MSC

MODERN **STEEL** CONSTRUCTION

October 2009

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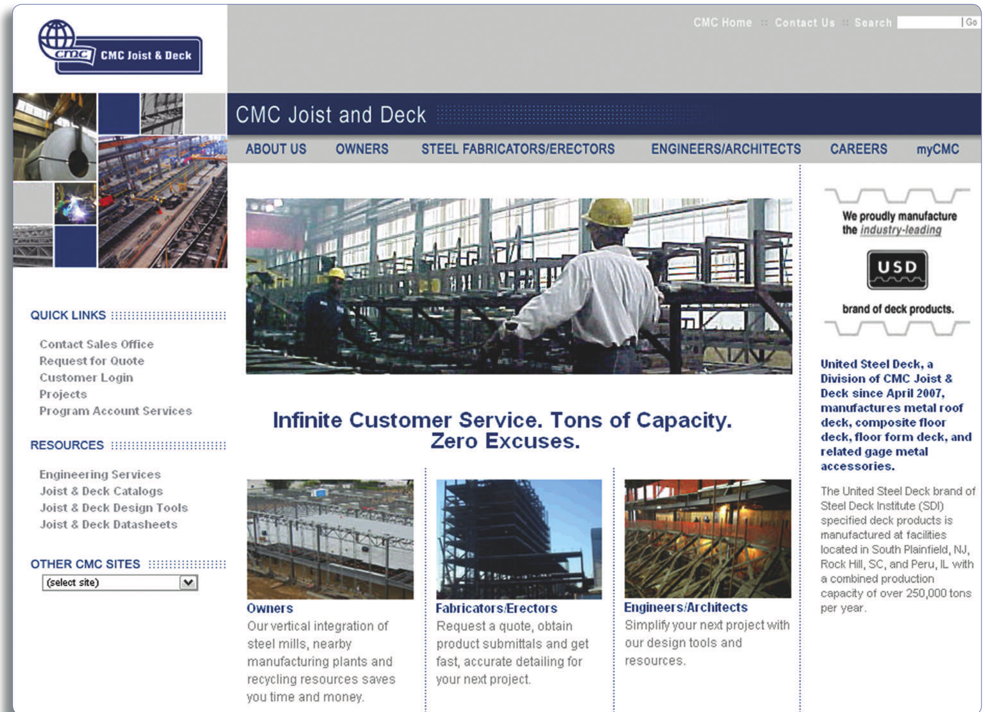
IN THIS ISSUE

NEW FALL 2009



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October 2009

MSC
MODERN STEEL CONSTRUCTION

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ON THE COVER: Crews attach the first of three candelabra arms on a new transmission tower in Miami. Photo: Stainless LLC.

MODERN STEEL CONSTRUCTION (Volume 49, Number 10. ISSN (print) 0026-8445: ISSN (online) 1945-0737. Published monthly by the American Institute of Steel Construction (AISC), One E. Wacker Dr., Suite 700, Chicago, IL 60601. Subscriptions: Within the U.S.—single issues $6.00; 1 year, $44; 3 years $120. Outside the U.S.—single issues $9.00; 1 year $88; 3 years $216. Periodicals postage paid at Chicago, IL and at additional mailing offices. Postmaster: Please send address changes to MODERN STEEL CONSTRUCTION, One East Wacker Dr., Suite 700, Chicago, IL 60601.

editor's note

MY KIDS HAVE A NEAT TRICK WHEN THEY WANT SOMETHING AND THEIR MOM SAYS NO: THEY COME AND ASK ME, HOPING I'LL GIVE A DIFFERENT ANSWER (AND IF YOU'RE A PARENT, I KNOW YOU'VE EXPERIENCED THE SAME PHENOMENON).

While this type of behavior is more-or-less expected in children, I'm more surprised when professional organizations try to pull the same end-run. But that seems to be the exact tack the Portland Cement Association has chosen to try. In this case, they're trying to increase the use of concrete construction by mucking with building codes and design loads. According to an article in the September 2 issue of *Engineering News Record*, "Concern is growing over a recently released 'sample' ordinance for high-performance buildings from the Portland Cement Association."

This sample ordinance is apparently designed to amend the *International Building Code* and "was developed outside the standard consensus process and is biased toward concrete." The article notes that many national standard-setting organizations are concerned about this effort; for example the American Institute of Architects does not support "wholesale changes to scope and requirements of the IBC outside of the established consensus process." Likewise, the Building Owners and Managers Association (BOMA) stated they do not support PCA's document and also called it "biased."

According to ENR's analysis, the PCA document would increase design wind pressure and design force by 20% for most buildings. Further, flood resistance is increased to at least 3 ft above flood elevation and no consideration is given for dams, levees, and other flood protection. In a slap at the wood industry, the document requires non-combustible framing for all multifamily housing.

And in a display of unparalleled chutzpah, Stephen Szoke, PCA's director of codes and standards, stated to ENR: "We did not try to promote specific materials." I guess he never looked at his own website, which states: "Since its founding in 1916, the Portland Cement Association has had the same mission: 'Improve and expand the uses of Portland cement and concrete.'"

As AISC Vice President and Chief Structural Engineer Charles J. Carter, S.E., P.E., Ph.D., states: "This looks like part of PCA's continued effort to spin a cement industry wish list that represents many failed code change proposals. AISC fully supports the use of consensus procedures for the development of codes and specifications. In fact, all of AISC's specifications are developed through an ANSI-accredited consensus process."

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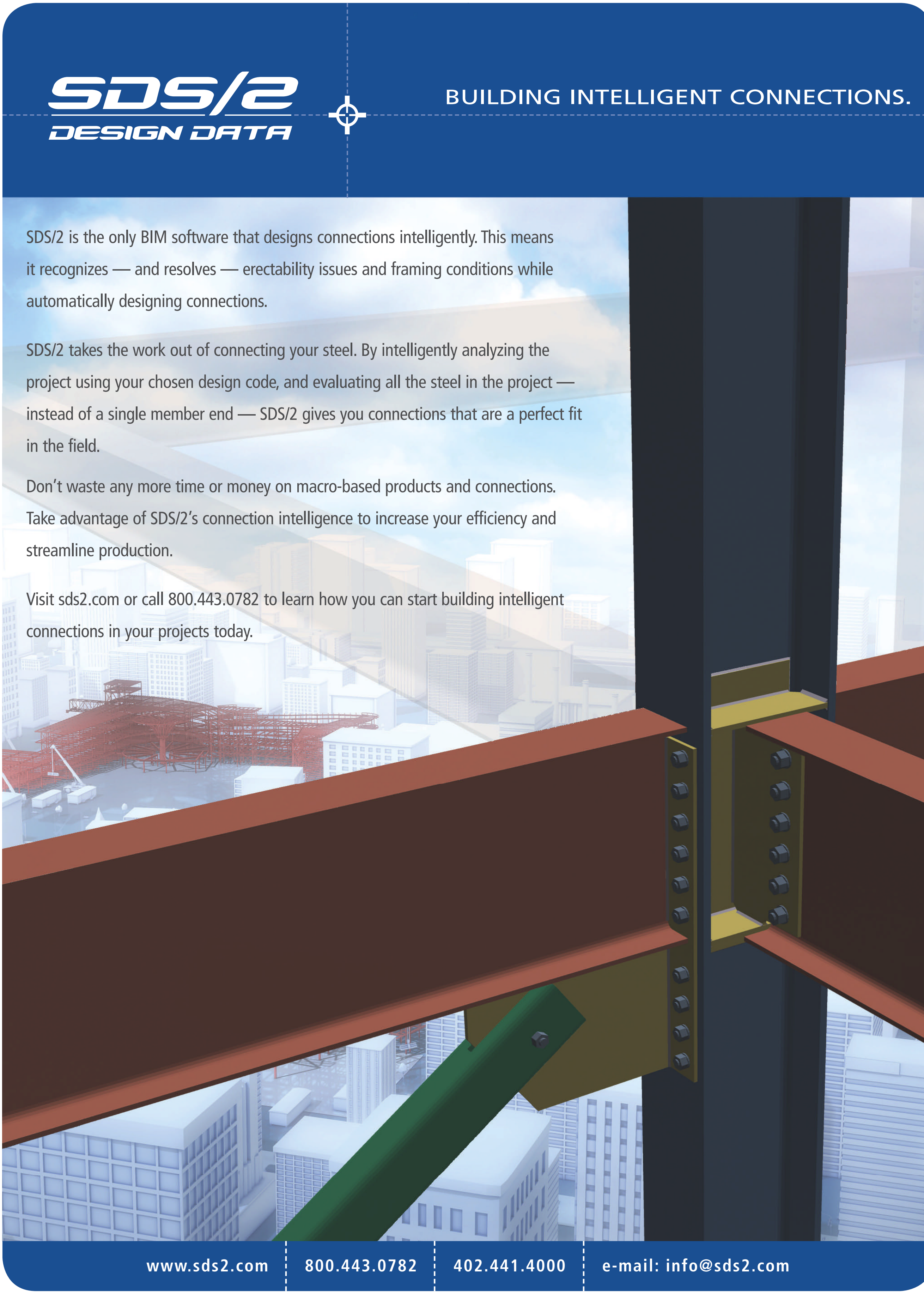
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IF YOU'VE EVER ASKED YOURSELF "WHY?" about something related to structural steel design or construction, *Modern Steel Construction*'s monthly Steel Interchange column is for you! Send your questions or comments to solutions@aisc.org.

SCBF X-Brace

Is a one-story X-braced frame permitted for a Special Concentrically Braced Frame?

X-braced frames are permitted for use in SCBF systems; however, each brace must be able to accommodate both the tensile and compressive modes. Tension-only bracing systems are not permitted in SCBF systems. See Section C13.1 in the AISC *Seismic Provisions Commentary* (page 177) for discussion.

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

Fillers

In Section J5 of the AISC *Specification*, one of the alternatives is that "The fillers shall be secured with enough bolts to uniformly distribute the total force in the connected element over the combined cross section of the connected element and the fillers." What does this mean? What are the design criteria to compute the number of bearing bolts in the filler plate outside of the primary connection?

The intent of this requirement is to try to eliminate uneven stress distribution due to bolt bending as the filler is developed in the joint. Obtaining the uniform distribution on the bolt is usually accomplished based on a consideration of the relative thicknesses of the elements involved. The number of bolts required can be calculated as

$$n = \frac{P\left(1 + \frac{t_f}{t_f + t_p}\right)}{\phi R_n}$$

Where P is the required strength (load), t_f is the thickness of the filler, t_p is the thickness of the plate, flange, or element being connected, and ϕr_n is the design strength of the bolt. The term in parentheses represents the increase in the number of bolts due to the presence of the fills.

Larry S. Muir, P.E.

Evaluation of Existing Structures

Is it permissible to use the ASD provisions of the 2005 AISC *Specification* to analyze an existing structure designed using the *Specification* of the 8th edition era? We're currently involved in the renovation of a structure designed and built in 1987/1988, and will need to slightly increase the load on several floor beams. Using the 8th edition steel manual several beams will be overstressed, from 8% to 13%. If the ASD provisions of the 13th edition are used, then these same beams are not overstressed.

Yes, you can use the current *Specification* to evaluate existing structures. You can use either the ASD or LRFD load approach to evaluate a structure originally designed using an older ASD *Specification*, as long as you use it consistently on both the load and resistance side of the design equation. Also, you can find provisions that may be helpful specifically when you are doing evaluation and/or repair in Appendix 5—*Evaluation of Existing Structures*—in the 2005 AISC *Specification*.

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

Bolt Hole Sizes

If a fabricator has detailed ⅞-in. diameter holes for ¾-in. diameter bolts can this still be considered a bearing-type connection? The loads are small—less than 10 kips per connection. It is for a pipe rack. Also, can you use slip-critical connections with galvanized steel?

Section J3.2 of the AISC *Specification* states, "Oversized holes are permitted in any or all plies of slip-critical connections, but they shall not be used in bearing-type connections." and "Short-slotted holes are permitted in any or all plies of slip-critical or bearing-type connections. The slots are permitted without regard to direction of loading in slip critical connections, but the length shall be normal to the direction of the load in bearing-type connections."

The first statement prohibits the use of oversized holes in bearing connections. The intention of both statements is to prohibit bearing-type load transfer in a direction where the hole clearance is greater than 1/16 in. From this the ⅞-in. holes would not be permitted in a bearing connection.

Galvanized material is allowed within the faying surface of slip-critical connections. Section J3.8 includes "hot-dipped galvanized and roughened surfaces" as a Class A surface. Section 3.2.2.(c) of the RCSC *Specification* (The Bolt Spec.) states, "Galvanized Faying Surfaces: Galvanized faying surfaces shall first be hot-dip galvanized in accordance with the requirements of ASTM A123 and subsequently roughened by means of hand wire brushing. Power wire brushing is not permitted."

This is an extra step required in the field or possibly at the galvanizers. For one connection or one beam this should not be a problem, but for an entire project this could represent a significant cost and schedule impact. There would probably also need to be additional people in the field to ensure compliance, at least for a while when the requirement was first introduced. I usually recommend avoiding slip-critical connections on galvanized material whenever possible.

Larry S. Muir, P.E.

Class A and Class B Coatings

How are Class A and B coatings qualified for slip-critical connections?

Coatings are qualified using the procedures contained in Appendix A of the 2004 RCSC *Specification*. This document is a free downloaded at **www.boltcouncil.org**. In my experience most coatings available on the market and qualified, are qualified for use as Class B. Since blast cleaning is required before coating, this is probably because the lower slip resistance of Class A would tend to make it less economical.

Larry S. Muir, P.E.

steel interchange

Second-Order Analysis

I attended a seminar on second-order analysis, where I heard that the loads must be multiplied by the alpha value of 1.6 when using ASD for the member design. Do the analysis results get divided by the same value of 1.6 for member design, or are they calculated? I have been using the analysis results as calculated, and not dividing by 1.6.

Yes, if you're using ASD, multiply the loads by 1.6 going into the analysis and then divide the resulting member moments and other force effects by 1.6 for comparison with M_n/Ω, etc. This is stated in the last sentence of Section 7.3(a) in AISC *Specification* Appendix 7, if you're using the Direct Analysis Method. If you're using the Effective Length Method, this is Section C2.2a(2).

Brad Davis, Ph.D., S.E.

Panel Zone Shear Strength

1. Based on AISC 341-05 Section 9.3a, panel zone shear strength is calculated per *Specification* Section J10.6. In J10.6, there are two sets of equations; one assumes panel zone is elastic, the other considers the inelastic overstrength. My question is when to use the inelastic equation.

2. After comparing panel zone shear demand with the column web shear capacity, we may need to provide a doubler plate. To calculate the required thickness of the doubler plate based on the additional strength required, what is the length of doubler plate that can be used? Do you suggest counting the full column depth or using the actual length of the doubler plate, which is (Column depth – 2 × column flange thickness)?

My thoughts are as follows:

1. AISC 341-05 Section 9.3a refers to AISC 360-05 Section J10.6, which provides two options. In the first option, one can do the frame analysis with panel-zone deformations not modeled; in this case the basic form of panel zone shear strength (Equations J10-9 and J10-10) is used. Alternatively, when a more sophisticated analysis that considers the effect of panel-zone deformations is performed, a higher shear strength can be used (Equations J10-11 and J10-12). This higher strength is based upon the deformations (inelastic action) of the panel zone. So, the inelastic equations can be used when you include the deformations in the analysis.

2. The calculations in AISC *Design Guide 13* (and other examples in AISC literature) implicitly use the full column depth when selecting the web doubler plate thickness. That is, the required thickness is calculated based upon the full depth of the column, and then the additional thickness required is determined by subtracting the column web thickness. The edges of the doubler plate along the column flanges are welded to develop the shear strength of the doubler plate, so I think this is appropriate.

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

Conventional Configuration Single-Plate Shear Connections

Design limitations for conventional configuration single-plate shear connections imply that long-slotted holes are not permitted. Why are these not permitted? Also, for the extended configuration, are long-slotted holes permitted? The limitations for the extended configuration refer to AISC *Specification* Section J3.2 requirements, which imply that long-slotted holes may be used. If these are permitted, would they need to be slip critical?

Yes, the procedure presented in the Manual for the conventional configuration of single-plate shear connections is specific to the use of standard or short-slotted holes. This procedure is based upon testing to define a simplified approach that can be used for the majority of cases. No tests were run on connections with long slots, so I would not apply the procedure to connections with long slots.

Long-slotted holes can be used with the extended configuration procedure, however. When using long slots, I would design the connection as slip-critical. I do not think the eccentrically loaded bolt group *C*-values in the Manual can be obtained in bearing-type connections using long slots.

Larry S. Muir, P.E.

Nut Type for Anchor Rods

We have a project with anchor rods specified as ASTM F1554 Grade 105. ASTM A194 Grade 2H nuts were substituted for ASTM A563 Grade DH nuts. Are the A194 nuts considered equivalent in this application.

The ASTM F1554 Standard permits the use of either ASTM A194 or ASTM A563 nuts having a proof load equal to or higher than the minimum tensile strength specified for the anchor rod. Table 4 in ASTM F1554 lists the axial tensile strength of the anchor rod based on the diameter and grade. Table 3 in ASTM A194 provides the proof load for the diameter and type of nut. Comparison of these values shows that ASTM A194 Grade 2H nuts are acceptable with ASTM F1554 Grade 105 rods.

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 in AISC's Steel Solutions Center. Charlie Carter is vice president and chief structural engineer at AISC. Brad Davis and Larry Muir are part-time consultant to AISC.

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

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:

Steel Solutions Center

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steel quiz

LOOKING FOR A CHALLENGE? *Modern Steel Construction*'s monthly Steel Quiz tests your knowledge of steel design and construction. Are you SteelWise? This SteelQuiz highlights some items that have appeared in the *SteelWise* feature.

1 Name six limit states that likely apply when designing simple shear connections?

2 According to the 2005 AISC *Code of Standard Practice*, the surface of steel that is to be painted must be prepared to a minimum of which of the following?
(a) Solvent Cleaning, SSPC-SP1
(b) Hand Tool Cleaning, SSPC-SP2
(c) Power Tool Cleaning, SSPC-SP3
(d) Commercial Blast Cleaning, SSPC-SP6

3 When it is suspected that installed bolts do not have the required pretension what procedures can be used for arbitration?

4 True/False: Additional shear studs beyond those required for support of gravity loads in a composite member must be provided to transfer diaphragm forces from the concrete slab to the steel in members that act both as collectors and gravity beams.

5 True/False: There is now an accepted method that can be used to protect ASTM A490 bolts with a metallic coating.

6 True/False: Weathering steel, which is also known as ASTM A588 steel, is a good choice for applications where the steel is constantly exposed to water and moisture.

7 There are six common mechanical fastener types that can be used in HSS connections? How many can you name?

8 Most structural steel produced in the United States comes from an electric arc furnace (EAF) process, which uses a large amount of ferrous scrap. The current surveyed value of total recycled content in steel produced by the EAF process is:
(a) 64.5% (b) 53.3%
(c) 93.3% (d) 32.7%

9 The current rate of recycling for structural steel in construction is:
(a) 55% (b) 78%
(c) 82% (d) 98%

10 True/False: The carbon footprint for structural steel material is currently 0.73 tons of CO_2 per ton of steel.

TURN TO PAGE 14 FOR ANSWERS


IN TOUGH ECONOMIC TIMES
IT BECOMES EVEN MORE APPARENT
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AS ONE OF THE NATION'S LARGEST STRUCTURAL STEEL FABRICATORS, W&W/AFCO Steel continues to forge ahead.
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Albuquerque NM | Chicago IL | Laguna hills CA | Las vegas NV | Philadelphia PA | Phoenix AZ

steel quiz ANSWERS

1 Six common limit states for simple shear connections are: bolt shear, bolt bearing, shear yielding, shear rupture, block shear rupture, and weld shear. The many limit states applicable to the various types of simple shear connections are covered in Parts 7, 8, 9 and 10 of the 13th edition AISC *Steel Construction Manual*. See also the *SteelWise* article in the February 2008 issue of MSC at **www.modernsteel.com**.

