is what snug-tight means.

Snug-tightened installation is all that's needed for the majority of joints. See the sidebar for cases where pretensioned or slip-critical joints are required. Those specific cases have special needs that are clear and definable. All other cases are basic statically loaded joints for which snug-tightening is all that's needed to prevent loosening of a joint.

Snug means bringing the connected plies into firm contact. RCSC defines firm contact as the condition that exists on a faying surface when the plies are solidly seated against each other. Note that this does not mean the plies must be in continuous contact. It only means that further tightening of a bolt should not loosen an adjacent bolt. When a joint is solidly seated, any further tightening of a bolt will simply add some reasonably consistent amount of installed tension in the bolt.

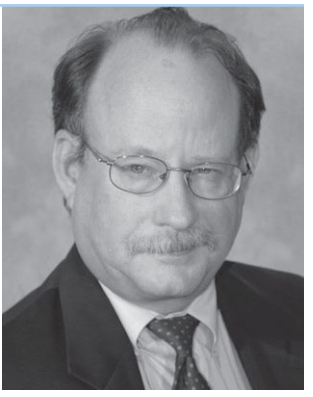
We don't care how much installed tension there is. The whole point of a snug-tightened joint is that we do not need to concern ourselves with how much installed tension is present in the bolts. Small joints with flat mating faces on the plies generally will have less installed tension than larger joints with curved or wavy mating faces. If the bolt tightening is used to compress gaps in the joint, some bolts may reach—and even exceed—the minimum pretension for pretensioned and slip-critical joints. This is acceptable! Above all, we do not require measurement of the installed tension in the bolts.

Note also that twist-off-type tension-control bolts can be used in snug-tightened joints, even if the splined ends are severed during installation.

Every bolted joint installation starts with snug-tightening. When you specify a snug-tightened joint, installation starts and ends with the requirements in Section 8.1. When you specify a pretensioned joint or a slip-critical joint, installation starts with the same requirements. Thereafter, the pretension is induced—i.e., snug-tightening is the starting condition for

Where Did Snug-Tight come from?

There was a time before snug-tightening existed and all bolts required pretensioned installation. When bolts were introduced, rivet manufacturers succeeded in forcing the most conservative installation requirements to be applied across the board. In the early 1980s, Bob Disque and Ted Winneberger—steel industry legends from AISC and W&W Steel, respectively—collaborated to lead an effort to free most bolts from decades of conservatism. The snug-tight concept was born and included in the 1985 RCSC *Specification*.



Charles J. Carter (**carter@aisc.org**) is a vice president and chief structural engineer and **Tom Schlafly** (**schlafly@aisc.org**) is director of research, both with AISC.

turn-of-nut, calibrated wrench, twist-off type tension-control bolt, and direct-tension-indicator washer pretensioning.

All joint types use the same bolts, but names have changed. Snug-tightened, pretensioned and slip-critical joints all use the same bolts; (same for N, X, and SC, too!). We are used to calling them ASTM A325 and A490. You also likely know that the twist-off-type tension-control bolt assembly equivalents are called ASTM F1852 and F2280. You also need to know that there is a new umbrella specification for all of these called ASTM F3125 and it replaces all of the previously separate standards.

This new umbrella standard is constructed in an intuitive and familiar manner. It ties the new to the old in a very direct and unmistakable way because the previously separate products are identified as grades A325, A490, F1852 and F2280. This is an easy adaptation that will not trip you up as the transition occurs in the marketplace. This was covered in the November 2015 article "Six into One" (available at **www.modernsteel.com**).

Additionally, ASTM F3125 appears in AISC 360-16, the next revision of the AISC *Specification*. Happy snugging! ■

When do I need more than a Snug-Tightened Joint?

Pretensioned

A pretensioned joint is a joint that transmits shear and/or tensile loads in which the bolts have been installed to provide a pretension in the installed bolt. Bolts can be pretensioned using turn-of-nut, calibrated wrench, twist-off-type tension-control bolt or direct-tension-indicating washer methods.

Section 4.2 in the RCSC *Specification* requires pretensioned joints in the following applications:

1. Joints in which fastener pretension is required in the specification or code that invokes the RCSC *Specification*
2. Joints that are subject to significant load reversal
3. Joints that are subject to fatigue load with no reversal of the loading direction
4. Joints with ASTM A325 or F1852 bolts that are subject to tensile fatigue
5. Joints with ASTM A490 or F2280 bolts that are subject to tension or combined shear and tension, with or without fatigue

Section J1.10 in AISC 360 requires that joints be pretensioned in the following circumstances:

1. Column splices in buildings with high ratios of height to width
2. Connections of members that provide bracing to columns in tall buildings
3. Various connections in buildings with cranes over 5-ton capacity
4. Connections for supports of running machinery and other sources of impact or stress reversal

These joints do not need the controlled faying surfaces associated with slip-critical connections.

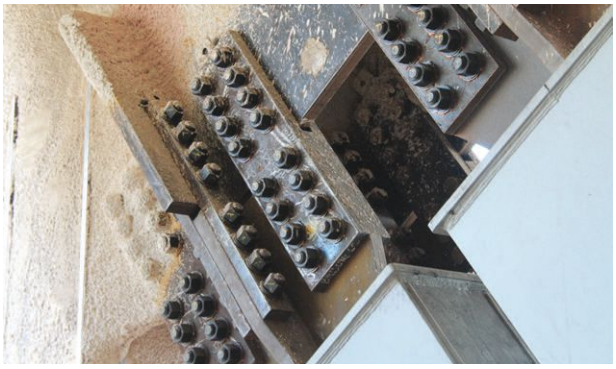
Slip-Critical

A slip-critical joint is a joint that transmits shear loads or shear loads in combination with tensile loads in which the bolts have been installed to provide a pretension in the installed bolt (clamping force on the faying surfaces), and with faying surfaces that have been prepared to provide a calculable resistance against slip.

Section 4.3 in the RCSC *Specification* requires slip-critical joints in the following applications involving shear or combined shear and tension:

1. Joints that are subject to fatigue load with reversal of the loading direction
2. Joints that utilize oversized holes
3. Joints that utilize slotted holes, except those with applied load approximately normal (within 80 to 100 degrees) to the direction of the long dimension of the slot
4. Joints in which slip at the faying surfaces would be detrimental to the performance of the structure

Requirements in AISC 360 are essentially similar.



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business issues

PYRAMID OF PRODUCTIVITY

Accomplish more in less time by climbing the seven-step productivity pyramid.

BY ERIC BLOOM

THE ESTABLISHMENT of an ongoing, organization-wide productivity improvement program requires the right company culture, a continuous improvement mindset, innovative thinkers and the active support of senior management—but this is not enough.

To be successful, it must also have a defined set of processes, the ability to measure and communicate your results and a clear understanding of how each productivity enhancement provides value to the organization. These processes are established on each of the seven steps on the Productivity Pyramid, which—if followed—creates a company environment where more is done in less time.

The Productivity Pyramid concept states that for productivity improvement activities to be effective and long-lasting, they can't be randomly performed. These activities must be organizationally grounded, systematically implemented and administratively supported. They must align with your corporate goals and culture, be implemented with formal plans based on anticipated results and able to be repeated going forward.

In addition to describing the stepping stones toward the creation of a successful productivity program, the Productivity Pyramid can also be used to assess your organization's current productivity maturity. The seven steps can help you craft a plan for the future, and also asses your current productivity abilities and needs.

Step One: Goal Alignment. The alignment of individual, project, department and corporate goals is a mainstay of the strategic planning process. This is also true for your productivity goals. As a result, as you define your productivity related activities, you must also prioritize them based on the answers to these two questions:

- Does this productivity project free up corporate resources that can be redeployed to achieve current corporate objectives?
- Will the productivity project, by its nature, assist in the potential success, efficiency or cost-effectiveness of any currently funded corporate projects?

If one or more answers to the above questions are "yes," then your proposed productivity project is a candidate for funding. Therefore, like all potentially funded projects, it should be prioritized based on its short-term and long-term return on investment (ROI).

Step Two: Holistic Mindset. Organizational productivity must be looked at holistically. All too often, individuals and organizations attempt to enhance their productivity through the improvement of one or two key business activities. It could be improved delegation practices, time management training and the implementation of email-oriented best practices or other key internal processes. Improvements in each of these areas individually have the potential to provide substantial productivity gains.

> Productivity improvements in one area can cause productivity losses in other areas.

By their nature, however, productivity improvements in one area can cause productivity losses in other areas. For example, an effort to reduce meetings may have the adverse effect of increasing emails. Reducing the number of people copied on emails may cause process inefficiencies. Improved time management prioritization techniques may help facilitate individual productivity improvements, but if team member priorities are not properly synchronized, project deadlines can be missed—and as a result—organizational infighting can counteract all previous productivity gains.

Eric P. Bloom is the president and founder of Manager Mechanics, LLC, a nationally recognized speaker and author of the forthcoming book *Productivity Driven Success: Hidden Secrets of Organizational Efficiency*. He is also a nationally syndicated columnist, certified executive coach, and an adjunct research advisor for International Data Corporation. For more information on Eric, please visit **www.mrproductivity.com** or follow him on Twitter at **@mrproductivity**.

Step Three: Supportive Culture. As people have personalities, organizations have cultures. Some people are open to change and some are not. Some organizations embrace change as a catalyst for future growth and profitability and some do not. Increasing productivity requires change. If your organization views the ability to change as an important business attribute, then ongoing productivity improvement can be the status quo. If your company is set in its ways, refuses to streamline its processes and shuns innovation, then your productivity initiatives are unlikely to gain traction.

Step Four: Amplification. Amplification is the implementation eight specific productivity amplifiers. It refers to projects that have the specific goal of enhancing organizational effectiveness. These eight amplifiers are:

Interactive Productivity

1. Creative delegation

2. Innovative meeting management

3. Communication efficiency

Personal/managerial productivity

4. Time management

5. Capability-based task prioritization

Organizational Productivity

6. Ongoing process improvement

7. Asset reuse

8. Knowledge storage and transfer

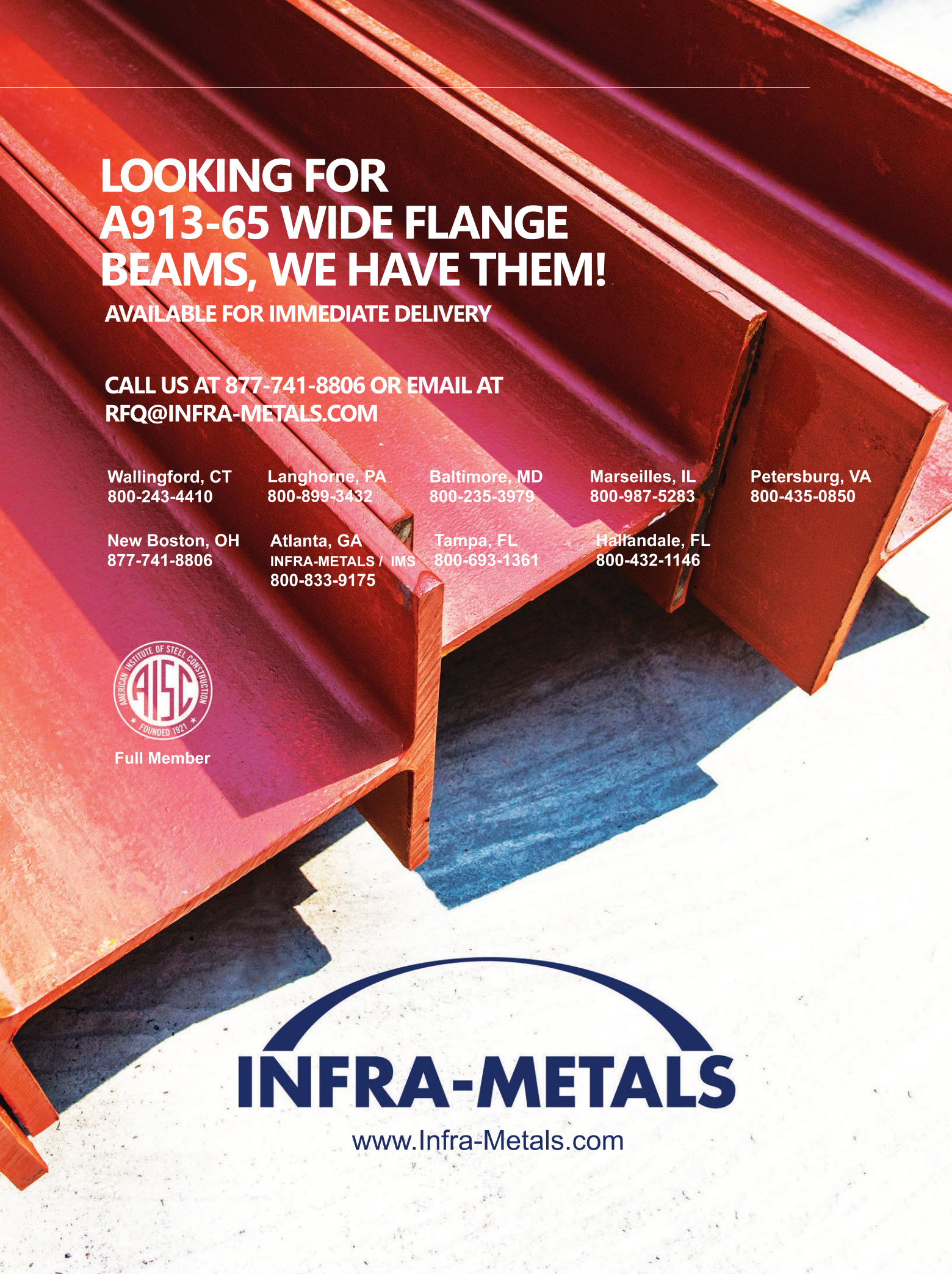
Step Five: Measurement. Productivity projects should be measured not only on the amount of time, money and resources they save, but also the organizational benefits they generate as a result. This step in the Productivity Pyramid defines the "opportunity cost" that would not have been possible without productivity gains. This realized opportunity cost is the true benefit of enhanced productivity.

Step Six: Productivity-Driven Reinvestment. Productivity-driven reinvestment is an extension and application of the productivity measurement process. Simply put, it forces organizational efficiency by requiring future projects to be funded, at least partially, through the savings of current productivity projects.

This concept can be implemented in three ways. First, if you require a portion of all projects, say 10%, to be funded by productivity savings, then you drive efficiency into existing processes while still providing needed funding for new initiatives. In effect, this forces managers to continue to search for organizational efficiencies within their existing operations and not just incrementally chase funding for the next hot project. Second, it can be used as a way to fund projects that are proposed after departmental budgets have been finalized. This gives managers a way to self-fund newly arising department activities. Lastly, if for business reasons your organization must keep spending flat, then this technique can be used as a way of funding new projects without increasing your overall budget.

Step Seven: Reiteration. As organizations mature, one of the key factors that drive their scale and profitability is their ability to efficiently and flawlessly perform the same task repeatedly. Regarding productivity enhancement, even though each individual project may take very different forms—such as time management, email reduction and meeting effectiveness—the overall process by which these initiatives are planned, approved, delivered and measured should be as consistent as possible. The ability to drive uniformity into the productivity improvement process will allow you to reap greater short-term savings as well as provide an ongoing framework that will help assure long term sustainability and maximized cost savings.

By climbing each of the seven steps in the Productivity Pyramid, you put your company in a position to reap a windfall of enhanced productivity. And then you'll be in the enviable position of being able to ask: How can we best use the newly found time, money and resources that this productivity provides? ■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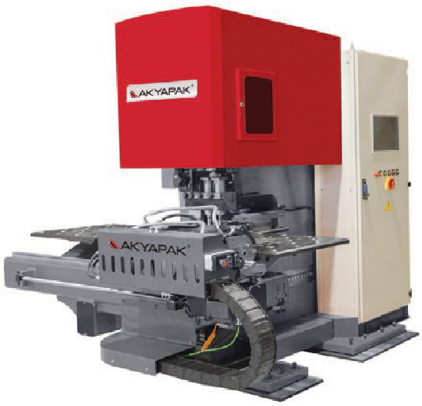

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Each year, *Modern Steel* presents a compendium of fun projects showcasing the cool use of steel.

What's COOL in Steel

This year's Cool List features a steel dragon, a bridge replacement involving a truss inside a truss, a mammoth steel mammoth and other unique steel creations.

What's COOL in Steel

Cool Backbone

Enter the Dragon Bridge

A GOOD BRIDGE can take you over troubled water. But Da Nang's Dragon Bridge can do that and more.

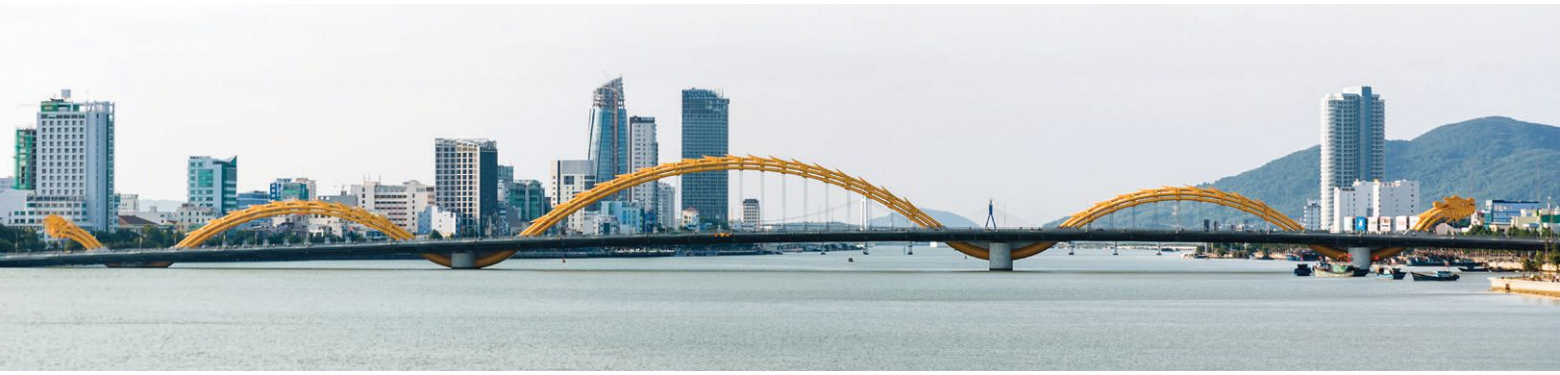
The dragon, a symbol of power and nobility in Vietnam, serves as the steel support structure for the bridge over the Han River in this city of 1 million. Oh, and it also breathes fire and spouts water.

