MSC

MODERN STEEL CONSTRUCTION

July 2008

AMERICAN INSTITUTE OF STEEL CONSTRUCTION
AISC
FOUNDED 1921

Bending Beautifully

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Deck Design Data Sheet 38R

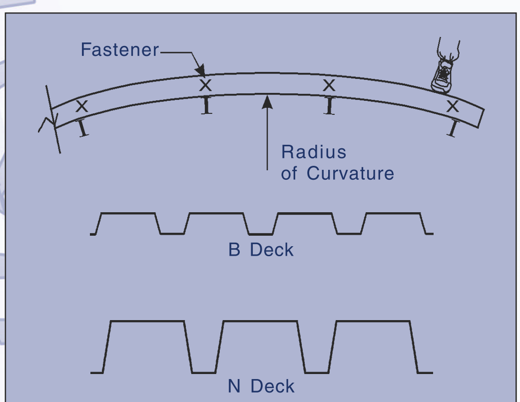
Throw me a CURVE.

QUESTION:

When field bending of deck is required in the strong direction, what is the minimum radius of curvature?

ANSWER:

A rule of thumb has been successfully used. If a 75lb/ft concentrated load applied over the beam can conform the deck to the required curvature, then the deck can be field curved.



B DECK

GAGE	BEAM SPACING 4' 0"	5' 0"	6' 0"	7' 0"	8' 0"
22	205 / 12.0	164 / 15.0	137 / 18.0		
20	246 / 9.2	197 / 11.5	164 / 13.8	141 / 16.1	
18	328 / 6.7	262 / 8.3	219 / 10.0	187 / 11.7	164 / 13.3
16	410 / 5.3	328 / 6.7	273 / 8.0	234 / 9.3	205 / 10.7

Minimum Radius of Curvature (ft.) / Residual Stress (ksi)

N DECK

GAGE	BEAM SPACING 9' 0"	10' 0"	11' 0"	12' 0"	13' 0"
22	387 / 12.9	348 / 14.3	317 / 15.7		
20	474 / 10.0	426 / 11.1	388 / 12.2	355 / 13.3	328 / 14.4
18	628 / 7.3	566 / 8.1	514 / 8.9	471 / 9.7	435 / 10.5
16	797 / 5.8	717 / 6.5	652 / 7.1	598 / 7.7	552 / 8.4

Minimum Radius of Curvature (ft.) / Residual Stress (ksi)

Spans that exceed the recommended maximum are left blank.

When field curving deck, fasten every corrugation at the ends of the sheets to resist spring back.

Detail butt end conditions to ease installation (no end laps).

The tables limit the maximum instantaneous stress in the deck to $0.8F_y$ and the maximum residual stress to $0.6F_y$. Residual moment is defined as: $M = EI / R$.

For quick selection of gravity load capacity, treat as a flat roof. Residuals will be additive over supports and offset load stresses at midspan. A recommended sum is 22 ksi.

B deck can be shop curved when field bending is not practical. Consult the nearest CMC Joist & Deck sales office.

For technical assistance please contact our Summit, NJ Engineering Office at 1.800.631.1215 or visit us on the web at www.cmcjd.com - *United Steel Deck.*

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editor's note

THE EDITOR AT ANOTHER ASSOCIATION WAS RECENTLY COMPLAINING ABOUT THE reaction she had received to a revamping of her association's magazine and website.

The old magazine was very gray, almost "journal-like", and the website was boring. The redesign added lots of color and snazzy graphics. Staff was very happy with the redesign, but a readership survey immediately afterward told a different story: Readers hated it.

Three thoughts quickly went through my mind. First, people generally don't like change. I wondered what the result of the survey would be six months after the redesign and if people would come to embrace the changes. My second thought was that maybe people liked the tone of the old magazine. The journal-like appearance was a metaphor for the serious nature of the content, and readers responded well to that. And my last thought was that maybe the redesign wasn't well executed. I've often seen magazine redesigns dominated by cutting-edge artists who create something fascinating to look at but difficult to read.

I went through a similar thought process during a recent discussion with the board of the National Institute of Steel Detailing (NISD). Detailers are traditionally underappreciated and underpaid and for years a greater and greater percentage of detailing work has moved offshore. But offshore rates are climbing and there are still quality issues (due, perhaps, to a lack of shop experience and a tremendous turnover rate). And the conversation ultimately turned to the Individual Detailer Certification (IDC) program.

According to NISD, the IDC program is designed to document that the professional detailer has "the knowledge and capability to produce quality shop drawings within the framework of various codes, specifications and contract documents." There are minimum experience requirements, and individuals need to pass a fairly rigorous test.

While a growing number of detailing companies are having their staffs go through the program, few (if any) fabricators or designers are using the presence of an IDC detailer as a criterion for selecting a detailing company. I'm familiar enough with the program to know there is anecdotal evidence that it's the better detailers who have IDC staff and that better detailers mean less fabrication issues. So why isn't there a greater demand for IDC?

My first thought is that NISD has done a poor marketing job. Do fabricators even know the program exists? And if they are aware of it, do they know the benefit of hiring detailers with IDCs on their staff? My next thought is that fabricators might be concerned that a growing IDC program would result in escalating detailing costs. But you get what you pay for. Just as good fabricators aren't concerned about two guys with a welding machine in the back of a pickup truck underbidding them, fabricators should also be aware that paying a little more up front for quality detailing can reduce costs in the long run. My final thought is that maybe some smart fabricators will take the time to learn more about the IDC program, and the next time they're hiring a detailer, they'll ask how many IDCs they have on staff.

On a personal note, I'd like to extend best wishes to Keith Grubb. Keith joined MSC as technical editor in March 1999 and was later promoted to senior editor and finally managing editor. But last month, Keith began serving as a regional engineer for AISC in the Mid-Atlantic Region.

Please join me in wishing Keith all the best and also in congratulating Geoff Weisenberger on his promotion to senior editor, Areti Carter to director of publications, and Kristin Egan to graphic designer.

SCOTT MELNICK
EDITOR

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IF YOU'VE EVER ASKED YOURSELF "WHY?" about something related to structural steel design or construction, *Modern Steel Construction*'s monthly Steel Interchange column is for you! Send your questions or comments to solutions@aisc.org.

Stiffeners Required?

When a moment connection is required on either side of a W-shape column, typically stiffeners are welded to the column web and flanges to transmit the beam flange forces through the column web. What is required when the column is a tube section and the beams are typical W-sections? Is any stiffening of the tube required?

It may be typical for some engineers to arbitrarily place stiffeners in W-shape columns at all rigid moment connection joints, but this may not always be the economical approach. It is sometimes more economical to revise the size of the column in order to eliminate the need for stiffeners (continuity plates) in such regions. AISC has developed a SteelTool (available at **www.aisc.org/steeltools**) called Clean Columns. This SteelTool can be used as an aide in determining what W-shape column size is required in order to eliminate the need for stiffeners.

The use of moment connections involving HSS columns may be more difficult if the tube wall is inadequate to accommodate the moment forces from the rigid beam connection. One would first want to check if the HSS can accommodate the concentrated forces using the specification's Chapter K provisions (a free download at **www.aisc.org/2005spec**). If the tube cannot accommodate those forces, then one may want to consider adding flange connection plates that are connected around the outside of the HSS, as adding internal stiffeners generally isn't practical (or possible).

Kurt Gustafson, S.E., P.E.

Standard Bolt Hole Size

The AISC standard hole is 1⁄16 in. larger than the bolt. I am designing bearing-type connections, but the steel fabricator is asking to provide holes larger than the standard holes for constructability. He is proposing to use holes that are 1⁄8 in. larger than the bolt diameter, rather than 1⁄16 in. Since this is a bearing-type connection rather than a slip-critical connection, I am not quite sure if this will affect the shear strength of the bolt for the connections. I know that the oversized holes should not be used for a bearing-type connection. However, the holes that the fabricator is proposing are between the standard and oversized. Could you give your opinion on this issue?

If a bolt hole diameter is 1⁄8 in. over the nominal bolt diameter, it must be considered oversized. The hole sizes specified in the AISC specification are maximums; intermediate values must be treated as the next larger size.

Amanuel Gebremeskel, P.E.

Fillet Weld/Base Metal Thickness Correlation

On page 13-27 of the 3rd edition LRFD manual, the minimum gusset plate thickness is calculated as $t_{min} = 6.19D/F_u$. The explanation is that gusset plate thickness is checked against weld size required for strength. In the 2nd edition LRFD manual, this equation is $5.16D/F_y$ (page 11-37 of Volume II, Connections). Can you please explain where the 6.19 is coming from?

At the time the 2nd edition LRFD manual was in use, the shear yield strength of the base metal was compared to the shear rupture strength of the weld. Now the shear rupture strength of the base metal is compared to the shear rupture strength of the weld. You can also find the current procedure, using the 6.19 coefficient, defined in Part 9 of the 13th edition manual as well.

Kurt Gustafson, S.E., P.E.

Slip-Critical Faying Surfaces

I have noticed a discrepancy between the 2005 AISC specification and the *RCSC Specification for Structural Joints Using A325 or A490 Bolts*. The Class A coefficient is 0.35 in the AISC specification and 0.33 in the RCSC specification. Which coefficient is correct?

The 2005 AISC specification was published after the 2004 RCSC specification and reflects later revisions made for simplicity in the area of slip-critical faying surface requirements. Note that besides the slight variation made in the coefficient for the Class A surface, the current AISC specification now only includes two classes (A and B), unlike the previous AISC specifications and the 2004 RCSC specification, which had three classes (A, B, and C). This slight change was made for simplicity.

As discussed in the Commentary to Section J3.8 of the 2005 AISC specification, "This Specification has combined the previous Class A and Class C surfaces into a single Class A surface category that includes unpainted clean mill scale surfaces or surfaces with Class A coatings on a blast cleaned surface, and hot-dip galvanizied and roughened surfaces with a coefficient of friction of $\mu = 0.35$. This is a slight increase in value from the previous Class A coefficient. Class B surfaces, unpainted blast-cleaned surfaces, or surfaces with Class B coatings on blast-cleaned steel remains the same at $\mu = 0.50$."

Kurt Gustafson, S.E., P.E.

V and Inverted-V Lateral Systems

For chevron braced frames, the AISC *Seismic Provisions* state that we must design the beam for the resultant force caused by one of the braces buckling in compression and the other yielding in tension. The beam design is generally an uncoupled design problem. However, it becomes coupled if using two-story X-braces or zipper columns (see Fig C-1-13.3 in 2005 *Seismic Provisions*).

It would seem to me that the design should proceed on a story-by-story basis. That is, you would assume that the brace buckling/yielding occurs in one story and then design the zipper/opposing V for the resultant. Is that true? Or do you assume that the buckling/yielding occurs in multiple stories simultaneously?

If you have a zipper column or a two-story X-braced system, it is not necessary to design for unbalanced load on the beam. The two-story X and zipper configurations provide a load path that does not involve the beam.

Amanuel Gebremeskel, P.E.

Column Splice Locations

We are designing a nine-story building, which makes it logical to have two column splices, with three segments of three-story columns. However, in some AISC articles on economy in steel design, it is noted that "three-floor columns are to be avoided due to erection difficulties." I found one article that suggests that erection typically occurs in two-story increments, and mentions the resulting problem of another long column dangling in the air if you use three-story columns. Is that the reason for the recommendation for either two- or four-story columns? With nine stories, we would end up with either 4-4-1 or 2-2-2-3. What are your thoughts?

The suggestion of two- or four-story lifts arises from the thought that three-floor column tiers are somewhat out of sync with the OSHA requirement for providing decking, planking, or netting within the lesser of two floors or 30 ft under steel erection.

In the two-story lift erection scheme, the raising gang will erect two levels of framing, and the decking crew will deck the top level first. That permits the raising gang to erect the next tier while the decking crew decks the intermediate floor.

The four-story lift erection scheme is slightly different. The raising gang will erect the first two levels of framing, and the decking crew will then deck the second level. The raising crew then continues with the erection of the third and fourth levels as the decking crew decks the first level. After that, the decking crew decks the fourth level, and the process is repeated up the building.

In a three-story erection scheme, some efficiency is lost: The OSHA height limit means that you can't nest two floors of decking in each cycle.

Kurt Gustafson, S.E., P.E

Direct Analysis Method

Section 7.3 of Appendix 7 of the 2005 AISC specification states, "For ASD, the second-order analysis shall be carried out under 1.6 times the ASD load combinations and the results shall be divided by 1.6 to obtain the required strength." Can you explain what this means? How do you incorporate this when using a computer program?

The application is actually quite simple. If the ASD load is 30 kip-ft, then the load that should be used for the DAM is 30 × 1.6 = 48 kip-ft. The resulting second-order moment (say, from the computer program) may then be 62 kip-ft, including P-Delta effects. The ASD load to use for design would then be 62/1.6 = 38.8 kip-ft. Note that the reason for this manipulation is because the relationship of forces when doing second-order analysis is not linear, and direct analysis and design for the service level forces underestimates the true impact of second-order effects on frame deformations.

In other words, if you simply apply the 30 kip-ft ASD load in the analysis, you would get a result that is less than 38.8 kip-ft, because the lateral deflections are lower.

Amanuel Gebremeskel, P.E.

Singly Symmetric Shapes

I have questions pertaining to Equations (C-F4-3) and (C-F4-4) shown in the Commentary to the 2005 AISC specification. What is the significance of $\alpha - \beta_x$? What is the F_{yr} being used in the calculation of L_r? It is not defined.

As indicated in the Section F4 Commentary, these Equations are suggested as possible alternative equations that can be used in lieu of the Specifications (F4-5) and (F4-8). Professor Don White of Georgia Tech is the author of the supporting references and has kindly responded as follows:

"Regarding β_x, this is the nature of the problem for singly symmetric girders. The shear center is closer to the larger flange; this leads to a decrease in the buckling capacity captured by the negative β_x.

F_{yr} should read F_L. We use F_{yr} for this term in AASHTO. It was that way in the AISC 2005 specification draft up until very late, when it was pointed out that this was in conflict with a symbol used by the composite committee."

Kurt Gustafson, S.E., P.E.

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

Kurt Gustafson is the director of technical assistance and Amanuel Gebremeskel is a senior engineer in AISC's Steel Solutions Center. Charlie Carter is AISC's chief structural engineer, and Lou Geschwindner is AISC's vice president of engineering and research.

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

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

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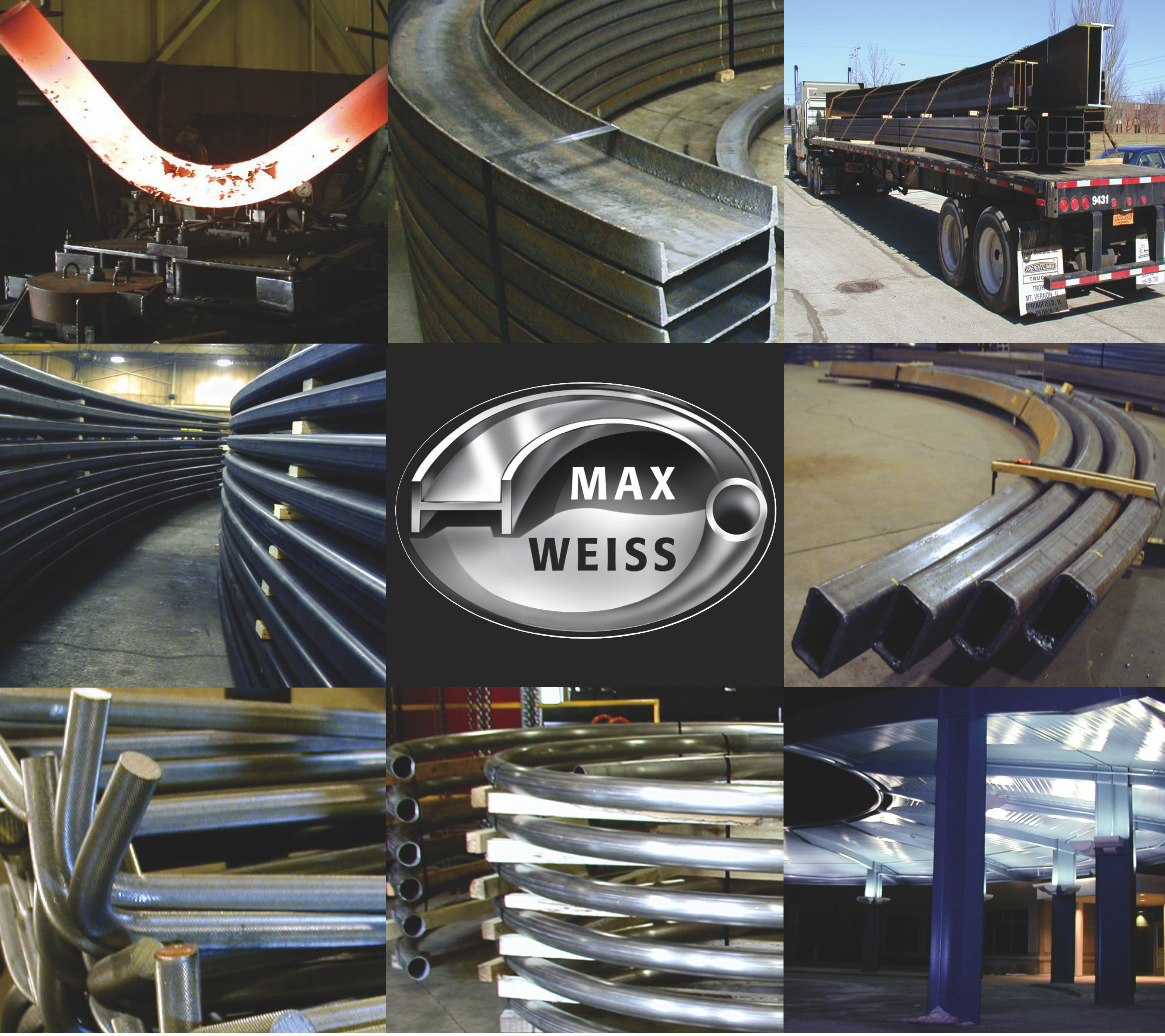

MAX
WEISS

LOOKING FOR A CHALLENGE? *Modern Steel Construction*'s monthly Steel Quiz tests your knowledge of steel design and construction. Most answers can be found in the 2005 *Specification for Structural Steel Buildings*, available as a free download from AISC's web site, **www.aisc.org/2005spec**. Where appropriate, other industry standards are also referenced.

This month's Steel Quiz was developed by AISC's Steel Solutions Center. Sharpen your pencils and go!

1 How many ASTM material specifications are contained within the scope of the 2005 AISC specification for hot-rolled structural shapes?

2 What ASTM specifications for bolting materials are available for use per the AISC specification when high-strength bolts longer than those commonly available in A325 or A490 are desired?

3 What are the two general approaches that are acceptable for use by the AISC specification when designing for fire resistance?