2 (b) According to Section 6 of the 2005 AISC *Code of Standard Practice*, steel that is to be painted must be prepared to a minimum of SSPC-SP2. More information on surface preparation requirements also can be found in the *SteelWise* article in the April 2008 issue of MSC.

3 Section 10 in the RCSC *Specification* [located in Part 16 of the 13th edition AISC *Steel Construction Manual* and also available as a free download at **www.boltcouncil.org**] provides a detailed procedure for such arbitration. More information on bolted connections also can be found in the *SteelWise* article in the July 2008 issue of MSC.

4 False. As stated in the *SteelWise* article in the December 2008 issue of MSC, shear studs have sufficient ductility to transfer horizontal shear loads equal to the summation of strengths of all the shear studs on the member regardless of the demand on the shear studs from gravity loads.

5 True. The ASTM A490-08a revision allows ASTM F1136 Grade 3 coating to be applied to ASTM A490 bolts. RCSC is currently considering the inclusion of this new option for ASTM A490 bolts in the RCSC *Specification*. More information on this topic also can be found in the *SteelWise* article in the January 2009 issue of MSC.

6 False. Frequent wetting and drying cycles are essential for the proper formation of the protective coating on weathering steel. The patina will not form, however, when the steel is constantly wet. More information on weathering steel also can be found in the *SteelWise* article in the February 2009 issue of MSC.

7 Six common mechanical fastener types used in HSS connections are: through-bolts, threaded studs, flow-drilled bolts, screws, blind bolts, and nails. More information on this topic also can be found in the *SteelWise* article in the July 2009 issue of MSC.

8 (c) The typical products produced using the EAF process include beams, columns, channels, and angles; some HSS, plate, piling and steel deck also is produced with an EAF process. More information on this topic also can be found in the *SteelWise* article in the August 2008 issue of MSC.

9 (d) This compares to a rate of overall recycling of all steel products (including those not used in construction) of 78%. More information on this topic also can be found in the *SteelWise* article in the August 2008 issue of MSC.

10 True. Structural steel has a very low equivalent utilization carbon footprint of 0.73 tons of CO_2 per ton of steel. Plus, you get a lot more structure out of that ton of steel than you get out of a ton of any other structural material. Thus, the effective carbon footprint per square foot of construction is very favorable to steel. More information on this topic also can be found in the *SteelWise* article in the August 2008 issue of MSC.

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 Solutions Center

news

ENGINEERING

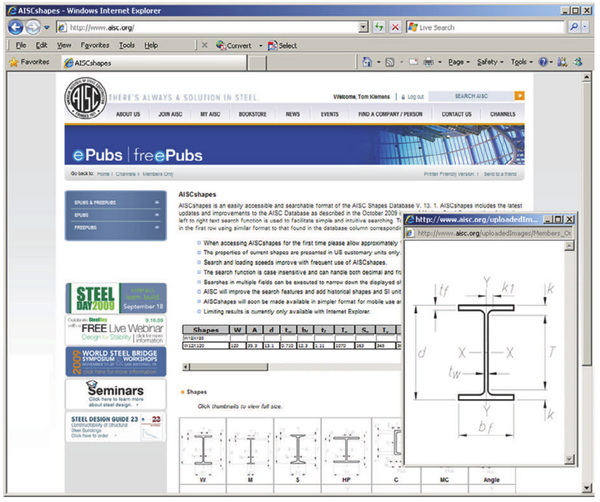
Steel Shapes–New, Old and In Between

AISC now offers AISCshapes—an easily searchable online interface that reflects the data in the updated Shapes Database (V13.1.1) and is accessible to members only. The page allows easy searching using the shape name or any other dimensional property. The intuitive online interface provides an easy tool to narrow down to a small number of shapes based on a search that satisfies a series of dimensional choices. To access the page first login at **www.aisc.org**, then visit **www.aisc.org/AISCshapes**.

The AISC Shapes Database has been updated to V13.1.1 and several improvements have been made, including the addition of detailing dimensions for all shapes and S_z values for single angles. The database provides electronic access to dimensions and properties of W-, M-, S-, and HP-shapes, channels (C- and MC-shapes), angles (L- and 2L-shapes), tees (WT-, ST-, and MT-shapes), hollow structural sections (HSS) and pipe (P, PX and PXX), as given in the AISC *Steel Construction Manual*, 13th Edition. U.S. customary and metric units are included.

The AISC Shapes Database V13.1H (Historic) provides electronic access to dimensions and properties of shapes published in the AISC *Manual* since the 5th Edition, and shapes from before that era as originally published in the book *Iron and Steel Beams 1873-1952* (the predecessor to AISC Design Guide 15, *AISC Rehabilitation and Retrofit Guide*). Thus, this database is the compilation of all of the structural steel shape dimensions and properties recorded by AISC from 1873 to 2001.

For members, these two files are available for free downloading on the AISC website at **www.aisc.org**. Non-members can download the files through the online bookstore for a $20 fee.



Record Number Attends Pennsylvania Powers Union Construction

In the single largest meeting of TAUC's history, more than 250 union contractors, labor representatives and industrial business owners from around the country convened at Pennsylvania Powers Union Construction on September 9.

Despite limited travel budgets, industry leaders came from around the country to address critical safety and labor relations issues in industrial maintenance and construction.

The meeting included representatives from Pennsylvania, New Jersey, Maryland, Virginia, West Virginia, Ohio, Massachusetts, Michigan, Indiana, Illinois, Wisconsin, Minnesota, Georgia, Alabama, Missouri, Oklahoma and California, according to TAUC CEO Stephen R. Lindauer.

"I believe this packed room is a testament to the fact that TAUC has very quickly established itself as an industry-leading association that is here to create lasting, positive change," TAUC president Robert W. Santillo said. "When other groups and associations are seeing a decline in attendance, interest, and support...The Association of Union Constructors is seeing a dramatic increase."

In his opening remarks, Santillo told the crowd that union construction's classic business models are no longer adequate.

"Our industry is now demanding bold, innovative approaches; approaches that may not feel completely comfortable at first," Santillo said. "However, if we can rise to this challenge and demonstrate the flexibility that these times require, union construction will see bright days again."

Pennsylvania Powers Union Construction was generously sponsored by: Aramark Uniform Services; Boilermakers Local 154; Blue Mountain Equipment Rental Corporation; the Ironworker Employers Association of Western Pennsylvania; Manning & Napier; the Mechanical Contractors Association of Western Pennsylvania; Mobile Medical Corporation; and, the National Maintenance Agreements Policy Committee, Inc.

TAUC will hold another industry-wide event on December 9, 2009, in Washington. Advance registration is required through **www.tauc.org**.

RESOURCES

Detailing Guide Now Available

The 3rd edition of *Detailing for Steel Construction* is now available in print. This is an update of the 2nd Edition to be consistent with the 2005 AISC *Specification for Structural Steel Buildings*. Topics included are:

- general fabrication requirements
- contract documents
- common connection details
- basic detailing conventions
- project set-up and control
- erection drawings
- shop drawings
- bills of materials
- detailing quality control and assurance

The new *Detailing for Steel Construction* and a corresponding online Steel Detailing Course are available for purchase at **www.aisc.org** in the bookstore.

EVENTS

NASSPA's Steel Sheet Piling Symposium

The Symposium will be held at The Westin Crown Center, Kansas City, Mo., October 23, 2009. The North American Steel Sheet Piling Association is presenting this symposium following the Deep Foundation Institute's Annual Conference. The half-day event will include technical presentations on steel sheet piling design practices and case studies illustrating steel sheet piling applications. A buffet lunch will also be provided to attendees. More information at **www.dfi.org**.

People and Firms

- **Scholarships Awarded by AISC Member Firms** AISC, in association with members of the structural steel industry, awarded 15 scholarships/fellowships totaling $46,000 for the 2009–2010 academic year. We would like to thank our industry partners for their continuing generous support of student programs. Congratulations to the very deserving students who have been awarded scholarships and fellowships for the upcoming school year.
- **2009-2010 Scholarship Awards:**

  AISC/Associated Steel Erectors of Chicago–$3,000: Hannah Durschlag, Northwestern University

  AISC/Southern Association of Steel Fabricators–$2,500: Laura Schultz, Georgia Institute of Technology

  AISC/W&W AFCO Steel–$5,000: Roger Mock, Georgia Institute of Technology
- **2009-2010 Fellowship Awards:**

  AISC/Associated Steel Erectors of Chicago–5x$3,000: Seth Hoffman, University of Illinois, Urbana-Champaign; Rusty Kucher, Illinois Institute of Technology; Andrew Langferman, Purdue University; Brenna Katherine Roether, Bradley University; Kristi Selden, Purdue University

  AISC/Fred R. Havens– $5,000: Christopher Putman, Stanford University

  AISC/Klingelhofer–$2,500: Neal Kwong, University of California, Berkeley

  AISC/Rocky Mountain Steel Construction Association–$3,000: Douglas Midkiff, Colorado School of Mines

  AISC/Southern Association of Steel Fabricators–$2,500: Scott Pabian, University of Kentucky.

  AISC/Structural Steel Educational Council– 2x$2,500: David Grilli, California State University, Sacramento; Joanna Huey, Stanford University.

  AISC/US Steel– $2,500: Kelly Young, The Ohio State University.

CORRECTION

The steel fabricator and erector were inadvertently not identified in the August 2009 MSC article about the Jacksonville, Fla., Naval Air Station Hangar (page 46). AISC member PKM Steel Service Inc., Salina, Kan., was the structural steel fabricator for this project and AISC member LPR Construction Co., Loveland, Colo., was the steel erector.

AWARDS

Kulicki Honored by AISI and AASHTO

The American Iron and Steel Institute's Steel Market Development Institute (SMDI) Steel Bridge Task Force and the American Association of State Highway and Transportation Officials (AASHTO) Technical Committee for Structural Steel Design have named John M. Kulicki, Ph.D., P.E., as the recipient of the 2009 Richard S. Fountain Award. Kulicki is the chairman and CEO of Modjeski and Masters. The award is named for the founder of the Steel Bridge Task Force.

AISI

John M. Kulicki, P.E. (second from right) accepts the 2009 AISI/AASHTO Richard S. Fountain Award. Presenting the award are Dennis R. Mertz, professor of civil engineering at the University of Delaware (far left); Alex Wilson, manager of customer technical services for ArcelorMittal USA and chairman of AISI's Steel Market Development Institute Steel Bridge Task Force; and Ed Wasserman, director of structures for the Tennessee Department of Transportation and chairman of the AASHTO-T14 Committee (far right).

letters

Unregulated Engineering

Matt Thomas (July 2009 MSC, p. 66) brings up a good point about the proper use of software in the engineering profession. The issue, however, is not so much that engineers are blindly relying on computers and software, but that sub sectors of the construction industry are relying on non-licensed technicians and sales people using proprietary software to provide engineering services. It is interesting that he mentions the Hartford Civic Center as a lesson. I would like to say lesson learned, but the L'Ambiance Plaza collapse in Bridgeport, Conn., and a lesser known prefabricated roof truss collapse show that lessons may be getting overlooked. Connecticut and other states as well need to clamp down on people "engineering" without a license. They also need to define more broadly what situations require the involvement of Professional Engineers.

Peter J. Cloudas, P.E.
Stamford, Conn.

More on the Connection Debate

I have been reading with great interest the articles about design connection responsibility. In the eight years that I've been practicing, no one has been able to give me a clear explanation about this topic.

It's my personal opinion that the code should include only two options—one in which the engineer of record designs all the connections, and one in which the fabricator is responsible for the design, and the engineer of record merely checks them as part of shop drawing review. I see no reason for any gray area in between that makes it even more difficult to explain the available options to a client.

I also want to express my opinion from a design consultant's point of view regarding the letter by Peter Officer in the July 2009 issue of MSC (page 18). I completely agree that without a complete scope of work it is difficult to make an accurate bid, and that the cheapest bid may win if it is not carefully reviewed by all the parties involved, including the design professional of record. However, a similar observation can be made for the design professional. The client will be inclined to go to the one that gives faster results and whose fees are lower. Then the question is: how many extra hours would the design of all the connections on a project take? Including those hours may well make the design consultant less competitive.

The effort to educate clients on this matter has to be shared by design professionals and fabricators alike. In the end, the premium paid to the engineer or the fabricator for connection design should be similar, and the client needs to understand clearly the pros and cons of the two alternatives.

Truly Guzman, P.E.
New York

The Message is More Than Words

I was very disappointed to find a picture of a woman in a bikini, focusing on her breasts, stomach and thighs, as part of an ad campaign for American Galvanizers Association. The current trend in the construction industry is to promote, retain and encourage women in math, science and technology careers. Advertising of this type is inappropriate for a trade magazine. A disregard for a woman's negative reaction is a marginalization of her value to the industry. As a member of AISC, I would appreciate it if you could communicate to AGA that women are numbered among your valued readers and contributors and that they should choose advertising that is positive for women. Your consideration is appreciated.

Rachelle Clark

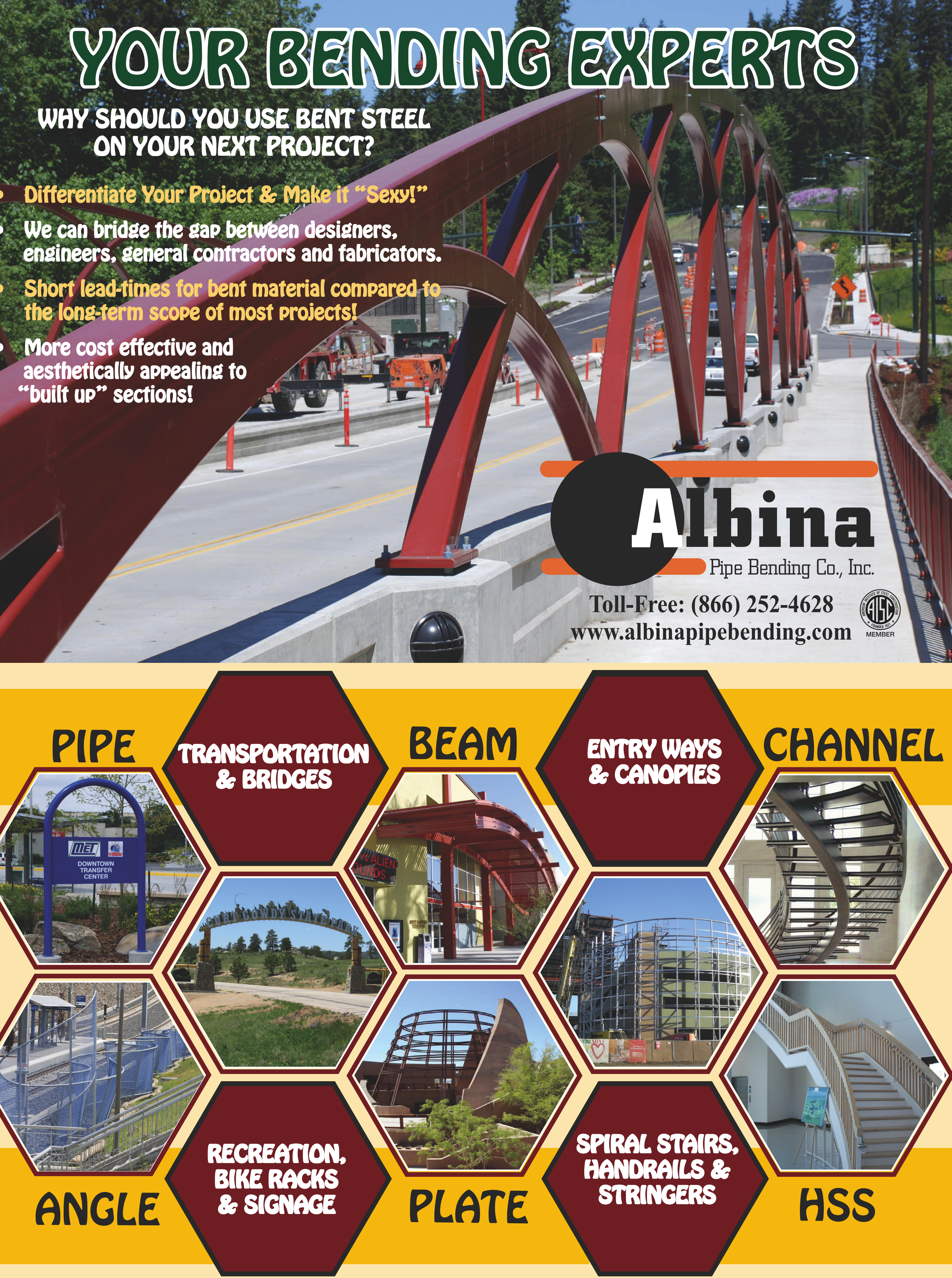
AWARDS

Engineering Creativity & Innovation Recognized

With structural engineering from Walter P Moore, Houston, Nerman Museum of Contemporary Art has won the "New Buildings Under $30 Million" project category in the 2009 Structural Engineers Association of Kansas & Missouri (SEAKM) Awards Program. The program is sponsored by SEAKM to recognize creative achievement and innovation in structural engineering.

Located on the campus of Johnson County Community College, Overland Park, Kan., Nerman Museum of Contemporary Art is the largest contemporary art museum in the four-state region. The elegant, minimalist building opened to international acclaim for its architecture, art collection and exhibition programming.

© Timothy Hursley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Knee braces are installed prior to setting each of the candelabra arms, which will be bolted onto the tabs (above and below the level of the crane hook) on the main tower. Between the knee braces you can see the two-person elevator, without which it takes an hour or more to climb the 950 ft to this level. The pulleys near the top of the photo are for the elevator hoist cable.

All photos and drawings: Stainless LLC

Good Morning, Miami!

BY THOMAS J. HOENNINGER, P.E.

Multiple television and radio antennas broadcast from high atop a new steel tower in Miami.

THE NEW AGE OF BROADCAST TV, especially the recent switch to digital transmission and high-definition TV (HDTV), has brought many changes to the broadcast industry. Changes in wind loading due to antenna and cabling replacement—or even just removal of analog equipment—can significantly affect existing towers. In addition, the telecommunications industry is also going through significant changes with the revision to its antenna supporting structure design standard, ANSI/TIA-222.

ANSI/TIA-222-G was adopted by ANSI and TIA (Telecommunications Industry Association) in 2005 and, with some exceptions, basically follows ASCE7 on the loading side and AISC and ACI on the design side. ANSI/TIA 222-G is now recognized as the telecommunication antenna supporting structure design standard by the International Code Council and is incorporated into the International Building Code (IBC).

The following are major changes included in ANSI/TIA 222-G:

- ➜ Three-second gust basic wind speed
- ➜ Mandatory ice loading (in certain regions)
- ➜ Pattern wind loading
- ➜ Load and Resistance Factor Design (LRFD)
- ➜ Rigging plan reviews and rigging tower effects

Candelabra

One tower project in Miami was affected by all these changes. The physical condition of WPLG's previous tower and HDTV's structural impact led to the decision to replace the station's existing tower. However, before going ahead with the replacement project, WPLG evaluated collocation opportunities that resulted in WSVN TV, WLYF FM, and many wireless tenants collocating on the new tower, which was completed in June.