The project was designed by the team of Louis Berger and Ammann and Whitney and commissioned by the Da Nang People's Committee, who wanted a low-deck bridge that did not block scenic views while linking Da Nang to its burgeoning eastern sector and famed beach resorts across the river.

The suspension-design superstructure intersects with a flying dragon, its undulating back placed along the center line. The dragon has a suspended head and tail and a body covered in scales that spike upward along the spine.

The head represents the Ly Dynasty stone dragons and the tail a lotus flower, the national flower of Vietnam. Both are 15 m (49 ft) long by 9 m (29.5 ft) high. At 1,000 metric tonnes (1,102 U.S. tons) and 500 m (164 ft) long, the dragon holds the Guinness World Record as the largest steel dragon (a one-off recognition by Guinness).

Dragon Bridge has a single central "rib" with five steel tubes of constant diameter that carry the superstructure through "spider frames" and suspenders placed at 8-m (26-ft) intervals. The five curving steel tubes are bundled for structural integrity, and the rib supports 14-m-wide (46 ft) hybrid steel box girders in the center spans.



The box girders consist of a triple-cell steel box for the suspended portions and prestressed concrete twin-cell boxes for sections over the piers. Cantilevers extend from the box girders to complete the superstructure cross section for a total width of 35 m (115 ft).

Below the road deck of the 666-m-bridge (2,185 ft), box girders are made of structural steel for the suspended portions and prestressed concrete over the piers. Double-cantilever road decks carry six lanes and two pedestrian walkways.

To understand the behavior of the complex and unique structure, the design team created computer models to analyze the bridge as a whole. Models were also created to analyze the spider frames, suspenders, central arch rib, box girders, drilled piles and support piers. The analyses covered 14 potential load cases, including dead, live, wind, thermal, longitudinal wind and asymmetrical live loads. In all cases, the analyses were based on both local and U.S. standards.

The design team weighed several potential designs for the superstructure with safety in mind. One consideration was to erect the arch rib first, using tie-back cables, with steel girders erected from barges and supported on permanent hangers. Another idea was to erect long girder segments on isolated temporary bents followed by long preassembled arch rib segments supported by extending the temporary bents above the deck level. In all cases, the concrete deck was to be built after all steel was in place.

Day or night (illuminated by 15,000 LEDs) Dragon Bridge provides an essential river crossing and has created an instant icon and economic engine for Da Nang, drawing three million visitors per year to the city.

Tom Bonner


Tom Bonner

What's COOL in Steel

Cool Pool
Swimming in Tinseltown


Jim Pearson


Tom Bonner


Jim Pearson

HOLLYWOOD IS KNOWN FOR GLITZ. But one of its public pools was no longer A-list material.

Built in the early 1950s, the pool's bath house had become obsolete, and its ventilation and lighting systems were well past their prime. In addition, the pool was cracked and the water-filtration system had become inefficient. So the City of Los Angeles' Bureau of Engineering worked with Frank Webb Architects and Saiful Bouquet Structural Engineers, Inc., to design a new 5,000-sq.-ft structure on the northeast edge of an urban park. The project scope included a new bath house, a pool deck, a water slide with a reception pool and a new 125-ft × 75-ft pool with new filtration systems and equipment. The pool was widened by five yards, with the deep end in the middle, allowing the two shallow areas to be used for recreational swimmers and programming, and includes lap lanes, a 1-m diving board (which has been missing at the pool for approximately 30 years) and the water slide.

The structural design of the project had to satisfy opposing needs of the client and the architect. The bath house required highly durable solid walls for privacy but also needed to have the open feel of the outdoors. The solution was a structure with partial-height masonry walls and an exposed steel structure floating above, which was accomplished by cantilevering round HSS columns vertically through the masonry walls. The columns support an undulating frame of rectangular HSS steel, and bare metal deck, also exposed from below, was used for the roof. The exposed connections of intersecting steel members were fully welded to provide a clean look and seal the HSS from moisture. Galvanizing and high-performance paint protect the exposed steel and deck from the humid environment in the bath house.

Canted columns were used at the front entry to create a whimsical feel and match the sense of movement in the roof shape. Around the pool, cantilevered sun shade canopies were provided for small bleacher stands. The project also included the reconstruction of an existing water slide with all new structural steel supports.

The rise and fall of the steel roof framing, floating above the concrete masonry bath house, gives the feel of waves in the water of the pool. A void is created by the cantilever columns between the building and roof structure, which allows daylight to penetrate the entire interior and provides an outdoor feel to patrons.

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What's COOL in Steel

Cool Replacement

Truss within a Truss

BY KENT A. KAPUSTAR, PE, RICHLAND ENGINEERING LIMITED

U.S. Bridge

Richland Engineering

U.S. Bridge

JUST OUTSIDE OF UPPER SANDUSKY, Ohio, a beautiful and historic valley cuts through the generally flat plains of Wyandot County. The valley holds the State Scenic Sandusky River and a museum within the Indian Mill, a grist mill built in 1861. In the middle of all of this was an aging, load-restricted truss bridge that crossed the Sandusky River.

The Indian Mill Bridge, a 177-ft single-span, single-lane, double-intersection Pratt through-truss, was originally constructed in 1913. The bridge became a languishing afterthought until it attracted the attention of the Wyandot County Engineer, Michael B. Kohl, PE. Given its presence in such a special location, Kohl initiated a project to investigate the structure's preservation. Richland Engineering Limited, a civil/structural firm from Mansfield, Ohio, was selected to prepare a study of various repair alternatives as well as prepare the final plans for the bridge's rehabilitation.

The rehabilitation plan included complete disassembly of the steel superstructure, replacement of the floor system including the timber strip deck, steel roadway stringers and floorbeams, replacement of deteriorated truss members and application of a protective coating for the steel.

Since the bridge crossed a scenic river, the project design team worked to minimize environmental impacts to the project's location. Based on past experience, the designers planned for the construction of a temporary work pad in the river, comprised of clean, non-erodible stone. And to avoid potential harm to the local mussel population, a survey and relocation was performed at the site to move over 100 bivalves out of the project area.

The project was awarded to fabricator U.S. Bridge (an NSBA member and certified fabricator), which had extensive experience with trusses and had worked closely with the Richland Engineering on several other truss rehabilitation projects. However, its ap-

proach to this project was radically different than previous ones: The team erected a 227-ft-long temporary truss (developed by U.S. Bridge and called a Liberty Truss) within the existing truss and used this temporary truss as a support to slide the existing one onto the east approach roadway. The bridge would then be disassembled or reassembled in pieces from the ground.

Analysis showed that the long-span truss was capable of carrying the bridge, provided the deck dead load was removed. U.S. Bridge first removed the dead load due to the asphalt surfacing on the bridge deck, then added temporary support frames. The existing wood deck was left on the bridge a little while longer to provide access for equipment installing the frames and to roll the Liberty Truss across. After the truss was in place and raised into position, but prior to lifting, U.S. Bridge removed the wood deck and 70% of the stringers, then lifted both the Liberty Truss and the (now) lighter existing truss.

The removal and re-erection concept was not only innovative, but also critical to the project's success. By not having to work in the Sandusky River, the team avoided delays and potential catastrophe during construction. Throughout the course of the project, the Sandusky River experienced several floods, which would have invariably precluded work in the river until the waters had receded and likely would have washed out any stone work platform constructed in the river. Had a flood hit while the Indian Mill bridge was supported by temporary columns in the river, the damage to the bridge may have been devastating.

With the bridge steel members transported back to its shop, U.S. Bridge set about fabricating new steel to replace deteriorated members. New steel members included all roadway stringers and floor beams, truss diagonal and lower chord eye bars and truss pins and bearings. The box-shaped truss top chords, end posts and verticals and original latticed portal and sway bracing were preserved.

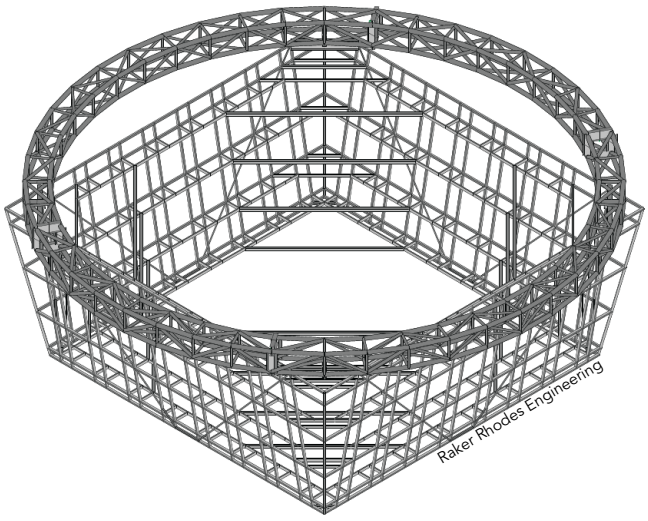
The new and existing steel components received a hot-dip galvanized coating for corrosion protection, and the bridge was re-erected using the Liberty Truss in a manner similar to what was used in the disassembly.


U.S. Bridge


Richland Engineering


Richland Engineering

Bristol Motor Speedway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What's COOL in Steel

Cool TV

A Screen of Colossal Proportions

BY JACOB PHIPPS, PE, RAKER RHODES ENGINEERING, LLC


Bristol Motor Speedway

NASCAR TRACKS ARE SOME of the largest sporting venues on the planet—so naturally, one of them is home to the world's largest outdoor center-hung videoboard.

Bristol Motor Speedway in Bristol, Tenn., gets those bragging rights with its new Colossus TV. Perhaps somewhat ironically, it wasn't racing that prompted the need for such a monstrous TV, but rather football. Next month, the iconic NASCAR venue will host the Battle at Bristol, which matches the University of Tennessee Volunteers against the Virginia Tech Hokies and is expected to be the largest college football game in history in terms of attendance (the venue is planning for an attendance in excess of 160,000). In order to accommodate a football field, the facility's existing pylon-style scoreboard at midfield needed to be removed. While the game was the catalyst for Colossus TV, it will remain as a permanent fixture to provide a unique spectating attraction for future events at Bristol.

The TV is suspended from four cable-stayed, galvanized steel towers that range in height from 189 ft to 221 ft. The towers are anchored by 4-in.-diameter structural strand cable backstays, grouted micropile concrete foundations and structural cable connectors. The videoboard display has four faces, each one composed of 240 individual LED panels that are stitched together, creating a 63-ft-wide, 30-ft-tall display. A 60-ft-diameter ring of LED panels (6 ft in height) is hung below the main videoboards.

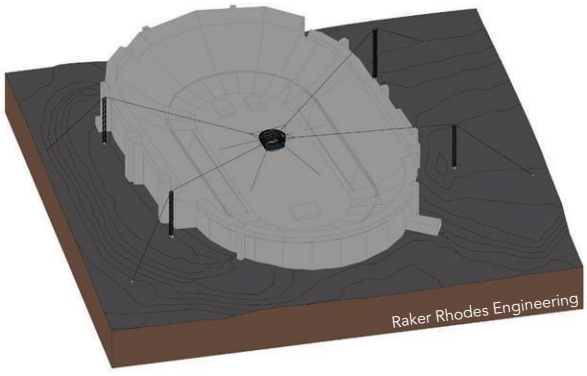
The videoboards feature over 20 million pixels, providing brilliant clarity and brightness to one of the largest sporting venues in the country. Since the videoboard clears the infield by over 100 ft (even exceeding the clearance of the mammoth video display at AT&T Stadium in Arlington, Texas), it is able to accommodate football field functionality (think high punts and kicks). The clearance is also high enough for improved sightlines to all portions of the famous short-track speedway, and the screens are demountable and leased to other venues around the country when not in use.

A hoist system raises and lowers the videoboard faces. The screens are supported by a galvanized steel framework, nicknamed the gondola, which consists primarily of rectangular HSS. The gondola has four levels of catwalks around its internal perimeter to access and maintain the videoboard panels and electrical systems. It is supported by a galvanized steel halo truss, made entirely of HSS pipe shapes, which is nearly 100 ft in diameter and has two top chords, two bottom chords and horizontal and vertical web members. The halo is suspended from the four towers by 3½-in.-diameter cable strands, each approximately 600 ft in length. Colossus TV is tethered to the infield by additional cable braces and 26-ft-tall masts made of HSS. The steel masts are founded by concrete drilled piers, and the entire structural system contains over 600 tons of structural steel fabricated by Superior Steel, Inc. (an AISC member and advanced certified steel erector).

Bristol Motor Speedway


Bristol Motor Speedway


Bristol Motor Speedway

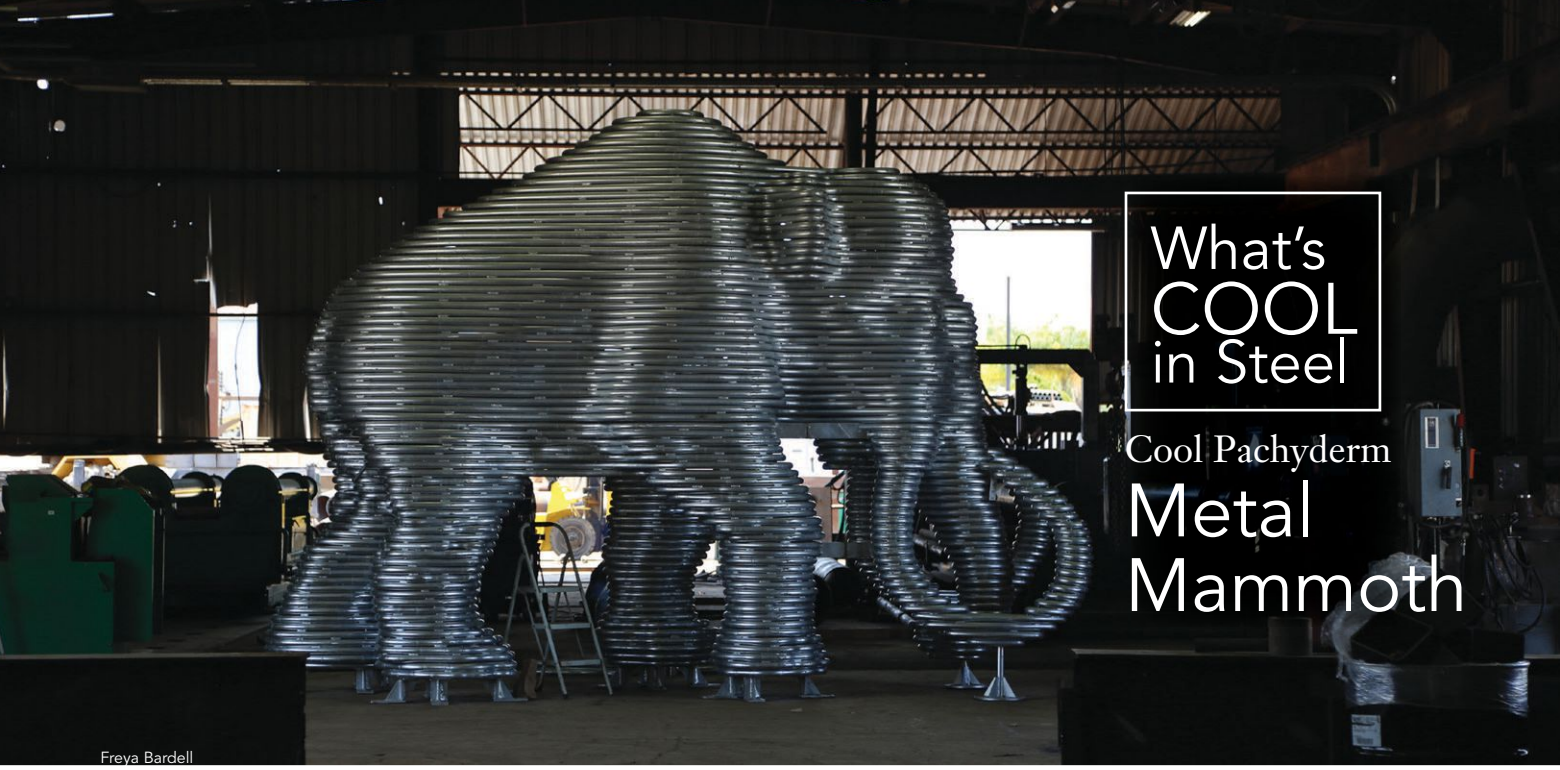

Raker Rhodes Engineering


Bristol Motor Speedway

The towers were shop-fabricated in 42-ft sections and spliced together in the field. Once the towers were erected, the backstay cables were installed and pretensioned to adequately reduce cable sag. This pretensioning pulled the tops of the towers back several inches in preparation to support the massive center-hung halo. Due to the length and weight of the main suspension cables, and because they had to be erected over existing infrastructure (skyboxes, lights, bleachers, fencing, etc.), the erector devised a strategy to temporarily hang the cables in position prior to the halo being lifted into place. The solution was to string temporary messenger cables from tower to tower in both directions. A tensioning wench was placed at the base of each tower so the messenger cable could travel up and over a tower and span approximately 1,200 ft to 1,300 ft to the top of the diagonal tower and down to the wench at the tower base. The main structural strand cables could then be lifted and temporarily hung in preparation to support the halo.

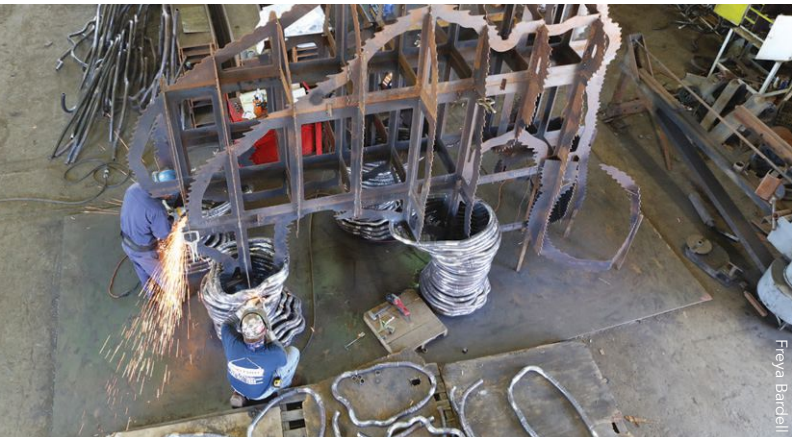
To facilitate shipping and galvanization of the large diameter halo, it was shop-fabricated in six arc sections, transported to a hot-dip galvanizer, delivered to the speedway and spliced together with bolted connections on the ground directly below the intersecting messenger cables. After hanging the structural strand cables, two lattice boom cranes could then lift the halo a vertical distance of 160 ft to where the final cable connections could be made. The messenger cables and cranes then transferred the halo onto the suspension cables, towers and backstay cables, and cable tensions and lateral tower deflections were monitored throughout erection to verify the system's load-distribution behavior and specified design limits.

