MSC
MODERN **STEEL** CONSTRUCTION

May 2008

Great IDEAS!

IN THIS ISSUE
Exposed Structural Steel
IDEAS^2 Awards
SteelWise: Welding

steel roof deck and WIND INTERACTION

DECK DESIGN DATA SHEET 46R
PART ONE

WIND EFFECTS ON DIAPHRAGM SHEARS

LOOK FOR OUR NEXT SHEET SHOWING A 36/7 PATTERN.

36/4 PATTERN

SHEAR AND UPLIFT INTERACTION'S IMPACT ON DIAPHRAGM SHEAR CAPACITY
1 1/2" Roof Deck — Structure = 5/8" ϕ Welds — 36/4 Pattern — Stitch Fasteners = # 10 Screws
Allowable Shear Strength is in PLF and includes a Shear Safety Factor = 2.75.

THICK-NESS	SPAN	SCREWS PER SPAN	UPLIFT PRESSURE IN PSF					
			0	20	30	40	50	60
.0295"	5'0"	0	172	156	143	126	105	79
		1	218	203	188	170	148	120
		2	256	239	224	205	182	152
		3	290	272	256	237	211	178
		4	321	302	285	264	236	198
	5'6"	1	197	181	166	148	125	92
		2	236	218	202	182	156	120
		3	268	250	233	212	183	142
		4	298	279	261	238	207	158
	6'0"	1	180	162	147	128	103	63
		2	218	200	183	161	132	84
		3	249	230	213	189	157	98
		4	278	258	239	214	178	108

THICK-NESS	SPAN	SCREWS PER SPAN	UPLIFT PRESSURE IN PSF					
			0	20	30	40	50	60
.0358"	5'0"	0	209	194	182	167	148	127
		1	264	249	236	220	201	178
		2	308	293	280	263	243	220
		3	349	333	320	302	281	255
		4	386	370	355	336	313	285
	6'0"	1	218	202	188	172	151	124
		2	263	247	232	213	190	160
		3	301	283	268	248	223	190
		4	336	317	301	280	253	215
	7'0"	2	224	207	193	173	146	104
		3	263	244	227	205	175	125
		4	295	276	258	234	200	142
		5	326	305	286	260	223	153

THICK-NESS	SPAN	SCREWS PER SPAN	UPLIFT PRESSURE IN PSF					
			0	20	30	40	50	60
.0474"	6'0"	1	287	273	261	247	230	210
		2	344	329	316	301	282	260
		3	393	378	365	348	329	305
		4	439	423	409	392	371	345
		5	482	465	450	431	408	380
	7'0"	2	296	281	268	252	231	206
		3	344	328	313	295	273	246
		4	387	369	354	335	311	281
		5	427	409	392	372	346	312
	8'0"	2	257	241	227	210	189	159
		3	303	287	272	253	227	194
		4	345	326	310	289	262	224
		5	382	363	345	323	293	251

THICK-NESS	SPAN	SCREWS PER SPAN	UPLIFT PRESSURE IN PSF					
			0	20	30	40	50	60
.0598"	7'0"	2	371	357	346	331	312	292
		3	429	414	401	385	367	345
		4	482	466	453	437	417	393
		5	532	516	502	484	463	437
		6	579	562	547	528	505	476
	8'0"	2	322	308	295	281	263	241
		3	380	365	351	334	314	289
		4	430	413	399	381	359	332
		5	476	459	444	425	402	372
	9'0"	2	284	269	256	240	221	198
		3	336	321	308	292	269	241
		4	387	370	354	335	311	280
		5	430	412	396	376	350	316

The structural welds are loaded in both shear and uplift (tension) during wind events.
Interaction affects diaphragm shear strength. Diaphragm stiffness is independent of uplift.
Table is based on F_y = 33 ksi & F_u = 45 ksi. Table is based on a multispan application.
Additional welds and/or stitch connectors will minimize the interaction impact and increase capacity.
Spans were chosen to provide shear capacities between 100 PLF and 600 PLF.
These are not absolute limits. F Deck is not available in t = .0598 (16 gage).
Capacity is not rapidly reduced from 0 to 20 psf. Interpolation is allowable.
Consult the Summit Engineering Office at 1.800.631.1215 for combinations outside this table.

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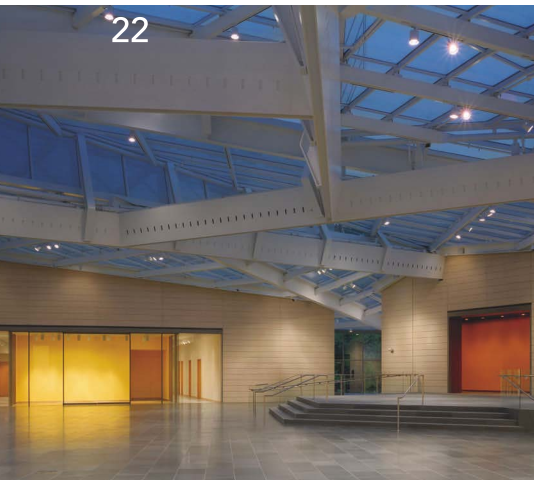

ON THE COVER: The Bronx County Hall of Justice, Bronx, N.Y. (2008 IDEAS² Merit Award winner). Photo by Paul Warchol Photography, Inc.

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editor's note

NEWS FLASH! AISC announces that development is underway on a new energy-saving standard to mandate the use of round ductwork in buildings over three stories.

Okay, that would be ridiculous. But is it any sillier than the American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE) and their proposed Standard 189.1, *Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings*? While much of the standard is clearly within ASHRAE's scope of expertise, for some reason they have included a section focusing on structural material issues. Adding insult to injury, the subcommittee that worked on that portion of the proposed standard was almost laughable in its lack of balance and expertise; it consisted of an architect working for a government owner, a marketing representative for the lighting industry, and a paid consultant representing the concrete industry.

The proposed standard also contains some of the most convoluted reasoning I've heard outside of my kid's kindergarten classroom. Essentially, the proposed standard would limit the contribution to the recycled content of the project of any one material to 5%. At the same time, the standard would allow concrete to claim a recycled content based not on its total recycled content, but instead on any one component of the mixture. That means that if fly-ash was substituted for 25% of the cement (which itself represents 10% to 12% by weight of the composition of concrete), concrete would be considered to have a 25% recycled content rather than the actual 3%.

Structural steel, which currently has about an 88% recycled content, would be given credit for contributing 5% to the recycled content of a building (the maximum allowed by any one material), while concrete, which even with fly-ash only has a 3% recycled content, *could potentially receive* the same 5% credit (*assuming they add some recycled aggregate*), PLUS an additional 5% credit for its rebar content (which, incidentally, typically has a lower recycled content than structural steel).

So what's the bone-headed reasoning behind this baffling conclusion? The theory is that steel is so inherently green that it doesn't need any incentive to be the premier sustainable material. Concrete, on the other hand, presents so many environmental issues that it's critical to give it every push possible on the sustainability front. In other words, punish the early adopters of a green sensibility in favor of those who resist it (or only give it lip service) in hopes of reforming them.

The argument ignores steel's long history of environmental activism, including reducing its carbon footprint by 47% since 1990 and cutting its energy use by 9% during the past decade (with plans for substantial future reductions). Steel is so desired as a recycled material that salvage yards are actually shrinking as they sell off their old inventory of scrapped cars. (As AISC's John Cross explains: "Today, demolition contractors are often paying for the opportunity to demolish and scrap a structural steel building because of the value of the structural steel. In contrast, buildings using other materials cost between $3 and $10 per square foot to demolish, scrap, and landfill.")

Finally, unlike other structural materials, the production of structural steel conserves our most valuable resource: water. The only water used in the production of structural steel is part of a closed-loop recycling process. Structural mills discharge no wastewater into the environment. And unlike other building materials, water is not used in the fabrication process, and no water is used or discharged at the job site as a result of structural steel.

I urge you to protest ASHRAE's absurd, misguided, and misinformed intrusion into the structural marketplace. Please visit **www.aisc.org/ashrae** to learn the specific issues involved with the proposed Standard 189.1, and discuss your objections with your peers and others involved in the design, construction, and regulation of the built environment.

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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.

CB Series Beams

Can you tell me the F_y and allowable stress that the CB series beams were designed for?

That would depend on the year of the design and material production. This CB-shape designation was largely used in the late 1920s and early 1930s when the ASTM A9 minimum yield point was 33 ksi and the basic AISC allowable working stress was 18 ksi. The AISC basic working stress was revised to 20 ksi in 1936. If you have a date for the project, you may want to verify the exact time of the construction.

AISC Design Guide 15 is a reference for historic shapes and specifications. This guide contains listings of which ASTM material standards were in effect during a specific period of time, as well as which AISC specifications were in effect. Design guides are available free to AISC members at **www.aisc.org/epubs**.

AISC has also developed a historic specifications CD, which is available as a free download for AISC members and ePubs subscribers at **www.aisc.org/epubs**.

There was an article published in the February 2007 issue of *Modern Steel Construction* (**www.modernsteel.com/archives**) called "Evaluation of Existing Structures." This article also includes historical information of this nature.

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

Drilled-in Anchors

When drilling for post-installed anchors in a concrete support for a steel beam, we encountered embedded reinforcing bars at the intended anchor locations. Is it advisable to cut through the rebar to accomplish anchor installation?

Generally, it is not advisable to cut the rebar; but the question should really be directed to the responsible design professional for the project.

When using drilled anchors into reinforced concrete, it is quite common to locate rebar by means of a "rebar locator meter" prior to the drilling operation. Then, depending on the findings, adjustments may need to be made in the anchor pattern. This should all be coordinated with the responsible design professional.

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

Historic Section Properties

I need to know the section properties of several shapes. I seem to be having difficulty because these seem to be old shapes. The sections are W14×311, W14×287, W14×246, and W14×167. Can you help?

You appear to have a mixture of new and old shapes. The section properties for the W14×311 are listed in Table 1-1 of the current 13th edition *Steel Construction Manual*. You will find the section properties for the other three shapes in the 7th edition AISC manual. The CD that is issued as part of the 13th edition manual contains the AISC Shapes Database v13.0 and 13.0H (the H is for "historic"). Look in the Historic ASD7 section for those shapes. Similar information can also be found in AISC Design Guide 15.

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

Use of Grade 65 Steel

Do you have a safety factor on the material, particularly on grade 65 steel, when you design according to ASD or LRFD?

There are inherent safety factors built into the specification strength equations regardless of the material type, for both ASD and LRFD. The AISC specification does not place safety factors on the material type, but rather on the limit state being considered. Note that only certain materials are listed for use under the auspices of the specification. See Section A3 for those listings. The yield strength (F_y) and ultimate strength (F_u) of the material is used in the nominal strength Equations where applicable.

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

Pretension for TC Bolts

When installing a tension controlled bolt (TC bolt), what pretension force should be induced in the bolt?

If the TC bolt is an ASTM F1852, it is equivalent to an ASTM A325. If the TC bolt is an ASTM F2280, it is equivalent to an ASTM A490. See Table 8.1 in the RCSC *Specification for Structural Joints Using ASTM A325 or A490 Bolts* (**www.boltcouncil.org**) for minimum bolt pretension. Note that ASTM F2280 is a new designation that was not available at the time of the current RCSC specification development, and thus is not included in the table heading under the ASTM A490 Bolts.

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

Remediation for Deflection Problems

I have seen many articles on how to reinforce an existing beam for strength, but none appear to go over deflection issues. Do you know of a resource that discusses how to analyze and determine appropriate reinforcing for an existing steel beam that has adequate strength but fails deflection criteria?

I do not know of a resource that discusses this, but can share the following thoughts. Deflection criteria are project-specific requirements based on serviceability needs. If you have a beam that is deflecting more than your criteria allows, you may need to remove some of the dead load prior to adding the reinforcing. Depending on the magnitude of the deflection, you may also need to consider introducing camber by some means such as heat cambering or jacking. This requires an engineering evaluation to determine in-place loads at the time of reinforcement, curvature shape of the beam, and anticipated additional deflection due to future loads after the reinforcing is added.

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

steel interchange

One-third Stress Increase

I have reviewed the AISC specification (AISC 360-05) and the AISC seismic provisions (AISC 341-05) for allowable stress increases with wind or seismic loads. I cannot find any references in these documents. Is there something I am missing, or are no stress increases allowed for wind or seismic loads?

The AISC specification no longer permits the one-third stress increase. Use of the increase stopped with the 1989 ASD specification Supplement No. 1. There is no permitted stress increase on the capacity side of the design equation for steel. The ASCE 7 load standard only permits such increase if it is justified by structural behavior caused by rate of duration of load, which is not usually appropriate for steel design.

There have been several articles written on this subject over the past several years, including "The One-Third Stress Increase: Where it is Now" (MSC, October 2003, **www.modernsteel.com/archives**).

Amanuel Gebremeskel, P.E.

Stiffness Reduction Factors

Why are the stiffness reduction factors in Table 4-21 of the 13th edition manual different than those in Table 4-1 of the LRFD 3rd edition manual?

The 1999 LRFD specification (and its equations) was based on the LRFD load approach only, while the current 2005 specification is based on a unified approach that includes both the LRFD and ASD load approaches. The τ in the 1999 LRFD specification was based on Equation (C-C2-3), which includes P_u, the factored design load. The τ_a in the 2005 specification is based on Equation (C-C2-12), which includes P_n, the nominal strength. This slight difference causes the difference you noted. See the Commentary to Section C2 of the 2005 specification for explanation of the derivation.

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

Single-Angle with Single-Bolt End Connection

I am trying to use the AISC 13th edition manual to design a single-angle member for a compression brace with one bolt through a leg at each end. This is a commonly used brace in the automotive industry for bracing conveyors and falling parts guards. There is usually very little load that must be resisted, and historically angles such as L2½×2½×¼ have been used. These braces often have a Kl/r_z that is greater than 200. I have looked at Section E5, but this requires two bolts at each end and limits Kl/r to 200.

First, note that the 2005 AISC specification is written with building structures in mind. The 200 limit on Kl/r for a compression member is a recommendation and no longer a requirement. However, when using the simplified method of Section E5 (i.e., ignoring eccentricity on an axially loaded member) you may elect to use the modified slenderness equations; but in this case Kl/r is strictly limited to 200. While connections with a single bolt are not explicitly prohibited, the parameters for such connections are not specifically discussed in the 13th edition manual.

Amanuel Gebremeskel, P.E.

R = 3.0 in SDC D?

In the AISC seismic provisions (AISC 341-05) there is a discussion for R = 3. As I read the discussion, I understand that if I have a structure in seismic design category D and R = 3, I still have to follow the provisions of AISC 341-05. What I would like to do is reduce the R factor, which increases the base shear, and then not follow the stringent requirements of AISC 341-05.

Such a procedure is not permitted for categories D, E, and F by the ASCE 7 load standard. The AISC *Seismic Provisions* do not define the design parameters that are to be followed; they are defined by the applicable building code or the ASCE 7 load standard. The classification of building structures, as covered by ASCE 7-05, Table 12.2-1, subsection H—where AISC 341-05 need not be followed when R = 3.0 is used—is limited to seismic design categories A, B, and C. If a structure is categorized in seismic design category D or above, this classification does not apply.

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

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

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

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

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

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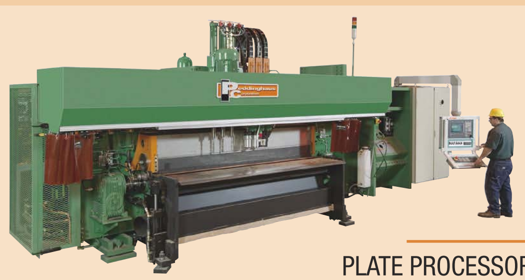

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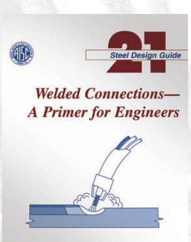

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- ☐ 5/6 Milwaukee, WI
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- ☐ 5/22 Baltimore, MD
- ☐ 5/29 St. Louis, MO
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- ☐ 6/10 Manchester, NH

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

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

1 What color codes are designated for F1554 anchor rods of grades 36, 55, and 105?

2 When anchor rods are too short, is it possible to make an extension with a coupling?

3 Does the 13th edition AISC manual include provisions for crane runway design?

4 What is the most likely ASTM designation of structural steel that is found in a building that was built in 1948? What is the tensile strength?

5 Is it possible to use the 2005 AISC specification for design work in a building rehabilitation project involving a structure built in 1948?

6 What is the weight-to-perimeter (*W/D*) ratio?

7 How many methods of providing pretension in bolted joints are presented in the RCSC *Specification for Structural Joints Using ASTM A325 or A490 Bolts*?

8 Why was it possible to change the minimum fillet weld size to be based upon the thinner part joined, in the 2005 AISC specification, when it used to be based upon the thicker part joined?

9 Is a groove weld appropriate for use in a lap joint?
a. Yes
b. No
c. Only when the thicknesses of the two joining pieces are equal

10 Do coatings have any impact on the slip resistance of a bolted joint?

TURN PAGE FOR ANSWERS

steel quiz

ANSWERS

1 Grade 36 is blue, Grade 55 is yellow, and Grade 105 is red. Section 2.5 of AISC Design Guide 1 includes this information.