4 What is the most rigorous method available in the AISC specification for frame stability analysis?

5 What is the lowest value of the shear lag factor, *U*, in Chapter D that can safely be used without consideration of combined tension and flexure per the AISC specification?

6 Can deep and narrow HSS flexural members fail due to lateral torsional buckling?

7 Does the AISC specification allow for the consideration of post-buckling strength of beam webs in shear?

8 Does AISC have guidelines on serviceability requirements for steel structures?

9 What do BOF and EAF stand for?

10 Where can I find information on the recycled content of structural steel?

TURN PAGE FOR ANSWERS

steel quiz

ANSWERS

1 There are seven ASTM specified hot-rolled structural shapes contained within the scope of the 2005 AISC specification. See section A3.1 (or the online version of this article at www.modernsteel.com) for a listing of these material standards.

2 Section J3.1 in the AISC specification (available at www.aisc.org/2005spec) recommends the use of A449 and A354 bolts when high-strength bolts that are longer than A325 and A490 are desired.

3 Either *qualification by testing* or *design by analysis* are accepted approaches for fire resistance of steel structures. See Appendix 4 of the AISC specification for structural design for fire resistance.

4 The Direct Analysis Method presented in Appendix 7 is the most rigorous method of stability analysis. Use of this method is permitted in all cases and is required (see Section C2.1) for all structures where the ratio of second-order drift to first-order drift (or B2) is greater than 1.5.

5 According to the Commentary of Section D3.3, for values of U less than 0.6 the connection may be used only if the provisions for members subject to combined bending and axial force are satisfied in the design of the member.

6 Yes, it is possible for deep and narrow HSS flexural members to fail in LTB. However, as Figure C-F7.1 in the Commentary to Section F7 illustrates, L_r for such members is relatively large. As a result, the LTB limit state for HSS rarely controls.

7 Yes. Tension-field action is recognized in Section G3 of the 2005 AISC specification as a method of evaluating the post-buckling strength of beam webs in shear.

8 Yes. The Commentary to Chapter L of the 2005 specification has a detailed discussion of several commonly encountered serviceability issues and limits. AISC *Design Guide 3, Serviceability Design Considerations for Steel Buildings*, provides further guidance and is available for free download by members of AISC at www.aisc.org/epubs.

9 BOF and EAF are abbreviations that refer to types of steel production processes. BOF stands for basic oxygen furnace, while EAF stands for electric arc furnace. EAF is scrap-steel-based, has become the predominant method of hot-rolled steel production today, and is the primary reason steel is the most recycled material available.

10 Visit www.aisc.org/sustainability for information on LEED-related subjects.

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

Steel SolutionsCenter

news & events

MARKET NEWS

Managing Steel Price Increases

Increasing global demand for both structural steel and steel scrap has triggered significant domestic increases in the producer price of structural steel during 2008. This year the mill price for wide-flange structural steel has increased 28% to just over $1,000 per ton. Other structural materials such as HSS and plate have experienced increases into the $1,100 to $1,200 per ton range. This increase is typical of the price volatility that has been experienced by all construction materials since early 2004; global demand peaks have triggered price volatility and availability concerns for cement, gypsum, copper, plastics, and lumber products during this period.

The current increase in the cost of structural steel products can be traced to an expanding global marketplace combined with increased competition for the purchase of steel scrap, iron, coke, and metallurgical additives that are used in the production of various types of steel. Scrap index prices have increased from $290 per ton in December of 2007 to a current level of $555 per ton. The recycled content of wide-flange structural steel is nearly 90%, which equates this $265 per ton increase directly to the $220 increase in the per ton price of structural steel. At the same time domestic structural steel, as a result of the weakened U.S. dollar, remains $20 to $40 per ton lower than the global price, which discourages imports.

At the present time, structural steel remains readily available in the U.S. market, with service centers holding over three months of inventory available for immediate delivery. Direct mill shipments of wide-flange shapes continue in the range of 12 to 14 weeks, while HSS is available from producers in four to six weeks.

The transition from a domestically driven market for construction materials to a global market requires significant changes in how construction projects are managed:

- ✓ Early involvement of specialty contractors, including structural steel fabricators, during project design as a means of optimizing the material supply chain, as well as the use of materials on the project.
- ✓ Engagement of product suppliers (mills and service centers) in early dialogue regarding pricing levels, material reservations, and the availability of price-lock mechanisms.
- ✓ Clear definition within bid solicitations of which party will be expected to hold the risk for material price fluctuations, with the understanding that the assumption of that risk requires compensation.
- ✓ On some projects it may be acceptable to incorporate an escalation clause into the contract. Typical contractual language is available upon request from the AISC Steel Solutions Center (solutions@aisc.org).
- ✓ Rapid acceptance of bids and early authorization of material acquisition, with the understanding that the specialty contractor will be reimbursed for both the material and storage charges when they are incurred.

For more information contact John Cross, AISC's vice president, at cross@aisc.org.

letters

Outside Problems

James Smelser's May article "Constraint and Stability" (p. 66) was very well thought out! Some [of these] things we already do and some we will rethink. When you state that shop management must have choices, it assumes that approved drawings are issued as part of the package. How do you address the problem of outside detailers and approvers not keeping up with the shop's needs?

Rod Spengler

James Smelser responds:

Great question, Rob. This is a problem that we all struggle with, but there are things that we all can do to streamline the approval process.

Make a large job small. Sequence projects into manageable erectable segments. This helps detailers submit drawings earlier. It also allows the shop to start earlier by reducing the lead time needed to produce parts.

Set up meetings with the structural engineer and other interested parties as soon as possible after a project is awarded. Agree on the approximate number of drawings in each submittal and how often shop drawings will be submitted. Produce a submittal schedule to be issued to the structural engineer. Ask for weekly meetings to clear up RFI questions. The answers to RFIs often create additional questions and more RFIs; the weekly meetings break this cycle. The submittal schedule and the weekly RFI meetings allow the structural engineers to plan and schedule their work.

Electronic transfer of drawings makes a huge improvement in the approval process. The hard copy process involves between seven and ten mailings. Even with overnight service this can add two to three weeks to the schedule. Electronic transfer can travel from detailer to fabricator to customer to architect to structural engineer in a matter of minutes. Approval comments can be added directly to the digital copy of the drawing, or a print can be run, marked up, and scanned to make a new digital drawing. In minutes, the approval drawings can make their way back through the chain to the detailer.

Quality in the Shop

I have noticed a lot of high-tech/engineering articles, but I haven't seen many about the actual steel that's fabricated and shipped having any quality inspections before shipping. If the material isn't checked before shipping, how does the fabricator/fitter ever find out if he's making mistakes?

I've been to several ironworker union halls and [discovered] they had small training areas to teach the workers how to erect and repair poorly fabricated structural steel. The older workers/instructors told me it's just that way and it's never going to change, so they just repair it and move on!

I started out in the structural steel industry around 1970 and went from holding the dumb end of the tape to fabricator/fitter/welder and everything in between, up to plant manager and quality control. That's how I learned. I recognize that even the best fabricators/fitters can have a bad day. I saw mistakes every day when I was in quality control, even in the smallest shops with as few as five workers. It's really bad when fab shops don't perform quality control. I wonder how many ironworkers have been seriously injured and maybe even died trying to erect poorly fabricated steel. I can understand why office personnel won't go out into the shop—too much noise, welding flash, sparks flying, etc.—but the shop absolutely must have quality control. It should involve the best and most experienced fabricator/fitter. He could even do some teaching/correcting along the way for young workers that want to eventually become fabricators. An experienced "old man" on the shop floor is like a gold mine.

Engineers are pretty much insignificant if the shop floor doesn't have quality control. It can be perfect on paper, but what's getting out the door wrong makes the whole company—president, engineers, and all—look really ignorant. If it fits in the field, word gets around; if it doesn't fit, word *definitely* gets around.

Jim Caudle
J&B Specialty Tools

PRODUCT DIRECTORY

We Have a Winner!

We're happy to announce that Brian R. Robertson has won the drawing for an Apple iPod Touch. Robertson, a graduate of Texas Tech University, is an EIT/structural engineer with Parkhill Smith and Cooper, Inc., Lubbock, Texas. His recent design projects include an elementary school and an office building addition, and he's currently working on a new high school.

So how did Brian win such a great prize? By visiting MSC's online product directory at **www.modernsteel.com/products.**

While the iPod has already been claimed, you should still visit MSC's online product directory. The directory includes more than 30 categories and hundreds of companies, and you can browse for products and services by category or via keywords. Search results include contact information, web site links, and company descriptions.

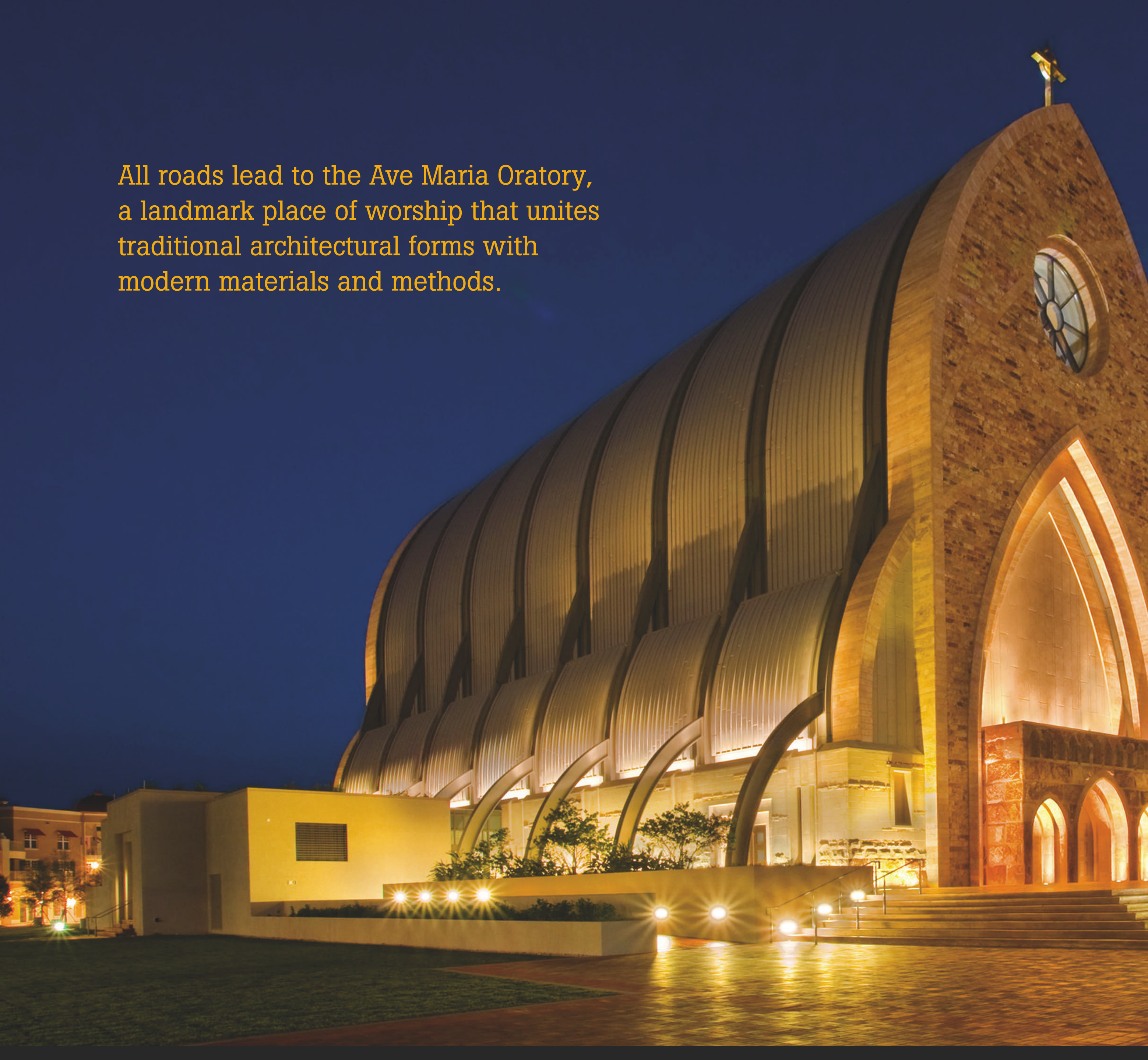
If your company offers a product that you would like to see listed in the directory, contact Lou Gurthet at gurthet@modernsteel.com) or 231.228.2274.

BIM

BIM Book

A new guidebook, the *BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors*, encompasses all areas of the A/E/C industry as it relates to building information modeling. Written by a group of leading pioneers and researchers in BIM, the handbook is a highly visual resource guide developed to help the building and design community better understand new businesses processes facilitated by this technology.

The *BIM Handbook*, by Chuck Eastman, Paul Teicholz, Rafael Sacks, and Kathleen Liston, is published by John Wiley and Sons, Inc. and is available for $85. To order it, call 800.225.5945.



All roads lead to the Ave Maria Oratory, a landmark place of worship that unites traditional architectural forms with modern materials and methods.

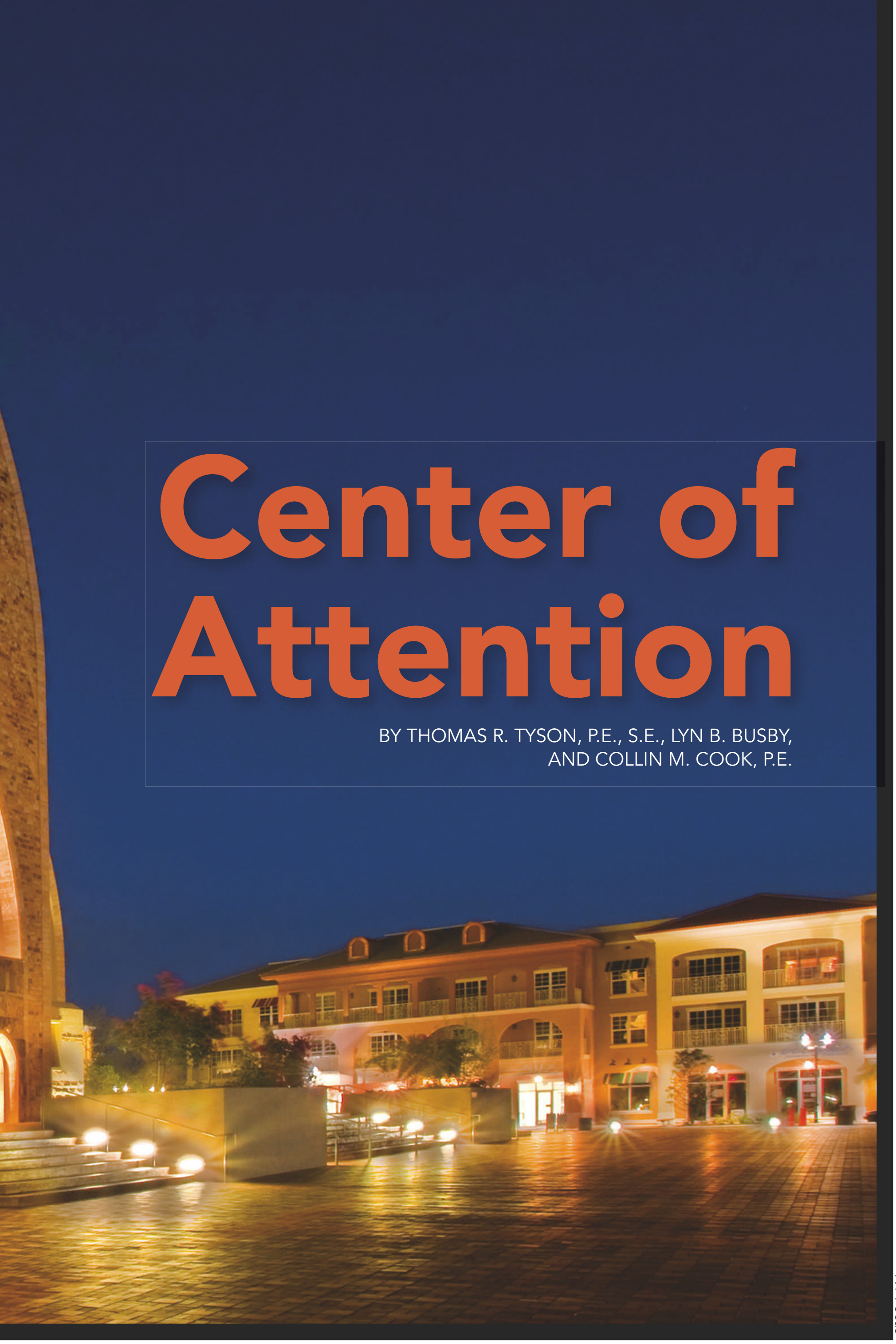
THE TOWN OF AVE MARIA SITS just northeast of Naples in southern Florida. While a brand-new community even by American standards, it adopts a decidedly old-world approach to layout by putting a church at its center.

The Ave Maria Oratory (a 2008 IDEAS[2] Award winner—5/08, p. 31) is at the convergence of major roadways and pedestrian paths leading from the surrounding residential communities and Ave Maria University. From a distance, the profile of the 120-ft-tall structure evokes images of a traditional cathedral. Moving closer, the clear distinction of a contemporary structure of glass, steel, and stone is revealed in greater detail. Entering the building, the soaring height of the nave is compressed by the choir mezzanine above and then dramatically expands upon entering the nave proper. The eye is drawn up to the light penetrating through the lattice of steel above, creating a "sense of mystery," the owner's primary design goal.

This design intent, not to mention the building's unique geometry, presented the team with a series of challenges. The Oratory's overall height, combined with a lack of interior floors, warranted careful attention to constructability considerations. The curved nature of the structure required complex connections that would remain visible. And, the final design needed to address the interface of stone and steel. Basically, it would need to orchestrate materials, assemblies, and aesthetics in a manner that would honor the spiritual significance of the Oratory.

All Together Now

From the very start, it was clear that the design effort could not be separate from



NY Focus

Center of Attention

BY THOMAS R. TYSON, P.E., S.E., LYN B. BUSBY, AND COLLIN M. COOK, P.E.

the fabrication and erection considerations that would prove critical to the project. The team took the unusual step of selecting the steel contractor during the schematic design. Under this arrangement, designers could work with the general contractor and steel contractor to develop connections for the steel frame that were not only functionally sound, but that also blended well with the architect's vision for the structure.

Several concepts were considered. The first design concept for connection used all field-bolted connections, but this method was eventually discarded, since many of the lower connections were very close to eye level, where the architect preferred smoother lines. While using all field-welded connections would resolve this issue, cost and schedule considerations ruled it out. The team eventually decided on a combination of the two methods, where the connections in the lower portions were field-welded and the upper connections were field-bolted where practical.