Following halo erection, the four-sided gondola structure was assembled on the infield. The gondola assembly took place a safe distance away from the overhead halo and suspension cables to eliminate potential conflicts with cranes working to assemble the gondola. Once assembled, a slide-beam system was used to move the 75-ton gondola into position directly below the halo. Again, the towers were pulled back several inches by tensioning the backstay cables in preparation to support the massive gondola. Seven cranes then worked to lift and connect the gondola to the halo with heavy pin connections. Once pinned, the cranes then transferred the gondola load to the suspension system. The center-hung system was then levelled using adjustable cable sockets provided at the halo connections. Finally, the videoboard screens and tethering cables were installed.



Freya Bardell

Cool Pachyderm Metal Mammoth



Freya Bardell

Freya Bardell

Freya Bardell

WANT TO SEE a mammoth in person?

Well you can't. They're extinct. But you can see the next best thing—a life-size steel version—in San Jose, Calif.

In July 2005, a San Jose resident took a walk with his dog along the flood channel of the Guadalupe River, the Lower Guadalupe Trail, just north of the San Jose Airport. It was here that the skeleton and tusks of a mammoth were discovered among the eroding banks of the river. The steel version, named "Lupe" and standing on the same site, was inspired by this discovery and serves as an entry point to the trail and a reminder that these mighty mammals once roamed the Santa Clara valley.

Commissioned by the San Jose Public Art Program and the Trail Program, the sculpture was designed by Freyja Bardell and Brian Howe of Greenmeme Studio, with structural design done by CM Peck Architecture and Engineering and Andrew Nasser Structural Engineer. The designers chose to stack bent steel pipe into a topographical animal form suggestive of geological stratum that the mammoth was buried in. Lupe is comprised of 78 layers of steel pipe (bent by AISC associate member Paramount Roll and Forming), stacked and welded to form a 1:1 scale adult Columbian mammoth.

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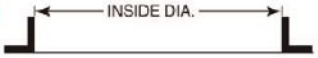
1 Angle Leg Out



10" x 10" x 1" Angle

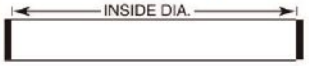
2 Angle Leg In

10" x 10" x 1" Angle

3 Flat Bar The Hard Way

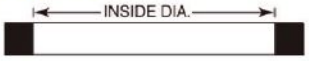
24" x 12" Flat

4 Flat Bar The Easy Way



36" x 12" Flat

5 Square Bar



18" Square

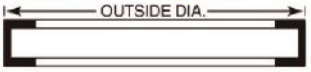
6 Beam The Easy Way (Y-Y Axis)

44" x 335#,
36" x 925#

7 Beam The Hard Way (X-X Axis)

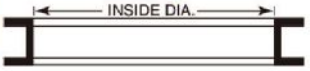
44" x 285#

8 Channel Flanges In



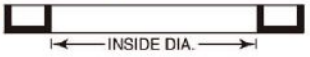
All Sizes

9 Channel Flanges Out



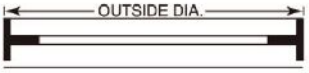
All Sizes

10 Channel The Hard Way (X-X Axis)



All Sizes

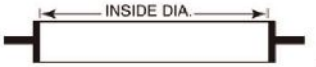
11 Tee Stem In



22" x 142½# Tee

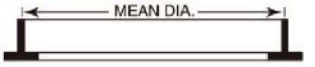
We bend ALL sizes up to:

12 Tee Stem Out



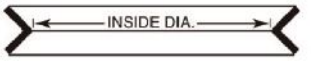
22" x 142½# Tee

13 Tee Stem Up



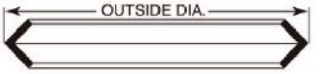
22" x 142½# Tee

14 Angle Heel In



8" x 8" x 1" Angle

15 Angle Heel Out

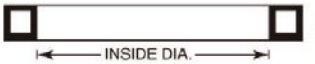


8" x 8" x 1" Angle

16 Angle Heel Up

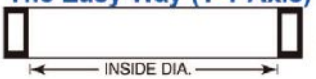
8" x 8"x1" Angle

17 Square Tube



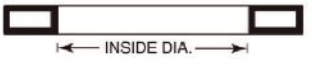
24" x ½" Tube

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



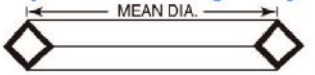
20" x 12" x ⅝" Tube

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



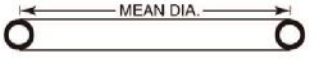
20" x 12" x ⅝" Tube

20 Square Tube Diagonally



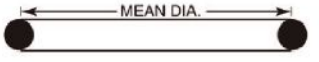
12" x ⅝" Square Tube

21 Round Tube & Pipe



24" Sched. 80 Pipe

22 Round Bar



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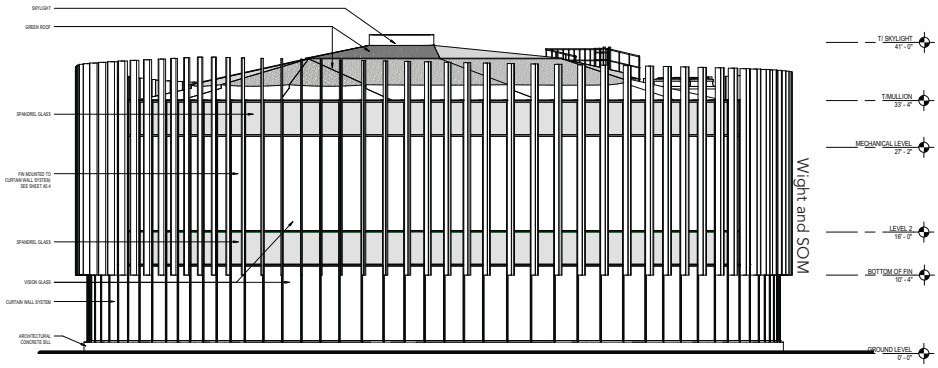
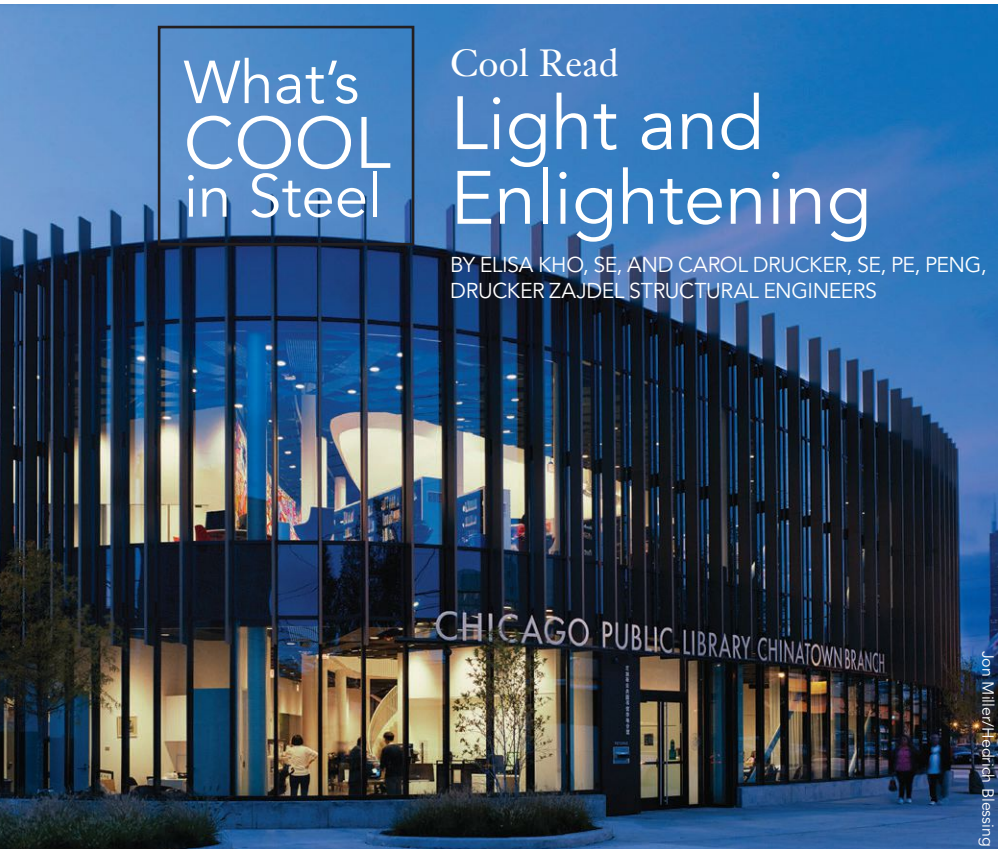




Jon Miller/Hedrich Blessing

What's COOL in Steel

Cool Read

Light and Enlightening

BY ELISA KHO, SE, AND CAROL DRUCKER, SE, PE, PENG, DRUCKER ZAJDEL STRUCTURAL ENGINEERS

Andrew Haas/DZSE

IN A CHICAGO NEIGHBORHOOD known for colorful facades with unique flair, it was only proper for a new library to buck the stylistic trends of its more staid contemporaries.

Led by Wight and Company in collaboration with Skidmore, Owings and Merrill (SOM) and Drucker Zajdel Structural Engineers (DZSE), the library's design-build team sought to create a modern design that would stand as a new icon in the area. The new $9.6 million, 16,370-sq.-ft branch library serves as a civic, educational and social hub for the Chinatown neighborhood. The exterior glass curtain wall creates an image of a glowing lantern at night while also providing plenty of natural light during the day. In addition, the building is ringed with 16-ft-tall rectangular aluminum panels that provide solar shading.

The team considered both steel and glue-laminated timber beams during the initial design phase of the curving, triangular two-story building that subtly reflects angle of the intersection where it sits. But given the demanding load requirements associated with a library, wood beams would have been heavier and bulkier than steel beams, resulting in a less economical option. Plus, steel was determined to be a more sustainable option when measured on a whole-building life-cycle basis. McFarlane Mfg. Company, Inc. (an AISC member) was chosen to fabricate the 98 tons of steel.

The building's interior space radiates from a central atrium, and the main structural beams are similarly arranged on a radius. Round hollow structural sections (HSS) columns provide a clean surface where several beams connect into a single point. The round columns (typically HSS10.75×0.375) also facilitate and simplify the non-orthogonal lateral bracing connections. To satisfy fire-resistance requirements, they are Fire-Trol columns, which are prefabricated, fireproofed units consisting of a load-bearing steel column encased in an insulating material that is permanently protected by an outer non-load-bearing steel shell. An option to use precast concrete columns was considered early on but promptly dismissed due to a longer lead time, heavier sections, larger


Jon Miller/Hedrich Blessing


Jon Miller/Hedrich Blessing


Jon Miller/Hedrich Blessing

footing sizes, more difficult beam connections and the resulting increase in project cost.

Smaller HSS round sections are used as bracing members in order to create a more uniform appearance between the columns and lateral bracing. The braces are strategically located at the exterior bays of the triangular building, which resulted in an unobstructed and flexible interior. Final column and brace sections were selected to be as small as possible for aesthetic reasons as well as structural efficiency. DZSE drew on extensive experience in connection design to select columns capable of resisting local effects at beam and brace connections without the need for stiffeners or doublers.

What's COOL in Steel

Cool Hybrid

A Museum that Amazes

BY REB HAIZLIP, HAIZLIP STUDIO

Jeffrey Jacobs

Ken Petersen

Ken Petersen

WHO SAYS AN ART museum can't be hands-on?

Planned as an addition to the acclaimed Crystal Bridges Museum of American Art in Bentonville, Ark., the Scott Family Amazeum is a 50,000-sq.-ft discovery museum dedicated to family learning experiences. The building takes its cues of form and materials from Crystal Bridges and its use of exposed steel and concrete, curved curtain wall and zinc metal cladding.

The museum is primarily a one-story building with four community faces, each of which has different design attributes. The expansive south facade of the museum overlooks a large outdoor discovery play area and features a simply detailed steel and cedar pergola structure to soften the transition between the indoors and outdoors. The east facade faces a busy thoroughfare and introduces the building to the community. The north facade greets church visitors while the west facade welcomes visitors to the main entrance from the parking lot.

Both the owner and the architect, Haizlip Studio, expressed a desire for the building connections to be visible wherever possible. Exposed steel was used so that these connections were bare, lean and muscular, allowing visitors to understand the physicality of the building and how it was built.

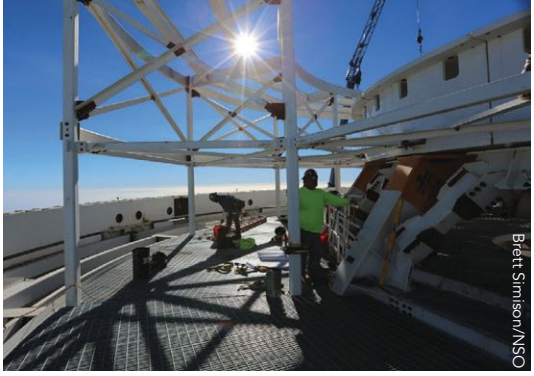
The building connections are most evident at the lobby entrance, where the roof canopy above opens wide to welcome visitors into the museum lobby. The HSS12.75 round columns support a composite structure made of laminated wood beams. The lobby and exhibit hall feature curved glue-laminated timber beams and a wood deck supported by exposed steel columns. The steel attachment between these two systems highlights the connection between the two materials.

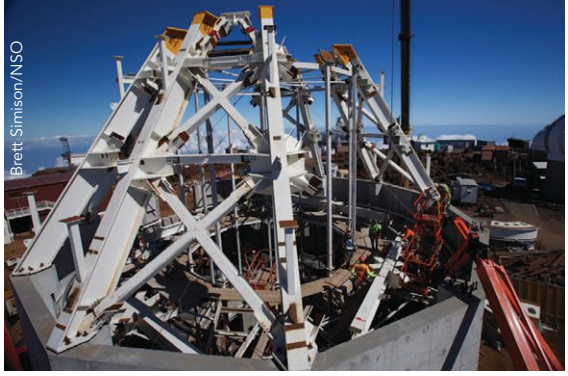
Throughout the exhibit hall, visitors can see many instances of exposed steel in the building architecture, as well as in the interactive learning exhibits that focus on technology, logistics, industry and creative play. The exhibit hall is full of modern industry and even has a full-sized semi-truck cab, a shipping container repurposed as a bridge and supported by an exposed steel frame and a beautifully complex tree-climbing experience made of formed plywood platforms mounted on a large steel structure (the project's steel was fabricated by AISC member and certified fabricator All Steel Construction). From the raw, exposed state of the building construction to the opportunities to work with machines, materials and tools in the tinkering lab, visitors have a sense of how different materials work together to form a new composite whole.

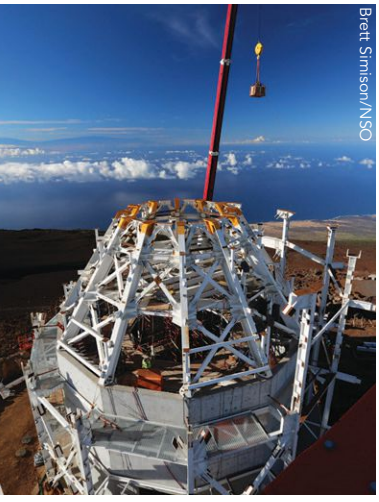

Ken Petersen


Ken Petersen


Jeffrey Jacobs





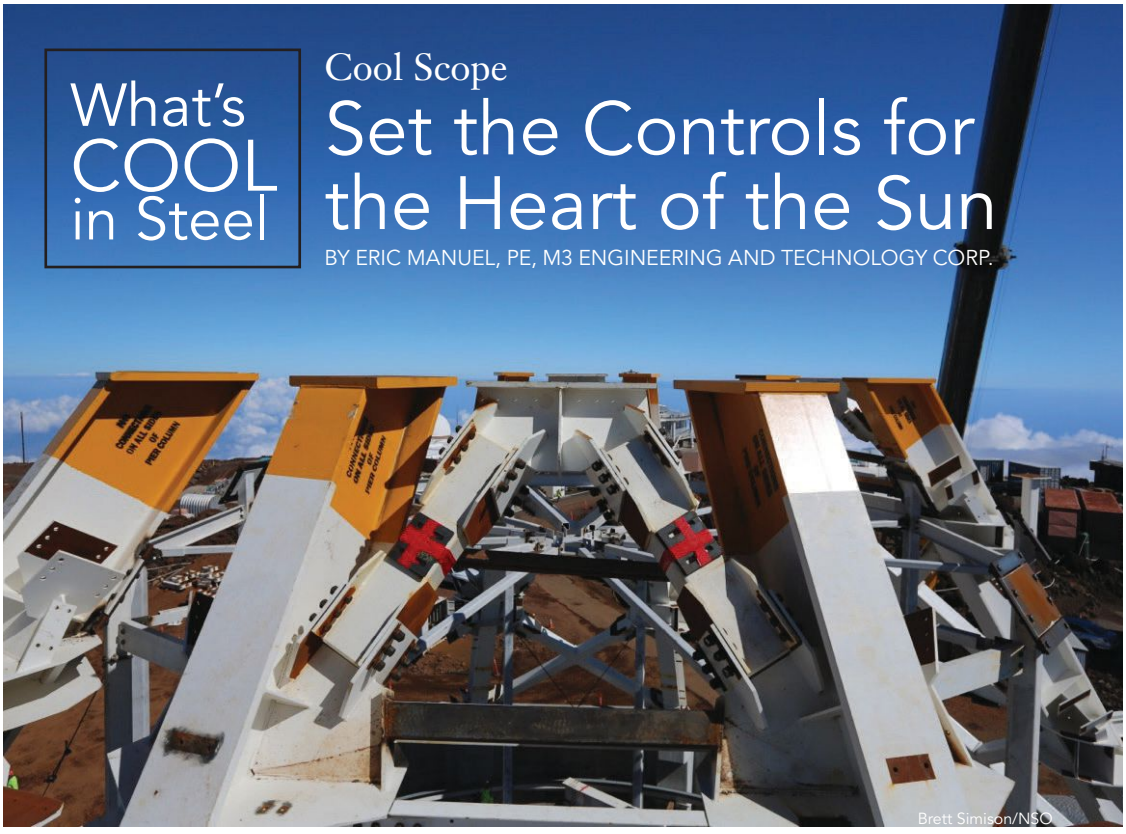


What's COOL in Steel

Cool Scope

Set the Controls for the Heart of the Sun

BY ERIC MANUEL, PE, M3 ENGINEERING AND TECHNOLOGY CORP.