2 Yes. Design Guide 1* describes methods of extending short anchor rods in section 2.11. Coupling is one option, and there are proprietary couplers available that facilitate this coupling process.

3 No. The 13th edition AISC manual does not specifically address crane runway design. However, section 18 of AISC Design Guide 7* discusses crane runway design and presents example calculations.

4 The most likely ASTM designation of structural steel that was used in 1948 is ASTM A7, with a tensile strength of between 60 ksi and 72 ksi. The yield stress is half the tensile strength with a minimum of 33 ksi. This can be found in Table 1.1 of AISC Design Guide 15.*

5 Yes. Many of the materials used in older structures are outside the scope of the 2005 AISC specification* as listed in section A3. Nonetheless, the methods presented in the 2005 specification can be used in rehabilitation projects with engineering judgment. Appendix 5 of the AISC specification covers the subject of evaluation of existing structures. Historic AISC specifications* can also provide clues about the original design.

6 This is a variable used to adjust fire-resistance ratings from the actual shape used in the test to the shape being used in the actual construction. For further information, see AISC Design Guide 19.*

7 Four methods of pretensioning bolts are presented in the RCSC: turn-of-nut, calibrated wrench, twist-off-type tension-control bolt assemblies, and direct-tension-indicators. These are covered in section 8.2 of the RCSC specification, available at www.boltcouncil.org or in part 16 of the 13th edition manual.

8 The introduction of ASTM A992 (which has a 50-ksi yield strength), along with its predominant usage for W-shapes, made the use of filler metals that are prequalified with lower preheats prevalent. These filler metals provide some control over hydrogen content and permit lower preheats and selection of those preheats based on the thinner material joined. Additionally, use of the thinner material joined when using these filler metals has been permitted by AWS for many years.

9 **b.** See Table 3-1 of AISC Design Guide 21*, which lists interaction of joint types and weld types.

10 Yes. Chapter 12 of the *Guide to Design Criteria for Bolted and Riveted Joints* (available at www.boltcouncil.org) discusses the effects of protective coating on slip resistance.

NOTE
*This publication can be accessed at www.aisc.org/epubs.

HOW OUR STEEL

BENT OVER BACKWARDS

(NOT TO MENTION OUR PEOPLE).

When the Prairie School in Racine, Wisconsin wanted the roof of a newly renovated fieldhouse to match the roof of an existing structure, there was only one problem. The joists required for the project would have to be 22 feet deep, 10 feet of depth larger than anything the Vulcraft plant produced. Enter our Nebraska team. Who brainstormed, planned an entirely new setup, then built it and assembled it (over 8 hours), having to angle joists across the production bay to make the project work. And literally bending over backwards for our customer.

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It's Our Nature.®

WOMEN IN ENGINEERING

Girs Inc. Honors Thornton Tomasetti's Brazil

Girls Inc. honored Aine Brazil at the annual Girls Inc. New York Celebration Luncheon at the New York Hilton on March 13th. A powerful gathering of more than 1,000 business and community leaders committed to the Girls Inc. mission of inspiring all girls to be strong, smart, and bold, the event recognizes women and men who, by their work and example, are creating a better future for girls.

Photo: Steve Friedman

Brazil

As one of 11 managing principals of Thornton Tomasetti, Inc., Aine Brazil helps guide the international engineering firm of 650 employees in the design of high-rise office and residential buildings, hotels, hospitals, and other projects. After 30 years in the field, her accomplishments include leading the design of the following Times Square properties: 5 Times Square, Times Square Tower, and 745 Seventh Avenue, all totaling over three million sq. ft. She is also responsible for the 975-ft-tall Comcast Tower in Philadelphia and the tallest building in New Jersey.

Brazil holds a B.S. degree from the University College in Galway, Ireland and a M.S. degree in engineering from the Imperial College of Science and Technology in London. She was the first president of the Structural Engineers Association of New York (SEAONY), a past board member of Women Executives in Real Estate New York (WX), and a member of the NYC Mayor's Commission for the Adoption of a Model Code. She has been featured in the *New York Times* and also in *Crain's New York Business'* "New York's 100 Most Influential Women in Business."

STEEL AVAILABILITY

Deepest Beams Yet

Nucor Corporation announced today that Nucor-Yamato Steel Company is introducing 44-in.-deep wide-flange structural shapes, becoming the first mill in the Western Hemisphere to produce sections to this depth.

Nucor-Yamato Steel Company, a joint venture between Nucor Corporation and Japan's Yamato Kogyo Company, is introducing four 44-in.-deep sections: W44×335, W44×290, W44×262, and W44×230. The maximum length for these sections is 120 ft. The first production rolling of the W44 sections is scheduled for the week of May 25, 2008 and will be included in future rolling schedules.

These beams are of particular interest to the highway bridge market for use as "stringers" (primary bridge beams), horizontal load-carrying members that carry the bridge deck and roadway surface.

Until now, the deepest sections available from U.S. mills had been Nucor-Yamato's W40×431 sections. The W40 sections and other deeper rolled beams have been seeing increased use in bridges, particularly in the Midwest.

JOIST NEWS

SJI Updates Reference

An updated version of Technical Digest No. 11 is now available from the Steel Joist Institute. The guide illustrates procedures for the structural engineer to properly analyze, design, and specify open-web steel joist and joist girder moment frames to resist wind and seismic lateral loads. The design methodology provided is limited to single-story structures subjected to wind and seismic loads; however, the design procedures are applicable to multi-story moment frames subjected to wind loads.

Offering an extensive update to the previous edition, this second edition covers the importance of the relationship between the specifying professional and the joist manufacturer, describes the analysis requirements for modeling the moment frame, and provides design methodology for lateral wind loads and seismic loads. To order a hard copy, download an electronic copy, or download an order form, visit **www.steeljoist.org**.

MARKET NEWS

Non-Residential Market Remains Active, but Construction Costs Continue to Increase

Turner Construction Company, in its quarterly market forecast, announced that construction costs increased 1.48% over fourth quarter 2007 and 4.96% over first quarter 2007. Turner has issued this quarterly forecast for more than 80 years.

According to Karl F. Almstead, the Turner vice president responsible for the Turner Building Cost Index, "The non-residential construction market remains active in spite of the residential market slowdown and the uncertainty in the credit markets. The perception that there may be an economic slowdown has lead to an easing of pricing pressure and an increase in competition among trade contractors in some markets. However, in major metropolitan markets such as New York City, the available volume of work continues to drive pricing upward."

Almstead also expressed that the industry is still facing a shortage of skilled labor, as well as uncertainty of the availability and cost of materials, adding that the pressure on construction costs in the non-residential markets will continue to result in cost increases over the next several quarters.

The Turner Building Cost Index may or may not reflect regional conditions in any given quarter. The Cost Index is determined by several factors considered on a nationwide basis: labor rates, productivity, material prices, and the competitive condition of the marketplace.

BIM NEWS

AGC Adds BIM Addendum to ConsensusDOCS

The Associated General Contractors of America (AGC) recently announced its approval of the addition of the Building Information Modeling (BIM) Addendum to the ConsensusDOCS catalog.

The ConsensusDOCS BIM Addendum is the first and only industry standard document to globally address the legal uncertainties associated with using BIM. The 21 leading associations representing owners, contractors, subcontractors, sureties, and designers that are actively supporting ConsensusDOCS have endorsed or are anticipated to endorse this consensus standard document.

The ConsensusDOCS BIM Addendum will be published in the first half of 2008 as part of the ConsensusDOCS comprehensive catalog of contracts and forms, which address all project delivery methods. The BIM Addendum provides a tool to utilize BIM from start to finish, thereby allowing contractors to more closely integrate project delivery with owners and design professionals. It is also flexible enough to be used as an addendum in more traditional contracting methods. The BIM Addendum has received extensive comment from the design professional community through the AGC BIMForum, a conglomeration of leaders throughout the AEC industry that have joined forces to facilitate and accelerate the adoption of BIM.

ConsensusDOCS is made up of more than 70 collaboratively drafted construction contracts. Its release last year represented the first time that broad industry representation has had an equal voice in collaboratively drafting construction contracts.

FABRICATION NEWS

OSHA Targets Crystalline Silica

OSHA has launched a National Emphasis Program (NEP) targeting health hazards associated with occupational exposure to crystalline silica. The new program directs OSHA regional offices to inspect workplaces with elevated exposure levels and to provide "compliance assistance" to employers. Crystalline silica is a carcinogen and can lead to silicosis, a disabling and irreversible lung disease.

The directive lists streel fabrication as one of the industries at risk for exposure. The exposure potential comes from sand blasting steel with silica sand. While not prevalent in the fabrication industry, sand may still be used in some situations. Companies using sand for blast media are encouraged to use the NEP to establish and enforce rigorous procedures to prevent exposure to blast personnel and bystanders. The NEP includes inspection procedure information and an inspector checklist. You can view the diretive at **www.osha.gov/OshDoc/Directive_pdf/CPL_03-00-007.pdf**.

news & events

ENGINEERING JOURNAL NEWS

Best EJ Paper of 2007 Winner Honored at NASCC

The winner of the Best EJ Paper of 2007 competition is James O. Malley for his paper "The 2005 AISC *Seismic Provisions for Structural Steel Buildings*," which was published in the first quarter 2007 issue of AISC's *Engineering Journal*.

The winning author was offered complimentary registration to the 2008 NASCC, held in Nashville last month, as well as travel expense reimbursement; the award was presented during the conference.

Be sure to participate in selecting the Best EJ Paper of 2008. Voters are eligible for a drawing to receive complimentary registration to NASCC, including travel reimbursement. Manuel Perez, employed by the City of Los Angeles, was the winner of this year's drawing.

letters

In Name (and Spirit) Only

Thank you for printing and endorsing my comments regarding the lack of recognition by architects of the indispensable contribution of structural engineers to the success of their designs.

However, please note that I am speaking as a *former* principal of the Cantor Seinuk Group. While I am proud of my role in founding and nurturing the Cantor Seinuk Group and watching its continued growth, I left the company in April of 1998 and have no ties—save the sentimental ones—to it.

Irwin Cantor

How to Progress?

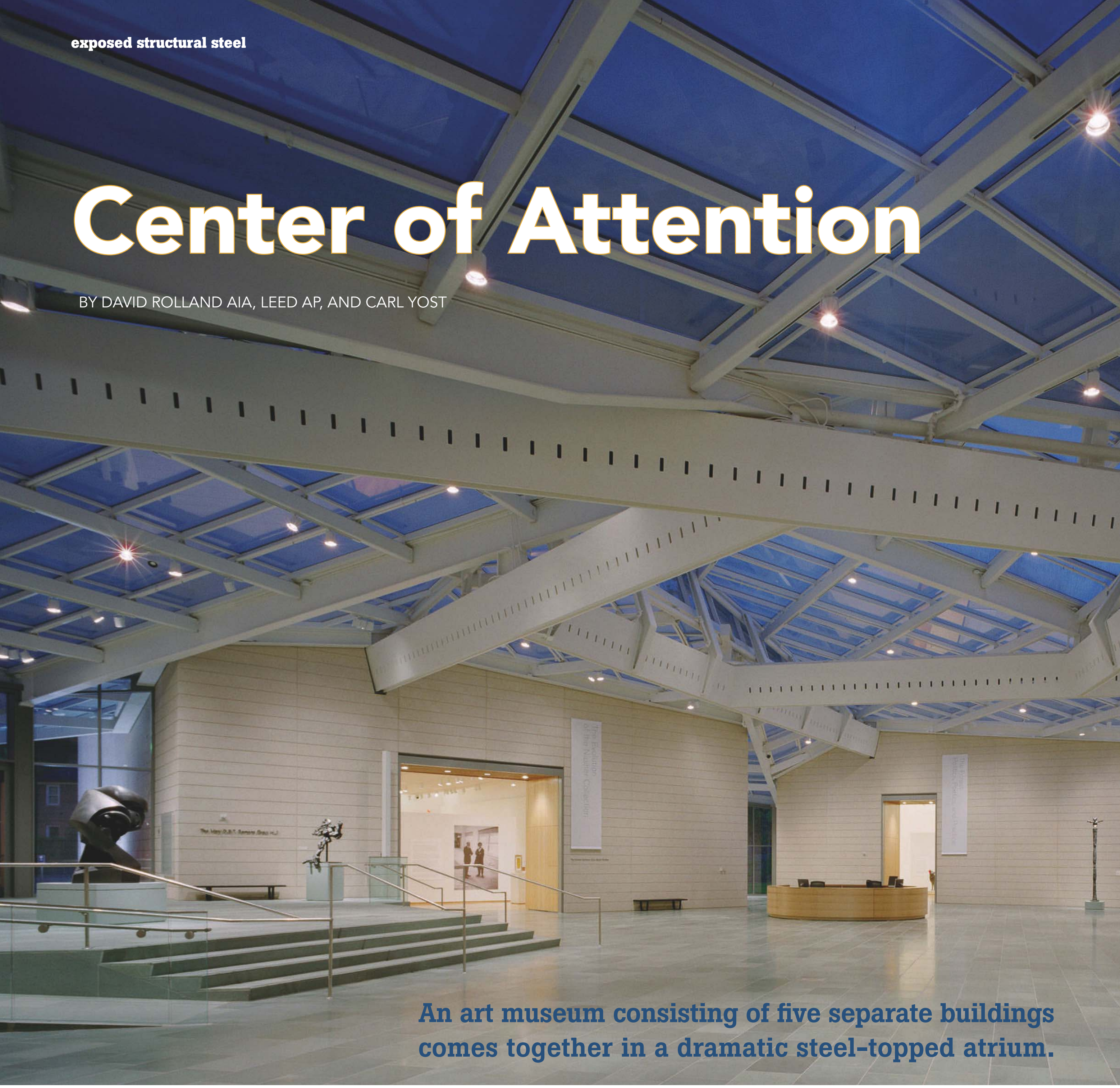
There is a very interesting contrast between Erik Nelson's article "The Progression of the Structural Engineer" (March, p. 93) and Xing Cai's article "Quality Assurance of Structural Engineering Design" in the March 2008 issue of *STRUCTURE* magazine.

Nelson's article describes a slow, unmentored, hit-or-miss—and therefore error-prone—learning process, while Cai's article recommends the use of checklists to ensure quality and avoid errors of omission.

I repeatedly learned the value of checklists in junior high school shop class, boy scouting, and the U.S. Navy. Engineering schools focus on teaching basic principles, but there is no reason that they cannot also strongly advise their students to obtain or prepare a checklist before designing anything.

I worked briefly as a non-structural civil engineering designer at the Oak Ridge National Laboratory (ORNL) before commencing a career in research. ORNL had an excellent system for accomplishing good design. A program engineer followed the job from concept through construction, preparing—jointly with the customer and the designer—a checklist of criteria that the design should meet. This was the beginning of the designer's checklist. Organized, high-quality work was not left to chance. Checklists contain cumulative corporate knowledge and experience, and can effectively guide a young engineer to recognize the needed knowledge that he/she did not acquire in school. Hit-or-miss, sink-or-swim learning is archaic and should be a thing of the past.

from the Reader Feedback forum at www.modernsteel.com



Center of Attention

BY DAVID ROLLAND AIA, LEED AP, AND CARL YOST

An art museum consisting of five separate buildings comes together in a dramatic steel-topped atrium.

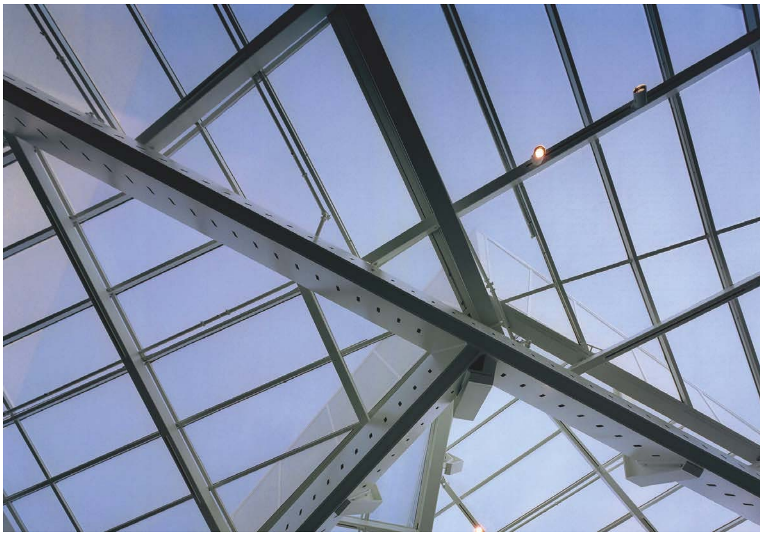
THE NASHER MUSEUM OF ART is located on park land between Duke University's East and West Campuses in Durham, N.C., suggesting the central role played by the arts in a university education.

