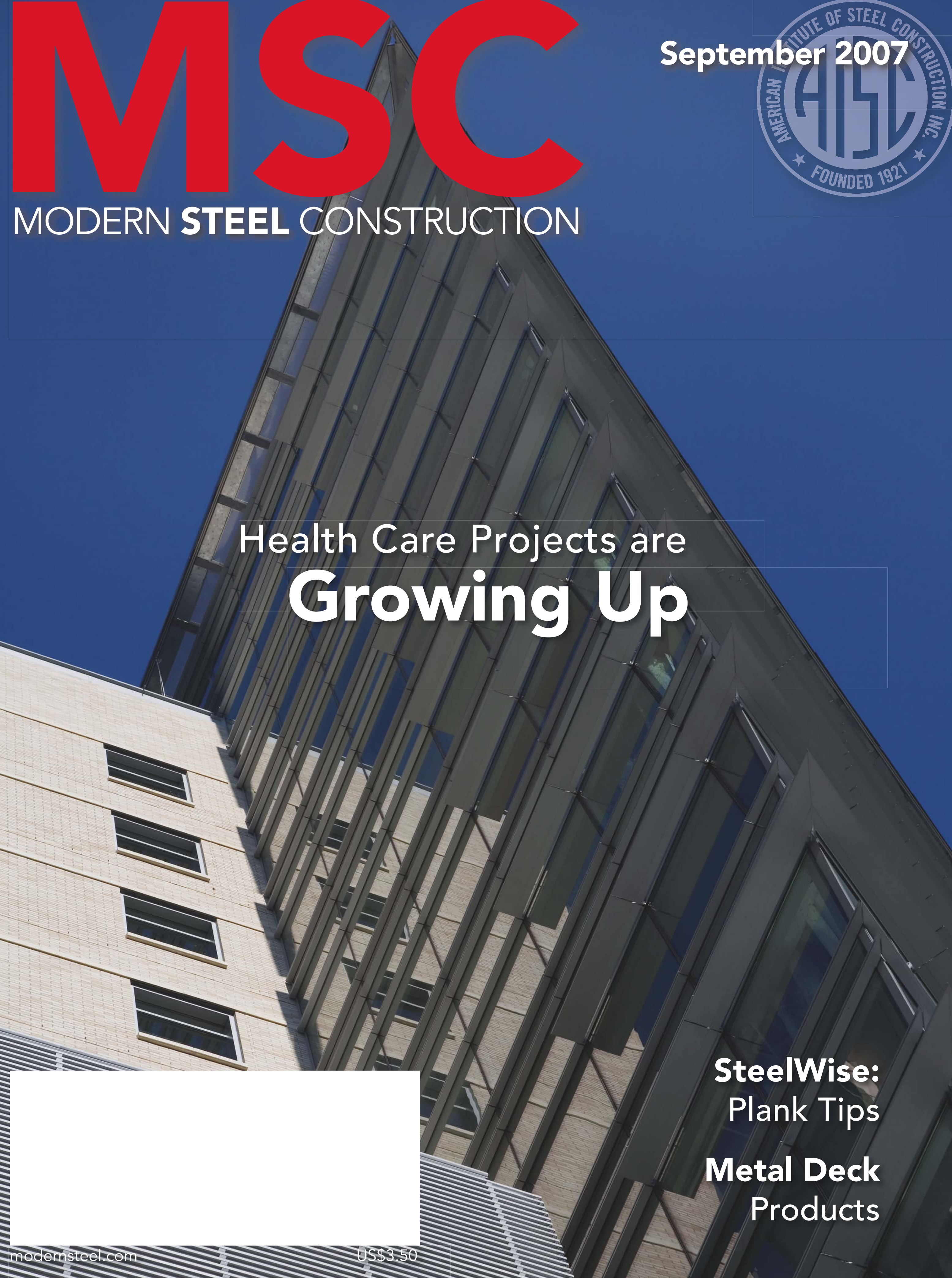
# MSC

MODERN **STEEL** CONSTRUCTION

September 2007



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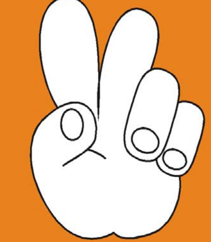


**PART TWO**

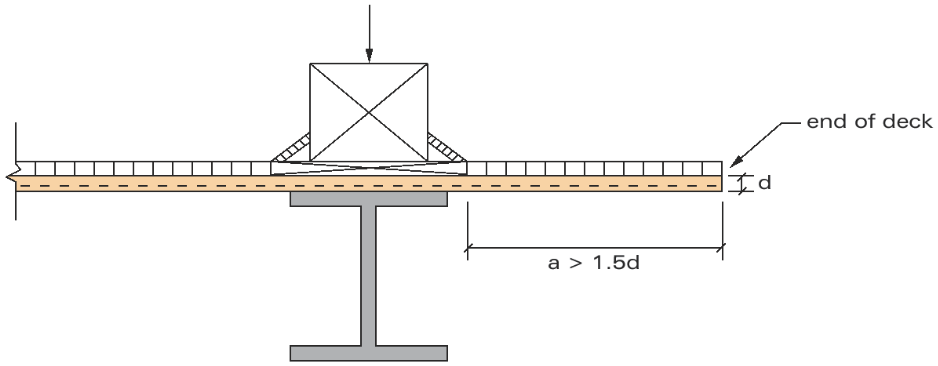
## DECK DESIGN DATA SHEET 37

## QUESTION

What is the crushing capacity of roof deck that is sandwiched between a load and a support?

## ANSWER

This is defined as the "Two Flange Interior Loading Web Crippling Capacity" when the load is not near the end of a deck sheet.




**Allowable Two Flange Interior Loading for Fastened Deck -- PLF**

| Deck Type | B | | | | F | | | N | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Min. "a" | 2.25" | | | | 2.25" | | | 4.5" | | | |
| Bearing Width | 22 | 20 | 18 | 16 | 22 | 20 | 18 | 22 | 20 | 18 | 16 |
| 3 | 1215 | 1765 | 3015 | 4680 | 1200 | 1745 | 2980 | 875 | 1280 | 2205 | 3445 |
| 3.5 | 1280 | 1860 | 3170 | 4905 | 1265 | 1835 | 3130 | 920 | 1345 | 2320 | 3610 |
| 4 | 1295 | 1880 | 3195 | 4930 | 1290 | 1870 | 3175 | 965 | 1410 | 2420 | 3765 |
| 4.5 | 1295 | 1880 | 3195 | 4930 | 1290 | 1870 | 3175 | 1005 | 1470 | 2515 | 3910 |
| 5 | 1295 | 1880 | 3195 | 4930 | 1290 | 1870 | 3175 | 1045 | 1525 | 2610 | 4045 |
| 5.5 | 1295 | 1880 | 3195 | 4930 | 1290 | 1870 | 3175 | 1085 | 1575 | 2695 | 4175 |
| 6 | 1295 | 1880 | 3195 | 4930 | 1290 | 1870 | 3175 | 1120 | 1630 | 2780 | 4300 |
| 6.5 | 1295 | 1880 | 3195 | 4930 | 1290 | 1870 | 3175 | 1135 | 1675 | 2860 | 4420 |
| 7 | 1295 | 1880 | 3195 | 4930 | 1290 | 1870 | 3175 | 1135 | 1725 | 2935 | 4530 |

1. Choose the lesser bearing width of the load or support to determine the capacity.
2. "Two Flange Interior Loading" applies when the end of the deck extends more than 1.5 times the deck depth beyond the edge of the beam or load point. An Interior Reaction is such a case.
3. The above table is based on Supplement 2004 to the North American Specification for the Design of Cold-Formed Steel Structural Members, 2001 Edition.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**September 2007**

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**ON THE COVER:** The Peter O. Kohler Pavilion, Oregon Health and Science University, Portland, Ore.

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# editor's note

***To hold the same views at forty as we held at twenty is to have been stupefied for a score of years, and take rank, not as a prophet, but as an unteachable brat, well birched and none the wiser.***

—Robert Louis Stevenson

The first disaster I wrote about for *Modern Steel Construction* was the Loma Prieta earthquake of 1989. Looking back on my coverage of that event (and the subsequent Northridge earthquake of 1994), I'm amazed at my impetuosity and how ready I was to jump to conclusions (and to put them down in print!). I still have the urge to jump to conclusions, but I hope I've learned to temper my feelings with patience. Given my impulsive nature, I'm especially impressed with many of the measured responses I've read in response to this latest disaster—the collapse of the Interstate 35W Bridge in Minneapolis.

While the usual suspects jumped in with sweeping generalizations (one well-known professor equated a truss bridge to a house of cards) and invariably wrong initial theories (I wish some media guru would compile some of these early comments and compare them with the studies that are always released about a year after events like this and then decide whether they still want comments from some of these self-serving experts), most of the engineering community showed remarkable wisdom in distilling a complex issue into understandable sound bites for the general public.

In the days immediately following the collapse, leading experts discussed how bridge design had changed in the 1960s and how engineers had developed more advanced analytical methods, thought they knew much more than their predecessors, and therefore designed for more precise loads and reduced redundancy. And many engineers further explained that today we use higher strength materials with better corrosion protection and increased redundancy. Here are some of my favorite quotes that actually help people understand what happened rather than simply satisfy the ego of the speaker:

From Joseph Yura, emeritus professor of civil engineering at the University of Texas: *The smaller amount of knowledge you have, the bigger the factor of safety you use.*

From Sue Lane, an engineer and manager at ASCE: *Redundancy is all about sharing. If four of us are moving a piano and one of us falls, maybe three will be able to hold it up. But not if there are only two carrying it.* And she added that today bridges are built with fewer joints, stronger steel, and greater redundancy.

Edward P. Wasserman, director of the structures division at the Tennessee Department of Transportation, explained that even fracture-critical bridges can be rehabilitated rather than replaced *as long as you put in place the proper design to virtually eliminate the risk of fracture and as long as you have a reasonable plan to inspect and maintain it.*

Caltrans director Will Kempton assured the public: *These things happen very rarely. There's no higher probability of this happening tomorrow than there was of it happening last month.*

And perhaps my favorite response of all came from David A. Fowler, a civil engineer at the University of Texas, during an online Q&A with *Washington Post* readers: *I can't answer that…it's far too early to be drawing any conclusions.*

My friend Richard G. Weingardt, a well respected structural engineer from Denver, has long stressed the need for the engineering community to get more involved in the public discourse—and at no time has this been more appropriate than now. Time after time, we've seen failures of our aging infrastructure. Yet funds for needed repair and maintenance are constantly withheld. I urge everyone to get involved with your local, state, and federal representatives and to stress the need for additional infrastructure funding. Insist that this be a priority of your local and national engineering associations. The readers of this magazine have the expertise; it's your responsibility to get involved.

*Scott Melnick*

**SCOTT MELNICK**
EDITOR


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

## Repairs at Protected Zones

**When installing the light gauge framing on a special moment frame with RBS connections, four shot pins were inadvertently installed into a beam flange in a protected zone. What criteria can we apply to determine if this exceeds an acceptable level? And if it does, what repairs are available to us?**

*Question sent to AISC's Steel Solutions Center*

The AISC *Seismic Provisions* state that "welded shear studs and decking attachments that penetrate the beam flange shall not be placed on beam flanges within the protected zone." There is no level of such attachments that would be considered acceptable.

Base metal repair requirements within the protected zone are given in Section 6.15 of the AWS D1.8 *Structural Welding Code—Seismic Supplement*. Subjects of weld removal and repair of gouges and notches in protected zones are covered.

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

## Design Wall Thickness

**What is the reason for the smaller gross areas of standard pipes in the new (13th edition) steel manual?**

*Question sent to AISC's Steel Solutions Center*

The areas of HSS and steel pipes listed in the 13th edition *Steel Construction Manual* reflect the requirement in Section B3.12 of the AISC specification that the design of HSS manufactured by the electric resistance welded (ERW) process be based on a design wall thickness equal to 0.93 times the nominal wall thickness. An HSS is defined in the AISC specification as "Square, rectangular, or round hollow structural steel section produced in accordance with a pipe or tubing product specification."

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

## 65 ksi Steel and LEED Certification

**We are considering the use of 65 ksi steel for building columns. Can you tell me what the availability would be for 65 ksi W-shapes? We are currently looking at sizes ranging from W14x61 to W14x605—the whole range!**

**Additionally, the project (located in Chicago) is to be LEED certified, so we would be looking for steel manufacturers within a 500-mile radius. Do you have any recommendations for steel suppliers that would be able to fulfill this requirement and supply 65 ksi W-shapes?**

*Question sent to AISC's Steel Solutions Center*

As you likely know, LEED 2.2 requires that local products be both manufactured and harvested within 500 miles of the project site (in previous versions the two were separate considerations). For steel, the location of the steel fabricator is the point of final manufacture, and this location is easily obtainable by numerous steel fabricators local to the Chicago area. For harvesting of material, however, you have to use the location of the scrap source for the mill where the material is produced, which is usually within approximately 300 miles of the mill.

Unfortunately, for your particular case, you will not be able to apply the steel toward this credit if you use 65-ksi steel, as shapes of this grade (ASTM A913) are currently only produced by Arcelor-Mittal steel in Europe. Thus, with respect to sustainable design, you will have to weigh the material savings that you yield by using a stronger grade of steel versus the environmental impact of shipping the material overseas. The closest mill of any structural steel material to your project site is Steel Dynamics in Ft. Wayne, Ind. If you choose to use a 50-ksi material, they can supply it from that location to meet your LEED criteria.

*Chris Hewitt, LEED AP*

## Slip-Critical Connection

**What is a slip-critical connection, and when must they be used?**

*Question sent to AISC's Steel Solutions Center*

Slip-critical connections are those that have an additional design requirement to provide a calculable resistance to slip on the faying surfaces provided by the force of friction between the connecting materials. Slip-critical connections are usually designed for service-level slip resistance, but strength-level slip resistance is sometimes required. In either case, these connections require proper faying surface preparation to achieve the minimum slip coefficient and the pretensioning of bolts during installation to achieve the minimum clamping force. The combination of these creates the frictional resistance to slip.

For more detailed information on how to design slip-critical connections, please see Chapter J and its commentary in the 2005 AISC specification, available at **www.aisc.org/2005spec**. Also, please refer to the RCSC *Specification for Structural Joints Using ASTM A325 or A490 Bolts* (available at **www.boltcouncil.org**) Section 4.3 for finding out when to use slip-critical connections. Further guidance also can be found in AISC *Design Guide 17: High Strength Bolts—A Primer for Structural Engineers*, available free to AISC members at **www.aisc.org/epubs**.

*Amanuel Gebremeskel, P.E.*

## Plate Girder Design

**Where can I find the current design criteria for plate girders? What used to be Chapter G in the 1989 ASD specification doesn't appear to be in the new 2005 AISC specification.**

*Question sent to AISC's Steel Solutions Center*

The term "plate girder" is no longer used in the AISC specification, but the 2005 AISC specification does contain flexural and shear requirements for built-up sections, although some are in modified form. There are special requirements for built-up sections with large $h/t$ ratios in the new *Specification*, and these are based on the older plate girder design requirements. The flexural requirements are in Chapter F (Section F5), and the shear requirements are in Chapter G. The 2005 AISC specification can be used to design plate girders, although a separate Chapter and/or Appendix no longer exists specifically for plate girders.

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

## Traceability

**Is it required to have evidence of traceability of heat numbers for clip angles, bar sections, or plate from inventory?**

*Question sent to AISC's Steel Solutions Center*

The AISC *Code of Standard Practice* does not require heat number traceability for structural steel, but it does require a method of material identification, which may include mill test reports. In some cases, the project specification may stipulate requirements more stringent than those provided in the *Code of Standard Practice*. As this adds significant cost, such additional requirements should only be specified when they are necessary.

Please refer to Section 6.1.1 of the 2005 *Code of Standard Practice* (a free download from **www.aisc.org/code**) for identification of material requirements.

