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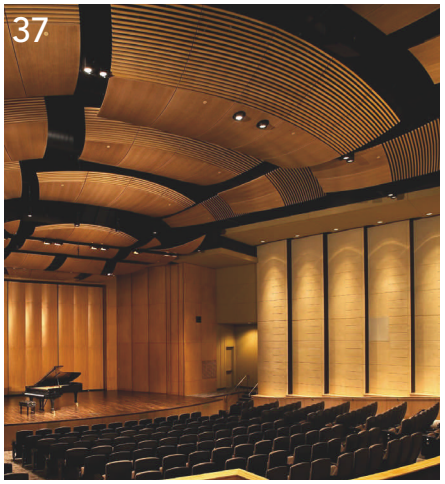

ON THE COVER: Nationals Park, the new home of the Washington Nationals baseball team.

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editor's note

WHENEVER I VISIT ENGLAND, I ALWAYS EXPERIENCE A COMFORTING SENSE OF FAMILIARITY. Even though my forebears can claim no ancestry in the United Kingdom, I still feel a personal affinity. It's not just the language, but also the cultural touchstones.

On a recent trip, I had the opportunity to visit Stonehenge. It was easy to feel a sense of awe, of things that are both at once familiar and mysterious. I drew comfort knowing that the same solar equinox recorded at Stonehenge is the same one my children talk about at home. And I loved hearing about the myriad theories of both why and how the stonework was hauled to the site over hundreds of miles and constructed.

Stories of construction seemed to fill my trip. When I travelled to Bath to see the ancient Roman baths, I marveled to learn that the Roman pipes that carried the water to and from the natural hotsprings still functioned. And I wondered how many current construction projects would be able to make the same claim in the next millennium.

Of course, not all of my visits were to ancient construction sites. I also was privileged to tour two of the U.K.'s top fabrication facilities. And as with Stonehenge, there was both the sense of the familiar and the foreign. Steel has become an international commodity and the shapes were more or less then same (though our wide-flange is typically produced from more than 95% recycled steel through the electric arc furnace process, and theirs comes predominantly from iron ore through the basic oxygen furnace process). We seem to use slightly more hollow structural sections while they seem to use an increasing amount of cellular beams (beams that have been sliced in half, round pieces removed from the web, and then re-welded). And the equipment is identical to that found in U.S. fabrication shops (primarily produced by Peddinghaus and Ficep; we seem to have more machinery competition here).

The biggest differences seem to be that they paint everything (they recognize it to be functionally unnecessary but like the aesthetic appeal) and they have a wholly different approach to sustainability.

While we of course emphasize the environmental aspects as well as the economic advantages of sustainability, they add a third leg: social. In the U.K., sustainability includes a focus on social issues, such as workforce training, community service, and even smoking in the shop.

The approach towards sustainability to look beyond simple material or energy use issues is wholly rational, and my guess is that the sustainability movement in the U.S. will soon move in that direction as well. The question about sustainability will go far beyond the fact that the U.S. structural steel industry has reduced its carbon emissions by 47% between 1990 and 2005 and has reduced its energy use by nearly a third over the past three decades. It will go beyond steel's obvious capabilities for deconstruction and material reuse. It won't just be concerned with emissions, energy efficiency, and related environmental concerns.

What intrigues me the most, however, is the question of whether we'll extend our concerns for sustainability to include not just what we're doing, but also what those we purchase from are doing. Will we start to hold overseas suppliers to our own sustainability standards? Will we look at their impact on the environment and on social issues? Will we start to demand that they reduce their environmental footprint, start paying living wages, and provide better health care?

I'll be intrigued to see if we're willing to pay more for a sustainable world. Because sustainability cannot be viewed as a purely local phenomenon. It's the same sun that rises over the U.K. and the U.S.; it's the same environment whether it's Sheffield, Seattle, or Shanghai.

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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.

It is with great sadness we report that David T. Ricker died on February 22, 2008 in Payson, Ariz. Dave was a longtime member of the AISC Committee on Manuals and Textbooks and a frequent contributor of articles, papers, and answers to questions about steel design and construction, including in this feature, Steel Interchange. He authored several professional articles that are still provided with great frequency in response to questions received by AISC. To honor the memory of this friend of the steel industry, Dave is the focus of this month's Steel Interchange.

Dave graduated from the Norwich Free Academy in Norwich, Conn. and earned a Bachelor of Science degree in civil engineering from the University of Connecticut, where he also was a member of the Tau Beta Pi Engineering Honor Society. After serving in the Army during the Korean War, he was employed at the American Bridge Division of U.S. Steel Corp. in Elmira, N.Y. Later, he moved to the Berlin Steel Construction Company in Kensington, Conn., where after 27 years, he retired as the vice president of engineering.

As a licensed professional engineer, Dave was an active member serving on numerous committees for both AISC and the American Society of Civil Engineers (ASCE). He was a very influential member of the AISC manual committee and the ASCE committee on design of steel building structures. Dave received AISC's Lifetime Achievement Award for excellence in his field and was also honored by the University of Connecticut School of Engineering with a distinguished alumni award.

To read more about Dave's career and accomplishments, please visit **www.modernsteel.com/connectionman**.

Dave Ricker and his wife, Jacquelyn, at their home in 1999.

The following are just a few of the many answers that Dave provided to Steel Interchange questions over the years.

Welding to Existing Members

It is a general rule that welding on an existing structural member is not permitted unless provisions are made to unload the member first (for example, if the member is being reinforced) and that the weld must not degrade the properties of the material. Is there a written reference that discusses this from both a code perspective and a practical approach?

There is no general rule requiring existing members to be unloaded prior to field welding. Despite the desirability of such a rule, in the real world it is rare that an existing beam can be shed of both of its live and dead load, and rarer still for a column. However, there are proven procedures for field welding to existing load carrying members. One reference is "Field Welding to Existing Structures" in AISC's *Engineering Journal*, First Quarter, 1988. This reference also lists several other articles on the topic.

Lifting Beams

A typical lifting beam or strongback in the materials handling, crane, and rigging industry takes the form of either a horizontal or wide-flange beam, with padeyes top and bottom at both ends. The lifting wire rope bridle with two legs at about a 45° angle attaches to the top padeyes, and the supported weight attaches to the bottom padeyes.

The wire rope bridle induces both compression and bending moment in the lifting beam. Again, there is no lateral support. What analysis would be used to solve for the safe lifting capacity of this form of lifting beam?

Procedures for both analysis and design of lifting beams are given in an article titled "Design and Construction of Lifting Beams," in the Fourth Quarter, 1991 issue of *Engineering Journal.* A more efficient section for resisting both bending and compression is generally a hollow structural section (HSS) rather than the pipe or wide-flange section.

Double-Angle Connections

How is a welded double-angle connection designed when the [wider] double angles are connected to the [narrower] flange of the column and welded on the back side of the double angles? This may be necessary when the column flange is short.

The design of double-angle connections using "back-side" welds is no different than when using conventionally placed welds. In fact, "back-side" flare bevel welds are quite common in HSS (hollow structural section) construction. The AISC connection tables can be used, as these take into account weld eccentricities on the angle legs connected to the column. But, do not attempt to make top returns on the vertical welds, as this may result in notches in the column flange edges.

If one needs to avoid a back-side weld, one can use angles with shorter legs, such as a 3½ in. by 2½ in., and use the normal weld placement. If this won't work, another connection such as a shear plate could be used.

steel interchange

Crane Rail Tolerances

How does the AISC *Code of Standard Practice* address the possible tolerance for vertical and horizontal alignment of a crane rail in a mill-type building?

The AISC *Code of Standard Practice* does not specifically address crane rail erection tolerance. However, AISE (now AIST) Technical Report No. 13 gives the following crane rail tolerances: The center-to-center distance of crane rails is not to exceed ¼ in. from the theoretical dimension. The horizontal misalignment of crane rails is not to exceed ¼ in. per 50 linear ft of runway with a maximum of ½ in. total deviation from the theoretical location. Crane rails should be centered on the crane girders whenever possible, but in no case should the eccentricity be greater than three-fourths the thickness of the girder web. Vertical misalignment of crane rails measured at the center lines of the columns shall not exceed ¼ in. per 50 linear ft of runway, with a maximum total deviation of ½ in. from the theoretical location.

Further information on crane runways can be found in AISC *Steel Design Guide* 7, *Industrial Buildings* and in the Fourth Quarter, 1982 issue of *Engineering Journal*, "Tips for Avoiding Crane Runway Problems."

Rivet Removal

During bridge repair, rivets are often removed and replaced with ASTM A325 or A490 bolts. Is there a standard procedure written for the removal of rivets and resizing of the fastener hole? If the base metal is going to be reused, I would think that it would be very important not to damage or overheat the base metal around the fastener hole. This base metal could be a multiple build-up of two-, three- or four-plys. Should these rivets be removed with a machine or cutting torch? Rivets are pressed in when newly installed; should they be pressed out? What preparation should be taken to remove and rework a riveted connection?

The rivet question was actually four questions and can be summarized as follows:

1. Is there a written procedure for rivet removal and hole rehabilitation? No.
2. Should rivets be removed by mechanical means or by torch? Both methods are commonly and successfully used. Mechanically extracted rivets will usually cause less damage to the base metal. This may be a factor in bridge rehabilitation, where constant vibrations will accelerate fatigue failure. Most building structures experience static loading. Burning off rivet heads and "coring" the shanks are common methods of removing rivets. If done carefully, no damage to the base metal results.
3. Should rivets be pressed out? Yes, there is no other way. If the original rivet was installed in a hole where the plies were not perfectly aligned, the hot rivet assumed the shape of the crank shaft. These are difficult to remove and coring the shank will ease the task.
4. What preparation should be taken to remove and rework a riveted connection? When removing the rivet head, either by chisel or torch, care must be taken not to gouge the base metal beneath the head to the extent that it would prevent proper seating of the subsequently installed high-strength bolt. Misalignment of plies can be treated with a reamer.

To summarize: Whether to use a mechanical means or a torch to extract rivets depends mainly on the use to which the structure is subjected. This should be addressed in the project documents. Burned holes have been the subject of much unsubstantiated concern in recent years despite evidence to the contrary. For more information, see "Effect of Hole-Making on the Strength of Double Lap Joints" by Thomas Schlafly and Nestor Iwankiw in the AISC *Engineering Journal*, Third Quarter, 1982.

Note: *Engineering Journal* articles mentioned in these questions are available to AISC members and *e*Pubs subscribers at no charge at **www.aisc.org/epubs**. They may also be purchased through the AISC bookstore at **www.aisc.org/bookstore**.

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

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

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

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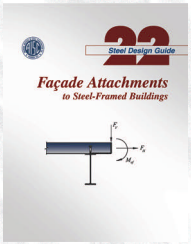

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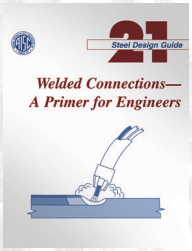

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steel quiz

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 **True/False:** According to AWS D1.1, all complete joint penetration groove welds are required to be inspected by ultrasonic testing (UT).

2 Which weld inspection methods can reveal discontinuities below the surface?
- **a.** visual inspection (VT)
- **b.** penetrant testing (PT)
- **c.** magnetic particle testing (MT)
- **d.** ultrasonic testing (UT)
- **e.** radiographic testing (RT)

3 Why is it necessary to preheat some joints before welding?

4 In the FCAW electrode designation E7XT-X, what does the "T" represent?

5 What is the heat-affected zone (HAZ) of a weld?

6 When combining the strength of longitudinal and transverse welds in the same joint using AISC *Specification* Equation J2-9b, why is the strength of the longitudinal weld(s) multiplied by 0.85?

7 Name the four common methods used to pretension a high-strength bolt?

8 When using a Class A slip coefficient to design bolted joints in a galvanized structure, why is it important that the faying surfaces be hand wire brushed?

9 If a shim pack consisting of two ⅛-in. finger shims is used in a slip-critical joint with standard holes, should the slip resistance be based on $h_{sc} = 1.00$ for standard holes, or $h_{sc} = 0.70$ for long slots?

10 If shims are used in a slip-critical joint, what are the requirements of the faying surfaces?

TURN PAGE FOR ANSWERS

steel quiz

ANSWERS

1 **False.** AWS D1.1 requires visual inspection of the joint and leaves other forms of nondestructive testing, if any, to be specified in the contract documents based upon the needs of the application.

2 Answers **c**, **d**, and **e**. Ultrasonic testing (UT) and radiographic testing (RT) can detect discontinuities below the surface. Magnetic particle testing (MT) is effective for detecting discontinuities at or slightly below the surface.

3 Preheat slows the cooling rate, producing a more ductile metallurgical structure. Also, the slower cooling rate reduces shrinkage effects and provides an opportunity for hydrogen to diffuse out of the weld, which reduces the chance of cracking.

4 "T" is used to designate a flux-cored (tubular) electrode.