Because multiple TV stations were planning to be installed on the new tower, a candelabra design was chosen to allow for all the stations to have their antennas located at approximately the same height. The candelabra design is basically three supporting structures that project out horizontally more than 40 ft at tower top to provide the 50-ft horizontal separation required between these antennas.

The overall height of the new structure is 1,042 ft, with the top of candelabra steel at 951 ft. The tower is also equipped with a two-person elevator, a climbing ladder with safety cable device, and an FAA-approved obstruction lighting system. In all, 510 tons of structural steel was used.

The ANSI/TIA 222-G design parameters used for the new tower were:

- ➜ Reliability Class II
- ➜ Exposure Category C
- ➜ 150-mph three-second gust basic wind speed (no ice loading)
- ➜ Topographic Category 1 (no wind speed-up effect)
- ➜ 0.05 earthquake spectral response acceleration at short periods (earthquake loading did not govern)

A 12-ft face, triangular cross-section tower was selected due to the high wind speed, candelabra design, and elevator. This tower design consists of standard components, including those used in the candelabara. The components were selected and arranged to resist the internal forces resulting from a rigorous structural analysis of various loading conditions.

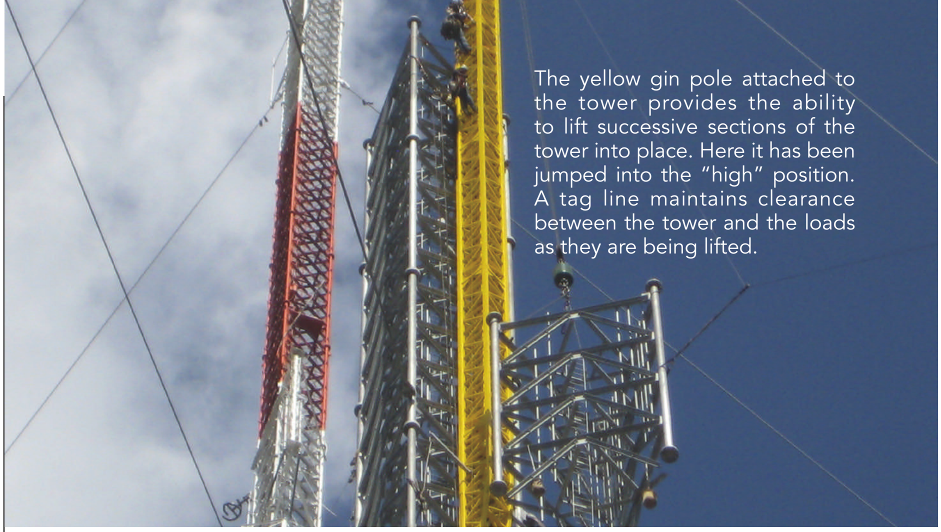
Also investigated were second-order effects that required a balanced design between mast and guys. A five-guy-level design was selected. The first four guy levels have three guy assemblies per level oriented at 120° from each other. The top guy level has six guy assemblies attached to the candelabra structure to provide torsional resistance due to the uneven loading on each apex of the candelabra. The guy assemblies were supplied in accordance with ASTM A586 GR2 with a threaded take-up at the anchor end to allow for final tensioning.

The tower mast uses 30-ft long sections assembled on the ground consisting of ASTM A572 GR 50 round bar vertical members (with additional mechanical requirements), 7-ft 6-in.-high bracing bays of ASTM A36 K-braced double-angle diagonals, and double-angle horizontals.

Erection

A significant amount of engineering labor was spent on evaluating the tower due to erection loads.

Thomas J. Hoenninger, P.E. is the vice president of engineering/chief engineer with Stainless LLC.



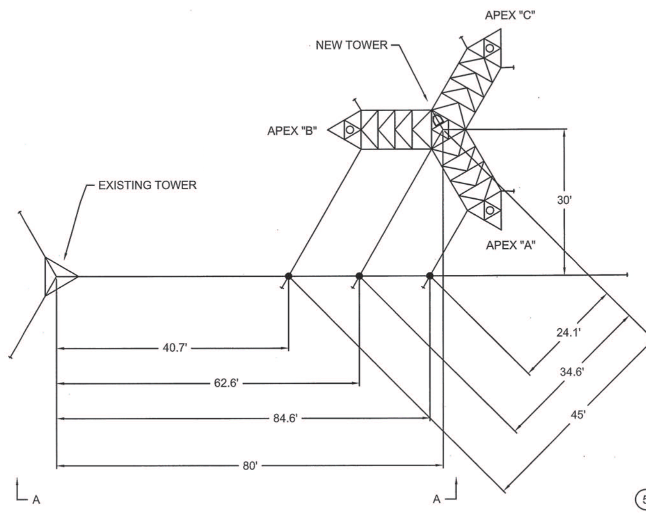
The yellow gin pole attached to the tower provides the ability to lift successive sections of the tower into place. Here it has been jumped into the "high" position. A tag line maintains clearance between the tower and the loads as they are being lifted.

Rigging supports were built into the base and anchor foundations to facilitate erection. A rigging plan was developed by the erector and was reviewed by the engineer of record (EOR). The main rigging equipment/lines were checked to ensure adequate safety factors were maintained. The effects of the rigging loads imposed on the tower were also analyzed. After completion and approval of the engineering rigging plan review, erection commenced in the following sequence:

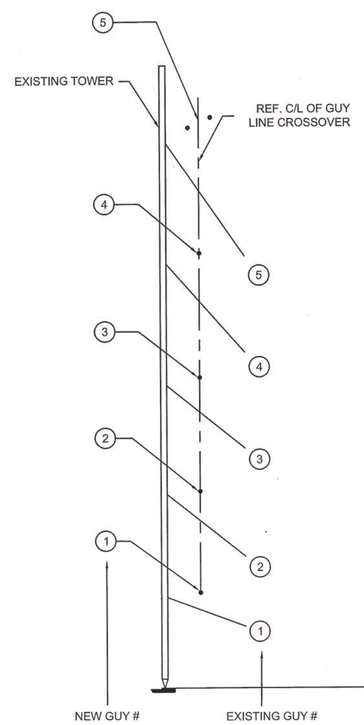
1. The first few tower sections were assembled together on the ground and lifted in place by a crane.
2. Temporary guys were installed to stabilize the tower since the base section tapers to a point allowing rotation.
3. The crane lifted the gin pole which was then attached to the tower. Lifting operations with a gin pole include a load line, gin pole jump line, and tag line. The tag line maintains clearance of the load away from the tower during the lifting process. On this tower an inverted trolley tag line was used.
4. The gin pole was positioned (jumped) into the high position to be ready to lift and install tower sections. After each section was lifted and installed on the tower, the gin pole was jumped again. This procedure was repeated until the section that contained the first permanent guy level was lifted and installed.
5. The guy assemblies were lifted and connected to the tower in each of the three directions.
6. The guy assemblies were then pulled out and connected to the anchor foundations. (Pulling out and attachment to the anchor foundations must be performed at the same time in all three directions to minimize unbalanced loading on the tower.) During this process it was important for the erection crew to watch the top tower section for lateral movement to maintain balanced loading and vertical alignment.
7. The gin pole jumping and tower section installation were repeated until the second guy level height was reached and the guy assemblies installed. Then the entire process was repeated until tower top was reached.
8. Temporary guys were installed near tower top. They were not required for the main mast erection unless more than three sections above a permanent guy level would have been left freestanding overnight.
9. The falsework and additional temporary guys were installed. This erection sequence was the same as for erecting tower sections. The falsework provided height above the candelabra structure level to install the candelabra outriggers and antennas.
10. The gin pole was again jumped in the high position.
11. The crane support assembly interface was then lifted and installed.
12. The crane was lifted and installed on the support assembly.
13. The knee braces of the candelabra were then installed.
14. Each candelabra arm structure was assembled on the ground, lifted, and installed.
15. The knee braces were then attached.
16. The antenna interface support assemblies and antennas were lifted and installed.
17. The crane and falsework were removed from the tower with the gin pole.
18. The gin pole was lowered below the candelabra. The candelabra was designed to allow clearance for the gin pole to pass through the completed candelabra structure.
19. The tower was rigged below the candelabra level and the gin pole was removed from the tower and lowered to the ground.
20. The tower was then derigged.

One set of guy lines from the new tower had to be threaded through the guy lines from the existing tower, further complicated design and erection.

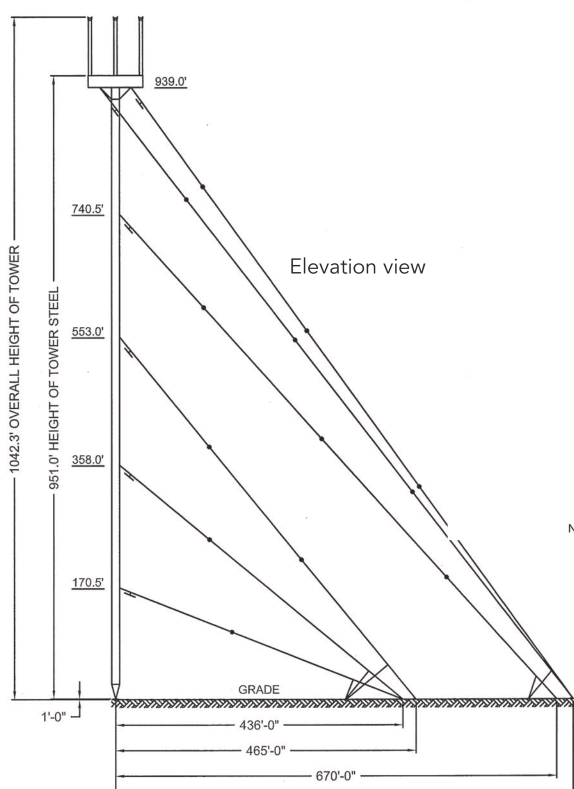
Each candelabra arm is assembled on the ground, then lifted and bolted into place. Here the top of steel is at 951 ft.



Plan view



Section "A" - "A"



Elevation view

Too Close for Comfort

The close proximity of the new tower to the existing tower created an amplified degree of difficulty for both the tower design and erection. In one direction the guy wires from the new tower, which ranged from $1\frac{7}{8}$ in. to $2\frac{5}{8}$ in. in diameter, were required to be weaved through the existing tower guy wires. At each guy level the tag line was first weaved between the existing guy levels above and below the elevation of the guy level on the new tower. The tag line was very light, so it was walked out to the guy anchor of the existing tower and weaved through the appropriate guy levels and then walked back to the correct position. The load line was then trolley attached to the tag line, lowered, and weaved through the existing tower guy levels. The tower end of the new guy assembly was attached to the load line and lifted. The lift was controlled by adjusting the tension on the inverted trolley tag line. This maintained the proper location of the lifted guy assembly through the existing guy levels. When it reached the guy attachment level it was positioned and connected to the tower. In the other two directions the guy assemblies were lifted and attached to the guy attachment connection on the tower using normal lifting procedures. Then all three guy assemblies were pulled out to each anchor simultaneously to minimize lateral load on the tower mast. MSC

Structural Designer/Fabricator/Detailer
Stainless LLC, North Wales, Pa.
(AISC Member)

photos this page courtesy of Jeff Young

On September 13, 2008, winds and debris from Hurricane Ike shredded the 20-year-old fabric roof of the Cynthia Woods Mitchell Pavilion north of Houston. The supporting steel survived intact.

The flexibility of structural steel and tensile fabric combine to allow the rapid replacement and expansion of a landmark amphitheater.

Just 7½ months after Hurricane Ike came to town, the storm-ravaged Cynthia Woods Mitchell Pavilion was once again ready for opening night but with more than double its original capacity.

WHEN HURRICANE IKE ravaged the Texas Gulf Coast on September 13, 2008, it left more than 3 million households without power for up to several weeks. As the storm moved northward out of the Houston area, it continued to carve a path of destruction. When Ike finally cleared the area, after almost 15 hours, it left the fabric roof of the Cynthia Woods Mitchell Pavilion in shreds. Thanks to the dedication of a multi-disciplinary design and construction team, the venue was reconstructed twice as large as—and more hurricane-resistant than before—after only a five-month reconstruction and expansion project. This compressed timeframe enabled the Pavilion to launch its 2009 season on time with the scheduled May 1 opening concert by the Dave Mathews Band.

For the three years prior to the storm, the 20-year-old Cynthia Woods Mitchell Pavilion had been ranked by *Pollstar* magazine as one of the top six amphitheaters in the world. Located 27 miles north of downtown Houston in The Woodlands, Texas, the outdoor venue has hosted a steady stream of events that range in style from the Houston Symphony to Kenny Chesney and Aerosmith.

More than $3 million in damage resulted from a combination of Ike's strong winds and windborne debris. Although the durable steel substructure survived intact, the venue's fabric roof was irreparably damaged. The Pavilion's board of directors took advantage of the opportunity to expand the structure during the reconstruction process by more than doubling the facility's covered seating capacity from 2,479 to 6,387 seats. After the $9.5 million renovation and expansion, the total capacity of the venue, including lawn seats, has grown to 16,040.

Steeling the Show

BY TAREK AYOUBI, P.E. AND RACHEL CALAFELL

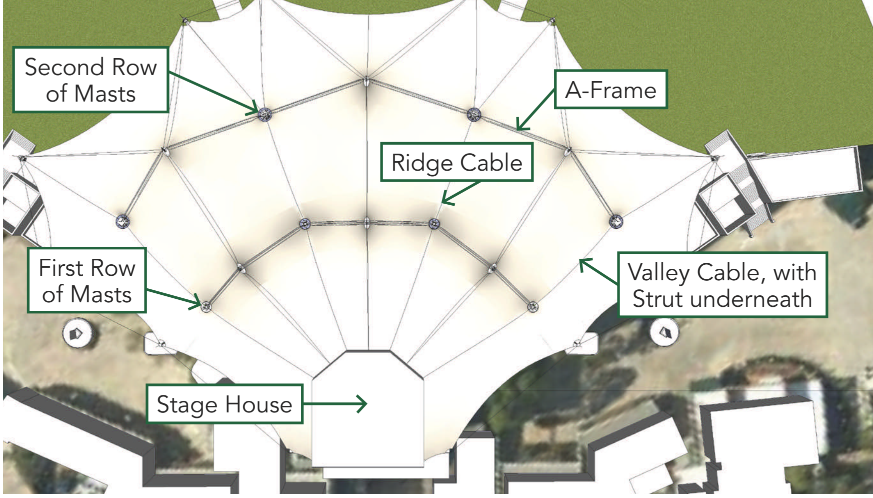
Installation of the 13 fabric panels was completed over a 51-day period ending less than a week before opening night. Total weight of the 82,000 sq. ft of fabric: 25,000 lb.

The Steel Skeleton

The requirement of creating a large open space using members with long spans made structural steel an ideal material for both the original and expanded structures. Laced steel struts and masts were used to ensure the feeling of openness under the canopy, to minimize impact on the sightlines, and for acoustical purposes. In addition, the use of structural steel improved constructability of the project, as members were fabricated in the shop and lifted into place in the field using a tower crane. With the complex geometry of the structure, the construction process was like putting together the pieces of a puzzle—everything had to fit together perfectly.

Tarek Ayoubi, P.E., is a principal and senior project manager at Walter P Moore. Rachel Calafell is a graduate engineer at Walter P Moore. Both are AISC Professional Members. They can be reached at 800.364.7300.

At one point, as many as 13 personnel lifts were being used simultaneously to erect the steel and cable framework as quickly as possible.



This plan view of the expanded structure, with the structural components identified, is from the Sketchup model.

The structure's gravity system involves compressive loads being transferred to spread footings through A-frames, struts, and vertical masts, while tensile loads are transmitted through a network of cables. Lateral loads are transferred through the compression and tension members to the stage house, where they are resisted by braced frames, and through diagonal cables anchored to new foundations. ASTM A586 structural strand cables of ⅝- to 1⅝-in. diameter with Type A inner and outer coating and breaking strengths of 48,000 to 324,000 lb were used throughout the structure.

The original structure consisted of one row of A-frames and masts, and a series of struts and cables. The expansion of the roof area required adding a second row of A-frames and masts with connecting struts and cables, while using as much of the existing structure as possible.

The vertical masts are laced members with a square cross-section comprising four ASTM A53 vertical pipe members and smaller pipe members acting as lacing between the vertical pipes. The four existing masts, which consist of four 6-in. diameter ASTM A53 vertical pipes in a 2 ft by 2 ft square cross section, were reused. The increased height, wind pressures, and tributary area of the roof resulted in larger sizes and cross sections for the new masts supporting the new, outer row of A-frames. The two interior masts were constructed using four 8-in. diameter pipes in a 2 ft by 2 ft cross section. The two exterior masts use four 10-in. diameter pipes in a 3 ft by 3 ft cross section.

Membrane structures achieve load carrying capacity in various directions through curvature, and saddle surfaces are formed by introducing supports that are not in a single plane. The A-frames, which are trussed elements between the masts, create external supports for

The masts consist of four ASTM A53 structural steel pipes ranging from 6-in. to 10-in. diameter arranged in a square cross section. The connecting struts and A-frame members use three pipes, 3-in. to 6-in. diameter, in a triangular cross section.


Walter P Moore

saddle surfaces of the fabric roof. The struts are nearly horizontal laced members in compression that offer support points at the perimeter edge of the structure and transfer load to the braced frames located at the stage house. All three of the existing A-frames and several of the existing struts were reused in the expanded structure.

The new A-frames, spanning up to a projected horizontal length of 130 ft, were constructed using 3- to 6-in.-diameter ASTM A53 pipes as continuous trunks, laced together with 1½-in.-diameter ASTM A53 pipes in a 2 ft by 2 ft triangular cross section. The new struts, which span up to 85 ft, have a 2-ft to 2-ft 6-in. wide by 2-ft to 3-ft deep triangular cross section, with 6- to 8-in.-diameter ASTM A53 trunk pipes and 2- to 3-in.-diameter ASTM A53 pipe lacing.

The stage house was extensively retrofitted to allow it to provide much of the lateral load resistance for the expanded structure, as it did for the original structure. The retrofits involved adding steel side plates to many wide flange members, adding bracing members, and strengthening several of the existing steel connections. In addition, existing footings were exposed and retrofitted by expanding their size and adding anchor rods to resolve higher uplift and lateral forces. The stage house retrofits were redesigned as needed during the construction process as existing conditions were discovered that differed from the 1989 design drawings.

The Fabric Membrane

Horst Berger, architect of both the original and the expanded roof structures, designed the new canopy to retain the same signature look as the original structure. Because of its ability to both withstand design wind loads and transmit light without the heat gain of traditional glazing, Sheerfill II fabric produced by Saint-Gobain Performance Plastics was used in both the original and expanded structures. The fabric is a composite material made of fiberglass and polytetrafluoroethylene (PTFE) with a Teflon coating. It is designed to maintain its original prestressed shape throughout its typical lifespan of 25 or more years.

The expanded roof of the Pavilion incorporates the use of 13 panels of fabric totaling an area of approximately 82,000 sq. ft, compared to the original 30,000 sq. ft. The fabric panels weigh approximately 25,000 lb in total.

Several aspects of the expanded fabric structure make it more resilient to hurricane wind loads now than when it was first constructed. These features include reinforcing the fabric with surface cables to act as rip stops and providing triangular fabric panels at the outer edges to avoid terminating ridge cables in edge catenary cables. The expanded structure also was designed for higher wind loads, including hurricane force winds of up to 110 mph, with a gust of three seconds.

The Effect of Fast-Track

On November 6, 2008, Walter P Moore structural engineers first visited the site to assess the structure's damage resulting from Hurricane Ike. Only 164 days remained before the grand re-opening concert when the first meeting of the design team was held on November 18. To succeed, the project team had to compress the entire design and construction schedule into those precious 164 days, demanding that some tasks often taking months or weeks be completed in days. Determining the effect of high winds was one such challenge.