Due to the complexity of the structure, the fabricator chose a select group of subcontractors to assist in the Oratory's construction. The project detailer was selected early and worked closely with the design and fabrication teams during the connection design period by providing 3D models of the different connection concepts. Once fabrication began, the detailer was also able to provide multiple services for the shop, such as rolling diagrams for the curved members, actual-size templates for the complex skew cuts on the beam ends, and 3D images of the more complicated connections to aid the fitters and inspectors in visualizing the end product.

The structure consists of 10 main uprights, which were field-assembled to the greatest extent possible on skids prior to erection. Once each upright was hoisted into place, a secondary crane was used to erect the infill steel for stability. Originally, the erection schedule called for 25 weeks. However, the erector was able to complete the work more than a month ahead of schedule due to better-than-anticipated fit-up resulting from tight adherence to tolerances by the detailing shop, bender-roller, and fabricator.

Going Wide

Early in the process, a critical design decision was made to use wide-flange shapes in lieu of hollow structural sections for the main members of the uprights, based on architectural considerations as well as fabrication and erection concerns. Fourteen-inch wide-flange shapes were selected as the interior structural members of the uprights because of their stoutness, which provided significant weak-axis stiffness and stability. In addition, the W14s also permitted the flexibility to select elements for loading and stiffness criteria while maintaining compatible depths, which directly affected the architectural appearance. Lateral stability in the transverse direction is provided by a series of latticed structural steel uprights, while stability in the longitudinal direction is provided by bracing along the perimeter of the building. The longitudinal bracing was also intended to express the design intent of interlacing the Gothic arch lines of the transverse uprights.

Steel buttresses were designed as free-standing exposed elements that penetrate the outer skin, hinting at the latticed uprights forming the basis of the overall structure. In this building, structure *is* architecture. For example, analysis showed that the buttresses—originally ornamental only—

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NY Focus

provide significant additional stiffness to the structure and help transfer the lateral load to the foundation.

Rolling Along

The overall structure consisted of 1,270 tons of fabricated structural steel, and more than 70% of the pieces had to be rolled to various radiuses prior to the start of fabrication. In order to roll the members to the required radii and within AISC tolerances, the fabricator chose a rolling shop based on its ability to roll the very large shapes with heat induction equipment.

While cold rolling applications were appropriate for some of the lighter members, heat induction rolling was required not only for the large shapes with tight radii, but also for control of accurate tangent points to reduce shop splices. Over 400 tons (153 pieces) were rolled through the heat induction process.

As might be expected, the largest steel sections on the project needed to be rolled to the tightest radius. The W24×207 outer buttress elements of the uprights were rolled to a 24-ft, 8-in. centerline radius. Control of the tangent point for the W24×207 elements following the main line of the exterior wall was critical, as it aligned with the most complicated connections of multiple elements, some at highly acute angles. The ability to accurately hold these tangent points eliminated a shop splice, reducing complications in a highly complex connection.

Heat induction bending was especially important for the curved elements that crossed diagonally from one upright to the next, following the line of an imaginary cylinder defined by elements in the plane of the upright. The line of these elements was approximated by determining three different radii along the length of the member, changing at two different intermediate tangent points. The heat induction process permitted these elements to be rolled as single pieces without the need for shop splices and accompanying ultrasonic testing inspections. Both the architect and owner were pleased with the level of control achieved on the rolling of the steel, since the uprights align visually and variations in the curvature would be obvious.

Updated Analysis Approach

The structure's lateral loads are transferred to the 3-ft-thick mat foundation via a combination of flexural bending and arching action of the curved steel members. The design of these members was governed by serviceability and stability concerns rather than strength design criteria. Stability analysis of the lateral framing was complicated by the members' curved geometry and unique connections, which made traditional effective-length and slenderness procedures ineffective.

Top: The end wall upright being lifted into place at the start of erection.

Middle: The full elevation of the uprights can be seen during erection.

Bottom: Longitudinal bracing in the plane of the side walls compliment the curves of the upright frames.

Fortunately, while the design of the Oratory was underway, AISC revised the *Specification for Structural Steel Buildings*, introducing new methods for performing stability analysis and design. In lieu of effective-length concepts, the Direct Analysis Method requires the user to perform a second-order analysis considering both local and global P-Delta effects to determine member forces and amplified deflections. In this analysis method, stability is verified by applying an out-of-plane notional load that provides the members with an initial out-of-plane geometry that is then amplified by the second-order analysis using reduced stiffness. Stability is verified by convergence of the P-Delta analysis.

Since the gravity loads for the Oratory are relatively small, the normally recommended notional load was not sufficient to provide the necessary distortion to perform the second-order analysis. Therefore, a notional load was amplified to produce the desired 1/500 initial out-of-plumbness. This load was applied at the upright lattice nodes of the main structural members.

Stormy Weather

The wind loads for the Oratory, sited in hurricane-prone south Florida, were determined by wind tunnel studies on a scale model. Since there are no diaphragms in the building, the dynamic response of the structure to the wind loads was an especially important design consideration.

For the apse of the Oratory, the structure is designed as a half-shell that frames into a D-ring-shaped member that functions similar to an oculus. The D-ring is supported in the vertical direction from the end wall upright, which controls the deflection of the half-shell. Internal stability for the apse is provided by a network of diagonal bracing that helps tie the individual arched ribs together so that they function as a shell-type structure. The interface between the apse and the end wall of the Oratory was designed as a soft joint to accommodate the difference in stiffness between the various components.

Support of the stone masonry end walls was another challenge addressed by the design team. The stone masonry façade was an important element of the architectural image, suggesting the traditional basilica. Since the geometry was clearly not conducive to self-supporting masonry, the stonework needed to be suspended from the steel frame. To provide an appropriate backup system for the stone, a series of site-cast concrete panels were suspended from the end wall uprights, providing adequate out-of-plane stiffness to transfer the hurricane wind forces to a longitudinal bracing system located in the side walls. These panels had a complex geometry with 5-ft returns on the outer edges, as well as complicated returns on the inner edges where the wall systems arch over both the entrance on the west and the apse opening on the east.

The integration of engineering, architecture, and construction is raised to an art form with the Ave Maria Oratory, as all systems unite to define and enrich the space. The final design is rooted in a combination of historic church forms, rendered with contemporary structure, materials, and technology. MSC

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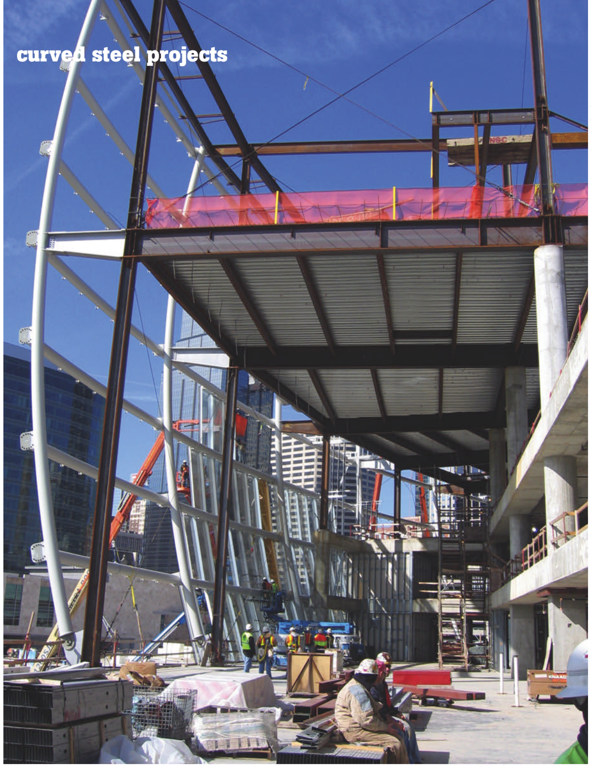
General Contractor
Suffolk Kraft Construction, Ave Maria, Fla.

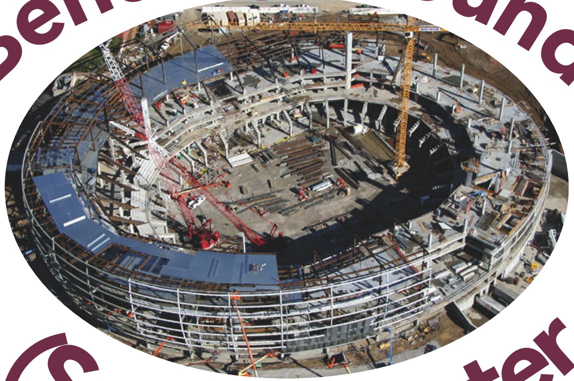
Structural Design Software
RISA 3D

Steel Detailing Software
Tekla Structures



Construction tolerances for the curved steel frame were reduced from those in the AISC *Code of Standard Practice* to facilitate connection of the cladding system.

Bending around



(Sprint) Center

BY DAVID LANDIS, P.E., AND GEORGE WENDT

More than 700 tons of curved steel shapes Kansas City's Sprint Center.

ELTON JOHN'S SOLD-OUT CONCERT IN KANSAS CITY LAST FALL RECEIVED RAVE REVIEWS. And so did the concert venue. The performance was the opening act for Sprint Center, Kansas City's newest landmark and the centerpiece of its downtown revitalization.

This 18,500-seat multipurpose arena will host more than 100 events per year. Designed to be the epitome of flexibility, Sprint Center will accommodate NBA basketball, NHL hockey, AFL arena football, concerts, circuses, and other performances and special events. With retractable and variable-rise seating to optimize sight lines, the arena can be reconfigured quickly to accommodate different events.

A Flexible Roof

That flexibility extends to Sprint Center's steel roof structure, which facilitates multiple stage configurations and show-rigging capabilities during a wide array of event types. In addition to code live and snow loads, the long-span steel roof was designed to support up to 425,000 lb of show rigging for concerts, plus an 80,000-lb scoreboard, four 8,000-lb speaker clusters, over 40,000 lb of hoisting equipment, and nearly a half-mile of catwalks loaded with sports lighting, spotlights, and electrical and sound equipment.

Open and spacious concourses, framed in HSS, provide views of the surrounding city.

Long-span steel roof trusses taper to 32 ft deep and span 334 ft over the seating bowl. The truss configuration provides an efficient low-profile roof, with truss top chords forming the roof surface and truss bottom chords supporting the rigging grid and catwalks. The trusses utilize A913 Grade 65 W14 chords and A992 W12 webs, and their connections were made with compact gusset plates shop-welded to the chords and field-bolted to the webs. In addition, W21 roof beams and W14 rigging beams span between trusses. Even with the considerable show loading, Sprint Center's long-span roof steel weighs about 25 psf overall, including primary and secondary structural elements, rigging grid, catwalks, hoist platforms, connections, equipment supports, bracing and bridging, deck support plate, etc.

Curving around the Arena

Sprint Center's most notable aesthetic design feature is its faceted cladding system that curves both vertically and horizontally. The system allows dramatic views both for people inside looking out at the city and those outside the arena looking in at the activity. The cladding suggests a pillowed crystal bowl. The faceted glazing, with its varied frit patterns, transforms the building's appearance as sun angles and light conditions change throughout the day. At night

Walter P Moore

Each roof truss was erected on a shoring tower in two halves. Once a truss was completed and stabilized to the adjacent framing, the tower was moved to the next truss location.

the arena glows like a colorful ornament, exhibiting the activities inside and beckoning to the surrounding city.

Numerous schemes for structurally supporting the cladding were considered. In response to the architect's desire for an elegant and unobtrusive support structure, a system of curved vertical and horizontal steel pipe was selected. Curved horizontal 16-in.-diameter hollow structural sections (HSS) span up to 50 ft and are supported by curved vertical 16-in.-diameter HSS spanning up to 48 ft. The horizontal HSS are moment-connected with end plates to reduce deflections. Using moment connections enabled the engineer to economically minimize member sizes while still meeting strength requirements and deflection limits. End plate connections with oversized holes accommodated the geometry and allowed for reasonable fabrication and erection tolerances.

The steel curtain wall support frame was designed and detailed such that it did not provide support for any of the floors or the roof. Since the curved frame supports only the cladding system, it was not required to be fireproofed. However, the curtain wall system did need to accommodate floor and roof live load deflections and building drifts due to wind and seismic loads, and these building drifts and support frame movements were outlined on the structural drawings.

Bending Together

Schuff Steel Midwest was responsible for the entire structural steel package and engaged Hillsdale Fabricators (an Alberici Enterprise) in St. Louis for fabrication of the curved steel curtain wall support frame. Chicago Metal Rolled Products earned the contract from Schuff Steel and Hillsdale Fabricators to curve 750 tons of the16-in. round HSS that gives the structure its unique shape. According to the site architect, Craig Milde of DADT, "The steel really helped give the glass enclosed arena its unique shape. Refining the geometry to attain the desired enclosure shape was most challenging: nine radius points in each of the four arena quadrants."

Chicago Metal was able to minimize construction time and cost by using both its Chicago and Kansas City plants. For example, raw material more readily available in Chicago was curved in Chicago and then sent to Hillsdale in St. Louis, which in turn shipped the parts to Kansas City to be erected. On the other hand, material purchased in Kansas City that was to be

Copyright Chicago Metal Rolled Products

The cladding system consists of 750 tons of 16-in. round HSS.

shipped to Schuff's facility in Ottawa, Kan. was curved in Kansas City. As the project progressed, Chicago Metal was in frequent contact with the fabricators to ensure that everything was fitting up well. Having two plants curving the HSS allowed for quick response, lower freight costs, and on-time delivery.

The project team held numerous planning meetings to discuss fabrication and erection issues, including geometry coordination, acceptable tolerances, erection sequence, and support frame movements expected due to thermal changes and construction progress. Clips for the curtain wall mullion attachments were welded to the curved horizontal HSS in Hillsdale's fabrication shop. Ensuring that the geometry of the fabricated curved steel and the curtain wall matched when erected was critical to the project's success.

The steel curtain wall support frame was primed in the fabrication shop, and the final coating was applied in the field, following erection.

From Bay to Bay

During design, structural engineer Walter P Moore developed an erection sequence to minimize the cladding support frame deflections during curtain wall erection; adjacent bays of curved horizontals and their moment connections had to be completed prior to erecting a bay of curtain wall. Erection of the 2,204 varying trapezoidal fritted glass panels of multiple sizes lagged erection of the steel frame by several bays.

To simplify erection, Walter P Moore designed compact connections that allowed for reasonable fabrication and construction tolerances. The bases of the curved verticals are connected with pin assemblies. Connections to the upper concourse floor and roof are made with slip-critical bolts in oversized holes. The curved horizontals are moment-connected with end plates with slip-critical bolts in oversized holes and shim plates. With few exceptions, erection of the curved steel frame proceeded smoothly.

Construction tolerances for the frame were reduced from those in the AISC *Code of Standard Practice* to facilitate connection of the cladding system. Any point along the steel support frame had to be erected to within 1 in. of the design location in any direction. Due to the meticulous attention to detail of the project team, the HSS fit their fixtures perfectly. MSC

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Steel Detailer
Dowco Consultants, Surrey, BC, Canada (AISC Member)

Steel Erector
National Steel Constructors, Plymouth, Mich. (AISC Member)

Bender/Roller
Chicago Metal Rolled Products, Chicago and Kansas City (AISC Member)

Branching Out

BY TERRI MEYER BOAKE

Terri Meyer Boake

Hollow steel castings help bring an exposed structural steel "tree" to life on a Canadian university campus.

TUBE-TO-TUBE CONNECTIONS, PARTICULARLY INVOLVING ROUND SECTIONS, ARE A POPULAR CHOICE WITH DESIGNERS. From the architect's perspective, round sections are desirable because of their clean appearance and their indifference to apparent orientation. Engineers like tubular members (HSS and steel pipe sections) for their efficiency; tubular structures provide a higher strength-to-weight ratio than wide-flange sections. And then there are the cost savings, thanks to a reduced surface area for paint or intumescent coatings.

Typically, when round sections have been selected, the inference is "Architecturally Exposed Structural Steel". But for all its benefits, this designation carries a complete set of additional baggage insofar as detailing, fabrication, erection, and finishing are concerned.

Fabricators must come up with connection details that are as clean and potentially seamless as envisioned by the architect; provide the strength and efficiency expected by the engineer; meet AESS requirements; and are able to be fabricated and erected in an economical manner.

Thankfully, fabrication methods have progressed significantly due to advances in computer numeric control (CNC) processes. But even if complex tube-to-tube connections can be made more accurately and more cleanly, they still exhibit geometric characteristics that may be too overwrought in appearance for some architectural applications.

Steel castings, however, can be used to solve complex tube-to-tube geometries while providing a solution that is potentially both technically and aesthetically superior. The use of castings to connect round tubular members is by no means new. But where numerous European buildings have employed castings, North American applications are rare.

Planting the Acorn

Because research institutions are known for helping to craft the future, perhaps it's fitting that one of the earliest casting applications on this continent is at a university. Phase one of the University of Guelph Science Complex in Guelph, Ontario, Canada is a 350,000-sq.-ft building with a triangular-shaped connecting atrium at its center, the focal point of which is a steel "tree" structure. Envisioning supporting structures as trees has its origins in the designs and load transfer mechanisms of Gothic cathedrals, which use compression to direct the forces through the stone pieces and into the foundations. In the case of the Science Complex atrium, the tree structure was to be fabricated from round tubular steel sections, prompting it to act more like a space frame. The upper branches of

Walters, Inc.

Terri Meyer Boake

The castings are prepped for connection to the tubes at Walters, Inc.'s fabrication shop (left). A top view of the casting, showing the beveled edge, collar, and alignment guide plates (right).

the tree carry the loads from the grid-like wide-flange framing system that supports the atrium roof, down through its tubular trunk to the concrete foundation below. This type of geometry, in its tree-like stretch, creates large eccentric forces that put significant moment stresses into the nodes connecting the branches.

The design of the nodes flowed from the architect's vision to create the tree-like exterior geometry. The wall thicknesses of the connectors were optimized to be both safe and economical, and the castings were determined to have superior performance characteristics if cast hollow (solid castings are sometimes preferred in seismic zones). It was deemed essential that if tested to failure, the node should be stronger than the tubular branches. In testing the node, short sections of pipe were added to the casting to simulate more closely the effect that the connection and transfer of the load to the branches would have on the material stresses.

Cast steel exhibits isotropic properties, making it quite suitable, in the case of these extremely eccentrically loaded nodes, for transferring forces through the connection in a reliable manner—i.e., being able to resist shear, moment, and torsional stresses. It accomplishes this by working the geometry as a function of variations in the wall thickness, independently of the finished form of the exterior. Unlike fabrications made from tubes or plates, the interior dimensions of the void in a casting do not have to match the exterior form of the object.

The steel specified for the tree casting had to meet ASTM A27 Grade 70/40, with a modified chemistry to ensure that it could be welded to the pipe branch with minimal preheating and would require no post-weld heat treatment (stress relieving). Although the casting would be shop welded and finished to one end of each branch/trunk, site welding would be required for the opposite end.