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

## Maximum Size of Fillet Weld

**Why is the maximum size of a fillet weld limited by the thickness of the thinner plate?**

*Question sent to AISC's Steel Solutions Center*

Section J2.2b (a) of the AISC specification states that for fillet welds along edges of material less than ¼ in. thick, the maximum size of the fillet weld should be no greater than the thickness of the material. In other words, one cannot specify a fillet weld thicker than the material thickness against which it will be placed. In material thicker than ¼ in., the limit is 1⁄16 in. less than the thickness. This requirement assures that the edge of material is still present and the weld size can be assured visually. A melted edge on thicker material tends to obscure the true weld size, as the material corner likely will melt faster than the root of the joint. When the welding is not along the edges of materials, however (e.g., a tee joint), the limitations stated above do not apply.

*Amanuel Gebremeskel, P.E.*

## Specification Conformance for Existing Buildings

**I have a multi-story building constructed circa 1970 that is being considered for re-use as a senior center. Should the structural engineer be required to check the bolts for conformance with modern criteria?**

*Question sent to AISC's Steel Solutions Center*

The applicable building code will typically define when an existing building must be upgraded to meet current design requirements. In general, it is commonly required when a change in occupancy occurs or there is an increase in loading. Chapter 34 of the 2006 International Building Code (IBC) includes such requirements. You should check your local building code for specifics. For further guidance on the subject you may also want to review Appendix 5 of the 2005 AISC specification, which covers evaluation of existing structures.

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

## Extended Single-Plate Shear Connections

**Does one use the 1.25 multiplier over the bolt shear values for the extended configuration single-shear plates? Per p. 10-103 in the 13th edition AISC manual, the 1.25 multiplier is used to determine the moment strength of the bolt group. But when you are calculating the bolt shear strength, is it correct to use the bolt shear values directly from the tables and multiply these by the "C" factor for the eccentricity?**

*Question sent to AISC's Steel Solutions Center*

Yes, the 1.25 multiplier can be used, but only in relieving the need to consider eccentricity in the design of the connection. In the extended configuration procedure, this is done by limiting the plate thickness in the $M_{max}$ equation. The bolts in shear still must be designed per Specification Chapter J, without consideration of a strength increase. For this check, a C-value is applied on the bolt shear strength, with an eccentricity taken as that from the support to the center of the bolt group.

*Chris Hewitt*

## Thread Engagement

**Is there a minimum number of threads that a nut needs to be engaged on a bolt?**

*Question sent to AISC's Steel Solutions Center*

Section 2.3.2 of the RCSC *Specification for Structural Joints Using ASTM A325 or A490 Bolts* (a free download at **www.boltcouncil.org**) defines the proper installation as follows: "The bolt length used shall be such that the end of the bolt extends beyond or is at least flush with the outer face of the nut when properly installed." Thus, the minimum number of threads that must be engaged is all of them; the full depth of the nut must fall within the length of the bolt.

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

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

The opinions expressed in Steel Interchange do not necessarily represent an official position of the American Institute of Steel Construction, Inc. and have not been reviewed. It is recognized that the design of structures is within the scope and expertise of a competent licensed structural engineer, architect or other licensed professional for the application of principles to a particular structure.

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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# 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 web site, **www.aisc.org/2005spec**. Where appropriate, other industry standards are also referenced.

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

1 What is the maximum slenderness ratio *Kl/r* required by the 2005 AISC specification for compression members?

2 **True or False:** Local buckling is not applicable as a limit state when checking HSS for flexure.

3 What is the minimum size of fillet weld required when two plates of ⅞ in. thickness are joined?

4 What is the minimum pretension required when using pretensioned high-strength bolts?

5 What design thickness is used for HSS walls produced by the electric-resistance-weld (ERW) process?

6 **True or False:** All structural steel is required to receive a shop coat of paint.

7 What is second-order drift?

8 **True or False:** Fatigue needs to be considered when designing a steel structure for seismic effects.

9 What is a protected zone in a high-seismic frame?

10 What do $R_y$ and $R_t$ in the AISC *Seismic Provisions* represent?

TURN PAGE FOR ANSWERS

# steel quiz

ANSWERS

**1** **Trick question!** There is no prescribed maximum slenderness ratio for members designed on the basis of compression. However, it is recommended in a User Note that this ratio not exceed 200. (Refer to Section E2 of the 2005 AISC specification, a free download at www.aisc.org/2005spec.)

**2** **False.** Local buckling can occur in compression walls of HSS when the *b/t* ratio exceeds the compact limit. Accordingly, the AISC specification includes local buckling as a limit state for HSS shapes subjected to flexure. (Refer to Sections F7 and F8 of the 2005 AISC specification.)

**3** A 5⁄16-in. minimum fillet weld is required when the material thickness of the thinner part joined exceeds ¾ in. (Refer to Table J2.4 of the 2005 AISC specification.)

**4** Minimum pretension required for pretensioned bolts is 70% of the minimum tensile strength of the bolts with UNC threads. (Refer to Table J3.1 of the 2005 AISC specification.)

**5** The design wall thickness for HSS walls with ERW welds is 0.93 times the nominal wall thickness. (Refer to Section B3.12 of the AISC specification.)

**6** **False.** Section M3 of the AISC specification states: "Shop paint is not required unless specified by the contract documents." Guidance on the subject of painting requirements can be found in FAQ 10.1.1 at www.aisc.org/faq.

**7** A structure subject to lateral loads (and/or unsymmetrical gravity loads) will initially drift an amount that is inversely proportional to the lateral stiffness of the frame. Because the gravity loads are now acting on the displaced structure, they cause an additional drift. This is the second-order drift.

**8** **False.** Seismic loading does not produce enough cycles to require consideration of fatigue loading. (Refer to Section B3.9 of the specification.)

**9** The protected zone is the region in a beam, brace, or other fuse element that is expected to undergo inelastic straining in a major earthquake. For example, a special moment frame beam has a protected zone at each end just outside the connection. (Refer to Section 7.4 of the 2005 AISC *Seismic Provisions*, available as free download at www.aisc.org/2005seismic.)

**10** $R_y$ is the ratio of the expected yield stress to the specified minimum yield stress $F_y$. $R_t$ is the ratio of expected tensile strength to the specified minimum tensile strength $F_u$. (Refer to 2005 AISC *Seismic Provisions* symbols and Section 6.2.)

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**.

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UNIVERSITY RELATIONS

## Bridge Competition Showcases Student Design Skills

Like the Dallas Cowboys of the early 1990s and the Michael Jordan-era Chicago Bulls, North Dakota State University has created its own dynasty. This past May, a team of NSDU civil engineering students gave the school its fifth National Student Steel Bridge Competition (NSSBC) title and its second in a row; the school also won in 1995, 2002, 2004, and 2006. Coming in second and third place this year were the University of California, Davis and the University of Wisconsin – Madison.

This year's competition, which took place May 25–26 at California State University, Northridge, marked the 16th anniversary of the annual event and the 20th anniversary of the Regional Student Steel Bridge Competitions. Each year, the NSSBC offers future structural engineers the opportunity to display their skills in steel design, steel fabrication, and teamwork. Teams fabricate the parts and practice erection in the months leading up to the competition, creating 20-ft spans that must be capable of supporting a load of 2,500 lb. During the actual competition, erection time is of the essence, and NSDU's team was able to put their 108-lb bridge together in around five minutes.

Forty-three student teams from across the country participated in this year's competition, and more than 600 students, faculty, and guests, including AISC president Roger Ferch, attended the awards banquet on May 26.

Besides the overall category, awards were also given in the categories of construction speed, stiffness, lightness, economy, display (formerly aesthetics), and efficiency.

Fromy Rosenberg, AISC's Director of University Relations, commented, "Every student team competing in the regional and national competition, regardless of rank, is a winner. Student teams work for months perfecting the design, fabrication, and construction of each steel bridge. The dedication, hard work, and ingenuity shown by each team is impressive."

Next year's NSSBC will be held on May 23–24 at the University of Florida in Gainesville. Visit the official 2008 NSSBC site at **www.2008steelbridge.com** for more details and information.

Shanna Quinn

The student bridges are on display (above) the day before testing takes place (below).

Shanna Quinn

INDUSTRY AWARDS

## AISI Award Recognizes Bridge Innovation

The American Iron and Steel Institute presented the 2007 Market Development Industry Leadership Award to Ed Wasserman, P.E., director of the Tennessee Department of Transportation's Structures Division, during steel bridge industry meetings held recently in Nashville, Tenn. The award was established by AISI to recognize individuals who have made significant contributions in advancing the competitive use of steel in the marketplace as a direct result of AISI Market Development initiatives in the automotive, construction, and container markets.

Dan Snyder

Wasserman was presented with the award by David Jeanes, P.E. (left), AISI's senior vice president of market development; and Alex Wilson (right), Chairman of AISI's Steel Bridge Task Force and manager of customer technical services for ArcelorMittal.

The award recognizes the "unified approach" that was developed after a multi-year research project championed by Wasserman. The research, performed at the Federal Highway Administration's Turner Fairbanks Research Laboratories, included testing of a full-scale curved girder bridge that was erected in the lab. Principal funding for the research was generated by joint funding from dozens of state departments of transportation and led to a complete overhaul of the AASHTO specifications to simplify the design of straight and curved steel girders, resulting in more cost-effective steel designs.

The award also recognized that the quick progression from concept to application resulted in large part from Wasserman's leadership and contributions toward this effort. The first bridge designed specifically with high-performance steel (HPS) 70W steel plate was constructed by the Tennessee Department of Transportation in 1998 (the State Route 53 bridge over Martin Creek in Jackson County, Tenn.). Since then, Wasserman has specified 24 additional HPS bridges in Tennessee and has contributed greatly towards educating other bridge engineers on the cost-effective benefits of HPS. HPS can provide up to 18% in weight reduction and up to 20% in cost reduction over conventional steels.

As the result of a partnership between AISI, the Federal Highway Administration, and the U.S. Navy to create cost-effective, durable steels for bridge design, HPS went from concept to application in just five years and is now being used in 44 states on more than 400 projects.

PUBLICATIONS

## New Steel Joist Guide Now Available

The second edition of *Technical Digest No. 3*, now available from the Steel Joist Institute, aids design and construction professionals in selecting steel joists that meet stability requirements when water accumulation (ponding) on a flat or low-sloped roof is a design consideration. Much of the new information is a direct result of changes adopted by recent building codes.

This 44-page guide details the structural behavior of steel joists that may be susceptible to ponding conditions. It makes use of the standard load tables found in the SJI 42nd edition catalog to assist designers in complying with the *Standard Specifications for Open Web Steel Joists, K-Series* Section 5.10, *Standard Specifications for Long-Span Steel Joists, LH-Series and Deep Long-Span Steel Joists, DLH-Series* Section 104.11, and *Standard Specifications for Joist Girders* Section 1004.8. In addition, the benefits of camber and pitch of joists in reducing the effects of ponding are discussed.

Equations for the determination of reactions, equivalent uniform loads, and deflections for cambered joists subjected to water loads are included in Appendix A. A method for calculating the effective moments of inertia for standard SJI joist products is provided in Appendix B. Appendix C offers several design examples worked out in detail. When appropriate, the examples utilize the refined ponding criteria found in the 2005 AISC *Specification for Structural Steel Buildings* Appendix 2, Design for Ponding. Appendix D contains an extensive bibliography of journal articles, conference proceedings papers, research reports, and other publications related to ponding.

*Technical Digest No. 3* sells for $25.00, plus $5.00 per order for regular handling and shipping within the continental U.S. To order a hard copy, download an order form, or download the document, visit **www.steeljoist.org**.

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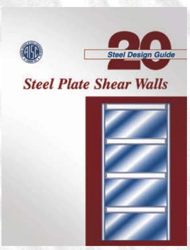
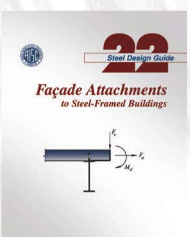



## NEW! Design of Steel Plate Shear

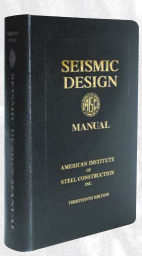
*Steel Plate Shear Walls for Wind and Seismic Loading*

This short course introduces engineers to steel plate shear walls, a new system for resisting lateral forces. The system provides significant benefits over other types of shear walls, including construction speed and cost, reduced weight, and very little loss of useable floor area. The course covers the basic mechanics of the system and simple methods for its design as well as the additional detailing, proportioning, and design requirements necessary for use of steel plate shear walls as a seismic system with $R > 3$. Design examples include both wind (low-seismic) and high-seismic design.




## NEW! Façade Attachments to Steel Frames

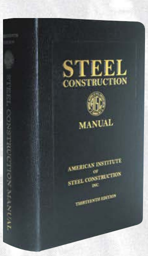
Perhaps the most complicated details in a building occur where the façade and structural frame meet. The details of this interface have a significant impact on the cost of the project. The performance issues that affect the façade attachment details include: proper support of the façade elements, structural anchorage to the frame, relative movements, fire protection, waterproofing, thermal and moisture migration, air infiltration, and sound transmission. Just as these details need to integrate all the above performance issues, the design team needs to coordinate responsibilities between the architect, base building engineer, façade engineer, general contractor, steel fabricator, steel erector, and façade subcontractor(s).




## AISC Seismic Provisions/Manual

*AISC Seismic Design – Updates and Resources for the 21st Century*

Structural engineers across the country have appealed to AISC for good resources and continuing education seminars on seismic design. In response, Dr. Thomas Sabol – referencing AISC's extensive Seismic Design resources – has developed a seminar to meet those needs. If you are a practicing structural engineer looking to increase your knowledge of seismic design of structural steel – make sure you attend this seminar!

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- ☐ 09/20 San Francisco (Area), CA
- ☐ 10/03 Memphis, TN
- ☐ 10/04 Chicago, IL
- ☐ 10/09 Charlotte, NC
- ☐ 10/11 Oakland, CA
- ☐ 10/23 Portland, OR
- ☐ 10/23 Atlanta, GA
- ☐ 10/24 Seattle, WA
- ☐ 10/25 Portland, ME
- ☐ 10/30 Denver, CO
- ☐ 11/01 Albuquerque, NM
- ☐ 11/06 Boston, MA
- ☐ 11/06 Oklahoma City, OK
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- ☐ 12/06 Boise, ID

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- ☐ 09/20 Dallas, TX
- ☐ 09/26 Los Angeles (Area), CA
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**Steel Plate Shear Walls**
- ☐ 10/17 Los Angeles (Area), CA
- ☐ 10/18 San Francisco (Area), CA
- ☐ 11/27 Seattle, WA
- ☐ 12/11 Portland, OR

**Façade Attachments**
- ☐ 09/19 Boston, MA
- ☐ 09/20 Pittsburgh, PA
- ☐ 10/10 Minneapolis, MN
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# news & events

PROJECTS

## New Stadium to Feature World's Longest Single-Span Roof Structure

Earlier this summer, Dallas Cowboys Stadium celebrated a milestone in construction with the installation of the first piece of a monumental arch truss that will serve as the primary element of the roof structure. This installation signified the beginning of many noteworthy design, construction, and engineering innovations that will be part of the new retractable-roof stadium and entertainment venue, which is scheduled to open in time for the 2009 NFL season.

The roof structure is comprised of twin 17-ft-wide by 35-ft-deep arch box trusses weighing 3,255 tons each and spanning 1,225 ft, creating the longest single-span roof structure in the world. The 84-ft-long, 180,000-lb section (left) was put into place at the stadium's southwest abutment, 128 ft beyond the perimeter of the stadium's seating bowl structure. The arch truss bears on a 64,000-lb cast steel arch pin assembly atop the concrete abutment. Steel for the stadium was fabricated by W & W Steel Co., Oklahoma City, and Prospect Steel Co., Little Rock, Ark. (both AISC members). Walter P Moore performed the structural design.