Although a wind tunnel analysis was performed for the original structure, another was required to accurately predict wind loads on the new structure due to geometrical differences between the structures. However, because the fabric panels, structural steel, and cables had to be ordered before the full wind tunnel analysis could be completed, the design was carried out on the basis of preliminary desktop studies. The wind loads resulting from the preliminary studies performed by the wind engineering consultant were later confirmed by the final wind tunnel test results and required only modest changes.

The construction drawings were issued in several packages to speed up the project delivery schedule. After receiving the fabric interface geometry and details from the fabric engineer, the structural engineer issued foundation, steel trunk, cable, connection, and stage house retrofit drawings in separate packages to allow timely procurement of long-lead materials while permitting construction to proceed at full-speed as design was being completed.

A specialty membrane and cable-net program was used for analysis of the fabric roof, with a separate program employed to pattern the fabric for installation purposes. SAP 2000 was used to design the structural members. Although AutoCAD 2009 was used for documentation, the creation of a 3D model of the steel structure and fabric using Google Sketchup was useful in detailing the complex geometry and facilitating discussions between consultants. The model was particularly helpful in determining potential interferences between the fabric and the steel structure, especially at the interface between the fabric and the A-frames.

Construction began on December 1 with seven-day work weeks, although crews later worked around the clock. As many as 13 lifts were used on the site at one time to erect 75 tons of steel in three weeks. During the first week of February, 2009, the reused masts, pipe columns, and A-frames for the first row were installed, along with new struts and tension cables. Over the next two weeks, the second row members were erected. Retrofitting the stage house was performed after the steel structure was in place.

Installation and tensioning of the fabric occurred during a 51-day period ending April 26, a mere five days before the opening concert. This left just enough time for the seating, handrails, landscaping, and final painting to be completed.

The Cynthia Woods Mitchell Pavilion opened on time for the sold-out May 1 concert and its 20th season. It is back, bigger and better than ever—and the structure indeed "steels" the show. MSC

Owner
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Structural Engineer
Walter P Moore, Houston

Fabric Designer
Horst Berger, White Plains, N.Y.
DeNardis Engineering, LLC, White Plains, N.Y.

General Contractor
Fretz Construction Co., Houston

Architect
Rey de la Reza Architects, Inc., Houston

Steel Detailer
LVJ Specialty, Inc., Lafayette, La. (AISC Member)

Fabric Patterning & Installation
FabriTec Structures, a brand of USA Shade & Fabric Structures, Inc., Dallas

Wind Tunnel Consultant
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HODGSON CAN HELP SOLVE YOUR PROBLEMS

Making More of a Good Thing

BY JEANNETTE M. PFEIFFER, P.E., S.E., LEED AP

Expanding aquarium facilities the Chicago way—by going up.

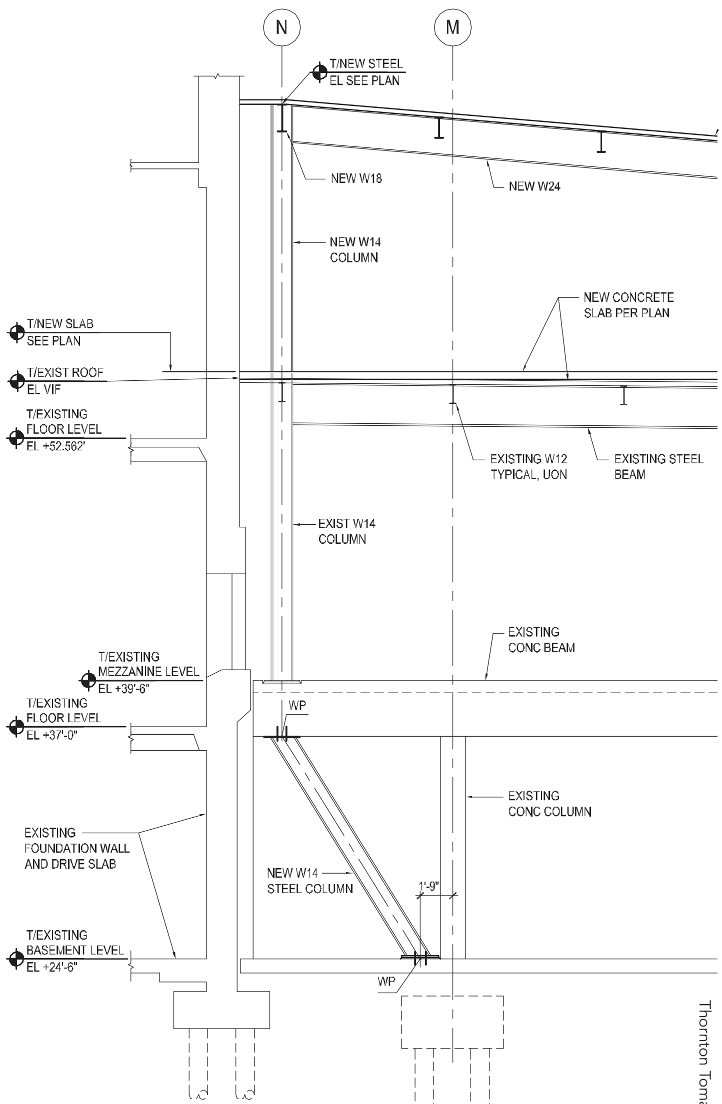


Figure 1

Thornton Tomasetti

WHEN AN OWNER WANTS TO EXPAND ON A VERY limited site, without increasing the structure's footprint, the obvious choices are to either go down or go up. For the John G. Shedd Aquarium, located in Chicago on a spit of land jutting out into Lake Michigan, that meant adding usable space on the largest available area around—the expansive roof of the aquarium's saltwater habitat, the Oceanarium (see sidebar).

The design for the first phase of the aquarium's Oceanarium Renovation project kicked off in the fall of 2007. The first phase consisted of providing 24,000 sq. ft of new office space above the existing Oceanarium roof for the aquarium staff. The second phase of the project included major changes to the large animal habitat pools in the Oceanarium.

For years the staff had been crowded into the basement and subbasement of the Oceanarium and aquarium. Adding new space above the existing roof would provide open offices and conference rooms.

The first phase also included renovations to all levels at the north end of the Oceanarium, consisting of the existing food service areas. The updates to this space included making accommodations for the use of the aquarium for events and adding an outdoor terrace on the lakefront with an exceptional view of the Chicago skyline. To accommodate the fast-paced design and construction schedule, a steel package was issued early in the design phase, just after the contractor was selected.

The primary design consideration for the renovation was coordination with the existing structure. Because the new office space sits on the existing roof, the change in loading requirements required careful review. Where it was possible, new columns were located directly above the existing columns; however due to field issues some columns had to be eccentrically located with respect to the existing columns. Those columns required an analysis of the existing concrete and steel columns.

The radial grid with more than 100 unique columns, multiple partial levels, and column sizes changing from level to level made the column load takedown a challenge. Several concrete columns were reinforced with steel channels to support the new loads. The existing steel columns on N line were supported on beams at the mezzanine level. When analyzing these existing beams with the additional office loading, they were found to be insufficient. Therefore new sloping columns were added from the mezzanine level to the basement level to transfer the load from the columns on N line to the existing foundation at M line (see Fig. 1).

A New Aquarium on the Third Coast

The John G. Shedd Aquarium in Chicago, Ill., was originally built in 1927 with Mr. Shedd's idea of, "build it and they will come." The only other similar exhibit in Chicago at that time was the freshwater fish collection at the Lincoln Park Zoo. Graham, Anderson, Probst & White, the architectural firm that designed Shedd Aquarium, also designed many notable Chicago structures including the Field Museum, Union Station, Museum of Science and Industry, the Civic Opera Building, Wrigley Building, Strauss Building (topped by the blue beehive), and the Merchandise Mart.

During the aquarium's construction, 20 railroad tank cars made eight round trips between Key West, Fla., and Chicago to deliver one million gallons of seawater for Shedd's marine exhibits. The aquarium is enjoyed by two million people annually and is one of Chicago's greatest attractions.

The Oceanarium was constructed in 1987 on an additional 1.8 acres of lakefill and became home to beluga whales, sea otters, Pacific white-sided dolphins and penguins. When the Oceanarium opened in 1991, it nearly doubled the size of the original aquarium, and is one of the world's largest indoor marine mammal habitats.

photos by John G. Shedd Aquarium

When the Shedd Aquarium officially opened in 1930, it was the first inland aquarium to have a permanent saltwater collection and housed the greatest variety of sea life under one roof. The 1987-1991 addition of the Oceanarium along the aquarium's lake side nearly doubled its size.

Thornton Tomasetti

Photo 1: Adding steel grillage under the existing concrete roof structure provided additional capacity for the new floor above.

Thornton Tomasetti

Photo 2: The low-rise addition atop the Oceanarium nonetheless adds a significant new wind load to the structure.

The existing Oceanarium roof has two distinct structural systems. At the north and south end of the building the structure is concrete beams and columns. The center area, shown in Figure 1, consists of concrete beams and columns below the mezzanine level between grids N and F; above the mezzanine the framing structure is steel beams and columns. To the right of grid F the roof system is steel trusses spanning the Oceanarium amphitheater.

At the existing concrete roof on the north end of the building, a grillage of steel beams was added below the roof structure to provide additional capacity for the new floor (see photo 1). The grillage works in combination with the existing framing and helps to support the heavier loading requirements. In addition, the grillage is located to take advantage of the stronger existing members and supplement the weaker members.

In the center area, where the existing roof is steel beams and steel deck, steel headed studs were welded to the beam through the existing deck and along with a concrete topping created a composite steel system. Analyzing and detailing the existing steel for composite beam design achieved the required capacity for office loading. The option of reinforcing from below was reviewed, but was not possible due to mechanical constraints. It was important that the existing roof remained in place to allow operation of the facility below while this new level was being constructed.

Jeannette M. Pfeiffer, P.E., S.E., LEED AP is a senior project engineer in the Chicago office of Thornton Tomasetti, Inc. She has been with the firm for four years.

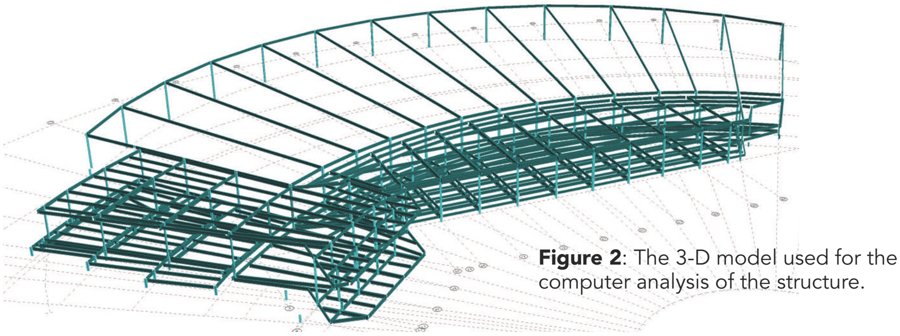
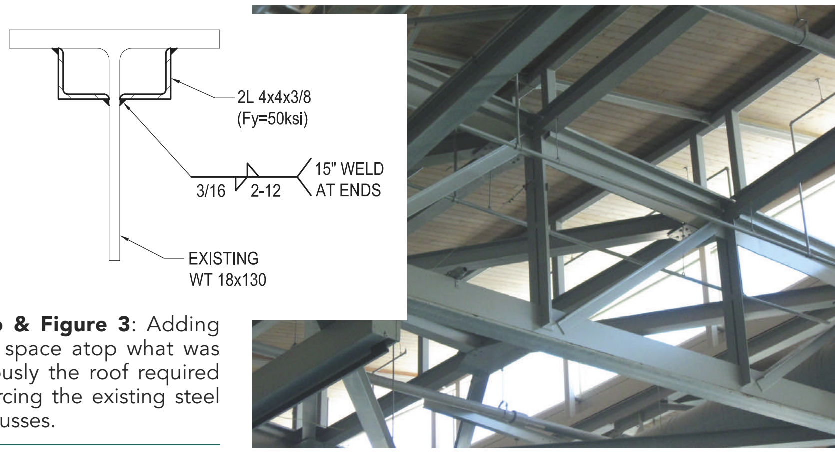


Figure 2: The 3-D model used for the computer analysis of the structure.



photos this page by: Thornton Tomasetti

Photo & Figure 3: Adding office space atop what was previously the roof required reinforcing the existing steel roof trusses.

The last challenge was transferring the wind loads from the new curtain wall down through the building to the existing foundations (see photo 2, previous page). The existing lateral force resisting system is a combination of steel trusses and concrete moment frames. A 3D analysis of the existing system determined that there was no reserve capacity for the new wind load (see Fig. 2). To resist the increased wind load, existing masonry walls were reinforced and steel braced frames were added within the building.

Truss Reinforcement

The Oceanarium amphitheater was designed for multi-species marine mammal shows with theater lights and sound. Design issues for the amphitheater revolved around the existing roof structure composed of steel roof trusses spanning more than 160 ft supported by steel columns. During the design phase it was determined that the trusses were performing at capacity and could not accommodate additional loads.

In addition to the amphitheater loads, the trusses were to be used as supports during construction. In lieu of scaffolding spanning from the bottom of the pool to the roof structure, the contractor selected a moving platform supported by the trusses to work in reinforcing the trusses and providing necessary mechanical upgrades in the roof space. Welding steel angles to the existing steel WT top and bottom chords provided the additional capacity required for the temporary condition and the new final condition. Figure 3 and photo 3 show an example of the steel angle added to the existing truss top chord. Angles were also added to select angle web members.

Construction began in the summer of 2008 for the new offices while much of Shedd Aquarium remained open to the public. Work was completed by the following Memorial Day weekend and Shedd Aquarium was again fully open to the public. Shedd is currently pursuing LEED certification. While the goal of the renovation was pool maintenance and upgrades, the animals were the primary design consideration; from accommodating their behaviors, to their weights and the support facilities that are required to feed and house these great animals! MSC

Owner
John G. Shedd Aquarium, Chicago

Architect
Valerio Dewalt Train Associates, Inc., Chicago

Structural Engineer
Thornton Tomasetti, Chicago

Construction Manager
Walsh Construction, Chicago

Steel Fabricator and Detailer
K&K Ironworks, McCook, Ill. (AISC Member)

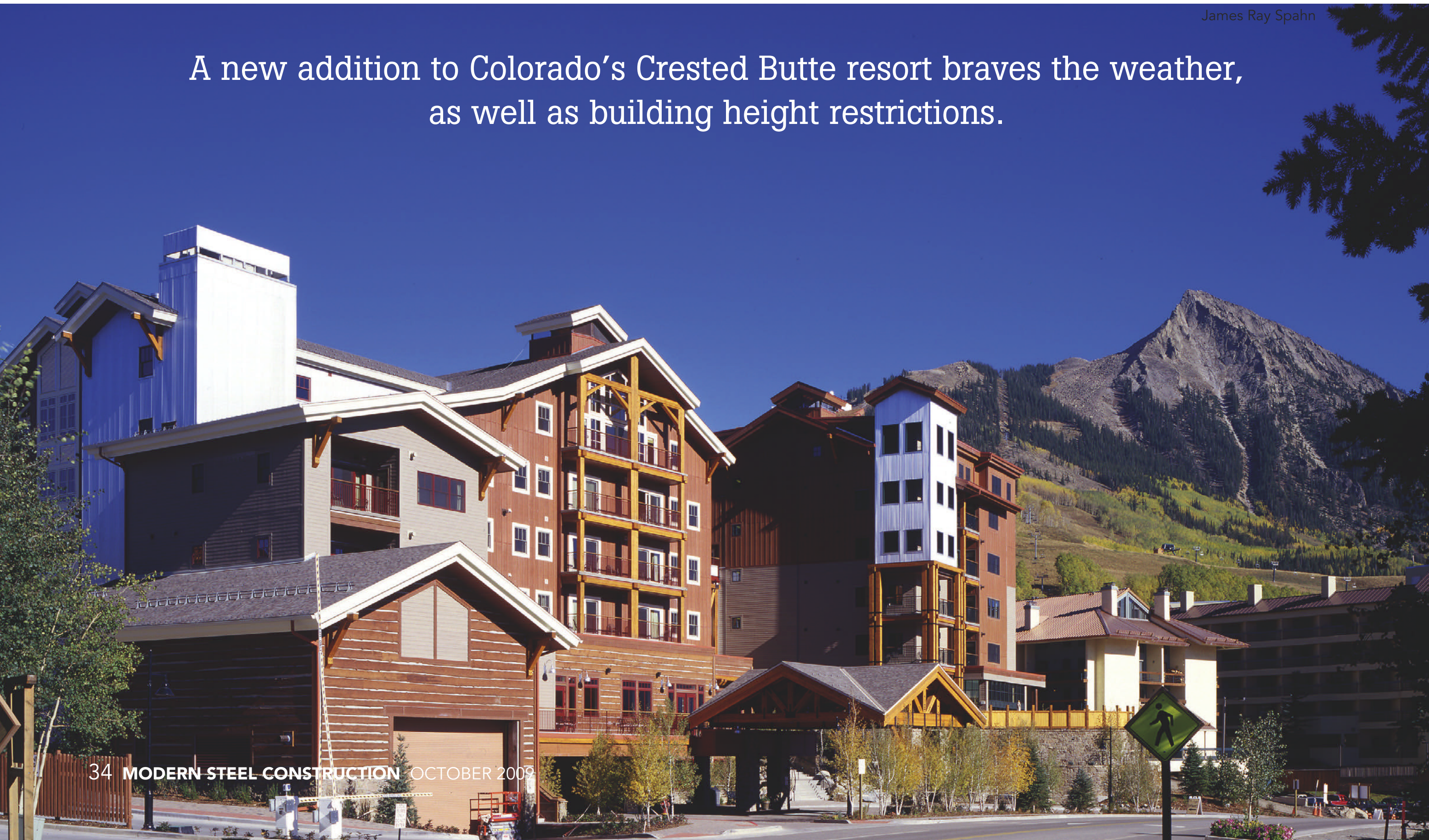
Bill Andrews

Winter Winner

BY DAVID KIRSCHENBAUM, S.E., AND WILLIAM ANDREWS, S.E.

James Ray Spahn

A new addition to Colorado's Crested Butte resort braves the weather, as well as building height restrictions.