While site conditions would make both pre- and post-heating difficult, weldability was improved by specifying a lower carbon and silicon content, eliminating the need for preheating. The casting steel's minimum yield strength was to be 275 MPa. Instead of using regular HSS sections, pipe was selected for the project due to properties that were more closely aligned with those of the casting.

The key requirements included in the bid for the node fabrication included:

Terri Meyer Boake

The completed steel support tree is the centerpiece of the atrium at the University of Guelph Science Complex.

- Patterning, heat dissipation analysis, stress relieving, and all other activities inherent to the steel casting process.
- Surface finish comparable to that of the seamless steel pipe to which it would be attached. This was crucial to achieving an AESS 4 Category in terms of the ultimate high-gloss surface finish to be applied. (For more on Canadian AESS requirements, see "A Categorical Approach," 04/08, p. 43.)
- Non-destructive evaluation of each casting, including 100% ultrasonic testing as a minimum. Acceptance criteria to be as per CSA W59 Clause 11.
- Dimensional verification that the casting and machining complies to the drawings, with tolerances of +/- 3 mm (0.12 in.) on diameter of cast surface.

Growing the Tree

The erection of the tree began with its "trunk," which included a series of welded plates that created a flare at the base, increasing its diameter and connection to the foundation. The 610-mm-diameter (24-in.) steel pipe trunk branches initially into four 406-mm-diameter (16-in.) seamless steel pipe branches via the main casting. These in turn branch through the secondary castings to form fourteen 273-mm-diameter (8-in.) branches—two sets in clusters of three and four branches. Each of the upper 14 branches terminates in a hinge connector, where each supports the steel wide-flange roof beam grid. The project included five castings to resolve the various branching conditions. The main casting weighed about 1,080 kg (2,381 lb) and measured about 900 mm (3 ft) in height and 1,200 mm (4 ft) across. Its wall thickness varies but is in the range of 65 mm (2.55 in.). The secondary set of four castings that branch into three or four limbs weighed about 500 kg (1,102 lb), were 640 mm (2 ft) tall and 1,000 mm (3.3 ft) wide, and had a wall thickness of about 40 mm (1.6 in.).

A cage of temporary steel was erected around the base column to provide support for the branches as they were erected. Until the welding of the pipe-to-casting was complete, the branches could not be self-supporting. The temporary support framework also provided shoring for the wide-flange roof grid. This construction sequence was necessary in order to allow the upper branches to be erected last and to allow the slotted hinge connections to slide easily into the mates already in place on the underside of the wide-flange sections.

The pipe-to-casting connection relied on the addition of a sleeve, inserted inside the casting, as well as paired plates, also inside the casting, that would help gravity-guide the branch pipe sections into proper alignment during erection. Because the final finish on the members was to be high-gloss, great care was taken not to damage the members during erection. Canvas slings were used for lifting, and pads were placed in the V-shaped rests for the branches to ensure against damage. The fabrication of the end connectors was performed to a high level of precision, with all marks and welds being ground completely smooth prior to priming.

Ostensibly Seamless

What makes the final resolution of this particular project, and its tube-to-casting connections, unique is the way in which the transition between the elements was made to appear completely seamless. Multiple passes of welding were used to completely fill the V-shaped gap in the connection between the pipe and casting. This was subsequently ground completely smooth, prior to accepting the final finish. The extra effort to detail and fabricate this connection speaks for itself, as the resulting structure exhibits an elegance and lightness that uses this combination of HSS and castings to the best advantage. MSC

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James Bowes

Airport Support

The European precedent for this particular tube-to-casting connection form can be found in the forest of steel trees that comprise the exposed structural system for Stuttgart (Germany) International Airport, Terminals 1 (1991) and 3 (2004). In this application, the main trunks have been fabricated from four round tubular steel columns rather than one. The cast steel nodes are detailed with a pronounced reveal at their top and bottom extremities, thereby accentuating the material and geometric differences of the systems.

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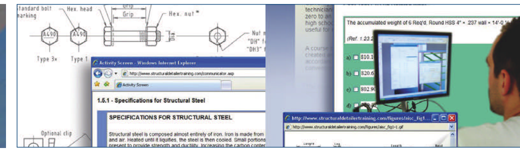
Architect
Young+Wright, Toronto

Structural Engineer
Carruthers and Wallace, Toronto

Steel Fabricator and Erector
Walters, Inc., Hamilton, Ontario, Canada





Detailing for Steel Construction

AISC Web-Based Course

Useful for students and experienced detailers.

The American Institute of Steel Construction (AISC) has retained Dowco Consultants, Ltd., to develop a new online program to train entry-level steel detailers. The new program utilizes the industry's premier reference, *Detailing for Steel Construction*, and is designed to take a student with no knowledge of the steel industry or detailing and provide the basics to allow them to work as an entry-level steel detailer.

This year-long, web-based course may be taken by any high school graduate and takes approximately 400 hours to complete. The course is also a good refresher for more experienced detailers.

Included in the program are lessons on contract documents and the detailing process, common connection details, basic detailing conventions, project set-up and control, erection drawings, shop drawings and bills of materials, and detailing quality control and assurance.

Membership in AISC or NISD will result in a fee reduction of 25% or 10%, respectively. Members of both organizations will receive a total fee reduction of 35%.

Fee Schedule

Full Course	**Fee (USD)**
Retail	$9,500
AISC Members (25% fee reduction)	$7,125
NISD Members (10% fee reduction)	$8,550
AISC/NISD Members (35% fee reduction)	$6,175

Part I (Chapters 1 through 4)	
Retail	$6,245
AISC Members (25% fee reduction)	$4,680
NISD Members (10% fee reduction)	$5,620
AISC/NISD Members (35% fee reduction)	$4,060

Part II (Chapters 5 through 8)	
Retail	$4,680
AISC Members (25% fee reduction)	$3,510
NISD Members (10% fee reduction)	$4,215
AISC/NISD Members (35% fee reduction)	$3,045

Final Exam Fee (USD)

The above pricing includes a certificate of course completion. However, if the student wishes to take a final exam to demonstrate proficiency in steel detailing, a certificate of proficiency will be awarded. To recover costs associated with hiring someone to proctor the exam and location usage costs, an additional fee will apply.

American Institute of Steel Construction   There's always a solution in steel.   Dowco Consultants, Ltd.

For complete information, visit **www.structuraldetailertraining.com.**

A new library in L.A. with an attractive, open plan lets readers check out more than just books.

Photos: Tom Bonner, provided by Steven Ehrlich Architects

Reading Materials

BY PATRICIA RHEE

IT IS THE MISSION OF EVERY LIBRARY TO EXPOSE ITS PATRONS TO READING. In the case of the new Westwood Branch Library in Los Angeles, exposure to structural steel and other building materials is also part of the experience.

Located near Westwood Village and the UCLA campus, the new library was designed in the spirit of the Case Study Houses that were built in the Los Angeles area after World War II. Like those homes, the project incorporates the idea of indoor-outdoor space, the expression of structural systems, and the use of natural materials, bringing the structural steel skeleton to the surface in an appealing way.

The entry plaza is composed of linear branch-integrated planters and shaded entries into the lobby and community room. The exterior presents diverse and durable building materials, including naturally weathering copper, burnished concrete block, clear and translucent channel glass, resin-impregnated wood panels, and an exposed structural steel frame.

The first floor includes a public meeting room that can open up to the plaza. A two-story entry lobby leads library patrons up to the second floor main reading room. The reading room follows the same design concept and expression of materials as the exterior, with exposed steel columns, beams, and bracing, and even an exposed steel deck ceiling. The deck, a proprietary system manufactured by Epic Metals, is acoustical, using a spongy insulation in every other flute; the steel itself is perforated so that noise travels through and is absorbed by the insulation.

The architect chose to leave as much as the structure as possible exposed to library patrons and staff.

Open to View

Due to California's well-known seismic issues, the structural system of the building is a steel moment frame combined with concrete masonry shear walls. Steel brace frames are exposed at the clerestory level and meet AISC *Code of Standard Practice* Architecturally Exposed Structural Steel (AESS) requirements (Section 10). As such, special intumescent paint was applied to the steel beams and columns for fireproofing, allowing the structural system to read through. Exterior steel on the sides and back is also coated with intumescent paint, given the close proximity to adjacent buildings. The idea is to express the beauty and nature of the steel, while maintaining a consistent aesthetic throughout. This way, the architecture is revealed, not hidden.

Not only is the structural system exposed in the reading room, but so are the building systems, and fire protection piping is routed through the ceiling beams. Steel interacts with the "plumbing" on the outside as well, as rain spouts are routed along the web and between the flanges of portions of the exterior steel.

A Higher Degree of Care

When it came to fabrication, a lot more care had to be taken with the exposed steel in order to meet AESS requirements. Most steel is essentially "buried" in a building, but when it's exposed, directions need to be made very clear on the plans. In the Westwood Library, not only did exterior exposed beams serve an aesthetic purpose, they also served as part of the waterproof skin of the building. As such, no "rat holes" were allowed on the exposed members, and this had to be communicated properly in the plans.

The goal of the exposed steel of the Westwood Branch Library didn't necessarily follow the typical exposed steel path of bending beams or using castellated steel for purposes of flair. Rather than altering the steel to transform it into an artistic element, the library's design allows the steel to simply speak for itself.

MSC

Patricia Rhee is an associate with Steven Ehrlich Architects and was the project architect for the Westwood Branch Library.

Owner
Los Angeles Public Library

Architect
Steven Ehrlich Architects, Culver City, Calif.

General Contractor
Sinanian Development, Inc., Tarzana, Calif.

Structural Engineer
William Koh and Associates, Los Angeles

All exposed steel in the library meets AISC's AESS requirements.

What is Value-Added Selling?

BY TOM REILLY

VALUE-ADDED SELLING IS MORE THAN A BOOK, A SPEAKER, A SEMINAR, OR THIS YEAR'S MANAGEMENT THEME. Since the publication of my first book in 1986, *Value Added Selling Techniques*, I've invested 90% of my speaking time spreading the good news about value-added selling to audiences all over the world. Many people think they know what it is, but in most cases they fail to understand the depth of this business philosophy and sales process.

The Value-Added Selling Philosophy

Value-added selling is a proactive philosophy of seeking ways to enhance, augment, or enlarge your bundled package solution for the customer. It's promising a lot and delivering more, always looking for ways to exceed the customer's expectations.

Value-added selling is a proactive philosophy. Value-added salespeople take the initiative to add value. Value-added salespeople do not wait for the customer to complain about the price and then say, "Hold on a minute while I whip some value-added selling on you!" Value-added salespeople build in more value on the front end so that price becomes less of an issue on the back end. Being proactive with customers means you never have to say you're sorry.

Value-added selling is more than a sales course. It's a course of action—a business philosophy that emanates from rock-solid core beliefs. The first belief is that trust is the currency of great relationships. If two people trust each other, like each other, and want to do business with each other, they will work out the details. Despite technology and the complexity of many industrial sales, selling is still relationship management. Buyers may prefer brands, but they reserve loyalty for people.

A second core belief is that people want to get as good as they give. This commitment to equity shows itself in the desire to achieve win-win outcomes. If it's not a good deal for the buyer or the seller, it's a bad deal for both of them. When customers feel that they gave better than they got, they defect when the first opportunity presents itself. Thus, the seller loses. When sellers perceive that they gave better than they got, they resent the business and fail to serve enthusiastically. Thus, the customer loses. Win-win outcomes are the only acceptable results for long-term relationships.

A third core belief stems from a customer value focus—that the sale is more about the customer than the seller. It's their problem. It's their money. It's a solution with which they must live. The sale should be about the customer. Value, like beauty, is in the eye of the beholder. Value-added salespeople define value in customer terms, not seller terms. If you define value in customer terms, they pay for it with a higher selling price. Conversely, if you define value in your terms, you pay for it with a bigger discount.

Because of this customer value focus, value-added salespeople are in business to make a difference, not just to make a deal. They approach the sale by asking themselves this question: "Where can we have the greatest impact on the customer's business?" The natural outcome of this belief is that you will generate all the deals you can handle. This follows a parallel belief that you achieve success by helping other people achieve higher levels of success.

A fourth core belief is that you sell a bundled package solution, a three-dimensional solution: your product or service, your company, and yourself. Two major studies found that salespeople contribute at least one-third of the value that customers receive. The company and product contribute the balance. The same product from the same company from two different salespeople results in two different solutions altogether. The salesperson's competence and attitude are primary drivers of customer satisfaction, loyalty, and retention.

This three-dimensional view of the solution offers great hope for companies and their salespeople. If you sell the product only, you open the field to too many competitors. Companies bring value to the table with their facilities, depth of resources, commitment to the industry, management philosophy, support, and people. People represent the single unique dimension of value, because there's no commodity in creativity and no traffic jam on the extra mile. Salespeople add value with their problem-solving skills, follow-up, accessibility, knowledge, ability to get things done, logistics support, and initiative. MSC

Tom Reilly is the keynote speaker at this year's AISC Annual Meeting, scheduled for September 11-12 at The Broadmoor in Colorado Springs, Colo. For more information on this event, please visit www.aisc.org/annualmeeting.

Shepley Bulfinch Richardson and Abbot

Express Yourself

BY DAN HEEMSTRA

Thin-film intumescent fire-protective materials provide designers with increased aesthetic flexibility when it comes to exposed steel.

THERE IS AN INCREASED EMPHASIS ON EXPOSED STRUCTURAL STEEL IN THE DESIGN OF COMMERCIAL AND INSTITUTIONAL STRUCTURES THESE DAYS. As a result, intumescent coatings are experiencing expanded use as a tool that offers fire-protective capabilities while at the same time meets the aesthetic objectives of architects, providing an opportunity for design expression in the exposed steel.

Cementitious Coatings

Before discussing the benefits and application of intumescent coatings, it's important to recognize the role of spray-applied fire-resistant materials. SFRMs are the most commonly used fire-protective materials and are usually gypsum-based or cementitious materials. They can be applied by means of wet spray, where the water is mixed with the dry material at the pump, or dry spray, where the water is injected at the spray nozzle.

Intumescent Coatings

By contrast, intumescent mastic materials or coatings are relatively thin-film products that expand rapidly in a fire to insulate the steel. They come in various proprietary formulas that include a mixture of binders and acids that react under temperature to expand up to many times the original thickness of the film, creating a char that insulates the steel. Normally, we expect this reaction to begin when the heat of the fire reaches 350 °F, and continue for a specified time to help the steel substrate remain below 1,100 °F during a test or actual fire (steel loses half its strength at 1,100 °F).

Intumescents are usually spray-applied at thicknesses less than 50 or 100 mils and rarely more than 300 mils, while typical corrosion-resistant coatings are considered thick-film if they are thicker than 18 or 20 mils.

Cost Considerations

Formulations for intumescent coatings have improved over the years, resulting in better-looking and easier-to-apply offerings; as demand for intumescents has increased, so have coating choices. So, engineers and designers that have not looked into using intumescent materials lately might be pleasantly surprised to see how much better and cost-effective today's materials are than those used 10 or 15 years ago.

Also, consider that since the material cost for intumescents increases as the number of coatings increase, one way to bring down the intumescent cost is to up-size the steel. This way, fewer layers will be required to achieve the two-hour fire rating.

Where It's Useful

In addition to wide-flange shapes, architects are increasingly employing hollow structural sections (HSS) in their buildings and are coating the members with thin-film intumescents in order to expose the steel. (When using conventional cementitious coatings and gypsum wallboard or t-bar ceiling enclosures, all of the steel and fire-protective materials are generally concealed.)

Intumescent coatings are also used in "clean-room" environments, because unlike most cementitious coatings, they do not "dust" or give off particles into the atmosphere. Other uses for intumescents include tight spaces and areas along window walls, as the films are 1⁄16 in. to 1⁄8 in. thick compared to 1 in. to 1½ in. for gypsum-based materials.

A typical coating system that includes an intumescent material might consist of the following:

✓ Shop-applied primer (modified alkyd, organic zinc, or inorganic zinc-based) in the 4 mils dry-film thickness range.

Projects such as New York's Hayden Planetarium, with its unique design and large amount of exposed steel, make attractive fireproofing a necessity. Photo: Polshek Partnership Architects

- ✓ An intumescent base coat of 22 to 465 mils, depending on substrate shape, assembly design, and hourly fire rating requirement.
- ✓ A top coat (optional in interior applications) of penetrating epoxy sealer (2 mils) followed by high-build polyurethane (3-5 mils).

Primers for intumescent materials are usually modified alkyds and epoxies. Typically, proper application of the primer is more important than which primer material is used. A poor-quality primer applied properly will likely do a better job than a great primer material applied improperly. (Primers are important to the adhesion of intumescent materials but are usually not required for cementitious materials unless the application setting is an aggressive environment.)

Top coats may vary widely depending on the type and use of the intumescent coating. It is always advisable to research the suitability of the proposed top coat with the intumescent coating manufacturer. It is also advisable to use materials from only one manufacturer to assure continuity of the system. However, it is important to note that many coating manufacturers do not manufacture primers or top coats.

Application Methods

Intumescent coatings can be applied in the field by airless spray following erection of the steel. If a coating is shop-applied, instructions for special care in the erection and transportation of the steel should be noted in the job specifications, and touch-up or re-application can be performed in the field as needed. The applicator's pump should be a large, industrial type—40:1 or 53:1 or even 56:1. Top coats also should be spray-applied with a similar process, but may be brush- or roller-applied if necessary.

Successful application of intumescent materials is dependent on good painting practices and adherence to standard quality control and quality assurance methods. These considerations include but are certainly not limited to:

- ✓ A well-written specification that takes into account intended use, exposure, and the suitability of material selection
- ✓ Provisions for using only "factory trained", certified, and qualified contractors and application personnel
- ✓ Verification of the substrate and assurance of the suitability and quality of the primer
- ✓ Use of proper equipment
- ✓ Consideration of environmental conditions, as in too wet, too humid, too cold, and at times, too hot
- ✓ Reference to applicable quality control documents such as Manual 12-B of the Association of the Wall and Ceiling Industries International and SSPC PA-2.

Intumescent mastic materials are supplied in water-borne, solvent-borne, and epoxy versions. As with SFRMs, intumescents are classified as interior conditioned space, general-purpose, and exterior use products. (These are important distinctions, as most interior-grade materials fail miserably in exterior environments.)

A simple way to distinguish the three grades is to think of interior conditioned space in terms of "air conditioned", while general-purpose refers to interior non-air conditioned space and exterior use refers to an outdoor setting such as a parking garage or awning exposed to the weather.

Testing Requirements

Coatings are tested and approved by several laboratories, but generally speaking, Underwriters Laboratories (UL) is the standard in the industry. UL provides the protocol and testing requirements and actually performs the fire testing at the UL facility in Northbrook, Ill. It also annually publishes a compilation of all the currently approved systems, assemblies, and designs in its *UL Fire-Resistance Directory* (2008).

