MSC
MODERN **STEEL** CONSTRUCTION

December 2009

AMERICAN INSTITUTE OF STEEL CONSTRUCTION
AISC
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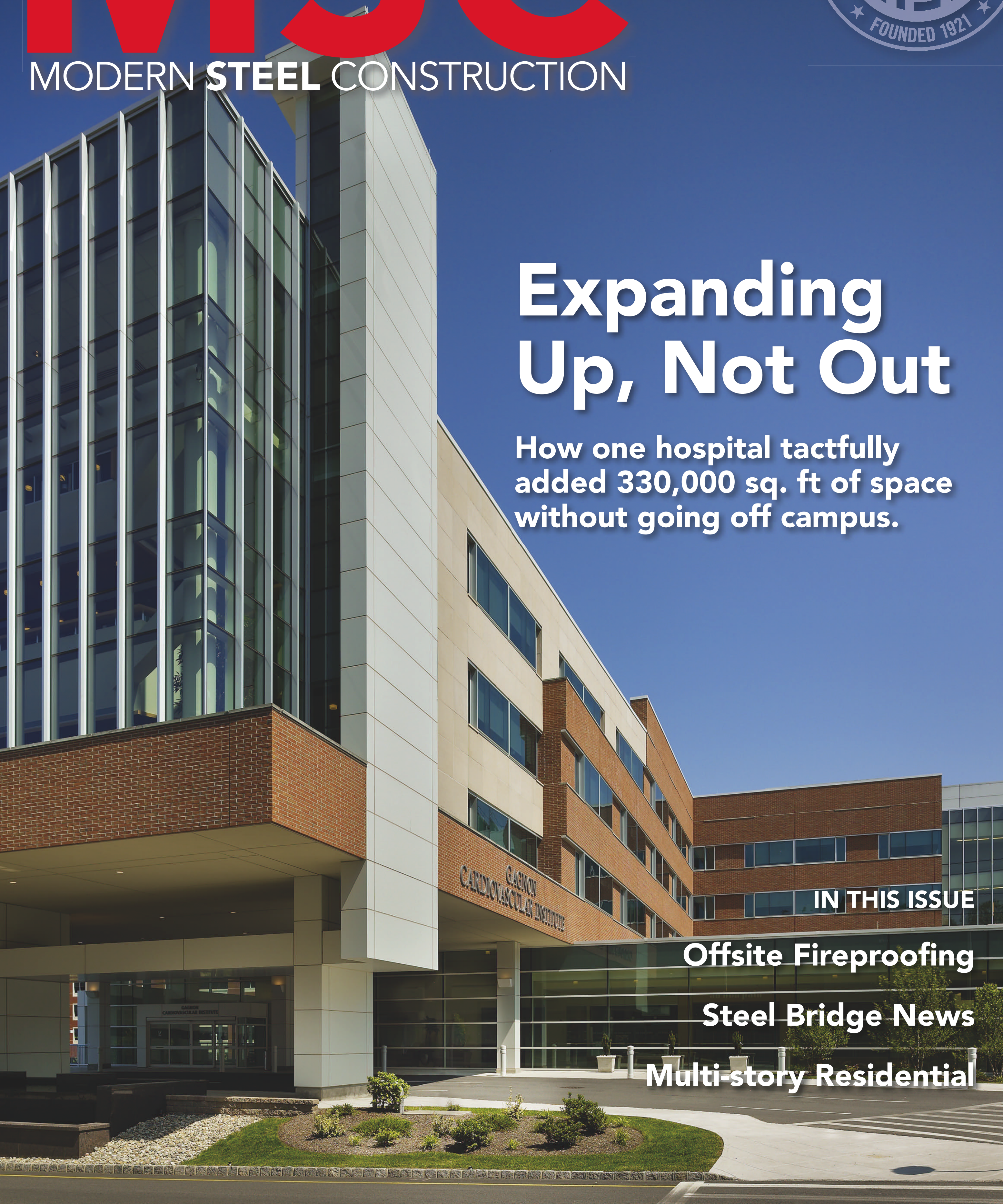


Expanding Up, Not Out

How one hospital tactfully added 330,000 sq. ft of space without going off campus.

IN THIS ISSUE

Offsite Fireproofing

Steel Bridge News

Multi-story Residential

Let's get the FACTS...

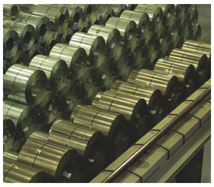
on the recycled content in steel joists and steel deck.

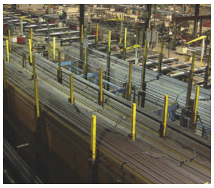
terms to know:

- **Electric Arc Furnace (EAF) Process** is traditionally used for hot rolled shapes, reinforcing bar, and other products that focus on strength. It can now be used for flat rolled steel, but not all flat rolled steel comes from these mills.
- **Basic Oxygen Furnace (BOF) Process** is conventionally used for flat rolled sheet steel as it focuses on drawability.
- **Post-Consumer Content** is recycled scrap that is from an end user product such as recycled automobiles and appliances.
- **Pre-Consumer Content** is recycled scrap that never reaches an end user form such as fall off collected during fabrication of a steel product.

CMC Steel Joists are typically manufactured using hot rolled shapes, which are produced using the EAF process. The total recycled content typically exceeds 95% with 50 – 80% being post-consumer content and 15 – 45% being pre-consumer content depending on the particular mill.

CMC Steel Deck is manufactured from flat sheet steel, which has been traditionally produced using the BOF process, but can be made through the EAF process as well. No more than 32.7% total recycled content (25.5% post-consumer content, 6.8% pre-consumer content, and 0.4% in-house content) should be counted on as many manufacturers purchase coil from BOF mills.





LEED® Material and Resources Credit 4

- Only 10% of the total material cost for a project must be recycled content (% post-consumer + ½ % pre-consumer) to achieve 1 point and only 20% is needed for 2 points.
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December 2009

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MODERN STEEL CONSTRUCTION

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ON THE COVER: Using steel framing for the Morriston, N.J., hospital expansion enabled designers to add on to existing smaller structures and meet current, more stringent seismic requirements. Photo © 2009 Halkin Architectural Photography.

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editor's note

IN THIS ERA OF BELT TIGHTENING EVERYONE IS LOOKING TO CUT EXPENSES WHEREVER POSSIBLE. And while normally the two major engineering conferences in the U.S. would be competing for your attendance, in 2010 the events have joined together to create a one-time mega-conference for the entire structural engineering and steel construction community.

On May 12–15, Orlando will play host to what promises to be an amazing event: a joint conference combining NASCC: The Steel Conference and the Structural Engineering Institute's Structures Congress. And for good measure, it also will include the Council of American Structural Engineers Spring Risk Management Convocation, SSRC's Annual Stability Conference, the 19th Analysis & Computation Specialty Conference, and NISD's Annual Meeting.

Wow. Sessions range from "Floor Levelness in Tall Buildings" to "122 Design Ideas in 90 Minutes." We'll even have a Pecha Kucha session on eight of the most interesting recent structures. (Pecha Kucha? Each presenter shows 20 images for 20 seconds apiece to stimulate discussion and an exchange of ideas.) There are sessions from some of the leading practitioners, from the top academics, and from the people who fabricate and erect buildings. In addition, there'll be an exhibit hall with everything from design software to fabrication equipment (yes, some of the exhibitors will be slicing up steel beams and plate right on the exhibit floor).

Keynoting the event is Rick Fedrizzi, founding chair and president of the U.S. Green Building Council (the group in charge of the LEED rating system). Sustainability is vying with BIM as the industry's leading buzzword and this is an opportunity to meet and hear the nation's leading proponent.

Despite offering nearly 200 sessions, we're intent on making the conference as affordable as possible. If you're a member of AISC, SEI, NISD, or CASE, registration to this exciting four-day event is just $390. (And if you're not a member, why haven't you joined yet? Visit **www.aisc.org/join** and sign up today.)

The full program will be available in January but I wanted to give you a heads up so you could mark your calendar now. So whether you're looking for technical information, the latest products, a wonderful networking opportunity, or just an excuse to visit Disney World (I know I'm trying to convince my wife to pack up the kids and bring them to Orlando), this conference promises to be the most talked about event of the year for the entire design and construction community.

Check out **www.aisc.org/nascc** after January 10 to see the full program and to register. If you can only attend one event next year, Orlando from May 12–15 is the place to be!

Scott Melnick

SCOTT MELNICK
EDITOR

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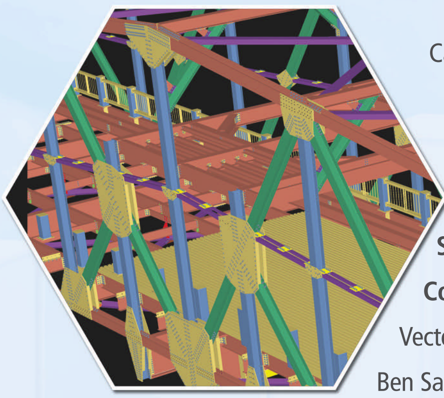
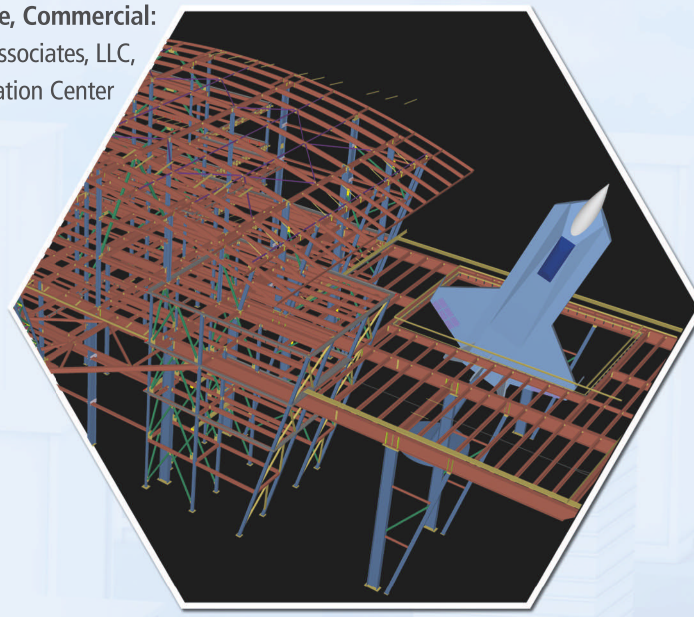
SDS/2 DESIGN DATA

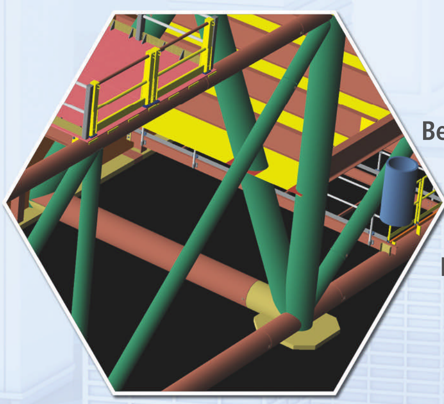
CONGRATULATIONS TO THE WINNERS OF THE 2009 SDS/2 SOLID STEEL COMPETITION



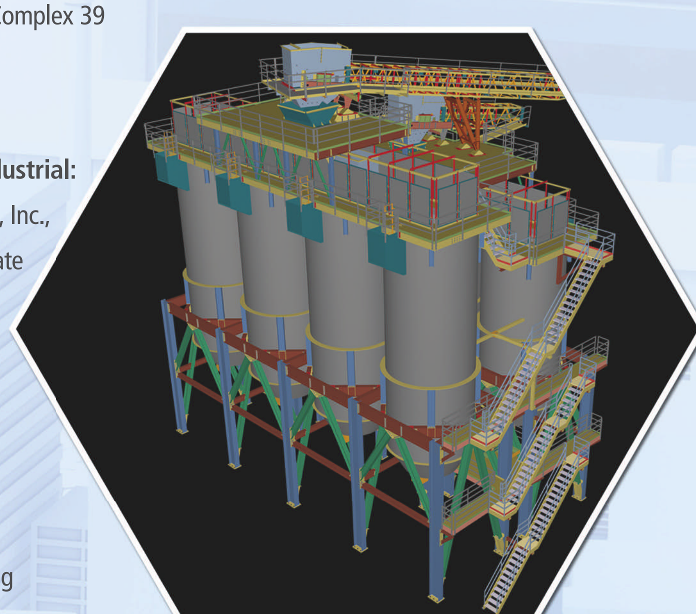
Grand Prize, Commercial:
Cartee-Berry & Associates, LLC,
Cyber Innovation Center



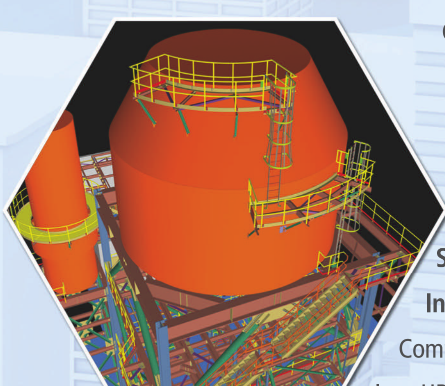
Second Place, Commercial:
VectorShades, LLC,
Ben Sawyer Bridge



Best of Show:
The Steel Detailers, Inc.,
NASA Mobile Launch Base - Launch Complex 39



Grand Prize, Industrial:
Quadrant Services, Inc.,
Corona Aggregate Facility



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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.

Reuse of Bolts

We are working on a bolted through plate girder bridge that is currently being dismantled and transported to be used at another location. The bridge was in service for roughly 5-7 years prior to dismantling. Can the bolts that have been removed for dismantling be reused? Would I need to look for certain types of damage before approving the reuse and/or any other items of concern that I should be aware of?

I am assuming that these are ASTM A325 or A490 pretensioned bolted connections.

Section 2.3.3 of the RCSC *Specification* (a free download at **www.boltcouncil.org**) discusses the reuse of high strength bolts as follows: "Reuse: ASTM A490 bolts and galvanized ASTM A325 bolts shall not be reused. When approved by the Engineer of Record, black ASTM A325 bolts are permitted to be reused."

Generally, ASTM A325 bolts that are not galvanized can be reused if they have only been retightened once or twice, and the nut can fairly easily be reinstalled on the bolt. For background and guidance in making this decision, you may want to look at page 62 of the *Guide to Design Criteria for Bolted and Riveted Joints*, which is also available as a free download from RCSC. There also is a discussion on page 47 of AISC Design Guide No. 17 *High-Strength Bolts: A Primer for Structural Engineers*, which is a free download for AISC members at **www.aisc.org/epubs**.

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

Slip-Critical Connections

When using slip-critical connections, is it common to exclude the threads from the shear plane, or does thread location matter since the design assumption is not based on load transfer by shear/bearing?

Section J3.8 of the AISC *Specification* requires that slip-critical connections must also be checked for the bearing condition. In most cases, the slip strength is less than the shear strength of the bolt and it does not matter whether the threads are excluded or not. In some instances, when the slip-critical connection is designed to the serviceability limit state, and employs standard holes and Class B faying surfaces, the design slip resistance can be slightly higher than the shear strength of the bolt with the threads included. In these instances excluding the threads can provide a slightly higher (about 1%-4%) design capacity.

Larry S. Muir, P.E.

UT of CJP Welds

Can UT be done on a complete-joint-penetration groove weld if the thickness of the steel is less than 5⁄16 in.? If not, can a visual inspection be performed, or can another type of NDT be done?

UT is not well suited to distinguishing defects in the first 5⁄16 in., so that is considered a lower limit. If visual is not considered acceptable, which it should be in most cases, MT is often selected as the next best alternative.

Tom Schlafly

K-Brace for OCBF System

I am designing an ordinary concentrically braced frame using a K-brace. AISC 341 Section 14.3 states that the column for K-type bracing is to be designed for the unbalanced loading. Is that accurate? Designing the column for the forces specified in Section 14.3 seems very high. Is there any alternative, such as designing the column for the amplified seismic load?

While K-type bracing is not strictly prohibited for OCBF (except for OCBF above seismic isolation systems), it is generally not considered desirable in concentrically braced frames, and is prohibited entirely for SCBF. It is considered undesirable to have columns subjected to unbalanced lateral forces from the braces, as these forces may lead to column failure. If one chooses to use K-type bracing, the *Seismic Provisions* requires that the unbalanced force be considered as defined.

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

Beam Bracing

I am designing a one-story open-framed (no decking) building and must provide lateral stability bracing of the beams. Working with the 2005 AISC *Specification*, Appendix 6.3 addresses the force required for both nodal and relative bracing in beams. I have a situation where nodal bracing is desired for architectural reasons. I am aware that this bracing force must be delivered to a rigid support at bracing ends. Does the bracing force act in an additive manner? For example, I have four parallel beams restrained from rotation via nodal bracing; does the bracing have to be proportioned to resist four times the force computed from Eq. A-6-7?

Appendix 6 requires that a minimum stiffness and strength be available to brace a beam to prevent lateral-torsional buckling. The implication of this is that if a member that has exhausted its axial strength due to other loads [$P_u/\phi P_n$ or $\Omega P_a/P_n = 1.0$] were to be used to brace a beam, there would be no brace strength remaining to prevent LTB. Therefore, the bracing member does have to be designed with the bracing force added to other loads on the brace. This is in addition to the stiffness requirement.

For your second question, if it is possible for all beams to buckle at the same time, the bracing forces will accumulate from the first beam through the last, and the brace at that point must provide the strength and stiffness required in Appendix 6 for all beams.

Amanuel Gebremeskel, P.E.

Channel Columns

What Section of the AISC *Specification* covers channel columns?

If there are no local slenderness issues, the provisions of Section E3 in the 2005 AISC *Specification* can be used to design the channel as a compression member. If there are local slenderness issues [as per Table B4.1] the requirements in Section E7 also apply.

Amanuel Gebremeskel, P.E.

steel interchange

Bolt Hole Alternatives for Fit-Up

In many instances bolt holes are required to be enlarged at the site because the size of bolt holes does not accommodate allowable deviations in the erection of the structure. Which of the following alternatives do you recommend to address this issue?

1. **Provide oversized holes during fabrication.**
2. **Limit the allowable dimensional deviations during erection.**
3. **Enlarge holes in the field for only joints where the misfit occurs.**

Common practice is usually to supply short-slotted holes for shear connections. This combined with the flexibility of typical shear connections allows some additional fit-up tolerance in the field. The joints can be designed as bearing connections as long as the slots are perpendicular to the direction of the load.

Option 1: It is not uncommon to use oversized holes designed as slip-critical connections for certain applications such as vertical bracing and bolted flange plate moment connections. It is rare to see oversized holes used in beam connections.