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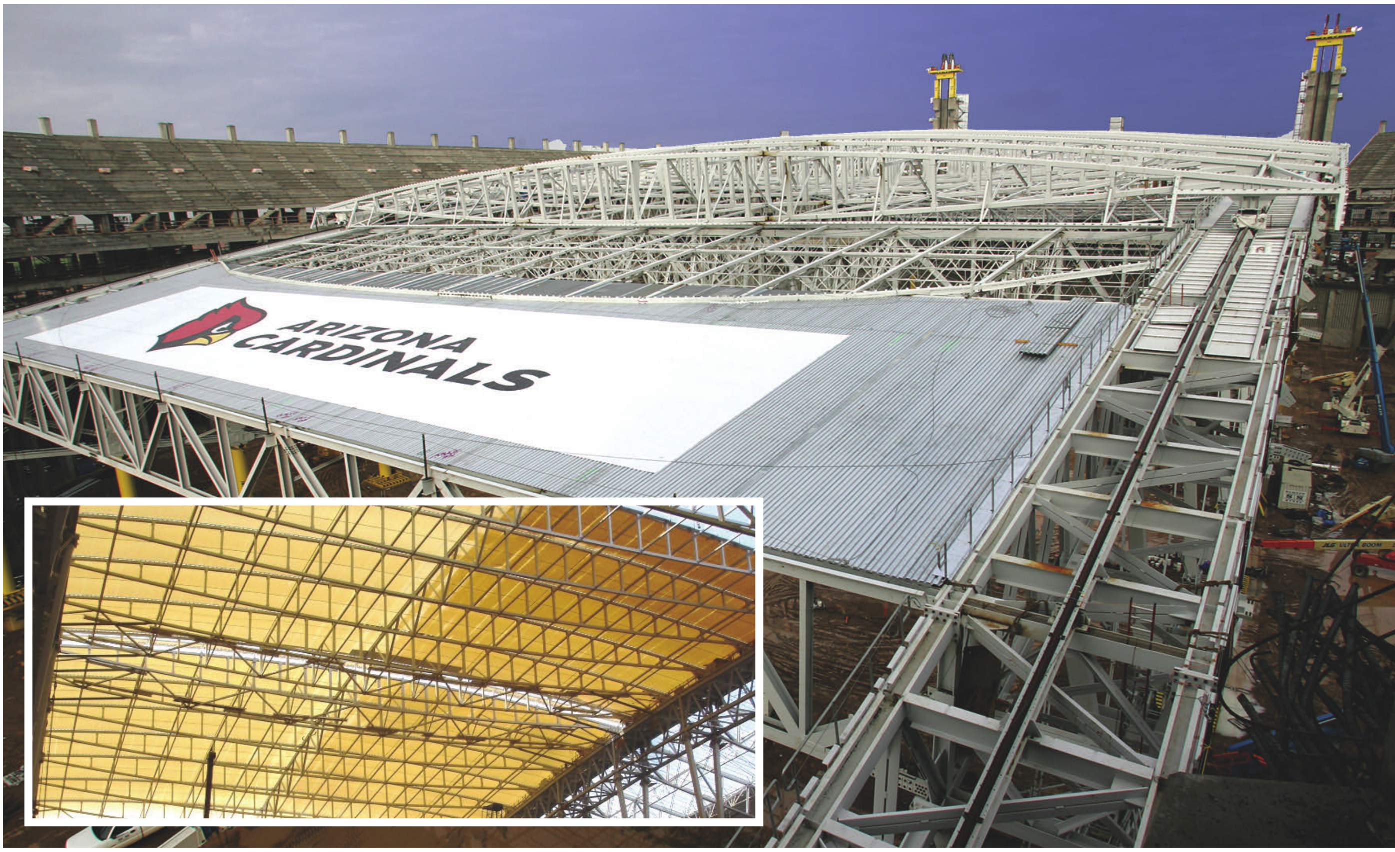

Early involvement in the University of Phoenix Stadium (2007 IDEAS^2 National Award Winner) allowed Chicago Metal Rolled Products to save their customer time and money when curving 402 tons of 12 x 12 x $\frac{5}{8}$ and 12 x 12 x $\frac{1}{2}$ tubing to radiuses from 1000 to 1200 feet for the roof trusses.

Using advanced technology, Chicago Metal curved 52 feet of distortion-free arc from stock only 54 feet long. With traditional curving methods, 6 to 10 feet of each tube would be lost to scrap. Chicago Metal's solutions also substantially reduced freight charges.

Always meeting the fabricator's schedule, the company received 213 pieces of tubing from mills, stored it clean and dry, and then curved and shipped it over the course of five months.

According to the project manager and subcontract administration manager, this project "went almost flawlessly despite its complexity and challenging schedule." A tribute to the teamwork of the roller, the fabricator and the erector.

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CRESTED BUTTE IS A BIT OFF THE BEATEN PATH compared to many of Colorado's other ski towns. But that hasn't stopped it from becoming one of the most revered and dramatic. At 9,375 ft, it is home to more than 3,000 ft of vertical drop and some of America's top extreme and elite winter athletes.

That said, the town maintains a less-developed feel than most other skiing destinations. And one of the goals of the newly constructed Mountaineer Square Lodge and Conference Center was to maintain this feel, expanding and upgrading the facilities at Mt. Crested Butte without harming the pristine natural environment or ruining the casual, small-town atmosphere.

The building is located a mere 100 yards from the ski lifts at the base of Crested Butte Mountain. The new complex incorporates regional architecture with 210,000 sq. ft of occupied space, and is composed of a "podium" structure and a superstructure consisting of two multi-story buildings sprouting up from the podium.

This overall desire to blend in with the natural surroundings and rustic atmosphere led to multiple specific structural framing challenges:

- Framing within tight floor-to-floor height limitations common for residential construction
- Framing complex, steeply-pitched roofs
- Providing a long-span, column-free ballroom space while supporting three stories above
- Staggering steel fabrication and erection to accommodate a fast-track construction schedule driven by harsh winter weather conditions.

Podium Structure

The podium consists of a large single-level underground parking basement that measures approximately 72,000 sq. ft, with parking for about 100 cars. Also housed in the basement level are the mechanical systems serving the superstructure via shafts extending vertically through the buildings.

Steel framing sloped to varying pitches supports heavy snow drift loads while also providing usable attic space.

Opposite page:

Above: The "podium" steel framing attaches to precast concrete columns in the basement level and supports a 3-in. by 16-gage steel deck and composite slab.

Below: Framed in steel, the complex gabled roofs of the Mountaineer Square Lodge and Conference Center were designed to blend in with the dramatic mountain setting.

The podium structure includes perimeter basement walls constructed with precast concrete panels, and interior precast concrete columns supported on spread footings with a floating concrete slab on grade. The outdoor plaza over the parking is subjected to heavy loads, including a robust floor deck "sandwich" of non-structural fill, waterproofing membrane, sand bed, radiant snow-melt heating tubes and pavers, as well as a 100 psf ground snow load and fire truck loads. Podium steel framing consists of 3½-in. concrete over 3-in. by 16-gage composite steel deck on W21×44 beams, spaced at 7 ft 6 in. on center, and W24×117 girders. Supplemental reinforcing steel is provided in the concrete deck to support fire truck loads. Drainage slopes are provided through a combination of sloped structural steel framing and tapered fill over the deck.

The irregular podium column layout beyond the superstructure footprint created many skewed framing conditions and some excessive end reaction loads. A number of different connection types were developed for the steel girder-to-precast column connections for the varying conditions, including single-plate bolted shear tabs welded to steel embedment plates in the precast columns, a seated connection on top of the columns, and a column haunch connection.

Superstructure

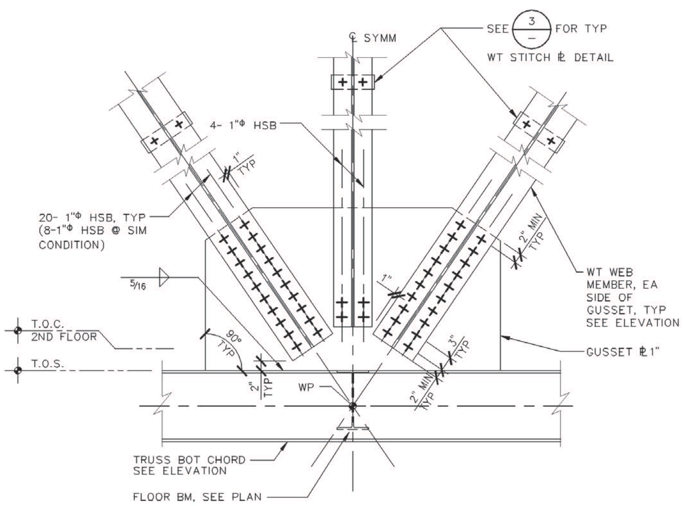
A six-story "boomerang"-shaped building and a five-story rectangular building housing the conference center comprise the superstructure. Each building features high-end condominium units (with price tags reaching upwards of $2 million), and the plaza level space features transit, retail, a fitness center, and skier services.

Due to the constraint of Crested Butte's mandated maximum 75-ft height limit, story heights were squeezed to 11 ft 6 in., leaving only 2 ft 6 in. above the ceiling available for framing and mechanical duct space. The superstructure floors are framed on a typical 30-sq.-ft grid consisting of 2½-in. normal-weight concrete fill over 2-in. composite metal deck supported on W12 beams and W16 girders, which frame to W10 columns. The 30-ft square column grid integrates well with the standard parking layout, thereby avoiding costly transfer girders. Floor vibration was mitigated by optimizing the combination of concrete floor deck and steel framing, slightly upsizing beyond service load requirements to minimize foot-fall perceptibility.

Story-height transfer trusses are enclosed in residential unit partition walls. Including a Vierendeel panel at midspan allows a corridor to pass through the truss.

The buildings' complex gabled roof structures consist of bare 16-gage, 1½-in.-deep metal deck supported on steel framing sloped to varying pitches. Steel proved to be an efficient framing material to support heavy snow drift loads while still allowing for usable attic space, with the flexibility to shape the various rake and eve overhanging conditions. Hollow structural sections (HSS) were used as secondary steel framing applications such as HSS5×5×3/8 partial-height posts and HSS10×8×3/8 tower roof members.

Resistance to wind and seismic lateral forces is provided by concrete shear walls located at building stair and elevator cores, plus other strategic locations as needed. The two buildings are interconnected via a 45-ft long, two-story steel-framed pedestrian bridge. A slip-joint connection is provided at one end of the bridge to accommodate both construction tolerances and the potential relative movement of the two building portions due to wind and seismic loads. Three-dimensional lateral analysis of the buildings was performed with ETABS, using the linear elastic requirements of the 1997 Uniform Building Code.



9 TRUSS CONNECTION DETAIL 3/4"=1'-0"

Ballroom and Conference Center

The plaza-level conference center space doubles as a ballroom and required an expansive 5,400-sq.-ft column-free floor space. The open area was achieved using story-height steel transfer trusses, with W14×145 top and bottom chords at the second and third floor levels, which span 60 ft and are integrated within the residential unit partition walls. Web diagonal and vertical members range from double WT4×15½ to double WT5×44 sections except at the mid-span, where an open 6-ft-wide Vierendeel panel allows for a walkway corridor to pass through the truss. The panel is framed with W10×45 vertical members, which are complete joint penetration (CJP) groove welded to the top and bottom chords. These trusses support a 30-ft tributary floor load above the conference center, as well as point loads from columns supporting the tributary loads of the fourth floor, fifth floor, and roof. Despite the resulting high load demands, the W14 top and bottom chords fit within the limited ceiling space, the truss live load design deflection was limited to ¼ in., and no usable floor space was sacrificed. All chord and web member end connections were bolted to minimize field welding and accommodate quicker fit-up.

Scheduling Challenges: Met

Given the fast-track schedule, the steel detailer collaborated with the structural engineer early in the design process. Steel detailing representatives visited DASSE's office to discuss various ways to refine structural steel connection details to suit the fabricator's and erector's preferences, thus making them more economical and erector-friendly. For instance, cantilever beam connections at numerous balcony and roof overhang conditions initially included CJP groove welded top and bottom flanges. However, after shoulder-to-shoulder review with the steel fabricator prior to final issuance of construction documents, this detail was modified to include a fillet-welded lapping plate across the top flanges in lieu of CJP groove welds. This detail change reduced costly field CJP groove welding and field weld inspections. Similarly, column splice connections were modified from partial joint penetration (PJP) groove welded to bolted plate connections.

Multiple design submittal packages were issued to allow foundation construction to begin as soon as the snow melted and the ground thawed. This approach also allowed the fabricator to place early steel mill orders, facilitated timely steel delivery to the site, and supported the phased schedule. The podium mill order was issued first, allowing the contractor to order the plaza level steel and begin detailing while the superstructure design was being finalized. The superstructure steel drawing package was submitted next, a mere two months after the first package. Lastly, a final building superstructure package was submitted, which included primary and secondary steel information, in addition to the completed architectural and mechanical/electrical/plumbing drawings.

The compressed construction schedule required continuation of construction through the extremely cold winter and in a relatively difficult-to-access location (Crested Butte is nowhere near an Interstate). Concrete slab pours during the cold winter days were particularly laborious, as heated tents had to be erected to achieve a favorable ambient temperature during placing and curing. Steel, by contrast, was erected relatively quickly despite record low wind chill temperatures dipping below -20 °F at times.

Up and Running

The project weathered the challenges of remote location, extreme winter conditions, low residential floor-to-floor heights, complex roof and plaza framing conditions, and achieving a column-free conference center and ballroom space—all within the overarching goal of adding new visitor space while maintaining the look and feel of a rustic, charming ski town. MSC

David Kirschenbaum is a senior project engineer with DASSE Design, Inc. (now Thornton Tomasetti) in San Francisco. William Andrews, principal-in-charge, formerly of DASSE Design, is now principal with Walter P. Moore, San Francisco. Both are AISC Professional Members.

Owner
Crested Butte Mountain Resort

Architect
BSA Architects, San Francisco

Structural Engineer
DASSE Design, Inc. (since acquired by Thornton Tomasetti), San Francisco

Steel Detailer
Podium structure: W&W Steel, Oklahoma City (AISC Member)
Superstructure: KL & A, Inc., Loveland, Colo. (NISD Member)

Fabricator
Podium structure: W&W Steel, Oklahoma City (AISC Member)
Superstructure: Cives, Roswell, Ga. (AISC Member)

Erector
Podium structure: Pioneer Steel, Inc., New Castle, Colo. (SEAA Member)
Superstructure: LPR Construction, Loveland, Colo. (AISC/SEAA Member)

General Contractor
Haselden Resort Constructors, LLC, Centennial, Colo.

Efficient Design and Spectacular Effects

BY GEORGE F. WENDT

A translucent, lightweight canopy on minimal framing energizes downtown entertainment venue.

A LIGHTWEIGHT AND SEMI-TRANSPARENT COVERING supported by a relatively open, curved steel framework creates a protected, yet light and airy, outdoor courtyard inside Kansas City's new mixed-use development known as the Power and Light District. The nine-block area is anchored by the "KC Live!" block, which is covered by a single-layer ethylene tetrafluorethylene (ETFE) membrane.

Structurflex, LLC, Kansas City, Mo., built the membrane system, the first single-layer ETFE system to be executed in North America. It is the same system used on the Beijing National Stadium—also known as the "Bird's Nest." Structurflex has a partnership with German membrane company Seele Cover (formerly known as Covertex), the manufacturer for the ETFE membrane that also designed/manufactured, and installed the membrane on the Bird's Nest. ETFE systems differ from fabrics in that they are much like a film or foil, rather than a woven fabric that is composed of a coated scrim.

Structurflex

An ETFE membrane, the first installed in North America, provides 75% transparency revealing the surrounding skyscrapers in downtown Kansas City. Structurflex partnered with Seele Cover who provided the same system for the Beijing National Stadium, also know as the "Bird's Nest." The membrane required far less structural support than a glass or metal-clad canopy.

Pneumatic ETFE membrane systems have been used extensively in Europe for the past decade. The Allianz Arena in Munich is a recent major application completed by Structurflex's manufacturing partner, Seele Cover. The German firm also pioneered the application of ETFE films for true tensile membranes where it was first used in large scale on the AWD Arena in Hanover, then more recently at the Beijing National Stadium. In all applications, the accuracy and sophistication of the structural steel support system is of paramount importance for the successful performance of the membrane system.

The Kansas City Live! canopy was designed to provide protection from rain and snow, to offer some shading and to define the space. The original concept of a glass roof greatly exceeded the project's budget. A conventional steel canopy was then considered, but the large and heavy structure coupled with a galvanized metal deck would zap away the energy that the space was meant to generate. The client had obvious requirements for lightness and transparency.

Structurflex proposed a turnkey system for the design, engineering, membrane, structure and construction of the canopy. Being able to offer both fabric and ETFE was a definite advantage: both options required less structure—and therefore less cost—than a glass or metal-clad canopy. The steel weight—about 100 tons—is 30% to 40% lighter than that needed for a glass canopy or that needed for a steel deck due to the fact that no purlins were needed. Using cables instead reduced not only weight but also the fabrication and installation costs. The cables also enhance the filigree appearance of the structure. The total cost was substantially less than a metal deck canopy and less than half the price of a glass canopy.

After extensive design collaboration with the owner and architect, ETFE was settled upon. The notion that this would be the first single-layer ETFE system in the Americas was actually an incentive for the owner to be a part of a groundbreaking system.

The canopy is 191 ft by 138 ft in plan; the arc of the top chord is 142 ft in length; the truss is 7 ft deep; the large bay has a 45-ft span while other bays have 36-ft spans; and the end overhangs have an 18-ft cantilever at each end. With a 65-ft elevation from street level to apex, the membrane covers some 27,000 sq. ft.

The membrane has a silver fritted reverse dot print in order to provide a certain level of shading. The fritting was also important to achieve nighttime lighting effects through an LED lighting system that covers the entire color spectrum. This design allows for the

Right: Chicago Metal Rolled Products rolled angles and 48 sections of 10-in.-sq. HSS rolled on complimentary radii that facilitated their integration by Collins & Hermann into the top chord of the framing for the canopy over Kansas City Live!

Inset: Using 10-in.-sq. HSS simplified both the erection of the steel and the subsequent attachment of the canopy fabric. Photo: James Visser.

Below: In erecting the Kansas City Live! framework, two cranes each having a reach of 170 ft, used radio communication for blind lifts of 11,000 lb truss sections from surrounding streets and over two-story buildings. Photo: James Visser.

Structurflex

James Visser

James Visser

canopy to constantly change its color throughout an evening to provide a truly lively and dynamic feel. It was also important to maintain enough transparency to see the surrounding downtown high rises as well, so that the feeling of being in the urban core was not lost. The reverse dot print provides approximately 75% translucency and achieves all of the aforementioned design criteria.

With 336 cable assemblies ranging from 5⁄16 in. to 7⁄8 in. diameter and all 1×19 construction integrated into the membrane and with stainless steel end fittings, the system can easily handle the live loading conditions that will be imposed by dramatic Midwest seasons.

Chicago Metal Rolled Products (CMRP) curved the roof members for the structural steel fabricator using both its Kansas City and Chicago plants. A number of different sections were considered for the structure including 12-in. standard pipe and 10-in. square hollow structural sections (HSS). To simplify the connections and the interface from the membrane system to the structural steel, the design settled on 10 in. × 10 in. × 0.3125 in. HSS.

Chicago Metal's Chicago plant provided 28 sections of the HSS rolled to a 160-ft 8.5-in. outside radius and 20 sections of the same size tube rolled to a 153-ft 8.5-in. outside radius. Material arrived on a Friday and on the following Tuesday two truckloads delivered the 32-ft to 48-ft-long curved sections to the fabricator, St. Louis-based Collins & Hermann.

The top chord required angles to be integrated in order to accept the cables and facilitate a seamless method of clamping the membrane. Chicago Metal's Kansas City plant rolled 41 pieces of 5 in. × 3 in. × ¼ in. angle and eight pieces of 3 in. × 3 in. × ¼ in. angle, 40 ft to 43 ft long, to a 160-ft 11.5-in. outside radius leg and sent them directly to the jobsite. Using two plants minimized transportation costs and saved time.

Erecting the structure was also done by Collins & Hermann and was the most challenging construction element of the $275 million development: two cranes were required, each with a reach of 170 ft from the surrounding streets. Always lifting over the top of surrounding two-story buildings, the crane operators did the lifts "blind" while relying on radio communication. To avoid vehicular and pedestrian traffic, much of the work was done on Friday nights and over weekends. Another challenge was managing the weight of man lifts within the structure because a parking garage had been constructed below.

An advantage to the membrane installation was that it was sectionalized into 12 panels thereby allowing other construction trades to

George Wendt is president of Chicago Metal Rolled Products (www.cmrp.com), which in 2008 celebrated 100 years of curving steel. He frequently writes and lectures on curving structural steel for architects, engineers, and structural steel fabricators.