In turn, an expansive courtyard plays the central role in bringing together the museum itself, which is made up of five separate, rectangular pavilions. Topped by a glass atrium featuring architecturally exposed structural steel fit for an art museum, this central court serves as the museum's main lobby as well as exhibition and function space, with a stepped platform along one side that can be used as a stage.

The museum creates a strong dialogue between indoors and outdoors, as abundant sunlight and glimpses between the pavilions to the surrounding gardens draw nature into the building. The complex, almost vertiginous, geometries of the glazed atrium roof are formed by a hierarchy of structural supports.

Five into One

The primary structure is comprised of five steel box beams that echo the five separate buildings. The beams are trapezoidal in section, and each extends outward on a perpendicular from one of the five pavilions to intersect with two of the other beams, interlocking to form a pentagon over the center of the atrium floor. The long-span, column-free exhibition space is thus achieved by supporting each of the five primary structural steel members in



three places—once by the load-bearing concrete walls of the pavilions, and twice by the other beams.

Forming the secondary structural system, five smaller steel beams extend from corners of the concrete pavilions to points on and above the primary structural pentagon; vertical steel arms joined to the box beams support the secondary members where they rise to form the apexes of the roofline. Onto this secondary structure are laid the purlins and aluminum mullions that support the roof glazing.

Because of the close fit between the roof structure and the skylights, the steel had to be constructed to a very high tolerance, which led the design team to use the AESS tolerances outlined in the AISC *Code of Standard Practice*. In order to achieve the necessary degree of precision in the geometric 3D work points, the design team provided a 3D model to the steel fabricator and skylight contractor, who then collaborated with each other during fabrication and installation. The Nasher Museum of Art was one of the first projects completed by Rafael Viñoly Architects to use 3D modeling in this fashion during the construction process.

In terms of erection, the five tapered box beams that comprise the primary structure were installed on-site with the aid of hydraulic jacks. Once all five beams were in place, the jacks were removed to test the deflection of the roof structure; subsequently, the jacks were replaced, the secondary structure and glass roof were installed, and then the jacks were removed a final time, and the structure was allowed to support itself once more. In all, the roof deflected nearly three inches under its own weight, which the construction team took into account when installing the roof glass. This process resulted in a building that conformed to the design standards with remarkable accuracy.

Additionally, load-bearing concrete perimeter walls form the structural system of the individual pavilions, supporting steel frame roofs with a clerestory to introduce natural lighting into the galleries in a controlled manner that preserves the artwork displayed there.

Painted Pictures, Painted Steel

The atrium steel is coated with a light shade of intumescent paint, creating an exposed framework that is eye-catching and at the same time blends in with the rest of the atrium and its visual elements.

The exposed steel was blasted and then given a protective coating: a two-component, moisture-cured, organic zinc polyurethane prime coat with a zinc content of 87% minimum by weight in dry film, meeting requirements of SSPC PS 12.01; a two-component epoxy polyamide intermediate coat; and a two-component, high-build acrylic polyurethane enamel, semi-gloss sheen finish coat. Intumescent paint from Carboline was used for fire protection on the roof structure.

Behind the Scenes (and in the Beams)

In addition to unifying the separate pavilions around one interior space and providing a sense of transition between the galleries, this seemingly complex, yet deceptively simple, network of structural supports also conceals the building services. Electrical conduit runs and sprinkler lines are hidden from view on top of the box beams, and rain gutters are positioned in the seams between the roof purlins. The box beams also provide air distribution to the atrium via vertical slots along their sides; the beams are actually part of the HVAC system.

Spatially and Visually Engaging

With pavilions and high-quality gallery space deployed radially along the contour lines of the sloping site, and with a flexible atrium area that allows visitors to engage with nature and allays museum fatigue, the Nasher Museum of Art creates a memorable and logical architectural experience that foregrounds the arts and forms a focal point on campus. It serves as the center of cultural life for both the university and the Raleigh and Durham communities, with flexible space that can be adapted for a variety of uses.

The pavilion structure yields the additional advantage of addressing the likely issue of future expansion, as additional rooms can be easily accommodated in the pavilion plan without compromising the integrity of the overall design. MSC

David Rolland is Rafael Viñoly Architects' project director for the Nasher Museum project, and Carl Yost is the firm's architectural writer.

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Duke University, Durham, N.C.

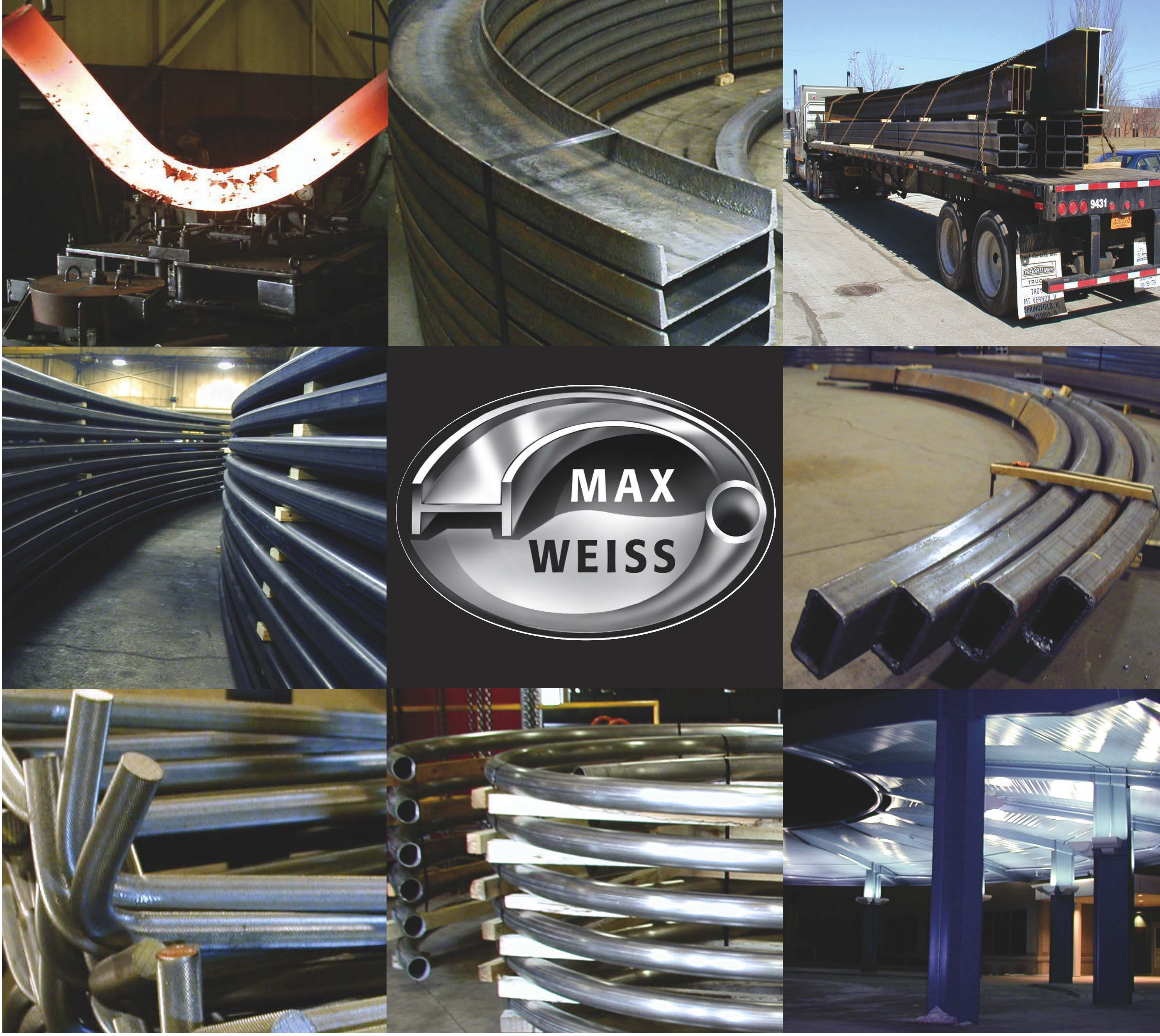
Architect
Rafael Viñoly Architects PC, New York

Structural Engineer
Thornton Tomassetti, Newark, N.J.

Steel Fabricator
SteelFab, Emporia, Va. (AISC Member)

General Contractor
Beck, Atlanta

Photographs
Copyright Brad Feinknopf


MAX
WEISS

Connecting on Campus

BY JAMES POSPISIL, P.E.

A new exposed steel pedestrian skyway links two parts of the Duquesne University campus.

DUQUESNE UNIVERSITY is situated on an urban campus in the Hill District of Pittsburgh. Bound on the south and west by a formidable cliff and the north and east by city streets, the university has faced challenges in meeting the growing need for new facilities.

This January, a new multi-purpose facility with a ballroom, fitness center, and retail space for the university was completed north of campus across Forbes Avenue. During the initial planning phase for the new building, a pedestrian skyway was envisioned to connect the parking garage and main campus to the new building. The skyway would improve student access to the new facility by creating a safe way to cross the street, and would also function as the primary conduit between the new building and the central campus steam, chilled water, and telecommunications infrastructure. In addition, the skyway would serve a symbolic function as well, as a gateway to the campus and Hill District. Construction of the skyway would take place concurrent with that of the new building, due to the critical nature of the infrastructure connections, and a total of nine months was allotted for building the skyway.

During the schematic design process for the skyway, the idea of using an exposed structural steel frame was conceived. The ability to prefabricate most of the structure either in the shop or near the site allowed the design team to resolve construction difficulties related to the small site and accelerated the construction schedule. Architecturally exposing the steel simplified many details while mirroring existing architecture on campus and highlighting the steel heritage of Pittsburgh.

Constructability Challenges

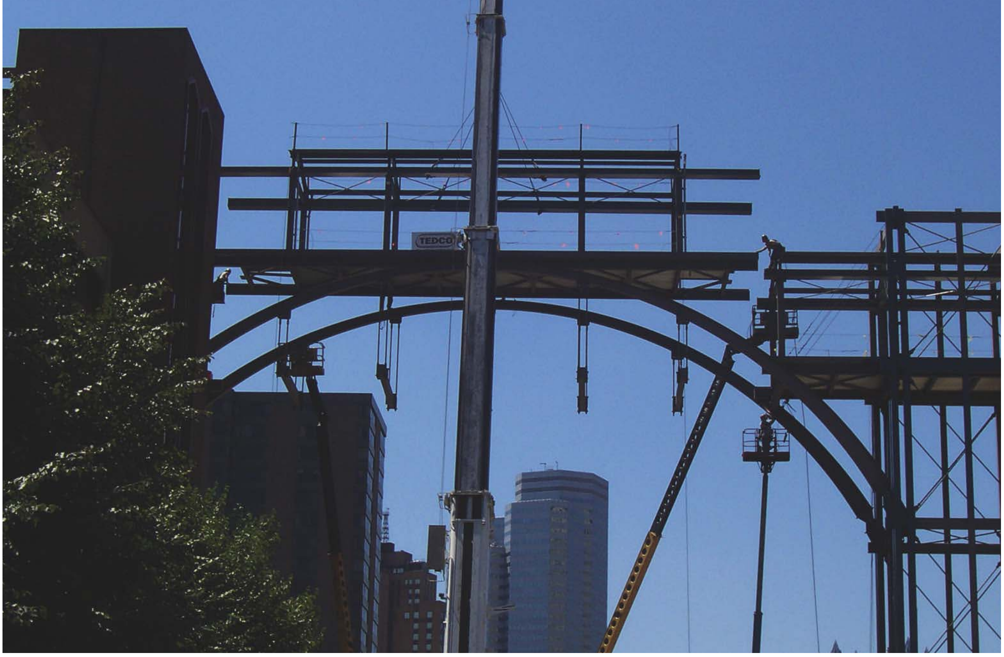
A key parameter affecting many aspects of the design was the city's desire to limit ongoing closures to Forbes Avenue to one lane and total closure of both lanes to one weekend. In addition, the close proximity of the parking garage to the south and ongoing construction of the new building to the north added to the complexity. With only one lane of Forbes Avenue accessible for construction, and a minimal lay-down area between Forbes Avenue and the parking garage, careful planning and extensive prefabrication were necessary.

Critical splice locations were identified to maximize shop prefabrication. To eliminate the need for long-term street closures, the center 74-ft portion of the bridge span would be prefabricated near the site in one lane of Forbes Avenue while the towers and 14 ft of cantilevered bridge span were being erected on each side of the street. Erection of the center portion of bridge would occur in a single lift on a single weekend.

During the tower assembly process, plumbness was maintained to within ¼ in. to ensure that the prefabricated center span would fit. Erection of the center span was planned for early morning so it could be installed "cold," reducing thermal growth and minimizing the overall length. To keep the visible connections clean, only ½ in. of shim space was provided at each end of the center span, allowing for tower plumbness and center span length tolerances of 1 in. maximum. The total time needed to erect the steel frame was approximately four weeks.

Trussed Towers

The primary structural components of the skyway include trussed towers on each side of Forbes Avenue, with a central Vierendeel truss span partially supported by two tapered plate girder arches. The trussed towers measure approximately 16 ft by 16 ft and have a network of rod and clevis X-brace assemblies providing stiffness and sta-



Above: One inch was allowed for tolerances when erecting the prefabricated center span.

Right: The tower columns support the pedestrian bridge; access to the bridge occurs through the adjacent structures.

bility. The south tower is more than 140 ft tall, while the north tower is 100 ft tall.

In each tower, horizontal X-bracing levels occur every 19 ft and are comprised of 2-in.-diameter 36 ksi rods with a #5 clevis and 2-in.-diameter pin at each end. Three horizontal bracing levels occur between the ground and the bridge deck. Vertical X-bracing consisting of 2-in.-diameter 50-ksi rods with a #8 clevis and 3-in.-diameter pins occurs at every level except the street. To fully develop the higher strength vertical rod bracing, up-set threaded ends were specified at the clevis connections.

Tower columns are made up of multiple HSS $10\times10\times\frac{3}{8}$ members with HSS $16\times8\times\frac{3}{8}$ horizontal members passing between at the bracing levels. To allow for pedestrian access to the garage and new facility, vertical X-bracing was omitted on the first level. Here, at the weakened story, each tower column was made up of four HSS 10×10 members acting as a moment frame. Between the first braced level and the bridge deck, the tower columns were reduced to three HSS 10×10s, and above the deck they were further reduced to two HSS 10×10s. The column reductions could occur above the first braced level because the towers behave more like a truss. The HSS 16×8 horizontal members passing between the column groups at the tower corners are spliced with end plates at the center. This detailing approach allowed for the complicated welded connections at the columns to be performed in the shop, while simpler bolted end-plate connections were used in the field.

The concrete bridge deck is approximately 75 ft above the street and is supported by a walkthrough Vierendeel truss with intermediate ties to the tapered plate girder arches. The chords of the Vierendeel truss are made up of continuous W14 members. Vertical truss elements are HSS $10\times6\times\frac{1}{2}$ with bolted end-plate moment connections to the truss chords. The tapered arches, while aesthetically important to the architecture of the bridge, are structural in nature. They provide intermediate support to the Vierendeel truss and add significant lateral stiffness to the structure by functioning like a knee brace between the bridge and the towers. The total span of the arch and truss system between the towers is 102 ft, and approximately 240 tons of structural steel were used in all.

> Architecturally exposing the steel simplified many details.

Foundation Stability

With the structural concept and basic construction sequence in mind, detailed analysis and design of the individual framing components and subassemblies was performed. The structure was analyzed as three individual subassemblies: the north tower and cantilever, the south tower and cantilever, and the center bridge span. Construction and environmental loads were considered, and the three primary subassemblies were evaluated for member stress and overall stability. After evaluating the subassemblies, the structure was evaluated as a whole. A three-dimensional finite element model considering wind, seismic, live, and temperature loads was used to verify member stresses and structure deflections.

Due to the height-to-width ratio of the trussed towers and the concentration of lateral load more than 75 ft above the base, very large overturning moments are present at the foundations. Further complicating the foundation design were the physical constraints imposed by the existing parking garage at the south tower and new building at the north tower. Different foundation systems were chosen for each tower to accommodate the specific design requirements.

The south tower used a spread footing bearing on shallow bedrock. Because the existing parking garage foundations were within inches of the new tower, overturning resistance of the foundation could not be achieved by using a large footing. Taking advantage of shallow competent bedrock, a permanent post-tensioned rock anchor system was chosen to achieve overturning stability. A total of six 150-kip rock anchors were used to anchor the foundation to the bedrock. The post-tensioning force and anchor layout were chosen so the footing would be in constant contact with the bedrock, even under the extreme overturning load.

At the north tower, lower bedrock and the concurrent construction of the new building resulted in a much different foundation design. To resolve the overturning forces, an aggregate-filled concrete ballast

Steel rods and clevises provide visually unobtrusive lateral bracing for the supporting towers.

box was designed. The ballast box is supported by caissons founded on bedrock and was configured so that the new building could be constructed without affecting the stability of the tower. The weight of the box was used to resist overturning forces; therefore, rock anchorage was not required.