5 The heat-affected zone (HAZ) is the portion of a welded joint that has experienced peak temperatures during welding. Those temperatures are high enough to produce solid-state microstructural changes, but low enough that melting does not occur.

6 Transverse fillet welds have less deformation capacity than longitudinal fillet welds. Based upon testing, it is known that the longitudinal welds will only reach 85% of their strength at the time the transverse welds reach their full strength.

7 From *RCSC Specification* Section 8: turn-of-nut method, calibrated wrench method, tension control bolts (twist-off bolts), and direct tension indicators (DTIs).

8 AISC *Specification* Section J3.8 classifies hot-dipped galvanized and roughened surfaces as Class A, which has a mean slip coefficient of 0.35. If the surfaces are not roughened, the slip coefficient is on the order of 0.19, and the joint will slip at about half of the calculated slip load. Hand wire brushing is required because power brushing tends to polish the surface, not roughen it.

9 The slip resistance should be calculated using $h_{sc} = 1.00$. AISC *Specification* Section J3.2 states, "Finger shims up to ¼ in. (6 mm) are permitted in slip-critical connections designed on the basis of standard holes without reducing the nominal shear strength of the fastener to that specified for slotted holes."

10 The faying surfaces of shim plates must meet the same requirements as the faying surfaces for the connected plies.

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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STEEL NEWS

AISC and ASE Host Staggered Truss Presentation and Construction Tour

Not surprisingly, Friday, February 8 was a cold, cloudy day in Chicago—not the best day to spend outdoors. But that didn't stop nearly 200 engineers, contractors, and others in the steel industry from taking an open-air construction site tour in the city's River North neighborhood. And that's because it wasn't just any site. The project, a 17-story Staybridge Suites hotel, will be the first staggered truss steel building ever constructed in Chicago.

The tour began with a breakfast presentation, sponsored by AISC and the Associated Steel Erectors. While filling up on a hearty breakfast to prepare them for the cold, participants were provided with an overview of the project by AISC's midwestern regional engineer, Tabitha Stine, and members of the construction team: Duke Miglin of owner/developer Miglin Properties LLC; structural engineer Socrates Ioannides of Structural Affiliates International, Inc.; architect Matt Dumich of Valerio Dewalt Train; Scott Robbins of steel fabricator/erector K&K Iron Works; and Jeff Rodgers of the project's general contractor, Walsh Construction Company.

While high-rise residential and hotel projects are often constructed with concrete, Stine noted that a staggered truss system—which works in tandem with precast concrete plank—can weigh 20% to 30% less, be erected quicker, and allow for more column-free space than when using a concrete framing system for the same project. AISC's Steel Solutions Center provided the project team with a conceptual design study featuring the staggered truss concept in 2003.

According to Robbins, the project will use 815 tons of structural steel in the form of approximately 1,500 erectable pieces. There will be 115 steel trusses and 100 columns in the building.

After breakfast, participants were bused to the jobsite a few blocks away and were given the opportunity to walk through multiple levels of erected steel framing. Construction began in the summer of 2007, and the building is scheduled to open later this year. The finished structure will house more than 200 suites.

For more information on the Staybridge Suites staggered truss project, including photos, PowerPoint presentations from the breakfast, and a live webcam, visit **www.aisc.org/staybridge**. For more information on the staggered truss structural framing system, please go to **www.aisc.org/residential** or contact the AISC Steel Solutions Center at 866.ASK.AISC or solutions@aisc.org.

STEEL BRIDGES

Myths and Realities Report on Steel Bridges Now Available

Did you know that modular prefabricated short-span steel bridges can be permanent structures? Or that bridge joints are not a prerequisite for steel bridges? Or that advanced, high-performance, EPA-approved steel bridge coatings can last more than 25 years? These topics and others are highlighted in a new free publication, *Steel Bridge Construction: Myths and Realities*, an updated, fact-based publication that addresses a wide range of topics about steel bridges.

Made available through a joint effort between AISC, the National Steel Bridge Alliance (NSBA), and the American Iron and Steel Institute (AISI), the 25-page document compiles and corrects top myths and misperceptions about the viability of steel in bridge design and construction for a wide range of bridge types.

The report references expert articles and studies from organizations such as the Federal Highway Administration (FHWA) and the American Association of State Highway Transportation Officials (AASHTO), as well as the Strategic Highway Research Program, professional associations, industry analysts, and academia.

One such reference refutes the perception that the life expectancy of a steel bridge is shorter than alternative materials. In fact, a 1992 study by Lehigh University analyzed the deterioration rates of the 577,000 bridges listed in the FHWA National Bridge Inventory and concluded that superstructure material type—steel, concrete, or other—was not an indicator of a bridge's life expectancy. Instead, life expectancy is strongly dependent on a bridge's age and average daily traffic.

The report also includes myth-busting analysis about topics such as the reality of maintenance-free bridges (regardless of material), cost competitiveness of simple-span bridges less than 140 ft in length, the viability of weathering steel, the value of jointless bridge decks, and the availability of simple, more economical bridge bearings.

To download a free PDF version of *Steel Bridge Construction: Myths and Realities*, visit AISI's web site at **www.steel.org/bridges/Myths_and_Realities.pdf**. To order printed copies of the report, visit **www.steel.org** and click "Shop AISI"—or call 202.752.7100 and ask for item #D432-07. Or, you can communicate your request via e-mail: mmccrady@steel.org.

Photo by Brian Fritz

Curve Your Enthusiasm

When it came time to turn Frank Gehry's inspiration into reality at Chicago's Millennium Park, Skidmore, Owings and Merrill turned to Chicago Metal Rolled Products for solutions to the challenge of curving pipe for the trellis that supports the speakers and lights at the Pritzker Pavilion.

Chicago Metal gave expert, seasoned advice on cold-bending 12, 14, 16, 18, and 20" OD pipe to multiple radiuses, with no distortion or even scratches to snag a fingernail. Its early involvement provided the answers that would save time and money in fabricating this integral part of the architectural art the Pritzker Pavilion would become. Gehry accepted the proposals and modified his design accordingly.

Chicago Metal then cold-curved 570 tons of pipe with such precision that the structural steel fabricator, the erector and the general contractor all remarked how "the trellis pieces went together so well."

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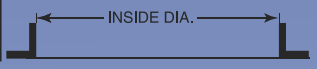
1 Angle Rings Leg Out



10"x10"x1" Angle

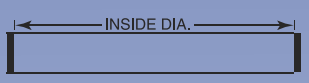
2 Angle Rings Leg In

10"x10"x1" Angle

3 Flat Bar Rings The Hard Way

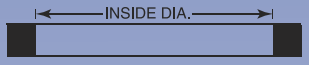
24"x10" Flat

4 Flat Bar Rings The Easy Way



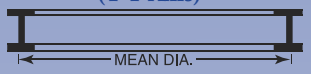
36"x12" Flat

5 Square Bar Rings



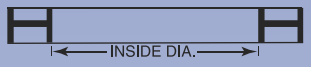
18" Square

6 Beam Rings The Easy Way (Y-Y Axis)



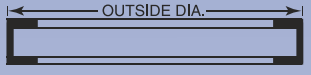
44"x 285#, 36"x 848#

7 Beam Rings The Hard Way (X-X Axis)



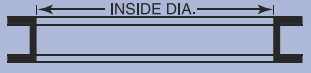
44"x 285#

8 Channel Rings Flanges In



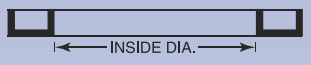
Any Size

9 Channel Rings Flanges Out



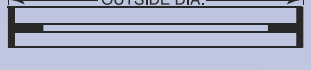
Any Size

10 Channel Rings The Hard Way (X-X Axis)



Any Size

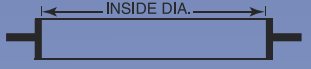
11 Tee Rings Stem In



22"x142 1/2# Tee

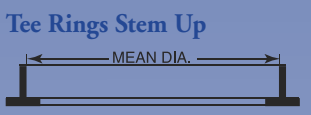
We bend ALL sizes up to:

12 Tee Rings Stem Out



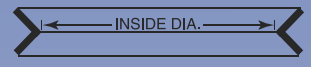
22"x142 1/2# Tee

13 Tee Rings Stem Up



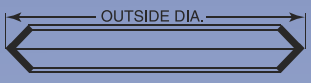
22"x142 1/2# Tee

14 Angle Rings Heel In



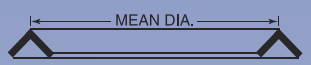
8"x8"x1" Angle

15 Angle Rings Heel Out



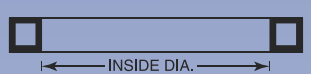
8"x8"x1" Angle

16 Angle Rings Heel Up



8"x8"x1" Angle

17 Square Tube Rings

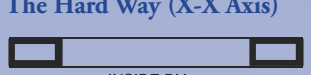


16" Square Tube
20"x12"x 1/2" Tube

18 Rectangular Tube Rings The Easy Way (Y-Y Axis)

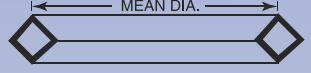
20"x12"x 1/2" Tube

19 Rectangular Tube Rings The Hard Way (X-X Axis)



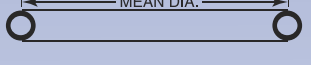
20"x12"x 1/2" Tube

20 Square Tube Diagonally



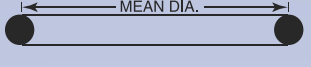
12"x 5/8" Square Tube

21 Round Tube & Pipe Rings



20" Sched. 80 Pipe

22 Round Bar Rings



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First Quarter 2008 Article Abstracts

The following papers appear in the first quarter 2008 issue of AISC's *Engineering Journal*. *EJ* is also available online to AISC members and ePubs subscribers at **www.aisc.org/epubs**.

Block Shear Equations Revisited... Again

HOWARD I. EPSTEIN AND LANCE J. ALEKSIEWICZ

Shortly after block shear was first identified as a possible failure mode for coped beam connections, design equations to account for it were incorporated into ASD provisions. These equations never changed, partly due to ASD not being updated since 1989. However, LRFD treatment of block shear changed with each new Specification. Over the years, it was suggested that the effect of eccentricity was missing from block shear equations. On the surface, it appears that the effect of eccentricity on the block shear strength of connections, as suggested by previous investigators, has now been incorporated into the latest unified Specification. For many connections, however, nothing has changed. It is the conclusion of this paper that additional important cases need to be shown in Commentary Figure C-J4.2 of the 2005 AISC Specification for which block shear equations now incorporate a new factor to account for connection eccentricity. In particular, as a minimum, angles connected by only one leg or tees connected by their flanges should also be included with other connections for which block shear capacities are now reduced.

Topics: Connections – Moment; Connections – Simple Shear; Specifications, Codes and Standards

Designing Compact Gussets with the Uniform Force Method

LARRY S. MUIR

The Uniform Force Method (UFM) is the preferred method given for determining the forces that exist at gusset interfaces. The UFM provides a standardized way to obtain economical, statically admissible force distributions for vertical bracing connections. One criticism of the method is that it sometimes results in oddly shaped or disproportionately large gusset plates. To overcome this perceived limitation of the UFM, designers have been seeking out alternate methods. This paper demonstrates that removing one unnecessary geometrical constraint from the formulation of the UFM will allow greater freedom in gusset geometry, while maintaining the efficiencies that result from the method. A new formulation of the UFM is presented, and the strengths and weaknesses of other proposed design methods are also explored.

Topics: Connections – Simple Shear; Connections – Moment; Lateral Systems; Detailing

Limit State Response of Composite Columns and Beam-Columns, Part II: Application of Design Provisions for the 2005 AISC Specification

ROBERTO T. LEON AND JEROME F. HAJJAR

The 2005 AISC Specification contains substantial changes to the design provisions for composite members and composite columns in particular. This paper presents detailed and cross-sectional analysis and design examples for composite columns illustrating the new provisions. The paper focuses on providing a detailed description of the development of simplified equations for the creation of interaction curves for composite beam-columns. This is the second part of a two-part paper; the first paper contains detailed discussion of the development of the new provisions.

Topics: Composite Construction; Columns and Compression Members; Combined Loading

Investigation of Flange Local Bending under Flexible Patch Loading

LYLE P. CARDEN, GOKHAN PEKCAN, AND AHMAD M. ITANI

The limit state of flange local bending due to applied flexible patch loads was investigated both experimentally and analytically in this study. Analyses showed that an unstiffened beam, supporting a timber or steel post similar to those found in bridge falsework, should be designed for a combination of flange bending and post strength. A series of experiments and finite element analyses were conducted to observe and quantify this limit state and to develop predictive methods for the evaluation of joint capacity. An interaction method was introduced in which both flange bending and timber post crushing capacities are considered. An alternative method that utilizes an effective bearing area of the post was developed, yielding more accurate capacity predictions when a steel post is used. Blocking, sometimes placed between the flanges, increased the capacity of the joint region by up to 70% with a timber post; in contrast, with a steel post, blocking improved the joint capacity by less than 25%. A post eccentricity of up to 1/6 of the flange width resulted in a reduction of flange-timber post joint strength by 10% to 15%. The effect of a post eccentricity was negligible with a steel post. Finally, equations to calculate the ultimate load for flange local bending are presented in both LRFD and ASD formats.