Option 2: The AISC *Code of Standard Practice* provides fabrication and erection tolerances that are in accordance with current construction and design practices. Additional limits might come at a high cost or scare bidders away.

Option 3: This option is problematic if the same bolt size is to be used, since the connection would have to be designed as slip critical at the outset. Slip-critical connections usually will have less strength than a bearing-type connection with an equal number of bolts. This will lead to uneconomical connections.

A common approach is to ream the hole to the next larger size and use a bolt with the corresponding larger diameter. Since the connection was originally designed based on the strength of the smaller bolt and the larger bolt will have both greater strength and deformational capacity, mixing the differing bolts does not present a problem.

Usually things fit up pretty well. In my experience misfits are the exception not the rule, so it is best to assume that things will fit as intended, unless your experiences with certain contractors or locations prove otherwise. I have listed some of the common ways these problems are dealt with, but each situation must be approached differently, taking into account cost, schedule, and most of all safety.

Larry S. Muir, P.E.

Use of Overstrength Factor

The AISC *Seismic Design Manual* (Page 3-43) does not use the overstrength factor in the design of the column in that example. However, other references design both columns and beams considering the overstrength factor. Which is correct?

The column check in Design Example 3.8 in the AISC *Seismic Design Manual* reflects a column where the axial load ratio $P_u/\phi P_n \leq 0.4$. Therefore, use of the overstrength factor is not required. This is covered in Section 8.3 of the AISC *Seismic Provisions*. If the axial load ratio is greater than 0.4, the overstrength factor must be considered. This may be the case in the other reference to which you refer.

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

Number of Washers

What is the maximum number of washers allowed on a bolt under the nut? What if it is for an anchor rod embedded in concrete for a column base?

The AISC and RCSC *Specifications* address installation requirements for high-strength bolts used in steel-to-steel connections where the steel faying surfaces are being clamped together. Even in such connections, there is nothing in the AISC or RCSC *Specifications* that limits the number of washers under the nut or the head of a bolt. Placing additional washers under the nut is a common practice used to exclude the threads from the shear plane. In steel-to-steel connections, it would be unusual for more than two washers to be required to exclude the threads using material thicknesses usually seen in structural work. The EOR needs to exercise some judgment as to when it is preferable to add washers or change out the bolt.

Anchor rods are used for a different purpose than high-strength bolts, and the evaluation of the restraint details is quite different. The EOR needs to assess the purpose of the anchor rod in the particular application, and the forces that the anchor rods are assumed to resist. Again, the engineer needs to use some judgment as to how the forces are transferred from the column to the foundation, and the effect that adding additional washers may have on that assumed force transfer mechanism. If the anchor rod is being used to resist base shear (which is not recommended by AISC) the evaluation will likely be quite different than if the anchor is only assumed to resist tension.

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. Tom Schlafly is AISC's director of research. Larry Muir is a part-time consultant to AISC.

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

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

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Chicago, IL 60601
tel: 866.ASK.AISC • fax: 312.803.4709
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steel quiz

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

1 True/False: Curved steel members must be designed differently because of the effects of the bending process.

2 Why are minimum radii specified for cold bending of plates?

3 Is there a tolerance specified in the AISC *Code of Standard Practice* for the shape of a curved member?

4 What is the limit in the AISC *Specification* on the surface roughness profile of thermally cut bolt holes?
(a) 1,000 µin.
(b) 2,000 µin.
(c) 3,000 µin.
(d) Both (a) and (b) are correct

5 True/False: The 2005 AISC *Specification* includes information on design and detailing of galvanized members.

6 What minimum radius is recommended in the AISC *Manual* for camber induced by cold bending in members up to nominal depth of 30 in.?

7 Where are tolerances for manufacturing HSS and Pipe given?
(a) ASTM A6 for both HSS and Pipe
(b) ASTM A500 for both HSS and Pipe
(c) ASTM A500 for HSS and ASTM A53 for Pipe
(d) ASTM A53 for both HSS and Pipe

8 Steel erection follows the proper installation or establishment of several items by the Owner's Designated Representative for Construction per Section 7 of the AISC *Code of Standard Practice*. What are several common eaxmples?

9 Which of the following can be a cause of brittle fracture?
(a) Triaxial state-of-stress
(b) Strain aging
(c) Increased strain rate
(d) All of the above

10 True/False: Appendix 4 in the AISC *Specification* addresses design for applications involving long-duration loading at elevated temperatures.

TURN TO PAGE 14 FOR ANSWERS

steel quiz ANSWERS

1 False. Bending steel typically elevates the yield strength and reduces the ductility of the material, but these effects are small for the usual case of bending and neglected in the design process. For more information, see "Bending Considerations in Steel Construction" by Russ Barnshaw in the October 2009 issue of *MSC*, and "Cold-Bending of Wide-Flange Shapes for Construction" in the 4th Quarter 2006 AISC *Engineering Journal*.

2 Care must be taken to prevent the initiation of cracks at edges. Minimum radii for cold bending from ASTM A6 Appendix 4 [reproduced in Table 10-12 of the 13th Edition AISC *Manual*] serve this purpose.

3 Yes. Section 6.4.2 of the 2005 AISC *Code of Standard Practice* states that the tolerance for curved members is equal to the variation in sweep permitted for an equivalent straight member of the same straight length in ASTM A6.

4 (a) According to Section M2.5 of the 2005 AISC *Specification* thermally cut holes shall be permitted with a surface roughness profile not exceeding 1,000 μin.

5 True. Chapters J and M in the 2005 AISC *Specification* include information addressing welding, bolting and drainage in galvanized members.

6 Between 10 and 14 times the depth of the member. See Part 2 of the 13th Edition AISC *Manual* on cold bending.

7 (c) HSS are manufactured to tolerances given in ASTM A500 while Pipe is manufactured to tolerances given in ASTM A53.

8 Possible answers include: job-site conditions (Section 7.2), foundations (Section 7.3), lines and benchmarks (Section 7.4), anchor rods and embeds (Section 7.5), bearing devices (Section 7.6), grout (Section 7.7), and installation schedule of non-structural-steel items (Section 7.10.2).

9 (d) All of these factors can be a cause. See Part 2 of the 13th Edition AISC *Manual* under Fatigue and Fracture Control for more on this topic.

10 False. Appendix 4 and AISC Design Guide 19 provide information for the design of applications involving short-duration loading at elevated temperature due to fire.

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

Steel SolutionsCenter

news

AWARDS

Museum Building Garners International Recognition

The Taubman Museum of Art building in Roanoke, Va., has been awarded a 2009 International Architect Award. The 81,000-sq.-ft structure is a dramatic composition of flowing, layered forms in steel, patinated zinc and high-performance glass and pays sculptural tribute to the Blue Ridge Mountains that provide Roanoke's backdrop and shape the region's spirit. The building was designed by Los Angeles architect Randall Stout and featured in the September 2008 issue of *Modern Steel Construction*. Structural engineering was provided by DeSimone Consulting Engineers, San Francisco.

The International Architecture Awards program recognizes the best built and unbuilt architecture from around the world and has become an important barometer for the future direction of new architectural design and thinking today. The award was co-presented by The Chicago Athenaeum: Museum of Architecture and Design and Metropolitan Arts Press Ltd. and The European Centre for Architecture Art Design and Urban Studies.

Randall Stout Architects, Inc.

The Taubman Museum of Art in Roanoke, Va., celebrated its one-year anniversary in the award-winning new facility in November 2009.

TECHNOLOGY

Technology Makes Coal Use Sustainable

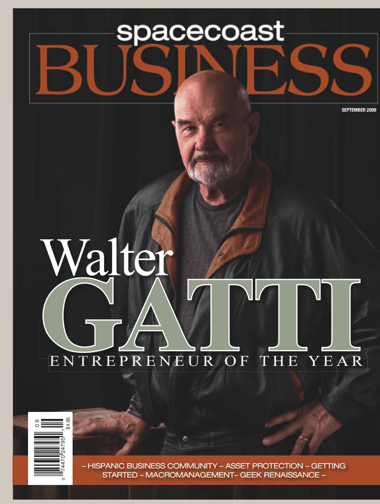
Hamon Research-Cottrell, Somerville, N.J., has entered into a formal license agreement with J-Power EnTech, Tokyo, to market the firm's ReACT technology in North America. ReACT (Regenerative Activated Coke Technology) is an advanced multi-pollutant control technology for highly efficient control of SO_x (SO_2 and SO_3), NO_x, mercury and particulates. It has been commercialized in Japan where there are numerous industrial and utility installations in industries such as steel, petrochemical, and waste incineration.

In addition to producing saleable byproducts, ReACT is a dry process that does not require water. The technology should be of special interest to utilities burning lower sulfur western fuels, especially at locations where there are significant water use issues.

The emissions from the coal-fired Isogo Power station (shown here) are at comparable levels to those from natural gas-fired facilities.

People and Firms

- **David Harrington**, a structural designer with Walter P. Moore, Houston, has co-authored *Mastering Revit Structure 2010*. The 896-page paperback covers both the program's basic and advanced features. It also includes hands-on tutorials and has an accompanying website with additional tutorial files. The book is published by Wiley.
- NSBA-member **Walter Gatti** has been named entrepreneur of the year by Spacecoast Business magazine. The president of Tensor Engineering, Indian Harbor Beach, Fla., Gatti founded the structural steel detailing firm in New York in 1958. The company relocated to Florida in 1971.



- **Jim Dager**, founder of Design Data, has been named a recipient of the American Institute of Steel Construction's Special Achievement Award. The award was presented at the AISC Annual Meeting, held September 24-25 in Braselton, Georgia. In recognizing Jim's achievement, David Harwell, Chairman of the Board of Directors of AISC and President of Central Texas Iron Works (CTIW), said, "Jim is definitely the visionary behind the development of 3D modeling. He revolutionized the engineering interface and detailing practice in our marketplace. He's a pioneer, and certainly deserving of the Special Achievement Award presented on behalf of AISC."

  In 1981, Dager founded **Design Data** based on his vision of computer-aided design and steel structures. Twenty-eight years later, most steel structures are detailed either with software sold by Design Data or by software based on Dager's ideas.

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RECOGNITION

Safe Work Record Celebrated

The Occupational Safety and Health Administration has re-certified **High Steel Structures Inc.**'s Lancaster fabrication facilities as a Star site in the OSHA Voluntary Protection Program, the agency's highest safety award. A celebration of the recertification, with an official ceremony and employee lunch, was held October 29. The VPP program was established by OSHA in 1982 to recognize employers that demonstrate excellence in their occupational safety and health programs through management leadership and employee involvement in the prevention of injuries, illnesses and fatalities. An early participant in the program, High Steel's Lancaster facilities first became a Star site in 1983.

CORRECTION

In the October 2009 *Modern Steel Construction* article "Efficient Design and Spectacular Effects" the fabricator of the ETFE membrane was incorrectly identified. The ETFE membrane used on the canopy for the Kansas City Power and Light District was fabricated by Novum Membranes GmbH (formerly KfM GmbH). The firm is a subsidiary of Novum Structures, **www.novumstructures.com**.

EDUCATION

Learn to Tweet With the Best of Them

This fall AISC in partnership with Relationship Economics has been offering a series of webinars on social networking best practices and Internet marketing. Presented by author, professional speaker and consultant David Nour, the third installment is "Why You Need to Get Proactive on Twitter" and is scheduled for Thursday, January 7, 2010, at 3 p.m. Eastern time. Registration for the 90-minute program is $97 and includes a link for a digital download of the session.

To register, go to **http://www.relationshipeconomics.net/AISC.html#linkedin**.

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letters

Folded Plate System Enhancement Suggestions

Dr. Azizinamini has presented a very nice concept for short-span bridges (September 2009 *MSC*, p. 53). In Illinois, where precast deck beams are almost failing everywhere due to corrosion of HTS wires, this concept will be extremely useful so as to take advantage of precast prefabricated construction. However, the following issues should be attended to as the author makes future presentations.

1. Steel type and grade
2. Cold forming using full length plate
3. Section geometry and properties
4. Cold forming costs
5. LRFD design for HL 93 loading
6. Load distribution per beam
7. Cross continuity
8. F type parapet and overhang
9. Load tests for deflection
10. Bearings details and integral abutments
11. Pigeon protection

Manhar Thakkar Ph.D., P.E., S.E.

Bundle Up To Go Inside?

I couldn't agree with more with your Editor's Note on over-air conditioning (September 2009 *MSC*, p. 6). We are in our 70s and I am retired now but my wife always reminds me to take a jacket or sweater when we go to the opera, a movie or an office building. Once at a restaurant I had to get a towel from the car to be comfortable. I now keep a sweater and a jacket in the car. Although the sweater or jacket in the car may not always be appropriate, at least I can be warm.

It is such a waste of resources! Thanks for calling attention to this problem.

Richard Huff

Questions About Building in the Woods

These questions are in reference to the article in the October 2009 *MSC* about the Mercer Slough Environmental Education Center. Many building codes worry about the "Urban Wildland Interface" and often require the brush and trees to be cleared in a relatively large area around any buildings. This was apparently not done in this case, which is most of what makes it look neat. How did the architect not have to follow this code requirement?

The second question is of much less importance, but is more of a personal wonderment. In the photo on page 20, the tree appears to be very close to the building—the roof is even notched for it. How do you keep the tree trunk from hitting the building when it sways on windy days?

Tim W. Elder

Author Marjorie Lund, P.E., S.E., replies:
The Bellevue fire department required removal of all plantings below the buildings and within 5 ft of the building perimeter. Quarry spalls were used under the buildings to eliminate vegetation and keep people from using the space.

The Douglas Fir tree is 2 ft, 6 in. clear of the building, although the photo certainly makes it look closer. The arborist who analyzed the trees for health and pruned dead limbs from the canopy advised that a fir of that size will sway up to two feet. The architect and landscape architect carefully planned the building locations with the intent of saving as many of the existing trees as possible. The close proximity of the trees is important to the treehouse feel of the classrooms.

EXPANSION Goes Up and Over

BY ERIN KELLY, AIA, AND RALPH D'APUZZO, P.E.

Steel framing facilitates multi-phase project designed to add space and functionality.

WHEN ATLANTIC HEALTH BEGAN TO IMPLEMENT its 330,000-sq.-ft master plan for Morristown Memorial Hospital in Morristown, N.J., in 2003, two things were immediately clear: the new buildings would be much-needed additions to their campus, and designing and coordinating the project would be extremely tricky, given that it would be built above existing structures and no part of the hospital could cease operations at any point during construction.

The campus-wide master plan for Morristown, designed by architecture firm Francis Cauffman, was created to expand the hospital's key cardiology, obstetrical, and surgery services; upgrade its infrastructure; improve internal and external circulation; and accommodate the hospital's projected growth. This was a long-overdue improvement for Morristown, which particularly needed an upgrade to its cardiovascular services. As one of the region's leading heart hospitals, it required a facility that could accommodate growing numbers of patients and provide the latest technology in cardiac care.

Building Up and Above

The master plan was organized in two principal phases. The first involved a major expansion of the hospital's north tower, which was to become a structure called the Meade Pavilion. This 120,000-sq.-ft addition was both a vertical and horizontal expansion of two existing structures, a one-story steel frame building and a two-story concrete building. Both were more than 20 years old. Before construction on the tower began, Francis Cauffman and structural engineer DiStasio & Van Buren, Inc., designated an existing 15,000-sq.-ft steel frame building as swing space for the hospital's cardiac care intake unit, a key programmatic element that had to be relocated in order to maintain continuous operations during construction.

The particular character of today's healthcare design posed a major challenge to the compatibility of the addition and the existing structures. Current demand for open floor plans, evolving technologies, and private rooms requires column spacings that can accommodate the present program yet be adaptable in the future. Accordingly, the addition to the north tower is a three-story steel moment frame that utilizes a 32-ft column grid. However, it is supported by the existing concrete structure, which has a 20-ft

Photo courtesy of William Blanchard Company, © www.AerialPhotosofNJ.com

Highlighted buildings indicate the additions to the Morristown Memorial Hospital campus. Both phases included building over existing construction to minimize campus size increase.

bay arrangement. The mismatch in size required the introduction of large transfer beams to make the transition between old and new structures.

In order to carry this out, the designers carefully located holes in the concrete flat plate roof slab to allow the new columns to pass down to transfer beams added just below the roof level. This required very close coordination with the operating mechanical systems already in the space through which the transfer beams would have to pass. Only a structural steel solution could meet the depth restrictions while still accommodating the heavy column load from the upper floors.

Evaluating Seismic Forces

The existing concrete building was originally designed for vertical expansion. However, since its construction the state adopted the BOCA 1996 national building code, which stipulates higher earthquake loads.

Based on the new code, the designers determined that both original buildings would need to be seismically reinforced to accept the vertical expansion. Each

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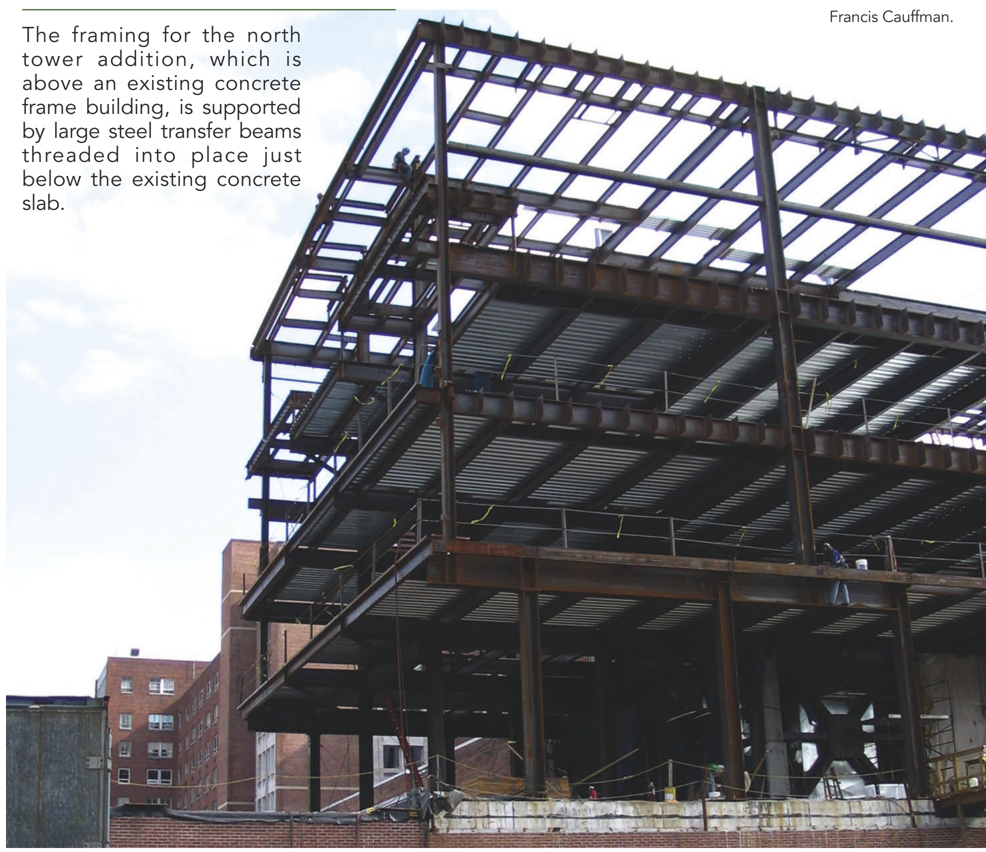
The 120,000-sq.-ft expansion of the north tower enveloped two older buildings—one a single-story steel frame building and the other a two-story concrete frame.