James Visser

The arched trusses were fabricated with beams curved by Chicago Metal Rolled Products. The accuracy and the sophistication of the structural steel support system is of paramount importance for the successful performance of the membrane covering this canopy.

work beneath in other areas of the structure. The system installation was so efficient that it did not hinder any other trades on the project.

The single-layer translucent ETFE membrane system over a steel frame has become a Kansas City landmark that defines the city's most vibrant gathering point. KC Live! borders the new Sprint Arena with its transparent glass curtain wall framed by 16-in. pipe that was also curved by Chicago Metal Rolled Products (MSC, July 2008). The views of activities both inside and outside the Power and Light District contribute to the excitement of an area adjacent to the city's tallest sky scrapers. This oasis attracts locals and tourists at the end of a work day, before and after major sporting events and concerts, or simply for a night on the town. According to the Kansas City Business Journal, more than 6 million people visited the venue in 2008, its inaugural year.

The architectural effects of the project have resonated well throughout the Kansas City architectural community and beyond. Architects, designers, owners and contractors now see this as an efficient and smart alternative to other systems. An inherent virtue of the system is that it incorporates "green" and sustainable attributes, key issues for the owner. This project won the highest award of the Industrial Fabrics Association International for 2008 in the category of commercial canopies. MSC

Owner
The Cordish Company, Baltimore

Structural Engineer
Wayne Rendely, P.E., Huntington Station, N.Y.

Architect
William E. Johnson, AIA, 360 Architects, Kansas City, Mo.

General Contractor
Structurflex LLC, Kansas City, Mo.

Cable Fabricator
Ronstan International Inc., Portsmouth, R.I.

Roller/Bender
Chicago Metal Rolled Products, Kansas City, Mo., and Chicago

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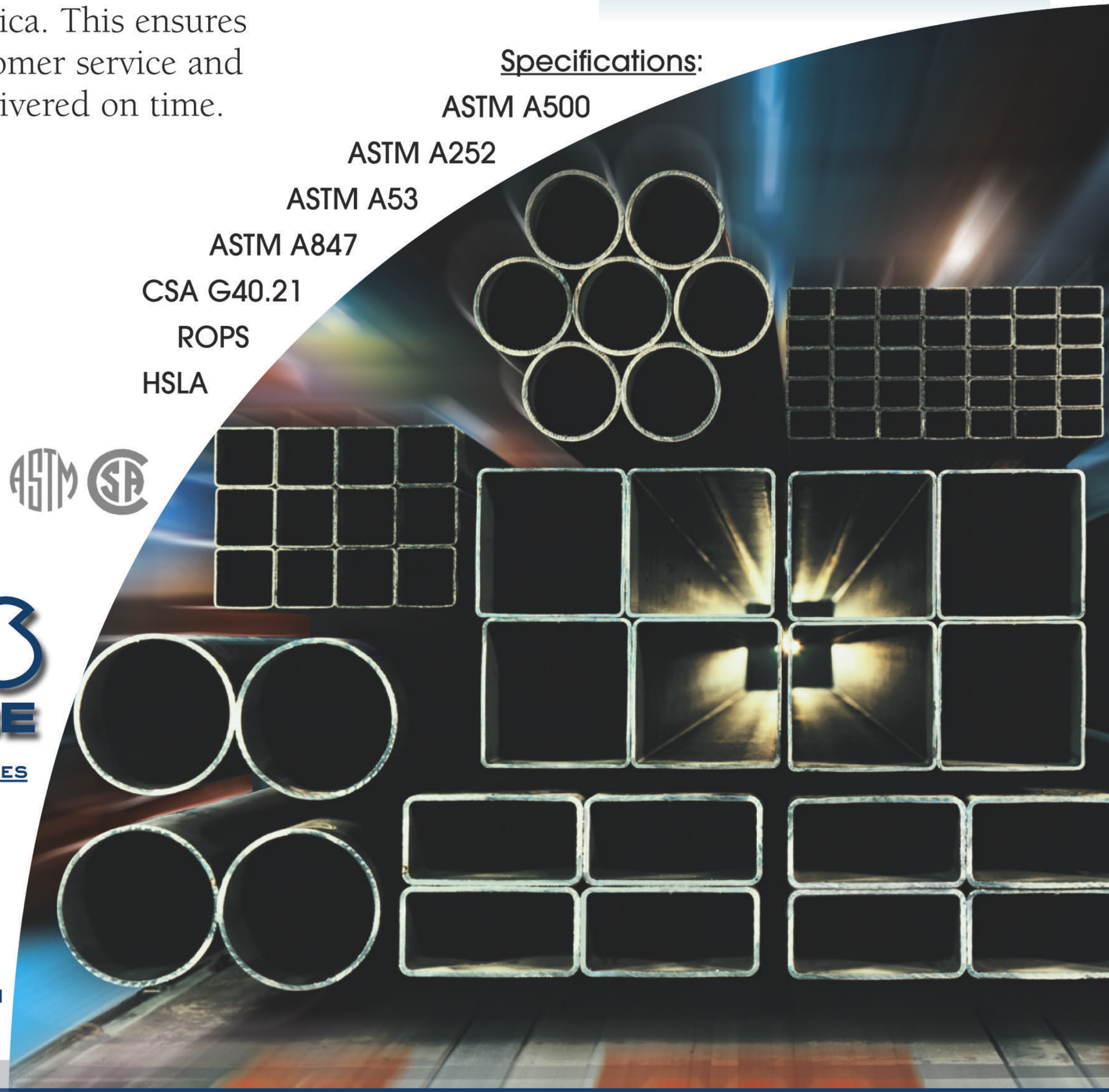

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Bending Considerations in Steel Construction

BY RUSS BARNSHAW

Incorporating curved members in structures adds value—and flare.

IT HAS BEEN POSSIBLE AND PRACTICAL, especially since the mid-1980s, to curve structural sections to form arches and curved elements for steel structures. This has given architects and consulting engineers greater freedom to design buildings that are both functional and attractive.

By definition, the act of bending steel changes the member's geometric properties. However, it also changes its mechanical properties, as well as its cost and value. Let us consider the effects some of these changes individually.

Metallurgical Changes

The most common question that arises is what happens to the steel when it has been rolled into a curve. When steel is cold rolled, it is taken past the yield point to create a permanent change in shape. This results in some strain hardening and subsequently the material properties are changed. The material shows some loss of ductility with a reduced percentage elongation and a reduction in the Charpy V-notch impact values. However, the steel exhibits the same elastic characteristics in the elastic range as it did before the bending process.

Therefore, the way to quantify the degree of strain hardening is to calculate the percentage of strain.

For example, the percent strain created when a section of depth D is curved is

$$\frac{D \times 100}{2R}$$

where R = mean radius
and D = the section depth.

Thus, an 18-in.-deep beam rolled to an 80-ft radius gives a percent strain of

$$\frac{18 \times 100}{2 \times 80 \times 12} = 0.94\%$$

From our experience you can curve steel sections up to approximately 3% strain before the properties are reduced below those of the specification of the unworked sections. This is about as small a radius as can normally be achieved for steel beams about the major axis.

Minimum Radius and Tolerances

We often are asked what the minimum radius is for a curved section. This apparently simple question does not have a simple answer, however. The actual minimum radius depends on many factors. For example, does the application of the curved member permit any distortion of the cross section, or is none allowable?

Each wide flange beam series has a range of flange and web thicknesses and it is generally easier to bend the heavier sections. General guidance is provided in Table 1. For specific advice, talk directly to a steel fabricator or bending specialist.

Table 1
Typical Steel Sections Curved about the Major Axis (50 ksi)

W-Shapes (Wide Flange Beams)	Minimum Bend Radius
W 24 x 176	70 ft
W 21 x 73	50 ft
W 18 x 60	42 ft
W 12 x 136	20 ft

Beams naturally can be curved more easily about the minor axis than the major axis, although bending about the major axis is the way most curved beams are used in steel construction. It is always advisable for consulting engineers to check with a steel fabricator or bending company to confirm that they can curve a section of a particular size.

It is easy to get confused about the way a section is bent. Using such terms as hard-way, easy-way, toe-in-angle, toe-out-angle and so on can give rise to errors. The best solution is to send a drawing or sketch to the bender and this usually clarifies what is required.

In our experience the typical tolerance on a curve is ⅜ in. on the radius. For cambers the tolerance is ± ¼ in. up to 24 in. deep and ± ⅜ in. on larger beams. There is, incidentally, no truth in what is sometimes said about cambers opening back to straight beams due to a journey by truck. The bending forces required to bend the beam in the shop are far greater than any of those caused by any jostling about in transit.

Costs of Curved Steel

Much of the steel construction industry figures costs in terms of price per unit weight. That creates a problem for the bending company because it takes a similar amount of time to curve a heavy weight and a light weight beam. The heavier beam can therefore be curved at a much lower price per unit weight.

It is much better to think in terms of bending as a cost per curved section. Naturally, in the end you can convert the cost to dollars per unit weight, but you will see a big variation between projects when it is expressed in this way.

The Architect's Pleasure

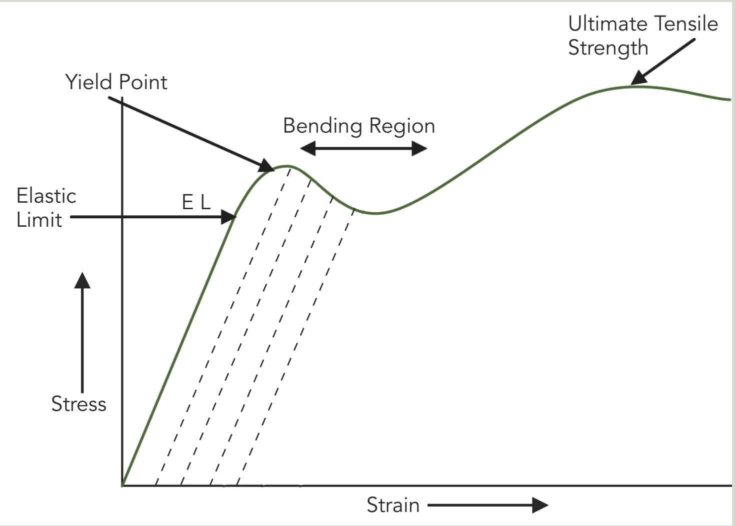
Curved steel sections have been employed in many structures and many award-winning structures involve curved elements as one of their main features. You do not need many curved pieces to make a considerable change in the appearance of a structure.

Curved structures are ideal for certain types of structures, for example, railway stations, airport terminals, exhibition halls, shopping malls and sports stadia. It is these structures that are required in a modern world—As people-holding structures they are seen mainly from the inside and the curved elements create ceiling forms that enhance the experience of being in the building.

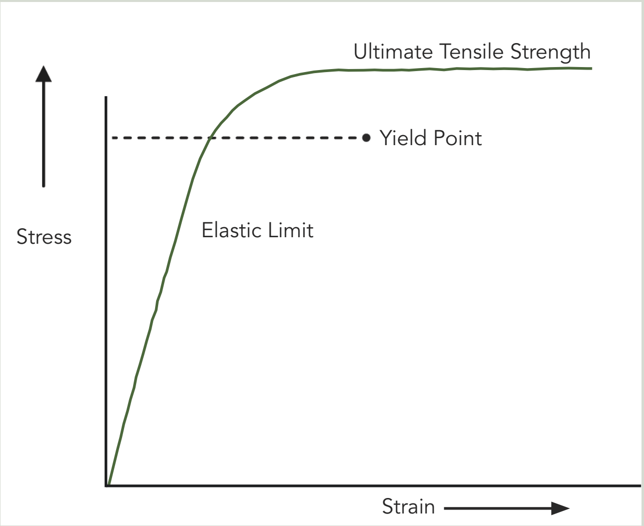
Architects are of course aware of steel's essential properties and characteristics, but AISC and other industry groups continually work to increase awareness of why steel framing is an attractive solution. Steel-framed buildings are generally light, which reduces foundation loads. The buildings also are

*Russ Barnshaw is chairman of Barnshaws Section Benders, based in the U.K., has been involved in section bending for more than 50 years. Barnshaws Group (**www.barnshaws.com**) has six bending plants in the U.K., employing 180 people, and has a turnover of around $25 million (U.S.).*

During bending, the steel section must be subjected to a stress that exceeds both the elastic limit and the yield point. The elastic limit is the maximum stress that the material can be subject to before a permanent change in the material length occurs, either stretching in tension or compaction in compression.



Plastic bending takes place in the zone marked "Bending Region." The dotted lines show how the material will spring back when the bending load is removed. The spring back reduces as the strain is increased.



After bending, the stress-strain curve takes a different shape. The yield plateau disappears and you see an increase in both the yield point and the Ultimate Tensile Stress (UTS).

much quicker to erect and require less site work. The material is almost 100% recyclable and is sustainable.

The introduction of accurate, smooth curved elements adds to this attraction, so the roller bender plays an important part in the steel construction industry and in its ability to compete with other forms of construction.

Closing Notes on Communication

With the increasing use of e-mail communication bending companies can receive early structural designs and quickly respond regarding the bendability of the sections proposed. This requires greater skill sets within the bending companies, including having sales people who are familiar with the use of CAD in order to respond electronically to inquiries—sometimes relating not only to the section but to the profile evaluating shapes being proposed. It also facilitates substituting alternative, more easily bendable shapes at an early point in the design.

As in all facets of design and construction, clear and open communication among the participants throughout the project is a keystone of success. And including curved structural sections often makes that success even better. MSC

photos by: New Millennium Building Systems

Raising Expectations

BY MICHAEL ROACH, P.E.

New design freedom for architects and engineers, and a growth opportunity for steel joist manufacturers.

TWO YEARS AGO, when engineers at New Millennium began developing a new architecturally oriented steel joist catalog, we thought it would be straightforward enough. By expanding the engineering specifications for gable, bowstring, scissor, and arch type steel joists, we believed architects could more readily achieve their most creative roofline designs using steel joists rather than alternative structural materials.

Thousands of engineering hours later, and after seemingly countless rounds of calculations and validations, the catalog became a reality. It wasn't so straightforward a task after all, but the purpose of the project has stayed the same. Using this specialty catalog, professionals have the creative freedom to specify special profile steel joists with the confidence of a design specification written with this purpose in mind. Hundreds of architects, engineers and fabricators have asked for the new catalog, and while we hope the catalog will benefit our business, the fact is that no joist company can own an engineering specification.

In the long run, and looking at the big picture, what's good for the steel industry is good for all of us. The opportunity fabricators have, once they recognize a simple truth regarding architectural roofline designs, is this: Specifying professionals need to be shown what is possible with steel joists, and how to open up and explore the possibilities.

Architectural schools for years have been teaching cost-accountable design. As a result, early conceptual sketches of novel roofline designs are soon tempered by engineering and fiscal realities.

Early in the design process, an architect will look to a structural engineer for a reality check. In turn, the engineer

Both pages: Steel joist design possibilities are endless when you consider various joist profiles, loadings and applications. These possibilities rise from four distinct joist profiles: gable, bowstring, scissor, and arch. An architect's vision often can be cost-effectively met during the early design stage of a project, based on one of these four types, a variation of one type, or a combination of types.

will look to the specification tables of various suppliers (perhaps not just steel, but other materials as well) to assess the concept's feasibility and cost. These specification tables are very likely the same tables used in the past, mostly because the engineer is familiar with them.

Moreover, there are bigger reasons an engineer will look to the tables. Straying from well-worn specification tables may seem risky. And given the fact that so many incomplete structural drawings are being handed down to fabricators, it is clear that fewer structural engineers are in a position to push the design envelope.

Whether for reasons of reduced engineering fees and fewer funded design-engineering hours, the tendency is to be creative only so long as creativity stays within the boundaries of a familiar, tried-and-true set of structural specification tables.

Enter into the design process an opportunity for fabricators to show architects and engineers greater design possibilities using steel joists. The new catalog includes more than 40,000 special profile steel joist designs—more than 10,000 designs for each profile. The tables include a wide variety of possible geometries for spans from 10 ft to 150 ft and include guidance on design considerations such as load, span, seat depth, bridging, and horizontal deflection. Whether for aesthetic architectural reasons or to help owners and developers reduce project cost, the specialty catalog offers a breadth of tools upon which fabricators may capitalize.

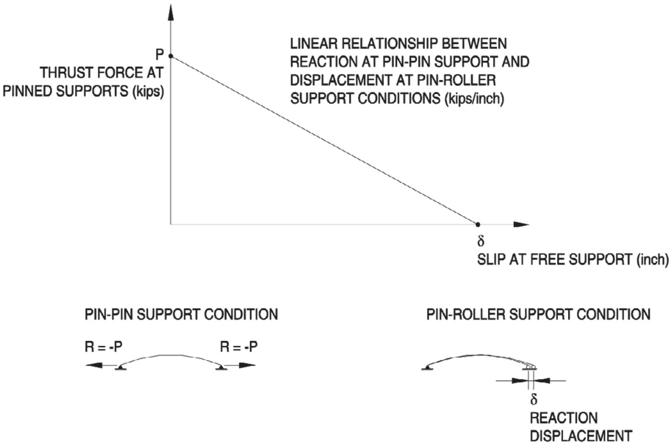
Accounting for Additional Stress

In the process of writing an expanded specification for special profile joist designs, we addressed several engineering problems that have long been neglected in the realm of published technical documents pertaining to steel joist design.

One of these issues is in regard to rolled chords. At the core of any structural analysis package is a stiffness matrix created in the modeling of the structure (e.g. truss, joist, girder, etc.) The matrix mathematically represents the stiffness properties of the structure being analyzed. All of the node-to-node forces occur along a straight-line, or node-to-node, distance.

Joists with rolled chords are therefore analyzed as joists with multi-pitched chords, where the web-to-chord location is correct but between the chord nodes there is a divergence of the linear element from the actual rolled structural element

Michael Roach, P.E., is an engineering manager with New Millennium Building Systems, Lake City, Fla. Rivers Claytor, Michael Winarta and Carl Pugh assisted in developing the company's new Special Profile Steel Joist Catalog. *You can reach Michael Roach at* ***michael.roach@newmill.com****.*



The new catalog includes text and illustrations providing guidance on design considerations such as load, span, seat depth, bridging, and horizontal deflection (shown here). graphic by: New Millennium Building Systems

(usually a pair of angles). The forces created by this condition may be visualized by imagining the forces that exist in an archer's bow. The compression in the bow is balanced by the tension in the string, but within the bow there is a secondary bending stress that occurs due to the divergence of the member from the line of force in the string. A similar condition exists between every panel point of a truss with rolled chords members. In the New Millennium Standard Specification, SP-Series, this stress condition was given the term "divergence stress" and added as a component to be included in the design of rolled chord elements.

Another structural condition that we frequently design for is that of a pitched or rolled bottom chord and a pin-roller truss anchorage condition. Such conditions require close coordination between the engineer of record and the joist engineer. Our special profile joist catalog specification provides a more thorough discussion of this topic than previously available.

The key concept that both the specifying engineer and the joist engineer should remember is that if the joist anchorage at each end is fixed by means of welding or slip-critical bolting, the horizontal displacement present in the structure is a function of the combined stiffness of the joists and the supporting structure along the direction of horizontal thrust or slip.

If the engineer of record requests that there be very little slip, there must be a mechanism in place to resist the thrust forces. The most common means of achieving this is by means of a tension tie. This mechanism effectively turns the entire joist (as fabricated) into a built-up top chord element, and the tie provides the tension. In this manner, the effective depth of the section becomes very large, and the resulting bending forces required to generate the bending moment are greatly reduced. Subsequently, the design may be more efficient and more economical.