Topics: Bridges; Erection; Non-Building Structures

Effects of Nonverticality on Steel Framing Systems - Implications for Design

ANDREA E. SUROVEK AND JUSTIN JOHNSON

The first section of the paper describes the types of initial imperfections typically considered in planar frame analysis and their effect on members and framing systems. This is followed by a discussion of how the effects of imperfections are treated in the AISC Specification. A parametric study is presented in which the sensitivity of framing systems to imperfection effects is investigated with respect to a number of parameters, including slenderness ratios, leaning load levels, gravity to lateral load ratios, and lateral frame stiffness, as measured by a second-order to first-order drift ratio. In addition to the sensitivity study, a number of columns and simple frames were analyzed with and without imperfections using the direct analysis approach for assessing frame stability outlined in Appendix 7 of the AISC Specification. The differences in the interaction checks for simple columns and frames are used to discuss the current limits on when imperfection effects may be neglected.

Topics: Analysis; Columns and Compression Members; Stability and Bracing

Capacity Design of Vertical Boundary Elements in Steel Plate Shear Walls

BY JEFFREY W. BERMAN AND MICHEL BRUNEAU

Consistent with capacity design principles, the 2005 AISC Seismic Provisions require that the vertical and horizontal

continued on p. 20

BOOK REVIEW

The Life and Times of an Engineering Giant

Professor Wai-Fah Chen is one of the major figures in the history of modern civil engineering. He is known to the steel construction community for his many contributions to structural analysis, stability theory and its applications, and behavior of connections. Many of the results of his research have found their way into several specifications of the AISC. He was a member of the AISC Committee of Specifications for many years, and he is presently an emeritus member of this group.

After his recent retirement as the dean of engineering at the University of Hawaii, he sat down and wrote a 450-page book, *My Life's Journey—Reflections of an Academic*, that delightfully combines his personal life experiences and family history; a history of the intellectual and practical developments in structural engineering, engineering mechanics, plasticity theory, and geo-engineering in the past half-century; experiences in engineering education; reminiscences about teachers, colleagues, and friends; reviews of his research contributions; and general philosophical comments on the past, present, and future of the civil engineering profession in general and the academic teaching/research community in particular.

Wai-Fah Chen had a very adventurous youth during World War II and the following Chinese Civil War, eventually ending up in Taiwan where he obtained his BCCE degree. He describes these early years through a lively narrative, setting the tone for the rest of the book. Many of the readers of MSC will find their name, or the names of their teachers and colleagues, in the book. They will also be able to trace the origin of many of the criteria that are now a part of their daily design life. Engineering teachers will appreciate learning about the origins of steel design, concrete design, and soil mechanics concepts from the many books authored by Chen and his students.

Professor Chen is truly a giant in our professional field. Readers will not only be delighted and educated by this book, but will also feel proud to be part of a dynamic and creative profession.

—By Ted Galambos, University of Minnesota

EVENTS

Engineering Conference Seeks Presenters

Presentation proposals are now being accepted for the for the 2008 Structural Engineers' Buildings Conference & Expo, to take place October 2–3 in Atlanta. One-page proposals should be submitted by May 15 to Amy Walsh at awalsh@zweigwhite.com or online at **www.sebuildings.com**. Please call 508.651.1559 with questions. Applicants will be notified of acceptance in June. Conference themes include:

- ✓ Building Codes: Navigating Your Way through the Updates and Changes
- ✓ Wind Design: Mitigating the Effects of Natural Hazards on the Built Environment
- ✓ Industry Evolution: Market Changes Affecting Your Business
- ✓ Business Management: Successful Strategies for Effective Leadership
- ✓ Technical Innovation: Cutting Edge Building Design Techniques and Tools

ENGINEERING JOURNAL

continued from p. 19

boundary elements of steel plate shear walls be designed to remain essentially elastic while the web plates yield under seismic loading. However, determination of the design loads for vertical boundary elements to reliably achieve capacity design is difficult, and a reasonably accurate approximate procedure is needed. This paper presents such a procedure for determining those design loads for the vertical boundary elements of steel plate shear walls so that the desired component yielding sequence is achieved. The procedure combines an assumed plastic collapse mechanism with a linear model of a vertical boundary element to determine the maximum axial forces, shear forces, and moments for vertical boundary elements considering fully yielded web plates and horizontal boundary elements hinging at their ends. Two methods for capacity design given in the commentary of the seismic provisions are also reviewed, and their shortcomings are identified. Then, design loads for the vertical boundary elements of two different steel plate shear walls are determined with the proposed procedure and the two current procedures. Results are compared with nonlinear static analysis results. The proposed procedure is shown to give VBE design loads that are significantly closer to the nonlinear static analysis results than the two current procedures.

Topics: Seismic Design; Lateral Systems; Analysis

Current Steel Structures Research

REIDAR BJORHOVDE

This regular feature of the *Engineering Journal* provides information on new and ongoing research around the world. In the 13th installment, research projects are summarized on the following topics: residual stresses in hot-rolled shapes of S460 steel, influence of the Bauschinger effect on deflections of cambered beams, equivalent moment distribution factors for lateral-torsional buckling, controlled rocking of steel-framed buildings with replaceable energy dissipating fuses, and software for design of plate structures against plate buckling.

Topics: Research

Correction

February's SteelWise article, "Simple Shear Connection Limit States," was written by Erika Winters-Downey and Matthew Fadden. Both authors were listed in the table of contents, but Fadden's name was inadvertently omitted from the article.

"We need joist and deck delivery in 10 weeks and the drawings are incomplete. Can you finalize them?"

"Yep."

"The barrel joists need to support some mechanicals. Can you design for this?"

"Yep."

"It's a quick turnaround and a little tricky... but you're flexible?"

"Yep."

"And, oh yeah, you meet these new green requirements?"

"Yep. You're golden."

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Whether it's detailing, tight deadlines or new green initiatives, we'll work closely with you to meet your project challenges and keep your customers happy. Because when your customers are golden, so are you.

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Capitol Improvements

BY MARK TAMARO, P.E., JEFFREY D'ANDREA, P.E. AND LUCAS NISLEY

WASHINGTON, D.C., IN 2005, ONCE AGAIN BECAME HOME TO A MAJOR LEAGUE BASEBALL TEAM. The Washington Nationals, formerly the Montreal Expos, made existing RFK Stadium their home turf for the time being, but with the stipulation that the city government would build them a new, modern ballpark. Thus began a race to select a site and design and construct a 41,000-seat stadium in time for Opening Day this spring; the result is the fastest major league ballpark construction project ever completed.

Design Development

During the conceptual design phase of Nationals Park, the design-build team determined that a predominantly steel superstructure was best suited for the project. The fact that steel could be erected quickly and could accommodate the large clear-spans and significant cantilevers for the seating bowls made it an easy choice for the designers. The question was: How quickly could the steel be procured and fabricated for erection? Early critical path scheduling determined that the foundations and below-grade service levels could begin construction immediately using cast-in-place concrete. But by the time workers got to the main concourse level, fabricated steel would be ready and would quickly surpass concrete when it came to speed of construction.

To manage and expedite the design process, the entire ballpark was separated into multiple areas by expansion joints, creating independent structural systems for each section. The lateral force resisting system of each of these areas was comprised of two different structural systems. Large structural bents, located 50 ft on center in a radial pattern around the ballpark, provide lateral resistance in the direction perpendicular to the field. These bents consist of cantilevered trusses that support the precast seating stadia, and a combination of moment frames and braced frames in the bays supporting the concourse levels and suites. The bents are then tied together along the circumference with four "belt

An innovative construction methodology speeds the way for the Washington Nationals' new ballpark.

trusses" and a series of five moment frames, which resist lateral loads in the transverse direction.

The structural designers created separate finite-element analysis models for each independent area of the structure. Each model was then analyzed for sensitivity to crowd-induced vibration as well as for gravity and lateral loading. To meet vibration-control criteria, many of the large cantilever truss members needed to be up-sized. Engineers used virtual work methods to determine which members had the greatest potential to reduce vibration, minimizing the need for additional materials while optimizing the structure's response.

Design-Build Phase

As soon as the general contractor was selected by the owner, the two firms began searching for a steel fabricator to perform a design-assist role with the engineers and architects. To ensure a competitive selection, candidates were required to submit a schedule of unit prices for a dozen different steel categories.

Working with the prospective fabricators, the structural team developed estimated tonnages for each category. Incorporating this information into the schematic documents allowed the contractor to make a more accurate calculation of costs and to select the fabricator that would provide the best value to the project.

With the steel fabricator on board and the guaranteed maximum price approved by the D.C. Sports and Entertainment Commission, the contractor set an "ultra-fast-track" final schedule. The tight timeframe necessitated a unique design approach; the structural team produced ten consecutive design packages, one for each of the independent areas of the ballpark, that were used to place five separate mill orders. Based on early and extensive input from the steel erector, these design packages were laid out in the order in which erection would proceed. The entire ballpark was designed, detailed, fabricated, and erected in this order.

Milestone dates for completion of the superstructure were established by the contractor, with the ultimate goal of removing all cranes from the infield by July 2007. This information allowed the architects and engineers to focus design efforts in parallel with the critical path for fabrication and erection. The project team launched a nine-month-long series of weekly progress meetings that involved regular participation by the architect, structural engineer, general contractor, fabricator, detailer, steel erector, and structural precast supplier. These meetings focused on making sure the design was on schedule and within budget, and all parties were engaged to make sure that their respective work was being planned in the most efficient manner possible.

The structural design and coordination process was streamlined by the use of building information modeling (BIM). Because each design package had to advance from schematic design to construction documents in only two months, the structural team built initial models of the steel frame and precast seating stadia units using Tekla Structures software. The models, which included basic geometry and member sizes and configurations, were created in parallel with the structural analysis prior to the production of paper drawings. Advance bills of material for each mill order were determined directly from the model, eliminating the need for a traditional material take-off from paper documents. This approach allowed procurement of steel to begin before the designers had finalized details and connections on the final construction documents.

After being used to produce the mill order, the building models were transferred to the project's steel detailer, where they were advanced to include all connection designs and detailed information for shop drawing production. The entire design-build team relied upon the Tekla models during coordination meetings. They allowed team members to visualize complex connections three-dimensionally and were revised on the spot as decisions were made.

The use of BIM also helped the team fulfill the designers' aesthetic vision. Because the exposed trusses could be fully visualized early in the design process, the connections could be designed to satisfy the architects' desire to maintain a light appearance. The steel fabricator's preference for shop-welded connections was also incorporated into the design solution. Partial penetration shop welds of W14 wide-flange shapes created clean truss connections without gusset plates or other miscellaneous connection hardware.

> Steel was the ideal material for the large clear-spans and significant cantilevers for the seating bowls.

The Tekla models allowed the team to design elements for ease of transport as well. Trusses and frames were preassembled in the shop in the largest possible shippable assemblies. They could then be quickly erected in the field, with minimal field-welded connections. The Tekla models were used to ensure that the weights and sizes of these prefabricated assemblies were within the shippable limits. The maximum out-to-out dimensions of all elements, including connection plates, were established in the model prior to finalizing

Q&A with Don Banker

AISC Senior Regional Engineer Tom Faraone chatted with Don Banker of Banker Steel to get a fabricator's perspective on the use of the design-assist role, rather than the traditional design-bid-build arrangement, on the new Nationals Park.

What's the advantage of design-assist?

We considered it an opportunity to participate at an early stage on making the design work for our unit prices, our shop, and our erector. We went to design meetings every two weeks as soon as we were released on the project. With the 3D model [developed using the Tekla Structures program] we were able to review and make adjustments to connections, material sizes, truss sizes due to shipping limitations, etc. [The benefit is] we are in control of our destiny. If you let the process roll over you, it can be very expensive. If you manage and participate at each stage, the ability to make money is in your control.

Did you use the 3D structural model to assist with pricing?

No. The engineer's 3D model was in too early a stage to be of use. The sketches and discussions on the design plan were useful in determining our unit prices.

Did you use 3D modeling and direct digital exchange of information?

Yes. It wouldn't have worked without the digital transfer of information. The timing of design input to design output, to material and detailing changes, to actual work in the shop was too short to allow any other method of communication. The use of 3D models provided enormous benefits to our shop. There were situations [where] we could not have built the component without having the model to view and determine its exact interface in the structure. The erector had similar instances, but was not as adept at using the model. The erector sees the opportunity of having the 3D model and is training staff to better utilize it. It can be used for piece counts, bolt orientation, how to access connections, productivity, etc.

How was the connection design handled?