Francis Cauffman.

The framing for the north tower addition, which is above an existing concrete frame building, is supported by large steel transfer beams threaded into place just below the existing concrete slab.

Erin Kelly, AIA, is an associate at Francis Cauffman and served as the project manager for the Morristown Memorial Hospital project. Ralph D'Apuzzo, P.E., is executive vice president of DiStasio & Van Buren, Inc., and served as principal-in-charge for the Morristown program. He is a Professional Member of AISC as well as being a member of ASCE, PCI, ACEC, SEA, and ACI.

Francis Cauffman.

Using modular metal panel assemblies with a thin brick facing sped construction.It also helps the new construction blend in with the older buildings on campus.

structure was analyzed and retrofitted to be integral with the addition. To meet the seismic code requirements, the designers introduced new structural steel braced frames in both structures, reinforced several columns, and modified footings. Bracing systems were tied into the existing concrete frame building with adhesive anchors and through-bolted connections.

Using structural steel for the vertical expansion resulted in a lighter structure that allowed the footings to accommodate the additional stories, as well as the high localized reactions at the braced frames due to the seismic loading. It also minimized the number of columns that required strengthening. Structural steel jackets were also used to reinforce existing concrete columns to meet the higher load demand at the new brace frames.

Staying Open for Business

Because the additions were both adjacent to and built over existing hospital operations, the construction manager, William Blanchard Co., staged the construction schedule to minimize its impact on patients, staff, and visitors while maintaining continuous operations. Breaking the overall project into smaller sub-projects allowed the construction manager to aggressively bid portions of the overall project independently to multiple fabricators and erectors.

Starting with the vertical expansion allowed moving quickly from bidding to construction. The contract documents were broken into a core and shell package, permitting steel design to run concurrently with the interior design documentation.

Because much of the new construction involved threading transfer beams—some as large as W40×503—and cross bracing through existing facilities, work often had to occur during the off-hours of the hospital's administrative departments to minimize disruption. More than 1,200 tons of steel were erected during the nine-month construction of the north tower. Meticulous project phasing allowed the construction team to reconcile large wall openings, headroom clearances, and the location of existing equipment without compromising hospital operations.

Toward a New Heart Hospital

Meanwhile, the design focus shifted to the second project phase: consolidating the hospital's cardiac care program in the west tower, which would become the Gagnon Cardiovascular Institute. The first challenge was to devise a practical

Francis Cauffman.

The west wing expansion was not originally conceived of with a panelized exterior. However, additional miscellaneous steel framing was easily incorporated to provide panel support as needed, such as where the open dimension exceeded the limits of a panel's ability to be self-supporting.

plan for building a new 10,000-sq.-ft loading dock in a two-story "knuckle" of the larger heart hospital assembly. The new loading dock had to be fully operational before construction could begin on the west tower because the existing loading dock, situated within the footprint of the new tower, would be demolished.

This scenario had the advantage of allowing interior fit-out plans to be finalized while excavation and foundation work began. The designers devised a structural steel framing system to create a cold joint between the two-story loading dock building and the five-story tower. As a further bonus, the two story addition was able to house a portion of the hospital's air-handling and electrical systems. This two-story structure was designed to be structurally independent of the tower, since it would stand alone for months before the tower construction could begin. However, it would become fully integral with the tower once construction was complete, thereby optimizing the lateral resisting system. Starting this portion of the work in advance of the larger tower also allowed framing design and installation of critical systems to begin early.

The Gagnon Cardiovascular Institute

The west tower addition added approximately 213,000 sq. ft of floor space to the existing campus and now houses the Gagnon Cardiovascular Institute. A five-story structure designed to accommodate a future two-story vertical expansion is part of the footprint, which includes mechanical rooms, loading docks, cardiovascular and endovascular operating rooms, and patient rooms. Using a modular steel façade for this tower helped speed construction, which also resulted in cost savings for the project because the team could work through the winter using cranes, as opposed to scaffolding, for installation.

The west addition that houses the majority of the cardiac functions consists of two pediment levels of metal on light gauge steel framing, capped by three levels of brick cladding. What is not readily apparent is that the metal panel and brick façade is actually a pre-fabricated panel system consisting of either composite aluminum panels or thin brick facing on light gauge framing supported by the main structural system. This structural system supports both the gravity and lateral loads created by the panels.

A Change in Codes

New Jersey adopted the 2000 International Building Code (IBC) just prior to final design of the west tower. This code is even more stringent than BOCA 1996 and required Francis Cauffman and DiStasio to swiftly assess the best approach for the lateral resisting system under the new code requirements and reevaluate elements of their design. Because of the mix of soils on the site and the criticality of hospital operations, the site was rated Seismic Class D, which carries more rigorous design requirements than those typical for the region. The designers selected intermediate moment frames, which are specifically detailed for seismic design, because they allow for maximum flexibility of present and future space planning while still affording an economic solution.

Several moment connection types were possible given the design, but the fabricator ultimately selected the reduced beam section (RBS) type for its ease of fabrication and reduced material requirements. This

© 2009 Halkin Architectural Photography.

Cantilevered steel beams over the Gagnon Cardiovascular Institute's new reception and drop-off area carry column loads from the three current stories. They also have the capacity to support the addition of two more floors in the future.

type of connection design was actually quite new to fabricators on the east coast at the time, so the structural engineer worked closely with the detailer and fabricator to clarify the detailing requirements. The RBS connection also was favored by the design team for its demonstrated performance in improving ductility under high seismic loading.

The balance of the building's exterior is composed of a field-built aluminum curtain wall. In some instances the curtain wall spans up to 60 ft and is supported by the frame's spandrel beams and dead-loaded on a hung steel lintel below. By hanging the lintel, Francis Cauffman was able to level the glass curtain wall with an adjacent roof. In the original design, a portion of this curtain wall framed a glass elevator lobby expansion, but that design had been submitted under the earlier code. By construction time, IBC 2000 precluded its use. The structural redesign for this area again relied on using steel cross-bracing to brace the original 1970s concrete frame structure and support the slender elevator hoist way and lobby addition. In some instances the support of the floor slab was achieved using a steel cantilever spanning in two directions.

More Steel Solutions

To create a pedestrian- and vehicle-friendly drop-off area for the Gagnon Cardiovascular Institute while maintaining the square footages dictated by the program, the lead designer proposed cantilevering the tower's bed floors over the access drive, thereby creating a main entry reminiscent of a hotel check-in area.

Creating this cantilevered condition was no easy task, as the cantilevers needed to carry columns from the three current stories and two future floors. The designers used W40 steel rolled shapes for the 16-ft cantilevers to limit deflections at the lowest level. This entrance also features a dramatic 40-ft-high atrium space enclosed by the exterior window wall system. Interstory movements had to be carefully considered when sizing the framing in this area due to the stringent tolerances and deflection limitations of the specified mullion assembly. Flying beams were also introduced to laterally support the window walls and create a bold architectural statement in the space.

More than 2,000 tons of steel went into the west tower addition, bringing the project's total to more than 3,200 tons. Through its flexibility and strength, using steel on this project enabled the design team to build upon and enhance the functionality of aging facilities to maximize their use in the present and for many years to come. MSC

Architect
Francis Cauffman, Philadelphia

Structural Engineer
DiStasio & Van Buren, Inc., Cranford, N.J.

Construction Manager
William Blanchard Co., Springfield, N.J.

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Benefits of Early Steel Detailing

BY MATT TRAMMELL, P.E.

The ability to quickly reach decisions as construction documents are being developed streamlines hospital project.

WHEN OUR LADY OF LOURDES HOSPITAL in Lafayette, La., decided to build its new 378,000 sq.-ft, six-level replacement hospital and 16,000 sq.-ft central energy plant with a $211 million construction budget and overall construction schedule that would allow for only five months to erect 3,000 tons of structural steel, the design team knew that a significant challenge lay ahead. Brentwood, Tenn.-based TRC Worldwide Engineering, the structural engineer of record (SER), decided to meet this challenge head on by being proactive and actively participating in discussions in meeting the owner's proposed budget and construction schedule. Typically, a structural engineer can offer marginal assistance with the overall construction schedule and construction budget. However, when the structural engineer is also the structural steel detailer, this influence is significantly increased.

Early in the design process, the owner brought on board the joint venture of The Lemoine Company LLC and Brasfield & Gorrie LLC as the contractor. That step was crucial in efforts to meet the schedule and budget. Collaboration between contractor and the design team allowed the selection of not only the most cost effective structural system but also the structural system that could be constructed in the least amount of time.

The first system considered consisted of composite structural steel with reinforced concrete shear walls at the stair and elevator cores to minimize disruption of the floor plan with braced frames. However using that approach meant delaying steel erection by several months while the shear towers were constructed.

The second system to be considered was a total cast-in-place concrete structure that would allow for the columns and floor system to be constructed concurrently with the shear towers. That system would have resulted in delays by the design team because initial column grids and floor layouts were based on a structural steel system. Further, a concrete structure is significantly heavier than a structural steel system resulting in heavier, more expensive foundations.

The selected structural system consisted of composite structural steel framing with a 6¼-in. lightweight concrete floor

Opposite page: The contractor's plan to speed construction by using multiple cranes meant steel detailing and fabrication had to be completed quickly. Importing the 3D model from the design software into the detailing saved a great deal of time in this regard.

Adopting an Early Steel Detailing process enabled creation of advanced bill of materials so the order could be placed for the heavier W14 columns, which had a longer lead time.

slab and concentrically braced frames. The architect agreed to the use of braced frames because of their economy relative to other lateral systems as well as the ability to maintain the construction schedule by using them.

Once the structural steel framing system was selected, TRC WW proposed to also develop the structural steel shop drawings for the steel fabricator concurrently with development of the structural construction documents, a process also known as Early Steel Detailing. To aid these efforts, the steel fabricator and steel erector were chosen by the contractor much earlier than usual in the construction process. The goal of such a proposal was to allow steel mill orders to be placed and shop drawings to be completed for certain erection sequences such that steel erection could begin immediately following the release of construction documents. At the time of the proposal, it was estimated that at least two months of construction time could be eliminated if the Early Steel Detailing process was implemented.

Once the design team and construction team agreed to Early Steel Detailing, the feedback obtained from the contractor, fabricator and erector with regard to sequencing and fabrication preferences became vital to the design team and steel detailer during development of documents. Construction documents were released by the design team on May 12, 2009, and steel erection began on June 8, 2009.

Structural steel shop drawings were prepared using SDS/2 using the engineering model prepared with RAM Structural System and imported directly into the detailing software. The steel detailers would not have been able to keep up with the aggressive erection schedule had it been necessary to recreate a detailing model from 2D drawings. Importing the engineering model initially took place in December 2008, three months before issuing the structural steel package and five months prior to the final construction document release package. This initial detailing model was used to develop an advanced bill of material to allow the contractor to schedule rolling dates for the heavy W14 columns, which had a longer lead time.

Importing the engineering model took place seamlessly several more times during the design process incorporating owner/architect requested design modifications that are inevitable in a project of this complexity. In this case it included the decision to construct an additional floor level that initially was planned to be constructed at a future date.

The steel erector planned to use three cranes to erect three sections of the structure simultaneously. To support the erector's aggressive schedule, the structural steel had to be detailed in time to be fabricated and transported to the job site. TRC WW structural engineers expedited that by in most cases reviewing and returning the shop drawing approval comments to the detailer prior to their being released for contractor/

Matt Trammell, P.E., is the structural engineering manager at TRC Worldwide Engineering Inc., Brentwood, Tenn. (www.trcww.com) He is a registered Professional Engineer in 10 states, an AISC Professional Member, and has 11 years of experience in the design of structural steel projects.

The architect's use of structural steel braced frames instead of concrete shear walls expedited the construction schedule.

architect approval. Thus the approved drawings could be released for construction as soon as the steel detailers had addressed comments from the contractor and architect.

In addition, during development of the steel shop drawings, no formal RFIs were issued by the detailer relating to clarifications in the structural contract documents. All discrepancies and detailer requested preferences not affecting construction or architectural requirements were handled internally at TRC WW without the time consuming process of preparing and documenting RFI responses.

Less than five months after erection began, the majority of the 3,000 tons of structural steel has been erected and construction of the structure is on schedule. Early Steel Detailing was vital in maintaining this schedule and its implementation was possible only through the tireless efforts and collaboration of both the design and construction teams. MSC

Owner
Our Lady of Lourdes Hospital in Lafayette, La.

Architect
The Estopinal Group-Jeffersonville, Ind./ HOK, St. Louis

Structural Engineer and Steel Detailer
TRC Worldwide Engineering, Inc., Brentwood, Tenn. (AISC Member)

General Contractor
The Lemoine Company LLC (Lafayette, La.)/Brasfield & Gorrie LLC (Birmingham, Ala.) Joint Venture

Steel Fabricator
Cives Steel Company, Rosedale, Miss. (AISC and SEAA Member)

Steel Erector
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Shop-applied intumescent fireproofing cuts schedule and speeds erection.

Fire Protection to Go

BY CHRIS GRIFFITH

THE BIOMED 21 initiative at Washington University School of Medicine in St. Louis was launched in 2003. The initiative has gained widespread recognition for its collaborative, interdisciplinary research and subsequent advancements in treating some of society's most prevalent health problems. By 2007, the program's success prompted BJC HealthCare, one of the largest nonprofit health care provider organizations in the U.S., to help fund the construction of a new research center on campus to house laboratories and support facilities for BioMed 21, which has since been renamed the BJC Institute of Health.

The architect, Canon Design, St. Louis, designed a portion of the 675,000 sq.-ft facility to be constructed as a canopy over the St. Louis MetroLink tracks that cross the campus property. To support the base floor of the 11-story structure, architects specified 45-ft to 55-ft cellular SMARTBEAM® construction. They were selected instead of standard wide-flange beams because of their light weight yet comparable strength and their excellent vibration control capability. The cellular design also allows for an easier installation of the ductwork through the openings in the beam webs, as opposed to cutting custom penetrations in the solid steel webs.

Above: A fireproofing system consisting of primer, a layer of carbon fiberglass mesh between two layers of intumescent fireproofing material, and a polyurethane topcoat was applied at ground level and in a climate-controlled environment in the fireproofing contractor's facility.

Opposite page: Because the new BJC Institute of Health facility was designed to straddle the MetroLink rail lines in St. Louis, a shop-applied fireproofing system saved much time and aggravation.

Robert Boston Photography, St. Louis

Photo: Robert Boston Photography, St. Louis.

Chris Griffith is engineering sales manager for International Paint LLC, Houston. ***www.internationalpaint-pc.com***

The St. Louis MetroLink rail lines are visible beneath the cellular beams for the base floor of the new BJC Institute of Health at Washington University, which all had to be placed between 1 a.m. and 3 a.m.

Because the new research center would literally straddle the MetroLink tracks, architects also had to provide a passive fireproofing system that would protect the steel against the high temperatures of a hydrocarbon fire, which can reach 2,000 °F. They also wanted to provide long-term corrosion and chemical resistance protection. The project's fireproofing contractor recommended International Paint's Chartek 1709 epoxy intumescent fireproofing technology based on its 30-year track record of protecting steel structures in this type of environment.

Another consideration was that the MetroLink tracks are in constant operation, making field application of fireproofing material extremely difficult. The performance benefits of the Chartek fireproofing technology, along with its shop-application capability allowing the structural steel to be installed as a finished system, led to its ultimate selection and use.

Application

The fabricated beams were shipped to the fireproofing contractor's plant in May 2008. The steel sections were blast cleaned to the specified SSPC SP-10 near white surface finish, followed by application of a fast-curing epoxy-based primer.

Next, a five-person crew spray-applied the first coat of Chartek 1709 at 210 mils. Carbon fiberglass mesh (HK-1) was then backrolled into the wet material on the bottom of the beam flanges only, which provided a real savings in labor and materials costs over traditional intumescent application procedures.

Just four hours later, the crew applied a second, 218-mil coat of fireproofing to achieve the UL two-hour rating. A highly durable polyurethane topcoat was then applied, completing the fireproofing application in one day.

After 16 hours of curing the beams' coating, Chartek is hard enough that they can be transported to the job site. However in this case, the cured pieces were stored in the shop yard prior to shipping each night to accommodate the project's restricted construction window that mandated a "just-in-time" delivery method.

Using this shop-applied system at ground level in a climate-controlled environment with strict quality control and production measures in place boosted both speed and quality. The fireproofing application to the 38 beam sections and associated truss sections was completed in two phases over a six-week period. That shaved several months of labor off the original construction schedule, compared to a field-applied option, by avoiding the need to set up and remove scaffolding and other field equipment. It also avoided any potential delays due to scheduling conflicts with multiple construction trades on site, seasonal weather changes, and other unforeseen field problems.

Construction and Erection

The building's unique design configuration presented several construction challenges. First, the new research center would replace the existing structure canopied over the MetroLink tracks. In order to protect the tracks during demolition, the general contractor would need to erect the first and second floors of the steel structure around the existing canopy. Also, because the MetroLink tracks are in continuous operation, demolition and erection of the beams was only permitted between 1 a.m. and 3 a.m. each day, creating a very narrow window in which to work.

After a temporary work platform was erected, demolition of the existing canopy began in late summer 2008. The stored beam sections were loaded onto flat bed trucks and transported 100 miles to the job site each night. Beginning in October 2008, approximately three beams were installed each day during the short two-hour window, with the final placement in November.