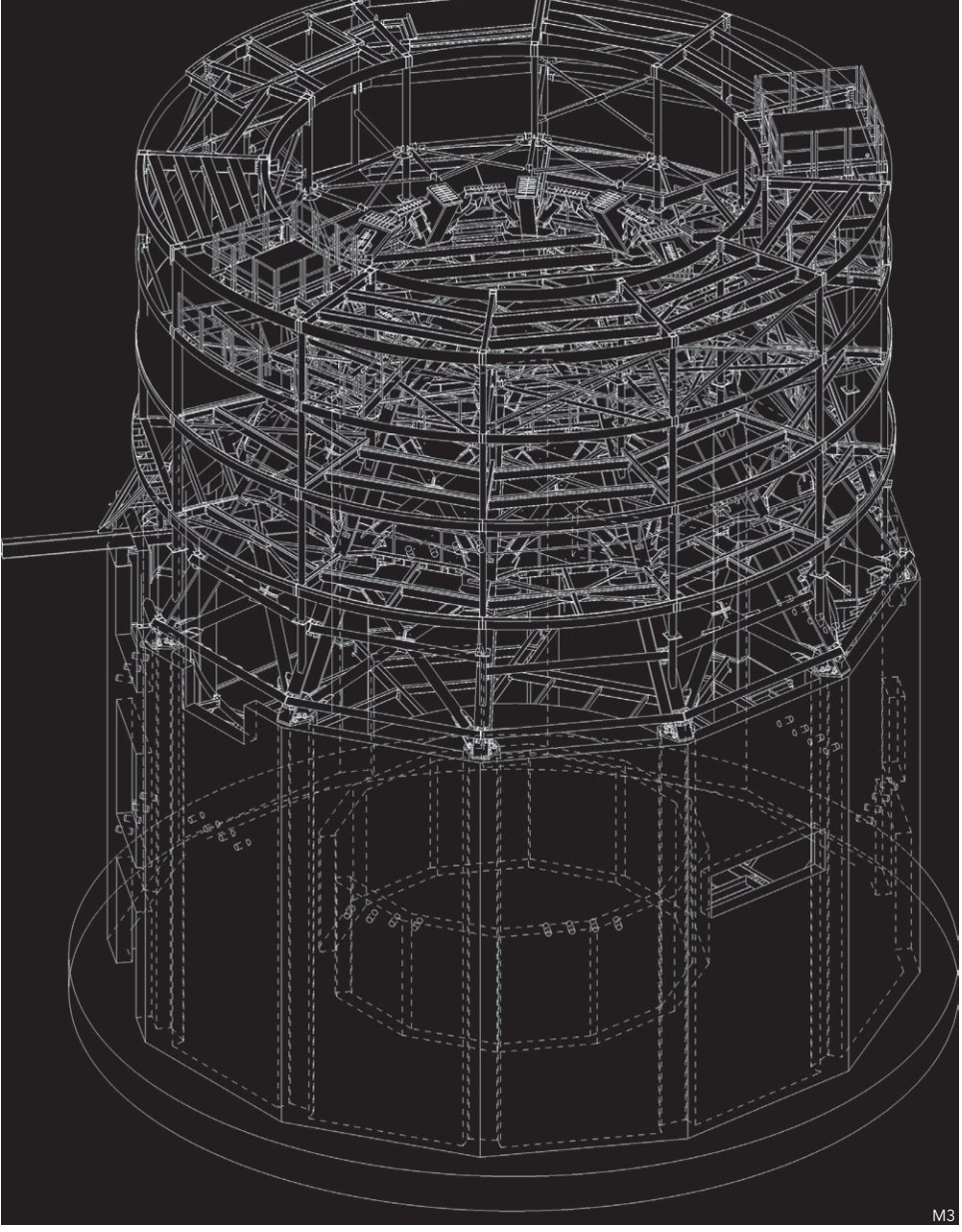
THE FUTURE OF the Daniel K. Inouye Solar Telescope (DKIST) is bright—really bright.

Situated at an elevation of 9,980 ft on the summit of the Haleakala National Park in Maui, Hawai'i, it is the world's largest optical solar telescope aimed at broadening solar physicists' understanding and interpretation of the sun and its complex interaction with the solar system. The telescope operation consists of an unobstructed 13-ft off-axis primary mirror to include state-of-the-art adaptive optics and instrumentation, which improve image resolution and minimize distortion. For years to come, DKIST will unravel many of the peculiarities and anonymities underlying the generation of cosmic magnetic fields and astrophysical plasma processes along with predictive modeling to forecast their effects on Earth.

A certain hierarchy is practiced in astronomical observatory design. In a general sense, the science mission of the observatory—telescope size, number of mirrors, mirror diameter, altitude axis and access to the telescope and its instrumentation—are of primary concern. The telescope pier structure that supports these elements is considered ancillary in nature and must be designed to fit within the remaining space allocation. In other words, form follows function—though obviously function wouldn't be possible without a strong form.

The telescope pier structure is directly below the telescope's azimuth track and provides independent support for the telescope. Thus, the geometry the pier assumes is largely predicated on the former and to its detriment cannot be the intuitive, squat structure with a low height-to-diameter ratio one would logically pursue.

From a historical standpoint, legacy telescope designs have been almost indiscriminately founded on massive cylindrical or polygonal concrete structures, as these are perceived to reduce vibration, thereby minimizing image distortion. At the onset, the DKIST pier was conceived as a cast-in-place lower dodecagon (12-sided polygon) with an upper truncated conical shape. This geometric arrangement was driven by the 29.5-ft diameter of the telescope base and the 52.5-ft diameter corotating Coudé laboratory inside the lower portion of the telescope pier. However, the telescope's lead mechanical engineer, the DKIST site construction manager and structural engineer M3 Engineering and Techonology Corporation concluded that building a tapered concrete upper pier section on a remote project site subject to strict mechanical tolerances would be cost-prohibitive and exceedingly complex. As an alternative, M3 suggested the possibility of a hybrid steel upper pier and a concrete lower pier, which gained closer consid-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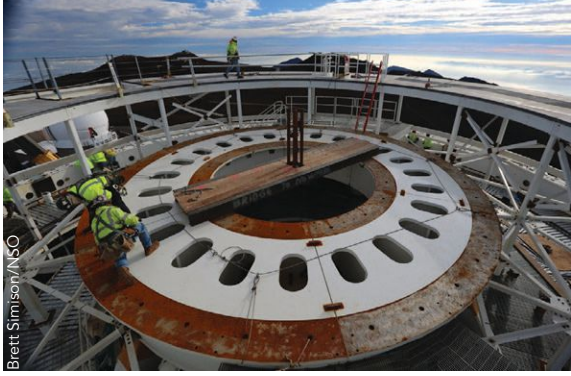
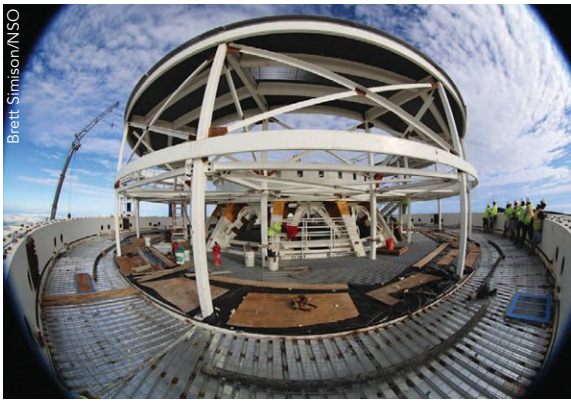
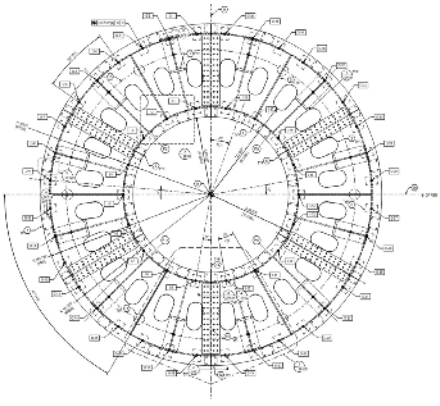

Brett Simison/NSO


Brett Simison/NSO


M3

eration and ultimately was selected for design and detailing. This hybrid steel-concrete solution is unique and completely new to the observatory community.

The framing configuration consists of inclined steel jumbo columns and square tube X-bracing, and approximately 375 tons of steel was used. At the top of the columns, a head ring was provided to join the azimuth track with the telescope pier. The head ring is a built-up, radially stiffened steel disc with manholes to facilitate bolted installation.

The upper steel pier structure was required to meet micron level operational deformations. As a result, the size and proportions of the column and bracing elements are seemingly larger and more robust than that of a traditional building. For example, W30×326 wide-flange columns with HSS10×10×⅝ braces were required to ameliorate pier deformations, whereas W14×48 columns with HSS4×4×¼ bracing would have sufficed under force based considerations. The single-story X-brace configuration was selected due to its superior stiffness compared to other bracing options. Of particular importance was detailing brace end-connections such that stiffness continuity was maintained through the brace-to-column. Though not a driving factor, the hybrid telescope pier was deemed lighter than the conventional concrete pier, with the added benefit of reduced seismic demands.

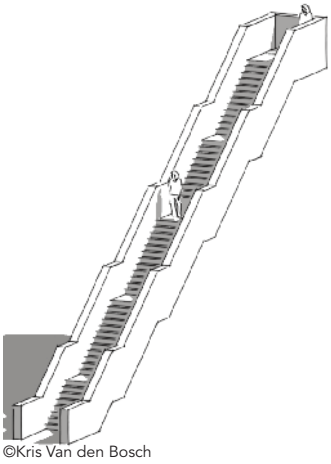
Access, ranging from personnel doors, a monorail crane to HVAC equipment and a removable floor at the utility level, provided additional challenges to designing within the allotted deformation budget. The proposed upper concrete section and the number of pier penetrations would have significantly reduced pier stiffness and performance. In the case of HVAC ductwork, open latticework bracing system with welded brace intersections facilitated routing a maze of ductwork and facilitated stiffness reduction.

The telescope pier columns are inclined at a 33.89° angle from vertical. To facilitate and expedite column erection, adjacent columns and infill bracing were assembled as steel bents by Parsons Steel Erectors (an AISC member and certified fabricator). Additionally, Parsons also developed rigging configurations for the bents, which were test lifted on the erection angle at the fabrication yard. This drastically reduced site assembly and alleviated many challenges associated with the pier erection.

The DKIST project traversed new terrain with the successful implementation of a complex hybrid steel-concrete telescope pier, representing a departure from the familiar and expanding horizons for future telescope projects.

What's COOL in Steel

Cool Tower Going Up

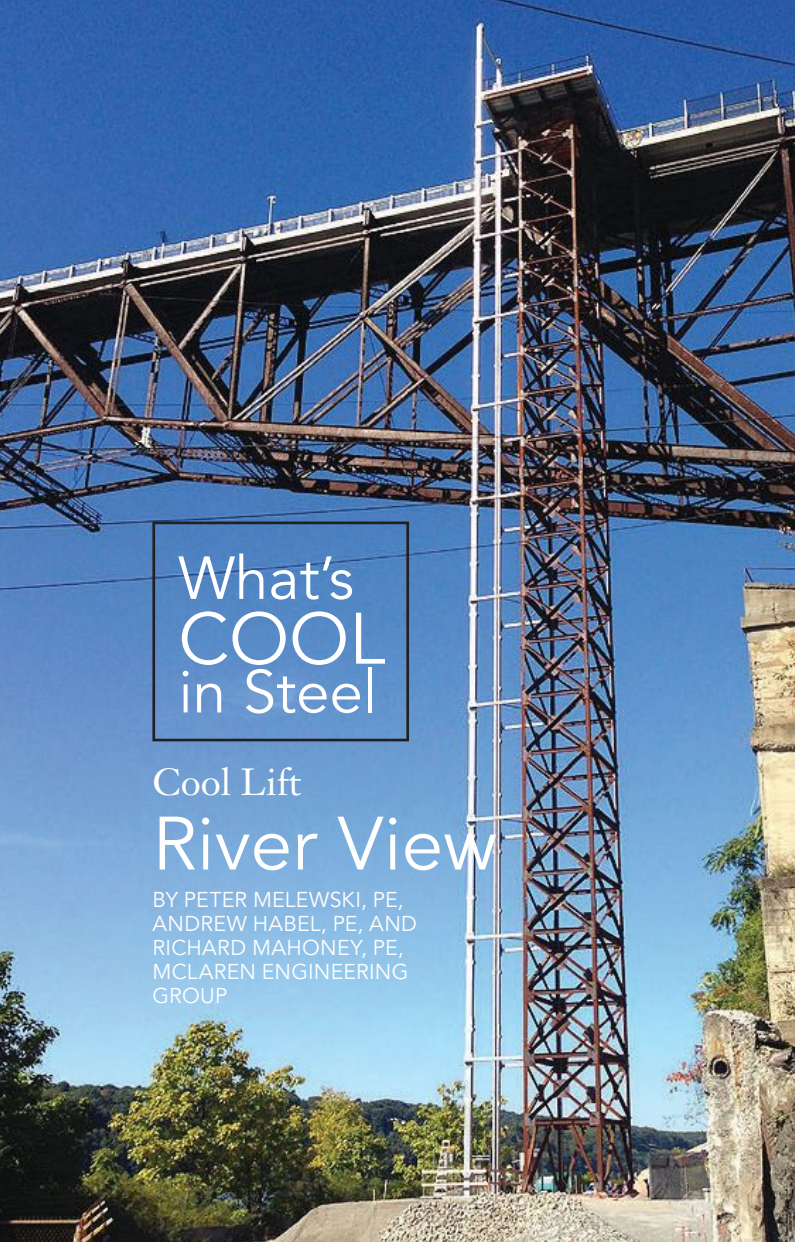


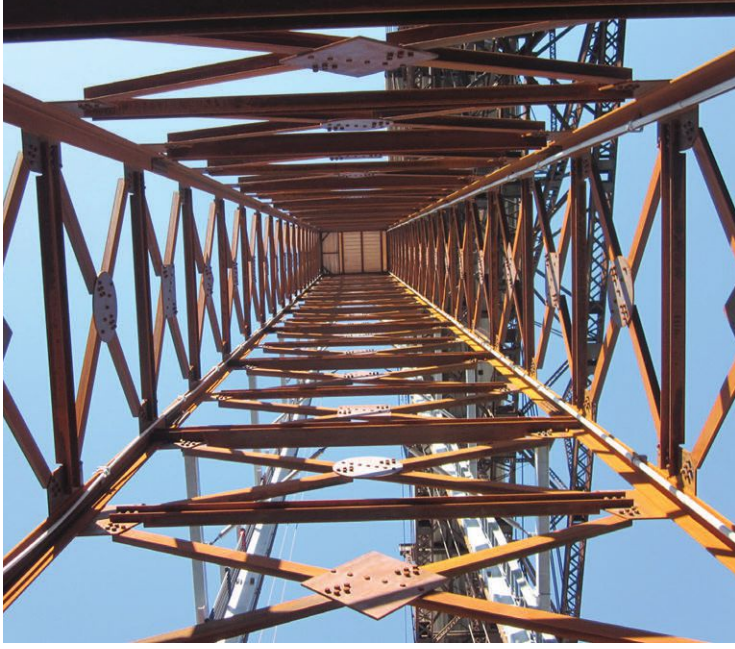
A SIMPLE WOODEN TOWER once overlooked the Kabouterbos "fairytale forest" in Tielt-Winge, Belgium.

Alas, the 4-m (13-ft) tower was irreparably damaged by vandals and had to be closed due to safety concerns. Local officials decided to replace the tower but knew they needed to do so with a sturdy and vandal-proof structure—but also one that was inspiring and seemingly magical (after all, it is the fairytale forest). The specification for the project dictated that the replacement must be made completely of metal and stand at least 10 m (33 ft) high.

Design firm Close to Bone came up with a structure that satisfied these requirements. Its creation, the Vlooybergtoren, is a staircase that cantilevers 37 ft into the air from the hill. Supported by a galvanized structural steel frame, it is clad with weathering steel whose reddish-orange hue pays homage to the region's ironstone.

Using just over 15 tons of steel, the staircase features two vibration dampers to resist the forces of eager climbers, and its left and right handrails act as structural beams to resist both gravity and visitors' weight. Held in place by structural bolts, it appears to float above the landscape. The staircase was fully prefabricated and was assembled on-site—and only took half a day to erect.





What's COOL in Steel

Cool Lift

River View

BY PETER MELEWSKI, PE, ANDREW HABEL, PE, AND RICHARD MAHONEY, PE, MCLAREN ENGINEERING GROUP

IN 2009, NEW YORK held a statewide celebration of the 400th anniversary of Henry Hudson's voyage to the new world and discovery of New Amsterdam.

There was one pivotal project that would serve as the state's legacy gift for this celebration: "The Walkway over the Hudson." The once-thriving Poughkeepsie-Highland Railroad bridge and freight connector had been left underused and abandoned since the 1970s. However, thanks to a group of visionary community members, the bridge was repurposed into a functional pedestrian walkway for the public to enjoy breathtaking views of the Hudson from 200 ft above the river, and nearly a half-million people visit the bridge every year.

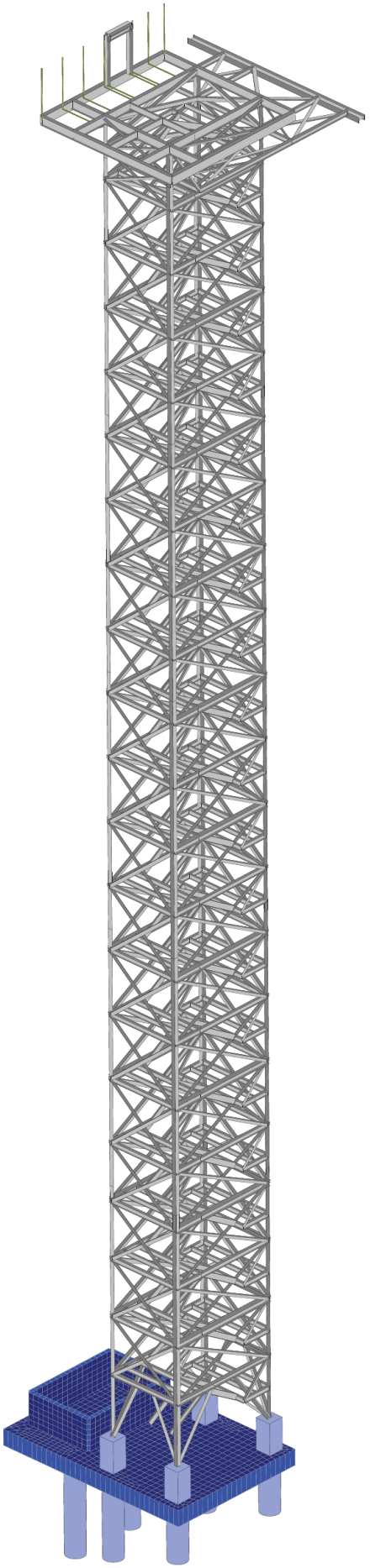
Since the inception of its design, many stakeholders wanted to create an elevator on the east shore of the Hudson River, which was approximately the midpoint of the bridge. The new site of the elevator was to be 0.75 miles from the walkway's west entrance and 0.5 miles from its east entrance.