Thornton-Tomasetti did the majority of the moment connections, and we did the remaining connections, such as the truss member and shear connections. Loading was obviously provided by Thornton-Tomasetti. All connections were given a final review by Thornton-Tomasetti—electronically, to expedite their comments. Mountain Enterprises and Banker Steel essentially developed the expansion joint details/connections as well.

Are you more profitable on design-assist projects or on traditional design-bid-build projects?

Design-assist projects, but with much greater exposure and risk. The risks were huge. Think about having very limited designs and creating a matrix for pricing that is used to the end of the job. Because it was a publicly funded project and our customer had a fixed price, we had to work very hard to make sure the design, utilizing our unit prices, was adhered to.

Did being at the table early help manage your exposure?

Yes. We went to design meetings every two weeks as soon as we were released on the project. With the [3D] model we were able to review and make adjustments to connections, material sizes, truss sizes due to shipping limitations, etc. We were the driving force if there were issues that impacted the unit prices, but without flexibility from the design team it would not have been successful. The difficulty, as with every job, is convincing everyone of the cost impact of changes.

Do you have advice for other fabricators who are considering this type of delivery method?

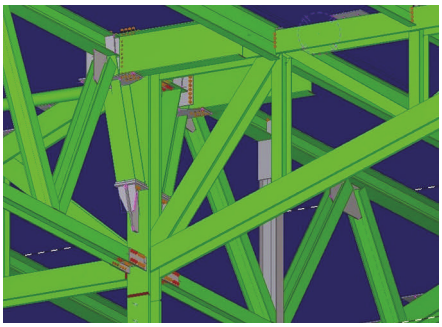
Make sure you have clearly understood the designer's intent with the structure. Make sure there is a clear matrix of pricing that everyone agrees to. Make sure that it's clear who is doing connection design and what the basis of that design will be. The fabricator, rather than the EOR, should make every effort to develop the connections and to get actual loads. These projects move so quickly that if you are not on top of them, it could cost you significantly if the EOR is more conservative with his connections than your estimate.

What was different about this project?

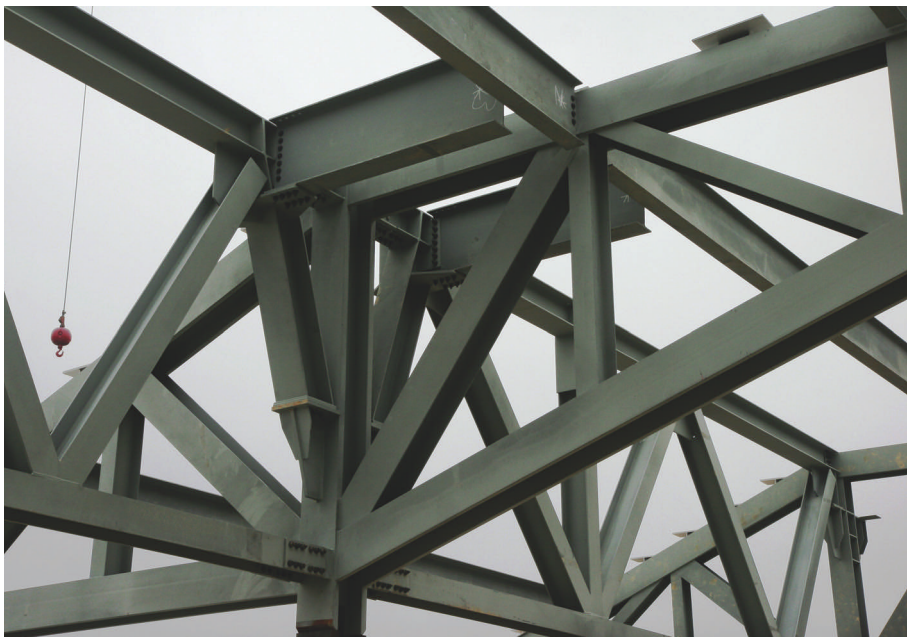
The biggest surprise was the architect's flexibility. You just don't see that happening in bid-build project delivery. The architect understood the need to get answers quickly. HOK, in most cases, either made decisions as we asked them or within a few days. It also helped that the architect was experienced in sports arenas. There were architectural features that the A/E included originally to define the project. A number of these features were dropped because of the budget constraints. The difference from normal bid-build work is that there is no discussion about "sacred cows," or if there is discussion it's how to keep them. On this job, the team [GC, fabricator, erector, precast contractors, etc.] discussed what was best for the project.

Any other advice for others contemplating design-assist?

This process requires a level of trust from the customer to the fabricator team and the fabricator team to the customer. It's important for fabricators to have a high level of integrity and to have an open-book policy that will withstand scrutiny by the customer. This project demonstrates that when the team works together with mutual trust and open communication, we can provide our customer a cost-effective and accelerated delivery project. We see this as the future of our industry.



3D modeling played a significant role in the stadium's design. The Tekla model (left) allowed designers to visualize complex connections (below).



the design and well before shop drawings were generated.

It is estimated that the release of early mill orders and design packages through the use of BIM shortened the overall project schedule by six months.

Construction Phase

The exceptionally aggressive schedule dominated all aspects of the project. A construction budget averaging one million dollars per day was put in place to meet the deadline. As the project progressed, design, detailing and shop drawing review, and construction were all taking place simultaneously on different sections of the ballpark. To manage this complex process, the design-build team implemented several strategies for avoiding conflicts and quickly resolving problems:

The team used the Tekla model to illustrate erection sequences in relation to calendar dates. The information was used to determine where conflicts in crane travel would occur between different cranes erecting steel and structural precast elements. Several portions of the bowl levels required the interruption of steel placement to set precast stadia units, with steel erection then continuing above. The fact that all lifts had to take place from the playing field area of the ballpark added to the complexity. The steel erector used two cranes simultaneously to negotiate the large radius and far-reaching picks necessitated by other work going on in the playing field.

Pre-installation of non-structural components. The design-build team worked together to identify opportunities for non-structural trades to pre-install equipment before the erection of large elements, such as the roof canopy. Sports lighting was built on the ground and then flown into place with the erection of the structural steel. Lights, handrails, gratings, etc. had all been added to the building model to ensure proper fit-up and eliminate construction coordination issues in the field.

Design-build team morning meetings. The design team attended daily meetings with project superintendents, creating a forum for the swift resolution of disputes and the coordination of construction issues. RFIs were thus limited, and most were used to confirm on-site direction provided by the architects and engineers. Total RFIs related to structural steel numbered less than 100.

Despite the speed of design and construction, the use of BIM technology and the collaboration between the designers and builders eliminated many potential problems. The new Nationals Park was made possible by the design-build team's ability to work together in innovative ways to bring about the construction of 9,000 tons of structural steel in time for the park's late March 2008 debut. MSC

Mark Tamaro is vice president, Jeffrey D'Andrea is a project engineer, and Lucas Nisley is a senior engineer, all with Thornton Tomasetti, Inc.

Architect
HOK/Devrouax & Purnell, PLLC

Structural Engineer
ReStl/Thornton Tomasetti, a Joint Venture

General Contractor
Clark/Hunt/Smoot, a Joint Venture

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

Steel Detailer
Mountain Enterprises, Sharpsburg, Md. (AISC Member)

Steel Erector
Bosworth Steel Erectors, Inc., Dallas (AISC Member)

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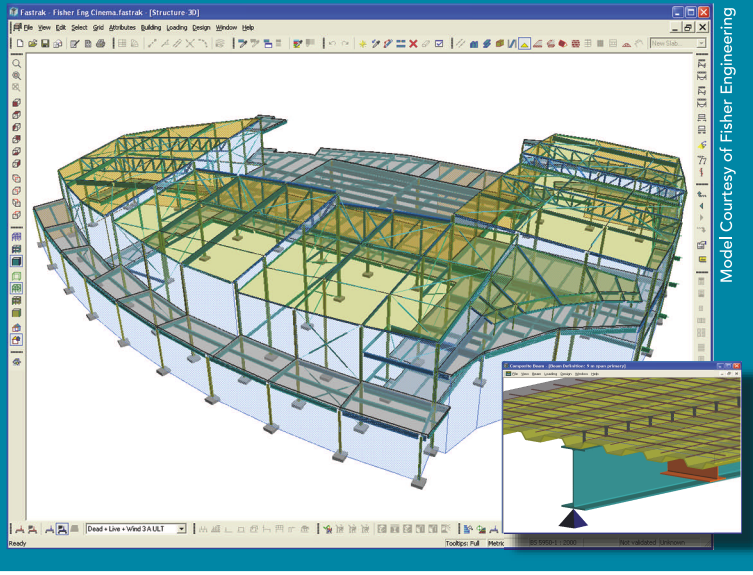

Model Courtesy of Fisher Engineering

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Taking it to the Next Level

BY LEN TSUPROS

Parking capacity is expanded at a growing university hospital thanks to hybrid steel and concrete design.

CHANGE IS A FACT OF LIFE, PARTICULARLY WITH LARGE, GROWING ORGANIZATIONS. To support expansion and all the benefits that come with it, it's essential to have parking facilities that can keep pace with changing programs and use requirements. It's also critical to construct those facilities in a manner that maximizes convenience and safety, minimizes maintenance costs, and leverages the full potential of the land they're built on.

In congested urban areas, surface parking lots are often viewed as less-than-ideal uses for open land. As a result, multi-level parking structures are frequently the preferred option. Building an urban parking structure can, however, pose some formidable challenges. Unlike garages built in suburban settings, urban garages must fit onto tight land parcels surrounded by existing structures. In addition, they must be constructed vertically to provide enough parking capacity and revenue potential to justify the cost of construction. Finally, because many of the structures surrounding parking garages typically house businesses that can't be disrupted or relocated during construction, every phase of construction activity must be carefully coordinated.

At Ruby Memorial Hospital, the teaching hospital for West Virginia University Medical School in Morgantown, W.V., the growth of the university's state-of-the-art cancer treatment programs demanded expansion of the parking facility serving the hospital; the hospital's campus had been augmented with the addition of a new cancer center building, a structure that was built on land previously used for surface parking adjacent to the hospital.

With real estate at a premium and the demand for parking growing quickly, it was essential for the hospital to maximize the capacity of its existing parking garage. However, since the parking structure was landlocked by the cancer center, other nearby hospital buildings, and the university's football stadium, a horizontal expansion was out of the question. Instead, it was necessary to expand parking capacity within the footprint of the existing structure, and at the same time maintain access to the hospital's emer-

gency room, which emergency vehicles accessed through the first level of the garage.

Creating a Hybrid Strategy from the Ground Up

Simply adding another level to the existing parking garage was, however, not an easy task. When Carl Walker Construction designed and built the original structure in 2003, the client decided not to include foundation structures designed to accommodate future vertical expansion. At that point in time, the cancer treatment facility was not yet on the drawing board, and it was anticipated that the capacity of the garage would effectively meet the needs of the hospital for years to come. But by 2005, as the hospital was putting the final touches on its new cancer center, it became apparent that the existing 225-space parking structure lacked the capacity necessary to support the parking volume created by the additional building. Aware of the foundation limitations and unwilling to demolish the entire structure and start from scratch, the hospital contacted Carl Walker Construction. The client challenged them to revisit the original designs of the building and provide a solution that would accommodate the construction of another parking level that would provide 105 additional spaces.

A steel-framed, post-tensioned slab system can be a good solution when foundation loads are an issue.

"Due to the weight considerations involved with the precast structural components, we knew from the outset that we couldn't simply add another level using the same type of structural system," observed Len Tsupros, president of Carl Walker Construction. "The foundations of the garage—and in particular, the network of precast beams supporting the center of the structure—were not heavy enough to handle the additional load. We needed to devise a structural system that was lighter in weight than the cast concrete components. We also needed to design a way to effectively attach that structural system to the existing garage. Whatever approach we took, we knew we couldn't do anything without significantly reinforcing the center supports."

To meet the challenge, Carl Walker Construction turned to the project's original engineer, Charles Churches, P.E., for guidance. Churches agreed with Tsupros that significant reinforcement of the structure would be needed to support the weight of the additional parking level. He then worked with Tsupros and his team to devise a reinforcement strategy that would deliver the required support and weight distribution, and to evaluate structural systems that could be married to the existing precast components.

Within a few weeks, Tsupros returned to Ruby Memorial Hospital with a comprehensive plan that would accomplish those goals and allow the new deck to be added to the structure. The hybrid construction strategy would directly link support of a new steel-framed, cast-in-place concrete post-tensioned deck to the existing foundation, and would not place additional stress on the precast columns already in place in the center of the garage. It would also minimize the overall weight of the additional deck and would provide a framework to mount and secure a series of precast panels. Those panels would seamlessly integrate with the existing building finishes and make the post-tensioned system essentially invisible when the job was complete. The project estimate was $2 million, or approximately $19,000 per additional parking space.

Bringing Together Old and New

After receiving the client's approval on the budget and the innovative design strategy, the demolition and strengthening phases of the project quickly commenced in January of 2007. Throughout the entire construction process, the garage remained open to hospital visitors, staff, and emergency vehicles.