Despite the considerable handling of the beams during transportation and erection using standard industry practices, the repair and touch-up to the epoxy intumescent fireproofing was almost negligible, at 1% to 2% of the surface area. These results are similar to the robust performance being reported on other shop-applied Chartek projects around the globe. Additionally, using this type of fireproofing means the beam's flutes do not have to be packed with mineral wool after the top flange is attached to the floor assembly, offering further savings in labor and materials over traditional methods. MSC

Owner
Washington University, St. Louis

Architect/Structural Engineer
Canon Design, St. Louis

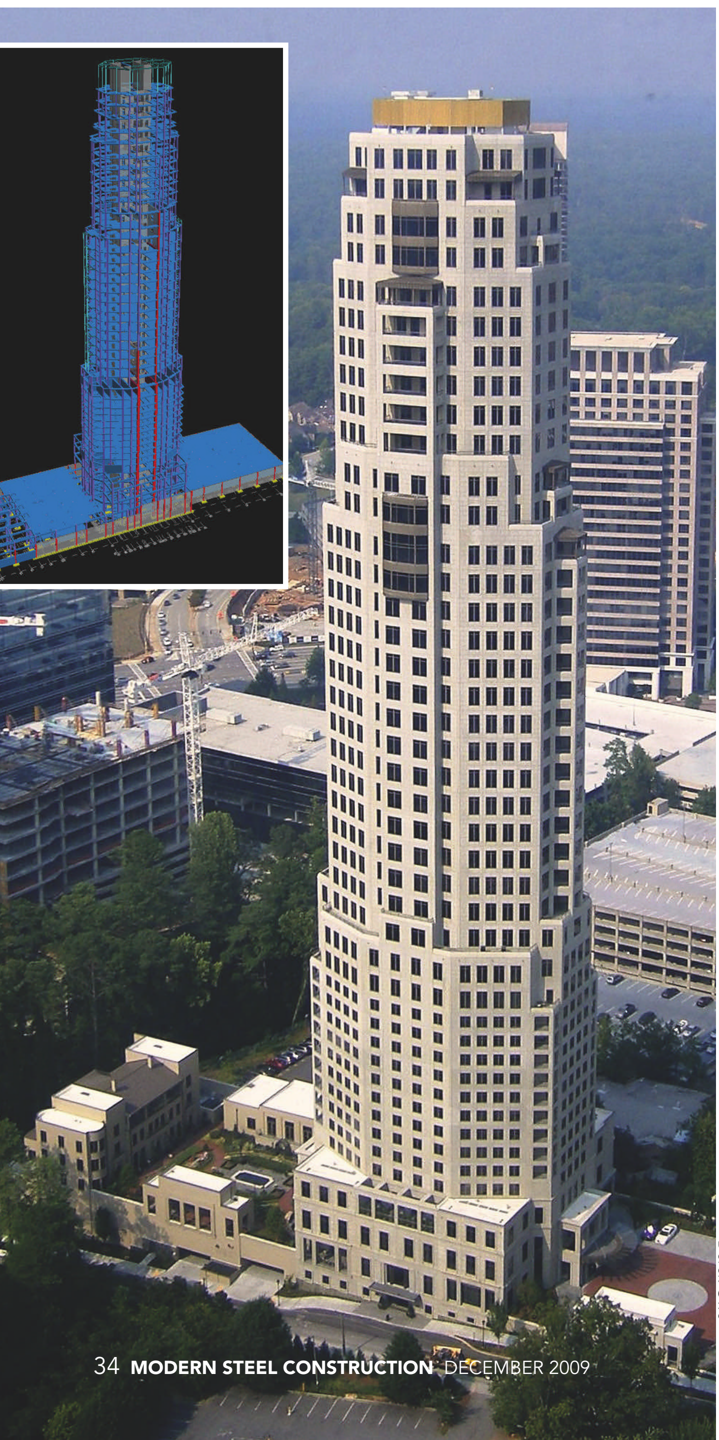
Structural Steel Fabricator
Hammerts Iron Works, St. Louis (AISC Member)

Cellular Beam Manufacturer
CMC Steel Products, Hope, Ark. (AISC Member)

Fireproofing System
Fire Stop Technologies, Taylorville, Ill. (contractor)
Precision Finishes, St. Louis (surface preparation)
Midwest Fireproofing, Frankfort, Ill. (application)

The Transfer Solution

BY KURT D. SWENSSON, PH.D., P.E., LEED AP



Derek Owe

Steel saves valuable space and time in accommodating high-rise column setbacks.

THE MANSION ON PEACHTREE contains many of the complicating elements of typical mixed-use buildings using a stacked configuration. The project includes a parking garage, elevated motor court and garden, 142-key hotel, 15,000 gross sq. ft spa, 8,000 gross sq. ft banquet and meeting space, two restaurants, a bar, three residential villas, and 41 high-rise luxury residential units.

The building is approximately 620 ft tall with a total of 46 occupied levels. It uses a "wedding cake" scheme with steps in the floor plan and column transfers at seven different floors. The design stacks a 27-story residential building on top of a 15-story hotel above a three-story parking deck. Only two of the columns from the residential tower extend to the foundation, while 26 of the 38 tower columns transfer at the top of the hotel floors.

The project presented many design and construction challenges, three of which had a significant impact on the transfer design.

1. Remove all interior columns from the hotel floors.
2. Maximize the number of saleable floors within the height limitation while maintaining 12 ft, 3 in. clear height on the residential floors.
3. Support a fast-tracked delivery process.

The combination of these requirements led to the use of structural steel transfer trusses at two of the seven transfer floors. At these two levels, the transfers span more than 36 ft, support more than 27 levels, and need to accommodate openings for utilities and personnel. The use of traditional concrete beams was considered for these conditions but was found to be unacceptable because the resulting designs either increased the building height, limited utilities and personnel movement, or could not accommodate the fast track schedule.

Stepping in the top 27 floors of this mixed-use high-rise required transferring the column loads from the top portion using 18 floor-depth structural steel trusses and W40 beams.

Structural Steel Provides the Solution

As the design of the transfer elements developed, it became obvious that structural steel was the only realistic option. The requirement to provide openings for egress and access by personnel severely limited the efficiency of any concrete option. The fast track delivery required detailed design before the final location of utilities, which also made the use of structural steel trusses advantageous. The multiple opportunities for penetrations through openings in the truss web allowed the design to proceed with minimal coordination. Further, the open web truss configuration provided flexibility for future replacement, relocation, or addition of utilities. The use of large concrete transfer beams would have made movement of existing or placement of new utilities very difficult.

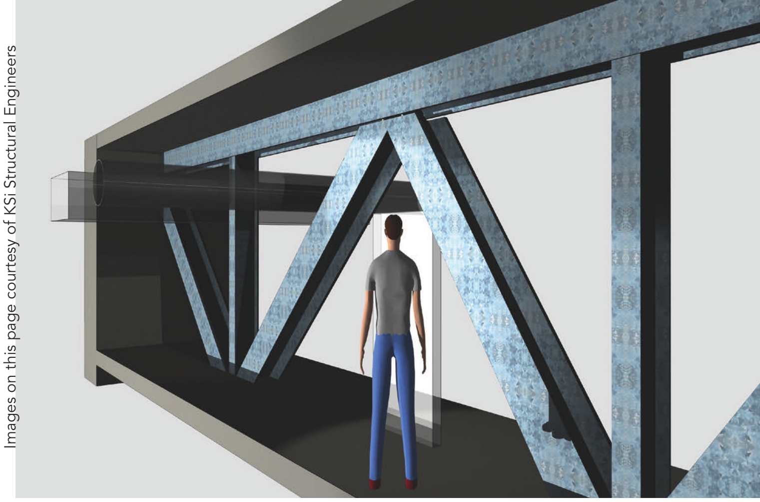
In the final design, 18 floor-depth structural steel trusses and four wide-flange beam sections transfer 22 columns at the transfer level. Fourteen of the trusses use a composite top chord configuration. Two trusses transfer columns above the ballroom just below the hotel floors.

Through the use of structural steel the column transfers were accommodated without adding height or square footage to the building. Space on the transfer floor was used to transfer the stairs and the elevators, support air handling equipment, as well as data and fire pump rooms. This integrated use of floor space allowed an additional level to become saleable residential space with a value, at the time of design, of approximately $4 million to $6 million.

Project Challenges

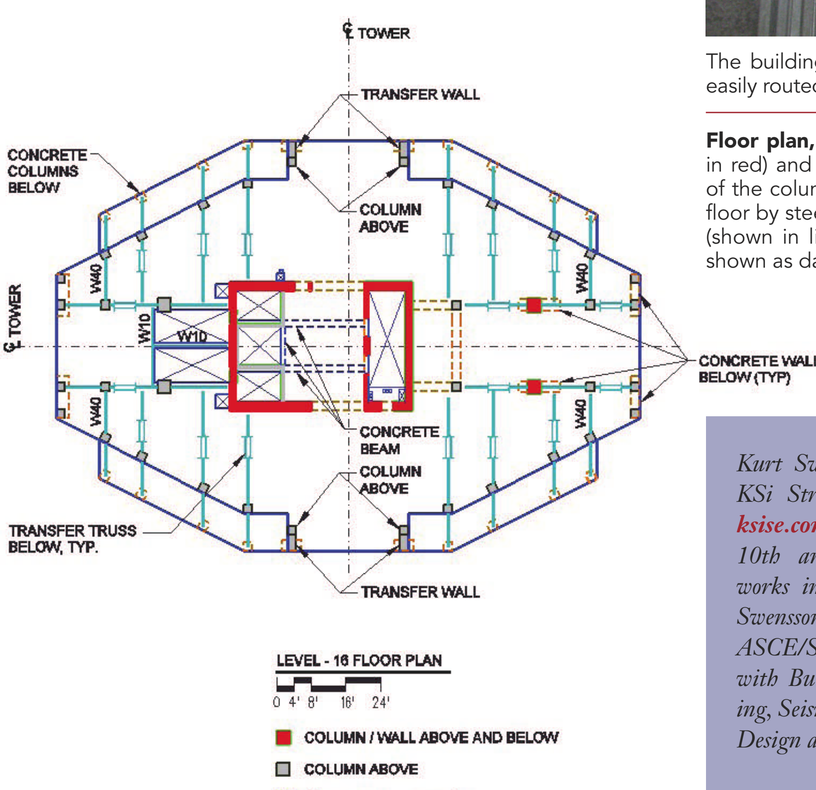
Once the decision was made to use structural steel, the challenge was to determine the most efficient way to execute the plan. The integral teamwork of the design team, owner, contractor, fabricator, connection designer, and erector was the key to the success of the plan. The following considerations were significant in the analysis, design, and construction of the trusses—minimizing transfer loads, controlling deflections, and minimizing impact on the construction schedule.

Images on this page courtesy of KSi Structural Engineers



The structural steel transfer trusses used on this project are the full height of the level. Their open web configuration allows people and building systems to pass through easily without extra coordination concerns.

The building's mechanical, electrical and plumbing components were easily routed through the structural steel transfer trusses.



Floor plan, left: Only two columns from the residential tower (shown in red) and the concrete core extend to the foundation. All other 22 of the column loads from the top 27 floors are supported at the 16th floor by steel transfer trusses and the four W40 sections at the corners (shown in light blue). The supporting columns and walls below are shown as dashed brown.

Kurt Swensson is the president of KSi Structural Engineers (www.ksise.com), which celebrated their 10th anniversary this year and works in their Atlanta office. Dr. Swensson is active in AISC and ASCE/SEI committees dealing with Building Information Modeling, Seismic Design, and Methods of Design and Analysis.

KSi Structural Engineersdef, not

Connector plates were provided on level 16, atop the transfer truss upper chord, to receive loads for each of the concrete columns.

Aerial Innovations of Georgia

The slab is being formed on the south side of the tower as truss erection continues on the north side. Integrated steel truss erection with slab placement minimized the schedule impact of on-site truss erection. The only way to transfer the column loads resulting from stepping the building in was to use structural steel transfer trusses that are the full depth of the floor.

KSi Structural Engineers

To keep from having to use a larger crane, the transfer trusses were lifted into place in pieces each weighing 22,000 lb or less, which were then bolted together using 14,200 high-strength bolts (in addition to the 5,700 used in the shop).

Minimizing Transfer Loads

An effective way to reduce the size of any structural element is to reduce the force it must resist. To this end, the structural engineer worked with the project team to reduce loads on the transfer girders early in the design process. A review of the tower geometry revealed that transferring particular columns on multiple levels provided significant advantage. This plan took advantage of building steps existing in the architectural plan on floors where transfers already were planned. The final geometry allowed the use of more traditional transfer beams with smaller spans reducing cost and schedule impact without increasing the building height. The changes made reduced the load on several trusses at lower levels by up to 60%. Without these adjustments, the transfers at lower levels would not have been economically or technically feasible.

In early computer analysis, it became evident that the transfer trusses attracted significant forces from lateral loading. Therefore, the trusses are de-coupled from the lateral load resisting system. One set of outrigger walls was located just above the transfer level thus transferring overturning loads directly to the columns. This measure isolated the trusses from significant overturning forces. Next, the slab was isolated from the bottom chords and the bottom chords were not extended to the supporting columns. These two measures interrupted the load path for lateral loads through the truss webs.

Controlling Deflections

Deflection criteria were developed accounting for the three-dimensional behavior of the floor, the relative distance between transferred columns, distance between transferred columns and the core, and the allowance for tile on the floors above. The resulting target deflection values varied from 0.25 in. to 0.5 in. for spans up to 38 ft, 6 in. Analysis indicated that shortening in the compression chord was a significant contributor to the truss deflection. To reduce the shortening the compression chords were designed to act compositely with the 10-in. slab placed at that level. The resulting design reduced the weight of the top chord of the trusses by between 60 to 70 lb per lineal ft.

Constructability

Two major challenges shaped the construction of the transfer system. The first was crane capacity, which was based on the requirements of the project's concrete slab and precast panel placement. The tight urban site would not allow the use of additional mobile cranes. Increasing the tower crane capacity for the several weeks needed to erect the trusses would have added $500,000 to the project cost. So the trusses were erected in pieces each weighing less than 22,000 lb.

The second challenge was to minimize the truss erection time. To accomplish this, steel truss erection was woven into a cast-in-place concrete flat slab building schedule. This required coordination of concrete shoring, placement and finishing around the in-place structural steel erection and assembly of the trusses.

Planning for the installation process began four months prior to truss installation, while design was still in progress. The coordination sessions included the general contractor, steel fabricator, steel erector, and the formwork subcontractor as well as the structural engineer. The result was the following process.

1. Place columns/walls to bottom chord level.
2. Set bottom chord with connection plates and independent shoring system.
3. Build slab formwork and shore.
4. Place slab at bottom chord level.

5. Place columns/walls to top chord bearing.
6. Set web elements/top chord.
7. Begin final bolting/welding of web members while forming top chord slab.
8. Place top chord concrete slab.
9. Complete bolting/welding while placing shoring/formwork for next level slab.
10. Remove shoring after bolting/welding completed.

Erection of the 18 transfer level trusses took six weeks during which three floor slabs were placed. When compared to a standard floor construction schedule, the truss erection added four weeks to the project schedule. However, when compared to the alternative—construction of large concrete transfer girders and the additional area that would have been required for a separate mechanical level—the impact of the trusses on the schedule was minimal.

In the final design the weight of the typical truss, without connection material, is approximately 600 lb per lineal ft. The largest truss spans approximately 39 ft, is approximately 15 ft deep, and weighs 1,343 lb per lineal ft. The truss supports two columns as well as reactions from three other transfer trusses. The total calculated load transferred by this truss is approximately 4,700 kips. In total, the structural steel system used to transfer columns included 165 structural steel pieces weighing 410 tons. The system utilized 19,900 high-strength bolts. Of those, 5,700 were shop bolted and 14,200 were field bolted. The approximate cost of the steel transfer system was $2 million, which resulted in an increase of saleable residential area with an estimated value of $4 million to $6 million. Not only was there a solution in steel, it also was a good investment. MSC

Architect of Record
Milton Pate Architects, Inc., Atlanta, Ga.

Structural Engineer of Record
KSi Structural Engineers, Atlanta, Ga.

Steel Fabricator
Steel LLC, Scottdale, Ga. (AISC Member)

Steel Detailer
Engle & Associates Detailing, Inc., Birmingham, Ala. (AISC and NISD Member)

Connection Designer
Ferrell Engineering, Inc., Birmingham Ala. (AISC Member)

Steel Erector
Williams Erection Company, Inc., Smyrna, Ga. (AISC, TAUC and IMPACT Member)

Software Used
RAM Advance

Flower Power

BY MICHAEL E. SHERIDAN, P.E.

A new mixed-use project blossoms in downtown Louisville.

THE FLEUR-DE-LIS, OR "LILY FLOWER," is an enduring symbol of France—and Louisville, Ky.; it appears on the latter's flag, as the city was named for King Louis XVI of France. In a similar fashion, the Fleur-de-lis on Main, a new mixed-use building at Preston and Main in Louisville, provides a new emblem for the city in its architectural revival of old downtown.

The first floor of the 200,000-sq.-ft, five-story development is contains retail space and two interior greenscape courtyards. Residential units, 82 of them, make up the top four floors of the building, with interior units overlooking the courtyards. A below-grade parking garage includes spaces for 150 cars.

Positive Projection

The building's architecture is intended to create an ambience of elegance and nature. The pointed balconies and plan projections of the residential units cantilever over the courtyards and out from the building's exterior, promoting a sense of being only steps away from nature, even at the upper levels. The structural design of these elements uses 26 weld-through beam connections at the second floor, with 13 vertical posts at the points of the plan projections. These vertical posts provided support to the upper floor projections and eliminated the use of 162 weld-through connections at the third, fourth, and fifth floors.

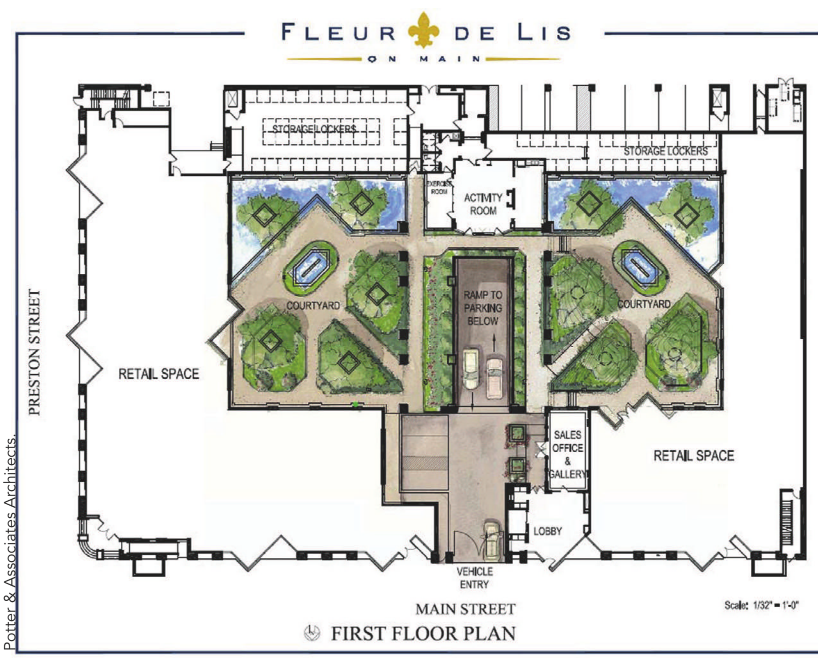
While this type of system is very economical, it does collect the entire load at the second floor cantilever. Therefore, a deeper beam system was required to support this large load on a 9-ft cantilever. The W30×116 beams at the second floor are accommodated by the extra story height provided by the grade-level retail space.