Innovation Before Standardization

In the history of our industry, non-standard design has always been at the discretion of the manufacturer, well before such innovations have been refined and accepted as common practice. So it has been with the adoption of higher strength steels, the use of expanded standard joist load tables into longer and deeper products, the creation of custom designs using computer technology, the use of joist girder products as economical replacements for rolled beams, along with joist substitutes and composite joists.

Industry leaders establish standards by way of innovation, so that the innovations of today become standards for tomorrow. With the *Special Profile Steel Joist Catalog*, architects, engineers, and fabricators have an opportunity to prove this yet again. MSC

Protecting Steel at High Temperatures

BY DALE P. BENTZ AND CHRISTOPHER C. WHITE, PH.D.

NIST researchers are developing new ways of testing and measuring fire-resistive materials.

FIRE-RESISTIVE MATERIALS (FRMS) perform a critical, life-saving function in buildings and structures, yet have received surprisingly little attention from the scientific community. At the National Institute of Standards and Technology (NIST), our goals have been to provide the measurement science infrastructure for assessing FRM performance and optimizing the abilities of these materials to protect steel structures during fires.

Some examples of FRMs are low-density gypsum or cement-based materials containing fibers or lightweight fillers. Other examples include intumescent coatings that may expand up to 40 times in thickness during exposure to a fire (see Figure 1).

The two major performance objectives of an FRM are to provide thermal protection (insulation) for the steel that it is safeguarding and to remain in place prior to and during an exposure to fire. With these objectives in mind, NIST's Fire Resistant Materials for Structural Steel project has focused on the measurement of the thermal and adhesion properties of these materials. As a validation of this research's high relevance to industry, we recently completed a successful three-year consortium entitled "Performance Assessment and Optimization of Fire Resistive Materials," with industrial participation from the American Iron and Steel Institute, Anter Corporation, Barrier Dynamics LLC, Isolatek International, Lightconcrete LLC, PPG, and W.R. Grace & Co.

One major accomplishment of the FRM project has been the drafting and subsequent approval (in September 2007) of a new test method that has been published by the ASTM International standards organization as ASTM E2584. This new test method measures the thermal conductivity of these materials at elevated temperatures using a methodology developed at NIST. This technology has been commercialized by a U.S. manufacturer of thermal testing equipment and the NIST experimental setup has been duplicated by several independent testing laboratories around the world. Currently NIST is coordinating an interlaboratory study to establish a multi-laboratory precision statement for the standard practice, with nine participants from the U.S. and Canada.

Figure 1. Commercial intumescent coating specimen prior to (left) and after testing in the slug calorimeter high-temperature experimental setup at NIST.

Dale P. Bentz is a chemical engineer in the Materials and Construction Research Division, National Institute of Standards and Technology (NIST), Gaithersburg, Md. He is a member of ASTM International, the American Concrete Institute, and RILEM, and serves as associate editor of the journal Cement and Concrete Composites. *His research interests include experimental and computer modeling studies of the microstructure and performance of cement-based and fire-resistive materials.*

Christopher C. White, Ph.D., is a research chemist in the Materials and Construction Research Division, National Institute of Standards and Technology (NIST), Gaithersburg, Md. He is a member of ASTM International and RILEM. His research interests include experimental studies for the service life prediction of materials exposed to outdoor weathering, and the durability of adhesives and adhesively bonded materials such as fire-resistive materials.

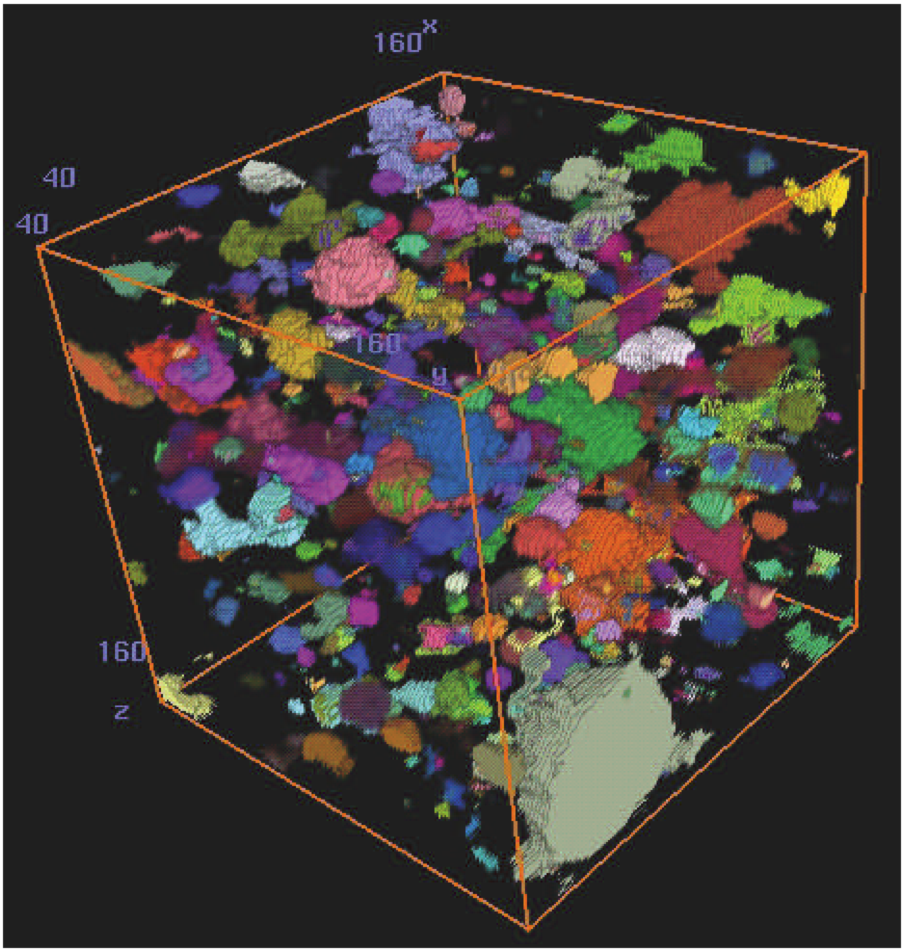


Figure 2. False color rendering of the individual pores in a gypsum-based fire-resistive material (FRM). Dimensions are 120 by 120 by 120 voxels (3D pixels). Voxel dimensions were 0.0273 mm in the x and y directions and 0.0361 mm in the z direction.

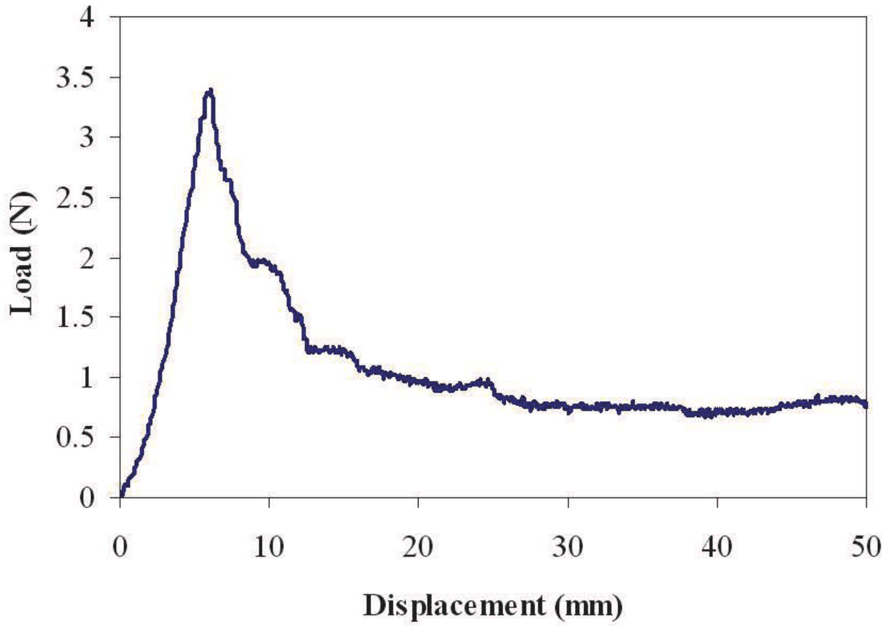
Other Results

Another significant accomplishment has been the development of a quantitative methodology for characterizing FRMs with respect to inputs for thermal performance models. We have recommended methodologies for obtaining thermophysical properties needed for computational thermal models, including density, specific heat capacity, thermal conductivity, heats of reactions and phase changes, and total emissivity.

We also have demonstrated x-ray microtomography as a powerful technique for characterizing the 3D microstructure of FRMs (see Figure 2). In this area we have employed the computational tool known as finite difference algorithms. Using this tool we accurately compute the thermal conductivity of FRMs as a function of temperature, based on a 3D microstructural representation of the porous FRM obtained using x-ray microtomography.

Finally, we have used fire testing of a bare steel column at a national testing laboratory to establish the appropriate viewing factor to use

Figure 3. A typical load-displacement plot for a steel/SFRM joint tested using the newly developed laboratory test method. Typical crack velocity was 0.4 mm/s.



for radiative transfer in computational thermal models. These tests showed that a viewing (safety) factor of about 0.45 was necessary to reduce the computed radiative contribution to energy transfer from the fire to the steel, in order to fit the measured temperature rise data for the steel column. This value is in reasonable agreement with factors determined previously for European test furnaces.

Will it Stick?

Adhesion research has focused on the development of new testing methods for both laboratory and field use. A new test method for lab use has been drafted and submitted for consideration to the ASTM E06.21 subcommittee on Serviceability. Entitled "Standard Test Method for Measuring Fracture Energy of Spray-Applied Fire-Resistive Materials Applied to Structural Steel Members," it is based on the simultaneous measurement of load and crack opening during a peel-type test to remove the FRM from the underlying substrate. A movie demonstrating this test method has been produced and is available at **http://concrete.nist.gov/FRMexp8.swf**. Typical load-displacement results obtained during the testing of a steel/FRM joint are provided in Figure 3.

Concurrently with the development of a laboratory test method, research has focused on the creation of a field test

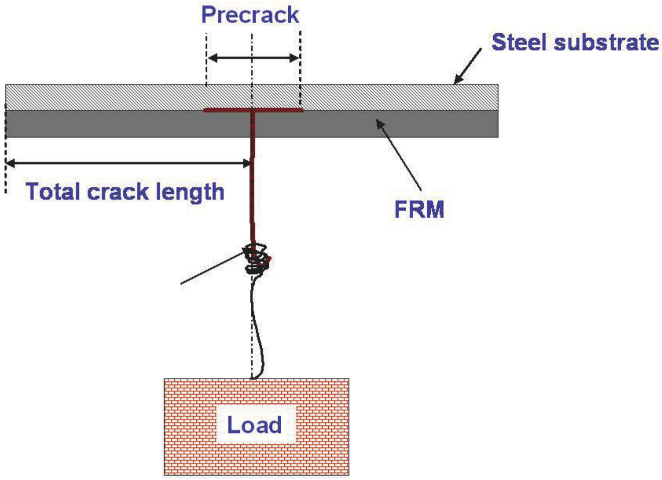


Figure 4. Schematic representation of the proposed field test method for measuring the fracture energy of the FRM/steel system.

method that would also provide a measure of the fracture energy of the FRM-steel system in real-world conditions. A prototype for a field test method to replace the so-called "mayonnaise cap" test (ASTM E736) has been successfully demonstrated. It consists of a cylindrical pin that is attached magnetically to the steel substrate prior to the application of the FRM. After application and curing, at a desired testing age, a simple loading test is conducted to measure the fracture energy of a known tested cylindrical area (see Figure 4).

As with the conventional E736 test method, sample isolation remains an unresolved issue. Possibilities to be explored further including cutting through the FRM to the steel surface using a circular template or placing a square section of release paper with a circular hole between the FRM and the steel at these testing locations prior to the FRM application to facilitate the isolation process. In the near future, the adhesion research will use these new testing protocols to examine the critical adhesion performance of these materials at high temperatures. Preliminary results indicate a substantial decrease in bond strength when these systems are exposed to elevated temperatures in a furnace.

Reports summarizing the research conducted during the course of this project can be conveniently found at **http://concrete.nist.gov/monograph/** under Part II: Fire-Resistive Materials. The development of the new test for assessing thermal conductivity at elevated temperatures also has been featured in the NIST Tech Beat (available at **http://www.nist.gov/public_affairs/techbeat/tb2008_1001.htm#slug**) and highlighted in the Federal Laboratory Consortium (FLC) newsletter (available at **http://www.federallabs.org/news/top-stories/articles/?pt=top-stories/articles/1108-01.jsp**). MSC

Evolution's Next Step

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

Welcome to AISC's new and expanded steelTOOLS—now with social/professional networking.

STRUCTURAL ENGINEERING CAN JUSTLY be described as a "tried and true" profession. Although innovation does occur regularly in our profession, the basic fundamentals of structural engineering are rooted deep in our history. Prior to advanced computer programs, nearly all analysis was done by hand. Still today, traditional methods are used frequently for back-of-the-napkin calculations and for checking software output. Advancements in technology have allowed us to do more sophisticated analysis to account for second order effects and complex lateral load systems. Efficiency with design speed also has improved, especially when analyzing and designing large structures with a high number of load combinations. The core concepts of structural engineering have not changed, but the tools we use to perform the work have vastly improved over time. The resulting faster and safer designs have enabled engineers to meet the schedule demands of the commercial and infrastructure boom over the last 50 years.

Commercially available software has made a profound impact on the design and detailing of nearly every notable structure in the United States today. However, shortcut spreadsheets and macros—designed to streamline calculations and perform tasks outside of the software's limitations—also have served an important role in optimizing the designs of those same structures. Many structural engineers and detailers alike have developed entire suites of design spreadsheets to streamline their daily work. For example, you or your co-worker may have a spreadsheet for wind load calculations, another for base plate design, and a macro for estimating beam sizes. Some of these tools are based on lessons learned in practice, current material availability, or fabrication allowances and tolerances that commercial software doesn't account for. Even as software capabilities continue to expand, these shortcut tools will continue to play a vital role in the design process.

Recognizing the importance of design aids, several years ago AISC developed Steel Tools, a series of automated calculators that helped designers arrive at an optimal solution quickly and easily for a wide variety of design challenges such as initial beam and column sizing. An engineer could download a Steel Tool from the AISC website (for free) and use it in his/her daily work as an alternative to back-of-the-napkin calculations, especially dur-

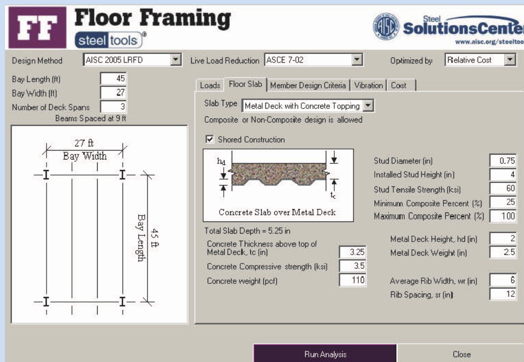
Tabitha Stine is AISC's director of techincal marketing. She encourages all MSC readers to participate in the steelTOOLS website. Please logon to the site, and become her "contact" on steelTOOLS. ***The first 10 people who add Tabitha as a friend and send her a message on steelTOOLS mentioning this article will receive $10 gift cards to Best Buy*** *to assist you in expanding your technological "tools" for social networking at home or work!*

A Few Samples from steelTOOLS

Many helpful tools are already available on **www.steeltools.org**. Some of our favorites currently on the site include:

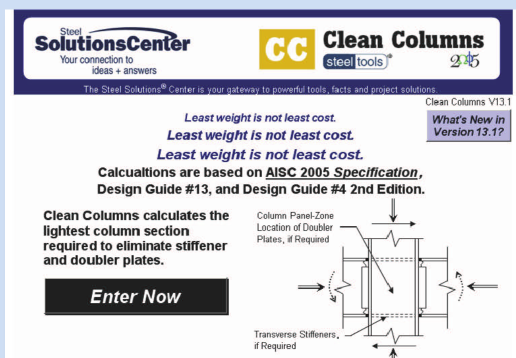
1. Floor Framing (posted by Steel Solutions Center)

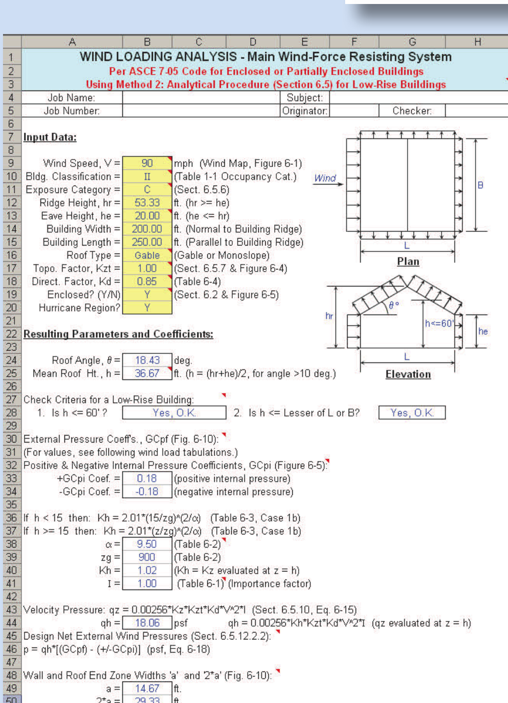
Floor Framing was written and released a few years ago by the AISC Steel Solutions Center. Floor Framing can help engineers optimize preliminary interior bay steel floor framing designs, based on either the overall weight or the relative cost of the framing system. Each evaluation is based on strength, deflection limits, and vibration criteria for walking excitation based on AISC Design Guide 11, *Floor Vibrations Due to Human Activity*. Each run takes less than a minute, so inputs such as slab density and thickness, beam spacing, and loading can quickly be changed to optimize the floor framing.



2. Clean Columns (posted by Steel Solutions Center)

With Clean Columns, users can quickly find the minimum weight column section that can be used without stiffeners and/or doubler plates to develop a specified moment. This tool is based on the criteria presented in AISC Design Guide 13, *Stiffening of Wide-Flange Columns at Moment Connections*, and applies in wind or low-seismic applications. After the user inputs the connection forces, this tool takes only a few minutes to identify the lightest unreinforced structural steel column section.





3. ASCE 7-05W

(posted by Alex Tomanovich)

This spreadsheet program can be used to determine wind loads for buildings and structures per the ASCE 7-05W standard. Specifically, wind pressure coefficients and related and required parameters are selected or calculated in order to compute the net design wind pressures.

ing the early stages of a project. Steel Tools quickly became very popular among the design community.

AISC also recognized that designers have their own personal sets of similar design shortcut tools, and the concept of file-sharing these tools took flight. Natural questions arose, including: *Why shouldn't engineers collaborate to avoid the reinvention of the wheel? Why not share Steel Tools with our peers and constituents as open source files so others can personalize and improve them?*

The future path became clear. With today's online social networking technology, we have the capability of easily sharing these tools with each other as a community, more tools than could ever be developed or maintained internally at AISC. This sharing will only help to grow and develop the expertise and quality of our profession and industry.

Recently, online "social networking" has begun infiltrating segments of most of our personal and professional circles. Whether you enjoy reading or contributing to blogs or connecting with old friends and colleagues, there are a multitude of social networking sites available, and some geared toward your specific interests. Today two-thirds of the entire Internet-using population is part of an online social community. Facebook is the fourth largest website in the world. In terms of minutes spent on the site, Facebook grew by more than 500% in the last year alone. Other social networking leaders in web traffic include MySpace, LinkedIn, Twitter, CafeMom, Classmates, and Flixster, to name just a few. Interacting socially in a virtual world is evolving into a mainstay of what we do and who we are. And a demographic shift is occurring—studies show that social networking is no longer "just for kids."