"To install the new structural columns in the center of the garage, we began by using a Bobcat outfitted with a jackhammer to break through the concrete floor on the first level between each of the eight previously installed precast columns," remarked Tsupros. "This allowed us to auger down, expose the grade beams that comprised the original garage foundation, and pinpoint areas where cast-in-place concrete columns could be directly attached to the grade beam system."

Once the concrete column bases were positioned on top of the

WVU's growing medical campus prompted the need for more parking.

The expansion to the garage added 105 parking spaces.

grade beams, the construction team inserted rebar cages around each junction point. Then, it backfilled each cage with concrete, which flowed around each grade beam and locked the column bases into position. When the concrete had cured in and around the cages, the team then poured concrete up to the floor level to close the holes. With firm footing in place, the team then constructed the concrete columns that would rise through the top deck of the precast structure, cutting through the existing decks to provide raceways for each new column.

With the reinforcement phase of the project complete, Century Steel Erectors and Carl Walker Construction began installation of the structural steel that would form the framework for the new post-tensioned parking level. The steel beams were connected to the new cast-in-place concrete columns—shear studs are welded to the girders—then bolted and welded in place to ensure structural stability. At the same time, the original elevator bank was extended up by one floor with the installation of an additional precast concrete section that was lowered into place by crane.

When the structural steel and the elevator shaft extension were completely installed, precast panels were trucked to the worksite and hung on the steelwork to integrate with the appearance of the original façade. Both the steel erection and precast installation phases of the project were carefully scheduled to minimize pedestrian and traffic obstructions, and to maintain ingress and egress from both the garage and the hospital's emergency department.

Lateral bracing for the new level was accomplished with the connection to the existing precast light wall and the precast façade panels. The panels have rods inserted at the floor level and are also composite with the floor slab. This also provides for the bumper restraint requirement at the perimeter.

Once the new precast-clad, post-tensioned structure was installed, work began on constructing the steel-reinforced parking deck surfaces. Shear studs welded to the steel members make the new slab act compositely with the steel. The concrete slab was supported by a temporary framing system that fit snugly between the steel beams supporting the new deck. When the concrete cured, the framing was removed from the underside of the new deck. The construction phase of the project was completed by May of 2007. One month prior to completion, cars were allowed to park on all but the top level of the newly expanded garage. Project clean-up and punch-list items were completely addressed by August 2007.

Well-Received Results

Tsupros was also pleased with his firm's accomplishments on this project. "This job required some out-of-the-box thinking, as well as a considerable amount of coordination between the client and our strategic partners," he said. "The end result, however, illustrated how marrying two different structural systems can expand the capacity and lifespan of existing parking structures. Our approach allowed Ruby Memorial Hospital to leverage the potential of their original precast structure and to obtain the additional capacity they needed to support their enhanced service offerings."

"I would encourage anyone who currently has a precast parking structure to consider the potential of a steel-framed post-tensioned addition if they need additional parking capacity and are facing foundation and structural load limitations." MSC

Len Tsupros is president of Carl Walker Construction.

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The Better Choice

BY PHILIP G. RAHRIG

Galvanized steel parking structures are stong contenders in today's parking market.

GIVEN THE STATE OF RISING COSTS FOR CONCRETE CONSTRUCTION MATERIALS, protracted delivery schedules for precast, and shrinking maintenance budgets, many owners are requesting a viable alternative parking structure design. Steel is such an alternative and although surrounded by many misconceptions, its strengths position it as a long-term solution.

For a number of qualitative performance-related reasons, steel—and in particular hot-dip galvanized steel—is a good choice for many parking structures. Here are my top 10 reasons you should consider a galvanized steel parking structure:

1. Galvanized steel has demonstrated a verifiable durability for decades in a variety of environments, including coastal and industrial. Learn more in the SteelWise article "Are You Next" in the September 2006 issue of MSC at www.modernsteel.com.
2. Castellated beams often used in steel design create an open and light-filled atmosphere where patrons feel safer.
3. Galvanized reinforcing steel in decks means no unsightly spalling and no corroding seams between deck panels.
4. Steel garage construction schedules are shorter.
5. Galvanizing of 60-ft to 80-ft girders is now common, accommodating almost all designs. The actual turnaround time to galvanize is usually less than five working days.
6. Steel designs are overall lighter in weight, meaning fewer and/or smaller caissons.
7. Galvanized coatings are aesthetically appealing not only for the structural members, but also for stairways, exterior mesh panels, and guardrails.
8. Painting structural steel means costly, scheduled maintenance and lost revenue. Galvanized steel is maintenance-free for 50–80 years.
9. Life-cycle costs of galvanized steel frame parking structures are two to three times less than precast. Life-cycle costs of galvanized steel frames are two to five times less than painted structural steel frames.
10. Galvanized steel framing is initially 10%–20% less expensive than precast construction.

Initial Cost

Once the qualitative analysis reveals that a galvanized steel frame is maintenance-free for decades and does prevent corrosion for many decades, even in harsh coastal climates, the owner's next step in the decision process is to develop the quantitative analysis and evaluate exact initial costs. The table on the next page illustrates the cost of hot-dip galvanized frame design compared to precast concrete design.

Life-Cycle Cost

Even though the initial cost of galvanized steel is favorable to precast concrete, responsible design requires the investigation of other coatings to protect the steel from corrosion. Although not necessarily the case, various paints are generally viewed as initially less expensive than hot-dip galvanizing, and while initial cost is often the decisive factor when selecting a corrosion protection system for steel a garage, there are other costs that dwarf this initial funding outlay. Those costs are associated with a series of scheduled maintenance costs necessary to protect the steel from corrosion over the planned service life. For maximum protection of the asset, plans should be based on an ideal maintenance cycle. For paint systems an ideal cycle calls for touch up, maintenance painting, and full-repainting prior to visual evidence of substrate steel corrosion. However, on most projects a practical, less rigorous cycle is used, and this means maintenance is conducted when the coating has deteriorated to the point where the project looks to be in disrepair and iron oxide (rust)

Comparison of Initial Costs

City	Concrete Cost[1] ($/sq. ft.)	Concrete Cost[2] ($/sq. ft.)	HDG Cost Range[3] ($/sq. ft.)
Atlanta	33.85	37.77	28.65 – 32.23
Baltimore	37.21	42.04	31.70 – 35.66
Boston	46.28	48.84	38.05 – 42.80
Charlotte	not available	32.32	25.86 – 29.09
Chicago	43.43	47.19	36.25 – 40.78
Cleveland	40.34	42.42	33.10 – 37.24
Denver	38.14	40.48	31.45 – 35.38
Dallas	33.68	35.66	27.74 – 31.20
Detroit	42.11	45.33	34.98 – 39.35
Kansas City	41.30	43.73	34.01 – 38.26
Los Angeles	42.91	45.12	35.21 – 39.61
Miami	34.81	36.59	28.56 – 32.13
Minneapolis	45.03	47.40	36.97 – 41.59
New Orleans	34.73	36.50	28.49 – 32.05
New York	52.49	55.73	43.29 – 48.70
Philadelphia	45.83	48.33	37.66 – 42.37
Pittsburgh	39.05	42.33	32.55 – 36.62
St. Louis	41.68	43.22	33.96 – 38.21
San Francisco	48.84	51.42	40.10 – 45.12
Seattle	41.74	44.02	34.30 – 38.59
National Average	**41.23**	**42.25**	**33.39 – 37.57**

[1]RSMeans, Reed Construction Data
[2]Parking Structure Cost Outlook for 2007 - "An Inconvenient Truth," Joey D. Rowland, P.E.
[3]American Institute of Steel Construction - estimate

is visibly evident. For a hot-dip galvanized corrosion protection system, maintenance is normally not required.

To determine the timing of practical maintenance, most paint coating systems have been tested in a laboratory using accelerated corrosion mechanisms. To be sure, if the testing indicates that a touch-up painting should be performed in year eight, a maintenance paint applied in year 13, and a full repaint in year 18, the actual project may require maintenance according to the wear and tear on the project and the toll environmental corrosive elements have taken. That may mean earlier-than-planned maintenance based on the accelerated testing.

Comparing one system to another can be an arduous number-crunching exercise further complicated by the various performance characteristics each coating system provides. A three-coat inorganic zinc-epoxy-polyurethane system may have initial durability, while hot-dip galvanizing provides corrosion protection inside hollow

LIFE-CYCLE COST CALCULATOR
Life Cycle Maintenance Cost

Data Input:

IPI University Parking Garage

English Units
USA US Dollar/ Conversion Factor: 1
IOZ/ Epoxy/ Polyurethane (21-year Service Life)
40 year projected life

Environment: C3: Medium Corrosion
Structural Member Type: Large Structural

Primer: IOZ
Surface Prep: SP-10 Automated (0.38)
Applied: PracticalSpray (0.212)
Primer Product: Zinc Rich Primers (0.50)

Intermediate Coat: Epoxy
Applied: PracticalSpray (0.172)
Location: Shop
Product: Two-Pack Products (0.48)

Topcoat: Polyurethane
Applied: PracticalSpray (0.304)
Location: Shop
Product: Two-Pack Urethanes (0.51)

Steel Area: 250,000 Sq Feet OR 2,500 Tons

3% inflation
6% interest

Paint Operation
Paint Initial Cost/Sq Feet: 2.43

Painting Operation	Original Painting	Touch Up Year 21	Maintenance Repaint Year 28	Full Repaint Year 39	Total
Cost in Current Currency	2.43	1.46	2.55	4.98	11.42
NFV costs futures value at 3% inflation	2.43	2.71	5.84	15.78	26.76
NPV costs present value at 6% interest	2.43	0.80	1.14	1.63	6.00

Average Equivalent Annual Cost/Sq Feet = $0.40
Total Paint Project Cost: $1,498,991

HDG Operation
HDG Initial Cost: 0.19/lb OR 3.80/Sq Feet

Galvanizing Operation	Original Galvanizing	Total
HDG in Current Currency/Sq Feet	3.80	3.80
NFV costs future value at 3% inflation/Sq Feet	3.80	3.80
NPV costs present value at 6% interest/Sq Feet	3.80	3.80

Average HDG Equivalent Annual Cost/Sq Feet = $0.25
Total HDG Cost: $950,000

The Delaney Square parking structure in Orlando, Fla. features a galvanized steel frame.

structural sections, and alkyds may be the standard of past projects. But once the field is narrowed to a couple of optimal coating systems according to desired performance, it is important to use all the financial tools and models available to quantify future costs as accurately as possible, especially with maintenance budgets shrinking and substantial long-term costs.

One tool is the Life-Cycle Cost (LCC) Calculator now available at **www.galvanizingcost.com**. As the URL implies, this site will compare the initial and life-cycle costs for over thirty (one-, two-, or three-coat) paint systems to hot-dip galvanizing. A unique feature of the software is that it allows the user to customize the input to fit his/her particular project exactly. Input variables include total size in tons or square feet, surface preparation type, structural steel component size (small, medium, large), and planned service life of the project. The calculator allows the user to input in either metric or U.S. units.

The primary driver and input variable of the life-cycle cost calculation is the corrosion data for the project's environmental location. If a parking structure is in a rural area, corrosion rates are low because of lower corrosive elements in the air. For a garage in an industrial area, aggressive corrosion may be initiated by sulfide and

chloride emissions from production plants, including high levels of automobile/truck exhaust. There are four input options for the environment and all correspond to categories described in ISO 12944-2 "Classification of Environments."

The financial component of the LCC Calculator is also customizable and based on standard net future value (NFV) and net present value (NPV) calculations where the time value of money is considered. The user selects what rate of inflation is projected over the life of the project in order to determine the value of money at each maintenance time, and the average interest rate future expenditures on maintenance could earn—i.e., lost opportunity cost. Both are used to calculate the more easily understood and meaningful average annual equivalent cost (AEAC) for each coating system being modeled for any specific project.

NFV = initial cost$[(1+i)n]$, where i = inflation; n = project life in years

NPV = NFV$[1/(1+i)n]$, where i = interest rate; n = project life in years

AEAC = NPV$[i(1+i)n/(1+i)n - 1]$, where i = interest rate; n = project life in years

The information on the cost of each paint system and its practical service sequence in years for each of the ISO environments is contained in a database.* Based on the user's selection of a particular coating system, the software accesses the appropriate field and incorporates the data into the life-cycle calculation. There are two options for the cost information of hot-dip galvanizing, also resident in a database. The user may either select the default, which is a U.S. average cost, or input any number in dollars per lb or dollars per kg, based on local market information.