The building employs an open-web composite joist system, and the first-floor gravity structure is a 5¼-in. concrete slab on composite deck, with typical composite structural steel beam and girder framing. The gravity system of the second through fifth floors is a 20-in. joist on a 3-in. cast-in-place concrete slab. The system is supported by typical composite structural steel girders, with a depth limitation in the interior of 18 in. The composite steel girders use ½-in.-diameter headed studs to achieve the required composite action with the 3-in. concrete slab. The 20-in. joist depth is standard throughout the project to furnish ample clearance for the duct penetrations through the webs, and provides a uniform depth of structure for the attachment of the sound barrier and ceiling grid.

Laterally Unique

One of the most unique structural features in the building is the lateral load resisting system. Early designs called for a series of solid concrete shear walls along the alley at the south and west sides of the building. However, when final grade of the existing alley was established and alley parking was implemented, the shear walls at the alley had

Thirteen vertical posts at the points of the plan projections support the third, fourth and fifth floors, reducing the number of weld-through beam connections required from 188 to just 26 on the second floor.



Potter & Associates Architects

Opposite page and above: The 200,000-sq.-ft, five-story Fleur-de-lis on Main in downtown Louisville, Ky., contains retail space, two interior courtyards, 82 residential units, and a covered entryway that leads to underground parking.

Michael E. Sheridan was the primary structural engineer for Fleur-de-lis on Main as an associate at Stanley D. Lindsey and Associates Ltd. He is now the chief structural engineer for the U.S. Army Corps of Engineers, Memphis District.

Designed with large openings and much glass, the building's front elevations left little room for a lateral load resistance system. Although perforated concrete shear walls were retained on the street sides, they were replaced by a steel system on the alley sides.

to be eliminated, which also allowed a smaller crane to be used and thus reduced the crane cost for the project.

The front building elevations only had a few locations for concrete shear walls: behind the brick panels and between the glass projections. Structural analysis indicated that the shear walls barely worked. But with so much glass and large openings, changing to braced frames at the front was not an option. Moment frames were considered, but to control the lateral drifts and column moments, the column sizes would have to be increased from a large W10 column to a large W14 column (about 16 in.×16 in.). However, increasing the column size would wreck the intricate space planning as well as make it very difficult to open a garage door in the below-grade parking area. Therefore, the W10 gravity columns had to stay and were incorporated in the final design.

In order to keep the series of perforated concrete shear walls at Preston and Main Streets, a braced frame system had to be designed at the south and west using structural steel. This system had to have similar stiffness as the previous shear walls. Designing to a normal ductility of R=3 was no longer an option, since the remaining north and east shear walls were designed with R=5. As such, a series of ordinary concentrically braced frames were designed with R=5 in conjunction with the ordinary reinforced concrete shear walls on the north and east sides of the building, and the perforated shear wall system was able to be maintained.

Below Grade

The parking garage offered the opportunity for another unique framing solution. Due to very soft soils near the Ohio River, the geotechnical engineer recommended a mat foundation for the building. The reinforced concrete mat is three ft thick and supports the parking garage's gravity steel columns. The special base plate has a 2-in. thick, 16,500-psi, epoxy grout bed (HP Epoxy Grout by The Five Star Company) formed, cast, and cut flush with the base plate. The base plate is slightly larger than the W10 columns and fastens to an embedded plate with cast-in-place headed studs in the concrete mat and four 1-in.-diameter threaded studs (Nelson CFL) welded to the top of the embed plate and field bolted to the base plate.

The use of above-slab grout pads and base plates with embedded steel bearing plates in the mat foundation is a truly unique solution for steel columns in parking structures. The design results in no exposed anchor rods, better facilitating parking access and minimizing the risk of damage to vehicles and the structure.

Thanks to the resourceful structural solutions employed on the Fleur-de-lis on Main project, the building is on the path to becoming an enduring edifice in the Louisville cityscape—much like its namesake symbol. MSC

Architect

Potter & Associates Architects, Louisville

Structural Engineer

Stanley D. Lindsey and Associates, Ltd., Brentwood, Tenn.

Steel Fabricator

Sentry Steel, Inc., Louisville (AISC Member)

A series of steel ordinary concentrically braced frames on the south and west sides of the builiding provide lateral load resistance, replacing the original concrete shear wall design.

Dave Hornby, Stanley D. Lindsey and Associates

Fabrication Tools Sneak Peek

An advanced rundown of some of the machinery debuting at NASCC next May.

IT MAY STILL BE MONTHS AWAY, but manufacturers are gearing up for the 2010 NASCC: The Steel Conference exhibition scheduled for May 12-14 in Orlando. Here are early tips on some of the new and interesting fabrication equipment that will be at the show.

Voortman Corporation will introduce its new V806 Structural and Plate Plasma Cutting System. This new design performs all structural connections in one machine, including layout, to drastically reduce labor and material handling costs. The new V505-2 Angle line with multiple tools, single cut shear, fully automatic loading and unloading and piece marking will be shown for the first time. The V320 Plate Processing Center also will be introduced. This new design will produce any shape using plasma cutting and a high-speed drilling head with 10-tool changer.

Years of development have gone into the new REVOLUTION coper that **Controlled Automation** will introduce at the NASCC 2010 show. This five-axis cartesian robot hybrid is the first of its kind. Structural members are processed with the aid of a tool changer for both oxy-fuel and plasma cutting. The combination of these technologies allows for the speed of plasma and the tight tolerances and thicker production parts associated with oxy-fuel cutting. The machine can process members up to 48 in. wide.

In addition to its popular Oceanettes, **Ocean Machinery** will be exhibiting its latest version of the Ocean Liberator (below), a five-axis beam coping workhorse. The versatile Liberator processes beams, columns, channels, angle, tube and flat bar. It will cut to length, perform all standard and custom copes, and bevels in both the web and flange for full-pen welds. This machine straddles the divide between the company's Avenger single-spindle drill and the PCD/BDL three-spindle beam line markets. With its affordable price of less than $150,000, it is a perfect fit for the medium fabricator doing more than 120 tons of steel per month.

Daito U.S.A. Inc. plans to introduce its all-new CNC Coping Robot model CRII7030, which offers highly advanced controls for its Six-Axis Robotic Arm. Software is also included that allows you to download to the machine from most detailing programs. The extraordinary capabilities of the six-axis robot allow this machine to produce an endless array of copes that are remarkably fast, accurate and also smooth.

After having introduced six new machines at the past two NASCC conferences, in Nashville and Phoenix, **Peddinghaus** will introduce two more innovative tools in Orlando. The patented Revolution AFCPS 833 Detail Master processes 8-in. by 8-in. by 1-in. angle iron, 12-in. by 1-in. plate, and 12-in. channel. No other machine provides this capacity for detail components needed for steel construction. Another new machine from Peddinghaus also will be unveiled. Both are designed to meet the need for increased productivity and efficiency in a tough market.

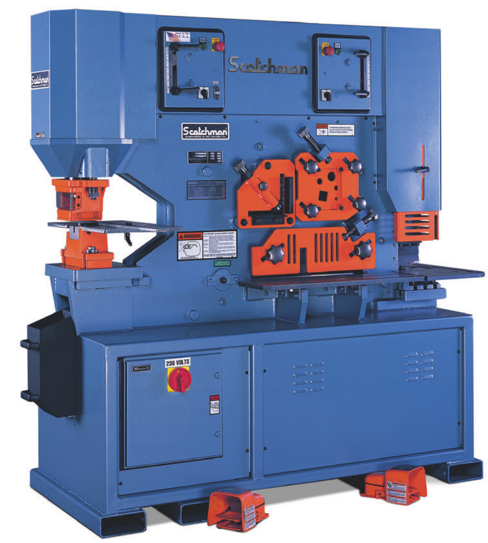
Behringer Saws will exhibit for the first time a "lift and carry" system, in addition to its broad array of high quality band saws and circular saws. Demonstrations throughout the course of the event will use a W24 beam to show how a saw and integrated material handling can boost sawing efficiencies.

Ficep Corporation will introduce its new Gemini line of CNC Gantry Style Burn Tables that also drill, mill, countersink, tap and mark. The Gemini incorporates a high performance machining spindle (8,000 rpm) with an automatic tool changer and ball screw feed. To increase productivity, the system includes a secondary "X" axis so the spindle can position

and machine parts without having to move the gantry. The Gemini includes internal material clamps within the gantry to secure the stock plate for subsequent operations.

The PythonX Structural Fabrication System, manufactured by **Burlington Automation**, is a beam line and coper all in one machine. It uses the latest in robotics and plasma technology to fabricate I-beams, channels, HSS, angle and strip plate all on one machine. The PythonX can produce bolt holes approved for structural joints, produce cope cuts, slots, cutouts, cut to length, miter cut, produce T-Beams, and scribe part/layout marks using one robotic plasma torch all in one place eliminating time lost to material handling between operations. It also saves valuable shop space.

Scotchman Industries will feature its Dual Operator 85-Ton Hydraulic Ironworker. This American-made ironworker with five built-in stations offers the versatile, flexible and dependable features that Scotchman is known for. The DO 8514-20M has an 85-ton capacity punch and a 14-in. throat depth, which can punch a 1 1/16-in. hole in 1-in. material. Its hydraulic system is designed with two pumps to ensure full hydraulic pressure and speed to both operations, complete with two valves, two stroke controls and two remote foot pedals. Standard features include 6-in. by 6-in. by ½-in. angle shear and a rectangular notcher that can notch 2 in. by 4 in. through ½-in. material. MSC



Steel Bridge NEWS
NATIONAL STEEL BRIDGE ALLIANCE
DECEMBER 2009

Steel Girders Support Bridge Construction Staging

BY AHMAD ABU-HAWASH, P.E., AND HUSSEIN KHALIL, P.E.

THE FIRST CONSTRUCTION PROJECT completed under the Council Bluff's (Iowa) Interstate System (CBIS) improvement project was the 24th Street interchange, which crosses the overlapping segments of I-80 and I-29. As an important arterial serving major attractions and businesses such as casinos, a conference/event center, hotels and large shopping outlets, it was essential to maintain three lanes of traffic—one in each direction, plus a turning lane—throughout construction.

Projects of this scope typically are constructed over two consecutive construction seasons, but the critical location of this interchange required limiting traffic restrictions on 24th Street to a single season (April thru October). Maintaining traffic flow and the accelerated construction schedule became the driving forces in the structure's design.

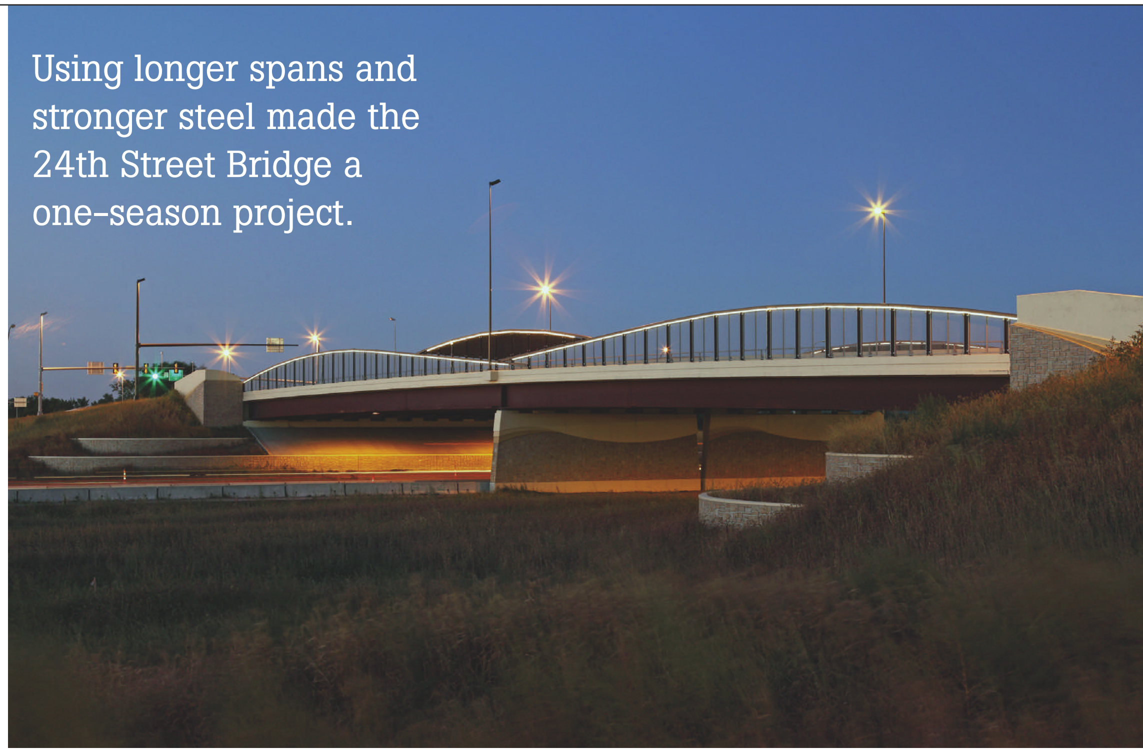
Fortunately, with the help of the Federal Highway Administration's Highway for Life (HfL) initiative and Innovative Bridge Research and Deployment (IBRD) program, Iowa Department of Transportation used innovations that are new to Iowa but already proven to meet the needs of the traveling public during and after construction. The HfL and IBRD programs accelerated construction while maintaining traffic access, reducing future maintenance and improving safety both during and after construction.

The Steel Solution

Several bridge types and construction phasing options were considered to best meet design and safety standards, facilitate traffic and minimize right-of-way impacts. The existing four-span, 216-ft-long by 64-ft-wide prestressed concrete beam bridge spanned five

Photos these pages by Keith Philpott

Using longer spans and stronger steel made the 24th Street Bridge a one-season project.



Opposite page: The existing 24th Street Bridge spanned five interstate traffic lanes, but the new bridge will accommodate future interstate expansion to a 12-lane dual-divided roadway section and shift the centerline approximately 42 ft.

Above: Alignment and clearances dictated a shallower than optimum girder depth, prompting the use of higher strength material for the bottom flange as well as the top flange between the two field splices of the pier section.

Ahmad Abu-Hawash, P.E. (left), is the chief structural engineer with the Iowa Department of Transportation where he has been involved in construction and bridge design for more than 20 years. Hussein Khalil, P.E., is a senior professional associate and vice president with HDR Inc. in Omaha, Neb. In addition to 25 years of practical experience, he also has research experience dealing with accelerated construction.

interstate traffic lanes, but the proposed bridge needed to accommodate future interstate expansion to a 12-lane dual-divided roadway section and a centerline shift of approximately 42 ft.

Shifting the I-29/I-80 centerline factored significantly into the design because it defined the location of the center pier. Interstate traffic beneath the bridge had to be maintained between existing piers and the proposed center pier during the first phase of construction. Adding more piers to reduce span lengths was not feasible when considering existing, staged and proposed roadway configurations.

The solution was a two-span, 354-ft-long by 105-ft-wide bridge with welded plate high performance steel (HPS) girders supporting full-depth post-tensioned deck panels. Steel girders were the most feasible option considering the required span lengths of 178.5 ft and 175 ft exceeded Iowa DOT's prestressed concrete beam standards. Longer spans accommodated the interstate final lane configurations and allowed the flexibility to stage interstate traffic without reducing the number of lanes. Furthermore, the contractor could choose whether to install the shear connectors after deck placement, which afforded the opportunity to make any needed adjustments. The final design featured 12 lines of steel girders spaced 9 ft on-center with a maximum length between field splices of 121.75 ft.

Constraints on vertical profiles required a shallower than optimum girder depth, which also favored the choice of HPS girders. The designer determined the use of higher strength material for the bottom flange and the top flange between the two field splices of the pier section to be the most economical. HPS 70W steel was selected for these areas based on its higher strength

Eliminating Congestion in Stages

The 75,000 vehicles that travel Interstate 80 through Council Bluffs, Iowa, on a typical day represent more than double the estimated traffic flow when the roadway was designed and constructed in the 1960s. With its capacity already stretched, the highway is expected to see daily totals climb to more than 120,000 in the next 20 years. Similarly, the 20,000 drivers using I-29, which interchanges and overlaps I-80 in Council Bluffs, is projected to double over the next two decades.

In response to the safety, congestion and capacity concerns created by the I-80/I-29 corridor's popularity, the Iowa Department of Transportation (DOT) initiated the Council Bluffs Interstate System (CBIS) improvements project. The project encompasses 18 miles of interstate highway in Council Bluffs and the eastern portion of Omaha, Neb., and affects 11 interstate-to-local road interchanges as well as three interstate-to-interstate interchanges. To help manage the magnitude of work, the overall project is organized into five adjacent segments. More information is available at **www.iowadot.gov/cbinterstate/**.


HDR Inc.

Allowing the contractor to install the shear studs in the field rather than having them installed in the shop as is traditionally done with cast-in-place decks provided greater tolerance for the erection of the deck panels and facilitated their placement.

coupled with improved toughness and durability. All other steel, including the web, was specified to be A709, Grade 50. The web thickness of 0.5 in. required no intermediate stiffeners in the positive moment regions and a minimal number in the negative moment zones. Cross-frame diaphragms consisted of two angle cross braces between two WT-shaped top and bottom struts generally spaced at 22 ft. A plate diaphragm was specified between the two phases of construction with one set of girder holes for Phase 1 to be drilled and connected after the Phase 2 superstructure was completed and most of the dead load applied.

Working Together

Because the steel girders were designed to act compositely with the deck, the girders and deck were joined together using shear connectors. Shear studs grouped together maximized the economy of deck panel fabrication and provided the necessary composite action. In addition, the plans allowed the contractor to install the shear studs in the field rather than having them installed in the shop as is traditionally done with cast-in-place decks. Again, incorporating an on-site installation method into the design provided greater tolerance for the erection of the deck panels and facilitated placing them more quickly.

The cross-section included two lanes in each direction, two turn lanes, a raised median, a raised sidewalk and a raised multi-use trail. Each of the 70 deck panels was fabricated to be 10 ft long by 52 ft 4 in. wide and 8 in. thick, comprising roughly half of the new bridge width. The design made it possible to construct each half in one phase, then join the two halves of the completed deck using a longitudinal closure pour. To improve ridability and provide an additional level of protection for the post-tensioned deck system, the panels were topped with a high-density overlay.