The superstructure-to-foundation connection involved transferring moment and shear in both directions in combination with vertical load either up or down. A non-bonded post-tensioned anchor bolt system was chosen to simultaneously resolve all loads. Post-tension forces were chosen to achieve a constant minimum contact pressure between the tower base plates and the concrete piers, eliminating cyclical loading on the anchors while maintaining enough contact pressure to resist shear through friction. A total of eight anchors were post-tensioned to 50 kips at each tower column. After tensioning and testing, the anchors were grouted, and custom steel anchor caps were filled with grout and welded into place to protect the anchor heads.

Successful Skyway

The successful completion of Duquesne University's skyway was due in large part to early interaction between the design team and the steel erector and contractor. With input from each entity, critical construction issues were raised and addressed while the design was in the early stages. Practical solutions to anticipated construction problems were identified by the design team and integrated into the structural and architectural concept for the skyway. And of course, success was also the result of the design flexibility afforded by exposed structural steel. MSC

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Steel Erector
Century Steel Erectors Company, Dravosburg, Pa. (TAUC Member)

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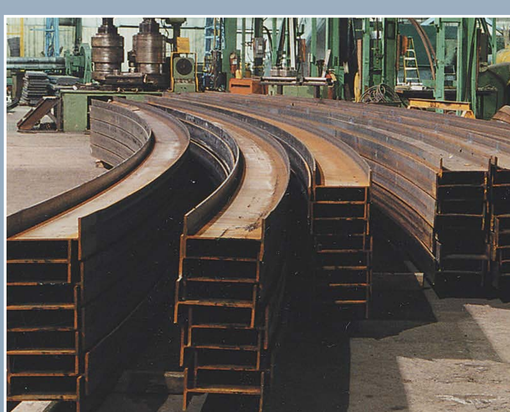

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Hodgson Custom Rolling has the expertise to roll curved structural sections into a wide range of shapes and sizes (angle, wide flange beam, I-beam, channel, bar, tee section, pipe, tubing, rail, etc.). We specialize in **Spiral Staircase Stringers**, flanges, support beams, gear blanks, etc.

PRESS BRAKE FORMING & HOT FORMING

Hodgson Custom Rolling's brake department processes all types of steel sections and plate up to 14" thick. Developed shapes such as cones, trapezoids, parabolas, reducers (round to round, square to round) etc.

PLATE ROLLING & FLATTENING

Hodgson Custom Rolling specializes in the rolling and flattening of heavy plate up to 7" thick and up to 12 feet wide. Cylinders and segments can be rolled to diameters ranging from 10" to over 20 feet. Products made include ASME pressure vessel sections. **Crane Hoist Drums**, thick walled pipe, etc.

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HODGSON CAN HELP SOLVE YOUR PROBLEMS

Innovative Design in Engineering and Architecture with Structural Steel

IDEAS² awards

THE DESIGN AND CONSTRUCTION INDUSTRY RECOGNIZES THE IMPORTANCE OF TEAMWORK, COORDINATION, AND COLLABORATION IN FOSTERING SUCCESSFUL CONSTRUCTION PROJECTS TODAY MORE THAN EVER BEFORE. In support of this trend, AISC is proud to present the results of its annual IDEAS² Awards competition. This program is designed to recognize all team members responsible for excellence and innovation in a project's use of structural steel.

Awards for each winning project were presented to the project team members involved in the design and construction of the structural framing system, including the architect, structural engineer of record, general contractor, detailer, fabricator, erector, and owner.

New buildings, as well as renovation, retrofit, or expansion projects, were eligible. The projects also had to display, at a minimum, the following characteristics:

- ➜ A significant portion of the framing system must be wide-flange or hollow structural steel sections;
- ➜ Projects must have been completed between January 1, 2005 and December 31, 2007;
- ➜ Projects must be located in North America;
- ➜ Previous AISC IDEAS² or EAE award-winning projects were not eligible.

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

- ✓ Less than $15 million
- ✓ $15 million to $75 million
- ✓ Greater than $75 million

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

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

Both national and merit honors were awarded. The jury also selected two projects for the Presidential Award of Excellence in recognition of distinguished structural engineering.

2008 IDEAS² Awards Jury

Craig McNay, chairman and CEO, CMC Holding Corp., Chicago

Lucien Lagrange, Lucien Lagrange Architects, Chicago

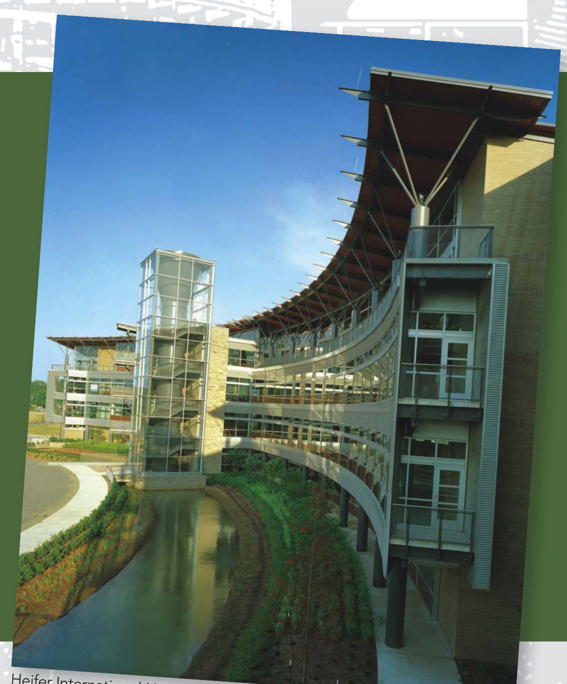
Charlie Thornton, founding principal, Thornton Tomasetti, and chairman, Charles H. Thornton and Co., LLC, Easton, Md.

Jerrold Pault, vice president and district manager of the Capitol District, Hensel Phelps Construction Co., Washington, D.C.

Steve Porter, AISC Treasurer and president of Indiana Steel Fabricating, Indianapolis

Katie Gerfen, associate editor, *Architect* magazine

Geoff Weisenberger, associate editor, *Modern Steel Construction* magazine



Heifer International Headquarters, Little Rock (a National Winner in 2007).

National Winner—Under $15M

156 WEST SUPERIOR CONDOMINIUMS—CHICAGO

This nine-story mid-rise tower explores the steel and glass language of the "second Chicago school" of architecture, which was defined by the work of Mies van der Rohe and early SOM designs. Expressed through simple and elegant detailing within a minimalist aesthetic, the building is meant to invest an image of structural architecture, conveying a sense of economy, efficiency, discipline, and order.

Located in the River North neighborhood of central Chicago, the project occupies a tight 45-ft by 100-ft mid-block site bounded by alleys on the west and north and an historic stone townhouse on the east. A lobby and tenant parking occupy the ground floor, with eight levels of housing above. The structural frame becomes a visible system that lends scale and identity to the building.

To articulate the building mass, a steel-framed structural bay, fully enclosed in glass, occupies the center portion of the south and north elevations. By expressing these elevations as a series of two-story frames with steel X-braces, the building seems taller than its 120-ft height and is able to hold its own in a dense area of tall buildings. The steel frames support cantilevered decks, enclosed with stainless steel railings, for each unit, as well as louvers for privacy from adjacent development. The building's base of concrete masonry provides a solid podium that visually supports the light steel-and-glass tower. The narrow building frontage led the team to develop units that span the entire width of the structure, creating a visual identity for each homeowner within the floor-to-ceiling glass façade.

For more on this project, see "Squeezed" in our June 2007 issue at **www.modernsteel.com/archives**.

Nic Lehoux

Architect
The Miller Hull Partnership, Seattle

Associate Architect
Studio Dwell Architects, Chicago

Owner/Developer
Ranquist Development, Inc., Chicago

Structural Engineer
Thornton Tomasetti Engineers, Chicago

General Contractor
Skender Construction Company, Palos Hills, Ill.

Nic Lehoux

Merit Award—Under $15M

CHRISTY WEBBER LANDSCAPES GREENWORKS PROJECT—CHICAGO

For over a century, a 12-acre land parcel just west of downtown Chicago was used for industrial purposes, serving as the home to one railroad company, then another, then a rock-crushing operation, and finally a city impound lot.

Fast-forward to the 21st century, when the principals of Christy Webber Landscapes (CWL) proposed a new vision for the site; the organization recently assembled a professional team and formed a company called Chicago GreenWorks to develop the area into an eco-industrial office park.

From conception to completion, the focus was on a thoroughly integrated design approach to make the most of free, renewable, and recycled resources to achieve a highly energy-efficient building. The CWL complex is actually three separate buildings that are sited to form an open-ended courtyard, with direct views of Chicago's downtown skyline. The largest of the buildings, the warehouse building, is located on the north side and provides access to and from the CWL storage yard. The southern-most building, a long narrow rectangle, is the main office wing and is the public entry point. The center building, a two-story structure, links the office and warehouse buildings and provides access to the greenhouse and the intensive green roof above the office building.

Supporting Sustainability

The use of structural steel was integrated throughout the project into its energy-generation and energy-saving features, as well as into the overall architecture. Structural steel's high recycled content, as well as its suitability to carry the heavy green roof loads, made it a natural choice for this LEED Platinum structure. All of the exposed structural steel was fabricated with standard AISC tolerances and finishes to reduce the additional energy use associated with AESS fabrication.

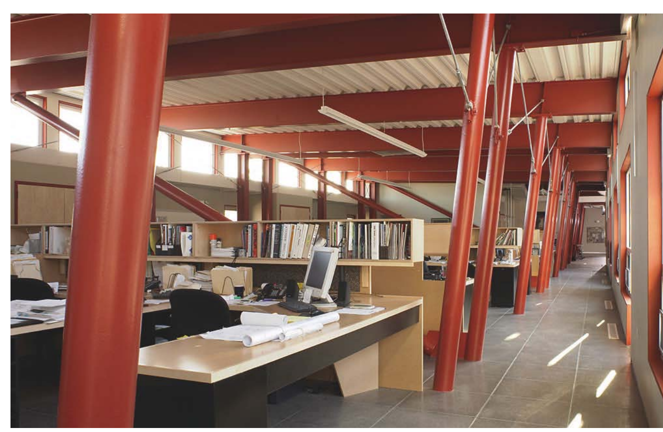
Flexibility in controlling solar heat gain has been optimized by careful and thoughtful integration of the structural elements with the architectural and mechanical elements. Slender round HSS columns are located on the interior to allow column-free exterior window walls to maximize natural light and minimize energy use. In addition, the east-west steel framing in the main office building is embedded within the composite roof slab and allows a higher ceiling height, resulting in unobstructed natural light. The sloped roof and sloped columns are braced not with costly moment frames or moment connected bases, but with bracing that divides the work stations without the use of partitions. In the end, the simple structural steel system also provided an overall lighter structure on smaller footings than the comparable concrete system that was originally considered for the project.

Structural steel is the backbone of some of the facility's "feature" elements as well. A wind turbine tower, located adjacent to the bioswale water detention pond, is constructed of round 2- and 3-in.-diameter HSS shapes that were shop fabricated into five sections. The round standard steel sections were fabricated and shop welded to the plate rings, and the horizontal ring elements are field bolted. The entire tower was erected in one day.

Steel also supports the solar capacity of the project. When visitors enter the office building through the front door, they pass under an eight-panel active solar thermal system supported on a sloped exposed structural steel frame. Exposed steel also enhances the second-story greenhouse, which provides growing space as well as pre-heats cold winter air, reducing the need for heat production by the building's other systems.

Steel is also present in the extensive green roof that covers a large portion of the main office building, where it supports the heavy soil loads. Additionally, the east-west light steel rod bracing maximizes the glazing while exposing the skeletal structure.

Shortall



Shortall

DZSE

Architect
Farr Associates, Chicago

Owner
Christy Webber Landscapes, Chicago

Structural Engineer
Drucker Zajdel Structural Engineers, Inc., Naperville, Ill.

Steel Fabricator
Steel Sales & Service, Lansing, Ill. (AISC Member)

General Contractor
The George Sollitt Construction Co., Wood Dale, Ill.

Merit Award—Under $15M

TAXI² MIXED-USE DEVELOPMENT—DENVER

A lot of design expertise went into transforming a former taxi cab maintenance facility in Denver into an 18-acre masterplanned, mixed-use development. In fact, the developers deliberately brought together four different architects to create an intentional "crashing together" of minds, styles, and aesthetics.

The building—TAXI²—is the second building in a series that will redevelop a Denver brownfield site into a forward-thinking, live-work community. (Phase I was an adaptive reuse project that took the original taxi headquarters and turned it into innovative workspaces.) The project includes 100,000 sq. ft of commercial and residential space—and plenty of exposed structural steel.

The structrual engineer designed an extraordinarily light structural steel system: 7.6 psf in the first two stories, topped by structural light-gauge systems for the upper two floors of residential space. The steel frame includes 15-ft beam spacing to minimize the number of pieces, and thus erection time and cost. All structural steel elements, including beams, girders, columns, braces, and floor deck, are left exposed.

Another unique aspect of the project was that the electronic data produced by the engineer eventually fed the CNC-driven equipment at the fabrication shop. Building geometry and steel framing were produced in RAM Structural System, and the electronic information was fed to the SDS/2 3D detailing software, which in turn provided CNC information to the fabrication equipment.

Stair cores, the primary lateral resisting system for the building, were perhaps the most visibly innovative component of the project. Constructed with prefabricated leave-in-place steel forms, they were placed by the steel erector and later filled with concrete. The custom-designed, one-story prefabricated modules are designed to support the steel framing prior to concrete placement. This sequencing removed concrete from the schedule, allowing the steel erector to continue without waiting for other subscontractors. The presence of the steel floor deck prior to concrete placement allowed the contractor to use the deck as the working surface when placing concrete in the cores, and further saved time and money by preventing the need for scaffolding. Developed by Cortek Building Systems and designed by the structural engineer, this was the system's first-ever installation.

Architect of Record
Alan Eban Brown Architects, Eldorado Springs, Colo.

Design Collaborators
Will Bruder + Partners, Ltd., Phoenix
Harry Teague Architects, Basalt, Colo.
David Baker + Partners, Architects, San Francisco

Owner/Developer
Zeppelin Development, Denver

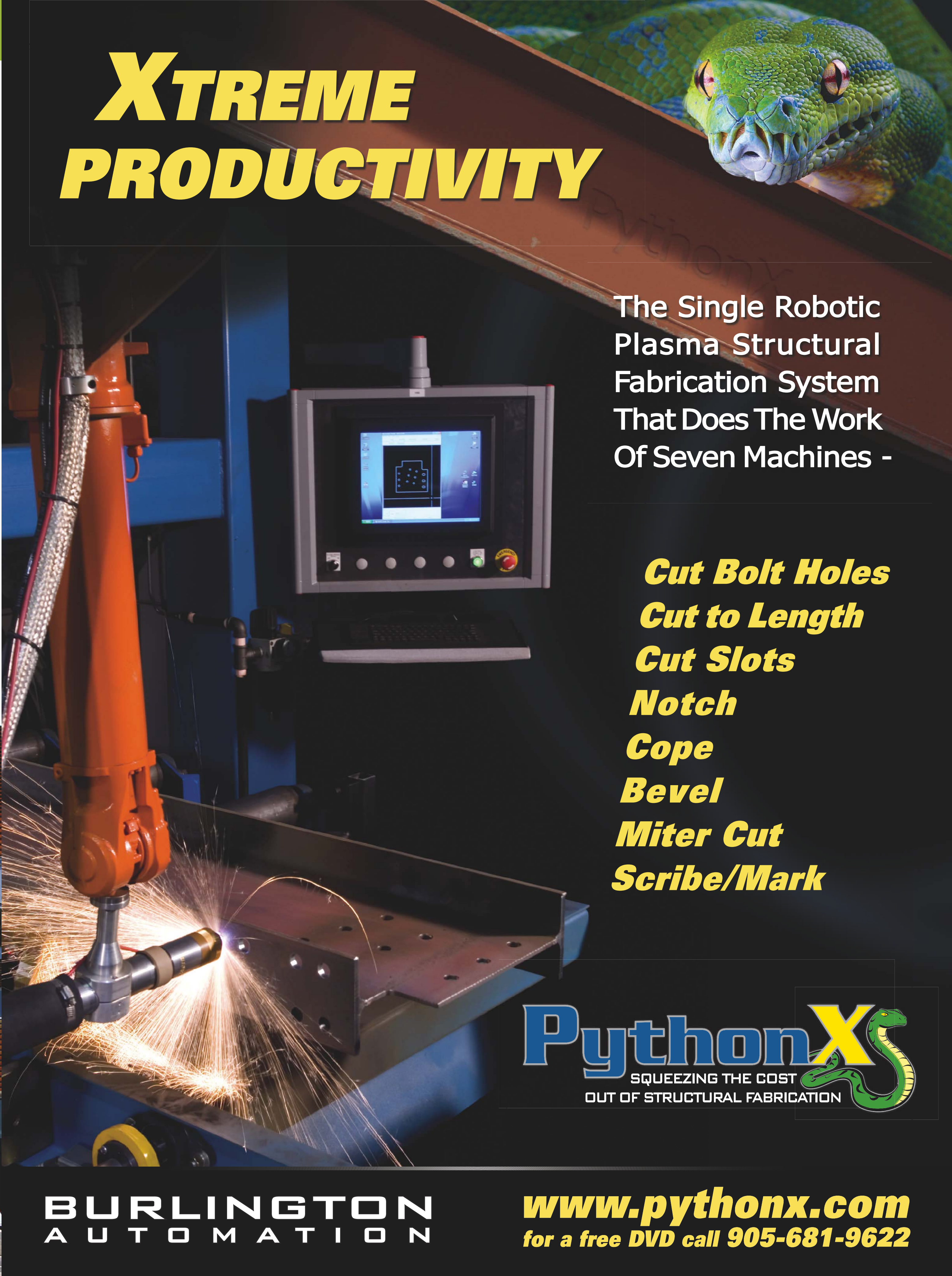
Structural Engineer
KL&A, Inc., Denver

Steel Fabricator
Western Slope Iron & Supply, Inc., Grand Junction, Colo. (AISC Member)

Steel Erector
LPR Construction Company, Loveland, Colo.