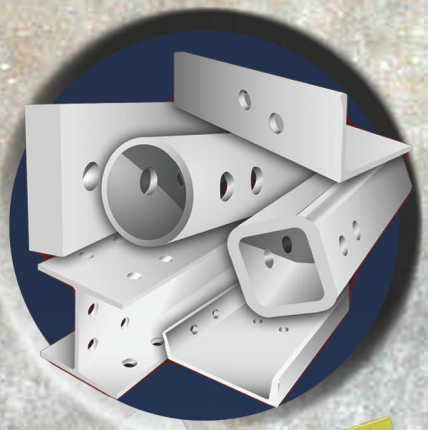
Output of the LCC Calculator includes a printable summary of all selected input as well as tables containing the initial, NPV, total project, and AEAC for the coating system and hot-dip galvanizing. The LCC Calculator output is available in U.S. dollars or in any country's currency. The currency conversion is real-time, making the LCC Calculator useful for export/import projects. MSC

Philip G. Rabrig is the executive director of the American Galvanizers Association.

The text of this article originally appeared in The Parking Professional *(November 2007).*

Note

*NACE Paper #06318, "Expected Service Life and Cost Considerations for Maintenance and New Construction Protective Coating Work," Helsel, Melampy, & Wissmar, KTA-Tator, Inc. 2006.



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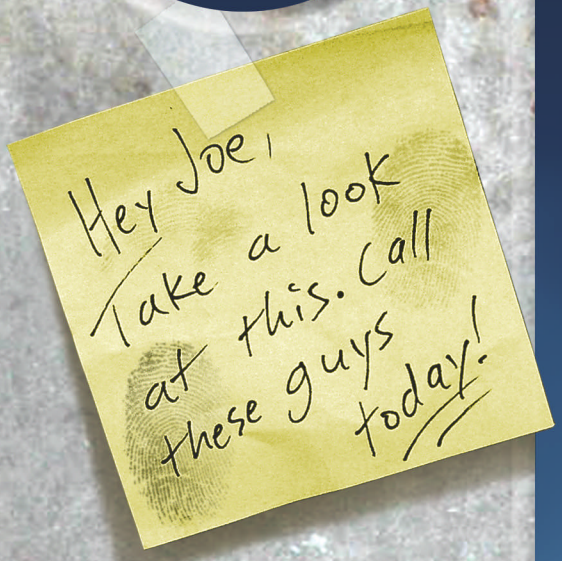

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Quality Space

BY BEN WHITE

Architects: Delawie Wilkes Rodrigues Barker

Steel trusses connect two new Qualcomm headquarters structures via a dramatic, column-free atrium.

THIS OFFICE BUILDING ISN'T JUST A PLACEHOLDER FOR CUBE FARMS. San Diego-based wireless technology giant Qualcomm expanded its corporate campus recently and chose to make a bold statement instead.

Its new headquarters structure, Building N, consists of a ten-story office tower adjacent to an integrated 534-seat lecture/concert hall, for a combined floor area of 473,000 sq. ft. The building is designed to accommodate 1,200-plus employees and encompasses private offices, research and development facilities, a fitness center, and a café.

While the tower and lecture hall are separated by a 12-in. seismic joint along the face of the tower, the two are architecturally connected; the tower atrium extends into the lobby of the lecture hall, creating a dramatic column-free space nearly 100 ft by 50 ft. Within the tower footprint, a seven-story atrium extends vertically from the ground floor up to a mechanical well, which houses three large fans, part of the required smoke exhaust system for the atrium. Steel trusses crossing the atrium support the floor and roof of the well, and the trusses also act as collectors, tying together the floor diaphragm of the two wings of the building. Six pivoting steel and glass doors, measuring 20 ft by 11 ft, are also connected to the atrium smoke exhaust sys-

Hewitt Garrison Architectural Photography

Interior view of completed atrium with steel cable-supported glazing system.

Hewitt Garrison Architectural Photography

Interior view of completed lecture hall/ theater.

Architects Delawie Wilkes Rodrigues Barker

Overall construction view of lobby and lecture hall steel roof framing.

Hewitt Garrison Architectural Photography

View of completed lobby and tower looking northeast from site.

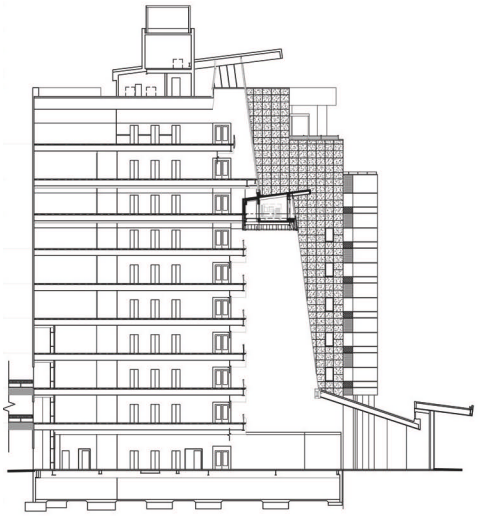
tem and create a unique architectural statement at the building's main entry.

Taking the Right Steps

The design developed for the roof of the lecture hall lobby generally forms a pair of very shallow bowls, with a curved step between the surfaces that varies in height from 6 ft to 9 ft. A concrete shell structure was considered, but it was ultimately determined that the desired form could be achieved in steel using a series of sloped and stepped beams with positive or negative cambers, within the range of standard fabricating shop practice. The use of a steel system eliminated the need for erecting formwork, which saved time and improved construction access to adjacent areas of the project. The geometry of the roof was delivered by the architect to the engineering in the form of an AutoCAD 3D file. The points in the 3D mesh were then translated into a RAM Advanse 3D model, which was used to analyze the roof structure for vertical and lateral forces.

Within the lobby roof, a series of stepped steel beams span from a radiused W36×210 beam over the lobby entry to a W33×118 beam near the seismic joint adjoining the tower. Because of the curved and stepped roof surface, each of the 11 stepped beams has a unique profile, with spans ranging from 46 ft to nearly 57 ft, and cantilevers at one or both ends ranging up to 15 ft. During the preliminary design of the lobby roof, it became apparent that it would be difficult to limit deflections to the desired levels without introducing beams that were significantly deeper and heavier than required for strength. In order to avoid these increases in depth and/or weight, a two-way system was introduced along the curved roof step. This was accomplished by a series of wide-flange beams along the top and bottom of the step, forming a transverse vierendeel truss with its joints at the top and bottom of each beam step. The resulting structural form, created by the interaction of the stepped beams with the curved and tapered vierendeel truss, garnered enough visual interest that the architect chose to modify their interior design of the lobby to expose the vertical elements of the vierendeel.

The exterior face of the atrium is enclosed by a cable net glass wall system, which is suspended from the mechanical well truss and supported out-of-plane by pairs of pretensioned horizontal cables at each floor level. The architect and engineer worked closely with Advanced Structures Incorporated (ASI), the cable wall designer, in order to assure that the large tension forces required in the horizontal cables were adequately



The seven-story atrium extends from the ground floor up to a mechanical space.

anchored to each floor level, and to study the relationship between the pretensioned cable system and the deformations of the supporting floor diaphragm at each level.

Acoustic Challenge

Another challenge to the design team was achieving the acoustical requirements for the lecture hall in spite of the frequent overflights from the nearby Miramar Air Station and occasional noise and vibration from the helipad on the tower roof. This required a complete acoustical envelope around the lecture hall, with all wall and roof surfaces requiring a minimum mass of 50 psf. The lecture hall roof is framed using four steel trusses in a radial pattern, supported by a girder truss over the backstage area and a concrete wall behind the balcony seating. In order to minimize the volume of concrete making up the acoustical envelope, the structural roof deck was supported from the bottom chords of the trusses, with the required top chord bracing hidden below a barrel roof framed of light-gage steel.

Ben White is a project architect with Architects Delawie Wilkes Rodrigues Barker.

Architect
Architects Delawie Wilkes Rodrigues Barker, San Diego

Structural Engineer
Hope Engineering, San Diego

Engineering Software
RAM Advanse

Construction Manager
Perry Consulting, San Diego

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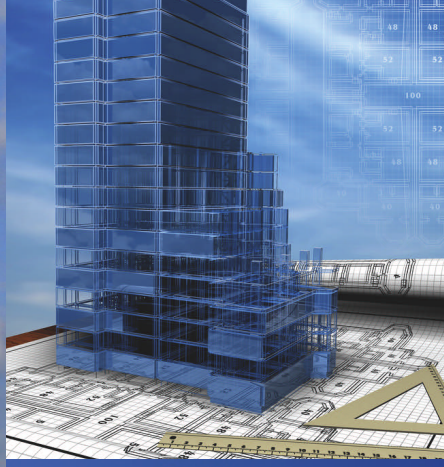

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A CATEGORICAL APPROACH

The Canadian Institute for Steel Construction is taking a new approach to specifying AESS requirements.

BY TERRI MEYER BOAKE, SYLVIE BOULANGER, AND WALTER KOPPELAAR

CURRENT SPECIFICATIONS FOR AESS (architecturally exposed structural steel) tend to invoke a one-size-fits-all set of fabrication requirements above and beyond those necessary for strength and safety. The need to somehow recognize the different levels of finishes to suit the specific architectural expression of the building—and to make it easier for architects and engineers to specify those requirements to fabricators at bid time—prompted a new approach to specifying AESS that emphasizes different categories of AESS, each category's characteristics, and the use of a cost matrix to compare the categories.

Canadian Initiatives: 2003 to Present

As AISC was developing its AESS Guide, concerns about AESS were also emerging in Canada. Regional initiatives of the Canadian Institute of Steel Construction (CISC) eventually culminated into the national CISC Ad Hoc Committee on AESS in 2005. The idea was to create a dynamic industry dialogue, including architects and engineers, in the hopes of providing a series of documents that would assist in re-visioning the design, specification, and construction process for AESS.

CISC decided it would pursue its category approach and adapt components of what AISC had developed.

The Ad Hoc Committee agreed on several key factors that would influence the creation of the new specification and accompanying guide:

Not all AESS needs to be created equal. The existing documents did not differentiate explicitly between types and applications. Airports, commercial buildings, and hockey arenas may all specify AESS, but each building type has different requirements for its appearance and ultimate cost.

Distance should play a factor. AESS that is within view (less than 20 ft from the viewer) would require more attention to the finishing and detailing than would AESS that was greater than 20 ft away. This dimension was roughly based upon a two-story height or distance to a ceiling structure.

Finish would play a factor. The selection of a high-gloss paint, galvanizing, or intumescent coating affects the appearance of the final product due to the impact of show-through of the steel finish. Finish also plays into the selection of fire protection systems, which needs to be addressed very early in the project.

Connection types should be considered. There should be different approaches to detailing AESS depending on the choice of welded or bolted connections. These connections also require differentiation during fabrication (level of shop fabrication required) and erection (in terms of sequencing).

It was ultimately decided that the new CISC AESS sample specification should adopt a "category" approach in order to be able to incorporate different levels of these primary factors. The combination of categories and characteristics quickly led to the creation of a matrix to describe the attributes of each category and serve as a visual decision-making checklist. The Canadian *Code of Standard Practice* would include an appendix that would elaborate on details relating to the categories and fabrication and erection requirements.

It was also decided that a guide would be written to better explain the intent of the various characteristics by providing more detailed descriptions and images of actual connections, finishes, and buildings that were not appropriate within the context of either the specification or the appendix. At the same time, more information on protective systems (fire protection, corrosion protection, etc.) and coatings would also be provided.

AESS Categories and Characteristics

The CISC Ad Hoc Committee on AESS felt that baselines needed to be established that could characterize each of the categories, and that each category would reference recognizable building types as a point of visual orientation. The initial point of technical reference was selected as Standard Structural Steel (SSS) as defined in CSA S16, as it was already an established and well-understood baseline in construction specifications. A set of characteristics was then developed that was associated with each category. Higher level categories include all of the characteristics of the preceding categories, plus a more stringent set of additional requirements.

The characteristics refer to both the fit and finish of the elements. The committee felt it imperative that an understanding of the nature of the final finish be incorporated into this decision-making process. Whether the structure was intended for an interior or exterior application would also impact decisions pertaining to fire protection and finish. It was not felt that finish selection should be part of the specification, as this was more appropriately addressed elsewhere (partially in the new guide) in greater detail. Here are the proposed AESS categories:

AESS 1 – Basic Elements. This is the first step above standard structural steel. This type of application is suitable

The new Canadian approach to specifying AESS uses the below matrix to graphically summarize the characteristics required for each fabrication category.