Only $2.8 million was available for design and construction of the elevator project, so economy was critical. To reduce construction costs, McLaren designed an exterior elevator while preserving the historic industrial nature of the bridge. The elevator would be installed on the west side of the steel tower to provide the best views of the Hudson River.

The design team's collective experience was that a rack-and-pinion elevator, the same type of elevator found on construction sites, was the best type of exterior elevator for resisting the dirt, snow and rain that would inevitably find its way into the mechanics of the elevator. However, the problem with most rack-and-pinion elevators is that they are typically a rougher ride than what the general public is used to.

Once the elevator manufacturer (USA Hoist) was selected, design for the steel tower began. The cross-braced, steel-framed tower was to be 21 stories, with a minimized footprint of 12 in. by 18 in., and was constructed of of A588 weathering steel angles to match the look of the existing bridge and to save costs associated with painting (the steel was fabricated by AISC member and certified fabricator STS Steel, Inc.).

Special attention was given to detailing the steel to preclude ponding and to provide drainage holes where ponding was unavoidable, in order to prevent excessive corrosion. Although economy was at the forefront of design considerations, careful thought was given to future expansion. The steel tower was designed to accommodate future steel-framed stairs at the tower's interior and a second elevator to be installed at the east side of the tower. At the upper level, the center section of the deck was designed to



be removable to accommodate the future interior stairs.

Wind controlled the tower's lateral design, which factored in code-prescribed wind pressures resulting from 100-mph winds. Because the steel elevator tower was to be attached to the existing railroad bridge, it was subject to the sway of the existing bridge. As a result, the elevator tower design accommodates this induced deflection from the sway of the bridge.

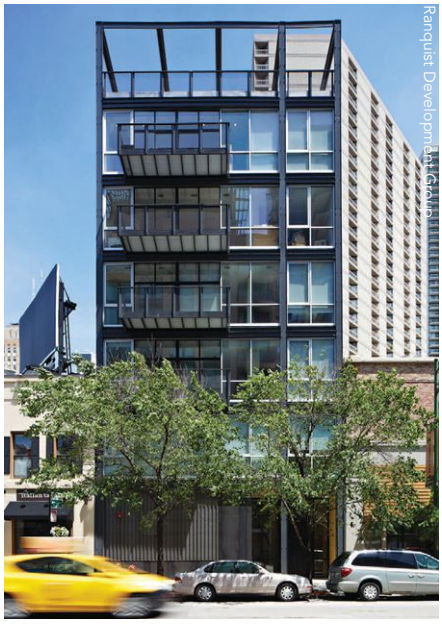
The tower construction proceeded on schedule and within budget and was completed in approximately 17 months. Since its opening, the elevator has added a convenient way for the public to enjoy and experience one of the Hudson Valley's most popular attractions.

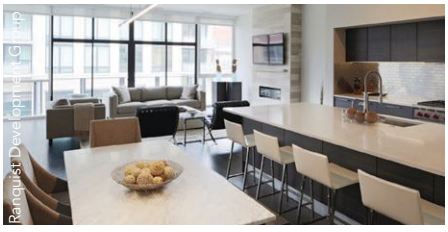
What's COOL in Steel

Cool Restart

Filling In

BY BOB RANQUIST, RANQUIST DEVELOPMENT GROUP





THE GREAT RECESSION OF 2008 all but sucked the life out of U.S. real estate development, especially in the urban multi-family housing sector.

In cities around the country, numerous projects were stopped dead in their tracks, leaving vacant lots and, in a few cases, empty buildings standing as monuments to a stalled economy.

One such development project in Chicago left a derelict shell at 747 North Clark in the city's River North neighborhood since 2009. But as the financial climate improved, Chicago developers Bob Ranquist and Zev Solomon put together a team to revive a nondescript building start into an inspired in-fill multi-family residential building. Seattle-based Miller Hull Partnership out of Seattle led the design, Sullivan Goulette in Chicago served as the architect and SP Engineers was the structural engineer.

The design team wanted the building to acknowledge the great tradition of steel and glass architecture in Chicago, with the facade allowing expression of the building's internal structure—much as Mies van der Rohe did with his famous apartments along Lake Shore Drive. For that reason, steel channel and bent steel plate were used in a rain screen application to face party walls and floors. The steel facade continues up as a seventh-floor pergola, tying the facade elements together and extending them to a more graceful vertical proportion. Steel plate applied to the walls of the ground-floor parking garage further celebrates the material's beauty. A clear coat of Permalac protects the ground-floor plate while high-performance paint was used to protect the steel frame.

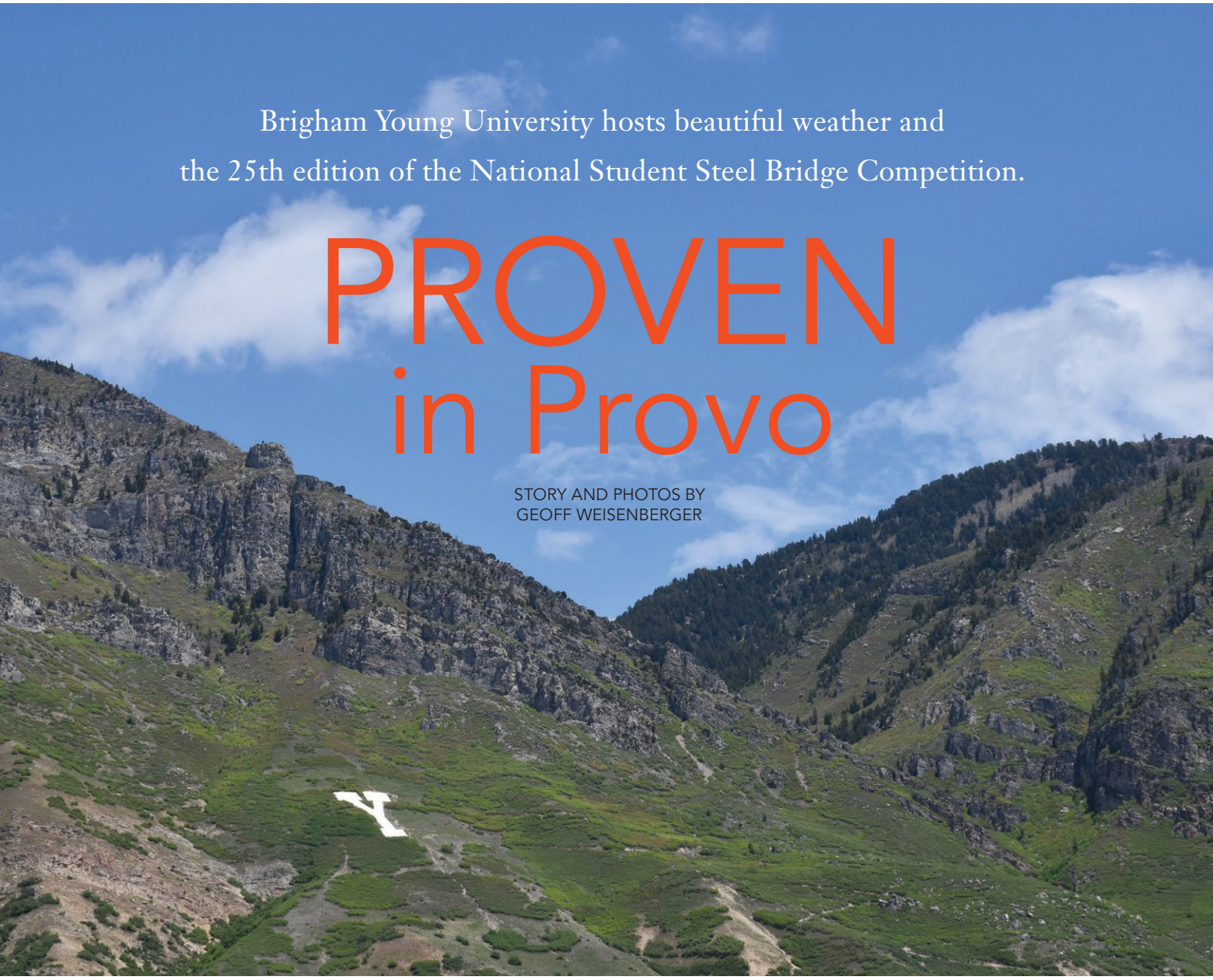
Each condominium is arranged on its own floor, with private in-unit elevator access. Clean lines and a palette of industrial materials, as well as exposed fasteners, give this project an authentic, urban feel in line with the industrial character of the surrounding neighborhood. The structural steel frame allowed for an expansive glass facade with windows that infill the steel elements on the street facade of the homes, allowing for a large amount of natural light. Custom finishes, including imported Italian cabinetry, complete the seamless interior and contrast nicely with the visually raw materials used on the exterior of the building. To that restrained paring is added a charred oak entry door, hot-rolled steel siding and wood ceilings. All units are between 2,000 sq. ft and 3,000 sq. ft and include private balconies and/or private terraces.

With the building stock in American cities aging quickly and energy efficiency becoming increasingly important, the opportunity and need to update existing in-fill buildings in established neighborhoods is necessary and becoming more financially viable as buildable land diminishes. And this former eyesore provides a solid link to Chicago's esteemed architectural history, rooted in steel and glass, making a positive contribution to the character of this popular urban neighborhood. ■

Brigham Young University hosts beautiful weather and the 25th edition of the National Student Steel Bridge Competition.

PROVEN in Provo

STORY AND PHOTOS BY GEOFF WEISENBERGER



BYU hosted this year's National Student Steel Bridge Competition over Memorial Day weekend.

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

ON THE FRIDAY of Memorial Day weekend, the sky over Provo, Utah, was about as blue as it can get.

The high altitude, utter lack of humidity and mostly sunny conditions made the upper-70s temperature seem warmer, though not in a bad way.

And on the wide expanse of Cougar Field, a green space on the campus of Brigham Young University (BYU) in the shadows of the Wasatch Range to the east, hundreds of college students had assembled nearly 50 bridges for the National Student Steel Bridge Competition. Now in its 25th year, the NSSBC tasks students with building 1:10 scale all-steel bridges as quickly and efficiently as possible. Today is the display portion, where the assembled bridges are evaluated on overall appearance and aesthetic merit by the judging team. This is the stress-free portion of the competition. Saturday is a different story.

Saturday is when the competition's more anxiety-inducing components take place: construction speed, stiffness (which includes vertical and lateral loading tests) and weighing. In addition, the economy and efficiency categories factor in these other segments.

▲ The Michigan Tech team.

▼ Illini hard hats, all lined up.

▲ Scouting the competition's connections.

▼ Students and their bridges basked in the sun for the display portion of the competition.

The students mill about the bridges, answering questions, looking at their peers' work—perhaps to get ideas for next year's competition—soaking up the sun and generally enjoying the beautiful day. Frisbees are abundant, as are confidence and hope. Today, everyone is still in it.

In Contention

One of this year's expected contenders is the Michigan Technological University (better known as Michigan Tech) team, which traveled from its home in Houghton, Mich., a town of nearly 8,000 on the Keweenaw Peninsula, the uppermost peninsula on Michigan's Upper Peninsula. The team is made up of 15 students, 13 of which flew while two braved the roughly 1,600-mile journey in the van, along with the bridge components.

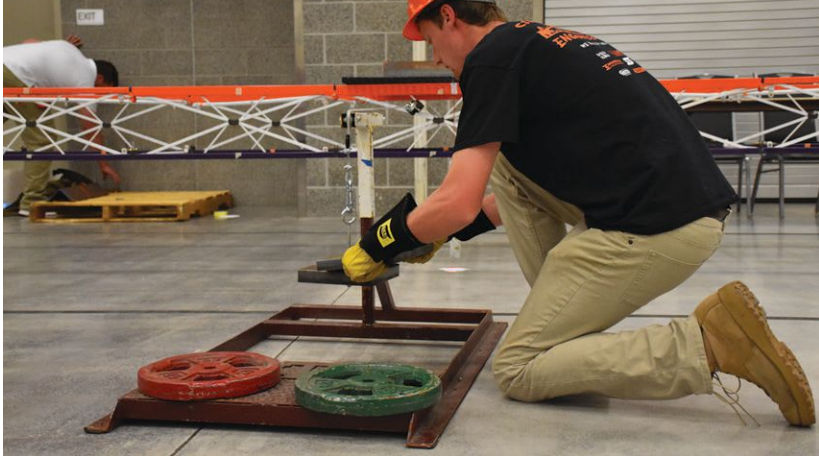
It's not atypical for a team to be this size, though only up to six are allowed to compete in the construction/build portion. The rest are available for the other portions of the competition and are also involved in the design and fabrication of the bridge and its components.

But it's the construction team that has the biggest commitment, explains Joseph Schmitt, a senior engineering student at Michigan Tech and the team's captain, noting that there are no understudies. "We make sure not to do anything stupid or get sick before the competition," he laughs. (But he's not kidding.)

On Saturday morning, the teams unload their bridge components, tools, hard hats and other equipment, which generally arrive in rolling crates, decorated with school colors. One by one, they queue up outside the loading dock of the Provo Convention Center, a few miles from BYU, which plays host to the remaining categories. Many national competitions are held in sporting (basketball) arenas, and while the floor area here—which includes six vertical loading stations, five build areas, three lateral loading stations and a weigh station—is the same size if not slightly larger than typical arena floors, it doesn't feel that way as there are no stands. Spectators—family members, fellow team members and others—are relegated to a 5-ft wide space around the competition floor, making for an intimate yet intense competition environment.

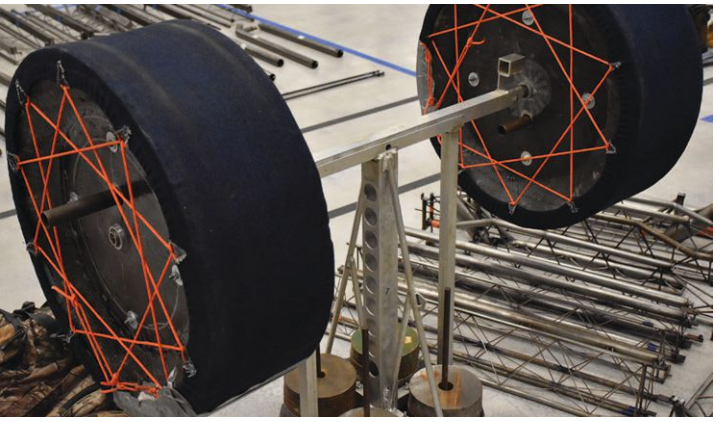
▲ Western Kentucky's striking powder-coated components.

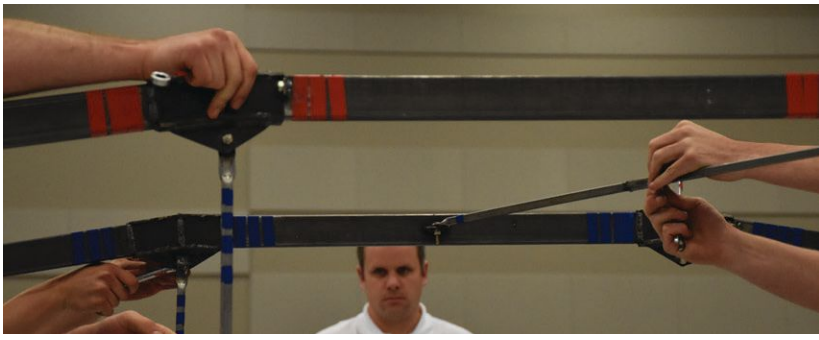
▼ Several teams like the University of Florida used rollers of some sort to project their bridges over the river.



▲ The lateral load test.

▼ Tightening up the final connections.





Rookies of the Year

Every team has its own expectations for the competition.

Some are in it to win it all. Others hope for victory in one particular category. Still others want to post a better time than last year or perhaps make a respectable return to the national stage after not qualifying for a number of years. And every now and then, a team makes its debut at nationals and simply wants to demonstrate that they deserve to be there.

This year marked Southern Methodist University's first time at the national competition. And in fact, the team has only been in existence for five years.

"Two students started the team five years ago, and we've been building it ever since," explains Alexandra "Alex" Yauch, the team's captain. "We were eliminated during regionals the last four years for one reason or another—one year our bridge was 2 in. too long, the next it was 500 lb and last year our fabrication was delayed by several weeks. But everything came together this year."

The team consists of eight members, most of whom are seniors. The six that made the trip to the competition all participated in the build (and all, coincidentally, speak Spanish). Yauch is the only returning member from last year's team.

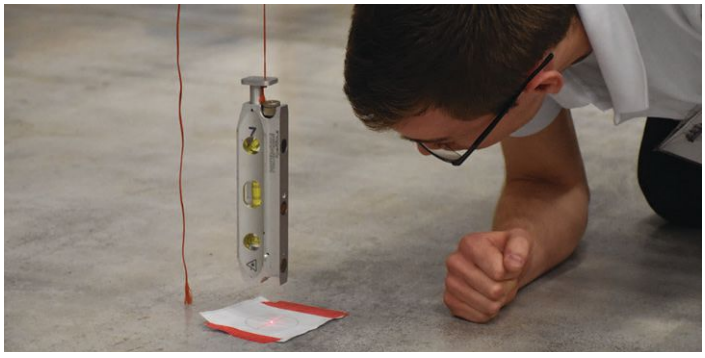
The team is one of the last to compete and puts their bridge together in just under 33 minutes (28 minutes, not counting penalties), then completes the lateral and vertical load tests. Next, it's on to the weigh station and after that, SMU has completed its first-ever national competition.

And now that they've had a taste of the big leagues, next year's returning members want to keep the momentum going.

"Now that we've been to nationals for the first time, we are excited to take the tips and techniques we learned back to the fabrication shop to make a better bridge," says Yauch. "It really opens your eyes to all the innovative ways different teams strive for the same goal. I'm graduating, but I can't wait to see what next year's team comes up with!"

▲ Clemson's dramatic lift over the river.

▼ Precisely measuring deflection following vertical loading.



▲ Testing for levelness following the build portion.

▼ The board test looks for elements projecting above the deck.