General Contractor
M.A. Mortenson Company, Denver

Patty Owens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National Award—$15M to $75M

NATIONAL MUSEUM OF THE MARINE CORPS—QUANTICO, VA.

The new National Museum of the Marine Corps illustrates a unique combination of architecture, symbolism, and geometry.

To successfully represent the honor, courage, and spirit of the Marine Corps, the designers drew inspiration from an enduring symbol of the Corps: the historic film footage (later immortalized in a statue) of a small group of Marines planting and raising the U.S. flag on Iwo Jima in 1945. The design uses the exact triangular geometry of that famous image.

Steel made the project possible, from the 150-ft-diameter skylight to the exposed, battleship-gray-painted steel observation structure and balconies in the museum's Central Gallery. The centerpiece, from a structural and symbolic standpoint, is the 210-ft.-long stainless steel-clad structural box beam that projects beyond the skylight at 60°, representing the flag pole. The piece tapers in section from about 15 ft by 17 ft at the base to 4 ft by 3.5 ft at the top.

For more on this project, see "What's Cool in Steel" in our August 2007 issue at **www.modernsteel.com/archives**.

Nick Merrick © Hedrich Blessing

Owner
Naval Facilities Engineering Command, Quantico, Va.

Architect
Fentress Architects, Denver

General Contractor
Balfour Beatty, Fairfax, Va.

Structural Engineer
Weidlinger Associates, Inc., Washington , D.C.

Steel Fabricator
Banker Steel Company, Lynchburg, Va. (AISC Member)

Merit Award—$15M to $75M

LAS VEGAS SPRINGS VISITORS CENTER—LAS VEGAS

The Visitor Center at the Las Vegas Springs Preserve is an interactive environment drawing upon the history of the site and surrounding Mojave Desert context.

The extensive use of exposed structure required a higher level of detailing than most projects with architectural finishes. The structural steel, interior screens, exterior shade structures, stairways, and awnings all required details that were sculptural in quality. The 72-ft diameter rotunda also featured a richly detailed, long-span roof system.

Nearly all of the elevated floor and roof framing in both buildings is architecturally exposed. Framing was organized and designed to create a handsome and efficient layout that is respectful of headroom requirements, particularly for architectural elements suspended from the roof.

An elliptical steel awning, measuring 33 ft from front to back and cantilevering more than 27 ft past its forward supports, forms the centerpiece of the main entry to the exhibit building. With a structure formed entirely of steel plates, the awning consists of three elliptical plates and a circular plate—each with a different center point along the front to back axis of symmetry—and a series of radial plates that create the appearance of a rising sun.

Architect
Tate Snyder Kimsey Architects, Henderson, Nev.

Owner/Developer
Las Vegas Valley Water District, Las Vegas

Structural Engineer
Leslie E. Robertson Associates, R.L.L.P., New York

Steel Fabricator
Southwest Steel (a division of SME Industries), Henderson (AISC Member)

General Contractor
J.A. Tiberti/Whiting Turner (a joint venture), Las Vegas

Tate Snyder Kimsey Architects

Merit Award—$15M to $75M

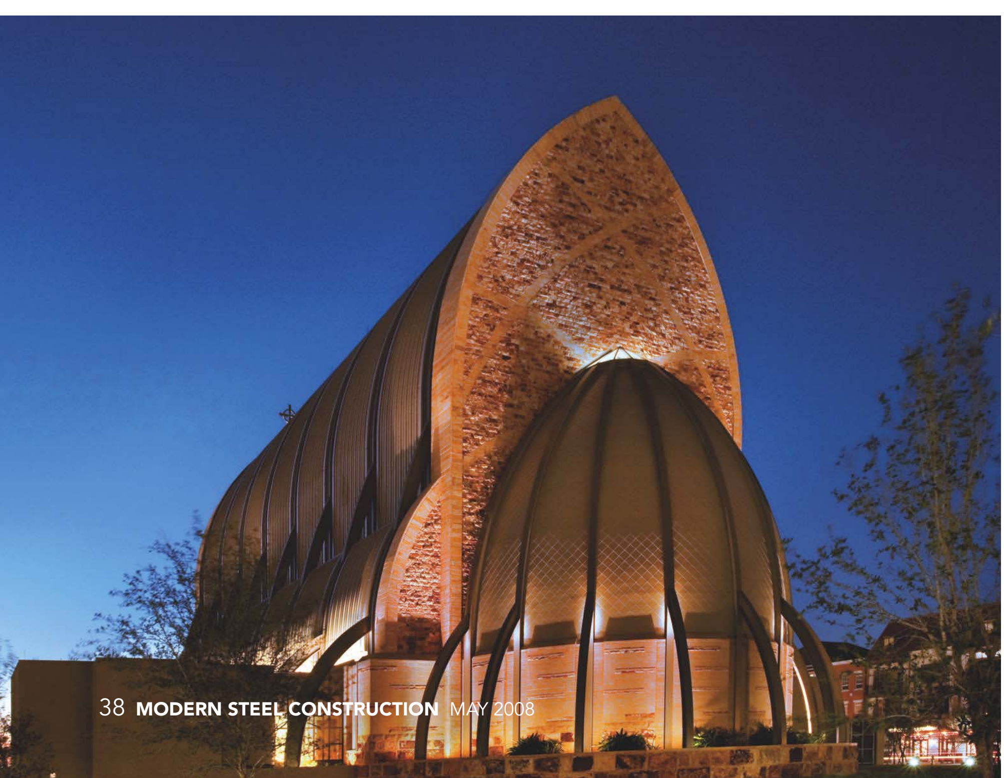
THE ORATORY AT AVE MARIA UNIVERSITY—AVE MARIA, FLA.

The Oratory at Ave Maria University is the focal element of a new town and university development on 4,000 acres of former agricultural land in southern Florida.

The Oratory's design was based on a traditional basilica form, built with modern methods and materials. The detail, structure, and finishes combine together to balance tradition and modernity. As one first sees the profile of the 120-ft-tall structure on the horizon, images and thoughts of a traditional cathedral are evoked. Moving closer to the Oratory, the clear distinction of a contemporary structure of glass, steel, and stone is revealed in greater detail. Entering the building through the narthex, the soaring height of the nave is compressed by the choir mezzanine above and then dramatically expands upon entering the nave proper. The eye is drawn up to the light penetrating from behind the lattice of steel above, creating a sense of mystery, the owner's primary design goal.

Steel "buttresses" are expressed from the interior to the exterior, as free-standing exposed steel frames penetrate the outer skin, hinting at the lattice steel bents that form the basis of the overall structure. In this building, the structure *is* the architecture and is the most prominent foreground element. The latticed steel bents take structural steel and infuse it with the delicacy of gothic tracery, intertwining the members to form the great steel frames from which the building form arises. Key intersections of steel members are lighted with punched openings to the exterior, thus the steel connection becomes a diffuser of natural light bounced across the interior spaces.

Photos: New York Focus LLC



The integration of engineering, architecture, and construction is raised to an art form; all systems integrate to define and enrich the space. Mechanical systems, lighting, controls, and subsequent wiring are all integrated within the steel framing system and disappear into the overall composition. A critical decision made early in the design process, and based on fabrication and erection concerns, was the use of wide-flange shapes in lieu of HSS for the main members of the upright steel bents. The geometry of these bents is comprised of a latticed grid of radiused steel members that were curved using state-of-the-art computer-controlled rolling equiment.

Lateral loads are transferred to the 3-ft-thick mat foundation via a combination of flexural bending and arching action of the curved steel members. Stability analysis of the lateral framing was complicated by the members' curved geometry and unique connections, which made traditional effective-length and slenderness procedures ineffective. Lateral loads were determined by wind tunnel studies on a scale model of the building. These loads were applied to a three-dimensional finite element computer model that incorporated the Direct Analysis Model along with a P-Delta anaylsis to determine member forces and deflections.

Architect/Structural Engineer
Cannon Design, Grand Island, N.Y.

Owner
Ave Maria University, Ave Maria, Fla.

Steel Fabricator
Cives Steel Company, Thomasville, Ga. (AISC Member)

General Contractor
Suffolk Kraf, Naples, Fla.

National Winner—$75M and greater

VIRGINIA BEACH CONVENTION CENTER—VIRGINIA BEACH, VA.

The Virginia Beach Convention Center is well suited to its location near the Atlantic Ocean, as architectural references to ships and sailing abound.

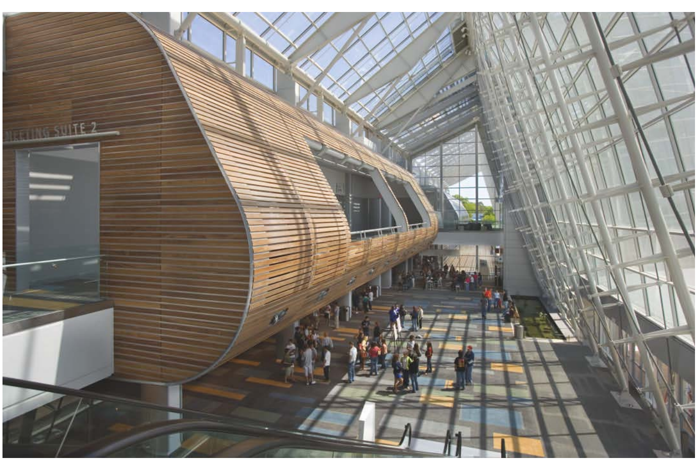
Exposed structural steel elements are used throughout the convention center as a common and unifying theme. A wide variety of architecturally exposed steel structures support the architectural vocabulary of modern, sleek, ocean-going vessels:

- ✓ A monumental pre-function entry area housed by a glass wall and cable-stayed mast trusses
- ✓ Glass roof scissor-frames in the pre-function area
- ✓ Long-span arched Pratt trusses and purlins over the exhibition hall spaces
- ✓ A 150-ft-tall steel-framed observation tower with high transparency
- ✓ Exterior exposed steel louver support frames at the entry to ballroom.

The entry glass support structure is a unique system of lens-shaped mast trusses spaced 15 ft on center and spanning vertically some 70 ft. These cable-stabilized trusses are composed of hollow pipe section masts with cruciform outrigger arms defining the doubly parabolic shape. Each truss is outfitted with an articulated pin assembly at both the top and bottom of the truss, nicely complementing the nautical theme of the center as a whole. Mast trusses are spaced along the entire length of the pre-function space, some 700 ft in length. The structural steel supports for the glass entry pre-function area gracefully provide for a light-filled, airy design aesthetic.

The long-span roof trusses over the exhibition hall space were shipped to the site in individual pieces, assembled on the floor of the hall in the lay-down position with specified cambers, and then lifted into place as an entire assembly without temporary support towers. All structural steel trusses, ceiling and roof purlins, diaphragm bracing, and roof decking are left entirely exposed in the final built condition, keeping consistent with the notions of exposed structure and inherent strength throughout the facility.

For more on this project, see "Ocean View" in our October 2007 issue at **www.modernsteel.com/archives**.



Owner
City of Virginia Beach, Va.

Architect/Structural Engineer
Skidmore, Owings & Merrill LLP, Chicago

Steel Fabricator
Cives Steel Company, Winchester, Va. (AISC Member)

General Contractor
Turner Construction, New York

Photos: Steinkamp Photography/James Steinkamp

Merit Award—$75M and greater

BRONX COUNTY HALL OF JUSTICE—BRONX, N.Y.

The Bronx County Hall of Justice stands prominently on a two-block site facing East 161st Street near Grand Concourse, a major civic thoroughfare in the Bronx. The L-shaped building houses 47 courtrooms, seven grand jury rooms, and offices, and provides underground parking for 240 vehicles.

While natural light and views were desirable, heightened security requirements demanded protective design. The Hall of Justice balances these concerns by expressing the judicial system's openness and transparency through a translucent curtain wall that is also blast-resistant.

Along 161st Street, an accordion-fold curtain wall features fritted glass in three horizontal bands of varying transparency. Structurally, the saw-tooth curtain wall is shaped primarily by aluminum mullions but is reinforced at strategic points with steel. The "V" shape gives the wall added stiffness and helps it to deflect and absorb blast forces, with laminated glass units used to reduce the likelihood of shattering. These units are attached to the frames with structural silicone to ensure that the glass is retained in the frame in the event of blast loading. Steel-frame structures are inherently more flexible than concrete, and thus able to distribute shock loading more easily, providing a further measure of safety.

A one-story-high transfer truss enables an 80-ft-wide, column-free lobby at ground level, reminiscent of vast traditional courthouse vestibules. Above, with slab-to-slab heights of 18 ft, the courtrooms are 40-ft, column-free spaces that possess a similarly commanding, yet appropriate, sense of scale. Ancillary rooms for attorney-client conferences, witnesses, jury deliberation, and judges' robing rooms flank the courtrooms on both sides; the lower ceiling height of these rooms (8 ft) permits light to pass over and filter inward, illuminating the courtrooms.

The floor slabs cantilever 20 ft on either side of the courtrooms, creating column-free perimeter circulation zones: a private zone for judges on one side and a public zone on the other. On the public side of the building, portions of the upper-story slabs cantilever 30 ft, with feature stairs suspended from the slab ends. Pairs of hollow, 10-sq.-in. steel trusses, along with 5-in. by 10-in. vertical hangers that attach to the staircases, hang beneath the cantilevers to support the public feature stair. These architecturally expressed structural members are visible from the outside of the building. The trusses are welded together, sanded smooth, and coated with a white intumescent paint for fire protection. Leaving the trusses exposed allows additional light to enter the circulation zones through the plaza-side glazed curtain wall.

Additionally, a two-story cylindrical jury assembly building in the courtyard gives scale to the plaza and is a visceral symbol of the true seat of justice, clad in precast concrete to contrast with the rest of the building. The cylindrical, steel-framed volume is structurally independent of the rest of the building.

Architect
Rafael Viñoly Architects PC, New York

Associate Architect
DMJM + Harris, New York

Owner
Dormitory Authority of the State of New York Corporate Headquarters, Albany, N.Y.

Structural Engineer
Ysrael A. Seinuk PC, New York

General Contractor
Bovis Lend Lease, New York

Paul Warchol Photography, Inc.

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STATE BAR OF CALIFORNIA BUILDING—SAN FRANCISCO

The State Bar of California seismic strengthening project exemplifies the use of structural steel to improve the seismic performance of a 13-story 1970s reinforced concrete building in high-seismic San Francisco. The project employed a state-of-the-practice seismic-mitigation technology and a number of other innovations to cost-effectively mitigate a very undesirable primary characteristic in the response of the existing structure to strong earthquake shaking. The defect involved the expected performance of the tall ground story, which was predicted by nonlinear response history analyses to experience large inter-story drifts and significant inelastic behavior verging on collapse in the event of a large earthquake. The building owner/occupant, the State Bar of California, desired improved seismic reliability if it could be achieved without severely disrupting operations, and embarked on a voluntary effort to mitigate the seismic hazard.

The most cost-effective and least disruptive solution that targeted the defect and avoided wholesale upgrading consisted of the addition of buckling-restrained bracing—infilled within new structural steel WT framing—to the lowest three stories of the existing perimeter reinforced concrete moment frame. This was the first application of this technology for seismic retrofit of a concrete building within the city of San Francisco. Buckling restrained braces consist of a ductile structural steel core located within a grout-filled HSS; the core is isolated from the grout by a bond-breaker, which enables the steel core to deform and yield without engaging the surrounding HSS. As the name implies, buckling restrained braces exhibit very stable hysteresis relative to other steel bracing systems, because they can yield in a ductile manner in both tension and compression. Furthermore, because the material properties of the core steel are tightly controlled, the strength of the braces is very predictable.

The design of the infilled diagonal bracing system, including the new steel framework and its attachment to the existing concrete frame, was predicated on a capacity analysis of the braces and iterative performance analyses of the building. Essentially, the maximum force that can be developed by each brace (i.e., the strength of each brace) was identified, and the whole of the supplemental system was designed for those computed forces using LRFD with lower bound yield strengths and associated phi factors. As a result, other than the desired yielding expected to occur in the new buckling-restrained braces, the supplemental system of steel framework is not expected to experience yielding even in the maximum considered earthquake event.