CATEGORY		AESS C Custom Elements	AESS 4 Showcase Elements	AESS 3 Feature Elements Viewed at a distance ≤ 20 ft	AESS 2 Feature Elements Viewed at a distance > 20 ft	AESS 1 Basic Elements	SSS Standard Structural Steel CSA S16
ID	**CHARACTERISTICS**						
1.1	Surface preparation to SSPC-SP 6		✓	✓	✓	✓	
1.2	Sharp edges ground smooth		✓	✓	✓	✓	
1.3	Continuous weld appearance		✓	✓	✓	✓	
1.4	Standard structural bolts		✓	✓	✓	✓	
1.5	Weld spatters removed		✓	✓	✓	✓	
2.1	Visual Samples		optional	optional	optional		
2.2	One-half standard fabrication tolerances		✓	✓	✓		
2.3	Fabrication marks not apparent		✓	✓	✓		
2.4	Welds uniform and smooth		✓	✓	✓		
3.1	Mill marks removed		✓	✓			
3.2	Butt and plug welds ground smooth and filled		✓	✓			
3.3	HSS weld seam oriented for reduced visibility		✓	✓			
3.4	Cross sectional abutting surface aligned		✓	✓			
3.5	Joint gap tolerances minimized		✓	✓			
3.6	All welded connections		optional	optional			
4.1	HSS seam not apparent		✓				
4.2	Welds contoured and blended		✓				
4.3	Surfaces filled and sanded		✓				
4.4	Weld show-through minimized		✓				
C.1							
C.2							
C.3							
C.4							
C.5							

for "basic" elements that require enhanced workmanship. This type of exposed structure can be found in roof trusses for arenas, warehouses, and canopies, and should only require a low cost premium in the range of 20% to 60% due to its relatively large viewing distance as well as the lower profile nature of the architectural spaces in which it is used.

AESS 2 – Feature Elements > 20 ft. This category includes structures that are intended to be viewed at a distance of more than 20 ft. The process requires basically good fabrication practices with enhanced treatment of weld, connection, and fabrication detail, and tolerances for gaps and copes. This type of AESS might be found in retail and architectural applications where a low to moderate cost premium in the range of 40% to 100% over the cost of standard structural steel would be expected.

AESS 3 – Feature Elements ≤ 20 ft. This includes structures that would be viewed at a distance of 20 ft or less. It is suitable for "feature" elements—where the designer is comfortable allowing the viewer to see the art of metalworking. The

welds should be generally smooth but visible, and some grind marks are acceptable. Tolerances must be tighter than normal standards. As this structure is normally viewed closer than 20 ft, it might also be frequently subject to touch by the public, warranting a smoother and more uniform finish and appearance. This type of structure could be found in airports, shopping centers, hospitals, or lobbies and could be expected to incur a moderate cost premium that could range from 60% to 150% over standard structural steel.

AESS 4 – Showcase Elements. Also known as "dominant" elements, these would be used where the designer intends that the form is the only feature showing in an element. All welds are ground, and filled edges are ground square and true. All surfaces are sanded and filled. Tolerances of these fabricated forms are more stringent, generally to half of standard tolerances for structural steel. The cost premium for these elements would be high, ranging from 100% to 250% over the cost of standard structural steel.

AESS C – Custom Elements. This category was created to allow for a completely custom selection of any of the characteristics or attributes that were used to define the other categories. It would allow complete flexibility in the specification of AESS, but would therefore require a high level of communication between the architect, engineer, and fabricator. The premium for this type of AESS could range from 20% to 250% over regular steel.

Design, Fabrication, and Erection Implications

Categories would need to be specified at the design stage. A building might include two categories within the exposed portion of the project: AESS 3 for the lower part of an atrium and AESS 2 for the upper, more distant portion, for example. The matrix approach helps qualify what is expected within each category. Initially, the structural engineers would include the AESS specification in the structural steel division of their contract. After categories are specified, they should appear directly on architectural and structural documents. The fabricator would then make a cost estimate based on the categories and would indicate categories on their shop drawings and later on the erection plans.

There are implications on the sequencing, cost, and constructability that are inferred through the categories and char-

acteristics of the matrix. Construction sequencing for AESS members places further limitations on detailing and increases the challenge of erection. Again, finish plays into the equation, as members that are delivered to the site prefinished require a higher level of care during the erection process to minimize damage and excessive remedial work.

New Documents

CISC plans to issue the new AESS Specification documents later in 2008. The documents include:

- ✓ *The Sample AESS Specification for Canada: Architecturally Exposed Structural Steel (AESS)*, a suggested AESS subsection of Section 05120 that includes the distinctive matrix chart. This is the standard specification chapter that is proposed for inclusion in the overall project specification document.
- ✓ *CISC Code of Standard Practice – Appendix I – Architecturally Exposed Structural Steel (AESS)*. The Appendix includes definitions and materials, related to scope, that clarify the terms of reference of the Specification outlined above.
- ✓ *Guide for Specifying AESS.* This document would not form part of the contractual specification, but would be used to clarify the intentions of the Specification, matrix, and Appendix.

When these documents are ready, they will be available for download from CISC's web site: **www.cisc-icca.ca**.

It is the intent of CISC that these documents should be used in concert to assist the decision-making process, as each complements, as well as extends, the information of the other. We feel that the category system and accompanying matrix will better respect the variation in requirements for AESS, thereby making AESS steel more competitively priced by eliminating a great range of fabrication and installation work that may be unnecessary. As an increasing number of AESS projects are constructed, we begin to realize that not all AESS is created equal, nor should it be specified as such. MSC

Terri Meyer Boake is the associate director of the School of Architecture at the University of Waterloo in Waterloo, Ontario, Canada. Sylvie Boulanger is Quebec Executive Director for CISC and Secretary of the CISC Ad Hoc Committee on AESS. Walter Koppelaar is the president of steel contractor Walters Group, Inc. in Hamilton, Ontario.

Clearly Certification

BY BRIAN RAFF

AISC Certification tackles a tough subject—what happens in a fabrication shop audit—with an innovative new brochure.

THEY SAY A PICTURE IS WORTH A THOUSAND WORDS. But by my calculations, it's actually worth at least 8,844 of them—the number of words that make up the AISC Certification Standard for Steel Building Structures. If you're reading this article, you are most likely an engineer—or at least a proponent of the steel construction industry—which means you are probably a visual learner like me. As a visual learner, pictures have always been more effective to me in explaining concepts and processes. And perhaps your learning and early career experiences have been similar to mine.

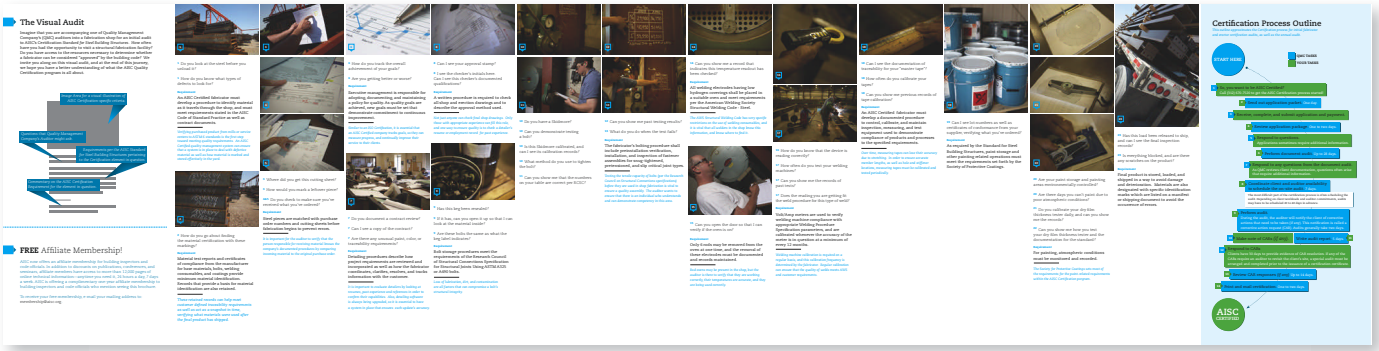
As a structural designer just out of school, I found myself checking shop drawings, preparing plans, details, and mounds of computer and hand calculations. However, *context* was not part of my early career. I knew what a W24x55 should look like, as I had seen pictures in textbooks. But W24x55s, like all other shapes, were just lines on a piece of paper or on a computer screen. It wasn't until I visited a steel mill and a structural steel fabrication shop that I truly understood what a wide-flange section was and how it was cut, drilled, burned, spliced, etc.

Similarly, I could not conceive what went on "behind the scenes" at a fab shop, and I had many questions. What types of errors affected steel fabrication, and how were they handled? What were shops doing to minimize these errors, and how were fabricators going to make my plans and details come to life in the field?

By tagging along on an AISC Certification audit years later, I gained some perspective on how fabricators approached quality, and as a result, many of the above questions were answered. Naturally, I thought it would be a great idea to create a tool that would speak directly to those who still have not found their own answers to questions like the ones above—a tool that caters to us visual learners.

And we've done just that. AISC Certification has developed a new brochure intended to take you along, albeit virtually, on a Certification audit. As you experience this visual journey, imagine that you are accompanying one of Quality Management Company's (QMC) auditors into a fabrication shop for an initial audit to AISC Certification's *Standard for Steel Building Structures*. See what the auditors see, listen to some typical questions that they ask, and find out what they are really looking for and why. By the end, we hope you will have a better understanding of what the AISC Quality Certification program is all about.

Looking through the brochure, you will notice some images indicating the importance of documentation and records—the basis of a company's quality management system. The AISC Certifica-



The new Certification brochure explains the auditing process clearly in words and pictures.

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**.

tion program requires that its participants write a quality manual, and AISC holds a fabricator or erector accountable for everything written. The only way to ensure that a company is meeting quality Certification requirements is to conduct an onsite audit to verify that a quality management system has been implemented effectively. One of QMC's auditors works their way through the shop and talks to everyone from the president to the employees on the shop floor, asking questions and checking records to ensure that all requirements set forth in the *Standard* are met, and that there are no interruptions in the flow of information.

In order to get a better understanding of this auditing process, we have visually stratified the brochure/audit into four separate layers:

Vision. See what the auditor sees and get an idea of what QMC's auditors are looking for.

Assessment. As the auditors go through the *Standard for Steel Building Structures*, there are many elements that require documented procedures as well as records, process knowledge, etc. The auditor asks leading questions, waiting for answers that verify the employee's knowledge of his or her roles and responsibilities.

Requirements. Requirements listed in the brochure are referenced directly from the *Standard* and are intended to give you a sense of what auditors are looking for when asking questions.

Commentary. This final layer is meant to place the technical content on the back burner and provide a conversational explanation of why the auditor is asking the question as it relates to the overall quality of the fabrication shop.

This virtual journey covers the entire spectrum of steel fabrication from receipt of materials from the mill or service center, to final product shipment to the job site. It provides a quick, effective way to educate members of your project team about the depth and breadth of the AISC Certification program without having to read through the technical Certification documentation. In addition to the visual representation of the audit, a timeline is provided to give you and your potential owner and contractor a better understanding of how long the Certification process can take. If you have ever specified the use of an AISC Certified fabricator or erector in the past, then you may have experienced a low bidder purporting to be in the pro-

cess of getting their AISC Certification. It is important to keep in mind that the certification process is a rigorous one taking many companies a significant amount of time to navigate—and some are never able to get the proper quality management system in place to become AISC Certified.

Sticking to Code

While it's extremely important for owners to understand the value that a Certified company can add to a project, it is also important that building code officials recognize the essentials of the program. Code officials and building inspectors also tend to fall into the category of visual learners, as this concept encompasses most of what they do. Because many local jurisdictions don't have the time or resources to fully research the details of the AISC Certification program, this brochure can be an extremely effective vehicle to pique interest and convey important aspects of the program. If a code official can identify with how an AISC Certified fabricator meets the requirements of an "approved fabricator" set forth in Chapter 17 of the *International Building Code*, time and money can be saved by avoiding code-required special shop inspections.

More than Words

As the number of AISC Certified fabricators increases to more than 700, the Certification program continues to gain recognition for setting the standard in quality steel fabrication. This recognition can be attributed in part to our Certified fabricators who stand up for what they believe in and act as advocates of the program in their communities. Specifiers play an equally important role contributing to the overall quality of the steel construction industry by requiring the use of AISC Certified companies on each and every project. As designers, you now have an even more effective tool to communicate the importance of quality Certified structural steel fabrication. This visual journey is more than just words; it's a realistic depiction of a comprehensive Certification audit. It provides a picture of what AISC quality Certification really represents. Experiencing this journey can help members of your project team not only understand, but also truly *see* why this program is so important.

For a hard copy of the brochure, call 312.670.7520 or e-mail certinfo@aisc.org. Or, you can download a PDF version at **www.aisc.org/certbrochure**. MSC

Brian Raff is AISC's manager of certification business development.

*Cives Steel Company – Midwest Division (**www.cives.com**) graciously allowed us to photograph their fabrication shop. Photos were taken by Jessica Sladek (**www.jessicasladek.com**).*

The brochure's easy-to-read timeline outlines the process of an initial certification audit.

In order to increase awareness of the Certification program, AISC is offering a complimentary one-year affiliate membership for building inspectors and code officials that mention this brochure. Visit **www.aisc.org** for the benefits of AISC membership. Contact **membership@aisc.org** for more details.

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ENGINEERS CAN—AND DO—COMMUNICATE WELL

Every technical professional has the capacity to develop presentation and sales skills.