Each panel was pretensioned in the transverse direction with ten, 0.5-in.-diameter, 270-ksi low relaxation strands at the top and ten, 0.5-in.-diameter, low-relaxation strands at the bottom of the panels. A total of 28 flat ducts embedded in each panel housed the longitudinal post-tensioning. Four 0.6-in.-diameter, low relaxation, 270-ksi strands were installed in each of the embedded ducts. Pockets in the panels accommodated the headed shear studs. Designing Phase 1 panels to be geometrically similar to Phase 2 panels provided economy of fabrication.

The deck panels were installed after the steel framing was erected and the slab buildup below the deck panels was formed. Slab build-up forming methods and leveling the panels to the correct elevation were left up to the contractor; however, the plans included optional leveling bolts embedded in the deck panels that could be used by the contractor to aid in setting the panels to the correct elevations. After all the deck panels for a phase were erected, the transverse joints were filled with high-strength, non-shrinking grout.

The 24th Street Bridge used female-to-female transverse joints between panels, eliminating the need for match casting and reducing the risk of damaging panel edges during erection and post-tensioning. Experience with other projects showed that this type of joint tended to perform better than alternative joints, especially where longitudinal post-tensioning was utilized. The transverse joint configuration in the panels was a very important aspect to the design and successful service life of the structure. A poor detail of the transverse joint could result in leakage of the joint material and spalling adjacent to the joint.

Coordination among the designer, the owner, local contractors and fabricators were key to developing an economical design for this project while also reducing future maintenance. Using accelerated construction techniques and innovative construction methods made it possible to maintain traffic access and improve safety during and after construction, and incorporating high-performance steel girders into the design made it possible to complete the project within a single construction season. MSC

The authors would like to thank Norm McDonald, P.E., James Nelson, P.E., and Kimball Olson, of the Iowa Department of Transportation; Brent Phares, P.E., of Iowa State University and Phil Rossbach, P.E., of HDR Inc., for their contributions to this article.

Owner
Iowa Department of Transportation

Structural Engineer
HDR Inc., Omaha, Neb.

General Contractor
Cramer & Associates Inc., Grimes, Iowa

The Cantilever Truss Shortcut

BY NATHAN BROWN, P.E., S.E.

Avoiding the need for several pesky permits also allowed the project to start much earlier.

Lyle Jansma, Jansma Design

THE NOOKSACK RIVER CROSSING is part of a widening project for Washington State Route 539. This section of highway is being converted from one lane each way to a four-lane divided highway. The river crossing is located near the town of Lynden, approximately six miles south of a border crossing to British Columbia.

The site provided numerous challenges. The foundation material is extremely poor, and the height of the roadway embankment is limited by settlement and existing profile grade. The superstructure depth was limited to about 6 ft based on clearance to high water. Environmental permitting restricted placement of piers within the river channel.

These site challenges dictated a clear span of about 340 ft, leaving the only reasonable option a truss to match the existing bridge. The right-of-way was extremely limited, and construction access would require a lengthy permitting process. It was anticipated obtaining permits for construction access within the river channel would take at least a year. Also, the river is too low during the construction season for barge cranes.

The design called for a truss span of 350 ft, with a roadway width of 40 ft. A cantilever method of construction was proposed to circumvent the year of permitting. Two configurations were considered in the preliminary planning phase: a three-span truss and a single-span truss with two concrete approach spans. The second option was selected to better match existing conditions. The concrete approach spans were to be used as anchors for a backstay system. This became a balancing act during design, because it was discovered that construction access for large land-based cranes was not available on the south shore. Tower cranes were cost-prohibitive for this application.

The backstay system, therefore, needed to accommodate crane access and weight, in addition to truss self weight. Fortunately, the approach spans provided enough counterweight. A launching option was studied, but the necessary apparatus was quickly determined to be much more cumbersome by comparison. The three-span construction option would have been patterned after a number of Columbia River crossings, albeit at a smaller scale. Very little modification was needed for truss member design based on the cantilever method of construction.

The contract included complete details for the backstay system, including attachments to the truss and anchorage to the approach spans, which is not common practice for a WSDOT design-bid-build contract. The usual WSDOT method is to ensure constructability and provide schematic construction information only, allowing a contractor to build as suited. The contract did allow for a contractor-designed system, but Max J. Kuney chose to erect the steel using the details provided, with modest changes in the jacking arrangement.

Opposite page: Cantilevering the new truss out from both sides of the crossing enabled construction to proceed much sooner than if the usual permits for construction access, including those needed to work in the river channel, would have been required.

The plans called for the truss to be assembled in the shop or yard to verify and record geometrics as-fabricated. The intent was to have a way to monitor geometry during fit-up in the field and make closure at midspan less prone to mismatch.

Procedures for closing and releasing the span were shown in the plans. Temporary construction pins were used in the last truss members installed to quickly provide joints with adequate strength and mobility. Once the truss halves were joined and geometry fixed, these last connections would be bolted. The plans called for closing the truss during stable thermal conditions, to avoid harmful movement of the steel.

Fortunately, a typical Puget Sound rainy day arrived when the time came to drive construction pins at midspan. Temperature during closure did not vary by more than a degree. After the truss connections were complete, jacks at thrust blocks and backstay anchorages were used to release the support system. These jacks were incorporated into the scheme for adjusting elevations and advancing or retracting the cantilevers at closure.

The contractor estimated it took an additional month to erect the steel, compared to using conventional shoring and work trestle. The steel erector thought it took closer to two months additional time. The crane access decking turned out to be tedious and time consuming to install and move. Also, there was down time waiting for completion of the north approach. Truss erection began in early May, and was completed by mid-September. All parties still favor conventional, contractor designed methods for erecting steel.

The steel fabricator proposed and used a less involved shop assembly. The truss was completed without the need to modify members or connections. Shop drawings for the bridge were created with Tekla 3D modeling software, to ensure proper fit-up. Gusset plates and splice plates were drilled on CNC drilling equipment using the downloaded Tekla data in order to maintain hole tolerances. Because most structural members were fabricated during the winter months, extra care was taken to maintain tolerances due to expansion and contraction as the temperature changed. Built up box members were welded in lengths longer than required due to some shrinkage in length of the member during welding. The members were then cut to length in Rainier Welding's environmentally controlled building, in order to maintain length tolerance.

The truss design was patterned after the Cooper River truss in South Carolina (see *Modern Steel Construction* October, 1996). The Nooksack River truss will have the same open appearance when complete. The usual portal and sway frames are absent, providing much higher vertical clearance from traffic.

The finished bridge consists of 705 tons of structural steel with an associated cost of $5.172 million, which includes a three-coat paint system and special erection. The roadway deck is expected to be completed late this year. MSC

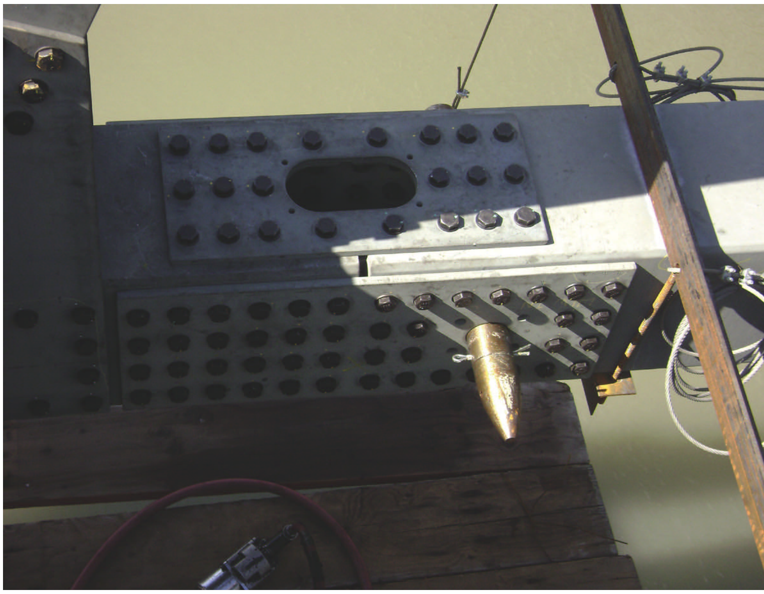
Owner/designer
Washington State Department of Transportation

Contractor
Max J. Kuney, Spokane, Wash.

Fabricator
Rainier Welding, Redmond, Wash. (AISC Member)

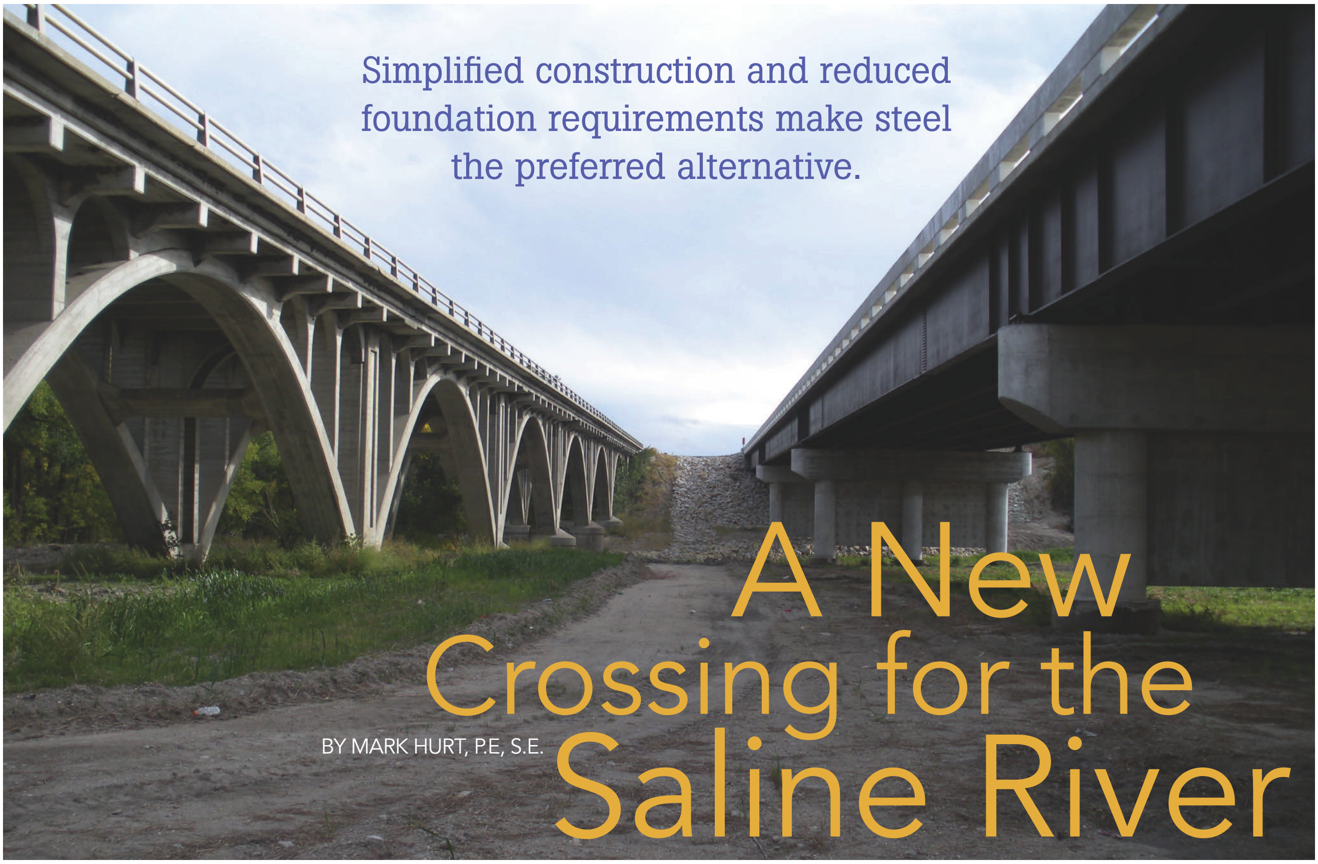
Erector
Schneider Up, Olympia, Wash. (IMPACT Member)

Because access for a large land-based crane was not available on the south shore of the Nooksack River crossing, the anchorage and backstay system had to support the weight of equipment as well as the truss weight.



Temporary construction pins were used in the last truss members installed to quickly provide joints with adequate strength and mobility. Once the truss halves were joined and geometry fixed, the last connections were bolted.

Nathan Brown, P.E., S.E., began his bridge design career in 1980 and since 1993 has been a steel specialist for the Washington Department of Transportation, Bridge and Structures Office, Tumwater, Wash.



Simplified construction and reduced foundation requirements make steel the preferred alternative.

A New Crossing for the Saline River

BY MARK HURT, P.E, S.E.

Foundations required for the new steel bridge (right) crossing the Saline River in Kansas were somewhat lighter than would have been required if concrete had been used, and far less than those required to support the old reinforced concrete bridge (left).

IN 1933 AN EIGHT-SPAN reinforced concrete spandrel arch was constructed to carry traffic on Kan.sas Highway 1 (now U.S. Highway 183) over the Saline River, north of Hays, Kan. In the intervening years, migration of the upstream section of the Saline changed the river's angle of attack on the piers of the existing bridge, resulting in scouring at its spread footings. Current road design standards require a wider roadway and although the spandrel arch possesses a stately profile, that type of structure is not easily or economically widened. A new bridge with modern, scour resistant, deep foundations was required.

The Kansas Department of Transportation decided this project would provide a good test of the viability of using post-tensioned, prestressed concrete girders compared to traditional steel plate girders. The requirement was for a bridge of moderate length (about 660 ft) and the site had room for construction staging. The location also was readily accessible to contractors in Nebraska and Colorado with post-tension construction experience.

Two designs were prepared for letting: a four-span (140-ft, 187-ft,187-ft, 140-ft) steel plate girder design by the in-house design staff of KDOT's Bridge Office and a four-span post-tensioned prestressed concrete girder design, with spans nearly identical to the steel design, by an experienced consultant. Though both designs carried the same 44-ft roadway, the superstructure and substructure of each design was unique.

The plate girders were designed to act compositely with the concrete and have a uniform web depth of 75 in. Grade 50 weathering steel was used with AASHTO M270 T3 certification called out for the flange material. This was one of the first structures erected using Kansas' Special Provision requiring that specific and detailed erection plans be provided to the engineer on site. This provision was formulated in consultation with the Kansas Contractors Association after multiple steel and prestressed concrete girder erection problems. At a minimum, the provision requires the approval of erection plans by the state and the use of a pre-qualified erection supervisor.

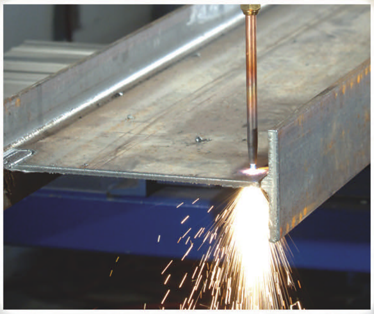
The design for the post-tensioned prestressed concrete girder option used 73-in.-deep modified Kansas K6+1 beams. The girder spacing was slightly wider than that used in the steel girder option (9 ft, 6 in. vs. 8 ft, 2 in.), resulting in one less girder line. The maximum piece length of the concrete girders was limited to 150 ft to facilitate shipping, requiring erection of the girders to be a multistage process using strong backs at the girder splice locations on both sides of the center pier and a falsework tower in span three. Post-tensioning was to have been in two phases, one before and one after placement of the concrete deck.

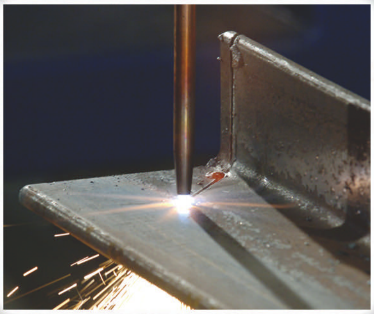
The greater weight of the concrete girders required more substantial foundation elements than the steel alternative. The design of the steel alternative required nine H-piles per abutment, as opposed to 11 of the same size pile for the concrete alternative. The steel bridge uses three 66-in. drilled shafts per pier as opposed to three 72-in. drilled shafts per pier for the concrete alternate.

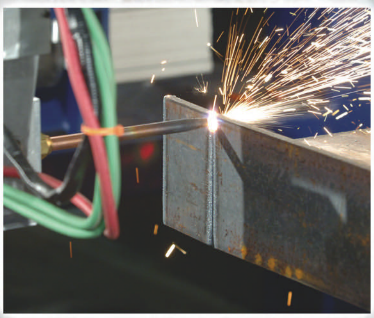
The engineer's cost estimates for the steel bridge and the post-tensioned prestressed concrete bridges were both around \$3 million, but a true comparison of the costs between the structure types is unavailable. When the project was bid in 2008, all four bidders bid only on the steel alternative.

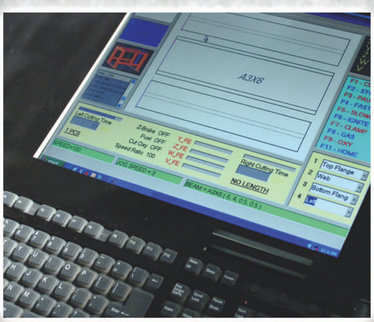
The new bridge was completed in the summer of 2009. The existing spandrel arch bridge, eligible for placement on the National Register of Historic Places, will be preserved on the old alignment adjacent the new bridge. MSC

Mark Hurt, P.E, S.E., is senior squad leader for bridge design with the Kansas Department of Transportation.