# letters

### The Numbers Don't Add Up

A few months ago, I saw a press release with renderings of the Grand Canyon Skywalk and was very impressed. When I read through the release and saw the 71 million-lb, "71 fully loaded Boeing 747s" statistic, I punched a couple of buttons on my calculator and dismissed these claims as unfounded early Internet blab. To see the same stats in MSC (July 2007, p. 74), a respected industry publication, astounds me. I don't know where those numbers came from, but they are undoubtedly false. I would be very surprised if the walkway's live *and* dead loads totaled over two million lb past the edge of the cliff. Run a few quick numbers yourself.

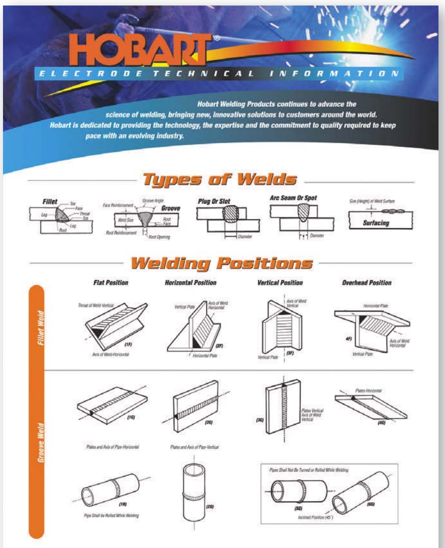
**David Soulier, P.E.**
**Baton Rouge, La.**

*MSC responds: The statistics mentioned above and in the article appear on the official web site for the Grand Canyon Skywalk (**www.grandcanyonskywalk.com**). However, other sources suggest that the Skywalk itself can support 70 tons and it is the foundation of the structure that can support approximately 71 fully loaded Boeing 747s.*

WELDING

## Welding Poster Now Available

Continuing its educational outreach efforts, Hobart Brothers now offers "Welding Types and Positions," the second in a series of electrode technical posters.




The newly available poster shows the five types of welds and the 12 welding positions with clear and easy-to-understand diagrams, including descriptions and corresponding welding terminology.

The "Types of Welds" section covers fillet, plug (slot), arc seam (spot), groove, and surfacing welds. The Welding Positions section covers everything from 1F through 4F in the fillet weld configuration and 1G through 6G in the groove weld configuration.

Both this poster and the first in the series, covering tensile and impact strength, are also available in Spanish.

To request a free copy of Hobart Brothers' Welding Types and Positions technical information poster, call Database Solutions at 888.462.2789 or e-mail databs@mindspring.com.

## Corrections

- In the August 2007 article "Designing for Long Spans," we incorrectly tallied the number of structural elements for the 40-ft bay spacing in Figure 3. Visit the back issues section of **www.modernsteel.com** for an updated version of this article featuring the correct numbers for the 40-ft grid.
- In the news story "Revised ASTM Spec Opens the Door for Hot-finished HSS" (July 2007, p. 19), the use of the term "hot-finished" should be uniformly replaced with the term "hot-formed." The ASTM A501 specification is for hot-formed material only. The confusion in terminology arises from the broader use of the term "hot-finished" in the equivalent European standard, EN10210. A corrected version of the article is available in the back issues section of **www.modernsteel.com**.

# Medical Marvel

BY RANDY KARL HAGENS, AIA, P.E.

**A new hospital tower overcomes access and siting challenges to become a welcome and appropriate addition to the Boise skyline.**

**COMPLETION OF THE NEW PATIENT CARE TOWER AT BOISE'S SAINT ALPHONSUS REGIONAL MEDICAL CENTER REPRESENTS SOME EXCEPTIONAL FEATS OF ARCHITECTURE, ENGINEERING, AND CONSTRUCTION INGENUITY.** The building team faced challenges in three primary areas: the building's site in relation to the local environment, its adjacency to existing buildings, and access issues relating to uninterrupted connectivity between those buildings.

### Rooms with a View

The initial design of the new tower was largely configured on a purely functional basis that took into account nursing ratios, the ability to accommodate the largest nursing unit on one floor, centralizing core circulation, and decentralizing the nursing functions, explains Jeff Cramer, AIA, of HDR, the project's architect and structural engineer. "But the real driver ended up being the desire to ensure that all patient rooms have views to the surrounding landscape. This resulted in reconfiguring the tower into its current bow tie-shaped footprint. This smaller footprint—32 beds per floor versus the original 48 per floor—allowed for a taller patient tower to extend further above the adjacent patient towers to better capitalize on views of the Boise foothills."

The original 30-ft by 30-ft framing bay scheme was driven by the operating room layouts on the second floor of the tower. However, the final shape and orientation of the bed tower dictated that a larger 42-ft by 42-ft bay be used instead. This larger bay reduced the quantity of the columns, but increased the load on the individual columns.

Wide-flange columns as large as W14×605 were also originally specified, but columns of this size are not domestically produced, so imported steel and its associated costs had to be considered. By using 65 ksi steel in lieu of 50 ksi steel, the savings from reducing column sizes and steel tonnage offset the higher material and shipping costs.

The original structural design was executed under the 2000 *International Building Code* that permitted use of a braced frame. However, due to the bow-tie configuration of the building, an inefficiency in the layout of braces allowed the tower to twist when subjected to a lateral load. To solve this problem, moment frames were added near the building perimeter to control the twisting behavior. This created a "dual lateral system" in the eyes of the building code and building official.

The design intent of adding moment frames to the braced frame system was to provide just enough stiffness to limit rotation, because the braced frame system had been designed to carry the full lateral load. However, in order to meet the building code requirements, a higher capacity in the moment frame portion of the system needed to be provided to meet the code provision stipulating that the moment frames carry at least 25% of the total design forces. This additional strength requirement resulted in a slightly higher construction cost that was necessary to maintain the desired building shape.

### Connectivity Challenges

Another challenge in the project was to join the new tower project to the existing north and south towers. Because of the new and existing buildings' irregular configurations, many cantilever beams, cantilever girders, and transfer girders were used to

> **Central Building Steel Facts**
>
> **Floor Area:** 399,500 sq. ft
>
> **Height:** 153 ft
>
> **Construction cost:** Approximately $95 million
>
> **Structural steel:** 3,710 tons (including 317 tons of 65 ksi steel used in the largest columns)


The new patient care tower was constructed around an existing two-level pedestrian sky bridge. During construction, the upper level of the sky bridge was demolished, and the bottom level was shored using 3- and 4-ft-diameter steel pipe sleeves. The lower level of the bridge remained in place and operational until the new building was in place, at which time it was demolished and the steel pipe sleeves were removed down to just below the basement slab level.

extend the new building to the existing buildings, creating the appearance of one continuous building.

Another challenge involved an existing sky bridge. The new patient tower needed to be built completely around the bridge that connected the existing north and south towers. Because this sky bridge was critical to patient transport and used as a utility conduit, uninterrupted access/egress was mandatory until a new corridor could be established. Also, hospital management rejected the idea of relocating the existing services and pathway to an area outside of the construction zone. As a result, the proposed central tower had to be placed over and under the two-story sky bridge, which measured approximately 200 ft in length and 30 ft in width, and connected at the second and third floor levels relative to the existing towers on the campus.

The lateral system is formed by a combination of braced frames (shown) and moment frames.

Several construction options were considered, and the hospital agreed that only the lowest of the two stories of the sky bridge was needed during the initial part of the construction period. That allowed temporary shoring to support only level two after level three had been demolished. Once an adjacent pathway through the new tower was sufficiently completed, the remaining sky bridge could be removed.

Initially, cast-in-place concrete columns were considered for the shoring design. However, the shoring contractor felt that demolition of the concrete columns would be difficult and time-consuming when the time came to remove the sky bridge completely. Consequently, the shoring design that was eventually selected consisted of 3- and 4-ft-diameter steel pipe sleeves acting as cantilevered columns to support new girders located near the existing sky bridge columns. (These pipe sleeves are typically used to confine concrete in the construction of drilled piers in unstable soil.) Though designed as hollow structural tube columns, the design team decided to fill the columns with gravel to guard against local buckling in the event of impact from construction equipment. In order to transfer the column load to a deep soil stratum, the bottom portion of the sleeve was filled with concrete.

When the time came to remove the shoring columns, the contractor could simply cut and remove the hollow shoring columns without having to jackhammer any concrete. Though larger than concrete columns of equivalent capacity, the steel sleeves worked perfectly and were easily removed and recycled. Only the lowest portion of the steel sleeves (the concrete-filled part located beneath the basement floor slab) was left in place.

Once the sky bridge load was transferred to the shoring, the existing sky bridge columns were cut and removed along with the shallow footings. This enabled basement construction to proceed beneath the sky bridge.

The weight of the sky bridge was successfully transferred to the shoring structure with almost negligible differential deflections due to the skill of the field crew and an adjustable leveling connection at each point of load transfer. The projected pre-load deflections were calculated with the help of the RAM Advanse finite element analysis program and reported to the field crew as a part of the construction documents.

Prior to the start of the tower construction, however, the general contractor proposed a further modification of the sky bridge that eventually saved several months in the construction schedule. The sky bridge being 30 ft in width prevented the installation of two columns that were critical in the erection sequence. Therefore, the modification called for reducing the sky bridge width by 10 ft. Simple in concept but challenging in practice, removing the 10-ft-wide by 200-ft-long section from the bridge's one-bay-wide frame required creating new rigid frames at each floor and roof beam along the length of the bridge. To support the new rigid frames and transfer loads to the shoring support girders, a continuous side girder was added along the cut area. Again, projected preload deflections were calculated for use at adjustable leveling bolt connections installed at each frame. Once this additional shoring work was completed, the surrounding frame erection activities could more closely approach the sky bridge and allow the new path through the building to be constructed sooner.

### Flexibility is Key

This project was essentially a fast-track project executed in several phases. As with any fast-track project, new design criteria can occasionally impact the structure that is already in place. This exact situation occurred when it was discovered that the glazing manufacturer needed a tighter floor deflection tolerance than was originally designed. Though tower steel erection was substantially complete, the cantilevered girders of the tower floors had to be modified to meet the more restrictive deflection criteria for the glazing system. Since these girders cantilevered more than 13 ft, a substantial amount of additional stiffness was needed to meet the new deflection requirement. Fortunately, it was relatively easy to add structural WT shapes to the bottom of the cantilevered girders and add reinforcing steel in the composite slab to achieve the increased stiffness.

Similarly, as the interior finish portions of the project were developed during construction, additional steel beams were added to support hanging partitions. The use of a structural steel frame made these modifications quite easy. MSC

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**General Contractor**
McCarthy Building Companies, Inc., St. Louis

**Engineering Software**
RAM Advanse

# Above the Rest

BY CHRIS D. POLAND, S.E.

OREGON'S POPULATION HAS BOOMED OVER THE LAST 25 YEARS, AND THE MEDICAL NEEDS OF THE STATE HAVE INCREASED PROPORTIONATELY. Oregon Health and Science University, the state's only health and research college, recently underwent an expansion to meet that demand. The university wanted the expansion to integrate seamlessly into the existing surrounding structures and landscape. With limited site options available for expansion, a new site alongside the existing hospital was created on a steep hill by building underneath the hospital and next to a road. Inventive design and planning placed the hospital's main street within a new, 14-story, 400,000-sq.-foot facility: the Peter O. Kohler Pavilion

Home to 120 hospital beds, 12 new operating rooms, outpatient care space for the Center for Women's Health and the OHSU Cancer Institute's Center for Hematologic Malignancies, as well as a new Radiation Medicine suite, the facility also holds 15,000 sq. ft of garage space, enough for 450 cars.

## A Precarious Perch

This expansion doubled the university's programming space—and created several design challenges. Programming required that the expansion integrate existing facilities with matching floor heights to allow for flexible growth in the future. Additionally, OHSU is classified by the state of Oregon as an essential facility, requiring it to meet strict seismic standards. The new facility had to be designed as usable after a major earthquake to ensure its ability to serve the community in that time of crisis. Additionally, the steep hill and a need to align floors that varied in height from 11 ft to 19 ft required a unique solution for this campus centerpiece.

**The composite system provided for an average ceiling height savings of up to 24 in.**

The combination of a steep site and the need to match floor elevations and support the main road while meeting seismic requirements led to a combined concrete and steel structural solution. The resulting dual structural systems provided the best seismic performance in each sector of the project, as well as maximum flexibility in the programming spaces. The engineer was able to make the varied structural systems harmonize with the projected budgets by maximizing design efficiencies. The seven-story base structure served to embed the facility into the hillside, providing the needed parking and support for the structural steel patient tower, which curves to match the hillside and interconnects with the existing hospital.

## Going Hybrid

The shorter story heights within the patient tower could not accommodate the conventional structural depth of steel composite floors and meet the utility system requirements. The engineer designed a hybrid composite steel and concrete flat slab system to address this issue. Though more costly than a traditional floor system, the hybrid floor allowed the new construction to match the floor heights of the adjacent building's existing concrete system, while proceeding with the desired steel framing system. Overall project costs were minimized as a result.

The hybrid system was used on floors five, six, eight, and 10 through 14, where the floor-to-floor heights were 12 ft 6 in. or less. The system utilized 4-in.-deep wide-flange beams spaced at 4 ft on center and spanning to column line girders. Up to three times as many beams were used with the shorter spacing distance to create the same strength as a traditionally spaced beam system.

The metal deck was supported on the

Oregon Health and Science University's new Peter O. Kohler Pavilion meets stringent seismic requirements while doubling the school's programming space.

Rick Keating

bottom flange, allowing the concrete to be cast fully composite with the beams to achieve the needed stiffness. The slab-reinforcing steel was interwoven with the steel beams to create a system that met rigorous strength and vibration standards.

The composite system provided for an average ceiling height savings of up to 24 in., creating adequate space for mechanical systems typically found in hospital construction. Additionally, the shallow framing system with intermittent girders created ceiling corridors for placement of equipment and mechanical system lines.

Floor construction at the other levels consisted of a traditional composite metal deck with reinforced concrete fill, supported on composite steel wide-flange beams and girders. Gravity loads are resisted by the hybrid and composite floor systems spanning to steel columns, which are founded on spread footings or pile caps and drilled piers embedded in hard basalt.

## An Essential Facility

Structural steel was further used in one of two seismic systems present in the building. As an essential facility designed to sustain minimal damage and remain operational after a major earthquake, the engineering team designed multiple systems that offered redundancy throughout the expansion.

The parking garage (floors one through

Rick Keating

seven), and the patient tower (floors seven and higher), each had their own unique systems. The lateral resisting systems included steel moment frames for the seventh floor and higher, reinforced concrete shear wall base structures, and rock anchors. The steel moment frames used reduced beam sections and deep columns to minimize the steel tonnage, based on research conducted by AISC at Lehigh University (which involved a series of tests on deep beams with RBS connections to expand the depth to which these connections were considered prequalified). Steel moment frames were selected to complement the hybrid floor system and provide superior lateral force resistance and flexibility for future uses.

The reinforced concrete shear wall base structure provided the foundation for the superstructure while accommodating the steep site. By incorporating the site retaining walls into the main building system and adding additional shear walls to fully support the lateral and earthquake loads, all structural elements were used to their full capability. Further, rock anchors were used over the height of the base structure to pin the base to the hillside and reduce the number of concrete shear walls and the size of the foundation structure. The garage, cast in concrete, served as the foundation structure that supported the hill, the road, and the steel-framed tower. MSC

## Commitment to Goals

At $216 million, the final approved budget reflected the university's commitment to meet its highest priority goals at Kohler Pavilion. The result was a building with state-of-the-art facilities and structural engineering that reflect the university's need for flexibility, shear strength, and sustainability.

*Chris D. Poland is CEO and president of Degenkolb Engineers.*

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**Structural Engineer**
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**General Contractor**
Hoffman-Anderson Construction Joint Venture, Portland

**Steel Fabricator**
SME Steel, West Jordan, Utah (AISC Member)

# Design Foresight

BY JEFFREY SMILOW, P.E., AND ALLEN THOMPSON, P.E.