For more on this project, see "Braced for the Big One" in our August 2007 issue at **www.modernsteel.com/archives**.

Architect/Structural Engineer
Wiss, Janney, Elstner Associates, Inc., Emeryville, Calif.

Associate Architect
Richard Pollack Architects, San Francisco

Owner
The State Bar of California, San Francisco

General Contractor
Turner Construction Company, San Francisco

Photos: Wiss, Janney, Elstner Associates, Inc.

The Year in Review

BY DAN KAUFMAN

What can we learn by examining trends in corrective action requests?

CORRECTIVE ACTION REQUESTS, OR CARS, are an important tool used by Quality Management Company (QMC) auditors to help audited firms improve their quality processes. And studying trends in the types of CARs issued is a good way to give our Certified firms guidance in areas that might require attention. In 2007, we asked our auditors to take a slightly different approach when evaluating procedures for potential CARs. In a nutshell, they are focusing on customer-critical issues—issues that can have an immediate impact on the product going out the door. While the auditors continue to review processes and procedures (remember, they are not product inspectors!), they are keying in on issues that can have the most impact on the final product. Thus, fabricators and erectors—and their customers—experience a "real-time" benefit from the audit process.

Of course, AISC Certified fabricators and erectors are still expected to perform their own "self-audits" to review their procedures, in order to find and fix issues before the AISC audit takes place. To help firms in this regard, QMC is emphasizing the "concerns" section of the audit report, which documents areas of the firm's operations that require further internal review. If a concern is recorded in an AISC audit, then it is expected that the fabricator or erector will use their internal corrective action procedure to resolve the problem. If that doesn't happen by the next year's audit, a CAR would be issued the following year. Overall, this change in focus should result in a change in the distribution of audit corrective actions, and makes it difficult to directly compare our 2006 and 2007 data.

The Big Picture

Even though statistically the data can't be compared, the distribution of audit corrective actions does not show a profound change from 2006 (Fig. 1). In 2006, the most-issued corrective action was process control, as it was again in 2007. That should not be too surprising, as problems in process control are most likely to immediately affect product shipments. The top three CAR categories for 2007 were process control, management, and detailing, in that order. In 2006, the same three categories made up the top three, but management and detailing were nearly tied for second place.

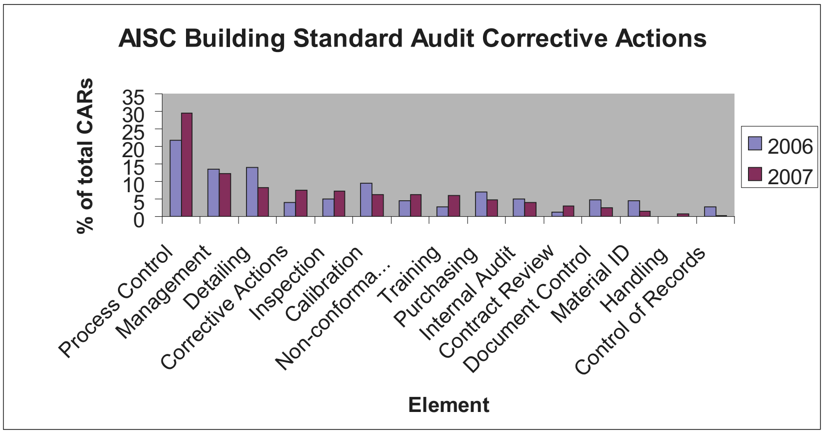

Figure 1. Corrective action requests, 2006 vs. 2007.

Welding Worries

Digging down to the next level, the most common CARs under process control were welding, and bolting (Fig. 2). The other potential process control issues—surface preparation, painting, and maintenance—were barely on the radar. Digging deeper still, the major welding problem was the misuse of weld procedure specifications (WPSs). Incorrectly written, missing, out-of-date, or incomprehensible procedures can have the same end result: poor welds.

The next major welding issue was documentation of welder qualifications. Typically, missing records regarding welder process continuity were the cause. AWS requires documentation that a welder uses a particular welding process once every six months. Process refers to a type of weld, such as GMAW or FCAW, not a specific position or specific WPS. Some shops only use a single process, so

Dan Kaufman is Manager of Operations for QMC.

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**.

in that case, documentation can be a record that a welder was welding in the required time period. A relatively simple system can help avoid the expense of re-qualification.

Finally, the third welding standout was storage of consumables. Low-hydrogen welding rods must be kept in a proper oven, and unfinished rolls of welding wire left on shelves need protection from moisture. This falls somewhere between a housekeeping issue and management issue; it's not difficult to cover the leftover spools with a plastic bag or to have at least a small rod oven working for low-hydrogen rods.

Bolting Bothers

Bolting issues made up the next largest process-control CAR. The causes were from two sources: testing and storage. The demonstration of bolt tension testing, which is required every three years (one full audit cycle), was not done or not done correctly. The next bolting contributor was bolt storage. High-strength bolts are really precision devices—carefully machined, heat-treated, and manufacturer-lubricated—that create consistent clamping forces when tightened in a repeatable process. It's a system that lets engineers predict and control the connective forces in a structure, even while using random human beings to tighten the bolts. Letting the threads of bolts or nuts deteriorate ruins any chance of a bolt system to achieve repeatable tensioning.

Management Miscues

Second to process control CARs, management CARs appeared due to two situations: quality system goals and management review meetings. Firms should keep in mind that goals don't have to be complicated or hard to track, and that they are chosen by the firm, not specified by AISC. The goals can be changed if they become problematic in the future, but they should always make sense in relation to product quality. As an example, tracking maintenance costs for parking lot paving does not relate to product quality. Goals involving customer satisfaction make the most sense to us Certification types, but again, it's up to the fabricator or erector to make that choice.

A management review meeting is the other contributor to an audit's corrective actions written within the management area. A management review meeting could be done by simply taking the bullet points in section 5.2 of the *Standard for Steel Building Structures* and using them as agenda items to assess your quality

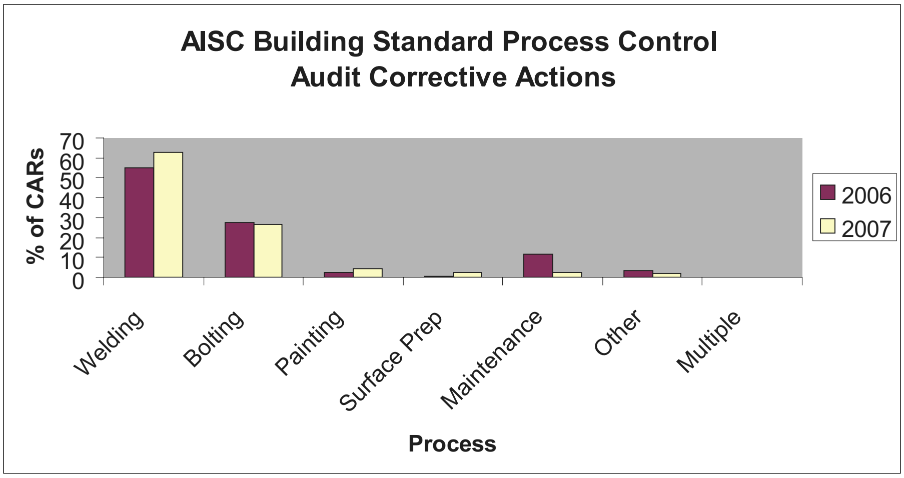

Figure 2. Process-control CARs, broken down by subcategory.

AUDIT CORRECTIVE ACTION CATEGORY	POTENTIAL REMEDY
Weld Procedure Specification	Make WPSs available and known to welders
Welder Qualification	Track welding process used
Welding Consumables	Use rod ovens when required, and cover partial spools
Bolt Tension Testing	Have a clear procedure for testing
Bolt Storage	Keep bolts clean and dry
Management Goals	Keep goals simple and easy to track
Management Review Meeting	Have a standard agenda
Checking of Drawings	Follow procedures and specify checking with detailing standards
Qualifications of Checkers	Use employee numbers

Figure 3. Recommendations for avoiding common CARs.

system. Not every item discussed has to be perfectly executed and completed, but the points need to be discussed for status. The object is to review whether or not the quality system is working for you.

Detailing Details

Finally, the third major contributor to corrective actions, detailing, is there for the same two reasons as in previous years: unchecked drawings observed during audits, or drawings checked by somebody whose qualifications were not documented. Although some contract detailers may be reluctant to give out checkers' qualifications for fear of losing their more advanced employees, it's completely acceptable to use an employee number or other code as identification. Even with these common detailing CARs, the total number of detailing audit corrective actions written was down significantly from 2006, although some or all of that reduction may be attributable to our new focus on customer-critical issues.

Summing it Up

So there we have another year's information. We've included a table (see Fig. 3) with some potential recommendations to help avoid these common CARs in the future. We hope you will use this information to set up your own internal review systems or to improve your current one. MSC

RECRUITING IN A DOWN ECONOMY

BY TIM R. JOHNSON

A slow economy can be the best time to hire top talent away from competitors.

THERE IS A COMMON MISCONCEPTION that recruiting in a down economy is easy.

It's true, job boards do tend to see an increase in posted resumes from job-seekers during an economic slowdown. But the best candidates for key hires, which are crucial during such times, are often already gainfully employed.

Less often do we see companies facing too much work with too few employees. Rather, the issue becomes a matter of staffing the top talent essential to maintain growth momentum as the economy decelerates—especially with a recession looming. A number of challenges stand in the way of obtaining that top talent. Firms that manage this appropriately through tough times position themselves for greater success when things speed up again.

Pulling up Stakes

In a down economy, chances are that employers need to look outside their immediate geographical region for top-talent candidates. With gas prices on the rise, people are not likely to favor a lengthy or extended commute. Relocation is often required. And a plummeting residential real estate market can make relocation undesirable. No one wants to endure financial loss on the sale of a home.

More and more firms are offering to cover more than simply the closing cost on the sale of a home, and this seems to be developing into standard practice. Now employers are also beginning to cover the loss suffered from declining market values versus mortgage balance. Some employers even propose to cover mortgage payments until a house is sold. Investments of this sort not only convey commitment and show that the candidate is valued, they also indicate growth and stability that promotes a company's "employment brand."

High Anxiety

Second to real estate on the list of concerns hindering recruiting in a down economy, is anxiety over the LIFO (last in, first out) rule of accounting in human resources. For example, let's say that an employee of company A is concerned about his job. The firm has seen a significant slowdown in work, bonuses are being slashed, managers are getting edgy, and lower-level coworkers are being laid off. Doesn't sound like the ideal situation, does it? And yet, while opportunity for betterment may exist with company B, the individual may be hesitant to make a job change because of LIFO anxiety. With continued talk of economic recession, the employee may fear that he or she would be the first to be put on the chopping block at a new firm if layoffs became necessary within the first year. Company B needs to communicate to the recruited candidate, who is still gainfully employed (for a reason), what is going well at the firm—and that the LIFO approach is not practiced there.

Show Them the Money

In a down economy, when work dries up, money can be tight—no surprise there. And money is the lifeblood of any business. It is also a signal of how much employees are valued. Even more so when industries decelerate than during times of stability should businesses review pay structures and compare with the industry standard. Being able to offer a pay increase to a recruited candidate is a virtual necessity during periods of economic downturn, if not at all times. The inability to do so can create a stigma that a company is unstable and perhaps in financial trouble. Stability equals growth, and a recruited candidate will be evaluating for stability and growth. Seldom will recruited candidates make a job change for the same salary, and the nature of the position itself is no different. Lateral moves are not likely to win recruited candidates and are even less likely to do so in a down economy. Framing a position as a promotional opportunity with an increase in salary is one of the only surefire ways to get a hold of the top talent that's so crucial during an economic slowdown.

Aim High

Grabbing blindly from the pool of eager job-

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seekers that flood job boards in a down economy presents risks. And when a slow economy pulls the tide of work further out to sea, financial matters have even greater gravity. As there are a number of costs associated with hiring new employees—time spent interviewing and putting together an offer, sign-on bonuses, relocation expenses, training—employers must be careful with new hires. Turnaround can be dangerous when work is slow. To ride out a recession (yes, it's time to use that word), companies have to be extremely careful when making new hires. Remember: odds are, the best of the best will still be employed. Those gainfully employed candidates make the best hires for staff upgrades. Firms need to find ways to attract these individuals.

Companies able to revamp their personnel policies during a down economy need to get the word out. One of the fastest and easiest ways to do so is through press releases. Not only can they announce the implementation of a new policy—such as flex-time or telecommuting options—they can also get the firm name out there in front of both potential hires and potential clients. Another method of communicating is to host an open house, inviting clients, business partners, networks, potential clients, and potential candidates.

A strong employment brand attracts top talent. What generates that reputation? Competitive salaries, clear opportunities for promotion, and indications of stability and growth can place a company a cut above seemingly struggling competitors. Proper assistance with real estate concerns and relocation expenses prevents an injured real estate market from hindering great hires. Allowing employees to work from home a certain number of hours (or days) per week helps to ease the burden of rising gas prices. Assurance that the LIFO approach to human resources is not the rule of thumb relieves concerns with recruited candidates and current employees alike. By addressing the challenges of a down economy with lasting solutions, companies build and promote strong employment brands. A firm that is able to effectively develop and tout a reputation as a good place to work will always have an edge in attracting top talent. MSC

THE COST DYNAMIC

Understanding the cost components for fabricated structural steel is the key to accommodating price changes in a global economy.

BY JOHN P. CROSS, P.E.

THERE CAN BE NO DOUBT that the most talked-about topic relating to structural steel over the past four years is cost. Even discussions regarding material availability pale in comparison to discussions about the price of structural steel. Interestingly, the focus changes depending on where the individual doing the talking is located along the structural steel supply chain. Owners and general contractors grumble about increases in the fabricated and erected cost of structural steel. Fabricators are concerned about what the price of the steel they ordered will be when it is actually shipped from the producer. And producing mills focus on increasing costs for scrap, electricity, and raw materials.

Global Change

The fact is that the economics of all construction materials, not just structural steel, changed in November of 2003. At that point the economic mechanism that determined the price for raw materials, producer products, and products installed at a job site for all construction materials, changed from being controlled by domestic supply and demand to being driven by the global market. This economic paradigm shift has significantly impacted the structural steel industry in several ways.

At the producer level, structural mills found themselves in competition with foreign buyers for scrap and raw materials. In November of 2003, the price of a ton of shredded automobile scrap was $162, and the typical cost of a wide-flange beam was $380 per ton. By April of 2008, the cost of that same ton of scrap had climbed 243% to $555 per ton. A ton of scrap today costs more than rolled wide-flange section just four years earlier! It must be noted that this phenomena is not just a product of China entering the world market; the largest net importer of ferrous scrap in 2006 was Turkey! Paralleling the increase in scrap costs have been similar increases in energy and other materials used in the production process.

At the same time, the global demand for structural steel has increased rapidly, outstripping increases in global production. The result is that the average global cost of structural steel has also increased dramatically. The global long products price index has moved from 114 at the end of 2003 to a current value of 251. While this index includes rebar and wire rod as well as structural products, it documents a 120% increase in the global price of structural products. Domestic mills compete in a global market from both the perspective of competition with imports entering the U.S. and a growing amount of exports leaving the U.S. In fact, U.S. exports of structural steel grew by 23% in 2007 over 2006 and account for 9% of domestic production.

Also impacting the global cost equation is the loss of value in the U.S. dollar compared to other currencies, particularly the Euro. In July of 2001, $0.84 would buy €1.00; in mid-2003, it reached parity with the U.S. dollar; and today it takes $1.50 to purchase €1.00. It is difficult to quantify specific cost increases because of timing differences between different trends. However, if the selling price of structural steel in 2003 is factored by the loss of value of the dollar over that same period, and then the increase in scrap price is added to the adjusted value, the result projects a typical mill price of $963 per ton. This is remarkably close to the current typical domestic price of $1,007 per ton.

Shifting Risks

While the entire project team has been impacted by both the magnitude and lack of predictability in the price of mill material, it's the fabricator that has become the default holder of the risk. Initially, many fabricators responded by asking their clients for adjustments to fixed-price contracts—and in most cases this relief was denied. As time went on, some fabricators sought to include escalation clauses in new contracts (which would allow for increases or decreases in material cost to be passed on to the project owner). And while many owners were open to discussing escalation clauses, few financial institutions were willing to proceed with what were perceived to be open-ended contracts.

As fabricators assumed this greater risk, they needed to adjust their pricing to accommodate volatility in the market (both the possibility of rising or falling prices). They needed to factor in the possible changes in material costs by providing a contingency against price increases and using declining prices as a buffer to carry them through unexpected price increases.

Unfortunately, in mid-2005 when material prices temporarily fell, some owners, developers, and general contractors did not realize that fabricators had built the potential for both material increases and decreases into their bid. So the same owners, developers, and general contractors who denied relief to steel fabricators when prices escalated were now asking for price cuts when material prices temporarily declined.