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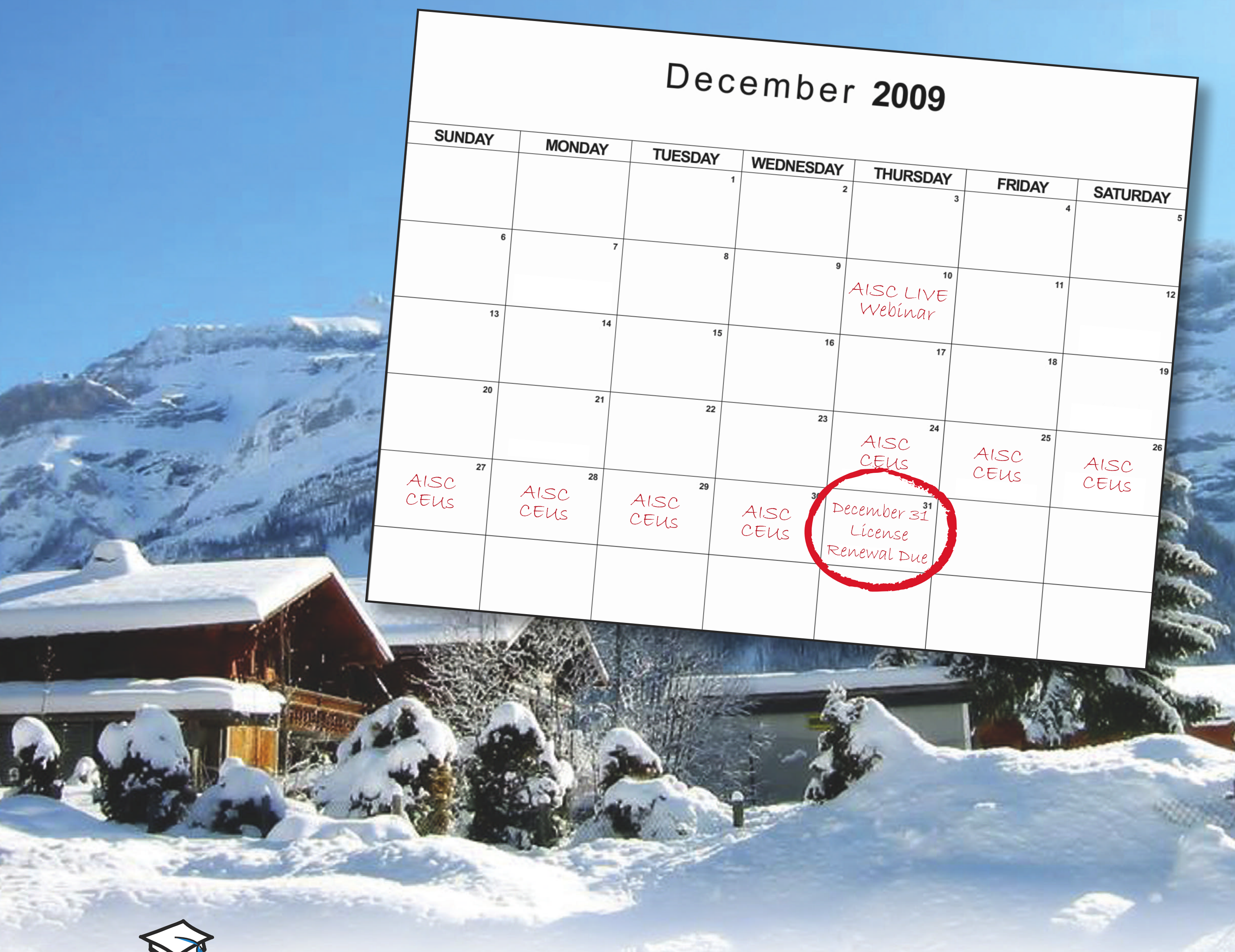

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Software and the Direct Analysis Method

BY AMANUEL GEBREMESKEL, P.E.

Understanding how your software is doing its work will help you do yours better.

MUCH HAS BEEN WRITTEN in AISC's *Modern Steel Construction* magazine, the AISC *Engineering Journal* and elsewhere on the design of steel structures for stability. AISC also offers continuing education seminars that address this topic. The Direct Analysis Method of Appendix 7 in the 2005 AISC *Specification* is often the focus of these articles and seminars. Additionally, the AISC Steel Solutions Center frequently receives questions relating to this method and the selection and use of appropriate commercial software to implement it.

This article adds discussion of the use of some common commercial software in stability design and touches upon the important items design engineers must be aware of when using structural analysis software to carry out stability analysis and design. A sample generic computer design process flowchart is also presented to serve as a reference for design engineers.

Numerical Methods in the Marketplace

***P*-Δ and *P*-δ:** Sections C2.1 and A7.3(1) of the AISC *Specification* state that any second-order elastic analysis method that captures the effects of P-Δ and P-δ may be used. Section C2.1b provides an approximate method that can be used based upon first-order analysis forces amplified by B_2 and B_1 to satisfy the requirement. Finite element analysis methods also can be used to capture second-order effects in structures. In fact, any method that works can be used. The Commentary to Section 7.3 of Appendix 7 provides benchmark problems that can be used to determine the adequacy of numerical methods.

Most programs use either an iterative approach or a geometric-stiffness-based method. In both approaches, it is common that small deformations are assumed.

Iterative methods perform repeated linear-elastic evaluations as the structure deforms laterally to capture the increased moments and forces imposed on the structure. The iterations continue until convergence is reached—until the deformations stop increasing. If convergence does not occur, the structure is said to be unstable and needs to be stiffened. RISA Technologies' RISA-3D makes use of such an approach. Nodal deformations are first used to generate forces, which are then iterated until convergence is reached.

The *geometric stiffness* methods change the stiffness of the structure by altering the stiffness matrix to simulate the effects of the destabilizing gravity loads. When using this approach, iteration may not be required and the resulting analysis can be less computationally demanding. It also allows use of superposition and determination of dynamic properties that account for second-order effects. Bentley's RAM Structural System makes use of such an approach, as an alternative to the B_1-B_2 approximation method that it also provides. CSI's SAP 2000 allows the engineer to modify the stiffness matrix to customize the method for unique applications.

CSC's Fastrak Building Designer uses a combined approach with a two-step iterative analysis of a geometric stiffness method, in order to gain from the benefits of both approaches.

While both approaches have their strengths, designers should also consider their weaknesses. Iterative methods do not account for the lengthening of vibration periods due to second-order effects, and typically require more computational power. On the other hand, geometric stiffness methods require that the matrix be modified for a constant destabilizing load, typically a load combination. This means assuming a reasonable load as the basis for the geometric stiffness adjustment is important. Whichever approach a program uses, the design engineer must ensure that strength level loads are evaluated by the software analysis, as required in Sections C2.2a(2) and A7.3(1) of the *Specification*.

P-δ effects are caused by deformations (curvature) of individual members, but they also can affect the overall force amplification when lateral loads are introduced. Therefore, Sections C2.1a and A7.3(1) of the AISC *Specification* require that they be considered. In many cases, P-δ are small and may be neglected.

Software developers have proposed various methods to incorporate P-δ effects, where required, in second-order analysis. Among other approaches, this can be done by adding nodes between support points of members. RAM uses a B_1 factor with a geometric stiffness method to accomplish this.

Amanuel Gebremeskel, P.E., is a senior engineer at AISC and part of the AISC Steel Solutions Center team.

Computer Design Process Using the 2005 AISC Specification

Using the Provisions of Appendix 7

MODELING

1. Input Standards and Specifications
2. Input Material Properties
- **a.** Static analysis for forces and deformations used in:
  - **i.** Strength Check [see **ANALYSIS** for stiffness required]
  - **ii.** Serviceability Check [see **ANALYSIS** for stiffness required]
- **b.** Dynamic analysis [see **ANALYSIS** for stiffness required]
- **c.** Performance check [see **STRENGTH & SERVICEABILITY** for stiffness required]

3. Input Geometry [see **LOADING** and **Appendix 7 Notes**]
- **a.** Ideal
- **b.** Imperfections

4. Input Trial Shapes and Sizes

RESIZE

LOADING

1. Input Load Cases
- **a.** Gravity
- **b.** Notional Loads
- **c.** Wind
- **d.** Seismic

	Static	Dynamic
Linear	ELF	RSA
~~Non-Linear~~	~~Pushover~~	~~Time History~~

- **e.** Other

2. Define Load Combinations
- **a.** With strength level Notional Loads [see Ideal **MODELING**]
- **b.** Without Notional Loads [see **MODELING** with Imperfections]

ANALYSIS

	Static	Dynamic
Strength	Load Combinations	Load Case
	Reduced Stiffness	Nominal Stiffness
Serviceability	Drifts & Deflections	Vibration
	Nominal Stiffness	Nominal Stiffness
Comments	Second-Order Effects	Period
	Determination	Determination

Stable?

no

yes

STRENGTH & SERVICEABILITY CHECK

1. Standard Specification [see **MODELING** for input]
2. Project Strength requirements [use Nominal Stiffness]
3. Project Serviceability requirements [use Nominal Stiffness]
4. Architectural and other requirements [see **MODELING** for input]
5. Shape selection and iteration [see **MODELING** for input]

N.G.

OK!

VERIFICATION & OUTPUT

Appendix 7 Notes

1. Second-Order Effects **a.** P-δ **b.** P-Δ	**ANALYSIS**
2. Distabilizing Perterbations **a.** Notional Loads **b.** Imperfections	**MODELING & LOADING**
3. Reduced Stiffness	**ANALYSIS**

Deformations: Section C1.1 requires that all relevant deformations be considered. Most commonly used programs, at a minimum, account for flexural deformations because they contribute significantly to overall drift in moment frames. However, it is important that the contribution of other deformations be considered when they are significant, including axial and shear deformations. While most programs account for these deformations, other effects like panel zone deformations are typically not accounted for. Some software developers recommend modeling beams from column centerline-to-centerline—rather than face-to-face—as one way to account for panel zone deformations.

Appendix 7 Requirements

The Direct Analysis Method is a powerful approach that can be used to capture the effects of residual stresses and initial imperfections. The direct modeling approach for initial imperfections also can be used to account for temperature gradients and foundation settlements. In cases of second-order effects such that $\Delta_{2nd\ order} / \Delta_{1st\ order} > 1.5$, the Direct Analysis Method must be used.

Two deceptively simple tools in this method—notional lateral loads and stiffness reductions—account for a host of destabilizing influences on the structure.

Notional Lateral Loads: Section A7.3(2) states that notional lateral loads must be applied to all gravity only load combinations. Where $\Delta_{2nd\ order} / \Delta_{1st\ order} > 1.5$, the notional load must be applied in all load combinations, even those with other lateral loads. These notional loads account for the effects of structure out-of-plumbness and are derived from the tolerances provided in the AISC *Code of Standard Practice*. However, the *Specification* also permits the use of notional loads that are smaller if a lesser out of plumbness is known to exist or can be ensured. Direct modeling of the actual geometric imperfections is also permitted.

Programs such as RISA-3D allow the user to input notional loads, while those like RAM and Fastrak automatically compute and add them to other lateral loads based on the gravity loads in the members. Automatic modeling of geometric imperfections is not provided by most structural analysis software developers at this time.

Stiffness Reductions: According to Sections A7.3(3) and A7.3(4), when calculating second-order effects a 20% reduction in axial and flexural stiffness must be made to all members that contribute to stabilizing the structure. A larger reduction applies to columns with high axial load, where τ_b is an

HOW TO USE THE COMPUTER DESIGN PROCESS CHART

The various phases involved in computer-based stability design are presented in this chart. The chart illustrates how all Appendix 7 requirements can be satisfied by using these phases, and how the phases affect each other. For instance, the modeling of a structure in step 3 of the **MODELING** phase can affect how the load combinations are defined in step 2 of the **LOADING** phase.

The process begins by listing the input parameters in the **MODELING** phase. The material properties to be input in this phase depend on the requirements of the **ANALYSIS** and **STRENGTH & SERVICEABILITY CHECK** phases. It then gives the more commonly used environmental loads in the **LOADING** phase. The choice of design process can influence this phase. Pushover and time-history analysis are not considered because non-linear seismic design methods are not addressed here.

In the **ANALYSIS** phase, computation of internal forces and deformations is carried out. A summary of the required stiffness for various analysis methods (static vs. dynamic) and purposes (strength vs. serviceability evaluation) is tabulated. This table shows that only second-order analysis to determine the forces in strength checks need use reduced stiffness values. Typically, even dynamic analysis for purposes of determining periods for use in strength checks should use nominal stiffness values. All other analysis to determine serviceability deformations and vibration periods should also use nominal stiffness values.

Finally the more common inputs required to asses the structural adequacy of the model are listed in the **STRENGTH & SERVICEABILITY CHECK** phase. In that phase it is shown that computations for purposes of both strength and serviceability checks utilize nominal stiffness values.

additional multiplier; alternatively, an additional notional load of $0.001Y_i$ can be added in the analysis to maintain $\tau_b = 1$. These stiffness reductions must not be confused with the reductions that are made to the stiffness matrix by second-order analysis tools that use the geometric stiffness methods. One is mandated by the AISC *Specification* whereas the other is at the behest of the software developer; and the purposes of the two are different albeit related.

Inputting stiffness reduction is not difficult because it can simply be applied to the modulus of elasticity (E). However, the reductions in Section A7.3 are only required for purposes of generating design forces and drifts—amplified by second-order effects and notional loads—and not for strength checks, or evaluation of the system for serviceability.

This may require that programs differentiate between members that are part of the lateral system and those that are not. The program may then use two different sets of stiffness for those that are part of the lateral system; one for analysis and another for strength checks. RISA-3D, for instance, automates this entire process, including the calculation of τ_b for each member, while Fastrak automatically makes the 20% reduction but uses a τ_b value of 1.0 to avoid iteration by adding to the notional loads as permitted in section A7.3(3).

Conclusion

This article does not provide an exhaustive list of the items that design engineers must be aware of when selecting or using structural analysis software for stability design, but it does attempt to motivate communication between design engineers and their software providers. This is the only way the full capability and limitations of the programs can be known. Allen Adams of Bentley, Josh Plummer of RISA Technologies and Jason Ericksen of CSC provided invaluable input and guidance for this article.

An article on stability design of steel structures would be incomplete without recognizing the contribution to this topic by R. Shankar Nair of Teng and Associates, Inc. His two papers, "Simple and Direct" (*Modern Steel Construction*, January 2009) and "A Model Specification for Stability Design by Direct Analysis" (*Engineering Journal*, 1st Quarter 2009) are highly relevant to the topic of this article. Moreover, the AISC seminar "Design Steel Your Way II" by Louis F. Geschwindner expands on many of the topics raised herein. MSC

AISC Certified Quality: In Their Own Words

BY KIMBERLY A. SWISS

Certified fabricators share their thoughts on how the program is benefiting their firms.

FOR THOSE WHO HAVE BEEN PARTICIPATING in or following the AISC Certification program for steel fabricators and erectors, there is no denying that the program is experiencing some very serious growth. In today's economic climate, this expansion is even more remarkable. With AISC Certification appearing in specifications now more than ever, it shows that more project decision makers also realize the importance of certified quality systems. This recognition is one huge factor in what is driving the increase of participants in AISC Certification.

Who can comment any better on the value of AISC Certification than participants who have experienced the benefits firsthand? Consider these comments from Brad Mannstedt, president of steel fabricator Ted Mannstedt & Sons, Inc., La Crosse, Wis. "With the current economy and the lack of projects bidding on the 'open building exchange markets,' there seems to be an increase in fabricators becoming AISC certified, and even more fabricators desiring certification."

> "We knew we wanted to become a better company and we felt that the process of becoming certified would take us in that direction quickly."
>
> —Mark Trimble, P.E., Huntington Steel

The concern, of course, is that the "value add" of AISC Certification may be diluted if the primary focus of obtaining certification is to acquire work. "If the only reason behind the energies and steps necessary to successfully complete an AISC audit are inspired to enable a fabricator to bid AISC certified work, then they may just be missing some of the best values they can offer their companies," Mannstedt says. "Fully implementing the *Standard for Steel Building Structures* into our fabrication process has increased fabrication accuracy and control, improved our maintenance program for major pieces of equipment, provided consistent material traceability and more. This is achieved by streamlining our operations to become more efficient and profitable, and has also greatly reduced our fieldwork back-charges. We have less downtime on the shop floor because of equipment failures and fewer scheduling conflicts than ever before."

In contrast, what is the experience like for fabricators and erectors who are beginning the AISC Certification process? When confirming that systems are in place, procedures are written, personnel is involved, projects are moving, and processes are flowing, it is then that the "value add" of having a solid quality management system in place really shows its worth and significance.

That was true for Jennifer Hennessy, AISC coordinator/project manager at Standard Supplies, Inc., Gaithersburg, Md. "Very early, we found how helpful it was for our company to put together a quality management system for AISC certification," Hennessy says. "The program really helped our company put a genuine focus on quality for both our products and services. We always thought we did a good job, but when we implemented our [certified] program, we had the ability to find areas where we could improve either our quality or our processes to become a better company. It helped guide us to be a more efficient and productive steel shop; and that makes everyone happy.

"By becoming AISC Certified, our company has learned much more about our industry and how to operate using the best methods and practices," Hennessy continues. "The certification program required us to take a hard look at our documenting processes, or more importantly, the lack thereof. Once we implemented our documenting into all the functions of our business, we saw immediate results. We finally had a record of non-conformances which instantly helped us fix problems and devise strategies to curb them. We finally developed and implemented a material tracking system to accurately track exactly where material is at all times. It was incredible how much we learned when we just wrote things down. Who knew!"

Mark Trimble, P.E., works at Huntington Steel, Huntington, W.Va., a well-established fabricator, and relatively new to AISC certification. "We have completed our first

Kimberly A. Swiss is manager of certification administration with Quality Management Company, LLC, Chicago.

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**.

year as an AISC certified fabricator," Trimble says. "Though we had talked about it for years, we really got serious about becoming certified in January 2008. What a difference two years can make! Being in business for 105 years, our company has some built-in credibility, but experiencing the certification journey has really boosted our expectations for quality and customer service."

Becoming certified has provided Huntington Steel with numerous benefits:

- The company has a marketing advantage over non-certified fabricators.
- The company bids "AISC Certified" projects without needing to request a waiver of the certification requirement.
- Because its procedures were developed using input from team members who would actually be using the procedures, the company staff enjoy a deeper understanding of its Quality Program and reportedly show more "buy-in."
- Regular evaluation of its Quality Program has resulted in a consistent search for ways to improve.

> "As you analyze your own processes, you can trim away the wasteful steps you do not need and become more efficient. Suddenly, your QA system is saving you money."
>
> —Seth Bransky, Munster Steel

"Being certified is just a certificate that hangs on the wall," Trimble says. "The process of becoming certified is where the real value is found. Back when we were still trying to decide if certification was for us, we knew that there were marketing reasons to be AISC certified, but that alone wasn't enough. We knew we wanted to become a better company and we felt that the process of becoming certified would take us in that direction quickly."

Appreciating the value of an effective quality management system (QMS) is not limited to AISC Certification newcomers. Steel fabricators and erectors who have been certified for some time are constantly and consistently trying to advance their current processes, streamlining their quality systems, and recognizing different ways to benefit their organizations. For these companies, benefit ties into the concept of continual improvement and seeing if their organization can do that much better.

"Jeffords Steel and Engineering Company has been certified for 10 years," says Larry Jeffords, president of the Plattsburgh, N.Y.-based firm. "The biggest 'eye opener' for me was how many procedures in our production process that we took for granted could actually have been compromised by suppliers or the workforce. We never had a 'quarantined' material pile until we were certified, and for the first few months of certification, I swear the quarantine pile was bigger than most job piles. Little things, like drawing logs and written welding procedures, seemed like wasted time, but after instituting the new operating procedure, I don't know how we ever existed before certification. It is very comfortable for me to say that we are a much better fabricator after certification than we were before. And now I can prove it!"