**A new office high-rise paves the way toward revitalizing Queens and creating a new business district for New York.**

Zoning setback requirements influenced the architect's design of a sloping east façade (right in picture) and a curved south façade.

**LONG ISLAND CITY IN QUEENS IS BEING TOUTED AS NEW YORK CITY'S NEWEST CENTRAL BUSINESS DISTRICT.** Certainly helping the cause is the recent addition of Long Island City 2 (LIC2), a $290 million, 16-story, 528,000-sq.-ft structure with an unusual architectural massing. The building is anticipated to be the primary catalyst in revamping the business and residential economies of Queens.

Owned by Citigroup, LIC2 is part of the company's relocation plan to move many back-office and support functions outside of Lower Manhattan. It will be the national headquarters for Citibank's credit card division and branch banking business.

LIC2's geometry was driven by tight site constraints and zoning regulations relative to sky exposure. To maximize office space, the building footprint stays as large as possible for as high as possible, and then the façades step inward accordingly. In combination with the required setbacks, the architect chose a sloping east elevation and a curved south elevation.

As Citigroup anticipated the possible need for more space at the same location, LIC2 is designed to accept a "phase 2" addition to the current building. The addition would complete the podium level and add a tower topping out at 36 floors. The tower would be supported by the podium portions of both phases.

## Framing System

The building's floor system is typically composed of 5½-in. slabs—2½ in. of concrete on top of 3-in. metal deck. Steel framing is designed compositely with slab via the use of steel shear studs. The distance from the core to the perimeter is typically 64 ft on the north side and on the south side up to the seventh floor. Above this point the core-to-perimeter distance is typically 40 ft on the north side and 48 ft on the south side.

The span from the core to the perimeter is divided into two bays with one interior column line. Typical beam spans are 25 ft on the interior bay and 41 ft on the exterior bay, and typical filler beams range from W14×22s spanning 25 ft with no camber to W21×44s spanning 42 ft with 1¼-in. camber. Girders are typically W24×84s with 1¼-in. camber, and girders over 21 in. in depth were raised 3 in., allowing the ductwork to fit in the ceiling zone without beam penetrations.

Because of the setbacks required for sky exposure, the north façade steps back 25 ft 10 in. on the seventh floor and 16 ft 2in. on the 12th floor. On the 12th floor the façade steps back to the tower columns, but on the seventh floor, transfer girders—41-ft-long W40×149s with 2-in. by 14-in. cover plates on the bottom flange—were required.

The lateral system is composed of three components. The first is steel bracing within the core consisting of concentric and eccentric bracing. Second is a perimeter moment frame consisting of W24 columns and W36 beams. The third is an outrigger truss system with trusses located on the 16th floor and the proposed future 36th floor. Four of the outrigger trusses are currently located in phase 1 on the 15th floor. In the proposed phase 2 portion of the building there are six outrigger trusses on the 15th floor and six on 36th floor.

## Phased Construction

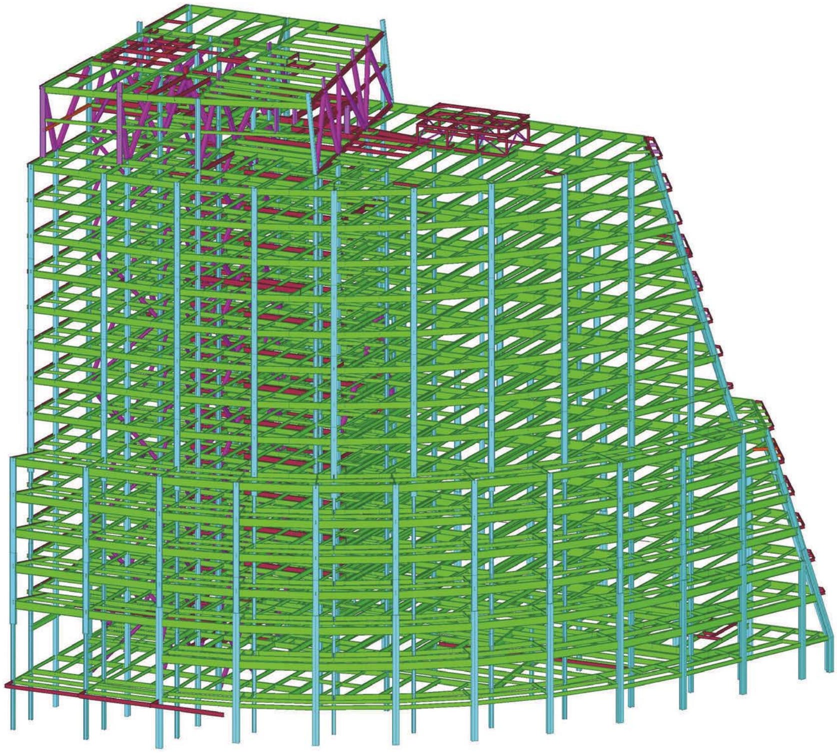
In order to properly design phase 1, phase 2 was designed to a "design development plus" level. The "plus" meant that the core configuration had to be 100% designed in order to properly lay out the phase 2 bracing. Without exact phase 2 bracing, reliable phase 2 forces acting on phase 1 could not have been developed.

The east façade of the tower is skewed and sloping, while the south façade is curved. The columns in these tower façades are at 30 ft on center and do not align with the podium below. In order to support the east façade, four columns in the podium were adjusted to fall in line with the intersection line of the tower's east façade and the 15th floor. From the 15th to the 16th floor (a double-height mechanical floor), a sloping transfer truss was designed to transfer the six tower columns to four podium columns. The south façade required sloping three columns, the most dramatic of which sloped 6 ft horizontally over 27 ft 4 in. vertically. The sloping columns were accommodated within the outrigger trusses. The outrigger and southern tower columns within the podium were located on a straight line drawn from the southern tower columns to the core columns from which the outriggers emanate. The floor plans allowed for column location flexibility in the east-west direction.

## Auditorium

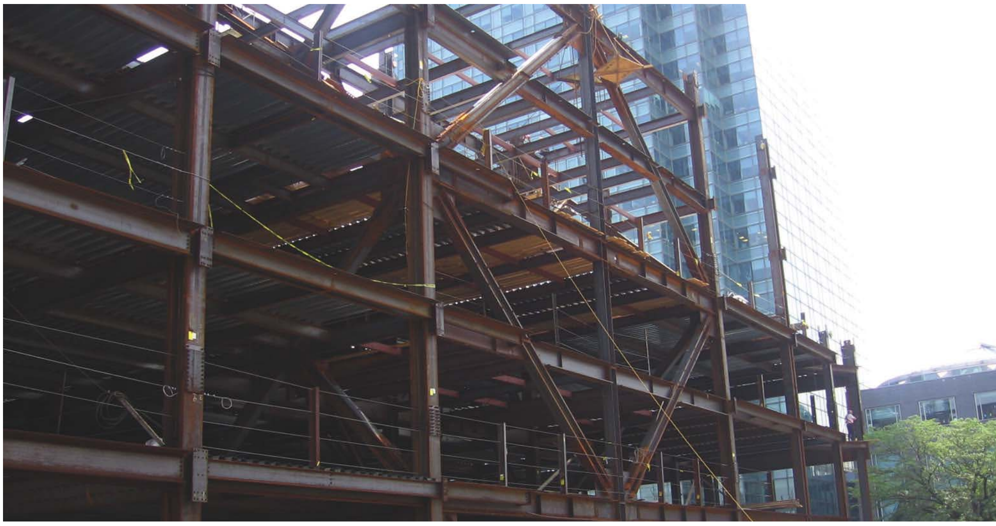
During the design phase, the owner chose to add an auditorium on the second floor of the phase 1 building. To create a column-free auditorium, one interior column had to be removed. Different options for carrying the gravity load from the third-floor column were investigated. One option included adding a transfer truss on the third floor, but the truss decreased headroom to an unacceptable level. The selected option included the removal of the column throughout the full height of the building. To accomplish this, an 83-ft long, W44×262 girder was added on each floor to span the longer distance. The benefit of this scheme was the 80-ft by 83-ft column-free zone created on each floor.

The W44 girders were each fabricated with a 2¼-in. camber. Although concerns were expressed about "ponding" at the center of the spans and about the accuracy of the camber, survey results after the concrete pour showed that the specified camber resulted in a level slab of uniform thickness.



**Above:** 3D X-steel model of the framing for Phase 1, looking primarily at the south façade. Transfer trusses (pink) at the top (15th floor) prepare the project for the construction of a future office tower.

**Below:** Transfer trusses transition the columns from the future office tower to the columns of the podium structure.



Structural stub-outs on the west side of the structure await the construction of phase 2 of the podium.

## Foundations

Long Island City is founded on glacial sediment over bedrock. As a consequence of the thickness of the sediment varying significantly from east to west across the site, the foundations under the new and future phases are different. In fact, phase 1 is supported on three different types of foundations. Spread footings on 3 tons per sq. ft soil support the lower podium columns. Due to their higher loads, the tower columns are supported on spread footings bearing on 40 tons per sq. ft rock or 120-ton piles, depending on the rock depth.

## Coordination

The developer authorized the creation of a three-dimensional detailing model (using Tekla's X-steel package) in order to get a head start on the steel shop drawing process, and steel detailers were subcontracted during the design phase in order to develop the model. Three primary benefits resulted from this effort. First, time was saved in the fabrication schedule, because a fully developed X-steel model was already available upon award of the steel contract. Second, the bid phase period was shortened, since the steel bidders were provided with the model. Third, the data that the detailer needed to create the model were incorporated into the design drawings, resulting in minimal RFIs during construction. MSC

*Jeffrey Smilow is the executive vice president and Allen Thompson is an associate at WSP Cantor Seinuk's New York office.*

**Owner**
Citigroup, New York

**Developer**
Tishman Speyer Properties, New York

**Architect**
Kohn Pedersen Fox Associates, New York

**Steel Detailer**
Dowco, Burnaby, B.C., Canada (AISC Member)

**Structural Engineer**
WSP Cantor Seinuk, New York

**Construction Manager**
Turner Construction Company, New York

**Steel Fabricator**
Owen Steel Company, Columbia, S.C. (AISC Member)

**Software**
ETABS
RAM Structural System
Tekla X-steel

# Five Questions I'm Asked Every Day

BY KIMBERLY A. SWISS

**Quality Management Company's manager of certification administration answers five important and frequent questions about AISC certification.**

**YES, I'M AN INTERNET JUNKIE.** I will do anything that I can online—from ordering groceries to reading the newspaper. I look for the answers to life's tough questions via the Internet.

At times, I become incredibly disappointed with web sites that don't provide solutions or can't predict my needs, and lately I have become aware of the limitations of canned, one-size-fits-all responses that are available on the Internet.

Quality Management Company (QMC) has posted more than 100 frequently asked questions (FAQs) about AISC fabricator and erector certification on our web site (**www.qmconline.com**) so that you have the answers you need at your fingertips. And although I think that our FAQs are a great tool, I realize that it isn't always that simple; some questions may require a conversation or two. So, as I share the top five questions I get asked everyday (and their answers, of course), I hope the message is clear: We want you to have the information you need when you need it, but if you don't find it online, just ask.

### What is the difference between AISC Certification and AISC Membership?

AISC certification and AISC membership are separate, and certification is not required for membership, nor is the reverse. AISC membership helps support the Association's technical and marketing activities, ranging from the development of the *Specification for Structural Steel Buildings* to the AISC Steel Solutions Center to our efforts to promote the use of fabricated structural steel. For more information on becoming an AISC member, visit **www.aisc.org/membership** or contact Carly Moore at moore@aisc.org or 312.670.5442.

Companies that become AISC Certified, on the other hand, do so to demonstrate to their customers that they have the personnel, knowledge, organization, equipment, experience, capability, procedures, and commitment to produce the required quality of work per AISC's certification standards. Certified firms are audited annually by QMC in order to verify the effectiveness of their quality management system. AISC certification signifies that quality is built into a project, and not inspected for after the fact. While a certified quality management system is a very significant benefit, AISC Certified companies also receive support from AISC via our "No More Waivers!" Program; are able to use the AISC certification logo for company letterhead, business cards, and websites; and are listed on the AISC web site in the certified fabricators directory with a direct Internet link to the company's web site. For more information, including application and fee information, please visit the AISC web site at: **www.aisc.org/certification**.

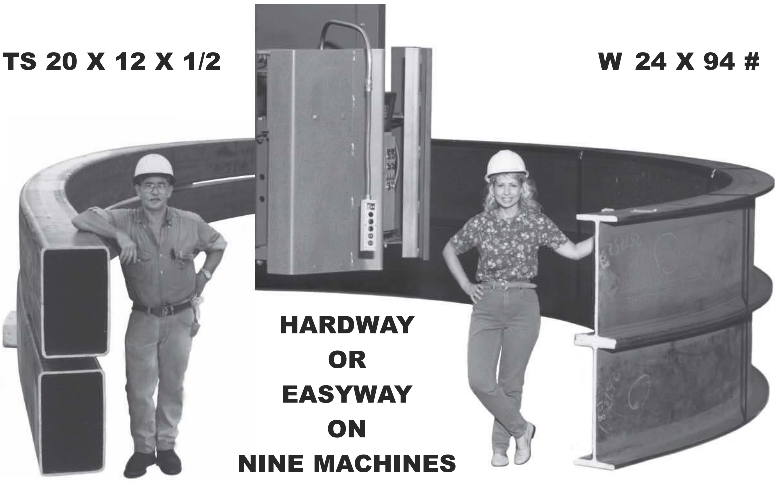
While a company does not have to participate in one of these programs in order to participate in the other, many participate in both. Approximately two-thirds of AISC fabricator members are certified, and approximately one-third of AISC Certified companies are not members (this includes companies located outside the U.S. who are not eligible for AISC membership).

### How long does it take to get certified, and/or what does it take to become certified?

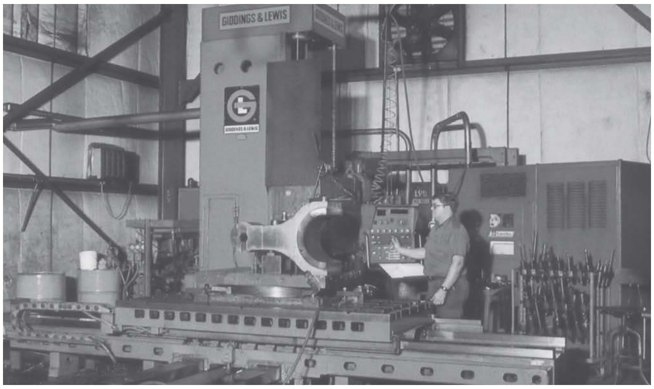
I get this question more than once a day, and I always say the same thing: "How long it takes to become certified is more contingent on you than it is on us." I say this because QMC always wants to meet a company wherever they are currently at in the quality process and work with them to reach the finish line. For example, if a company already has a quality system implemented and has documented what they are doing, they might get through the process faster than a company who is just beginning to write their quality manual. Having said that, see our July 2005 Quality Corner article "Good Things Take Time" at **www.aisc.org/quality-corner**. This article contains a timeline that details how long it takes to become certified and can be

*Kimberly A. Swiss is manager of certification administration for Quality Management Company.*

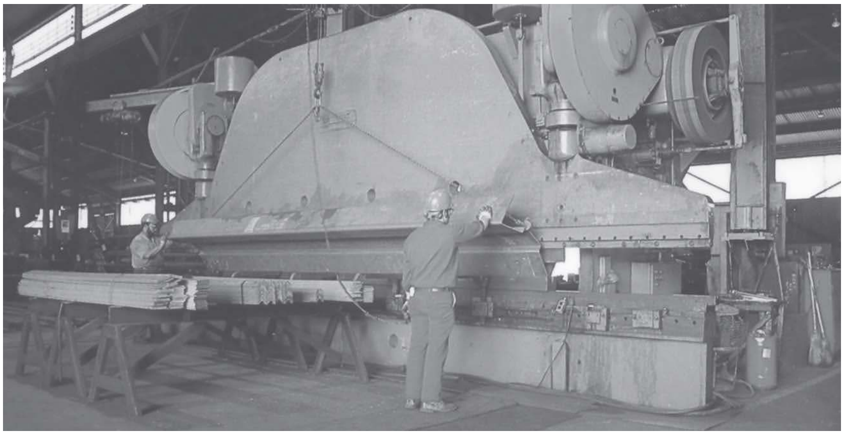
**Quality Corner** is a monthly feature that covers topics ranging from how to specify a certified company to how long it takes to become a certified company. If you are interested in browsing our electronic archive, please visit **www.aisc.org/QualityCorner**.













very helpful to those entering the program for the first time.