In evaluating fire-protective materials, UL conducts three levels of laboratory environmental testing. The most demanding test is for exterior materials, and the procedure involves material weathering, humidity, carbon- and sulfur-dioxide air mixture, UV, and salt spray. Two levels of testing for interior materials involve weathering and high humidity, with general-purpose materials required to last longer under the test conditions.

Cementitious and intumescent coatings are both listed in the *UL Fire Resistance Directory* and classified as beams and columns and assemblies of structural steel and floor and roof designs. The directory also includes many types of construction, such as gypsum walls and concrete floor and composite roof systems, and the fire resistance of various assemblies as measured in hours. Architects and engineers use the designs listed in the directory to help them in meeting the hourly rating required by the prevailing building code.

While high-performance coatings are tested in various chemical exposures, fire-protective materials are tested in accordance with ASTM E119 and UL 1709. The E119 test applies to general building materials placed under a "time temperature" fire test, where the materials are cooked over a few hours as the heat in the oven temperature increases. The UL 1709 test is a "rapid rise" test where the sample item is immediately exposed to a full 2,000 °F to replicate an industrial fire where the fuel would primarily be petrochemicals.

Most intumescent coatings are tested and approved under the ASTM E119 test, as they are usually applied to structural steel on commercial buildings. In some cases intumescent coatings are approved for use in chemical or industrial applications such as refineries.

Weight and Mass of Steel

The terms *W/D ratio* and *A/P ratio* (weight over heated perimeter [for W-shapes] and area over heated perimeter [for hollow sections]) refer to formulas where the area and exposed perimeter of the steel is measured to determine a value. With all fire-protective materials, the size and the weight of the structural steel to be protected may be a factor in determining the thickness of the material needed to achieve the required fire rating. This is particularly important with intumescent coatings applied to HSS.

In many cases UL has published a listing of the applicable steel members by size, with the corresponding dry film thickness (DFT) of the fire-protective material. Steel members having greater mass or weight per foot versus the exposed perimeter area (measured in square inches) are likely to require a lesser thickness of material coverage, and those with less weight with the same surface area will usually require more material to provide the same hourly rating.

Inspection Guidelines

The Association of the Wall and Ceiling Industries International (AWCI) publishes inspection manuals that are widely accepted as the basic criteria for the inspection of both cementitious and intumescent coatings.

An important guide here is Technical Manual 12-A, *Standard Practice for the Testing and Inspection of Field Applied Spray Fire-Resistive Materials; an Annotated Guide*. This is the initial guide specific to cementitious materials.

AWCI also publishes Technical Manual 12-B, *Standard Practice for the Testing and Inspection of Intumescent Fire-Resistive Materials; an Annotated Guide*. This guide is specific to intumescent coatings.

Both guides are similar in nature to SSPC PA-2 and include protocols for measurement of thicknesses, the number of readings required, and other procedures. Other inspection criteria and guidelines in the manuals address general information; surface conditions such as the substrate and primer; site conditions including environmental conditions; and actual inspection procedures including design criteria and an inspection form.

Exposed Equals Intumescent

Designers can choose from many different types of SFRMs and intumescent fire-resistant materials for different applications. But in exposed structural steel applications, thin-film intumescent mastic materials are becoming an increasingly popular choice thanks to their combination of fire-protective capabilities and utility in not only showcasing the steel, but also maintaining its attractiveness. MSC

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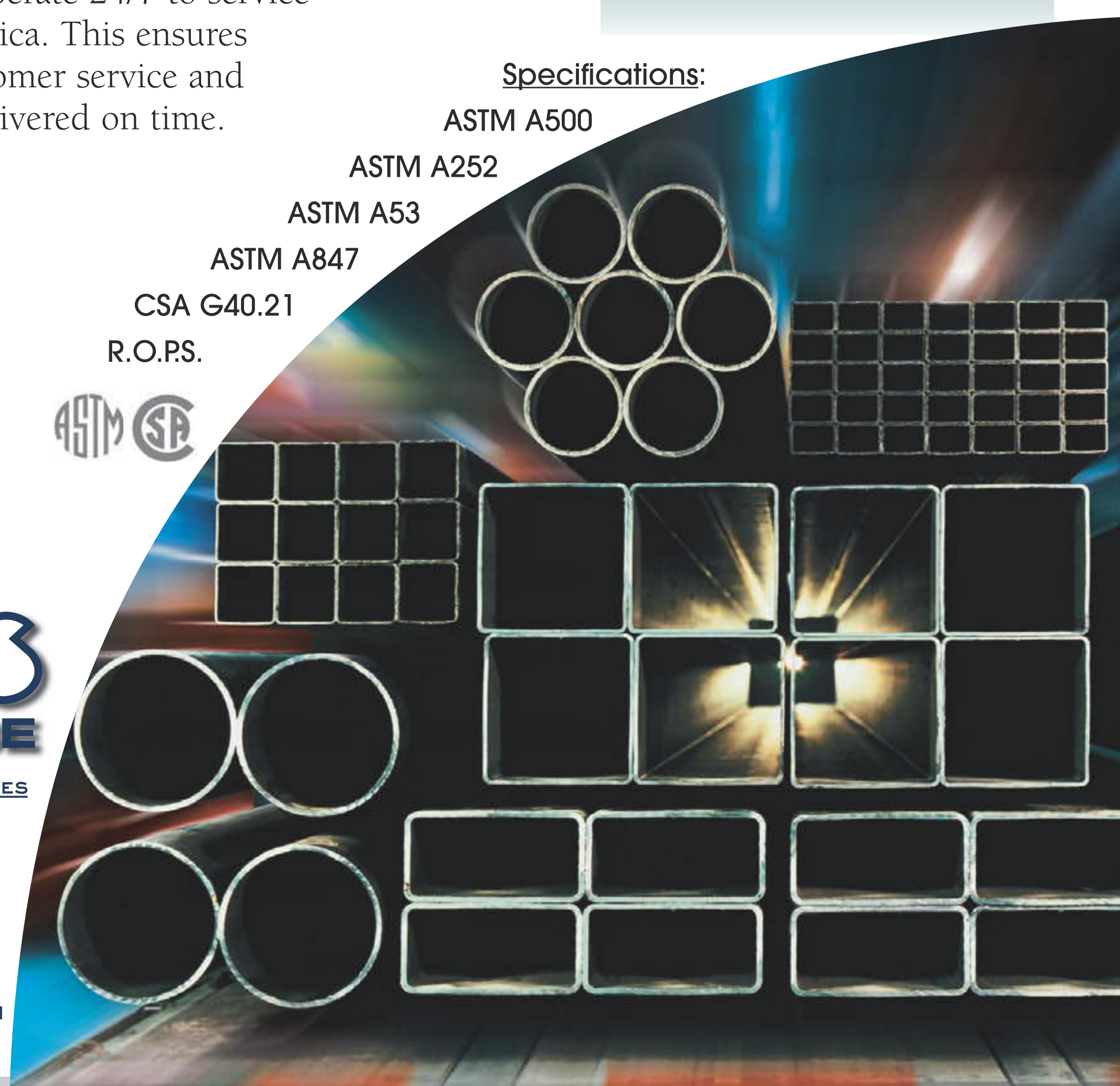

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Jessica Sladek

Managing the Roller Coaster

BY TABITHA S. STINE, P.E., LEED AP

Material volatility can turn a construction project into a bumpy ride, but a thorough understanding of HSS can help smooth things out.

DESIGN AND CONSTRUCTION PROFESSIONALS HAVE EXPERIENCED THE ROLLER-COASTER RIDE OF CONSTRUCTION MATERIAL VOLATILITY SINCE EARLY 2004. Every material has experienced the ups and downs of availability and pricing. And for the time being, it looks like we'll all have to stay buckled in and continue this dynamic ride.

But as experienced riders, we have an edge. We recognize that the best approach to handling the challenges of material pricing and availability is to understand the supply chain for every type of construction material.

This is especially true for structural steel. If we are going to effectively manage the ride, it is necessary to broaden our perspective, look around, and consider all types of structural steel—not just wide-flange, but also steel joists and hollow structural sections (HSS). We will never be able overcome all the twists and turns of the roller coaster, but with the right information, we can anticipate and manage them. Instead of fear, the result will be an enjoyable ride resulting in a successful structural steel project. And HSS can help us get there. But first, we need to gain a clear understanding of HSS by asking What, Who, Why, Where, and When.

What?

What is HSS? How is it different than our standard image of "steel" or "structural steel"? When considering whether HSS is a viable option for a specific project, you should evaluate the following HSS characteristics, among others, to determine if HSS can assist in achieving the desired structural and architectural needs of your project—and in turn, address the current market volatility concerns:

- **Strength.** HSS has high strength-to-weight ratios, excellent compression-support characteristics, and excellent torsional resistance.
- **Appearance.** In exposed applications—such as architecturally exposed structural steel (AESS)—round, square, and rectangular HSS becomes an exciting, attractive part of a structure. HSS, along with wide-flange sections, can be readily bent, formed, punched, and drilled for particular architectural needs and finishes.
- **Uniformity.** HSS provides a uniformity of size, shape, strength, and tolerance that makes its use totally predictable.
- **Cost-effectiveness/fabrication.** HSS is competitive in cost with other structural materials. Lighter sections can often be specified when choosing HSS over other steel options, particularly in column applications. And today, with increased material costs but steady labor costs, HSS may prove more cost-competitive than in the past. However, in terms of connections to other HSS, it can become more costly to fabricate over standard steel sections due to its increased labor requirements, as HSS-to-HSS connections can sometimes be complex. It is always best to speak with a fabricator early in the project to discuss these fabrication issues and get their recommendations on best practices.

The glass walkway of the Cleveland Heights – University Heights Public Library features HSS prominently in its exterior trusses.

In addition, there are now large amounts of ready-to-ship domestic inventories of HSS. With a current domestic capacity of nearly 5 million tons and a consumption of around 3.2 million tons, HSS is a readily available option to help smooth out the ride of volatility. Relying heavily on the scrap market for its high recycled content make-up, HSS has seen price fluctuations similar to those of other structural steel shapes. Since December 2007, HSS is up over 50% on average, whereas wide-flange sections are up a little over 30% in the same period. However, in the last two quarters of 2007, the price-per-ton of HSS actually dropped slightly lower than that of wide-flange material.

Who?

HSS has become increasing popular domestically, taking the lead in many countries in Europe, as well as in Japan. In a recent survey of structures currently in the conceptual study phase in AISC's Steel Solutions Center, it was found that approximately 12% of all steel in these structures was HSS. In fact, it has been estimated that over the last five to seven years, domestic HSS consumption has grown 5% to 7% each year, with a predicted increase of 10% in 2008 alone.

Why?

All this information begs the question "Why?" Why are so many people looking to HSS for structures that would normally not have even considered structural steel?

First of all, let's look at rolling cycles. Many tube producers domestically roll tube on a four- to six-week rolling schedule. With turnaround time this quick, fabricators and service centers can navigate the volatility roller coaster a bit more comfortably, since the material price that is being paid is only a few weeks out from when the material is ordered. In a global market, this affects our domestic roller coaster in a more diverse way than ever before, as these ups and downs can be harder to handle. The more you can "crunch" your window to minimize the risk of the next major price fluctuation, the more you can "grease the wheels" to make it a less bumpy ride.

Where?

HSS producers are located all across North America and produce shapes to the specification of ASTM A500. Again, the domestic market is also being impacted by international players today more than ever. The importance of knowing your supplier and asking questions about where the steel is originating (in order to ensure a high-quality ASTM A500 product) cannot be stressed enough. The same applies when working with a steel service center. Nearly 90% of all HSS used in the building sector now is channeled through service centers, where it is readily stocked and available for shipment.

When?

As a matter of fact: Now! As the roller coaster is never predictable and you never know where that next dip, dive, or climb may be, working with a steel fabricator, HSS producer, steel service center, and the AISC Steel Solutions Center (**www.aisc.org/solutions**) early in the project is a top priority. "Not all steel sizes are created equal" is an understatement. Steel availability should always be referenced at the beginning of the job to ensure that the desired sizes are readily available (**www.aisc.org/steelavialability**). Just because the size appears in the *Steel Construction Manual* does not ensure it can be ready for your next project. As always, look to AISC's one-stop-shop for any and all issues related to HSS: **www.aisc.org/hss**. MSC

Tabitha S. Stine is AISC's Director of Technical Marketing. She can be reached at stine@aisc.org.

Jessica Sladek

The Hole Story

BY JACINDA L. COLLINS, P.E.

What part do you play in the continuing saga of bolted connections?

IN THE WORLD OF STRUCTURAL STEEL CONSTRUCTION, THE STORY OF BOLTED CONNECTIONS IS AN EPIC AND GRAND TALE. It is a story that includes intrigue (fastener component selection), drama (design of the connection), mystery (pre-installation verification), action (installation), thrills (inspection), horror (arbitration), history (references), and the occasional miracle. The AISC *Specification for Structural Steel Buildings* (ANSI/AISC-360-05), the RCSC *Specification for Structural Joints Using ASTM A325 or A490 Bolts*, and numerous other publications provide a detailed account of the "hole" story from start (manufacture) to finish (recycling). The intent of this article is not to replicate those references, but to give you a clear view of your own chapter in the bolted connection story. So think of it not as a design guide, but as your handy set of crib notes for the tome that is Bolted Connections.

Chapter 1: Bolts

The choice between welded and bolted connections depends upon a variety of factors. A few of these factors include shop preference, connection geometry, and additional attachments that are to be placed on a structural steel member. When bolted connections are the choice, bolt holes are made as part of the automated fabrication of the structural steel pieces. These holes provide a method of locating pieces of structural steel quickly, as well as reduce the time necessary for the steel piece to be held in place by a crane at the erection site. In fact, OSHA requirements state that at least two bolts must be provided, as positive attachment of a steel member before the crane can be unhooked from it during erection.

The most commonly used high-strength bolts are those that are manufactured to ASTM A325, A490, F1852, and F2280 specifications. However, it should be noted that there are other high-strength bolts with unique characteristics that make them ideal for specific types of connections. Some of these high-strength bolts include:

ASTM A193 – for use in elevated-temperature service

ASTM A320 – for use in low-temperature service

ASTM A354 Grade BD – properties similar to A490, but can be obtained in larger diameters

ASTM A449 – properties similar to A325, but can be obtained in larger diameters

Chapter 2: Joint Selection

There are three types of joints that are available for bolted connections: snug-tightened, pretensioned, and slip-critical joint. The selection of which type of joint is required for a connection depends upon the application and loading conditions that the joint will experience. Table 1 illustrates some general guidelines for the three joint types.

The general cost of a bolted connection in a final structure includes the cost of the bolts, nuts, and washers (if required), the fabrication cost of

Table 1: Joint Type Requirements

Joint Type		
Snug-Tightened	**Pretensioned**	**Slip-Critical**
Applicable except when a pretensioned or slip-critical joint is required	As required by the AISC Specification *(see below)*	Joints that are subject to fatigue load with reversal of loading direction
	Joint subjected to significant load reversal	Joints with oversize holes
	Joint subjected to fatigue with no reversal of loading direction	Joints with slotted holes, except those with applied load approximately normal to the dimension of the long slot
	Joint with A325 or F1852 subjected to tensile fatigue	Joints in which slip of the joint would be detrimental to the performance of the structure
	Joints with A490 (or F2280) bolts with tension (tension or combined shear and tension, with or without fatigue)	
	Seismic connections in lateral force resisting systems when *R* is taken >3	

The AISC Specification requires that joints be pretensioned for the following circumstances:

- ➜ Column Splices in multi-story structures over 125 ft
- ➜ Connections of all girders and beams to columns and any other beams and girders on which the bracing of the columns is dependent in structures over 125 ft
- ➜ Connections in structures that support cranes with a capacity over 5 tons
- ➜ Connections for the support of machinery and other sources of impact or stress reversal
- ➜ End connections for built-up compression members (fabricated with Class A or B faying surfaces)

making the holes in all plies, the preparation of surfaces (if required), the installation of the bolts, and the inspection of the connection. These costs can increase significantly when comparing snug-tightened joints to slip-critical or pretensioned joints.

Snug-tightened joints are more economical when compared to pretensioned or slip critical joints. The reduction in the comparative cost of snug-tightened joints comes from the absence of faying surface preparation requirements and a reduction of inspection requirements. Therefore, if allowed, remember to specify snug-tightened joints whenever possible.

For applications in which seismic design is performed using $R = 3$, if given the choice, pretensioned joints are more economical than slip-critical joints. Slip-critical joints have special faying surface preparation requirements that do not apply to pretensioned joints. Thus, the reduction in the comparative cost of pretensioned joints results comes from the reduction in the overall fabrication cost of the connection.

The choice of faying surface selection in slip-critical joints may depend upon whether the steel member is (or is not) blast-cleaned and coated for other reasons. If the steel is to be blast-cleaned or blasted and coated with a coating rated for Class B slip resistance, then it is more economical to use a Class B faying surface. Otherwise, a Class A design may be a more appropriate choice.

Chapter 3: Connection Design

After you have selected the joint type, the next step is to design the connection itself. Table 2 illustrates some general design guidelines for each of the three joint types.

In general, the type of bolt hole selected for a joint should be based upon constructability. Standard holes and short-slotted holes can be used in each of the joint types. Long-slotted holes are permitted in each of the joint types with the approval of the Engineer of Record, while oversized holes can be used only in slip-critical joints. The selection of the type of bolt hole selected is a great topic of conversation with a steel fabricator. It is considered good practice, when using standard and oversized holes, to specify the same hole type in all plies so that the plies can be aligned using a spud wrench and drift pins during erection.

OSHA requires at least two bolts (or an equivalent attachment) in all connec-

Table 2: Joint Design Requirements

Limit States	Joint Type		
	Snug-Tightened	Pretensioned	Slip-Critical
Design shear or tensile strength of a bolt	X	X	X
Strength of the bolt when subject to combined shear and tension	X	X	X
Design Bearing strength at bolt holes of connected material and bolt	X	X	X
Design Slip Resistance (faying surfaces and bolt pretension)			X

Additional considerations for the design of the joint include:

- ➜ shear and/or tension yielding
- ➜ shear and/or tension rupture
- ➜ block shear rupture
- ➜ shear lag
- ➜ prying action

tions, and these bolts must remain in place after the member has been released from the crane. It is considered good practice to have connections that do not share bolts through a support. If this is not possible, a discussion with the steel fabricator should occur to determine a solution. Some examples of typical solutions to this situation can include providing temporary erection seats, offsetting connections, making one connection deeper than the other to make sure that some bolts are not shared by both connections, or another solution that will address erection safety.