Keith Corneau, vice president of sales for United Steel, Inc., East Hartford, Conn., offers an interesting perspective as a participant in the two types of AISC certification. "As both an AISC Certified Fabricator and an Advanced Certified Erector, we find that having both provides an overlap that benefits United Steel in its entirety, creating a consistency throughout," Corneau says. "AISC certification provides a structure that allows for continuous improvement at United Steel. The yearly audits reinforce the importance of safety and quality control, which helps us in providing the best possible service to our customers."

Seth Bransky is the senior estimator, project manager and QA manager at Munster Steel, a company going into its 17th year of AISC certification. "I think the biggest payoff from our quality system has been the honest look at how our company processes operate," Bransky says. "A good QA system exposes the gaps, the extra steps, the inefficiencies that you probably did not realize were occurring in your everyday processes and communication. As you analyze your own processes, you can trim away the wasteful steps you do not need and become more efficient. Suddenly, your QA system is saving you money."

The same analysis process can also show where you may be leaving your company exposed to risk and liability, Bransky notes.

"Good documentation and communication are vital for protecting your work, as well as for your customer. When you can demonstrate to your customer that you have a QA system in place that offers good documentation practices, you reduce their risk as well. This is a strong endorsement for keeping that repeat customer.

"I don't know who to credit for this quote—I saw it on the Internet—'Quality does not occur by chance... Quality is the result of intelligent activities.' I believe this is true, and a good QA system can set in place the framework for 'intelligent activities' that ultimately benefit your company."

Continual improvement is a concept that AISC embraces as well. The AISC *Standard for Steel Building Structures*, for example, written in 2005 experienced clarifications and updates in 2006. Moving from a checklist to a standard-based criterion is helping many participants incorporate quality throughout their organizations, because it is an effective resource for supporting customer-focused, management-driven, process-based quality management systems.

"I am very excited about the progress made by the AISC certification program," says David Harwell, president of Central Texas Ironworks, Inc., Waco, Texas. He notes that until the introduction of the *Standard for Steel Building Structures*, there was no requirement for any fabricator to possess an operating procedures manual, which made it very difficult to make uniform and meaningful audits.

"One of the primary objectives of any certification program is to announce to the marketplace those companies that have achieved the level of quality expected," Harwell says. "The development and implementation of the building standard was no easy task but it has formed a basis for many fabricators to better understand how their business functions. By identifying the fundamental operating elements of a quality organization and defining their role in the process, fabricators are much more aware of how each element can affect their ability to produce a quality product.

"It is the responsibility of the certified company to place responsible and qualified individuals in their respective roles. By doing so and following an acceptable quality procedures manual the end product will meet the expectations of the customer. Focusing on the importance of providing a quality product to our marketplace is one more reason steel remains the framing material of choice by owners, developers, and construction professionals. At CTIW we continue to embrace the program and have found it very useful in the daily operation of our business."

The sense of pride that AISC certification participants have is also a tribute to the merits of their efforts. Bruce Basden, CEO of Basden Steel & Erection, Inc., Burleson, Texas, comments, "AISC certification in both fabrication and erection affords our company something that we have never been able to sport in the past, bona fide credentials. With the certification, I now have instant recognition as a legitimate member of a qualified team. Just as an architect is AIA, or an engineer is P.E., this certification affords the holder a more professional stature."

These testimonials should be music to the ears of all the new participants of the AISC certification family, and those considering joining. Even if the initial reason for becoming AISC certified is to get more work, benefits will come through the process of becoming certified. For some, it takes longer for the advantages to reveal themselves, however, if you look hard enough, you can see it on the wall even before the certificate is printed. **MSC**

Demystifying Social Media, Part Two

The plan is simple: Give value, get visibility.

BY ANNE SCARLETT

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PART ONE OF THIS ARTICLE (see September 2009 *MSC*) addressed the question of what social media is, and what makes sense for the AEC professional. Part two covers making wise decisions on how and where to become active within the social media community.

Because you are an AEC technical professional, social media is clearly not your full-time focus. It would be easy to become overwhelmed, resentful, and stubborn about the whole thing. No doubt you are skeptical about its value. Take time to review the numbers. Articles run rampant across the Internet regarding how businesses can use social media to their advantage. It's not just in business-to-consumer scenarios, but also for business-to-business (B2B) relationships—which is what the AEC industry is typically all about. Every day more opportunities emerge in social media for B2B relationships that yield real value. If you have not already done so, it's time to open your mind to the possibilities.

Establishing your social media program requires patience, focus, and organization. Start by dedicating an entire day—preferably an entire weekend—to focus on the set up. Do not do this in dribs and drabs; you will only lose your place and become frustrated. Setup involves registering on multiple accounts, making sure you "claim" your own name wherever possible on the Internet. The initial "getting started" steps were explained in September in part one. *In addition* to those basic steps, here's a list of *musts* if you want to take this seriously.

First, attend to the three tools that some people refer to as the trifecta of social media.

- **LinkedIn:** Complete your profile. Give valuable details on your education and career path. Take time to write an eloquent, easy-to-understand narrative description. Add a personal interest or two. Let the application go through your email address books, but then hand-select individuals with whom you want to link. Join relevant groups in your industry and in your clients' fields. Finally, make sure to add your picture, and include a status update (which you should keep updating, because your "connections" will receive weekly LinkedIn reports that will include your new status).
- **Twitter:** Start by signing up, completing your description/profile, customizing your background, and uploading your picture. Then, hook into people you already know, and look for people you admire and want to follow. You may not have much to say at first. In that case, watch carefully to see how the system works. *Selling* is not well-received in this medium. Twitter is about providing valuable data; helping others; collaborating; offering kudos. Intertwined within, you are occasionally welcome to toot your horn or link to content about you/your firm—an article, blog entry, upcoming speaking engagement, new service offering. You also should set up your profile on Twellow (twellow.com), which bills itself as "The Twitter Yellow Pages." Make sure to place yourself/your firm in all appropriate search categories. And familiarize yourself with Twitter-related tools that will make it easier for you to manage. One example: socialoomph.com (formerly tweetlater.com), where you can schedule future tweets of quality content that you'd like to share.
- **Facebook:** Create a fan page for your company. Make sure that someone is monitoring the content of that page. Re-purpose content from your firm's blogs and articles. Further, use RSS feeds (mentioned in part one) as a means for collecting great data that can also be shared on your firm's Facebook page. If you use Facebook for your personal life as well, then be cautious about your privacy settings. Business and personal lines can get dangerously blurred unless you are smart about it. Also, try to reserve your own name (if still available) as your Facebook direct link.

Next, realize that variety is an important social media strategy. Consider adding:

- **YouTube:** Many marketers recommend video as an essential part of a savvy firm's marketing program. Videos are informative, endearing, and can most certainly create a connection that starts to feel more real, and more human.
- **PRWeb (or similar):** Press releases are designed and optimized, by you, in a step-by-step process. As long as you have quality content and keywords, this program will help ensure that your firm shows up in the Readers (i.e. Google; Yahoo) reviewed by editors, bloggers, and prospects alike. In the past, your press releases would only be received and read by editors. Each editor would either opt to use your content and quotes or not. Now, with today's various key word alert functions, your releases will reach a much wider audience, even if the editor chooses not to publish your material.
- **Google Voice:** Google Voice gives you a single phone number that rings all your phones, saves your voicemail online, and transcribes your voicemail to text.
- **Steeltools.org:** For structural engineers specifically, become active on steeltools.org, your industry-specific Facebook-esque application that serves as a forum to discuss steel activities and products. And don't forget the opportunities for file sharing among your peers. I'm guessing this model soon will be mimicked by other disciplines within the AEC industry.

How deep should I/we go?

I read an exceptional article entitled "*SWOT Analysis for Social Media*" by Pete Hollier, a consultant to SEO Wizardry. Conducting this analysis is a perfect way to determine the depth to which your firm, or you as an individual, should get involved in social media as a means for new business and higher visibility. For example, your current target client audience may not yet be highly involved (the public sector would be a good example of people that are not truly engaged in this medium as of yet) but believe me, someday they will be. You and your firm might as well get ahead in the game, masterfully dancing through the system so that by the time your clients really are "listening," you're already a true social media and Web 2.0 player. Voila! Instant credibility.

What return will I/we get?

Data is constantly coming in now regarding the actual returns on investments that people are receiving from their active involvement in social media and Web 2.0. The biggest plus seems to be the access to people and the true relationship building and rapport that can occur between people who otherwise would not naturally cross paths. This is always taken into the real world at some point, where you meet these people in person, yet feel like you already know them quite well. Other returns: referral sources; increasing your firm's visibility; respect for your brand; leads and business opportunities.

Sharing and Monitoring

By reading and researching, you can find many tips regarding getting involved as a newbie in social media—from proper online etiquette (yes, this is taken seriously) to ways to grow your followers on sites such as Twitter. One thing is certain: gone are the days of "black box" and "proprietary" information. You must be willing to share good, valuable, worthwhile content. You must have something to say that others want to read. You cannot be concerned about whether or not your competitor learns something about the way you handled a particular design challenge. Keep in mind, you can also keep tabs on what they are saying. The best way, in my opinion, to keep your eye on your clients, competitors, and what people are saying about your own firm is to set up a reader (I prefer Google reader for it's simplicity and organizational functions) where you can get *alerts* and *RSS feeds* from blogs. Once you've set this up, it becomes your perfect one-stop shop to ensure that all things relating to your hottest topics are constantly fed into one place (and yet, it won't clutter your inbox).

Continuing Education

The resources for self-education on Web 2.0 (which includes social media) are abundant. I do suggest two "musts" to help you self-train and stay informed: **Mashable** (follow on Twitter, and sign up for the RSS feed), and the dozens of **"Plain English" videos** on social media topics, produced by Commoncraft.

Social media really is like anything else; what you put into it is what you'll get out of it. That said, you must stay in control—put your time toward the content and relationship building, rather than worrying about mastering every detail or new gadget. Commit to a small selection of organizational tools (several were mentioned in this article) from the beginning. Strategize with your firm about messages and content. And remember, because so many AEC firms are not yet deeply engaged, you and/or your firm will still be considered on the forefront if you elevate your online presence, *right now*. MSC

new products

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.

Bring the Drill to the Beam

The Atra Ace Automatic Drill from Nitto Kohki is a high-productivity solution for medium-volume and irregular-shaped beam drilling. Because operators can bring the drill to the beam, rather than moving the beam to the drilling line for processing, it enables fabricators to efficiently drill holes in applications unsuitable for a CNC beam drill line. An efficient and cost-saving improvement over manual drilling machines, one operator can use two or more of these automatic drills simultaneously, positioning one while another is in the process of drilling. Available in five models, these drills are equipped with variable automatic feed with a dual sensing controller and produce holes up to $2\frac{9}{16}$ in. diameter and cutting depths to 3 in.

For more information visit www.nittokohki.com/tools or call 800.323.8828.

No-solvent Parts Cleaner

The Bio-Circle parts cleaning system from Walter Surface Technologies is a safe, efficient and sustainable "green" cleaning technology. It eliminates hazardous chemical waste by combining a powerful blend of surfactants with specialized microorganisms cultured for bioremediation. It uses a patented cleaning solution called Bio-Circle L, which is not only a powerful cleaning agent capable of removing the toughest grease, but also is completely safe for workers and the environment. The system cleans aggressively and breaks down oil, grease, and other hydrocarbon contaminants into H_20 and $C0_2$. Available in three sizes, the cleaning system saves time and money and allows industrial manufacturers to practice environmental stewardship and gain a new competitive advantage.

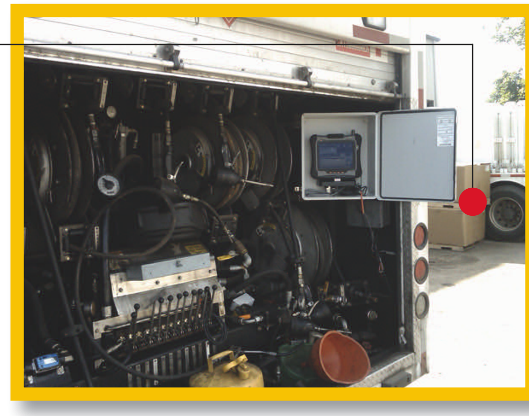
For more information visit www.biocircle.com or call 800.522.0321.

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

Asset Management Tracking Tool

Dexter + Chaney's Spectrum Equipment Service System electronically collects asset-management data for a company's heavy equipment, including equipment hours, fuel usage and maintenance, for improved equipment costing and management. Recording accurate equipment hours eliminates the time and hassle of manual data collection and results in accurate and reliable asset-management information. The system alerts fuel truck drivers when preventive-maintenance tasks are due and records the maintenance activities when performed. The system includes three main components. The Equipment Monitor, a small device attached to each piece of machinery, records operating hours and idle hours and relays that data each time the equipment is fueled or serviced. The Field Master—mounted in a fuel truck or service vehicle—collects data from individual equipment monitors via wireless RF signal, displaying and logging information on a touch-screen. The Fuel Controller captures gallons of fuel dispensed to each piece of equipment, enabling the company to track use and reduce fuel theft.

For more information visit www.dexterchaney.com/spectrum/ess/or call 800.875.1400.



Rollerbeds for Workpiece Handling

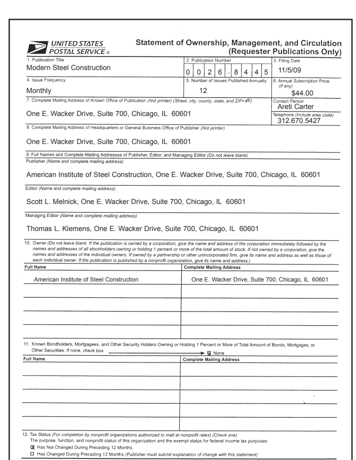
ESAB Welding & Cutting Products has added new conventional and self-aligning rollerbeds to its line of automated handling equipment products. The new rollerbeds are available in North America and replace the company's previous turning roll products. They are grit-blasted with a polyurethane finish coating to endure abrasive environments and feature solid-state inverter technology for precise speed control to ensure welding accuracy. The rollerbeds are available in a variety of sizes and driver/idler rail bogie versions. Depending on the project, fabricators can choose from conventional rollerbeds with load capacities from 2.5 to 60 tons or self-aligning rollerbeds with load capacities from 2.5 to 50 tons. ESAB Canada will stock the new rollerbeds at its Mississauga, Ontario, and Edmonton, Alberta, warehouse facilities for distribution throughout North America.

For more information visit www.esab.ca or call 877.935.3226.

Welding Fume Extractor

Designed specifically for welding, the FILTAIR 130 from Miller Electric Manufacturing Co. provides a high level of fume filtration in a light and portable package for intermittent welding applications. Single filter is manually cleanable, using compressed air, and captures particles down to 0.1 micron in size. Many competitive products capture only 0.4-micron particles, even though 90% of welding fume particulates are between 0.1 and 0.4 microns. The unit's variable speed 1hp motor filters up to 132 CFM at just 68.5 decibels, making it one of the quietest units available. An 8-ft collection hose is standard; 17- and 34-ft hoses are available options. All connect to funnel or slotted nozzles or a fume extraction welding gun.

For more information visit www.millerwelds.com or call 800.426.4553.



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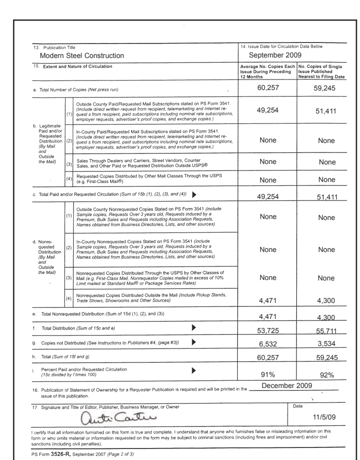

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Be Solutionary, Not Revolutionary

BY SCOTT BELSKY

New ideas only become really useful when someone works out the details.

IT IS INVIGORATING to accomplish a huge project. When we sit down with a blank canvas or clean sheet of paper, we have the tendency to think big. We tend to ask ourselves, "What can I think of that is new, surprising, and transformational?"

However, some of the greatest advancements across industries were not singular achievements but rather incremental improvements. Even bold ideas such as online music stores, departures in architecture, and new genres of music were the result of new ideas refined over time. The iPod was not the first MP3 player. Google was not the first search engine. And the list goes on…

While logic should encourage us to improve what is around us, we still tend to think of innovation as creating something new. Creative minds have the tendency to lose interest after the first generation of a new idea. Marginal improvements are, frankly, less interesting for the cutting-edge creative mind. Nonetheless, incremental improvements often make up the difference between success and failure.

Consider, for example, the whole idea of building steel bridges. Someone had to be the first to do it. Bridge designer and builder James B. Eads ushered in the serious use of steel in bridges with the Mississippi river crossing in St. Louis that bears his name. When it opened in 1874, the Eads Bridge was the longest arch bridge in the world, made possible because he had chosen steel. But things haven't just stood still since then.

Today designers and builders continue to push the envelope, using steel in creative ways to build truly remarkable, sophisticated structures. The Blennerhassett Island Bridge, which crosses the Ohio River near Parkersburg, W.Va., is one such high-tech project. Completed in 2008, it was built on the steel bridge legacy started by Eads, but also incorporated new technology in its design and construction.

For example, it uses a networked tied-arch center span. Engineers surveyed the bridge as it was being built, plugged the data into a 3D finite element model of the bridge, checked actual stresses in the members, and refined the construction process based on that. It may not be as radical as using steel for the first time, but we sure have come a long way since then.

Especially productive creative teams are able to find excitement in solving problems both big and small, and in varying stages. It's these accrued solutions that make up the distance between a new idea being created, and actually being adopted.

Leaders who focus on incremental progress—being "solutionary" rather than revolutionary—are the ones that truly push ideas to full fruition. Such behavior takes a tremendous amount of discipline. But with conviction and clearly defined goals, creative energy can be channeled to refine a good idea enough to make a great impact. MSC

Wikipedia/Public Domain

Construction of the Eads Bridge crossing the Mississippi River at St. Louis, Mo., around 1874.

Michael Baker Jr. Inc.

Constructing the networked, tied-arch span of the Blennerhasset Island Bridge over the Ohio River in 2007.

Parris Whittingham

*This article is based on research by Scott Belsky and the Behance team. Belsky is the founder of Behance, a company that develops products and services that boost productivity in the creative professional community. Behance runs the Behance Creative Network (**behance.net**), the 99% productivity thinktank (**the99percent.com**), the Action Method project management application (**actionmethod.com**), and the Creative Jobs List.*

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