This is such a popular question because many first-time applicants are on a tight schedule and need to become AISC Certified in order to bid on a job that requires it. The urgency of this situation is significant, and we work diligently to get companies where we they need to be. In fact, we even offer an expediting option where an auditor can be at a domestic facility within three weeks of the completion of the documentation audit.

In order to start the process, we do require full materials, an application, and payment. Documentation requirements depend on which certification category you are applying for. Please visit the AISC website at **www.aisc.org/become_certified** for the specific requirements.

### Is Certification only for large companies?

Absolutely not. All shops should be concerned with quality. To date, there are nearly 90 certified companies with 20 or fewer employees. There is a basic level of quality that all AISC Certified companies meet, regardless of shop or project size. Obviously, at a smaller company employees wear many hats, but that's both expected and acceptable within the certification program.

### How do audits get scheduled?

With nearly 800 audits to conduct each year, scheduling can be a little tricky for QMC. The goal is to visit as many fabricators as we can in one area at a time, allowing us to pass the savings on to our customers.

QMC audits annually on what is considered a three-year cycle. The first audit is what we refer to as the *Initial*, and we do an audit of all the required criteria. The year that follows is what is referred to as an *Annual Review 1* (AR1), where we audit approximately half of the required criteria. On year three, we perform an *Annual Review 2* (AR2), where we audit the rest of the required criteria. The year after that is the *Full* audit, where we look at all the criteria again.

When a company takes the beginning steps toward becoming AISC Certified and has submitted payment and passed their documentation audit, the process of scheduling their on-site audit begins. I start by asking the certification contact when they would like to have their on-site audit, and then I look at auditor's schedules to accommodate the proposed time frame. After this, the auditor takes over, sending an audit plan and introduction letter, and eventually conducting the audit.

Once a fabricator passes their initial audit and becomes AISC Certified, I immediately plan for future audits. The first step is to look for other companies that will be audited in their area, since we put each fabricator in a "scheduling package" with other fabricators in their vicinity. I also try to choose a package that is as close to one year from the initial audit as possible, since we audit on an annual basis and want to give the customers a year before being audited again. Most times, I am successful, but for certain locations, we only visit once a year and may have to have a time frame of eight or nine months between the first initial audit and the first annual review audit. In subsequent years, we send out the audit date notice to all the fabricators four months prior to the certification month. Having each company in a package helps to ensure that our customers can forecast a time frame for their audit and we can see as many clients as we can while in one area. All of this becomes more complicated by the fact that the auditors live all over the country and audit all over the world.

Scheduling erector audits is slightly different, since job site locations for erectors can vary, and certified erectors are more dispersed; it is difficult to put them in the same package system that the fabricators are in. So instead, I put them in a month package, October for instance, and ask that the auditor contact them to set up their audit based on when they are erecting steel during that month.

Occasionally, it is possible that a company's certification month can change. Every three to four years it becomes necessary to adjust our audit schedules in order to evenly distribute the number of audits conducted each month, particularly when the program grows as much as it has in the last year. Should your company be impacted by this process, you will receive notice several months in advance of your audit.

### Why don't I have the same auditor every year?

We strive to send a different auditor to a given facility whenever possible and practical. The contract auditors who audit for the AISC certification program go through continuous training with QMC and AISC in order to stay updated on program goals, criteria, and industry trends. This training could be viewed as a type of calibration, but since the contract auditors are human beings, calibration can not truly be expected. And while we strive to achieve consistency, we also find great value in the differences between the auditors due to their professional and personal experience and knowledge, which they can share with each participant, thereby enriching the value of the program. We find it to be a positive aspect when one auditor sees something that the previous auditor did not.

We certainly appreciate hearing from you and welcome your questions in order to better serve you. Knowing your concerns and our ambiguities is important to QMC's continuous improvement, and it helps us to be as effective as possible for our customers. Please call me at 312.670.7521 or email me at swiss@qmconline.com whenever you have a question, and be sure to visit **www.qmconline.com** for valuable resources. MSC

# Let's Be Plank...

BY TODD ALWOOD

**Plank experts offer a few things for the structural engineer and fabricator to keep in mind when designing projects involving plank.**

**THERE ARE PLENTY OF GENERAL DISCUSSIONS OUT THERE ON CONCRETE PLANK AND ITS ADVANTAGES—LOWER FLOOR-TO-FLOOR HEIGHTS, FAST ERECTION, ETC.** But what about the specifics?

I chatted with Phillip Iverson, P.E., Director of Business Development for Spancrete of Illinois, Inc., about plank issues that every structural engineer and fabricator (and detailer and general contractor!) should keep in mind when they begin their next plank job. Here are the highlights.

## Know Your Plank

There are three general types of plank, based on their method of manufacture. Each type of plank can be used in a wide variety of projects.

**Wet-cast** plank offers a lot of design flexibility. The plank is wet-cast within a form, and collapsible tubes are placed within the plank to provide regularly spaced cores. This product can accommodate top and bottom embed plates, special block-outs, and specific forming requirements for complicated layouts during the casting process.

**Slip-form** casting is also very flexible. The plank is made of a very dry concrete, which has almost zero slump. The concrete is placed into a hopper and mechanically vibrated onto curing beds. Within the hopper are tubes that form the cores inside the plank as the slip-former moves down the bed; they are pulled out during the forming process by the machine, thus permanently forming the cores within the plank. Bottom embed plates are placed during casting, but top plates and block-outs are installed after casting before the concreted has cured.

**Extruded** plank is produced from an extremely dry concrete mixture. The concrete is squeezed though the machine using a hydraulic and auger-driven system. The force of the extrusion process propels the machine down the curing bed. With this method, embed plates and block-outs are added by hand after the extrusion process but before the plank has completely cured.

## Plan for Bracing

When diaphragm loads are to be transferred or plank connections are needed to brace a beam, then those loads should be noted on the construction documents. Iverson recommends that the design professional note the function of the connection and specify a resistance, since he has observed many professionals note an arbitrary spacing, which is costly and overly conservative. For hollow-core plank, load-carrying connections are typically bottom embed plates that are welded to the supporting steel after erection.

Both service and erection loads need to be considered in the design of any structure, and Iverson notes that the majority of the time, the W-section supporting the plank can be stiff enough to support the unbalanced erection loads. Of course, the structural engineer of record or the erection engineer (usually hired by the fabricator) are required to check and confirm this before erection. If the beam is not stiff enough, then embedded plates could be used to attach the plank to the top flange and brace the beam during erection. Otherwise, alternate bracing would need to be considered.

## Consider Connections

When it comes to moment connections and plank bearing, plank producers cut the plank around columns, diagonal gusset-plates for braced frames, and anything else that might interfere with plank bearing. This also includes top-plate moment connections. When the precaster has to cut around the column and moment connections, the cut-out can become extremely large and present several difficulties, such as limited bearing for the plank and the potential need for expensive "drop-in" pieces to be formed. Plank producers usually recommend avoiding steel-framed connections that affect the top flange of a beam, and they recommend using alternate moment connections when possible. Iverson recalled a five-level building where the owner was able to save more than $50,000 in time and effort when the design team selected moment connections to simplify plank bearing details.

## Stay on the Level

"Do we need a topping?" is a common question with plank. It's an important consideration, because topping can lead to heavier structural loads, higher costs, more construction time in the field, etc. Several plank producers offer "carpet-ready" plank that can be erected to form a smooth surface, ready for carpet and pad installation.

But the fact is that the plank producer is usually unknown until after the bid has been accepted, and there is always the possibility that the carpet-ready requirement will be overlooked. It's a good idea to include a leveling compound in the initial schematic estimate to ensure a smooth finish. There are several leveling materials available, and this is a common practice for bringing concrete slabs into the required tolerances—and it usually adds less than

## Six Plank Tips for Fabricators

The potential for steel using hybrid structures—i.e., precast hollow-core and structural steel framing—is considerable, especially in the multi-story residential market where steel framing has not had a large presence.

Structural and miscellaneous fabricators are accustomed to dealing with collateral materials such as joists, joist girders, metal deck, roofing, wood, concrete, masonry, or drywall; precast hollow-core is simply another product. With any project, we must define the scope of work, identify the risks, and specify the responsible party for various aspects of the project. What is new to this equation is that precast hollow-core is a much more significant portion of the structural framing system and therefore presents some potential pitfalls.

Due to the magnitude of the product cost, the age-old question remains: Who is going to buy and therefore be responsible for detailing, fabrication, delivery, and installation of the product? Historically, general contractors have been reluctant to pay the necessary mark-up on this magnitude of work, and insist on buying direct. The coordination of the plank with the steel is critical to the project's success and must be in the hands of a competent manager or the project is doomed to failure. In my opinion, the fabricator is in the best position to assume this responsibility (checking shop drawings, establishing sequences, coordinating deliveries, and overseeing erection) and must be compensated for that responsibility and risk. The project site and nature of the framing system will determine whether steel and precast is erected by a single company or by two specialty firms.

Here are six suggestions to help highlight and streamline the construction process for this system:

**Educate.** Contact the Precast Concrete Institute to obtain manuals for design, detailing, production, and erection of precast hollow-core. Revisit the AISC Code of Standard Practice and compare steel issues to precast issues.

**Partner up.** Visit precast plants and discuss the issues with the staff and management. Perform the due diligence necessary to establish the credibility and reputation of the various firms. At the very least, coordinate your proposal in much the same way you would with a miscellaneous fabricator, erector, or supplier.

**Define scope and schedule.** What you are doing and what you are not doing are very important. The schedule must include all aspects of the framing system. Identify who is responsible for what.

**Details.** Pay attention to specifications and architectural details, and review these with your precast partners, erectors, and contractors.

**Establish expectations.** What are the expectations of owner, architect, engineer, and contractor? What kind of finish can be expected and achieved by the precasters on the top and bottom of the plank surface? Define tolerances for plank dimensions, openings, camber, etc.

**Manage the project.** Consider using the same firm to detail the steel and precast. Lines of communication must be established between the fabricator and precaster. Determine sources of information for answering questions, RFIs, etc.

*Ted Hazledine is president of Benchmark Fabricated Steel, Terre Haute, Ind.*

¾ in. to the floor height. If a carpet-ready plank producer is selected for the project, this estimated item can be eliminated.

Another important aspect to remember is using a high quality erector for the plank installation, since the plank producer is only one part of a "carpet-ready" floor. The erector may need to do additional labor, such as feathering out joints, etc., to provide a final product that is acceptable in the field.

## Go Shallow

Steel and plank systems are already known for their effect in lowering floor-to-floor heights, but can heights be reduced even further? The answer is yes, if the top of the plank is lowered to meet the top of the structural steel. While this option can increase labor and fabrication costs for the steel and precast plank package, this can be offset by the reduction in overall elevator, façade, and mechanical costs. These trade-offs need to be analyzed early in the schematic design phase to see which direction will be the best for the project. The fabricator should be a key player in this decision.

One option is to cut out the top flange of the supporting member (roughly a 5-ft cut for a 4-ft plank) and drop/slide the planks into place (see Figure 1). This can require much time and effort on the part of the steel erector and ironworkers—plus, the top flange must be welded back into place to ensure the structural capacity of the member, which is not an easy task to perform in the field.

Figure 1. Wide notches in the beam flanges allow the plank to be dropped in and slid into place.

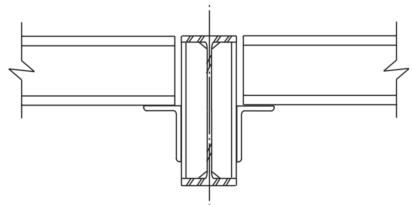


Figure 2. Adding vertical angles as stiffeners and then attaching a continuous horizontal support angle keeps the plank flush with the top flange of the beam.

Another option, which requires no cutting or dropping/sliding of plank, is to add vertical angles or stiffeners to the inside of the beam to support a continuous horizontal angle for plank bearing (see Figure 2). This simplifies erection, but the trade-off is increased shop labor. Regardless of which option is chosen, additional labor and costs will be incurred, so one must determine if added benefits of either option justify their application.

## For More Information

These are just a few helpful suggestions to keep in mind on your steel plank projects. If you have more questions about plank and steel framing, contact AISC's Steel Solutions Center at 866.ASK.AISC or solutions@aisc.org. They can even provide a conceptual solution to get you going on your next steel and plank project. Learn more at **www.aisc.org/conceptual_solutions**. MSC

*Todd Alwood is the Upper Midwest regional engineer with AISC.*

# ON RECYCLING
## Moore

**CHANGES** What you have to keep in mind is that getting rid of waste material is a big expense. The demolition industry is a lot more sophisticated than it used to be. There's new equipment. Government regulations are tighter...and harder to comply with. We've become more involved in recycling than ever before.

***Bill Moore, Vice President, Brandenburg Industrial Service Co., Chicago, one of the largest demolition companies in the U.S. President, National Demolition Association. Degree in Safety, Indiana State University. Spent a decade in insurance and safety specializing in the construction of high-rise buildings, another in demolition safety, and another in marketing for Brandenburg.***

**PROCESS** First thing we do is gut the interior of a building as much as possible and do whatever handwork is needed. We remove all the hazardous materials – mercury bulbs, asbestos, that sort of thing. And if there's office furniture or architectural artifacts, et cetera, left in the building, we'll pull them out and re-sell that too. Then we'll tear out the drywall, glass and wood – basically strip the building down to its structure. Once we're ready to wreck, we use a crane to drop a big machine on the roof to hammer out the concrete floor by floor, crushing it, until we're at ground level.

**REALITY** We don't necessarily recycle for good "green press" – it's economics pure and simple. Anything we can salvage out of a building, we'll do it because there's a market for it. The more we recycle, the more we salvage and less we landfill, the more competitive we can be for our customers.

**DELICATE** Brandenburg does much more than complete demolition. One job we did – the Rookery building at the corner of Adams and LaSalle – is the oldest high-rise building in downtown Chicago. It's a landmark, more than 100 years old. So the owner decided that rather than tearing the building down, it should be completely gutted to make way for a modern interior. So we do work like that too.

**COSTS** If we go to a landfill with a load of concrete, it's going to cost three or four hundred dollars here in Chicago – and probably double that on the East Coast. Landfilling concrete is expensive, so we're always trying to find different things to do with it. We'll crush it, use it to fill basements, try to find other jobs that need fill – we even have portable crushers to make it into CA6-type material for road beds and parking lot bases. Anything to get rid of it.

**WORTH** Concrete, basically, has no value. Even when we recycle it, we still have the expense of crushing it, which is about 10 to 50 dollars a truckload. While that saves us from having to go to the dump with it, it doesn't have a positive value. You'll never break even. Steel, on the other hand, has always been valuable. And like other commodities, the price varies quite a bit – right now, we're in a very good position when we sell steel.