However, it's important to remember that the fabricator was still being asked to assume the cost risk of upwardly volatile prices, so it was only right that they would accrue the potential reward from a price reduction; alternatively, owners can offer escalation clauses (again, which allow for increases or decreases in material prices). In other words, if the steel fabricator assumes the risk, then compensa-

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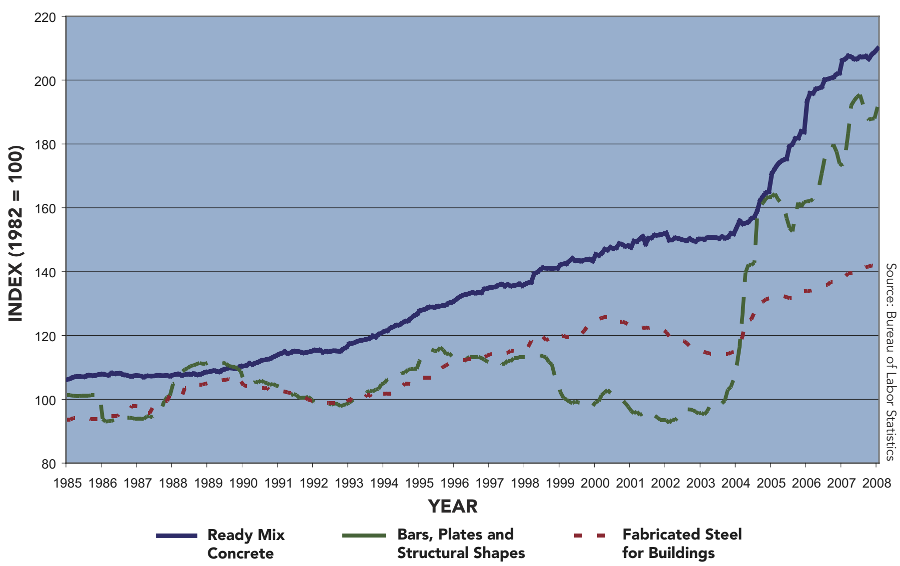
COMPARATIVE PRICE INDEXES



tion for that risk must be factored into the price for the fabricated material.

Big Picture

So what does this all mean on a relative scale? The U.S. Department of Commerce, through the Bureau of Labor Statistics (BLS), tracks the cost of materials used in the construction process. Using an index system where the cost in 1982 is defined as 100, a monthly index for the relative cost of the material is developed. In January of 2008, the index for structural mill products stood at 191.6 and the index for fabricated structural steel was 141.9.

Interestingly, the index for ready-mix concrete was 209.9! The concrete industry has a habit of adjusting the starting point of this study to lower their number below that of steel, but the actual BLS data consistently shows ready-mix concrete above structural steel.

In November of 2003, the BLS index for structural mill products was 103.8 and was 114.6 for fabricated material. What this indicates is that while mill products increased by 88%, the increase for fabricated material was only in the range of 27%. This is consistent with the percentage mill material represents of the fabricated cost of structural steel, increases in fabrication and transportation costs, and the cost for the fabricator assuming the risk of price volatility.

The cost dynamic of structural steel or any construction material will never return to the steady predictability of the past. Even as mills and fabricators continue to make every effort to gain a level of stability in their pricing practices, there will continue to be periods of price increases and decreases. The key question is: how should the construction market manage this new global scenario? AISC's message over the past four years has centered on five major points:

1. There must be a clear understanding of the supply chain and pricing dynamic for structural steel.
2. Structural steel fabricators that deal with the materials on a daily basis must be engaged early in the design process.
3. The process of material acquisition must be defined early in project's life cycle and should emphasize the early reservation or purchase of the construction materials and the compensation of the fabricator for the purchase and storage of the material.
4. Risks related to material acquisition should be defined, assigned, and accepted by the appropriate party, with appropriate compensation for the assumed risk.
5. As market conditions change during the life of the project, the project team must be willing to make appropriate adjustments in the design of the project to ensure an adequate flow of material. MSC

Next edition: The Impact of Economic Trends

DOWN TO THE WIRE

A guide to troubleshooting the most common self-shielded FCAW problems.

BY CHARLES SCHARFY AND BILL GIESE

SELF-SHIELDED FLUX CORED ARC WELDING (FCAW) has proven itself as a viable welding process for structural steel erection and bridge construction, among other uses. It offers high deposition rates, a wide range of mechanical properties, and good weldability, among other desirable features and benefits.

This doesn't mean that it's free of challenges and difficulties, however, as there are common pitfalls to be encountered during the normal course of self-shielded FCAW. But armed with some practical information and tips, you can avoid—or fix—these problems and maintain a high quality of welding work.

Wire-Feed Problems

Wire feed stoppages and malfunctions—birdnesting and burnback—are among the most common FCAW issues, especially on construction sites. More than just an annoying source of downtime, they can prematurely extinguish the welding arc and create irregularities that may weaken the weld bead.

Birdnesting is a tangle of wire that halts the wire from being fed. Incorrect drive rolls, tension settings, blockages in the liner, improperly trimmed liners (too short/burred/pinched), or the wrong liner (too small or large for the electrode diameter) are all sources of birdnesting.

For example, FCAW wire is a tubular consumable and therefore is much softer then GMAW solid wire. The correct drive rolls for FCAW wire are knurled V groove drive rolls. With the correct drive roll, the correct tension must also be used. Too much tension will flatten the wire and will not allow the wire to feed through the contact tip, causing a "bird's nest."

To set the proper tension, a good technique is to start by releasing the tension on the drive rolls. Increase the tension while feeding the wire into the palm of your welding glove and continue to increase the tension one-half turn past wire slippage. Blockages in the liner can also cause birdnesting, so replace the liner if you find a blockage. Always trim the liner according to the manufacturer's direction, and be certain you are using the correct size liner for your electrode.

When birdnesting does occur, the situation can be fixed by flipping up the drive roll and pulling the wire back out of the gun, then trimming off the affected wire and re-threading it through the feeder and back to the gun.

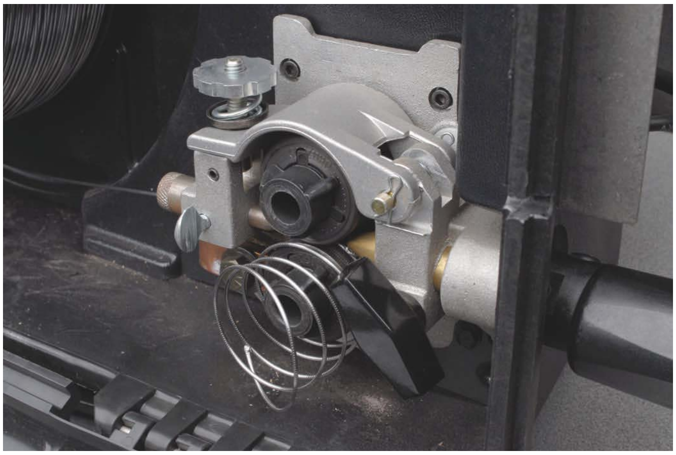
Burnback is the formation of a weld in the contact tip that occurs when the wire feed speed is too slow or if the gun is held too close to the work piece. Correcting this problem is easy: increase wire feed speed and the distance from the gun to the work piece (the contact tip should be no further than 1¼ in. from the metal). Also remember to replace the contact tip if burnback occurs.

Gas Discontinuities

Another set of problems with welding relates to gas. **Porosity**, for example, is a small pocket of gas caught in the weld metal that can appear at any specific point on the weld or along its full length. This discontinuity, whether internal or on the surface of the weld bead, significantly weakens the structural integrity of any weld.

A dirty work piece can cause porosity, so be sure to clean the surface of the base metal to remove rust, grease, paint, coatings, oil, moisture, and dirt prior to welding. You can also use filler wire with added deoxidizers to "clean" the weld.

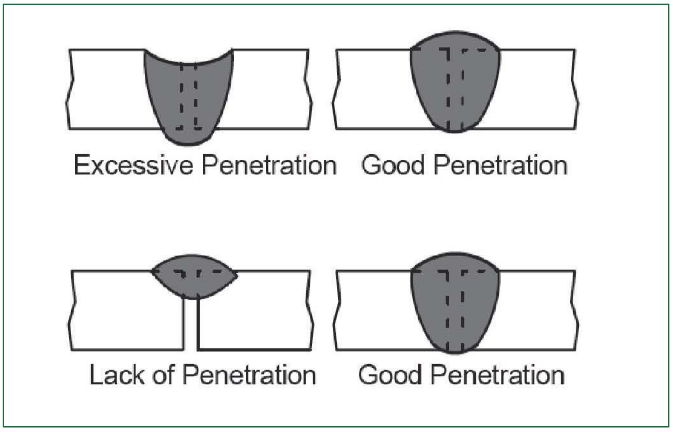
Additional causes of porosity include welding wire that ex-



Often resulting from incorrect drive roll tension, birdnesting, as seen here, can be a frustrating source of downtime.

Caused by slow travel speed or holding the tip too close to the weld, burnback requires the contact tip to be replaced.

This image shows a combination of worm tracking and porosity, both outcomes of too much voltage. Worm tracking is both easily diagnosed and easily corrected by lowering your voltage. Porosity, seen on the face and cross section of this weld, can significantly weaken the structural integrity of the weld.



In addition to using increased current and a slower travel speed, a beveled joint can greatly reduce the occurrence of incomplete penetration.

tends too far from the contact tip (the wire should extend no more than 1¼ in. beyond the contact tip). Impurities in the base metal, such as sulfur and phosphorous in steel, are yet another cause, but the situation can be remedied by changing the base metal to a different composition (where specifications allow).

Another gas-related problem is **worm tracking**: marks on the surface of the weld bead that are caused from the gas that is created by the flux in the core of the wire. It occurs when there is excessive voltage for a given wire feed setting/amperage. To prevent worm tracking, use the manufacturer's recommended parameters for a given wire diameter. If it does occur, reduce your voltage by increments of one-half volt until it no longer appears.

Slag Inclusions

Slag is a naturally occurring part of FCAW, caused when the molten flux from the core of the wire solidifies on top of the weld. **Slag inclusions** happen when the slag gets trapped inside of the weld metal, creating the potential for weakened weld components and reduced serviceability. These inclusions can be caused by incorrect weld bead placement, incorrect travel angle, low heat input, or poor interpass cleaning.

Weld bead placement is critical when making multiple passes on thick sections of metal, especially on the root passes of plug welds or wide V-groove openings. Careful consideration must be paid to providing sufficient space in the weld joint for additional passes, particularly on root joints requiring multiple passes.

The travel angle of self-shielded FCAW can also cause slag inclusions. In general, if slag inclusions are caused by incorrect travel angle, you should increase your drag angle. In the flat, horizontal, and overhead positions, your drag angle should be between 15° and 45°. In the vertical up position, your drag angle should be between 5° and 15°.

If welding heat input is too low, this may also cause slag inclusions. Always use the manufacturer's recommended parameters for a given wire diameter. If slag inclusions still occur, increase the voltage until the inclusions cease.

Fusion Issues

Improper fusion is another area of concern. One such problem, **undercutting**, occurs when a groove melts in the base metal next to the toe of the weld and is not adequately filled by the weld metal. This discontinuity creates a weaker area at the toe of the weld and can lead to cracking. To correct this problem, reduce the welding current, decrease the welding arc voltage, and adjust your electrode angle as needed. Reduce travel speed so that the weld metal completely fills the melted-out areas of the base metal and/or pause at each side of the weld bead when using a weaving technique.

Another fusion issue is **incomplete fusion** (or lack of fusion), the failure of the weld metal to fuse completely with the base metal or the preceding weld bead in multipass applications. Incorrect electrode/work angles that cause the weld metal to get ahead of the arc can be the culprit and should be adjusted accordingly.

To prevent incomplete fusion, place the stringer bead in its proper location at the joint, adjusting the work angle or widening the groove to access the bottom during welding. Keep the arc on the trailing edge of the welding puddle and remember to use a correct gun angle drag of 15° to 45°. If using a weaving technique, momentarily hold the arc on the groove sidewalls when welding.

If correcting the electrode/work angle does not remedy the problem, check to see if the electrode is getting ahead of the welding puddle. Simple adjustments, such as increasing travel speed or using a higher welding current, will correct the problem.

A dirty work piece can also be the cause of the problem. Always clean the surface of the base metal prior to welding to remove contaminants. If you suspect insufficient heat input could be contributing to incomplete fusion, select a higher voltage range and/or adjust the wire feed speed as necessary.

Proper Penetration

Lastly, penetration is another factor in accomplishing a quality weld. **Excessive penetration** occurs when the weld metal melts through the base metal and hangs underneath the weld; it is often caused by excessive heat input. To correct the problem, select a lower voltage range, reduce wire feed speed, and increase travel speed.

At the other end of the spectrum is **lack of penetration**, the shallow fusion between the weld metal and the base metal. An obvious cause is insufficient heat input. Increasing wire feed speed, selecting a higher voltage range, and/or reducing travel speed are viable remedies.

Lack of penetration can also be caused by improper joint preparation and/or from the material being too thick. Joint preparation and design must permit access to the bottom of the groove, while also allowing you to maintain proper welding wire extension and arc characteristics.

Quality Welds

Quality self-shielded flux cored arc welds are the result of good welding technique, the proper choice of parameters, and the welder's ability to identify a problem quickly and rectify it. Armed with some basic information, you can aggressively tackle the most common problems without sacrificing time or quality. MSC

Charles Scharfy is the structural segment manager with Hobart Brothers Company, and Bill Giese is a product manager with Bernard.

What Every Fabricator Wants You to Know about Welding

BY MONICA STOCKMANN AND THOMAS J. SCHLAFLY

There are plenty of things that engineers can do to make the welder's work easier and more efficient.

IF YOU ASKED THE OPINION of a typical steel fabricator, he or she would probably tell you that there should be a class (or two) in engineering and architecture curriculums that focuses on welding and connection design—from both the engineer's and the fabricator's perspective. However, there's simply no space in the typical curriculum for such a course. To help fill that need, we've developed this article to cover several welding design recommendations from the fabricator's standpoint, including filler metal specifications, preferred weld types, and other applicable weld advice. Obviously we can't cover everything here, so refer to AISC's Design Guide 21, *Welded Connections—A Primer for Engineers*; the American Welding Society 2006 *Structural Welding Code—Steel* (AWS D1.1:2006); and Section J2 of the AISC 2005 *Specification for Structural Steel Buildings* for additional information.

When performed properly, welding is an economical and efficient tool for joining steel. However, welding can become altogether uneconomical when improperly specified. The skilled labor cost required to make a weld typically accounts for 75% to 95% of the total cost of a weld. Thus, cost-effective welding is typically achieved when the required weld metal is deposited in the least amount of time. Here are some tips and highlights on how to design and specify economic welds.

Welding Processes

In total, there are approximately 100 different welding processes. At present, the steel construction industry uses about five of them: shielded metal arc welding (SMAW); flux cored arc welding (FCAW), which can be gas or self shielded; submerged arc welding (SAW); gas metal arc welding (GMAW); and electroslag welding (ESW). Design Guide 21 describes many of the pros and cons of the different types of welding, as well as several process-specific welding issues, such as applicability of low-hydrogen electrodes in SMAW; the conditions under which short-circuit transfer may occur in GMAW; and the use of active fluxes in SAW.

The choice of welding process can significantly affect the cost of a project. Typically, the contractor makes this important decision, as he or she is usually best positioned to select the optimal welding process for a given application. When properly used, all of the welding processes listed in AWS D1.1 are capable of delivering adequate welds for building construction.

Over-use of CJP welds

It is common knowledge that complete joint penetration (CJP) groove welds are typically the most expensive type of weld and thus should be reserved for situations in which they are the only viable option. In a CJP groove weld, the full strength of the attached materials is developed. Thus, no design calculations are required when specifying CJP groove welds in statically loaded structures. However, this design advantage can be abused by specifying CJP groove welds in situations where there are better, more economical options. The most commonly abused situation involves longitudinal welds on built-up beam and column sections. These welds are typically loaded in shear, which rarely requires the strength of CJP groove welds. Fillet welds or PJP groove welds are typically better, lower-cost options for this case. Fillet and PJP welds are also typically the more environmentally friendly option, because depositing less metal saves energy too!

Fillet Welds vs. PJP Groove Welds

A helpful rule of thumb is to use fillet welds whenever the required weld leg size is 1 in. or less, and PJP groove welds or a PJP and fillet weld combination when larger sizes are required. Because most structural steel fillet welds are not required to have leg sizes greater than 1 in., fillet welds are typically the most economical choice, with the exception of skewed T-joints, which must be examined on a case-by-case basis. The table on the next page, taken from Design Guide 21, guides the user through an economical weld selection process based on loading and joint type.

Monica Stockmann is a Steel Solutions Center advisor, and Thomas J. Schlafly is director of research, both with AISC.