To serve and assist its constituency in this regard, AISC is proud to announce the official launch of **www.steeltools.org**, its new "one-stop shop" for the design and construction community.

While the name is familiar, the new steelTOOLS online community offers many useful features, including:

- ➜ The full set of previously released AISC Steel Tools—in an open-access file format that enables users to download, update, and modify the tools as they see fit.
- ➜ A file-sharing platform for all members of the design and construction industry

to download or post files, vote, and comment on others' design tools and software utilities. One such user-provided tool, ASCE 7-05W from site contributor/steelTOOLS member Alex Tomanovich, is shown elsewhere in this article.

- A free, full-service social/professional networking environment that includes the ability to connect with others, read current hot topics, and set up blogs about issues that interest you.

It's easy to create a free **steeltools.org** profile and network with other users on the site. The site is open to all members of the construction industry, and any construction-related tools, files, and topics are welcome.

Why should you join and participate?

- Get free access to valuable utilities created by the AISC Steel Solutions Center.
- Contribute your files and tools to share with others.
- Download and comment on other users' tools.
- Read and blog about topics related to design and construction.
- Connect with others on common specific interests.
- Find great free software and tools from various software companies.

The question then becomes: Why *wouldn't* you join?

The website will host many ongoing programs and contests to highlight frequent contributors and to reward those who post especially valuable tools on the site. Online communities with common interests such as "Detailing" and "Sustainability…and Going Green!" have already formed with a number of associated followers and interesting blogs. And, if you already are a registered user of the AISC website, joining the steelTOOLS community is especially easy—you can login with the same user name and password.

We at the Steel Solutions Center see this as a great avenue to learn more about the designers, specifiers, and detailers in our industry. This much-needed platform enables us all to share knowledge in an open and collaborative environment, continually increasing the quality and productivity of the steel and construction industry. We at AISC look forward to reading your blogs, downloading your files, and networking with you. MSC

One Word

BY ZANE R. KENISTON

Simplification is the Key to Success.

I BEGAN WORKING in the wonderful world of steel when I was a senior in high school. Through a co-op work program, a local steel forge shop in my Pennsylvania hometown hired me. I attended school in the morning and went to work in the forge shop in the afternoon. As I tried hard to figure out my new job, an old-timer at the shop colorfully explained to me the meaning of the acronym K.I.S.S.—Keep It Simple Stupid! To this day, I am continually reminded of the importance of this acronym and the practical nature of its application.

With simplicity in mind, think of one word that defines the key to your success in the steel fabrication industry. What word would you choose? Would it be quality, value, control, responsibility, excellence, or some other word? Give careful thought to this. If you could pick just one word upon which owners, financial officers, project managers, and shop superintendents and foreman could build their strategies and successes, what would that one word be?

First, consider the goal of your company. Put aside all of the nuances embodied in a good quality statement or the "meet and exceed" style objectives and try to state the overall goal in just a few words. Author Eli Goldratt in his book *The Goal* narrows the goal of any for-profit company to simply "be profitable." Is that the goal of your fabricating business? If so, then what is one word that will get you to your goal and keep you there, especially in these challenging economic times?

Arguably, when compared to the other links in the structural steel supply chain, it is the fabricator who has the greatest to gain from this one-word concept. Consider steel fabrication as it relates to sailing on an unpredictable ocean. One minute the ocean is dead calm and then the next minute it's the "perfect storm." Without the right quality goals in place, the winds can shift and profits can evaporate before there is time to react.

A Complete System

In order to arrive at the one word that best suits your organization, focus on your company's overall operation. This one-word concept applies to the entire system of a steel fabricator, specifically all the processes (written or otherwise) and the products and/or services that a fabricator provides. A complete system consists of processes, products, and services.

The idea of "Garbage In, Garbage Out" can be easily applied to any process in your system. In other words, it is difficult to produce a good result when given poor data.

As an example, consider the detailing process. First, we will assume that your procedure (written or otherwise) for the detailing process states that all shop drawings are produced according to your detailing standards, and checked by a qualified checker. (It is understood that depending on the schedule, some drawings are checked before approval, some during and some after; but all are checked before they hit the shop).

Now, imagine that too much information is provided on the shop drawings. Impossible, you say? Well, if this one word we are discussing is not applied to the purchasing process, for instance "Control," here is an example of what can happen:

Three-in.-thick Grade 50 moment plates to be welded to column flanges are detailed on the shop drawings as a single bevel joint with a steel backing bar in order to achieve a complete joint penetration (CJP) weld. The shop drawings are checked and make it through the approval process unscathed. You have everything in place. All the material has arrived on time.

However, on receiving the shop prints, the shop foreman determines that the shop can increase productivity and reduce field fit-up errors by simply changing the single-bevel joint on the moment plates to a double-bevel and the CJP can be achieved by backgouging. He even has a written Welding Procedure Specification (WPS) to back him up. So it happens; the moment plates are cut, drilled and beveled and fabrication begins. In this case, the shop foreman was correct in that productivity levels are strong and the problem with warpage is minimized thus reducing the likelihood of field fit-up problems.

Soon thereafter the owner's inspector arrives and notices that something is different from his approved shop drawings and the actual work being performed on the moment plates. His drawings show the original, approved, weld details, not what is being performed in the shop. He makes a call and fabrication is halted until, days later, the matter is resolved between the inspector, the EOR and the fabricator. The good news is that

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Quality Corner is a monthly feature that covers topics ranging from how to specify a certified company to how long it takes to become a certified company. If you are interested in browsing our electronic archive, please visit **www.aisc.org/QualityCorner**.

the fabricator can continue to fabricate with the double-bevel joint design. The bad news is the fabricator is now behind schedule.

What went wrong in this case? The fabricator failed to exercise control over the detailing process. First, the detailing standards contained no direction as to the preferred means and methods for welding in that shop. Second, the fabricator abdicated control of welding joint selection to a sublet detailer who may have never set foot into a fabrication shop. Little wonder, then, that all of the fabricator's efforts to increase productivity in this case were moot.

Without a doubt, the above situation does not bring value to your ultimate goal, which is to be profitable and stay in business.

While detailing is just one of many processes within your company, regardless of the process, the one word that contributes to your success needs to be applied to all of your processes. Since it "takes two to tango" let's look at the progeny of processes—"product or service."

Product (Service)—Fabricated Steel

Let's use the K.I.S.S method and refer to fabricated steel as "a product."

Many steel fabricators apply this one-word concept to the "product" or the actual work performed more than at the process level. Why is that? Possibly because the steel industry is a conservative group of professionals and for many decades the focus was on product. Or it might be that steel fabricators continually find themselves in the bottom part of the construction industry food chain. Whatever the reason, many times we have heard, "Nothing leaves this place unless it is right!"

Certainly, nonconforming product only results in a negative impact on someone's bottom line. And if you have been in the steel fabrication business long enough, you have been there to one degree or another.

Yet, when it comes to actual steel fabrication, the key to success can become a double-edged sword. If you exercise too much or too little of your chosen word during the "product" phase of your operation, operational costs will only increase. Achieving an optimal balance can minimize costs.

A Balanced Approach

What can a steel fabricator do to minimize "product" nonconformances? The answer goes back to a balanced application of the one word at the two levels—process and product—of your system; with a primary focus on the process side. It is typically cheaper to fix a process than to fix a product. For example, consider which costs more: checking a shop or erection drawing or incurring back charges from the field because "the steel doesn't fit?" Also consider the loss of precious time and resources trying to get the EOR to approve a substitution of material simply because a purchase order failed to stipulate the correct grade of material.

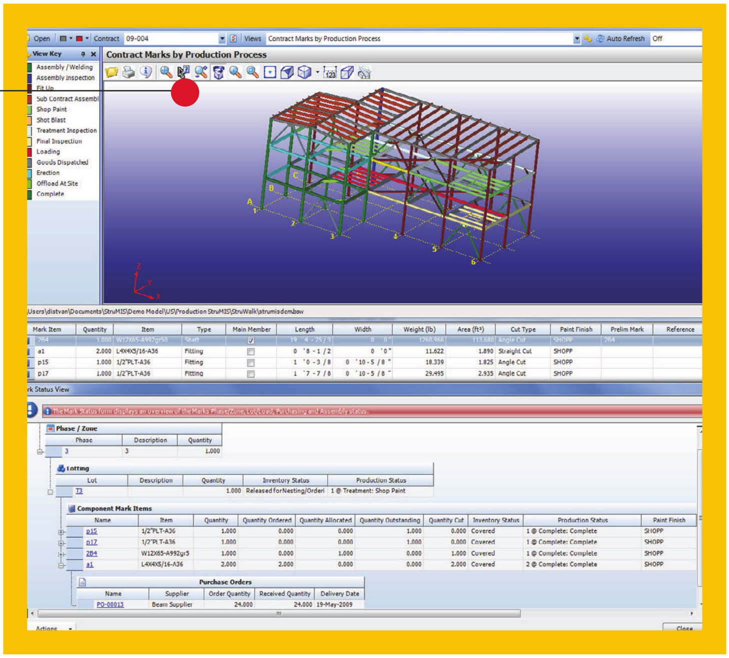
Think of it as preventative maintenance. What would you rather pay for: a lube, oil and filter job or a new drive motor for your beam line? Or, on a larger scale, how about paying to maintain an overhead crane or paying for the consequences of a failed one?

So, what is the one word you've chosen? Perhaps you thought I was going to tell you. No, you see, I don't have to tell you, because you already know what one word best aligns with your organizational goals. The challenge is to choose the right word and close the gap between knowing the word and then properly applying it to your business. If you are successful at properly implementing your one-word concept within your entire operation, with special emphasis at the process level, then you have simplified your road to success. MSC




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.

Fabrication Management



Version 7.3.10 of the StruM.I.S .NET fabrication management system brings the steel fabrication industry up to date with the very latest processing, tracking, planning and reporting facilities. StruM.I.S .NET streamlines the estimating, procurement, and fabrication process by providing seamless interaction among departments, suppliers, and clients. Advanced .NET technology makes real-time progress reports available anytime and from anywhere. The system can be implemented in several versions. The newest release has been written entirely in .NET to facilitate a more flexible, modern, and faster platform. StruM.I.S .NET offers fabricators a centralized system for providing live status of any item in the fabrication system and managing estimating, drawing and document management, nesting, purchasing, inventory control, production and shipping management.

For more information visit www.acecadsoftware.com or call 610-280-9840.

Accurate and Fast Cuts Automatically

The new Eisele PSU 450M circular cold saw from Behringer Saws can be programmed to automatically and accurately replicate cuts in iron-and-steel based materials to improve a company's operational cutting efficiencies while reducing labor and material costs. Controlled by a programmable logic controller (PLC), the PSU 450M requires minimal operator intervention once running. It stores up to 10 numerically controlled program applications, each with 3 sets, which also can be recalled to provide time and labor cost savings on future cuts. The number of pieces to cut, cutting length and one miter angle cut on each end of the finished material can be saved with each set. Additionally, all movements can be performed manually. The saw has a miter angle adjustment to cut materials at infinitely variable angles, with fixed stops at 45° and 90°, and can cut solid rounds up to 5.7 in. at 45° and 5.9 in. at 90°.

For more information visit www.behringersaws.com or call 888-234-7464.

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 Tom Klemens (klemens@modernsteel.com). To be included in MSC's online products directory, contact Louis Gurthet (gurthet@modernsteel.com).

High Portability Welding

The CaddyTig 2200i AC/DC power source produces quality TIG and stick welds in a variety of materials. This fifth generation of Caddy machines features advanced inverter technology and offers a compact design with an impact-resistant polymer and aluminium casing that is rugged yet light (about 21 lb) and easy to carry. The unit's control panels present all welding parameters in an easy-to-understand layout. A two-program function allows pre-programming and program changes during welding. A pulse TIG feature provides greater control of heat input and the weld pool, and a Micro Pulse feature minimizes the heat-affected area, particularly with thin metals. Other features include a hot start and arc force settings. Equipped with large cable connectors for high durability, these IP23-compliant machines are built for use outdoors, even in the rain.

For more information visit www.esabna.com or call 800-372-2123.

Comfortable, Effective Eye Safety

Gateway Safety's Wheelz safety eyewear combines all-day comfort with popular sport styling and the maximum splash and impact protection of a goggle. Unlike traditional goggles that can be big and bulky, this eyewear has a compact, lightweight frame made of a soft, flexible material. An optional foam edge absorbs perspiration, preserving a clear view of the workplace and serving as a cushion for added hours of comfort. Ideal for use in laboratories, light manufacturing and industrial applications, Wheelz goggles feature a patented ventilation system that minimizes fogging by circulating air through the optical chamber. Ten unique conical air chambers line the frame's brow area. Secondary air enters the goggle through 10 additional ventilation ports on the frame's underside, creating a strong "whirlwind" of air that circulates through the inner frame.

For more information visit www.gatewaysafety.com or call 610-280-9840.

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Quality Systems Auditor Wanted

Contract Auditor wanted to audit Quality Management systems, to AISC steel fabrication and erection certification criteria for Quality Management Company. Applicant must be willing to travel. Typical workload is 10-14 audit days per month, not including travel time. Audits are mostly in North America (90%), but also throughout the world (Asia, South America, Europe, Middle East). Prefer applicant with background in steel construction (fabrication or erection) and Quality system auditing, ASQ/CWA/CWI certifications a plus. International travel experience and multi-lingual abilities preferred but not required. Auditors must be fiscally responsible.

Please send cover letter and resume to:
Pat Thomashefsky, patt@qmconline.com. No phone calls please.

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WHAT'S NEXT?

Please e-mail Brian Quinn, P.E., and Lisa Willard, P.E. from SE Solutions (Brian.Quinn@FindYourEngineer.com; Lisa.Willard@FindYourEngineer.com) with why you would be interested in either one of these positions. All inquiries are kept confidential. For more information on **SE Solutions**, please visit **www.FindYourEngineer.com**.

Marketing Director – NSBA

Are you a strategic and innovative marketer looking for an exciting challenge? AISC is looking to hire an accomplished marketing professional to take charge of its bridge division: the National Steel Bridge Alliance (NSBA). NSBA is the technical and marketing arm of the steel bridge community and is dedicated to increasing the market share of steel bridges.

The successful candidate will work with an oversight committee to develop and implement a strategic plan, including success metrics, incorporating three key areas: marketing, technical activities, and governmental action.

A degree in marketing plus a minimum of 10 years of experience with engineering or construction companies is preferred. Excellent presentation and management skills are critical. This position is based in our Chicago office. The ability to travel is required.

We offer an excellent salary and benefits package and numerous professional development opportunities. If you are interested in applying for this position, please forward your resume and cover letter, including your desired salary requirements, to Cathy Becker at: HR@aisc.org

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Glenridge Fabricators, Inc. is a dynamic, successful structural steel and miscellaneous iron fabricator and erector for more than 30 years, in the New York City area. Our expanding volume of work necessitates a highly qualified candidate with 5 years minimum experience with knowledge of AWS D1.1, welding and bolting inspection, WPS, PQR and NDT. We offer a competitive salary with year end bonus, and an excellent benefits package.

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Success by 1,000 Paper Cuts

BY JAKE MCKEE

Want to change the world?
Start small, create success, share results.

I LOVE PUBLIC SPEAKING and I do quite a bit of it. Most of my engagements focus on social engagement and customer experience, specifically helping business people figure out how to better connect with their customers, fans, and clients.

There are a few questions I can always count on getting during or after the session:

> *"But what if nobody in the organization is empowered to make the changes you mention? Who's job is this change you refer to?"*

Out of all the frequently asked questions in my sessions, that is the one that gets me the most amped up and ready to pounce. My reaction is normally summed up by a quote overheard in the hallways of the South by Southwest conference (SXSW) earlier this year:

> *"If you know something's wrong…f*****g fix it!"*

We've come to see that fear dictates many of our external-facing business decisions, giving rise to massive terms of service agreements, non-disclosure agreements, massive legal team power, and other protectionist tactics. But it continues to surprise me how afraid we are of our bosses, colleagues, and management teams.

Whose job is it to fix things we recognize as problematic? *Ours!* It is every employee's *obligation* to stand up for their customers, to be on the lookout for ways to improve the company.

When I started at LEGO, I was a senior web producer who saw instantly that the adult enthusiast community was being completely overlooked. I took on a few extra hours a week to help them. Those few hours turned into an official part of my job, and then my entire job. I didn't ask for permission, I just started fixing it.

Surprisingly, especially for me, nobody told me to mind my own business or focus on my "real job." They started seeing results I was producing and asked me to take on more and more and more of those duties.

The trick to making this process work is to use a tactic I call "Success by 1,000 Paper Cuts." The idea is simple: start with the biggest element of activity that you can do without having to get full blown approvals, budget sign offs, or legal approvals. A single paper cut barely gets noticed, but enough of them and you can cut off a limb.

> *Start small, create success, and share results.*

Then repeat over and over again until you have a collection of successes that represent a landmark. Bundle that landmark up and show it off. Use the landmark to get permission to do bigger and more radical—and perhaps more expensive—projects, but only by the new increment.

> *Start just a bit bigger, create success, and share results.*

So what are the small things you're going to do today to impact change and improve your customer experience? MSC

Jake McKee is the chief strategy officer at Ant's Eye View, Redmond, Wash., a customer experience strategy practice, where he helps organizations understand how to act like groups of people rather than soulless money-making machines. In a past life, Jake was the global community relations specialist for the LEGO Company, where he spent five years on the front lines of customer-company interaction, specifically working to change the way the company thought about and engaged its most loyal fans and customers. Jake blogs at ***www.communityguy.com****.*

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

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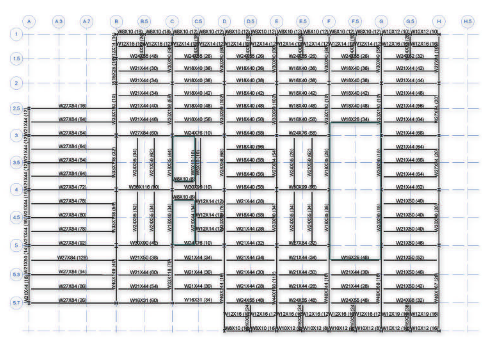

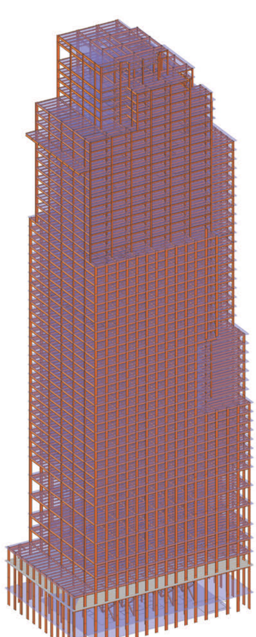

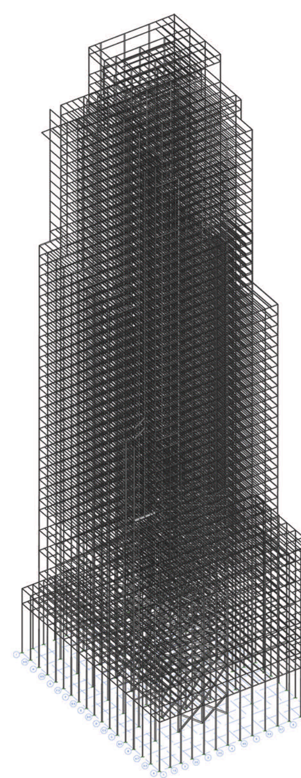

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