**SHIPPING** Let me explain something about the transportation of material. You have a tractor trailer and it weighs about 40,000 pounds. Well, the legal load limit on most highways is 80,000 pounds. So you're going to put 40,000 pounds of material into the back of the truck. It really doesn't matter whether it is filled with steel or concrete because you're not going to load that trailer to water level and still be legal. But because steel is so much lighter and less bulky, you get rid of a greater percentage of material each time you load a truck with steel. To ship material is expensive – you want to do it in the least amount of trips.

**PLANNING** Building owners and developers need to think about demolition someday – what's going to happen to the material when the building isn't useful anymore? There's a movement by the Green Building Council pushing owners to think about their building when it has to be torn down. If you make a building out of steel, it will always be recyclable. Steel will always have value.

**MIXING** Try to picture a pot of molten steel, it's kind of like a big pot of stew or soup. When you're cooking and you want to make it spicier, you just put an additive in. But instead of pepper, you might put in more manganese or chrome. That's what's called altering the chemistry of the batch. Basically, if you're making structural steel, the mill will put in a base of reclaimed structural steel – like a recipe. Now if we were making re-bar, the chemistry for that is completely different than structural steel.

**STEEL** We always factor the scrap price into a project. In fact, there are jobs valuable enough that we will actually pay to do the work just for the scrap material. We're even going back to bids from a year and a half ago where we said we'd wreck the building for a quarter of a million dollars. Now, we're calling them up asking to do the job for free. We might even give them 50 grand or something like that. That's the great thing about steel – it always has value.

Steel Bridge NEWS
NATIONAL STEEL BRIDGE ALLIANCE SEPTEMBER 2007

# You Can't Judge a Cable by Its Cover

BY RONALD M. MAYRBAURL, P.E., AND HELEN GODDARD

**"Getting to the heart of the matter" is a good philosophy to adopt when evaluating suspension bridge cables.**

**THE NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM (NCHRP), IN 2004, PUBLISHED THE FIRST-EVER STANDARDIZED GUIDELINES FOR INSPECTING AND EVALUATING SUSPENSION BRIDGE PARALLEL-WIRE CABLES.** A report on background research accompanied the book, concluding a four-year effort by Weidlinger Associates to develop a nationally recognized procedure. It was a significant milestone in the battle to extend the service life of cables on U.S. bridges, the majority of which are more than 50 years old and carry increasingly heavy traffic.

Less conservative and rigorous techniques, based on limited data and unexplored assumptions, can lead to overestimations of strength or unnecessary repairs. Weidlinger's method is statistical, encompassing other methods that depend on minimum or average wire strengths. When a bundle of wires is tested in a machine, the wires break one at a time as the strain is increased. By exploiting this phenomenon, Weidlinger's strength calculations rationalize the process and give owners of aging bridges a crucial bonus: information about how the cable is likely to fail.

The cables on Scotland's 3,300-ft-long Forth Road Bridge were recently inspected for damage.

## Survey Says

The cables are the major carrying elements on a suspension bridge. They are constructed of many thousands of individual wires, usually laid parallel to one another and clamped at points where the suspenders connect with them to support the deck. The wires are galvanized or otherwise protected, but are susceptible to corrosion and an even more sinister form of degradation: the development of transverse cracks. In a survey of U.S. and Canadian suspension bridge owners, Weidlinger confirmed that the degree of internal corrosion can vary widely, from zinc deterioration to the presence of broken wires inside the cable. The survey results indicated that inspections are limited and inconsistent (wrapping removed for several inches to full cable length), but sufficient to correlate degree of damage (major vs. minor) with bridge age at inspection, leading to the conclusion that early inspection is best.

## No Crystal Ball

There is no shorthand method or engineer's sixth sense that can predict cable condition. The only foolproof method is to unwrap the cable and do sample wire testing, because even bridges with perfectly formed and well-maintained cables surprise inspectors. Weidlinger's experience inspecting bridge cables since 1978 confirms that it is prudent to begin at 30 years or soon thereafter and make sure the inspections are complete enough to determine the type and

*continued on p. 45*

*Mark your calendar:* **2007 World Steel Bridge Symposium** • December 5–7, 2007 • New Orleans, La.

A MESSAGE FROM THE

## Executive Director

As we enter the fall and reflect upon the past few months, consider that 70 million Americans traveled more than 100 miles from their homes to visit family and friends this summer. One should not forget the transportation infrastructure that allows us to make these visits. It is in fact the ability we Americans have to travel and enjoy the many wonders of our country that makes this such a great place to live. Yet there is a price to pay for these arteries that bring us together.

The collapse of the I-35W Bridge in Minneapolis reminds us of the need to continue, if not renew, the vigilance necessary for keeping the safety of our roads and bridges up to par.

Members of the National Steel Bridge Alliance should realize the challenge before us in improving our infrastructure. I'm confident we will rise to the occasion and display the technical knowledge, pride, and sprite needed to keep our nation's bridges safe and usable for generations to come.

This task will require the consensus of the entire steel bridge community, with efforts to influence our congressional representatives, state and local government agencies, and decision makers to properly assign funding to projects in areas that need it the most.

Our current Buy America laws will need to be supported, if not enhanced, to protect the industry base of steel producers and steel bridge fabricators. Technical advancements in techniques to accelerate construction, improve design, enhance maintenance criteria, and raise bridge safety measures will be the industry's and transportation department's responsibility.

The opportunity for a bright steel bridge future is achievable with a concerted effort on our part. Let's use the recent tragedy in Minneapolis to springboard our industry to renewed greatness for years to come.

Best regards,
*Conn Abnee*
NSBA Executive Director



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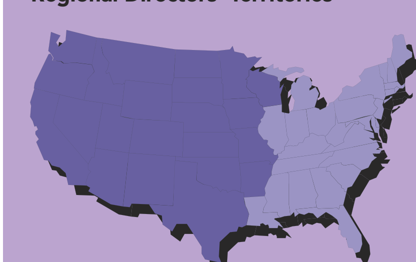
**Regional Directors' Territories**



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severity of deterioration. Early intervention is always more effective, because the type of protective measures to be implemented, if needed, and the schedule of future inspections can be better tailored to the conditions on a particular bridge. That's late-arriving advice, as most existing suspension bridges have passed the 30-year milestone; because of the costs involved, rare is the bridge inspected before 60 years.

### Forth Road Bridge

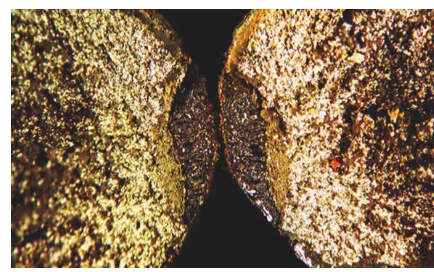
A recent investigation of the cables on the Forth Road Bridge in Scotland should persuade everyone to rethink the one-size-fits-all, let's-wait-to-the-last-possible-minute approach.

Alastair Andrew, general manager and bridge master of the Forth Road Bridge, first learned about Weidlinger's work during one of many presentations made at national and international conferences. Andrew was impressed enough to think it wise, if overcautious, to inspect his 40-year-old cables. Based on their excellent external condition, he surmised they were "a long, long way from wires breaking" and would pass inspection easily. One of the longest suspension bridges in Europe, the Forth spans 3,300 ft and carries 24 million vehicles a year in four traffic lanes. Its construction in 1964 ended an 800-year history of ferry-boat transport across the Firth of Forth. Weidlinger led the investigation and trained engineers from the UK firm Faber Maunsell in its new standardized technique; testing was conducted by Bodycote, Ltd.

The process began with a cable walk to observe the condition of the wrapping. The cable appeared to be well maintained: There were no visible water leaks, rust stains, or bulges, although the presence of ridges indicated that wires were crossed and susceptible to rust because of the voids they created. Next, a total of ten cable panels were unwrapped. To be economical, several feet of wrapping wire were left in place at one end of each inspected panel, so that only one machine was required for rewrapping. That still left a generous 55 ft per panel for internal inspection. Eight lines of wedges were driven into the center of the cable, and the condition of visible wires was recorded by inspectors. Much to everyone's surprise, broken wires were found to a six-wire depth, as well as a considerable number of corroded wires. Eighty wires

## Cable Dehumidification

Although early inspection may be controversial, the cure is not. Dehumidification at the early stages of deterioration extends cable life, as does improving the wrapping to prevent water from entering. Acoustic monitoring to detect breaking wires and dehumidification using the Japanese system of dry-air injection for prevention are being implemented on the Forth Road Bridge in Scotland. Both cables should be water-free by late 2009 or early 2010. The bridge continues to be monitored for further wire breaks.



Close-up view of cable corrosion on the Forth Road Bridge.

## All Wrapped Up

Here's what's involved in inspecting and repairing the cables for Scotland's Forth Road Bridge.


The existing wrapping is removed from the cable.



Wedges are driven into the center of the cable so that they can be inspected.


A sample wire is cut and tested.


New wires are installed as necessary.


The cable is recompacted…


…rewrapped…


…and repainted.

were removed and rigorously tested. The wires were graded according to the corrosion stages developed by Hopwood and Havens (1984), from 1 (wire and zinc coating barely oxidizing) to 4 (more than 30% covered with brown rust). The data were used to estimate how many of the 11,618 wires in each cable were in each stage and how many were cracked.

Analysis confirmed that the cable had lost 8% to 10% of its strength. Early estimates before the number of cracked wires was known suggested almost double that loss, based on experience with other bridges. Testing revealed fewer cracked wires than anticipated and confirmed that every bridge is unique in this regard. Cracked wires are the major determinant in calculating cable strength. Unfortunately, cracks are not visible during inspection. When broken wires are found, cracks are likely to exist in unbroken wires; but they only become evident after testing, when the failure surface is inspected under a microscope. When wire sample selection and testing are as rigorously specified to yield consistent and sufficient data as they were on the Forth Road Bridge, it ensures confidence in the conclusion. An owner armed with a statistically clean set of data and a safety factor rating can plan and budget more efficiently. As more inspections take place, a central database of test results would be invaluable to keep track of cable strength results versus age and help engineers estimate future deterioration rates more precisely.

## Digging Deeper

One cannot safely predict cable condition from observation alone, nor how much strength loss can be sustained on a particular bridge. There is no rule about permissible strength loss, but a safety factor below 2 spells trouble. Even this number is not absolute when there is careful monitoring. Based on the sobering experience with the Forth Road Bridge, another suspension bridge in Great Britain was inspected and yet another is under consideration. The NCHRP guidelines are also being used to assess cables on the Bear Mountain Bridge in New York, among other spans. MSC

*Ronald Mayrbaurl is consulting principal and former director of bridge engineering with Weidlinger Associates in New York. Helen Goddard, also with Weidlinger, edited the* NCHRP Guidelines and Report.

# Making a Statement

BY STEVE HAGUE

**Designers blend clean, sweeping lines with creative use of steel to produce a signature span for Ohio's capital.**

CIVIC LEADERS THESE DAYS ARE ALL TOO EAGER TO ATTACH THE LABEL "SIGNATURE BRIDGE" TO ANY NEW SPAN THAT ENHANCES THE LOCAL SKYLINE. Other bridge designs, however, deserve the label because they are so bold and innovative that they quickly become synonymous with the city where they were built.

The new Main Street Bridge now under construction across the Scioto River in Columbus, Ohio is in this latter group. Given the opportunity to create a new structure, city leaders wanted a bridge that would support and add value to urban and regional development plans, create desirable public spaces, and ultimately make an unmistakable statement.

In fact, one state transportation official expects the Main Street Bridge to achieve the iconic status of the Brooklyn Bridge or the St. Louis Arch. The dramatic design represents several significant firsts:

- The inclined single-rib arch will be the first of its type in the United States and one of only a handful in the world.
- It will be the first inclined arch—designed or built—tied together with cables and struts.
- It will be the world's first single-inclined arch bridge that incorporates separate pedestrian and vehicular decks.

## Meeting a Pressing Need

The Main Street Bridge will link downtown Columbus with the older community of Franklinton to the west. The previous Main Street Bridge, a 70-year-old concrete span that was on the National Register of Historic Places, had deteriorated to the point that the city was forced to close it in 2002. Because the multiple-span, open-spandrel concrete deck arch bridge was an important eastbound artery, Columbus needed an efficient and effective solution for commuters. So, ODOT and the City determined that building a new bridge would be more cost-effective than renovating the existing one.

The diverse group of stakeholders involved in the design process underscores the project's significance to the city. That group includes state and federal transportation officials, city leaders, the Ohio historic preservation office, the Franklin County engineer, developers of a high-rise residential complex near the bridge, the Greater Columbus Arts Council, and the

The new Main Street Bridge in Columbus will be completed in 2009.

City's Historic Preservation Office. This group agreed on specific design criteria:

- Access for bikes and pedestrians in addition to vehicles.
- Aesthetic and architectural compatibility with the Broad Street Bridge, the primary artery into downtown Columbus, and with the Civic Center Historic District.
- An unobstructed view of the river and skyline for motorists and pedestrians.
- Structural life of 100 years.
- The ability to accommodate the transportation needs of an expected 400,000 new residents over the next two decades.
- A link to the Riverwalk project now under development.
- Accommodation for several area summer festivals.
- Low-maintenance service.

### A Design that Works

All of these criteria culminated in what could be called a tall order for the design team. The team developed more than 50 preliminary concepts during a two-day charrette, which were narrowed down to six. At that time, S.N. Pollalis of the Harvard University Graduate School of Design was invited to join the team, and three new design concepts were presented to City officials. By public vote, the inclined arch concept developed by Pollalis was chosen as the preferred option.

A paramount design consideration was the use of clean, classical lines that evoke the city's neighboring arched bridges and art deco buildings. The final design is a single rib-tied steel arch inclined at a 10° angle from vertical. The arch emerges through the bridge deck, and steel hangers descend from the arch to support members below the deck. Unlike traditional tied-arch bridges, stay cables are used for the tie.

The bridge features three vehicle lanes for eastbound traffic, a 5-ft sidewalk on the south side, a steel box girder roadway, a concrete pedestrian path, piers that complement the superstructure design, and a pedestrian deck that sweeps horizontally and vertically away from the roadway to provide an unobstructed view of the city's downtown.

The overall length of the three spans is approximately 660 ft. The main span is 400 ft long, and the spans on each end are 130 ft long. The three-lane vehicular deck is 35 ft wide, and the pedestrian walkway is 18 ft wide. The curved pedestrian bridge is

### Main Street Bridge by the Numbers

- 42 million – project budget in dollars
- 1937 – year original bridge was built
- 100 – years new bridge is designed to last
- 10 – degrees of angle from vertical of the rib-tied arch
- 5 – width in feet of sidewalk on south side
- 18 – width in feet of pedestrian deck
- 660 – overall length in feet of three spans
- 400 – length in feet of main span
- 130 – length in feet of end spans
- 35 – width in feet of vehicular deck
- 3,000 – tons of ASTM A709 Grade 50 steel that will be used

connected to the arch by a series of cables and struts that support the structure.

### Committed to Steel

The design team was committed to using steel, in large part because of budget constraints (overall cost is $42 million); although the location and structure type determined materials to some degree, cost was the overriding decision point.

Designers originally selected concrete to achieve the pure, smooth lines the project required. They later decided they could attain the same look with steel, which would be lighter and easier to fabricate, and take less time to construct. The use of box girders under the roadway achieves the same clean look as concrete. Designers and engineers also recognized that steel would require a shorter erection time, which would reduce the length of time the temporary supports were exposed to flooding risk.

The creative use of steel solved several engineering challenges. For example, designers switched from concrete to steel boxes to support the road deck and enable it to span the river more safely. Using steel also lightened the bridge load and allowed the removal of composite concrete that originally was going to be put in the arch.

Nearly 3,000 tons of ASTM A709 Grade 50 steel will be used during construction. The general contractor ordered steel when the old Main Street Bridge was removed last fall, and fabrication was expected to take about one year. Because the bridge is being built in a heavily developed area, the logistics of shipping fabricated parts required careful planning.