Table 3–2. Weld Selection Based on Loading and Joint Type

Joint Type	Force Type	Loading Level	Normal to the Weld Axis	Parallel to the Weld Axis	Shear
Butt Joints	Tension	Light	PJP	PJP	
		Heavy	CJP	PJP	
	Compression	Light	PJP	PJP	
		Heavy	PJP with bearing considered, CJP	PJP	
	Shear	Light			PJP
		Heavy			CJP
Tee Joints	Tension	Light	Fillet	Fillet	
		Heavy	Fillet, PJP, PJP/Fillet, CJP	Fillet	
	Compression	Light	Fillet	Fillet	
		Heavy	PJP with bearing considered, CJP	Fillet	
	Shear	Light			Fillet
		Heavy			Fillet, PJP, PJP/Fillet, CJP
Corner Joints - Outside	Tension	Light	PJP	PJP	
		Heavy	CJP	PJP	
	Compression	Light	PJP	PJP	
		Heavy	PJP with bearing considered, CJP	PJP	
	Shear	Light			PJP
		Heavy			CJP
Corner Joints - Inside	Tension	Light	Fillet	Fillet	
		Heavy	Fillet, PJP, PJP/Fillet, CJP	Fillet	
	Compression	Light	Fillet	Fillet	
		Heavy	PJP with bearing considered, CJP	Fillet	
	Shear	Light			Fillet
		Heavy			Fillet, PJP, PJP/Fillet, CJP
Lap Joints	Shear	Light			Fillet, Plug/Slot
		Heavy			Fillet, Plug/Slot, Fillet/Plug/Slot

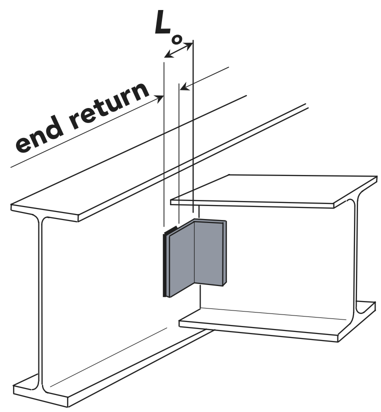
Source: AISC Design Guide 21, *Welded Connections—A Primer for Engineers*

Taking the Short Cut—Specifying the Joint Strength

In many cases, an alternative to specifying information in the weld symbol is to specify the required strength of the joint required. The fabricator will then design the weld to develop the strength specified as he or she sees economically fit, while still abiding by the design rules of AWS D1.1. For example, a weld symbol without a dimension and without CJP in its tail designates a weld that will develop the adjacent base metal strength in tension and shear.

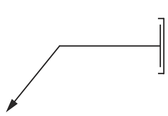
To return or not to return?

End returns, otherwise known as boxing, are the continuation of a fillet weld around the corner of a member as an extension of the primary weld. End returns are used to ensure quality terminations to welds and to provide some resistance to prying of the weld roots. In general, end returns are neither prohibited nor required. AISC specification Section J2.2b provides further discussion on the requirements and limitations for end returns. In statically loaded structures, fillet welds can be stopped short of the end of the joint by a length equal to the leg size of the weld, or continue to the end or be returned around the corner, except as noted in J2.2b(1)-(4). One exception to note is that for flexible connections, such as framing angles and tees, the tension edges of the outstanding legs or flanges must be left unwelded over a portion of their length to assure flexibility of the connection. If end returns are used in this case, their length must be restricted to not more than *four times the weld size or half the width of the angle*, as shown in the following figure.

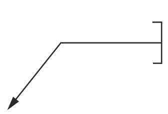


End return length = 2*w* (preferred), with a maximum of 4*w* or ½L_o, whichever is less.

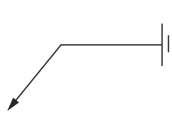
There is no defined or code-specified standard symbol for welded clip angle connections. Some firms include figures and descriptions of their typical weld practices on the general detail sheet of their shop drawings. Thus, it would be reasonable to include typical weld end condition details on this sheet as well. Some commonly used weld symbols for a returned and a "stopped-short" (non-returned) weld are shown in the figures below. In addition, a commonly used symbol for an angle that is welded on three sides is also shown below. These symbols are not AWS standards; they are simply suggestions.



C-shape with vertical line indicates weld is to be returned.



C-shape indicates weld is to be made on three sides of the angle, full length.



The pair of vertical lines, one shorter than the other, indicates weld is to be stopped short.

Why Weld All Around?

The "weld all around" symbol specified by the designer is a convenience that often results in unnecessary work and confusion for the fabricator. The symbol is all too often used in applications where the weld is not necessarily required on the entire perimeter of a connection, such as certain types of column-to-base plate connections. Instruction for the fabricator to weld all around typically requires him to reposition the steel pieces several times, and the process often requires welding in areas that are difficult to access. To avoid specifying a fabrication headache, the engineer should think twice about how much weld is actually needed in the connection. For a column-to-base plate connection, perhaps a weld along the top of one flange and the bottom of the other flange would suffice—and the fabricator will be able to access the specified weld areas easily, even without having to reposition the members.

CVN Toughness

Toughness is a material property that measures the resistance to cracking in certain conditions. Charpy V-Notch (CVN) toughness is a test requirement related to material toughness. Some filler metal classifications include CVN requirements. In the U.S., common classifications require a CVN toughness of 20 ft-lb at -20 °F or 0 °F as used in seismic applications. If notch toughness of welded joints is required, the engineer needs to specify the minimum absorbed energy and the corresponding test temperature for the filler metal classification to be used. As an alternative, the engineer needs to specify that the Weld Procedure Specification (WPS) be qualified with CVN tests.

Weld Design Information

Engineers often provide guidance on welding in design drawings and specifications in order to prevent misunderstandings and to emphasize code requirements. Although the design professional may intend to avoid past welding conflicts or errors, the welding information provided on their design drawings can often conflict with code requirements and cause unintended confusion.

Most welds performed on structural steel are meant to be conducted in accordance with prequalified weld procedures. The code includes provisions for selection of appropriate welding processes, filler metal classifications, joint designs, procedure variables, and other provisions guiding fabrication. Weld procedures that are not prequalified have to be tested, and the AWS D1.1 limits the essential variables to ranges around those that were tested. Information about these items on design drawings may not be helpful, and in some cases may conflict with good practice. For example, do you really want to specify E70 in cases that AWS D1.1 would indicate an E80 electrode for weathering characteristics?

Chapters 1 and 2 of AWS D1.1 illustrate all of the specific welding requirements that the engineer shall specify in the contract documents as necessary. Some key things to remember include: *tell* the fabricator what strength you assumed when sizing fillet and pipe welds; *tell* the fabricator to comply with AISC and AWS; and then *check* Chapters 1 and 2 of the AWS code to see if you need to *tell* the fabricator any more.

Call to Action

Proper weld design and specification results in significant project cost savings. Although many engineers enter the workforce with little or no weld design experience, it is important for them to research, learn, and master welded connection design based on both safety and economy. The best weld detail for a specific connection is one that reliably and safely transmits the imposed loads, and yet is economical and easily made by the welder. Your challenge: put these lessons learned to practice in your everyday design work, and you will surely put a smile on the welder's face during fabrication. 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.

Lucky 13

Tekla Structures 13, the latest version of Tekla's building information modeling software, is here. To follow our users' wishes, Tekla has concentrated on improving the existing functionality of the software. The drawings, for example, now look better than ever, and the drawing list has been enhanced with efficient filtering to make your work easier and let you concentrate on your business with more time to design and more time to build.

Tekla Structures 13 online help includes an extensive What's New section that offers thorough information on new and improved functionality, with lots of practical examples. New Windows-style keyboard shortcuts are listed on the Help menu. Users can also participate in the new Automatic User Feedback Program that helps us develop the software further. Here's a short overview of new features and benefits:

Better modeling
- Enhanced performance
- Faster modeling tools
- Improved components

Enhanced output and drawings
- More automated GA drawings
- Quicker assembly drawings
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- Faster and easier navigation in the new drawing list

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- Faster and more complete links to other systems
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For more information, visit www.tekla.com or call 877.835.5265.

A New Set of Wheels

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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 Keith Grubb (grubb@modernsteel.com) or Geoff Weisenberger (weisenberger@modernsteel.com). To be included in MSC's online products directory, contact Louis Gurthet (gurthet@modernsteel.com).

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ACTIVE MEMBER

continued from p. 66

members. The main member prep department should not be over one day ahead of the shop, and the parts department should not be over a week ahead of the shop. Going beyond these time periods causes secondary non-productive operations. I am aware that this just-in-time process causes anxiety with shop managers and may be one of the hardest concepts to buy into. However, the big gains in productivity are often counterintuitive.

Combining shop releases is the last chance for controlling the mix of work going into the shop. Shop management must have the flexibility to pick and choose what is released next. In order to do this, three things have to happen: there must be adequate lead time, several releases to pick from, and the proper materials to fabricate the work. Without lead time, managers are forced to release work to the shop to meet schedules. Without sufficient releases to pick from, managers are forced to release what they have. The main function of managers is to evaluate the available options and pick the best course of action. Shop managers need to be able to make choices; if they only have one release, they don't have a choice to make. And if there are no choices to be made, you don't need managers.

One more way to effectively fine-tune the effects of a bad mix of work, that's worth mentioning: schedule overtime by workstation.

All of these factors point to the fact that stabilizing the impact of the mix of work is important to the TOC. Without this stabilization, the constraint moves every time the mix of work changes. This makes finding and correcting constraints almost impossible.

Identifying Constraints

When looking for constraints, we need to look closely at the time between operations. Most of the time spent in fabricating steel is for tasks that add no value. When we think of fabricating steel, we think of receiving, sawing, burning, drilling, welding, fitting, loading, etc. All of these functions add up to less than half of the hours expended on a project. The real productivity gains are in the lost time in between operations. Once a constraint is identified, research needs to be done to determine why there is a bottleneck at this point. There are several questions we need to ask to define the cause and nature of the constraint:

- ➜ Have we done everything we can to control the mix? (Review the above steps concerning the mix of work.)
- ➜ Is this a temporary or permanent constraint?
- ➜ Can I solve this constraint by improving productivity?
- ➜ Is this constraint at the workstation, or is it a result of poor flow in and out of the station?
- ➜ Do I have to add people to eliminate the constraint?
- ➜ Do I have to add equipment to eliminate the constraint?

Whether a constraint is permanent or temporary is sometimes a judgment call. In these cases it is better to have a temporary solution to a permanent constraint than a permanent solution to a temporary constraint. Shops can get bogged down with permanent solutions to temporary problems. After the temporary constraint goes away, the shop may have to live with changes in production procedures, additional employees, and equipment. This is the opposite problem of a constraint. This can be an overstaffed, over-equipped, nonproductive part of your operation. Shop supervisors are quick to point out what they think are constraints, and they may hide an area of the operation under their control that has an overcapacity.

Consider the example of a shipping department that is not getting the load list in a timely fashion, forcing double-handling. The solution is to get the load list when it is needed. (The temporary solution is to lease additional forklifts and to add forklift operators.) After the shipping department starts getting the load list, they hold on to the forklifts and forklift operators to make sure that they never become the constraint again. This becomes a permanent solution to a temporary problem.

Another example is an inspection department faced with a prolonged project requiring special fabrication and inspection procedures. New fabrication and inspection procedures are compiled, inspectors are trained, and shop employees are trained in the new requirements. Everything is done to avert a potential constraint caused by fabricated material not meeting specifications. When the job is complete, is an equal effort taken to return to standard fabrication and inspection methods, or is the shop saddled with all or part of this added cost forever?

When faced with a constraint, we should first evaluate our production procedures, a step-by-step written document on how we want to process material through a workstation. These procedures should be developed with strong input from the workstation operators and shop managers. Once a procedure is developed, it should be followed. Without follow-up work, station operators can revert back to the way they have always done it. Production procedures are an important tool in implementing a constant improvement program. Shop employees should be encouraged to improve these procedures. Shop management needs to review suggestions and make a determination about revising the production procedures. Implementing these suggestions is a powerful tool in establishing operator ownership of the procedure. This ownership lets operators know that management is listening to them and values their input.

Flow in and out of a constraint is important. Adding buffers and handling equipment can often eliminate the constraint. Most saws are actually cutting metal about 30% of the time. The other 70% of the time, the operator is discharging the piece, waiting on the next piece to cut, or aligning the next piece in the saw. It makes a lot more sense to concentrate on the big piece of the pie. Reducing the 70% to 40% will increase productivity by 60%, while buying a saw that cuts twice as fast only increases productivity by 18%.

Staffing workstations is part of having a flexible workforce. Employees should be moved with ease from an overstaffed station to a constraint. Hiring new people to eliminate a constraint should be done with care.

Adding equipment to eliminate a constraint should also be done with care. This should only be done after all the above steps have been taken.

Upping the Standards

On May 6, 1954, Roger Bannister became the first person to run a mile in under four minutes. Since then, this feat has been accomplished hundreds of times. All of a sudden, the standard changed and all of the top runners knew that not only was a four-minute mile possible, but they now needed to meet this new standard in order to even remain competitive.

Someone will raise the standard for productivity in the steel fabrication business, and everyone will have to follow suit to stay competitive. If it's not your company, you need to hope it's not your competition. The truth is that some shops have already embraced these simple yet forward-thinking principals of production. MSC

CONSTRAINT AND STABILITY

Eliminating the former and striving for the latter will promote efficiency and productivity in your fabrication shop.

BY JAMES SMELSER

AFTER 35 YEARS in the steel fabrication business, I am continually surprised at how little has changed. I visit present-day shops that are almost identical to the shops I ran in the seventies. The good news is that it does not take a lot of effort to achieve major improvements in these operations.

Early in my career I was told a story about how geese were fattened up for market. The first step was to make a rack out of wood. A two-by-six was laid flat and two troughs were attached to the front edge of the board, one for food and one for water. A gaggle of geese were attached to the board by nailing roofing nails through the webs of their feet. All day long the geese had food and drink directly in front of them. When the food and water ran low, more was added to the troughs.

After listening to this story, I realized that this is how a steel shop ought to work (roofing nails aside). The fitters in the shop should always have what they need in front of them, all day long. The needs for the fitters are main members, parts, drawings, and the equipment and tools needed to do his or her job. Once one piece is completed, another is ready and waiting for the fitter's attention. This process doesn't make anyone work harder; it just removes lost time and frustration. This philosophy is not limited to the fitters; every department and process needs to be fed. No one wants to search for the things that they need to do their job. Bottom line, do not frustrate the geese. Give them what they need, express the company's expectations, and let them do their job. And don't try to use roofing nails with your fab shop employees; it doesn't work.

Keeping main members, parts, and drawings in front of the fitters at all times can double their productivity. Controlling weld parameters and eliminating oversized welds can double a welder's output. Every operation in the shop can experience major productivity gains once the emphasis is placed on eliminating non-productive tasks.

James Smelser is vice president of SME Steel Contractors (AISC Member) in West Jordan, Utah.

Ongoing Improvement

According to the Theory of Constraints (TOC), every organization, (or in this case, every fabrication shop) has a limiting constraint—a bottleneck—that limits the shop's performance. Production volume (throughput) cannot increase until steps are taken to eliminate the constraint. When one constraining process is eliminated, another is created. The process of finding and correcting these constraints is commonly referred to as *continuous improvement* or the *process of ongoing improvement*. This is a straightforward process in manufacturing operations that consistently produces a standard product.

Steel fabrication shops present a more complex challenge to this process. This is caused by variations in the *mix of work* released to the shop. The mix of work is the percentage of the total hours that each department or process is allocated for the work released to the shop at any given time. Some work mixes may need more fitters and less welders; or individual operations such as a burn table or shear may have to handle a larger percentage of the workload. Simply put, the equipment and personnel in the shop needs to match the requirements of the work being released to the shop.

Stabilizing Factors

This is not as complicated as it first appears to be. A flexible work force, back-up processes, and controlling shop releases can, in many cases, stabilize the impact of a bad mix of work. Once the effect of the mix of work is stabilized, it is much easier to identify the location of the constraint. Without stabilizing the mix of work, the constraint moves from station to station and department to department without adequate time to react to the problem. This is called a *floating constraint*.

A flexible workforce is accomplished by cross-training employees. A good example of this is developing the role of fitter-welders. By training welders to fit and fitters to weld, it no longer matters if the mix is 10% fit and 40% weld or 40% fit and 10% weld.

Other disciplines that should be cross-trained are shipping and receiving, CNC operators, the drill line, saw and camber machine operators, and equipment operators in the parts department. Not only does cross-training allow employees to broaden their skills and increase their value to the company, it also helps minimize the impact of vacations, sick leave, and turnover.

Back-up processes are necessary to supplement a flexible workforce. Shop equipment requirements should be based on being able to handle all but the worst mixes of work. After all of your TOC and mix-of-work issues have been addressed, what's left is called *variation*. This variation has to be handled by excess capacity. How well we are able to control the mix of work and implement TOC practices determines how much excess capacity is required to run a highly productive shop. In the parts department, this may mean that there is an extra ironworker or plate duplicator that is underutilized until he is needed to stabilize an unusually high demand for parts. In the main member prep department, this may mean that there is an extra saw that is underutilized. This over-capacity requirement is essential in developing an efficient shop. The shop should never have to stockpile parts or main

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Have an opinion you'd like to share in "Topping Out"? Send your feedback to Keith Grubb, managing editor for MSC, at grubb@modernsteel.com.

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