Washers are required for all joint types that have sloped surfaces or use slotted holes in the outer ply. For pretensioned and slip-critical joints, washers are required for the following types of connections:

- ➜ when using ASTM A490 bolts and the connection material is less than 40ksi (not required under the head for the ASTM F2280 bolts)
- ➜ under the turned element when using the calibrated wrench pretensioning method
- ➜ under the nut when the twist-off-type tension-control bolt pretensioning method is used in certain bolt configurations (reference Section 6.2.4 and Figure C-8.1 in the RCSC Specification)
- ➜ when the direct-tension-indicator pretensioning method is used
- ➜ when oversized holes are used in the outer ply

Table 6.1 in the RCSC Specification illustrates the conditions that require thick or plate washers for bolted joints with oversized and slotted holes in the outer ply.

When designing bolted connections it is always best to limit the number of different bolt strengths and diameters being used on the entire project. It is also advisable to use different diameters of bolts when different bolt strengths (for example ASTM A325 and A490) are mixed on a project. This reduces the chances of the wrong bolt strength being placed in the wrong connection during erection, and simplifies the purchasing, installation, and quality assurance functions.

Chapter 4: Fabrication and Installation

During fabrication of structural steel members, bolt holes are generally created via drilling, punching, or thermal cutting. Additionally, bolt holes can be created by sub-punching, reaming, and hole-sawing.

Bolts, nuts, and washers must be stored properly when delivered to the job site and during construction of the structure. Proper storage of bolts is particularly important for assemblies that will be pretensioned. Containers should be used to protect the fastener components from dirt and moisture. In addition, the containers should be kept in a protected shelter to ensure accidental exposure does not occur. The fastener components should only be removed from the protected storage when installation of those necessary parts will occur. Fastener components that are not used right away should be returned to protective storage as soon as possible.

Table 3 illustrates the current accepted bolt installation requirements and methods. Tightening of the bolts in a joint should begin with the bolt at the most rigid part of the connection being installed. Subsequently, the additional bolts of the connection are systematically tightened in a manner that will minimize the relaxation of the previously installed bolts.

Chapter 5: Inspection

The AISC Specification references the RCSC Specification for bolted joint inspection requirements. When inspection of the bolted joints is required in the contract documents, an inspector is responsible for assuring that the installation of the bolted connections meets the requirements of the RCSC Specification. When Inspection of the bolted joints is not required, the contractor is responsible for assuring that the installation of the bolted connections meets the requirements of the RCSC Specification.

Prior to the actual installation of the bolts, a visual inspection should verify that all mandatory markings are present. All manufacturers or suppliers of high-strength bolts and components should provide certification documenting their conformance with the ASTM Specifications.

During the inspection of all joint connection types, the fastener components, connection plies, bolt holes, faying surface conditions, and proper bolt storage/usage procedures need to be evaluated. Note that there is no requirement for the inspection of each bolt, but rather that the bolt installation procedure in place results in required processes being met. For snug-tightened joints, only a visual inspection is required to determine that the correct bolt types are in their specified holes and that the plies are drawn into firm contact. For pretensioned and slip-critical joints the RCSC Specification specifies that the following inspection procedures are required:

- ➜ When the turn-of-nut pretensioning installation method is used, it is necessary to observe that the bolting crew properly rotates the turned element relative to the unturned element by the specified amount.
- ➜ When the calibrated wrench pretensioning installation method is used, pre-installation verification procedures are performed daily for the calibration of the installation wrench. In addition, routine observation that the bolting crew properly applies the calibrated wrench to the turned element is necessary.
- ➜ When twist-off-type tension-controlled bolts are used, it is necessary to observe that the splined ends are properly severed during installation by the bolting crew.

Table 3: Detailed Bolt Installation Requirements

Joint Type	Installation Methods
Snug-Tightened	A few impacts with an impact wrench or the full effort of an ironworker using an ordinary spud wrench to bring the plies into firm contact.
Pretensioned and Slip-Critical	**Turn-of-Nut**: Installed first as snug-tight, then additional rotation of the nut or head is applied ranging from 1/3 to 1 turn based on grip geometry and bolt aspect ratio.
	Calibrated Wrench: Installed first as snug-tight. Subsequently, a predetermined torque (calibrated daily to provide the required pretension) is applied with a wrench that indicates the torque applied to the nut or head. The nut or head does not need to be rotated greater than specified limits (for turn-of-nut method).
	Twist-Off-Type Tension-Control Bolt: Bolts meeting F1852 or F2280 are used and installed as an assembly. Installed first as snug-tight without severing the spline. Subsequently, all bolts are pretensioned with the twist-off-type tension-control bolt installation wrench.
	Direct Tension Indicator: Direction tension indicators must meet ASTM F959. Bolts (with washers) are first installed as snug-tight, making sure the gap is not less than the job installation gap. Subsequently, the bolts are pretensioned until the direct tension indicator protrusions have been compressed and the gap is less than the job inspection gap.
	If alternative design fastener or alternative washer-type indicating devices are used, install per manufacturer (and as approved by the Engineer of Record).

➜ When the direct tension indicator method is used, the inspector shall observe the pre-installation verification testing. Furthermore, prior to pretensioning, routine observation is necessary to verify that the appropriate feeler gage is accepted in at least half of the spaces between the protrusions of the direct tension indicator, and that the protrusions are properly oriented away from the work. After pretensioning, routine observation is necessary to verify that the appropriate feeler gage is refused entry into at least half of the spaces between the protrusions.

Pre-installation verification is used to check that the fastener assemblies and pretensioned installation procedures perform as required prior to installation. The RCSC Specification provides detailed procedures for the pre-installation verifications methods available for each of the installation types. It should be noted that pre-installation verification is required on-site daily for the calibrated wrench pre-tensioning procedure. In addition, it should be noted that detailed inspection instructions should be provided by the manufacturer(s) for the chosen fastener components.

Chapter 6: Arbitration

In the instance where there is valid reason to believe that the installed bolts do not have the required pretension, arbitration may be required. The RCSC Specification provides a detailed procedure for arbitration of pretensioned and slip-critical joints.

During arbitration it should be noted that reliability concerns may occur due to the nature of the testing procedure used. Conditions that are present at the installation site are not wholly present at the arbitration testing site. These conditions can include the use of hardened washers, the lubrication condition, and the effect of the passage of time/exposure of the joints. If it is found that the RCSC procedure is not appropriate for the specific situation of the joint(s) in question, an alternative arbitration procedure from the one described may be permitted. MSC

Jacinda Collins is an advisor in AISC's Steel Solutions Center.

References

Research Council on Structural Connections (RCSC): *Specification for Structural Joints Using ASTM A325 or A490 Bolts*, dated June 30, 2004.

ANSI/AISC 360-05: *Specification for Structural Steel Buildings*, dated March 9, 2005.

ANSI/AISC 341-05: *Seismic Provisions for Structural Steel Buildings*, dated March 9, 2005, and *Supplement No. 1*, dated November 16, 2005.

AISC 303-05: *Code of Standard Practice for Steel Buildings and Bridges*, dated March 18, 2005.

AISC *Steel Design Guide 17: High Strength Bolts, A Primer for Structural Engineers.*

Kulak, Geoffrey L., Fisher, John W., and Struik, John H.A., *Guide to Design Criteria for Bolted and Riveted Joints,* second edition.

Steel Structures Technology Center, Inc. (SSTC): *Structural Bolting Handbook.*


QUALITY SAFETY
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New Ways to Achieve Quality and Improvement

BY BRIAN W. MILLER

AISC Certification adopts a team approach.

THE CERTIFICATION GROUP AT AISC has begun implementing an organizational change that will result in us working a little differently than we have in the past. AISC and Quality Management Company (QMC) personnel are in the process of transitioning from a traditional hierarchical management structure to working as a self-directed work team (SDWT). This new way of doing business requires some adjustment, but we believe it will allow us to unleash our potential and more effectively engage limited resources.

Why the Change?

The trigger for the transition to a team-based organization was Bobbi Marstellar's announcement to leave AISC to pursue other interests. As the AISC vice president overseeing Certification, Bobbi contributed remarkable talent, leadership, and energy that will be difficult to replace. The Certification program is growing rapidly, with new standards being developed and program participation growing at an annual rate of greater than 10%. The SDWT approach provides a way for the Certification group to continue functioning effectively while avoiding the disruption of an executive search and hiring process.

A Good Fit

The SDWT is defined as "a group of people with complementary skills, working together in their own ways toward a common purpose, performance goals, and approach, which the team defines and to which they hold themselves mutually accountable." This approach is expected to minimize administrative disruption and enable Certification staff to stay focused on the tasks at hand and make progress toward established goals. The loss of a key individual presented a challenge, but objectives and goals are well understood and the group works well together, openly offering and soliciting one another's talent and creativity to accomplish the job that needs to be done. The SDWT concept stood out as an ideal solution to pursue—one that fits the group and our needs.

Implementation

Transitioning to a team-based organization from a traditional management structure is challenging. It requires new ways of thinking and making the decision to unleash self-actualization and creativity. It also requires an organization to establish operational ground rules and define processes. Adjustment from both the team itself and those working with the team from the outside is required. Fortunately, good team development resources, such as *The Magic of Self Directed Work Teams: A Case Study in Courage and Cultural Change* by Paul C. Palmes, are available that improve awareness about the inherent risks and help with the transition process. Four stages are widely accepted as a bumpy but normal part of the team development process:

- ➜ Forming. Team members wrestle with excitement, anticipation, and anxiety in the process of establishing basic team rules and decision-making processes.
- ➜ Storming. The team development process involves work and adjustments that, to team members, may seem slow and in competition with day-to-day tasks.
- ➜ Norming. Team members gain acceptance of ground rules and their roles in the team, focusing increasingly on team cohesion and goals.
- ➜ Performing. Team members have adjusted to the team structure, expectations, and relationships and have become confident in their ability to address challenges and chart and accomplish team goals.

How's it Going?

We are still very early in the transition process, but making very strong progress. When we first started, the team-based concept seemed new and unfamiliar to many of us. As we progressed, however, it became rapidly and increasingly clear that we had been preparing for this for a long time and that the team approach is a natural approach to engaging all of the group's resources. The Team already has top leadership support, a high level of people equity, and a quality culture—three criteria identified in research as critical for successful application of quality initiatives and for successfully managing resources and business processes (J.T. Kostman and W.A. Schlemann, "People Equity: The Hidden Driver of Quality," *Quality Progress*, May 2005).

The Certification group has the full support of top management at AISC in making the transition to a SDWT, reporting directly to AISC's president. It also already possesses a high degree of people equity. Bobbi Marstellar concentrated first on "who" then on "what," often citing management consultant Jim Collins, who advocates for "getting the right people on the bus." Objective hiring and firing decisions have been based on organizational goals, and careful attention to regular, meaningful employee reviews has yielded a capable and engaged workforce and aligned individual and organizational goals.

Certification group members have worked individually and as a group to identify and cultivate individual strengths through con-

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AISC ASSOCIATE MEMBER · STEEL DECK INSTITUTE sdi · ICC INTERNATIONAL CODE COUNCIL · FM APPROVED · UL · AMERICAN STEEL tinuing education and professional development opportunities. AISC has provided team members access to a self-assessment tool that helps them gain a better understanding of their natural behavior and how it affects their work style (Managing for Success, Renaissance Executive Forums, Target Training International, Ltd.). Complementary talents and skills naturally emerge, which leads to group-strengthening synergies and sharing responsibility for specific tasks.

As for quality culture, this comes naturally to the team through continuous immersion in the AISC Certification Program and through QMC's ISO 9001 registered quality management system. AISC and QMC staff meet regularly, either in person or online, to review and evaluate progress toward accomplishing organizational goals. Commitment to continual improvement, focus on customer feedback, goal setting, process definition, review of performance measures and non-conformances, internal auditing, and management reviews are simply the way we do business.

A quality culture has taught us to trust the process in order to achieve results. It draws attention beyond resources alone to the processes that connect the resources: inputs, outputs, methods, and communication. Process is where the action is, where the measurable results occur. We plan for, and then expect, the best possible outcome, recognizing that failure comes only in neglecting to apply what we learn when an objective is not fully achieved.

Expected Achievements

By adopting a team approach, AISC Certification expects to maximize effectiveness in serving clients and users of our Certification programs and to unlock the full potential of our people and the equity philosophy of the group. Our quality focus and the strong, dynamic connections we will develop as a SDWT will position us well for the future and for new challenges that are sure to come along.

We also expect to learn a great deal in this process and look forward to sharing our experiences as a SDWT with our colleagues in other AISC divisions and with individuals in the steel construction. You might also consider the SDWT concept for your own operation. Please feel free to inquire about our progress or share your thoughts by e-mailing certinfo@aisc.org or calling 312.670.7520. MSC

Brian Miller is AISC's director of certification.

CREATIVITY IN THE WORKPLACE

BY TIM TOKARCZYK, JAKE APPELMAN, AND VANESSA WINZENBURG

Encouraging creativity in the workplace can do great things for productivity, not to mention morale.

CREATIVITY PLAYS A VITAL ROLE IN ALL ASPECTS OF AN ORGANIZATION, YET ITS IMPORTANCE IS OFTEN MISUNDERSTOOD OR BRUSHED ASIDE AS INSIGNIFICANT. Creativity involves the ability to transcend traditional ideas or processes and create meaningful, novel ideas and applications. By better understanding creative thought and by increasing the creative ability of your workers, the workplace can be transformed into an environment of increased productivity and superior performance.

Thinking: Productive or Reproductive?

True creative thought comes from a shift in your basic mental paradigm. As you grow up, you face problems and develop solutions to those problems. When you face similar problems, you refer to your past solutions to shape your response. Humans are uniquely suited to learning from experience and rapidly responding in a conventional manner.

This type of thought is *reproductive*, meaning you look back on similar problems and generate a response. Reproductive thought is vital, because it saves the time otherwise required to mentally process the answer. The speed and familiarity with which we solve common problems often limits our ability to generate novel, creative ideas. For example, let's say a worker is assigned a problem to solve that he has faced many times throughout his career. Most likely, the worker will use reproductive thought, recalling how he solved the problem in the past, and follow the same steps to reach the solution. However, this limits the worker in his problem solving, since by relying on previously used methods, he eliminates the possibility of finding new, better ways to reach a solution. While the worker may reach the conclusion desired using reproductive thought, he may overlook a much more effective and efficient way to reach an even better solution. Furthermore, in a constantly changing business environment, the solutions used in the past will not necessarily work in the future.

One key to creative thought is shifting from reproductive thought to *productive* thought. Instead of referencing your mental library for examples of successful solutions, productive thought requires you to look at problems differently and develop an entirely new set of possibilities. When you convince yourself there is only one answer to a problem, you limit the potential of opening up new worlds. In many cases, creativity comes from exploring all the possibilities when a proven solution is already on the table.

In an increasingly competitive world, organizations need to consistently challenge themselves to reassess their current activities, looking for not only a solution to a problem, but the best solution. The best organizations—and the ones achieving the most success in the 21st century and beyond—will be the ones that are never satisfied with their current operations and are constantly pushing themselves to dig deeper, to think in new ways, and to relentlessly pursue improvement.

When we find an answer or solution, most of us stop searching. However, simply because we have one possible answer does not mean that we have found the only answer or solution, or even the best one. Being inquisitive after arriving at one possible solution will most likely lead to even better results. What would people in your organization do?

Reproductive thought is fine as long as your organization continues to face the same types of problems you have always faced. However, the modern challenge of a flattening world makes this more and more unlikely. The strategies and techniques you employed in the past will work less and less well. Countries and people from around the world share a connection in ways unlike any before in human history. While this has created great opportunities for people all across the globe, it has also made the world a much more competitive place. The flattening of the world has created vast opportunities, yet it challenges companies to innovate persistently and constantly assess past actions in order to facilitate constant improvement. The answer to this challenge is the flexibility and adaptability that comes from creativity.

Creativity Myths

Multiple myths about creativity work to discourage leaders from creating a truly creative environment in their workplace. These myths range from the type of people who can be creative to the role creativity should play in the workplace. Only by examining these myths and pursuing the truth about creativity can we gather a real understanding of the value creativity brings to organizations.

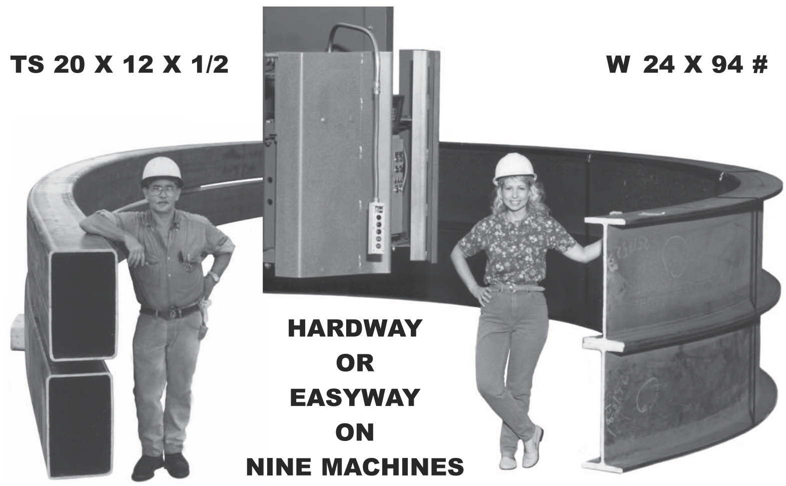
Myth 1: Creativity is for dreamers. An often-cited fallacy about creativity is that it is only for the unrealistic dreamers and artists among us. However, creativity as a strategic advantage plays out at all levels and across all job functions. The most successful companies are the ones that utilize the creative potential of all their workers, not just "the creative ones." Anyone can learn to be creative and contribute that creativity towards enhancing the bottom line. For example, *The Wall Street Journal* reported that following a two-year internal creativity course at General Electric, a 60% increase in patentable ideas occurred throughout the organization. At Sylvania, thousands of employees took a 40-hour course in using creativity to solve problems in the workplace. The return on investment for the creativity course was $20 for every $1 spent. Pittsburgh Plate Glass offered its employees a creativity training program, which resulted in a 300% increase in practical ideas among attendees compared with those who declined to enroll in the program. Each of these examples shows an organization that committed itself to improving workplace creativity, and witnessed fast, measurable results as a result.

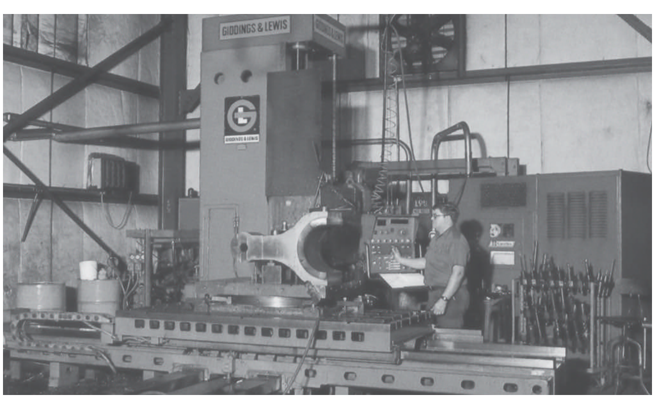
Myth 2: Creativity is for geniuses. You may also find it surprising to know that creativity is not linked to intelligence. The physicist Richard Feynman is widely regarded as the last great American mind, despite having a merely above-average IQ of 122. However, his ability to think differently led to paradigm-shifting work including expanding the theory of quantum electrodynamics, exploring the physics of the superfluidity of super-cooled liquid helium and developing particle theory. You can probably come up with examples from your own experiences of people who were brilliant but lacked a shred of creativity, and people with average intelligence who were bursting with creative ideas. Creativity is not tied to genius. Under the right circumstances, any employee is capable of generating true creative thought.