The construction speed portion takes place first. Once a team signs in, it is assigned a build area and stages its tools, bridge elements and fasteners in preparation for its turn. Everything is precisely placed in the materials area, like surgical instruments. This area, like the rest of the build station, is designated by tape. The setup varies year by year, and this year there is a river in the middle, and the supports must only touch one of two piers on either side of the river.

Once the clock starts, team members collect their fasteners and run back and forth between the material staging areas to the spot where they assemble their bridges, starting, of course, with the supports. The floor seems particularly slippery this year, and many teams take some practice runs to get accustomed to skidding to a stop, much like a tennis player on a clay court. Several teams designate a member to document their build via a GoPro attached to a hard hat.

Michigan Tech is 15th out of 48 in the build order. As the team waits outside the loading dock, they go over notes, discuss strategy and generally try to simultaneously psych themselves up while also keeping each other calm.

"You're always jittery, no matter how many times you've practiced," says Bailey Ramler, a returning builder from last year's team.

When their turn comes, the six Michigan Tech designated build team members set up, do some jumping, stretching and high-hives, plus a lap around the build area, warn each other about how slippery the floor is and give each other a last-minute pep talk. "Take your time," advises Schmitt.

Wait, what? It's a timed competition. Speed is of the essence.

But it's not everything. There are penalties for infractions such as stepping in the "water," dropping a bolt, stepping outside of the build station or letting a vertical support slip off of a pier. So while a team wants to build their bridge as quickly as possible, they also want to do so with as few penalties as possible. If the judges have an issue or the team requires a clarification, the clock is stopped and, if necessary, the rules committee is consulted. (One case in this year's competition involved a bolt issue with a bridge. Following an appeal, the committee determined that a bolt was not in full contact with its components, and the team was given a penalty.) Once everything is cleared up, the clock starts again and the team continues to build the bridge.

There are various approaches to building the bridges. Some teams build the entire thing on one side of the river, then find a way to get the far support over the river and onto the opposing pier. These included various rolling devices and a drawbridge approach to connect one side to the other. Perhaps the most dramatic and death-defying approach was taken by the Clemson team, who constructed the bridge on one side of the river then pivoted the entire thing, with one support planted on the near-side pier, and swung the opposite end over the river. While this technique certainly demonstrated some real showmanship, it also involved a certain amount of danger, and multiple judges commented that such a technique would be addressed in future competitions. Nevertheless, it was within the rules this time around, and certainly garnered some (unofficial) points for resourcefulness, as well as kudos from some of the other teams.

While several teams went with this "build it all on one side then figure out how to get it across the river approach," most took the approach of splitting the build team up on either side of the river and coming together in the middle. Michigan Tech adopted this latter strategy. With Schmitt off to the side of the build area, scrutinizing his team and offering encouragement or advice, much like a basketball coach on the sidelines during a big game, the team pulls off a very respectable time of just over six minutes. There is a sense of pure joy amongst the team as they whoop and congratulate each other.

Prep Work

While the build takes place in a matter of minutes, getting to the national competition takes a lot longer. First, it's a matter of assembling a team, and sizes range from four to 20-plus

members (again, up to six members can take part on the build team, though at least one team only used three—which can increase build time but also factors into the efficiency and economy scores). While some teams, like Colorado School of Mines, trend toward upperclassmen—every year, their team is composed of only seniors as part of a senior design project—others take the opposite approach.

"We try to recruit members as freshman, so that they're involved throughout their whole college career," says Schmitt. "We work on keeping people interested during that first semester, especially the younger ones. But once they make it to a competition, they're hooked." Longevity of another sort is also sought after. Schmitt points to the tallest member of the Michigan Tech team, laughing (but again, not kidding), "He was picked first because he can reach that bolt in the very middle without falling into the river."

For the Michigan Tech team, preparation for the competition starts at the beginning of the fall semester. The bridge is designed and modeled, steel is ordered by Thanksgiving, preliminary fabrication is performed before the winter break if possible and fabrication is typically 90% completed by spring break. All welding and fabrication are performed by team members, who pass down their skills to the younger members.

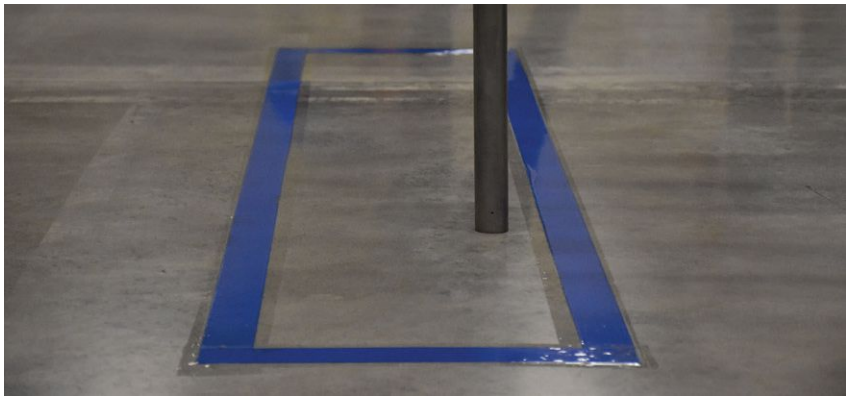
"The competition is a wonderful learning experience," says Judy Liu, a professor with Oregon State University's School of Civil and Construction Engineering, which will host next year's competition in Corvallis. "Students engage in a project from conceptual design to construction and then get to load test their designs! They gain hands-on experience in fabrication and build their project management and teamwork skills."

"Teams from across the globe meet in the spirit of friendly competition to present their bridges and perform tightly choreographed construction," says Paul Richards, faculty advisor for host BYU. "This type of experience is more valuable than anything they can get in class."

Scouting is part of the process as well (especially during the display portion). Schmitt explains that taking notes on another team's bridge is one thing, but copying an entire bridge is generally frowned upon. "Everyone pays a lot of attention to the other teams and what worked for them," he says, noting that his team's bridge is fundamentally the same design as in years past, with slight modifications to address the rules, which are updated every year.

More than 200 teams end up participating in 18 regional competitions; the seven international teams in the competition this year are assigned to geographically appropriate regions. The best teams from each region then go on to the national competition, and regions vary in size and competitiveness (the discussions about this are much like the arguments that tend to flare up about the various conferences during college football season).

A bridge's design can evolve throughout the year, even following regionals, and Schmitt notes that



▲ A bridge achieves a perfect landing after being projected over the river.

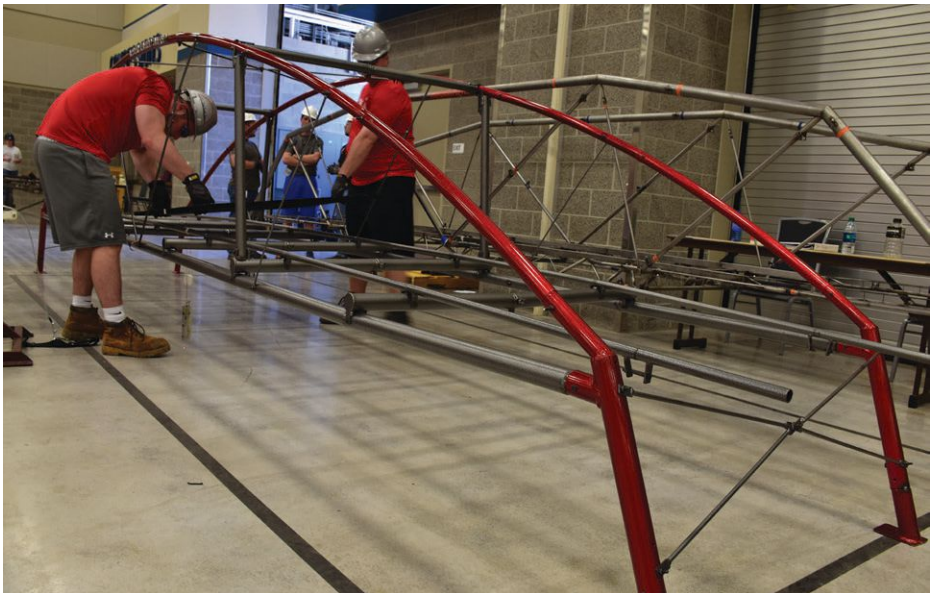
▼ Oregon State will host next year's competition.

▲ West Virginia prepares for the build portion.

▼ The University of California, Berkeley, overall winners in 2008, 2012 and 2013.

The University of Michigan, racing to complete their bridge.

Getting started. Vertical supports must only touch the pier.



A "superieure" bridge.

Texas A&M, getting started on their build.

All components must fit in the box.

Western Kentucky's display category winning bridge.

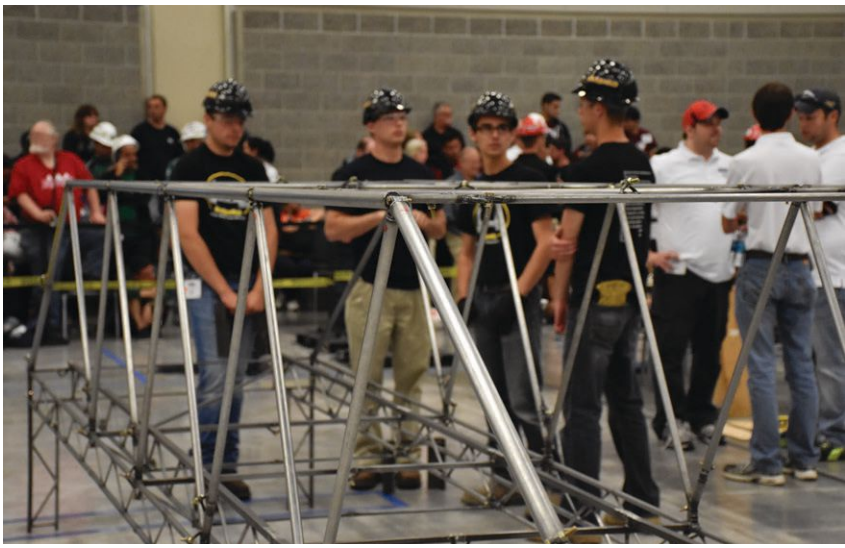
The rules committee discusses an appeal.

The Michigan Tech team takes a warm-up lap.

Reaching over the river. Height can definitely come in handy.

Starting the build.

Waiting for the next category.



Setting the fasteners.

Applying load, 25 lb at a time up to 2,500 lb.

High-fives before the build.

Disaster strikes.

And the Winners Are…

Mere hours after the competition was the awards dinner, and students quickly went from comfortable duds to formal attire.

In honor of NSSBC's 25th year, Bob Shaw, its founder, gave a short presentation.

"It's amazing to think that the competition has grown from just three Michigan schools—about 30 students—to the size it is today, and also how it's reached students and schools around the world," he said.

Following the presentation, the winners for each category were announced. The University of Wisconsin – Platteville won the construction speed category with a build time of 2.62 minutes (roughly 2 minutes, 37 seconds). (To get an idea of just how fast that is, the second-best time, posted by Youngstown State University, was just under 6 minutes, and the slowest time was nearly 44 minutes; anything over 45 minutes results in a disqualification.) The team also won the economy category. The University of Florida had the lightest bridge, at 113 lb, as well as the most efficient bridge. Western Kentucky University, with its graceful arch and enviable red powder-coated finish, won the display category. The stiffness category, a combination of the lateral and vertical load tests, was won by George Mason University.

And the overall prize went to École de Technologie Supérieure of Montreal, with Cal Poly San Luis Obispo taking second place and the University of Florida coming in third. Aside from the display category, ETS placed no lower than 12th in every other category and was actually in the top five in three of them. For the full results, visit **www.nssbc.info**.

"When the students gave Bob a standing ovation at the banquet, it was clear the significance that this event holds for their careers and their lives," said Nancy Gavlin, AISC's director of education. "And once again, they demonstrated this with their inventive, practical and beautiful steel bridges."

his team even cut out a few components between regionals and nationals. The goal is to achieve the perfect balance of a bridge that's light and quick to construct—without sacrificing stability—in many cases designing right up to the limit. It's a long road from the beginning of the school year to this point, and it requires a lot of commitment, patience, trial and error and practice.

Loading Up

But after making it to nationals—and especially the minutes immediately following completion of the building portion—it's all worth it. Following the build, the judges inspect Michigan Tech's bridge—making sure it's level and that all the connections are tight—then the team waits until a lateral load station opens up. Once it does, they carry it over and weight is applied to the side of the bridge to test lateral stability. Tech's bridge passes with flying colors—only ½ in. of deflection—and then it's on to the vertical loading station.

Plastic paint barrels are stacked upside-down under the bridge for safety purposes, then a six-sided die is rolled to determine where the 2,500 lb of weight—in the form of 100 25-lb angles, added one at a time—is applied. When the die is rolled, the team isn't thrilled.

"We rolled the worst-case scenario, which is to have all of the weight applied in the middle of the bridge," explains Nick Toomey, a former team captain. "Last year, two bridges failed in the station next to us. With one of them, a bolt failed. It popped right off, and you could hear it skitter across the floor."

Only three team members are allowed to apply load, so he stands outside of the station, along with his other teammates, and watches the angles pile up on his bridge, one by one. One member picks up and hands the angles to a second member, who sets them with the third member on the opposite side of the bridge. "This one," repeats Schmitt, who is receiving the weight on the opposite side of the bridge, each time pointing to one of the piles that are accumulating on the bridge, in an effort to apply the load evenly. There's a palpable feeling of relief as the pile of angles to be added dwindles, and his teammates pick up and begin to set the last angle. "Careful," Schmitt says as he receives the angle and begins to set it down. There's a pause, everyone inhales and then… disaster. The bridge collapses, toppling to one side and sending the angles onto the floor. It's an automatic disqualification.

A few minutes later, it would be determined that the bridge buckled laterally, which set off a chain reaction in which a handful of connections and welds failed.

But right now, the team is stunned. After quickly confirming that no one was hurt, Schmitt calmly exclaims, "Well… now we know what not to do next year."

And that's what the competition is about: perseverance and learning. (Two other teams learned the same lesson, as their bridges also failed the vertical loading test.) You can build on years of experience, spend countless hours perfecting the design, practice building your bridge over and over and over, check and recheck every detail, and at the end of the day one little design flaw—and perhaps an unlucky roll of the die—can bring it all crashing down.

"But this is why we hold the competition," says Larry Kruth, one of the rules committee volunteers. "It's a learning opportunity that these kids will take with them for the rest of their lives."

But even shortly after such a disappointing result, the team is able to recognize that it brought a damn good bridge to the competition.

"If that hadn't happened, I honestly think we would have won it all," says team member Jeremy Dziewit, with no trace of sarcasm or jest in his voice. And he very well could be right. No doubt, he and his returning teammates will be looking forward to bluer skies next year—and another chance to win it all. ■

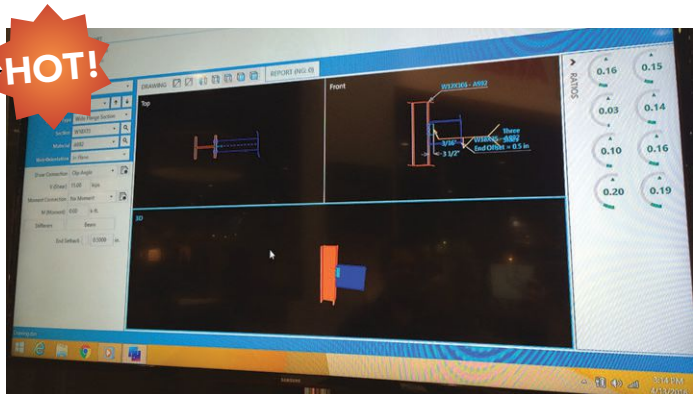
It's been a while, but Hot Products are back!

HOT 2016 Products

ALL WINNERS, HONORABLE MENTIONS and other offerings discussed were on display at the 2016 NASCC: The Steel Conference in Orlando this past April and represent the wide range of machinery, technology, tools and other products that service the structural steel industry. All exhibitors were eligible, and products were chosen by AISC staff. Selection was based on manufacturers' descriptions and claims; no product testing or evaluation were performed. This list does not constitute a product endorsement by *Modern Steel Construction* or AISC.

Descon Version 8 Basic

HOT!



Built on more than 30 years of user input, Descon Version 8 features a new user-friendly interface and new features that make the software easier and quicker to use. Add highlighting and comments to the calculation reports, switch a design between ASD and LRFD on the fly, quickly view limit states with capacity gauges and more. The five different drawing views allow you to zoom, rotate, toggle and select connection drawings. "No-goods" are flagged dynamically in the report as the connection is designed.

For more information, visit www.desconplus.com or call 1.888.8DESCON (833.7266).

EuroBoor ECO-Tube 30

This one-of-a-kind magnetic drill is specifically designed to drill holes up to 1¼ in. in diameter in round material. Traditionally, magnetic drills work only on a flat surface, but the ECO-Tube.30 has a feature that allows the magnet to conform to round material no matter the diameter. It can also drill internal materials like tube or pipe—as well as flat surfaces—and is already being used on a national project to convert existing light poles into public charging spots for hybrid cars.

For more information, visit www.euroboor.com.

Inovatech Engineering Group SP900

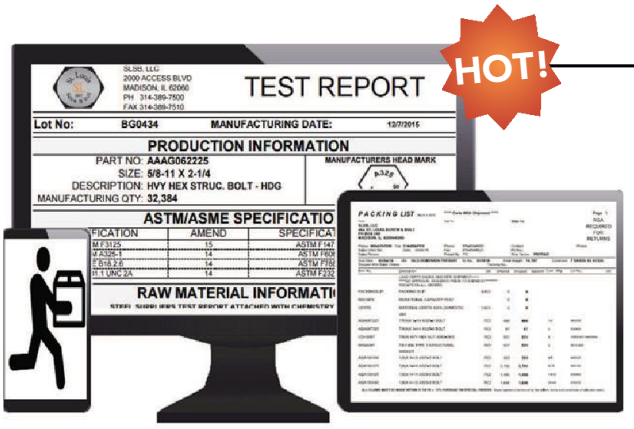
The SteelPRO 900 3D plasma cutter combines numerous processes such as: drilling, coping, beveling, marking, plate cutting and punching. The robotic cells, which include SteelPRO Series Software, provide everything required for 2D/3D robotic plasma cutting. Tor users who need to create or convert parts, the standalone Builder tool can be used to create DSTV (3D) files for SteelPRO Nester. Nester can organize parts into stock material and provides a multitude of options to control how parts will be processed and can process DSTV (3D) and G-Code (2D) data into SteelPRO Director-ready cutting operations. Director is used for real-time control over 2D/3D robotic plasma cutting and seamlessly integrates all machine components into an easy to use interface.

For more information, visit www.inovatechengineering.com or call 613.809.3614.