As soon as foundation and substructure work is completed, contractors will build temporary towers along the roadway box girder to support construction of the vehicular steel box and the arch. After these are completed, workers will install floor beams to support the pedestrian deck on the north side and the permanent struts and hangers for the arch. Finally, the contractor will build the pedestrian and bridge decks before removing the towers.

### A Strong Statement

Building a bridge that meets the needs of diverse stakeholders is always a challenge. Making an architectural statement that will define the city's skyline for the next century takes the challenge to an even higher level. The Main Street Bridge is on track to meet this challege when it opens in 2009.

MSC

*Steve Hague is chief structural engineer for HNTB Corporation's Kansas City Bridge Group and the firm's project manager for the Main Street Bridge.*

**Owner**
Ohio Department of Transportation

**Design**
DLZ Ohio, Inc., Columbus
HNTB Ohio, Inc., Columbus

**Project Architect**
Dr. S.N. Pollalis, Harvard University Graduate School of Design, Cambridge, Mass.

**General Contractor**
Kokosing Construction Co., Inc., Fredericktown, Ohio

**Erection Engineer**
Janssen & Spaans, Indianapolis, Ind. (AISC Member)

**Steel Detailer**
Tensor Engineering, Indian Harbour Beach, Fla. (AISC Member)

**Steel Fabricator**
PDM Bridge LLC, Eau Claire, Wis. (AISC Member)

# The Other Side of the Tracks

SUBMITTED BY HDR ENGINEERING, INC.

**A new viaduct provides motorists with an alternate route over multiple tracks in a western Iowa railroad town.**

**THE ORIGINAL STARTING POINT FOR THE TRANSCONTINENTAL RAILROAD, COUNCIL BLUFFS, IOWA, HAS TRULY BECOME A RAILROAD TOWN.** The presence of multiple railroad companies in the city divides the community physically with tracks dissecting it in both the east-west and north-south directions.

This creates some life safety issues in the event that the only east-west railroad overpass becomes blocked or closed for any reason. It therefore became a priority for the city to construct a second viaduct over tracks of the Union Pacific (UP) Railroad and the Chicago Central and Pacific (CCP) Railroad.

The chosen location for the new railroad overpass is north of the primary central business district on an arterial route, the Avenue G corridor, through a primarily residential area of Council Bluffs. As Avenue G crosses the two railroad companies' tracks, it is also flanked by various industrial buildings and a school. The locations of these facilities, as well as numerous primary utilities in the tight Avenue G corridor, eventually led to a partially offset alignment for the overpass. To provide adequate offset to the adjoining buildings, the alignment of the bridge structure required reverse curvature.

## Smooth Curves

The Avenue G Viaduct project incorporates a four-lane cross-section in its 54-ft clear roadway and includes a 10-ft wide trail on the south side. The 1,290-ft long bridge crosses two city streets, a three-track cluster of the CCP Railroad, two yard tracks and a proposed future yard track of the UP, and a separate five-track cluster of the UP. This five-track cluster includes the UP's two mainline tracks, an industrial lead track, and two additional yard tracks. The curving bridge alignment also passes within approximately 10 ft of an existing brick railroad maintenance building that was formerly a UP roundhouse, and within approximately 15 ft of an industrial building housing a furniture manufacturing facility. To minimize the required bridge length, the abutments at each end of the bridge are situated behind mechanically stabilized earth (MSE) walls.

Preliminary design of the viaduct presented several challenges including:

- Consideration of steel plate girder and prestressed concrete beam superstructures.
- Detailed cost estimates for each superstructure type.
- Minimization of MSE wall heights at the abutments because of settlement and stability constraints stemming from poor geotechnical conditions.
- Accommodation of the reversed curve alignment.
- Minimization of the required utility relocations for bridge substructures.
- Accommodation of vertical and lateral clearances to adjacent railroad tracks and city streets.

In addition, because of the curving bridge alignment, there was also a preference for providing constant bridge deck overhang widths and having the fascia of bridge girders follow the curved

The proximity of the bridge to adjacent industrial structures required a reverse-curve alignment.

alignment of the bridge rather than using chorded girders.

### Decision Time

When weighing steel plate girder against concrete prestressed concrete beam alternatives, both standard Iowa Department of Transportation (IaDOT) bulb-T prestressed concrete beams and IaDOT's newer metric bulb-T beams were considered. These inventories of prestressed beams allowed a maximum span of approximately 140 ft using IaDOT's design criteria for providing structures that are considered continuous for live load. The prestressed beam structure type would have required a 12-span structure, given the constraints of pier placement that resulted from the locations of existing roads and railroad tracks. The limitation on the maximum span length also would have placed one pier within a 25-ft clearance envelope of a proposed future track for the UP. This constraint would have required approval from the UP as well as the addition of a crash wall to protect the pier. Furthermore, the reversed curve alignment would have prevented the desired uniformity in casting lengths for prestressed girders in a given span, which promotes efficiencies in this type of structure.

The steel plate girder structure type, on the other hand, would allow for longer span lengths of up to 180 ft within the same structure depth as required for the standard prestressed concrete bulb-T beams. These longer span lengths would provide a particular advantage for this bridge, considering the locations of the existing streets and railroad tracks. As a result, the steel plate girder option would require only an eight-span structure, thus saving three pier elements throughout the length of the bridge. Because the alignment of the bridge is on a reversed curve, the sweeping alignment crossed over the center line of the existing Avenue G corridor. This sweeping alignment would wreak havoc with the existing utility facilities in the corridor. Consequently, a reduction in the number of piers also translated into fewer utility conflicts.

### Early On

IaDOT typically does not take alternate steel girder and prestressed beam bridge designs all the way through final design and letting. The agency's normal practice is

## Comparison Matrix of Steel and Prestressed Concrete Bridge Alternatives

| | Advantages | Disadvantages |
|---|---|---|
| **Steel Girder** | ✓ Slight cost advantage<br>✓ Longer spans/increased lateral railroad clearances<br>✓ Fewer piers/fewer potential utility conflicts<br>✓ Fewer pier footings next to UP roundhouse<br>✓ All piers outside of desirable 25-ft railroad clearance<br>✓ Better overall aesthetics (no chorded girders) | ✗ Generally longer lead time on girder fabrication<br>✗ More field pieces to erect<br>✗ Potential staining of piers from weathering steel |
| **Prestressed Beam** | ✓ Improved speed of erection<br>✓ Faster fabrication/delivery turnaround | ✗ Slight cost disadvantage<br>✗ Chorded girders not as aesthetic<br>✗ Variable slab overhang more difficult to form<br>✗ Piers on both sides of UP mainline less than 25 ft clear<br>✗ More piers/more potential utility conflicts<br>✗ Span limitation doesn't allow for future UP railroad track<br>✗ Variation of beam lengths in curved sections |

to evaluate the different structure types in the preliminary design stage and to make a decision on the structure type at the conclusion of this design. Therefore, a detailed quantity and cost estimate was prepared for each alternative at the preliminary design stage. Substructure dimensions were estimated, and reinforcing densities were assumed based on past projects utilizing similar multi-column bents and abutment types. The number of piles per substructure element and pile lengths were also estimated. The number of girder lines could be determined and the structural steel quantities could be estimated based on preliminary girder designs for both the steel and prestressed beam alternatives. The bridge deck concrete quantities could be determined based on the assumed bridge cross section, and deck reinforcing quantities were estimated based on deck reinforcing densities from similar IaDOT projects. Finally, recent IaDOT average bid tab unit prices were applied to the appropriate quantities to establish base estimates for the steel girder and the prestressed concrete beam alternatives. These detailed estimates indicated that the steel alternative was slightly (approximately 2%) less expensive than the concrete alternative.

Because the cost estimates of the two structure types were very close, a decision matrix was also prepared to compare various parameters. The matrix indicated the advantages and disadvantages of the steel girder and prestressed concrete beam alternatives.

After consideration of the expected cost and functional advantages of the steel girder alternative, a decision was made to proceed with steel. The contract was awarded with an in-place bid price for fabricated structural steel of $1.13 per lb, which closely matched the unit price estimated in preliminary design. With an expected opening by late November of this year, the Avenue G Viaduct will provide a welcome alternative route over the tracks for Council Bluffs residents. MSC

**Owner**
The City of Council Bluffs, Iowa

**Bridge Design**
HDR Engineering, Inc., Omaha, Neb. (Subconsultant to HGM Associates, Inc., Council Bluffs)

**Project Architect**
RDG Planning & Design, Des Moines

**General Contractor**
Cramer & Associates, Des Moines

**Steel Fabricator**
PDM Bridge Wausau, Wis. (NSBA Member)

**Engineering Software**
STLBRIDGE, Bridgesoft, Inc.

# Rolling Along

BY GEOFF WEISENBERGER

## An inside look at how large coils of flat steel become uniform pieces of metal deck.

THE CMC JOIST AND DECK FACILITY IN PERU, ILL. IS HARD TO MISS. Just north of I-80 about 100 miles west of Chicago, the mammoth blue metal building clearly stands out from the surrounding flat landscape.

The facility, which opened in 2000, was formerly part of Nicholas J. Bouras, Inc. before that company was purchased by CMC Joist and Deck in April. It makes metal deck exclusively, producing approximately 300 tons of deck per day to be used as composite and form decking (both with concrete), as well as roofing. It is one of three CMC Deck facilities; the other two are in New Jersey and South Carolina.

Speaking of which, the main benefits of steel deck are its high strength-to-weight ratio and load-carrying capability, which it gets from its corrugated profile. In flooring applications, these attributes supplement and reinforce the concrete, which is placed over the metal deck. Composite flooring systems allow for longer spans and thinner floor slabs than do non-composite systems. Quick assembly is another advantage, as metal deck can serve as a work platform for all trades. It is used for flooring in a wide variety of steel-framed buildings, but especially with high-rises, where it can help reduce floor-to-floor and overall building heights.

### A Different Environment

Before touring CMC, I'd visited a fabricator, a mini-mill, and a galvanizer, and I immediately noticed two key differences between those facility types and this one. First, where metal shavings, soot and ash, and condensation are the norm at these other facilities, making metal deck is a very—well—clean operation, even with painting as part of the process.

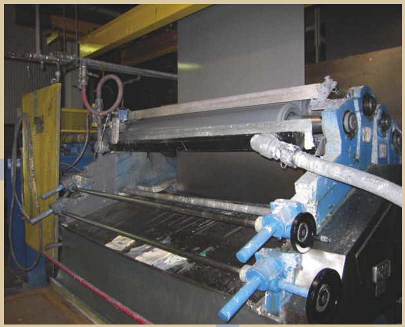
The other difference I noticed was that there was no steel piled up outside the building—no materials yard for finished product. That, says Ron Grant, the Peru location's general manager, is because the facility works on a daily schedule. Where outgoing materials can stay for days or even weeks at galvanizers, fabricators, and mills, it's pretty much off-site by the next day at CMC, primarily shipped directly to job sites; the idea is "fabricate today, deliver tomorrow." Most deck produced at Peru is slated for jobs within a 500-mile radius, although the facility has shipped deck to projects as far away as the West Coast. Grant emphasizes that every order is customized; they don't stock material for sale.

Of course, a large warehouse adjacent to the deck-making building houses coils and coils of cold-rolled plain and galvanized flat steel—the vast majority of which is manu-

### How Metal Deck is Made

Ever wonder how metal deck achieves its fluted form? Producing metal deck is a fairly simple, albeit precise, process. The below photos walk you through a typical deck job at the CMC Deck facility in Peru, Ill. The series shows the painting, roll-forming, and cutting of 48.25-in.-wide flat steel that ended up as 36.125-in.-wide metal deck. The finished product is generally shipped the next day, directly to the job site.

1 A coil of steel is put through the painting machinery, which somewhat resembles a newspaper printing press.



2 Three coats are applied to the steel, then it travels through ovens that dry the paint. The steel is then cooled and re-rolled back into a coil.

3 The steel coil is put through the roll-forming line.

factured by U.S. Steel in Gary, Ind.—waiting to be rolled into the final product. Quality control for the steel is performed at the mill, although CMC verifies that the lengths and widths of the delivered bundles are correct.

Although cleaner and without a materials yard, the metal deck operation is just as loud as the others, especially thanks to the machine cutting the steel. As such, ear protection is the rule, along with hard hats, eye protection, and gloves.

## Cutting Grooves

Both hot-dip galvanized and cold-rolled (uncoated) materials are used to make metal deck. The majority of uncoated material is furnished to the end user with a shop coat of primer. The process itself is fairly simple. First comes the painting, for corrosion protection and aesthetic purposes. The painting schedule is determined approximately two weeks ahead of when the job is actually going to be rolled. Steel to be painted—mostly for roofing deck—is put through a long series of painting machinery that somewhat resembles a printing press. Three coats are applied via rollers: a pretreatment that helps the paint better adhere to the metal, a primer coat, and a finish paint coat. Two colors are available—gray (UL listed) and white primers—and any combination of colors and sides is possible: gray on one side, white on the other; gray on both sides; white on one side, no paint on the other; etc. After paint is applied, the steel travels through heating ovens, which dry it, then through a chilling unit before being rolled up into a coil again.

From here, the steel is placed in inventory, where it will stay for a day to two weeks before being roll-formed. The roll-forming process is what creates a finished metal deck product. The Metform roll-forming lines that CMC uses are roughly 100 ft long and can run 250 ft of steel per minute with most products. A line contains four sets of rafts, which are sets of tooling rolls that create the width of the deck and the flutes. The first raft creates one flute down the middle of the steel, drawing the metal inward. As the steel travels down the line, each set of rafts create more flutes, outward from the center. At the end of the line, the steel is cut into the exact lengths required for each order. A worker controls the roll-forming line from a nearby station at this end of the machine, and another worker seated just past the shear pulls each deck piece off the line and places it into a stack as a finished product.

As we watch the worker pile up section after section of finished steel deck, Grant explains that this step in the process isn't

4 The first flute is made in the center of the steel, drawing it inward.

6 At the end of the line, the deck is cut with a shear machine, then is stacked and bundled, ready to ship.

5 As the steel travels down the line, more and more flutes are created from the center out.

as easy as it looks. Each piece of deck can weigh as much as 350 lb, and stacking the pieces while getting the flutes to line up requires finesse. Grant says that the key is using the momentum of the steel as opposed to muscling it. The end result is a short, neat stack of deck, perfectly lined up, bundled, and ready to be shipped. Six loading docks provide trucks with direct access to the finished products.

## A Good Gauge

The majority of the steel rolled at the Peru facility is 0.028-in.-thick (22-gauge) steel that starts out at 48.25 in. wide and ends up at 36.125 in wide, although the plant is capable of working with gauges of up to 16. The rafts are removable and can be switched out to accommodate deck products of different numbers, widths, and depths of flutes. It takes about 45 minutes to change all the rafts on a line.

The facility has four roll-forming lines, three for its standard roof and flooring projects and one cell deck line for specialty products. This specialty line generally rolls a thicker gauge of steel, much of which is perforated and has an insulation bat installed in it for soundproofing purposes. The bulk of the deck produced from this specialty line is used in gymnasiums, cafeterias, and other school areas. This machine generally rolls far less steel per minute than the three main lines, and product created on this machine tends to stack much higher.

There are also machines that produce "accessory" products: end caps, flashings, etc., which are used to close in the ends of the decks at the edges and corners during installation. Grant also says that his facility has the capability to produce special accessory items as needed.

## Room to Grow

The Peru facility employs 55, including 12 detailers. Grant notes that CMC is committed to hiring locally, and all but a handful of the employees are from the area. He explains that employees are cross-trained for various tasks (meaning that the worker stacking the steel deck at the end of the roll-forming line doesn't have to do that all the time). All production is performed during one shift, but Grant anticipates that business will increase enough to warrant a second shift some day.