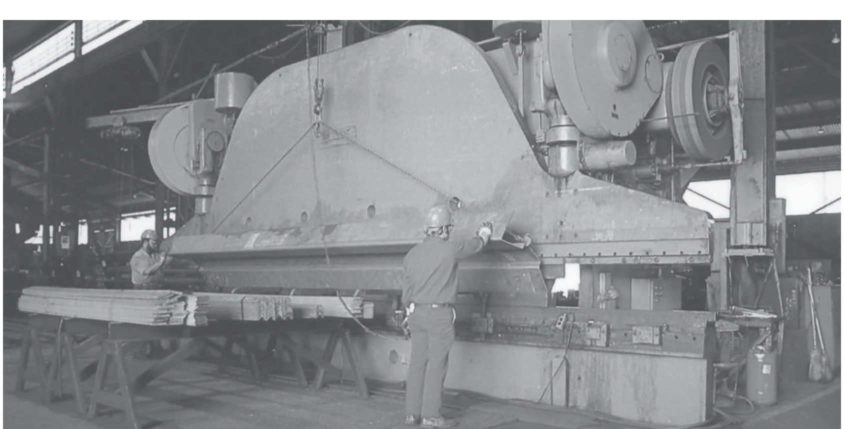
Myth 3: Creativity does NOT belong on the front lines. One of the most limiting approaches a leader can take is to assume that creativity belongs only in the executive suite or marketing department. Some of the most creative approaches come from front-line people who have the opportunity to problem-solve on a day-to-day basis. While they obviously have other tasks and need to complete their jobs on time, it is essential for field employees to play a role in developing creative solutions for the organization. These employees are the ones who put work in place for the organization.

Building a Creative Workforce to Enhance Productivity

One of the difficulties with enhancing creativity in organizations stems from involving field people as agents of creative change. To capitalize on this worker perspective, leaders must create an environment in which these workers are encouraged to develop creative ideas and solutions that will better the whole organization. Sadly, most American companies fail to capitalize on valuable innovations created by employees. In his book, *Corporate Creativity: How Innovation and Improvement Actually Happens*, author Alan Robinson reports, "American companies adopt about 38% of all creative ideas presented to them,







as compared to Japanese companies that adopt about 90%." By taking steps to ensure your workplace is conducive to creativity, your organization can benefit from the creative innovations your employees are capable of developing.

To improve creativity in the workplace, leaders need to focus on creating a more open and supportive environment. They can accomplish this by providing better support for their employees, recognizing them for good performance, and giving them positive feedback. Leaders also need to actively listen to their employees and act on their needs.

There are a number of structured systems and processes that managers can employ to ensure their organization is actively searching for and utilizing the creative ideas of the workforce. These include formal After Action Reviews (AARs), suggestion systems, individual meetings or lunches, and employee surveys. AARs are professional discussions that allow groups or teams to assess a project or major activity and determine specifically what outcome occurred and why. Through AARs, employees learn from both the successes and stumbling blocks encountered during a project or activity, and use that knowledge to broaden their perspectives. Instead of simply having a suggestion box, organizations should move toward suggestion systems, a formalized process for listening to employee thoughts and ideas and then aggressively acting on them.

When leaders react positively and openly toward new ideas, they help create an open and supportive environment in which employees not only feel free to express ideas, but also feel encouraged to do so. Employee surveys can be used to elicit suggestions and ideas from the workforce, while conveying the message that employee input is valued and expected. Similarly, all ideas should at least receive consideration, and those that potentially add the most value should be acted upon quickly.

Leaders can also take steps to encourage their employees to think differently. A popular tactic is to make one worker each month responsible for explaining an innovation in the industry, or a new business idea that they have read about and researched, to the team. By presenting an idea or innovation and then discussing how it could be integrated into their own organization, the employee will start thinking about their own work in new ways. The employee will also begin focusing on creative solutions to improve the way they perform. Leaders can also focus more on asking the right questions, rather than always supplying an answer. This will work to stimulate employees' creativity and allow them to think through complex issues.

Major Barriers to Creativity

Leaders face several challenges in developing a creative environment for their workers. Understanding the major barriers to this process can help leaders avoid stalling in their attempts to increase creativity in the workforce. Many organizations do not focus energy on increasing creativity because of a lack of time; a lack of understanding of the role that creativity plays; biases as to the types of people capable of truly creative thought; and a lack of a sense of urgency for innovation. These challenges can be overcome by addressing each and developing solutions that fit your individual organization.

Research shows that the quickest way to suppress workplace creativity is through managers who too closely monitor their workers. Employees need to feel that they have some degree of independence in their work. The resulting increase in the employees' sense of personal responsibility will create an environment where they feel free to come up with new, useful ideas to improve multiple aspects of the workplace. To foster a creative culture, employees must be motivated primarily by the work itself, not the organization's system of rewards. Meaningful, challenging work coupled with an environment in which employees are free to express their opinions, share ideas, and stimulate thought will bring forth the most creative ideas from the workforce.

Benefits of Developing a Creative Workforce

Injecting creative thought into organizations results in multiple benefits. These include increases in quality, productivity, and efficiency. Dr. Ellen Domb, president of the PQR Group and editor of the *TRIZ Journal*, conducted research on the relationship between creativity and quality, and concluded: "Creativity improvement enhances quality improvement. Quality analysis tells us what our customers want, what our processes need, and what our employees need, but creativity is needed to find ways to make these new products, services, systems, and processes happen." Creativity allows organizations to work more intelligently.

Finally, employees who are allowed to tap into their creative sides are generally more highly engaged in their positions and experience higher morale. This causes these employees to have a higher sense of commitment to their jobs and their companies, which results in higher productivity by minimizing the amount of turnover. In addition to a more productive workforce, increasing employee creativity may result in performance or process improvements that allow you to better serve your customers and gain competitive advantage. MSC

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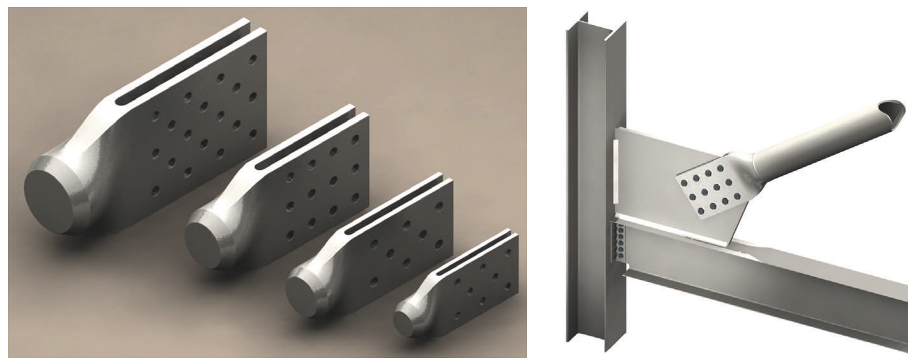
CONVENIENT CONNECTIONS

Cast connections provide an efficient and attractive connection alternative for exposed hollow sections.

BY CARLOS DE OLIVEIRA AND TABITHA S. STINE, P.E., LEED AP



Cast ConneX high-strength connectors for seismically loaded HSS bracing connections (left). A connected brace in frame (right).

IF YOU'VE BEEN TO EUROPE LATELY — or within the last few decades—chances are you've seen structural steel castings in action. Since their landmark applications in structures like the cable-net roof for the Olympic Stadium in Munich and the truss nodes in the Centre Georges Pompidou in Paris, steel castings are seeing increased use in structural applications not only in Europe, but all over the world as well.

Steel castings are especially common in European bridge applications, where cast steel nodes significantly improve the fatigue life of otherwise highly complex welded joints. Conversely, castings in building applications have been predominantly used for statically loaded exposed structural steel connections, particularly in structures using hollow structural sections (HSS). Generally speaking, custom-designed steel castings are particularly well suited for any application requiring intricate geometry and a little extra finesse.

With steel castings gaining in popularity, recent research at the University of Toronto focused on exploiting the most significant advantage that casting manufacturing provides over standard fabrication: mass production. The result was the development of innovative cast steel connectors for two common yet complex steel fabrication issues for HSS: seismic bracing connections and true-pin connections suitable for architectural exposure.

Special Concentrically Braced Frames

Concentrically braced frames are among the most popular lateral force resisting systems for medium- to low-rise steel structures. In the event of an earthquake, the diagonal brace members of braced frames dissipate seismic energy through yielding in tension and inelastic buckling in compression. This cyclic yielding and buckling imparts significant loading on the brace's connections. Consequently, North American design codes require seismic bracing connections to be detailed such that they are significantly stronger than the nominal cross-sectional capacity of the brace member.

The degree to which the connection strength must surpass the nominal cross-sectional yield capacity of the brace is dependent on the expected overstrength of the brace. Detailing connections to provide this level of strength can be rather difficult, particularly when dealing with HSS, which are the preferred bracing elements due to their efficiency in carrying compressive loads, their improved aesthetic appearance, and the wide range of sections sizes that are readily available in North America.

End connections for hollow section brace members are typically achieved through a gusset connection between the brace end and the beam-column intersection. However, conventional slotted HSS-to-gusset connections have been shown, both in the laboratory and in the field as witnessed during post-earthquake reconnaissance, to be prone to failure when subjected to cyclic inelastic loading. Thus, current seismic design provisions recommend the use of net-section reinforcement whenever slotted HSS-to-gusset connections are specified in seismic-resistant frames.

However, designing, detailing, and fabricating reinforced slotted connections to HSS can be both challenging and costly. Recognizing the need for a simple solution to the seismic brace connection dilemma, a research team at the University of Toronto, headed by Professors Jeffrey Packer and Constantin Christopoulos, developed standardized cast steel seismic-resistant HSS connectors shaped to eliminate the need for connection reinforcement. The geometric freedom that casting manufacturing provides allowed for the design of a connector that accommodates bolted connection to a gusset plate on one end and complete joint penetration (CJP) welded connection to a round HSS brace member on the other.

Thus, in practice, the cast connectors can be welded to round HSS braces in the shop using a turning roll, with the brace-connector assembly being bolted to the

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Editor's Note: Cast ConneX 's Universal Pin Connectors for HSS were launched at the North American Steel Construction Conference in April in Nashville. More information on structural steel castings can be found at the Steel Founders' Society of America website, **www.sfsa.org.** For more information on Cast ConneX, visit **www.castconnex.com.**

A brace assembly being tested.

gussets in the field. Further, each connector is standardized to accommodate all round HSS of a given outer diameter, regardless of wall thickness or grade of steel. The specification of a pre-qualified CJP shop weld between the connector and the round HSS eliminates the need for field welding of the demand-critical welds between the gusset plate and the brace member.

Standardized HSS Connectors for Architectural Use

An emerging trend in steel construction is the use of exposed structural steel and connections. Because of its aesthetic appeal, HSS are commonly used in exposed applications, and true-pin connections to round HSS are commonplace in airports, stadiums, and atriums. However, it's no secret that the fabrication complexity of true-pin HSS connections increases significantly as the required aesthetic increases.

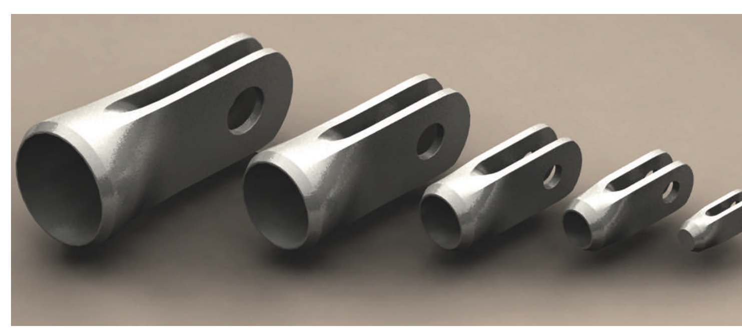
When extraordinary aesthetics aren't required, a pin connection detail can be accommodated with a single gusset plate inserted into a slot created in a round HSS member. As discussed above, this slotted HSS-to-gusset detail is a typical end connection for wind loaded HSS braces and does not present any significant fabrication challenge. The complexity of the pin connection arises in the clevis-type connection at the base of the pin that receives the single plate fixed to the HSS member. Here, two plates are necessary, since pin connections must maintain a concentric load path. Due to the relatively small gap between the two plates, both cannot be fillet welded to the base plate; one of the two plates must be fastened to the base with a groove weld. Further, the parallel alignment and match up of the pin holes in the two plates is critical, as the 2005 AISC *Specification for Structural Steel Buildings* requires that the pin hole be only 1⁄32-in. larger in diameter than the pin itself. With almost no tolerance allowed in the pin hole, any out-of-straightness or misalignment of the plates may lead to significant field erection challenges. The fabrication difficulties increase with other more aesthetically pleasing pin-type end connections for round HSS.

Mass Quantities

It is well known that castings become economically viable with repetition or as the fabricated alternative increases in complexity. Given the complexity of aesthetic fabricated pin connections, as well as the opportunity for mass production, it is clear that a series of standardized cast steel pin connectors for HSS could be practical. In addition, casting manufacturing allows for a streamlined and curving connection geometry that is otherwise unattainable using standard fabrication practices.

Cast ConneX has now developed a line of standardized pin connectors that are meant for use as architecturally exposed structural connections. The company's "Universal Pin Connectors" provide attractive, smooth, compact, and robust connections that can be easily integrated into a structure and can save steel fabricators and designers hours of complex engineering, detailing, and fabricating. And with the "off-the-shelf" approach, schedules can easily be accommodated in a fast-track job. MSC

Carlos de Oliveira is CEO of Cast ConneX Corp. Tabitha S. Stine is AISC's director of technical marketing.



Cast ConneX Universal Pin Connectors.

References

AIJ (1995), Reconnaissance Report on Damage to Steel Building Structures Observed from the 1995 Hyogoken-Nanbu (Hanshin/Awaji) Earthquake, Architectural Institute of Japan, Steel Committee of Kinki Branch, Tokyo, Japan.

AISC (2005), *Specification for Structural Steel Buildings*, ANSI/AISC 360-05, Chicago, Illinois.

AISC (2005), *Seismic Provisions for Structural Steel Buildings*, ANSI/AISC 341-05, ANSI/AISC 341s1-05, Chicago, Illinois.

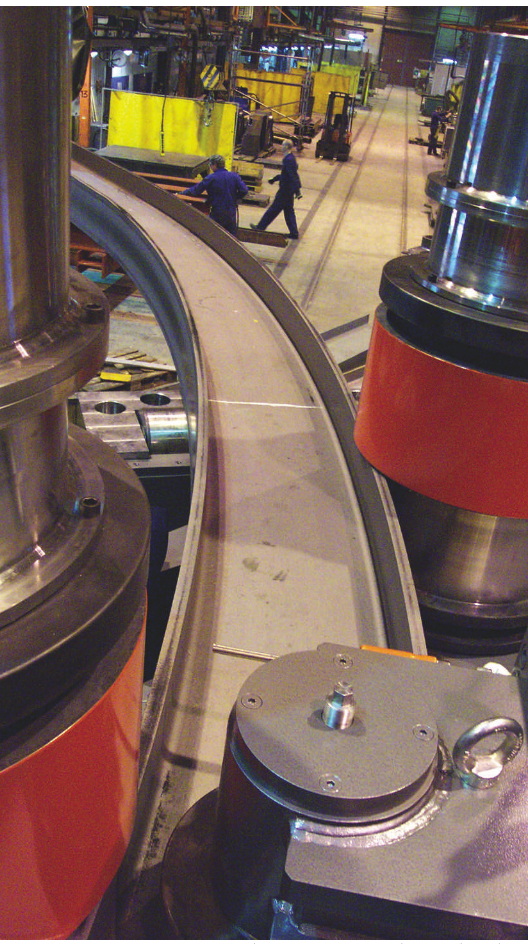
Bonneville, D. and Bartoletti, S. (1996), Case Study 2.3: Concentric Braced Frame, Lankershim Boulevard, North Hollywood, 1994 Northridge Earthquake; Building Case Studies Project; Proposition 122: Product 3.2, SSC 94-06, Seismic Safety Commission State of California, pp. 305–324.

de Oliveira, J.-C., Packer, J. A., and Christopoulos, C. (2008), "Cast Steel Connectors for Circular Hollow Section Braces Under Inelastic Cyclic Loading." ASCE *Journal of Structural Engineering*, 134(3), 374–383.

Johnston, B.G. (1939), Pin-Connected Plate Links, Transactions, American Society of Civil Engineers, pp. 314–339.

Lee, K. and Bruneau, M. (2005), "Energy Dissipation of Compression Members in Concentrically Braced Frames: Review of Experimental Data," ASCE *Journal of Structural Engineering*, 131(4), 552–559.

Bender-rollers are very secretive when it comes to their processes, but they're very open about the benefits of bending steel.



Photos: Courtesy Kottler Metal Products

A Conversation with a Bender

WHAT DO BENDERS WANT YOU TO KNOW ABOUT BENDING? Brian Smith, CFO and general manager of Albina Pipe Bending Co., Inc. and vice-chair of the AISC Bender-Roller Committee, offered his insight to MSC on the benefits of bending-rolling structural steel, why there isn't more bent steel out there, and what benders—and engineers, architects, owners, and general contractors—can do about it.

What can a bender offer a project (besides curvy steel)?

Construction projects often take time in planning and securing a contractor and then the subcontractors. By the time steel fabricators (a subcontractor to the general contractor) issue a purchase order to a bending company, it is quite often very late in the process, and the materials are required quickly. Luckily, this is a situation where a bender can be most beneficial.

Typically, steel is readily available at local service centers and can be sent to a bender within a day of ordering it. If necessary, an AISC bender has the ability to set up a machine and bend steel the day material is received—to a high level of quality and to spec. While this isn't the cheapest option, it can come in handy when time is crucial. Many benders have the equipment, tooling, and abilities to bend whatever is required in very fast time frames. Because we are typically toward the bottom of the "supply food chain", we are used to working and performing under considerable amounts of pressure. And in many cases the time it takes to provide the bent materials on a project is miniscule when compared to the duration of the entire project.