Ajax Fasteners ONESIDE

The ONESIDE structural blind fastening system is the first true structural blind fastener on the market. By using a collapsible washer rather than sleeve deformation, it is capable of being installed in friction grip design and can be used as a one to one replacement of standard structural bolts in many engineering applications. The same design methodologies applicable to standard A325M structural bolts are suitable for the design with ONESIDE in blind applications.

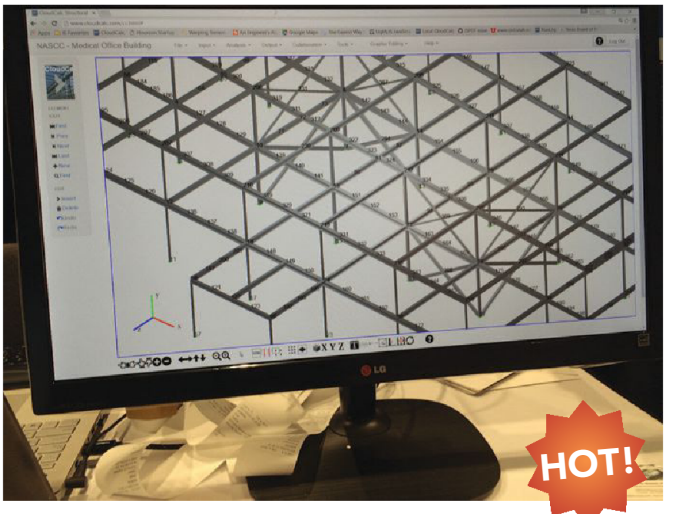
For more information, visit www.ajaxfast.com.au.



St. Louis Screw and Bolt HEXPORT

HEXPORT is a new cloud-based portal for all structural bolt documents and order tracking, making document retrieval and important information available to our customers anytime they need it, 24/7. This includes material test reports, rotational capacity test results, DOT approval documents, packing slips, order tracking and signed proof of deliveries. And it's a free service!

For more information, visit www.stlouisscrewbolt.com or call 800.237.7059.



CloudCalc Structural Analysis in the Cloud

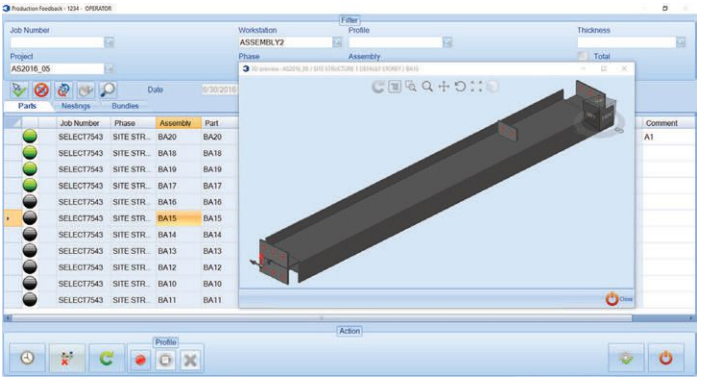
CloudCalc structural engineering analysis software runs in the cloud, freeing the engineer from the confines of PC-installed software. Members of a distributed project team can easily share models. Working over the cloud, all team members always have access to the same data and the same version of the engineering software. The software is accessible via computer, tablet and smartphone, allowing engineers to make better informed decisions at the job site, since potential modifications can be analyzed right on the spot. By offering the Software as a Service (SaaS), licenses can be added nearly instantaneously to easily match the cyclic workload of a typical engineering firm, and users are not restricted by perpetual licenses and enforced maintenance payments.

For more information, visit www.cloudcalc.com or call 713.623.1263.

What Wires?

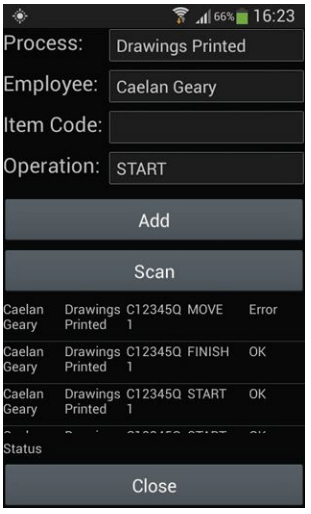
A number of applications at NASCC this year featured mobile or cloud-based capabilities. Here's a sampling:

Steel Central LLC (offered by Steel Projects) Mobile Production Tracking and Private Inventory Clouds



This tablet-based production module contains all the information any worker on the shop floor needs to perform their duties and record their work. It provides details on each piece, assembly, bundle or nest that is to be worked on—including material lists, 3D views, detail drawings and any other attached documents like as RFIs or change orders. In addition, information about the "route" of the piece through the workshop is provided—which workstation it came from and where it needs to go next. Lastly, a forecasted time for completion of the work at any particular workstation is provided. Employees log into the module and select the job and piece they are working on. They are then presented the information and documents they need, and the system records the time they spend working on it. Input is via a simple barcode reader, touchscreen or keyboard. All the information is immediately available in the office for production managers to review and track progress.

Private inventory clouds (PICs) allow any supplier the opportunity to share their inventory with customers and project teams. The information they share is private and secure, with only those granted access able to view the data. The amount of information shared is also completely controlled by the supplier, enabling an effective method of channel management. Those granted access to this private space can view, search, save, and print the results. They can also access the results live via a web stream directly into their MIS, inventory management or BIM application, which provides them instant feedback for any problems ahead regarding availability.



For more information, visit www.steelcentral.com.

StruM.I.S Mobile Scan App

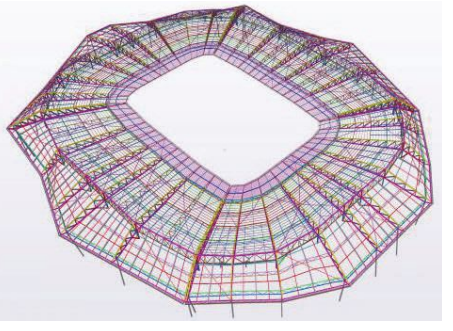
This mobile management solution provides easy access to information and data from anywhere, on any type of device to suit your specific needs. Available on iPhone, Android and Windows devices, the app is usable on- and offline, providing you with the ability to update all users in real time. It also offers integrated bar-coding to address full traceability and tracking needs of steel fabricators.

For more information, visit www.strumis.com or call 610.280.9840.

Trimble Tekla Structural Designer, Model Sharing and Trimble Connect

Starting with a true physical model, Tekla Structural Designer automatically establishes the correct analysis wire model from which traditional analysis can be completed—and it also allows the engineer to complete multiple building analyses at the same time an auto-design selecting the most efficient sections is carried out. In addition, it can be integrated with BIM platforms such as Tekla Structures and Autodesk's Revit Structures. As well as sharing initial geometry, all amendments made in either system can be easily synchronized and managed with sophisticated class leading integration management tools.

Through Tekla Model Sharing, Tekla users and their partners can collaborate on the same model at the same time in different locations and time zones, and can work online and/or offline and sync only the changes made to a model instead of the entire file. For large companies, that means global partners can work on a project during their working time—and for contractors and subcontractors, it means an increased presence in local and global markets. It requires no additional software.



Trimble Connect is a new way for designers, builders, owners and operators to collaborate, share and view project information regardless of software platform. Exchanging files and project information is simplified by combining file management, viewing, messaging and activities in one simple-to-use tool that is available anytime, anywhere. This cloud-based platform combines models created in any modeling tool into one common coordination view, which incorporates all of the measuring, clash and markup tools needed by the project team.

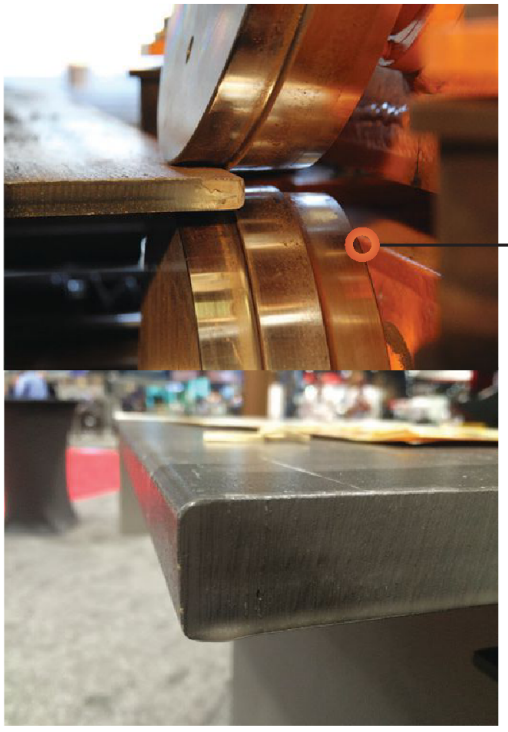
For more information, visit www.tekla.com or call 877.TEKLA.OK.

Honorable Mentions

D-MAC Industries, Inc., Same Day Steel Deck

D-MAC Same Day Steel Deck has added 15 new regional locations since last year's Steel Conference, for a total of 23 same-day facilities specializing in solving steel deck emergencies by shipping steel deck and accessories and cutting steel to required lengths the very same day. We stock over 1.2 million sq. ft of steel deck at our 23 regional warehouses. D-MAC stocks over 1.2 million sq. ft of steel—all profiles and finishes of composite, form and roof deck in gauges from 16 to 22. Visit our website for a list of our locations.

For more information, visit www.samedaysteeldeck.com or call 888. 731.7368.



HGG Profiling Equipment Edge Rounding Line

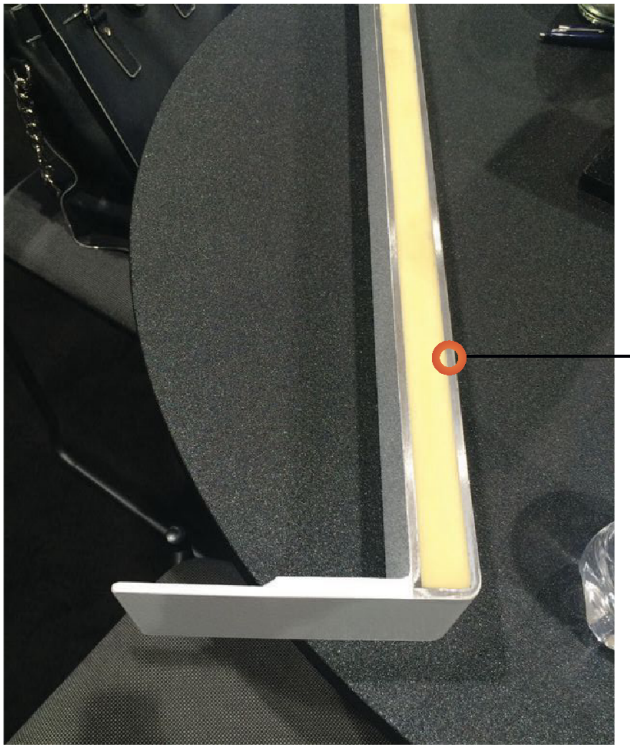
HGG's new Edge Rounding Line delivers a smooth and perfectly rounded surface edge to I/H-beams, tees and flat bars to prevent corrosion, while eliminating the labor-intensive costs of grinding. It is available as a standalone machine solution and can also be fully integrated with the HGG Robotic Profile Cutting Line (RPC) for even higher levels of productivity through totally automated cutting and material handling. The line includes a conveyor for in-and-out material feed, aligning rollers to position and guide material and an edge rounding unit to stabilize and round the bottom and then top flanges. It also includes a handling conveyor for out-feed to a revolver, which revolves material so that the top flanges can be been rounded, in turn, once bottom flanges have been rounded.

For more information, visit www.hgg-group.com or call 330.461.6855.

Intelligent Engineering Sandwich Plate System

The Sandwich Plate System (SPS) is a structural load bearing panel comprising two metal plates bonded with a polyurethane elastomer core. It replaces reinforced concrete and eliminates the stiffening elements required in conventional steel construction, simplifying the structure and reducing vulnerability to fatigue and corrosion. It is much lighter and thinner than conventional reinforced concrete with equal or better performance in dynamics and acoustics, and can be used in stadiums, buildings, bridge decks, maritime and offshore industries as well as special applications.

For more information, visit www.ie-sps.com or call 613.569.3111.



Exciting Equipment

On the heavy equipment side, one innovation came in the form of a compact, multipurpose CNC machine while the other isn't so much about the cutting and drilling work itself, but rather how that work can be performed more efficiently.

Peddinghaus Peddi XDM-630 High-Speed Drill/Saw

The two-in-one Peddi XDM-630 combines a true multi-spindle CNC drill line and a structural band saw into one productive yet space-saving CNC solution. Achieve complete carbide drilling, double-miter sawing, four-axis scribing, tapping, countersinking and milling (slot and cope) with no stop in production.

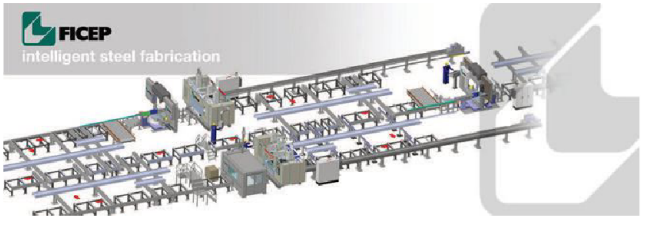
Three drill spindles can operate independently or simultaneously catering to individual processing needs while three five-station tool changers eliminate the need to manually change tooling. The machine is capable of milling out copes, tapping and countersinking on both the web and the flanges for maximum efficiency. The band saw carriage transfers the saw to the profile following drilling processes, with no need for manual positioning and no loss in measurement occur as material passes through the drill line to the saw. The entire profile can be processed with final remnants as small as 13 in.

For more information, visit www.peddinghaus.com or call 815.937.3800.

Ficep Corporation Intelligent Steel Fabrication

Intelligent Steel Fabrication, developed by Ficep, incorporates a level of automation and software integration that was not available previously to the steel fabrication industry. It can achieve the actual extraction of a single XML file from the 3D model for one job rather than a separate DSTV file for each part in the contract. Once the XML file is transferred into the software, the fabricator can simulate the actual fabrication of the job to determine the fabrication time required for the job and the most productive sequence of the production flow to maximize the fabrication system's productivity. After the most productive sequence is determined, the job is released to production, where the Ficep system's automation starts to run the complete material handling system and work centers to their maximum efficiency. This is without direct operator involvement of material handling operations, CNC program selection and the automated CNC work centers, as an attendant just supervises the fabrication processes.

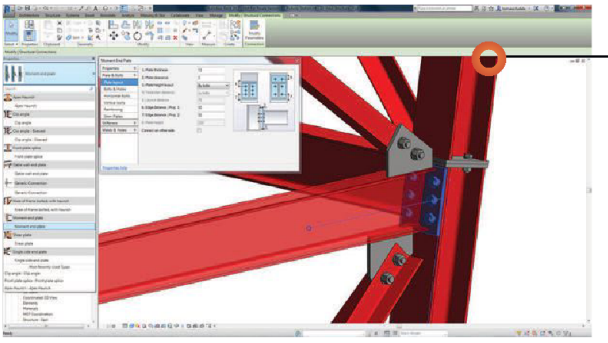
For more information, visit www.ficepcorp.com or call 410.588.5800.



Autodesk Steel Connections for Revit

Autodesk Steel Connections for Revit extends the capabilities of Autodesk Revit software for structural designs and detailing. It provides access to a variety of parametric steel connections in Revit, enabling connections to be modeled with a higher level of detail. The application also includes a built-in steel connection design engine based on U.S. and European codes. This functionality helps to bridge the gap between design and fabrication as both members and connections can be synchronized between Revit and Autodesk Advance Steel for detailing.

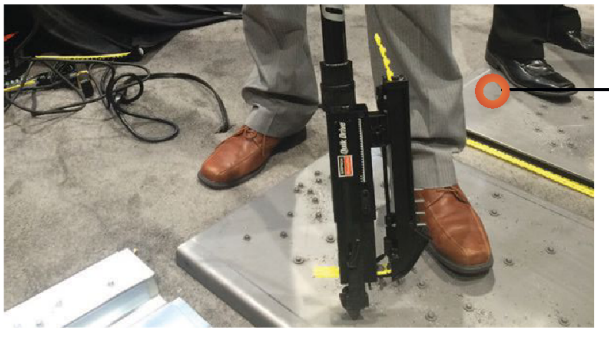
For more information, visit www.autodesk.com or call 855.301.9562.



Simpson Strong-Tie Strong-Drive Screws

The new Simpson Strong-Tie Strong-Drive XM Medium-Head Metal screw (in conjunction with the new Simpson Strong-Tie Quik Drive PROSDX150 Steel-Decking auto-feed screw driving system) is specially engineered for interlocking steel deck applications. It features a ½-in. washer head and is designed for narrow flutes commonly found on interlocking decks. The screw can be hand driven or driven with the Quik Drive auto-feed PROSDX150 system, which is designed for specially collated screw strips. The new Strong-Drive XL Large-Head Metal screw (in conjunction with the new Quik Drive BSD200 Structural Decking auto-feed screw driving system) is engineered as a 1-for-1 screw replacement option for pins in steel decking, and is an ideal choice when high shear or uplift resistance is required. The BSD200 provides hands-free screw advancement, eliminating the need to handle individual screws. Unlike welding and powder actuated tools, no special inspections or certifications are necessary.

For more information, visit www.strongtie.com or call 630.613.5100.



Seismic Solutions

Advanced seismic-related offers were also on tap at the show. Here are a few select seismic solutions:

Lindapter USA Hollo-Bolt

ICC-ES report ESR-3330 now verifies that Hollo-Bolt, Lindapter's expansion bolt for structural steel, can be used in seismic design categories A through F for resisting wind loads and seismic loads. In addition, the Hollo-Bolt provides the highest resistance to tensile loading in accordance with AC437 while ensuring compliance with the 2012 international building code (IBC). The ICC-ES report further defines the connection: "Hollo-Bolt Fasteners are designed for connecting structural steel to hollow structural section (HSS) steel members and other structural steel elements where access is difficult or restricted to one side only." Unlike alternative connection methods such as welding, a Hollo-Bolt is conveniently installed by simply inserting the fastener into a pre-drilled hole and tightening with a torque wrench, which ultimately saves the contractor time and money.

For more information, visit www.lindapter.com/american.

SidePlate Systems Bolted SMF

SidePlate's new bolted SMF (special moment frame) requires no field welding at all, making it significantly faster and easier to erect steel buildings in seismic areas. (A low-seismic version of the SidePlate bolted connection has been successful over the past several years, with contractors and erectors commenting that they're saving days to weeks of field time on projects.) Multiple full-scale tests were recently performed on the connection at the University of California San Diego, proving that it far exceeds the AISC 341 requirements for special moment frames, and, in fact, has ultimate capacities of 7% to 9% rotation versus the required 4%.