And things are looking good. The Peru facility is capable of using 75,000 tons of steel per year, and last year's production was up from the year before. MSC

| Company | Products Offered | Product Descriptions |
|---|---|---|
| **A.C.T. Metal Deck Supply**<br>www.metaldecksupply.com<br>**800.894.7741** (Chicago, St. Louis, Indianapolis, Kansas City, Mo., Fort Worth)<br>**866.668.3325** (Knoxville, Greensboro, Jackson, Fla., Columbus) | **Metal deck distributor** | Distributor of steel floor, roof deck, and related products. All metal deck is available in all types, gauges, and finishes. Specialty products and a full line of accessories are also available. |
| **ASC Steel Profiles, Inc.**<br>www.ascprofiles.com<br>www.ascsd.com<br>**800.360.2477** | **DeltaGrip** | A side seam attachment system that is a revolutionary alternative to welding. A lightweight and easy-to-use pneumatic tool that clutches the seams together in one-seventh the time of welding and includes a Go-No-Go gauge to ensure that each grip stacks up to its name. Installation is fast, safe, and consistent. |
| **Canam Steel Corporation**<br>www.canam.ws<br>**508.238.4500** (Easton, Mass.)<br>**301.874.5141** (Point of Rocks, Md.)<br>**636.239.6716** (Washington, Mo.)<br>**904.781.0898** (Jacksonville, Fla.)<br>**509.837.7008** (Sunnyside, Wa.) | **Roof deck 3615/3606** | Roll-formed to cover 36″ wide; flutes are 1.5″ deep, spaced 6″ on center. Deck can be rolled to lengths from 6′ to 42′-6″. |
| | **Composite deck 3615/3606** | Roll-formed to cover 36″ wide; flutes are 1.5″ deep, spaced 6″ center to center. Deck can be rolled from 6′ to 42′-6″ with enough space to weld headed studs through deck to top of beams/joists for composite action. |
| | **Composite deck 3623/2432** | Roll-formed to cover 24″ wide; flutes are 2″ to 3″ deep, spaced 12″ from center to center. Deck can be rolled from 6′-6″ to 40′ with enough space to weld headed studs through deck to top of beams/joists for composte action. |
| | **Form deck 3012** | Roll-formed to cover 30″; flutes are 9/16″ deep and spaced at 2½″ center to center. Rolled to requested length or stocked in 20′-4″ lengths to cover multi-spans of form deck. |
| **CMC Joist & Deck**<br>www.cmcjd.com<br>**908.277.1617** | **Roof deck** | 1.5″ (B & F) and 3″ (N) roof deck. Finishes include gray or white primer, G30, G60, and G90 galvanized and special paint coatings. Acoustic treatment is available. |
| | **Composite floor deck** | 1.5″ (B Lok & Lok Floor), 2″, and 3″ (Lok Floor) composite deck. Finishes include painted, galvanized, and galvanized + primer finishes. |
| | **Deep deck** | "Deep deck" roof deck profiles in 4.5″, 6″, and 7.5″ depths. Finishes include galvanized, galvanized + primer finishes, and special paint coatings. Acoustic treatment is available; thicknesses to 10 gage on type LS. |
| | **Cellular roof and floor decking** | 1.5″-, 2″-, 3″-, 4.5″-, 6″-, and 7.5″-deep acoustic and non-acoustic are available. Finish options include galvanized, galvanized + primer finish, and special paint coatings. Fiberglass insulation batts are shop installed when acoustic. |
| **CSi Metal Dek Group**<br>www.metaldek.com<br>**803.251.5034** | **Bridge deck forms** | CSi Metal Dek Group produces metal stay-in-place bridge deck forms. |
| **Curveline, Inc.**<br>www.met-tile.com/curveline<br>**888.998.0311** | **Custom crimp-curving** | Curveline's service center provides custom crimp-curving of 22-18 gauge "B" deck and "N" deck profiles into the desired radii and angles of curvature. The crimp-curving process increases panel strength, making it possible to achieve multiple-span panel designs that use lighter-gauge material. Savings from reduced substrate and structural requirements can be significant. Applications include standard, perforated, and acoustic decking panels. |
| **D-MAC Industries, Inc.**<br>www.d-macindustries.com<br>**800.878.362** | **Roof deck** | Sections kept in stock for immediate shipment nationwide include Types A, B, F, and N in prime-painted or galvanized finishes, cut to any length. |
| | **Floor deck** | Galvanized 1.5″, 2″, and 3″ composite decks and 9/16″, 15/16″, 1 5/16″, 1½″ and 2″ non-composite floor decks are available cut to length from stock in gauges 16 to 28. |
| | **Bridge form** | D-MAC produces 1.5″, 2″, 2.5″, and 3″ deep form sections in gauges 16 to 22 and pitches ranging from 5″ to 10″ with G-165, G-210, and G-235 galvanized coatings. |
| | **Deck accessories** | D-MAC manufactures deck accessories such as closures, pour stops, and custom shapes, and supplies rubber closures, fasteners, and related items. Short lead times are standard practice for all products. |
| **DACS, Inc.**<br>www.dacsinc.com<br>**757.393.0704** | **Roof decks** | Include type A, B, F, J and H. Cellular roof decks are available also. Most decks are available in galvanized or prime painted gray or white. |
| | **Composite floor decks** | Include 1.5″, 2″, or 3″ and are available galvanized. Cellular floor decks are also available. |
| | **Non-composite form decks** | Include 9/16″ (S-deck), 7/8″ (heavy-duty), and B-inverted (1.5″). All are available in galvanized. |
| **Hilti, Inc.**<br>www.us.hilti.com<br>**800.879.8000** | **DX 860 HSN** | The stand-up DX 860 HSN Powder Actuated Fastening System fastens into 1/8-in. to 3/8-in. bar joists and can drive up to 1,000 fasteners per hour from a comfortable stand-up position. For increased safety, it has a unique piston/brake system that stops the piston on every shot to help prevent fasteners from punching through the deck when the support beam is missed. This feature helps prevent damage to the deck and saves time because there is no need for patching. A preset setting depth provides consistent fastening quality. |
| | **DX 860 ENP** | The stand-up DX 860 ENP Power Actuated Fastening System fastens structural steel applications and can drive up to 800 fasteners per hour, and has the potential to reduce total deck installation time by up to 40%. |
| | **ST 1800/SDT 25** | With increased power and torque, the ST 1800 Adjustable Torque Screwdriver sets the standard for fast, reliable metal-to-metal fastenings. It can be used alone or with the SDT 25 Decking Tool to work in an upright position for added comfort and flexibility to fasten into metal decking and bar joists. Using the SDT 25, a worker can convert the ST 1800 from a hand-held to a stand-up system that can be used for both fastening deck sidelaps and attaching metal deck to thin bar joists and purlins. |
| **MBI Products Company, Inc.**<br>www.mbiproducts.com<br>**216.431.6400** | **Acoustical products** | MBI manufactures acoustical products of all types and provides insulation for perforated acoustical metal deck flutes. Insulation is available in different thicknesses and densities, and comes in rolls or pieces. |

# products



| Company | Products Offered | Product Descriptions |
|---|---|---|
| **Metal Dek Group, a unit of Consolidated Systems, Inc.** www.metaldek.com **800.DEKDSGN** | **Roof deck** | Standard and architectural deck systems and accessories. |
| | **Floor deck** | Standard and architectural deck systems and accessories. |
| | **Form deck** | Full line including accessories. |
| | **Bridge deck** | Full line including accessories |
| **New Millennium Building Systems** www.joist-deck.com **260.868.6000** | **Roof deck** | Attached to steel joists or beams and used as support for roof coverings. Available in a galvanized or prime painted finish. |
| | **Form deck** | Attached to steel joists or beams and used as forms for poured concrete platforms. Available in a galvanized or prime painted finish (1" depth or less, galvanized only). |
| | **Composite deck** | Attached to steel joists or beams and used in conjunction with shear studs to form a composite floor system. Available in a galvanized or uncoated top/painted bottom finish. |
| **Nucor Vulcraft** www.vulcraft.com **435.734.9433** (Brigham City, Utah) **607.529.9000** (Chemung, N.Y.) **843.662.0381** (Florence, S.C.) **936.687.4665** (Grapeland, Texas) **402.644.8500** (Norfolk, Neb.) **260.337.1800** (St. Joe, Ind.) | **Steel deck, steel joists, and joist girders** | Nucor Vulcraft Group is the nation's largest producer of steel deck, steel joists, and joist girders. Vulcraft also works with highly engineered products like composite floor joists. Vulcraft supplies products for a wide range of structures. Vulcraft products are made from more than 90% recycled materials and have been essential elements in green buildings. |
| **Pneutek, Inc.** www.pneutek.com **800.431.8665** | **Fasteners and fastening tools** | Pneumatically driven mechanical fasteners and fastening tools used to attach steel roof and floor deck to the structural substrate (1/8-in. minimum, no maximum) of steel-framed buildings. |
| **Roof Deck, Inc.** www.roofdecking.com **609.448.6666** | **Roof and floor deck products** | Complete manufacturer of roof and floor deck products. Delivery is fast, and most items can be manufactured in just one day. |
| **Steel Deck Institute** www.sdi.org **847.458.4647** | **Steel floor and roof deck trade association** | The trade association for manufacturers of steel floor and roof decks and related products. The SDI provides industry guidelines for engineering design, manufacture, and field use of steel decks. SDI also prepares, reviews, and distributes literature, and liaisons with construction industry associations on matters of common interest. |
| **Wheeling Corrugating Company** www.wheelingcorrugating.com **304.234.2332** | **Roofing and siding** | Our painted and roofing products come in seven distinctive profiles. Each comes in a variety of colors. Tough enough to handle light commercial applications and handsome enough for residential installations. |
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| | **Painted coil products** | Wheeling has added another technically advanced coil coating line. This new system, along with our well-established double coat paint line, dramatically increases the availability of our premium quality coil. |

# project case study

## **Curveline, Inc.**—Vancouver Clinic at Salmon Creek, Vancouver, Wash.

**WHEN PLANNING THE 92,000-SQ.-FT VANCOUVER (WASH.) CLINIC AT SALMON CREEK, THE BUILDING TEAM NEEDED TO FIND AN EFFECTIVE WAY TO SUPPORT THE LARGE BARRELED ROOF THAT ACCENTS THE DISTINCTIVE MAIN ENTRANCE OF THE BUILDING.** To meet the challenge, they installed approximately 10,000 sq. ft of curved 20-gauge "B" deck panels manufactured by ASC Steel Deck, West Sacramento, Calif. and custom-curved by Curveline, Inc., Ontario, Calif.

The barreled deck and roof extend back 260 ft in length above the second floor of the clinic. Curveline used its proprietary "crimp-curving" process to curve panels 18 ft 3 in. in length to an outside radius of 37 ft 6 in. and a 28° angle. The crimp-curving process increased the strength and rigidity of the panels, allowing the deck to be erected with minimal framing. Curved decking also shelters an attached carport area.

The crimp-curving process has become increasingly popular for radiused steel deck construction, because it creates a strong, economical, virtually self-supporting structure. Decking panels curved by this method are installed the "hard way," saving time and money, versus straight panels applied "the easy way." When decking panels are curved the easy way, straight panels are simply laid on the substructure along the direction of the curve. Applied this way, the panels add no structural value. With the Curveline process, panels are crimp-curved to the desired radius before being shipped to the job site. Panels are then installed the hard way to form the radiused deck. The crimp-curving process actually increases the load factor of the panels. In addition, crimp-curving increases panel strength to allow use of lighter-gauge material and achieves 15% to 20% longer spans for reduced framing and substructure costs.

# employment

To advertise, call 231.228.2274 or e-mail gurthet@modernsteel.com

## DETAILERS/SDS2 OPERATORS WANTED

We are currently seeking (2) experienced detailers/checkers proficient in AutoCAD & (2) skilled SDS2 operators. The ideal candidates must have a minimum of 3 years structural and/or miscellaneous steel detailing experience, a comprehensive knowledge of AISC codes and standards, strong attention to detail and good organizational skills. For inquiries and resume please contact:

**LA STEEL DESIGN GROUP LLC**
3800 La Crescenta Ave # 203
La Crescenta, CA 91214
e-mail: rita@lasteeldesign.com

## STRUCTURAL STEEL DETAILER/ CHECKER

Rankin Manufacturing, Inc., located in northern Ohio, is seeking a structural and miscellaneous steel detailer/checker. Must have a minimum of 5-7 years experience and have the ability to do metal take-offs.

We offer competitive wages, medical benefits, 401K, and paid holidays. Moving allowances and signing bonuses are extended in certain circumstances.

Send resume to: **Teressa@rankinmfg.com** or mail or fax to:

Rankin Manufacturing, Inc.
201 North Main Street
New London, OH 44851
Fax: 419-929-0021

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**e-mail: rstauffer@unitedemployment.com www.unitedemployment.com**

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Frazier Industrial, one of North America's largest structural steel racking suppliers has an immediate opening for a Project Engineer/P.E. Candidates must have a current P.E. License and have 5-8 years of experience in the structural racking design. Candidates must have strong computer/technical skills, communication and organizational skills, and strong knowledge of the warehousing/material handling industry.

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Qualified candidates to send resume to: **mmiller@frazier.com**, or mail to:

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Attn: Marty Miller, HR Manager
908.876.3001 x316

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**Boulder Steel, Inc.,** located along the front range of the Colorado Rocky Mountains in the greater Denver area and one of the largest fabrication shops in the Rocky Mountain Region, is seeking experienced, talented and dedicated **Steel Detailers**. We are looking to add to our experienced team of seven detailers. Utilizing SDS/2, our detailers work on projects ranging in size from the most simple rail designs to complicated buildings in excess of 800 tons. BSI offers excellent pay, great benefits, 401(k), profit sharing, overtime and a relocation allowance. If you are a detailer with at least two years of steel detailing experience, have a two year degree and, preferably, have experience with SDS/2, please respond to this ad! EOE M/F/D/V

Resumes to:
**Boulder Steel Inc.**
11575 Teller St.
Broomfield, CO 80020
or e-mail: **ahill@bouldersteel.com**

## Ramar STEEL ERECTORS INC.

**Ramar Steel**, a member of AISC, is one of western New York State's most reputable structural steel fabricators and erectors. Ramar is located in Rochester—on the shores of Lake Ontario and within the Finger Lakes region of the state. We are seeking experienced, talented and motivated steel industry professionals to support our plant expansion and sales growth. We are currently seeking:

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P.O. BOX 668
BEDFORD, IN 47421-0668
OR E-MAIL: **joew.elliott@iseco-bcs.com**

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A W & W STEEL COMPANY

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AFCO Steel is one of the nation's leading structural steel fabricators with offices and fabricating facilities in Little Rock and Van Buren, AR, as well as Greeley, CO. This position is for our Little Rock location. Complete benefits package includes: health, life and disability insurance, paid vacations and holidays, Sect. 125 plan, and 401k plan.

Please send resume to:
**AFCO Steel**
Attn: Human Resources
P.O. Box 231
Little Rock, AR 72203
Fax: 501-340-6215
e-mail: bsnyder@afcosteel.com

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## The Steel Deck Institute – Technical Director

The Steel Deck Institute (SDI), the trade association responsible for setting standards for the steel deck industry, is currently seeking qualified candidates for the position of Technical Director. The Technical Director is responsible for coordinating the Institute's technical committees and research programs, the presentation of technical seminars, representing SDI and participating in activities of other organizations such as AISI, AISC and ICC, providing engineering assistance to design professionals and managing special projects such as updating ANSI/SDI standards.

Qualified candidates should possess a BS in Civil or Structural Engineering. Professional Engineer's License or the ability to be registered is required. Experience in cold-formed steel design or metal building industry is also a plus. Strong communication, organizational, presentation and computer skills a must as well as the ability to work with limited supervision. Relocation to the Chicago, IL suburban area is preferred.

We offer a competitive compensation package including medical insurance and paid vacation.

Applicants should mail, fax or email resumes (in confidence) to:

Steel Deck Institute
Attention: Steven A. Roehrig, Managing Director
P.O. Box 25
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847-458-4647 (fax) 847-458-4648
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