An example: We were contacted by a customer in California who forgot to order some spiraled material for a new jazz club. The club had a published opening date and a planned party, neither of which could be negotiated. The fabricator needed some tubing spiraled immediately or they would be faced with significant liquidated damages. We got material the next day from a local service center, spiraled it immediately, and had the bent material for the spiral staircase on-site in time for the fabricator to fabricate and install—prior to the opening.

Benders, if included early in a project, can help provide assistance on what is and isn't feasible concerning a design and can help save time and money as a project moves forward.

In all cases, a qualified bending company is going to know what processes are required, what tooling is required, and what material thickness/size is required to meet an A/E's design and quality requirements. But again, benders are typically not contacted early in a process, and projects (at times) are designed where no one can bend the material to the quality standards that are required.

Consulting a qualified bender early in the design process will allow them to identify potential problems prior to the finalization of a design and provide some potential alternatives when necessary. For example, an architect may want to design a bent section out of HSS 7" × 3" × 0.25" wall material, which, if it can even be found, would be very expensive. The qualified bender could recommend alternatives such as HSS 8" × 4" × 0.25" wall or HSS 8" × 2" × 0.25" wall, which is more readily available, will bend easier, and will cost less.

Length can also be an issue. At times, designs are finalized using uncommon lengths or require arc lengths that are not possible from assumed lengths. For example, a building may require HSS 12" × 12" × 0.375" wall to be bent, and the design requires 21 ft of arc (bent material). The architect assumes that a 24-ft length (which is available) will be required. If a qualified bender is consulted, the bender can explain the bend process and the requirement for tangent/straight material on either side of the arc section—and in this case, the bender will point out that a 24-ft length would only result in 17 ft to 20 ft of arc (depending on the bend process employed). To generate a 21-ft arc, 28-ft to 32-ft lengths would be required. By contacting a bender early, not only would the A/E be aware of this requirement, but also the material size or arc section could be altered to save in wasted "drop" material.

What are your thoughts on "fake" bending?

Rolling a length of material into a circle, utilizing a consistent radius and a consistent smooth finish, is really not (in many cases) an extremely time-consuming process. However, if you were to take many smaller, miter-cut pieces and put them all together with welding, it will be much more time-consuming and in turn, much more expensive. Furthermore, it will be very difficult to achieve the quality and consistency the bending process could have offered; the finish will not be consistently smooth and there won't be a consistent radius over the entire arc. Besides that, it's a waste of resources (welding wire, welding gas, power, etc.). Unfortunately, while this seems like a basic concept to benders, it isn't always so obvious to others.

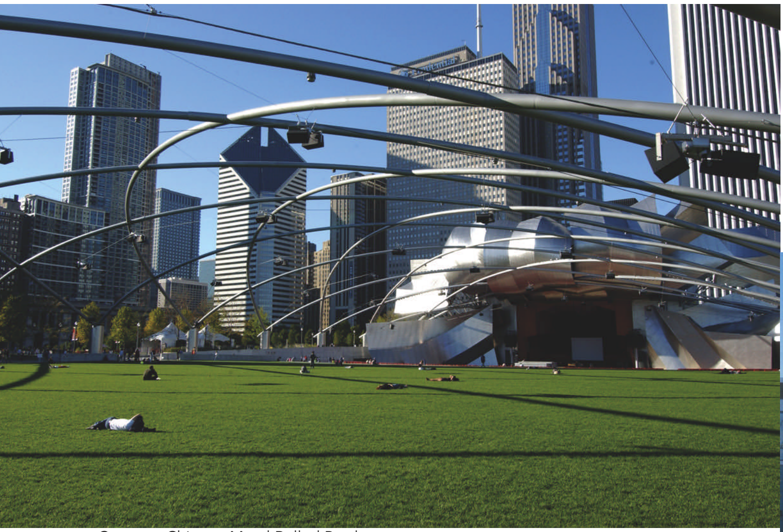
Bending material with the proper process (many processes are available), proper tooling, and proper expertise will result in a product that is smooth throughout the entire bent section of material and has a consistent radius over the entire arc. Furthermore, bending a length of material will use less resources and can be produced in a quicker time frame.

What will it take to get more A/E's to request bent steel in a project?

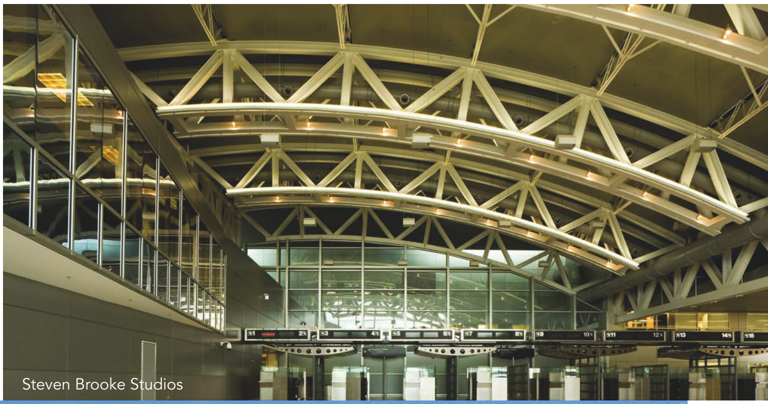
I would hope that early involvement would help change old opinions and misconceptions about bending. If a bender is consulted early in the design process, it will allow them to provide pros and cons associated with the bent material in that particular design. By educating A/Es on the availability of benders, I would hope they would start to use our knowledge to help with the design.

We rarely deal with A/Es directly—which I hope will change. Our main customers are steel fabricators, who are hired by the GCs, and the GC is the direct contact with the A/E. Benders are often twice removed from the A/Es and have little to no contact with them. By the time a bender is given drawings, the design is typically finalized. If the bender has issues with a particular design, it is almost too late at that point to assist.

The more A/Es know about bending, the better it will be for our industry. In most cases, professionals do not know that many different bending techniques exist, each one resulting in a different level of quality and consistency. Furthermore, within a process different types of tooling can be used, again, resulting in different levels of quality and consistency. By educating A/Es about the bending process, it will help them ask the proper questions early in the process. It can help identify quality requirements on a project and confirm whether those requirements are achievable. Hopefully, understanding the bending process



Courtesy Chicago Metal Rolled Products



Steven Brooke Studios

Courtesy Wagner Murray Architects

and understanding that their are many qualified AISC Member benders readily available to talk to will help A/Es feel more comfortable designing with bent material.

The other key element is to share the above information with GCs. Some GCs are not comfortable taking on steel jobs, especially those that include bending; they are more comfortable working with concrete or other materials. If A/Es continue to work with GCs that are not willing to pursue projects that include bent steel, we will continue to have a problem. Communication with GCs and A/Es will result in knowledge of the bending industry, which should equal more projects being designed and built out of steel (and in particular, bent steel).

So are benders making an effort to get "closer" to the owners, and therefore, the decision-making process on projects?

Our firm tries to get our name in front of anyone who will listen, and educate them on what we do. Obviously, our major focus is the steel fabrication market, but we do not limit our marketing efforts to just fabricators. There is a massive group of individuals to market to and educate, and there needs to be a collective effort of everyone in the steel industry. Steel needs to become a more common concept to owners, and the strengths of steel need to become common knowledge.

The fact is that many potential "owners" have no idea that that steel is bent by a bending company. We hear: "You mean it just doesn't come that way?" and "Wow, there is a lot of bent steel around, but I never noticed it before you mentioned what you do." The best way to get owners to ask for a project to be erected from steel, and to include bent steel, is to help open their eyes to the readily available options that steel can provide.

But if an A/E or GC is not willing to design with bent steel, unless an owner is adamant about it the design will shift to other alternatives. In our opinion, the other options are typically not the best options, but are comfortable. Benders need to make everyone involved with the process feel comfortable with the bending option! MSC

*If you have any questions on bending-rolling or are looking to use curved steel in a project, visit **www.aisc.org/benders** or contact the AISC Steel Solutions Center at 866.ASK.AISC.*

Each month MSC's product section features items from all areas of the steel construction industry. In general, these products have been introduced within the past six months. If you're looking for a specific product, visit MSC's online product directory at **www.modernsteel.com/products**. You can browse by product category or search on any term to help find the products you need, fast.

At the Touch of a Button

The Jobber 6 construction calendar features a numerical keyboard that goes up to 15. It automatically solves: right triangles; circles and segments of a circle; degrees, minutes, and seconds; hip/valley (pitch and degree); hip/valley beam length; cubic and square yards; board feet; rake (walls or grades, both up and down); circle arches (segmented rise dims); area of circles and triangles; and jack rafters. It also provides instant conversion of all types of measurement with the touch of a button. New features include six permanent, regular, or accumulative memories; retaining triangle data when turned off; review of the last 16 entries; and FIS (feet, inches, sixteenths) dimensions can be set to stay as 16th fractions or convert to the lowest denominator fractions.

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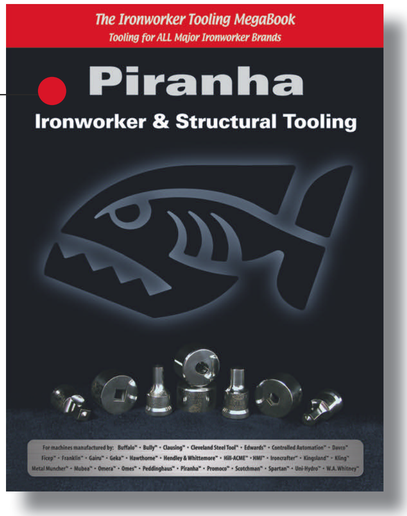
A One-Two Piranha Punch



Piranha has released its *Ironworker Tooling MegaBook* in conjunction with a new web site: www.ironworkertooling.com. The book serves as an essential guide when purchasing tooling for more than 30 major ironworker brands. Charts, graphs, and a comprehensive section of engineering data help fabricators determine the best tool for a specific application. Dimensional drawings and photos are plentiful throughout and allow you to quickly and easily select tooling options. All information needed to order punches and dies for standard shapes, special shapes, marking, and forming tools is included. The new web site replicates the *Tooling MegaBook* and easily navigates the user through tooling charts and application information, along with an on-line ordering procedure. Both the web site and book feature information on Piranha special tooling and how it can expand metal fabricating capabilities.

For more information, visit www.piranhatooling.com or call 815.964.6771.

All products submitted are considered for publication, and we encourage submittals related to all segments of the steel industry: engineering, detailing, fabrication, and erection. Submit product information via e-mail to Geoff Weisenberger (weisenberger@modernsteel.com). To be included in MSC's online products directory, contact Louis Gurthet (gurthet@modernsteel.com).

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- Tekla Division Lead Trainer

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AMERICAN IRONWORKS MFG., INC.

American Ironworks Mfg., Inc. is a structural and miscellaneous steel fabrication and erection company based in the City of Los Angeles, CA. It provides competitive salary package, paid annual vacation leave, health benefits, 401K profit-sharing plan to its employees. Currently, we are seeking high-caliber candidates for the following positions:

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FABRICATION MANAGERS. Minimum 5 years experience in Structural Steel and miscellaneous metal fabrication. Manage shop of 20-25 employees. Must be a hands-on professional, able to work under pressure and with outstanding track record in meeting schedules and deadlines.

ESTIMATORS. Minimum 5 years structural or miscellaneous steel estimating experience. Possesses excellent computer skills, able to work under pressure, good in meeting schedules and deadlines.

DETAILERS. Minimum 3 years structural or miscellaneous steel detailing experience. Possesses excellent computer skills and preferably proficient in AutoCAD operation. Should be able to work under pressure and meet deadlines.

QUALITY CONTROL. Minimum 5 years quality control experience in fabrication and erection of structural steel and miscellaneous items. Detailed, analytical, computer literate and good in reporting and in meeting schedules and deadlines.

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The ideal sales manager will have experience in the steel fabrication/detailing industry, with several years working with in-house or outside detailers; reading contract drawings; preparing detailing estimates; and successfully selling. He/She must have the capability to travel extensively to meet with senior management at the customer's offices and conduct meetings in a professional manner.

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FULL POTENTIAL

BY MARK D. WEBSTER, SECB, LEED AP

The steel industry has plenty of opportunities to be the most it can be from a sustainability standpoint.

AS THE TREND TOWARDS SUSTAINABILITY AND EVER-GREENER BUILDINGS CONTINUES TO GAIN STEAM BOTH HERE AND ABROAD, it looks like a good time for the steel industry to consider how it can do more to address this issue. With global temperatures and energy prices on the rise, there is little doubt that the push towards a less ecologically destructive economy will do anything but accelerate. I offer here a few ideas for how the steel industry can actively engage this process.

Love it or hate it, LEED is the de facto green building standard in the U.S. today. So working to make changes in LEED that reward innovative approaches to reducing buildings' environmental impact, and at the same time help the steel industry advance its green credentials, would appear to be a sure-fire way to positively impact both the environment and the industry.

What sorts of changes? Two effective green building strategies that are not currently recognized in LEED's Materials and Resources category are material efficiency and design for deconstruction.

A credit for material efficiency would reward designs that make the most with the least. One way to measure achievement might be to compare a project's per-square-foot weight of structural steel, concrete, or other structural system to industry averages. If the structural engineer can figure out how to support the required loads with, say, 25% less material, that achievement should be recognized. And it need not be limited to the structural system. Eliminating finishes and exposing the structure can further reduce material consumption and allow building users to appreciate the exemplary work of the structural engineer and the builder.

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One source of tension, of course, is economy of materials vs. economy of dollars. We've all seen the articles in this magazine giving tips on "economical" steel design. For instance, one tip is that it is better to increase the column size than to add continuity plates at the beam-to-column connections. But this design strategy comes at a cost—not to the pocketbook, but to the environment, since it increases the overall structural steel weight, sometimes significantly. Extra labor that reduces weight may add expense but reduce ecological cost. Perhaps incentives in LEED and other green building rating systems for material efficiency could start to turn this logic around, or at the very least bring into focus, for the designer, the occasional trade-offs between designing for the environment and designing for the pocketbook.

Designing for deconstruction (DFD) is a green building strategy where steel structures could really shine. The goal of DFD is to construct a building that can be easily disassembled at the end of its life, permitting reuse of its materials. Steel, with its standard shapes and its potential to use bolted connections, is well suited for DFD. At end of life, steel shapes could be unbolted like pieces of an Erector Set—catalogued and stored to find life again in a new project, without ever having to return to the mill.

In addition to tackling LEED, there's another initiative the steel industry could take. Let's face it: Climate change is the defining environmental challenge of our generation, and all industries need to step up with effective plans to reduce their carbon emissions. The U.S. steel industry should look to its counterpart in the United Kingdom for inspiration. In the U.K., industry-wide average emissions per unit of steel production are being determined. Further, steel fabricators are calculating the life-cycle carbon efficiency of their own product, and work is underway to make these findings available to others. If this plan reaches fruition, a specifier could require that the steel used on a project be sourced from a lower-carbon producer. Nothing like a little competition to effect a change in practice! In the international market, the U.S. structural steel industry should be well positioned for this type of competition, with its reliance on relatively efficient electric arc furnaces and scrap steel for production.

So there you have it: several suggestions for ways the steel industry could step up its green building leadership. The steel and other building material industries need to be active drivers of effective change in building practice, and not allow themselves to merely be reactive players while others develop standards and policies based on incomplete understanding of each industry's environmental potential. Steel has a lot to offer in green building design, and I'd like to see its potential fully realized. MSC

Have an opinion you'd like to share in "Topping Out"? Send your feedback to Geoff Weisenberger, senior editor, at weisenberger@modernsteel.com.

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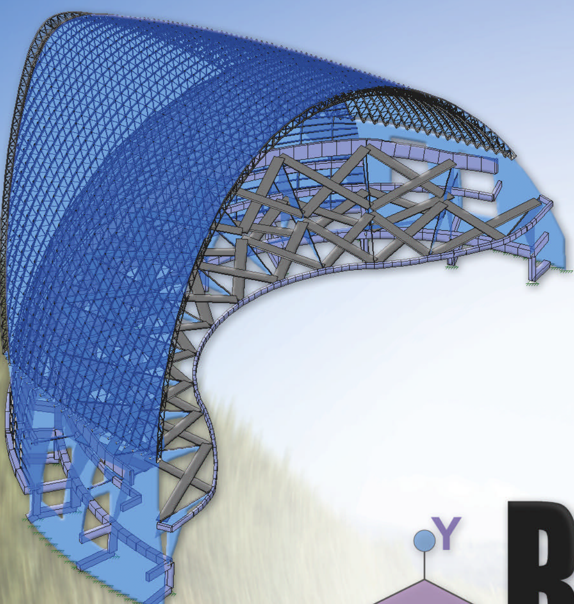

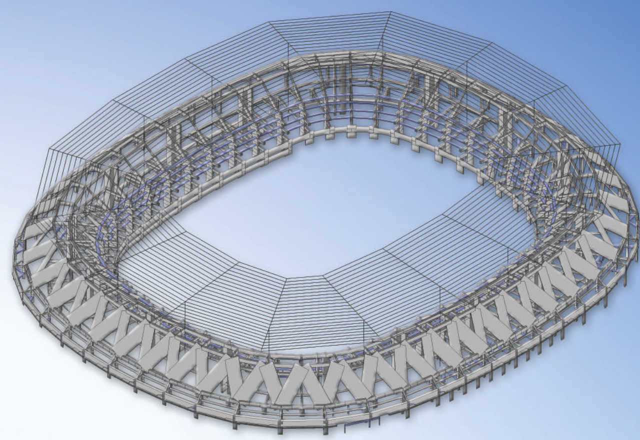

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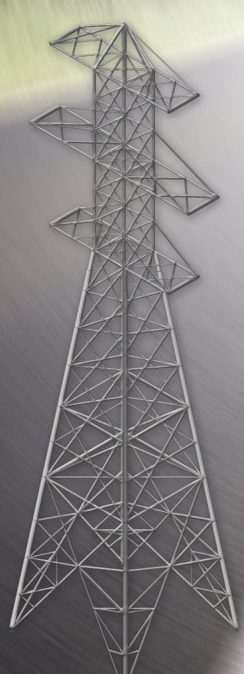

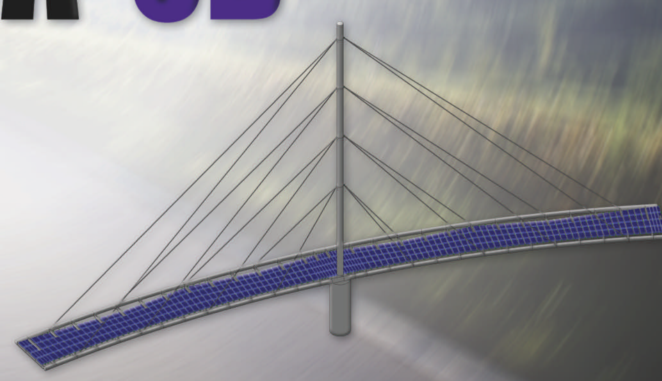

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