For more information, visit www.sideplate.com or call 949.238.8900.

RISA Technologies RISAConnection

In addition to the recent addition of seismic moment connections and flush end plate connections, RISAConnection now also offers the design of seismic braced frame connections. Take the confusion and complexity out of designing a gusset plate for a special concentric braced frame with transparent calculations based on the uniform force method that are perfectly formatted for calc packages. Expanded options for work point location and new shape types such as tube columns and wide-flange braces are also included, and the software offers tight integration with frame analysis (RISA-3D and RISAFloor) and with detailing/BIM packages such as Tekla Structures.

For more information, visit www.risa.com or call 949.951.5815.

AISC NEWS

Charles J. Carter Named New President of AISC

Charles J. Carter, SE, PE, PhD, has been named the new president of the American Institute of Steel Construction. Previously, Carter was vice president and chief structural engineer with AISC.

"AISC is one of the premier standard-setting organizations in the U.S., and I'm proud and honored to be offered this opportunity," Carter said.

"I've been fortunate to have a number of very strong mentors," he continued, "particularly Jerry Haaijer, who was AISC's vice president of Engineering and Research when I started, and my friend Lou Geschwindner, who was my immediate predecessor as vice president as well as my professor and faculty advisor when I was a student at Penn State. So many of AISC's fine and dedicated volunteers also have helped and guided me."

Carter has a bachelor and master of science in architectural engineering from Penn State as well as a doctorate in civil and architectural engineering from Illinois Institute of Technology.

While at AISC, Carter has spearheaded a number of important initiatives, including the revitalization of the AISC *Code of Standard Practice*, the development of a unified *Steel Manual* (combining both ASD and LRFD), the development of AISC's first *Seismic Design Manual* and the expansion of AISC's continuing education programs into the online realm. He's also a well-known speaker and the author of numerous papers as well as AISC Design Guides on *Torsional Analysis of Structural Steel Members* and *Wide-Flange Column Stiffening at Moment Connections*. "I'm grateful to have worked closely with and learned from some of the top fabricators, structural engineers, researchers and educators throughout the country," Carter added.

"AISC stands in such a good position thanks to its recent leaders, especially my immediate predecessors Roger Ferch and Lou Gurthet," he explained. We need to continue to develop, promote and advance the use of structural steel, and help educate professionals and students. Our challenge for the future is to enhance the benefits we provide to the customers of the steel industry and tune our market development efforts to successfully communicate the advantages of structural steel to designers, constructors and owners."

Carter succeeds Roger E. Ferch, PE, who is retiring this December. Ferch, who was previously vice president of the Herrick Corporation (the largest structural steel fabricator on the west coast), has served as AISC's president since 2006. "I'm proud of the role I've played in bringing together the entire structural steel industry to communicate our technical and marketing message of economy, efficiency and beauty when you build with structural steel," Ferch said. "AISC has the best staff of any trade association in the industry and I'm happy that our board has recognized our staff's quality by promoting our next president from within for the first time in our nearly 100-year history. I think Charlie will do an outstanding job of leading AISC and the structural steel industry."

People and Firms

- **Josh Cilley**, president of **American Steel and Precast Erectors (ASPE)** and Buckner Steel and Precast Division of **Buckner Companies**, has been inducted as president of the Steel Erectors Association of America (SEAA). Cilley, previously SEAA's vice president, will serve a two-year term and succeeds Stephen Burkholder, president of S&R Enterprises, who was instrumental in the implementation of SEAA's Ironworker Training and Apprenticeship program.
- The **American Society of Civil Engineers (ASCE)** has honored **Matthew R. Eatherton**, SE, PE, PhD, **Xiang Ma**, **Helmut Krawinkler**, PhD, **Gregory G. Deierlein**, PE, and **Jerome F. Hajjar**, PE, PhD, with the 2016 Moisseiff Award for their paper "Quasi-Static Cyclic Behavior of Controlled Rocking Steel Frames," published in the November 2014 *Journal of Structural Engineering*. The paper describes testing and analysis of a new controlled rocking system, a seismic lateral force resisting system for steel-framed buildings. The experimental program described in this paper is part of a multi-institution, international research project to develop the controlled rocking system.
- The **Steel Tube Institute (STI)** has released Design Forms HSS Tools Pack, a new software for the design of hollow structural sections (HSS) members and connections. Developed in conjunction with SCIA, a maker of BIM-related structural design software, the pack is a offers a suite of engineering checks to aid engineers in the design of HSS beams and columns as well as their connections. It is being made available at no charge to STI Professional Members. For more information, visit **www.scia.net/hss**.

ENGINEERING JOURNAL

Third Quarter *Engineering Journal* now Available

The third Quarter 2016 issue of *Engineering Journal* is now available at **www.aisc.org/ej**. Articles in this issue include:

➤ **Kinematics of Self-Centering Steel Plate Shear Walls with NewZ-BREAKSS Post-Tensioned Rocking Connection**

By Daniel M. Dowden and Michel Bruneau

This paper presents information on the combined contribution of post-tensioning and beam-to-column joint rocking connections in self-centering steel plate shear walls (SC-SPSWs) with the NewZ-BREAKSS connection (i.e., NZ-SC-SPSW). Detailed free-body diagrams developed and presented in this paper provide insights on the basic, fundamental kinematic behavior of this lateral force-resisting system.

➤ **Notes on the AISC 360-16 *Provisions for Slender Compression Elements in Compression Members***

By Louis F. Geschwindner, PhD, and Matthew Troemner

This paper will briefly discuss past specification provisions for slender element compression members and introduce the new provisions in the 2016 AISC *Specification*. It will present a simplification that reduces the number of constants that must be used and will present the specification requirements in an alternate format. Because the 2016 requirements result in different strengths than the 2010 requirements, figures are provided to illustrate the overall impact of these changes on column strength.

➤ **Establishing and Developing the Weak-Axis Strength of Plates Subjected to Applied Loads**

By Charles J. Carter, SE, PE, PhD, Larry S. Muir, PE, and Bo Dowswell, PE, PhD

This paper provides a suitable method for determining the minimum size of fillet welds necessary to prevent weld rupture as out-of-plane deformations occur. It can be used for fillet-welded gusset plate edges in SCBFs to satisfy the exception provided in Section F2.6c.4 of AISC 341-16.

➤ **Strength of Beams in Beam-to-Column Connections with Holes in the Tension Flange**

By James A. Swanson

A discussion of several approaches to predicting the flexural strength of beams with holes in the tension flanges is presented. Experimental data pertinent to the discussion is then presented, summarized and analyzed.

UNIVERSITY RELATIONS

2017 AISC Milek Fellowship Call for Proposals

University faculty are invited to apply for the 2017 AISC Milek Fellowship, a four-year fellowship awarding $50,000 per year (for a total of $200,000) to a promising university faculty member to conduct structural steel research. In addition, the awarded faculty member will be recognized in *Modern Steel* and receive complimentary registration to NASCC: The Steel Conference for the four years following their selection as a Milek Fellow.

Named for William A. Milek, a former AISC vice president of engineering and research, the award is intended to contribute to the research careers of young faculty who teach and conduct research investigations in the U.S. related to structural steel, while producing research results beneficial to designers, fabricators and erectors of structural steel. It also supports students with a high potential to be valuable contributors to the U.S. structural steel industry. Funds are provided to conduct research that meets the long-term needs of the structural steel industry, to assist in leveraging additional outside funds for fellowship-related research and to develop graduate students for academic and design careers in the structural steel industry.

The selected faculty fellow is required to fund one doctoral candidate each year with at least half of the yearly fellowship funds. The chosen students will be named AISC Graduate Fellows and also will be featured in *Modern Steel*.

Proposals will be accepted until September 15, 2016. For information on submitting a proposal, please visit **www.aisc.org/facultyfellowship**.

AISC Webinars

30 SPF and 1.5 PDHs

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August Live Webinar Schedule

Basic Steel Design

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August 4 | August 11 | August 18 | August 25

1:30 p.m. EDT | www.aisc.org/webinars

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Ficep 2004 DTT CNC Drilling & Thermal Coping Line, 78-3/4" x 24" Max. Beam, 3-Drill, Ficep Arianna CNC Control, 2003 **#20382**
Ficep TIPO A31 CNC Drill & Thermal Cutting System, 10' x 20' x 5" Max. Plate, Ficep Minosse CNC, 2009 **#25937**
Controlled Automation ABL-100-B CNC Flat Bar Detail Line, 143 Ton Punch, 400 Ton Single Cut Shear, 40' Infeed, 1999 **#24216**
Controlled Automation 2AT-175 CNC Plate Punch, 175 Ton, 30" x 60" Travel, 1-1/2" Max. Plate, PC CNC, 1996 **#23503**
Peddinghaus F1170B CNC Plate Punching Machine, 170 Ton, Ext Tables, Fagor CNC, 30" x 60" Trvl., Triple Gag Head, 2005 **#19659**
Peddinghaus FPB1500-3E CNC Plate Punch with Plasma, 177 Ton, Fagor 8025 CNC, 60" Max. Width, 1-1/4" Plate, 1999 **#25161**
Controlled Automation BT1-1433 CNC Oxy/Plasma Cutting System, 14' x 33', Oxy, (2) Hy-Def 200 Amp Plasma, 2002 **#20654**
Peddinghaus Ocean Avenger II 1000/1B CNC Beam Drill Line, 40" Max. Beam, 60' Table, Siemens CNC, 2006 **#25539**
Franklin AFC 5108x196 CNC Angle Punch & Sheer Line, 6" x 6" x 1/2", 100 Ton Punch, 196 Ton Shear, 40' Infeed, 1990 **#26122**

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FLYING OVER

Courtesy of Griffith Co.

APRIL SAW THE OPENING of Universal Studios Hollywood's Wizarding World of Harry Potter attraction, and muggles arriving at the park via public transportation were simultaneously provided with a safer, sleeker way to cross a busy intersection to get to the entrance: broomsticks!

OK, it's actually via a steel-supported bridge, not an enchanted sweeping implement. The Universal City Station Pedestrian Bridge fulfills a decade-long quest by the Los Angeles County Metropolitan Transportation Authority and NBC Universal to provide a grade-separated path of travel between the park and the L.A. Metro's Universal City Red Line Station.

The 400-ft, L-shaped bridge spans over both Lankershim Boulevard and Universal Hollywood Drive, with its light, transparent architecture and roofless design serving as a gateway to the park. The structure offers pedestrian access in the busy area surrounding the rail station and the Universal Studios shuttle stop, allowing people to ascend to the bridge platform from three corners of this busy intersection.

The bridge, designed by Miyamoto International, Inc., consists of an exposed V-section steel through-truss supported by four HSS columns with a span of nearly 150 ft across Lankershim Boulevard. Wind and seismic forces are resisted by steel buckling-restrained braced frames in the three elevator shafts and in the middle staircase. Extensive 3D dynamic modeling ensured that the structure performed well under seismic, wind, vehicle collision and pedestrian loading. The project uses about 300 tons of steel, which was fabricated by Thompson Metal Fab (an AISC member/certified fabricator). ■

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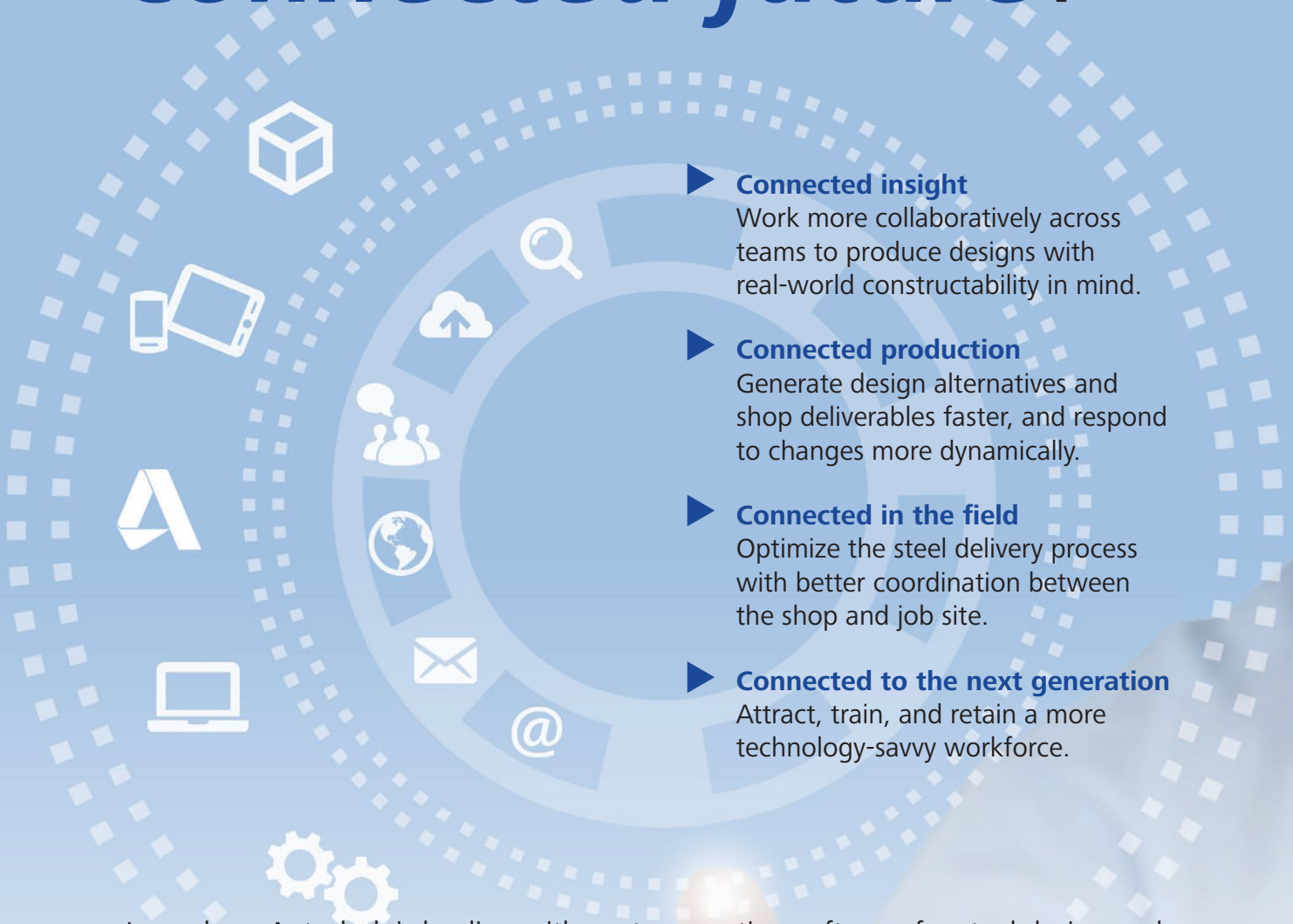

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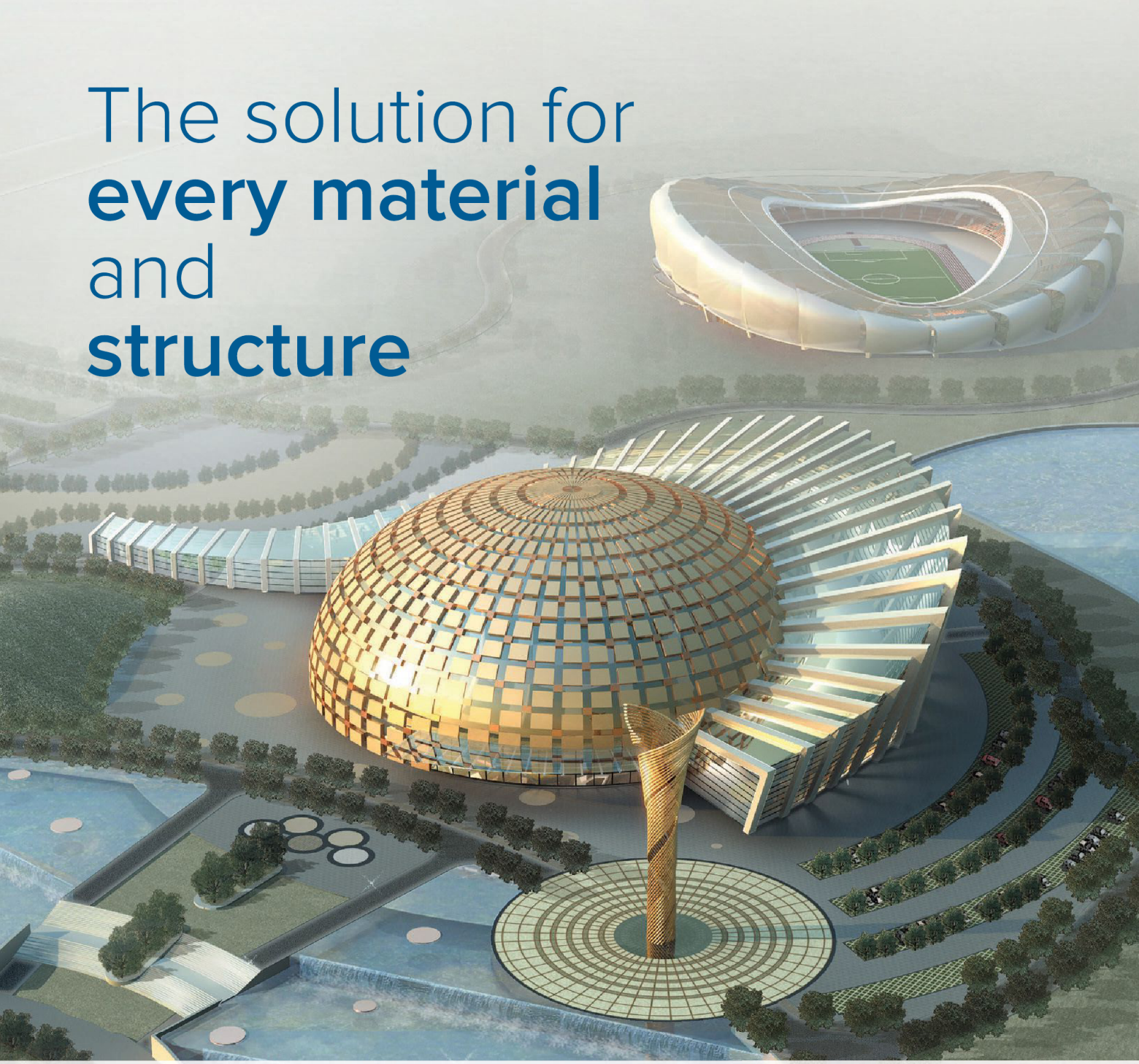

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