BY ANNE SCARLETT

EFFECTIVE COMMUNICATION SKILLS do not come naturally for many. It's no wonder that abundant information has been written on the topic; in fact, it's a multi-billion-dollar industry and growing! So why write yet another article on effective communication skills? Because engineers are special, and I personally believe in you all. Not only can these skills be learned, they can even be mastered! Some engineers just need an extra boost to discover their inner communicator.

There are several aspects of good communications, but for now we'll focus on two: presentations and selling. The intent here is not to describe how to present and sell, but rather to offer solid reasons to boost confidence and pique interest in honing your own communication abilities.

Presentations are structured—and developed—using a process. Just as an engineering process is logical and orderly, so too is an effective, well-structured presentation. The steps are similar to what you've always been taught: Choose your theme and core messages, and then build an outline where every element of your content reiterates, supports, or explains your intent. Extraneous information that does not belong will simply dilute your intention, much like including irrelevant information within a drawing set. As you prepare your next presentation, try tackling the content exactly as you would an engineering challenge, using one of the many presentation outline formulas that exist.

> Some engineers just need an extra boost to discover their inner communicator.

Communication is a team sport. Just as when you are working on a multi-disciplined project team, common language must also be attained between the speaker and his "audience." Prior to a presentation, we know that we need to do our research in terms of demographics, buying decisions, existing knowledge on the subject, attitudes/personalities, and the venue itself. And when you are in the moment, selling or presenting, you must be cognizant of the audience every step of the way—gaining attention, establishing common ground, sharing information, checking for understanding, and checking for agreement.

"Strangers are friends you have not yet met." Whether you are giving an informal presentation while sitting across the desk from your prospect, or you're speaking to an audience of 200, these people share something in common with you. They are human, plain and simple, and they are *all* actually rooting for you to do well. Think about it: When you sit in an audience and watch a speaker struggle, do you squirm uncomfortably and strongly hope that they will eventually pull themselves together to succeed? It's rare for audiences (even skeptical prospects) to want others to fail in their presence. So think of your audience as a group of cheerleaders, rooting you on toward success!

The eureka! factor. Just as how you get excited when you solve a complex engineering challenge, that same "Ah-ha!" occurs when people understand you and how you can solve their business challenges. And that feeling is *well* worth preparing for! So yes, while it may be tough and unpleasant to prepare, delivering presentations and sales pitches is actually quite rewarding when you are able to successfully pump everyone up! Be assured, a sincere enthusiasm and delivery style will be welcomed by even the most disinterested of audiences.

Nervous energy is better than no energy! Why not welcome those "nerves" with open arms? Let it be your chance to share stories, teach, inform, persuade, and even entertain/perform. Think about it: You've got the floor, and you've got stuff to say! Good stuff. It's all a matter of organizing, culling, and delivering it in a way that makes good sense to your audience. There's a fine line between being nervous and being excited, and with the right attitude and personal pep talks, you can transform your nerves into a vibrant, engaging delivery.

Prove it. As an engineer, you often apply formulas and logic to reach solutions. As a result, you have backup to support your decisions every step of the way. Similarly, in order to deliver a powerful, highly credible presentation or sales pitch, you must provide backup statements to succinctly support your claims. Why are you the best firm for the job? Why is your expertise different than your competitors'? How did you add value to a particu-

*Anne Scarlett is president of Scarlett Consulting (**www.annescarlett.com**), an A/E/C marketing advisory services firm that provides customized business development/marketing training programs. She can be reached by phone at 773.251.8132 or by e-mail at anne@annescarlett.com.*

SCARLETT CONSULTING

lar case study? To keep your proof statements on track, try preparing them using the STAR technique (situation/task, action, and result). Sophisticated human resource professionals often rely upon this format when they are conducting behavioral interviewing with job candidates, but it works well in any situation where you are supporting your claims through stories.

Selling is not an imposition! Your instincts may tell you that if you are selling to a prospect or existing client, then you are pestering them or overstepping your bounds. In fact—provided that you *do* have something valid and valuable to offer—you would be doing them a disservice *not* to sell! When you view yourself as a consultant doing consultative-based selling, then it's about helping the clients and making them aware of their options.

Keep your eye on the ball; it's about them, not about you. When you are in a position where you could up-sell an existing client, offer them services that will truly add value. When you worry about their well-being first and foremost, (and not about your firm's bottom line), then you will naturally find yourself in a position to offer additional services that could better support their business.

Wrap it up; elicit action! Never (ever!) close a presentation or a sales pitch without a call to action. Whatever your intentions and message, make sure that the listeners walk away with an action item, even if it's just to contemplate a specific aspect of your content. When possible, try to ensure that you too play a role in that call to action. Perhaps you encourage them to contact you with their thoughts within a specific timeframe. Perhaps you state what action you will be taking, with the understanding that they should expect this action (e.g., receiving more information from you) by a certain date and that you will be following up to hear their thoughts (again, by a certain date). What's key here is to not just create a call to action, but to also establish timeframes—much like when you manage a technical project. Depending upon the scenario, setting timeframes may increase your odds in terms of how many listeners actually take that next step.

> A sincere enthusiasm and delivery style will be welcomed by even the most disinterested of audiences.

Call to Action

Here is my call to action for you: Pick at least three of these nine elements and choose the ones where you feel you have the most room to grow. Write down the steps you will take to develop yourself in those three areas. Find a buddy with whom you can share your progress every two weeks for a total of three months. And finally, if you need consulting assistance to help you in this matter, feel free to contact me or another competent professional to give you guidance and additional motivation. Don't let anyone tell you that engineers are rotten communicators. If you apply the same gusto to developing your communication skills as you did when earning your engineering degree, then you most certainly can be an effective presenter! MSC

Sustaining Your Future...

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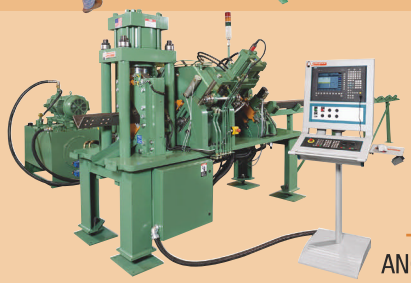

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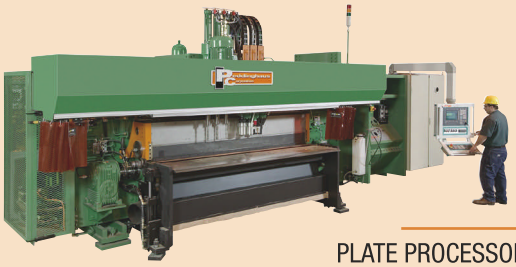

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Properly Prepared

BY ERIKA WINTERS-DOWNEY, S.E.

There's more than one way to surface prep a member.

WE ALL WORK HARD TO MAKE THE STRUCTURES WE DESIGN PERFORM WELL FOR OUR CUSTOMERS. But in addition to meeting safety and serviceability requirements, appearance can also be an important measure of success. In order for primers and paints to work as intended, structural steel must go through a surface preparation process. Specifying the correct level of surface preparation is key to achieving the finished look you want.

Why is steel prepared?

When contaminants such as dirt, rust, salts, or oil are left on the steel's surface and painted over, they have the ability to draw in moisture, which will chip the paint and rust the steel. The most common cause of painting and coating failure is improper surface preparation. A level of surface preparation that complements the paint specification ensures that the primers and paint will uniformly adhere to the steel and last for the intended service life. Common surface preparation techniques include solvent cleaning, wire brushing, power tooling, and abrasive blasting.

Why are there different preparation categories?

The level of surface preparation required will vary based on the end use of the steel and the coatings desired. Steel members that will remain enclosed usually require no painting and will receive minimal surface preparation. Pieces that require a high-end finish will require a more rigorous preparation to ensure that the product adheres uniformly. Members that are to be galvanized go through a pickling process to chemically clean them of any surface oils, dirt, and rust before being galvanized. Finally, members that will be located in severe environments, such as coastal areas, industrial facilities, or high-humidity areas, require high-end coatings and higher levels of surface preparation.

What must I include on my drawings and specifications?

Members that are to be prepared and painted must be designated in the contract documents. In addition, the level of surface preparation and coating information must be included in the specifications accompanying the documents.

A worker uses a wire brush to prepare a member to SSPC-SP2. Photo courtesy of Atlas Iron Works, St. Louis.

Does AISC give recommendations about surface preparation? If not, who does?

Section 6 of the AISC *Code of Standard Practice* (COSP) states that steel that is to remain unpainted "*shall be cleaned of oil and grease with solvent cleaners, and of dirt and other foreign material by sweeping with a fiber brush or other suitable means.*" Steel that is to be painted must be prepared to a minimum of SSPC-SP2 (Hand Tool Cleaning).

The COSP addresses AESS in Section 10. This section notes that weathering steel must be prepared to category SSPC-SP6 (Commercial Blast Cleaning). This is done to remove scale that prevents the material from generating the even patina it is chosen for. However, nowhere in this section are guidelines given for general surface preparation of AESS members. Levels of preparation beyond SSPC-SP2 must be specified by the designer.

Industry standards governing the description of surface preparation categories are published by the Society for Protective Coatings (SSPC). The *Steel Structures Painting Manual Volume 2, Systems and Specifications* gives detailed descriptions of each surface preparation category. The SSPC also publishes its VIS series of standards; these are pictorial standards that govern visual inspection of prepared steel.

Erika Winters-Downey is an AISC regional engineer based in Kansas City, Mo.

A worker prepares a member to category SSPC-SP3. Photo courtesy of Atlas Iron Works, St. Louis.

What is "surface profile" in reference to prepared steel?

Surface profile refers to the depth and shape of the microscopic pits and peaks that make up the steel surface. The depth and shape can be varied to some degree by the surface preparation chosen and the abrasive media used. Some high-performance coatings adhere better to a deeper or more angular profile. The profile depth can be measured and is quantified in mils. Surface profile is also commonly referred to as "anchor profile" or "anchor pattern." The abrasive media must be clean so as not to redeposit oil on the steel. Blasting with abrasives can either be done with commercial rotary blasting machines or with nozzles.

What are the different categories of surface preparation?

A basic description of the different standards is as follows:

SSPC-SP1 – Solvent Cleaning. Oils used in various cutting and drilling machines are deposited on the steel. These must be cleaned off prior to applying any coatings. The solvent cleaning process uses an organic solvent that is either wiped or sprayed on the steel to remove dirt, oil, grease, and other contaminants from the surface of the steel. This can be followed with detergents or steam cleaning. This step is integral because it is the only surface preparation process that removes oil and grease from the steel. Other processes will roughen the steel but not remove oil and grease.

SSPC-SP2 – Hand Tool Cleaning. Hand tool cleaning is usually done with a wire brush or sandpaper. This process will remove loose surface rust and mill scale but is not intended to remove strongly adherent rust. This preparation is generally not adequate for structural steel that will remain exposed. This method is often used to spot clean areas of a structure that might have rusted, at regularly scheduled maintenance times. It does not require a large working area or produce as much dust or noise as power tool cleaning. As a result, it can be performed in higher profile areas without disturbing the surroundings. Oil-based alkyd paints and epoxies work well with hand tooled preparation.

SSPC-SP3 – Power Tool Cleaning. This level of preparation will produce the same results as SSPC-SP2, but uses power tools such as grinders or sanders instead of wire brushes or sandpaper. The cleaning removes all loose mill scale, weld spatter, rust, paint, and other surface contaminants. This level of preparation is usually a minimum for most AESS steel. The main advantage of this method over hand tool cleaning is time savings when working with larger quantities of material.

SSPC-SP5 - White Metal Blast Cleaning. Blasting to white metal is the most rigorous preparation that can be specified. The surface shall be completely free of all contaminants; no surface contaminants may be visible. These include oil, grease,

dirt, rust, paint, mill scale, and oxides. In a 9-sq.-in. area, no rust staining can be present. Blasting is done in a rotary blaster or with compressed air through hand-held nozzles. Small abrasives of metal shot or mineral grit are used.

SSPC-SP6 - Commercial Blast Cleaning. This process is common for AESS steel that will receive a high-end finish. It is more intense than brush-off blast cleaning but not as rigorous as near-white or white metal blast cleaning. No surface contaminants may be visible. In a 9-sq.-in. area, no more than 33% of the area can be stained due to rust. It is required for most epoxy primers and polyurethane finish coats.

SSPC-SP7 – Brush-Off Blast Cleaning. This is the least intensive type of blast cleaning. Its main advantages are speed and economy. Tightly adherent contaminants may remain on the surface of the steel.

SSPC-SP8 – Pickling. This process is most commonly seen as one in a series of baths used in preparation for hot-dip galvanizing. The steel is dipped in a series of tanks to cleanse, pickle, and flux the material. The pickling material can be sulfuric or hydrochloric acid. It will provide a chemically clean surface for galvanizing.

SSPC-SP10 – Near-White Metal Blast Cleaning. This category is more rigorous than commercial blast cleaning but not as rigorous as white metal blast cleaning. It will add significantly to the cost of the preparation, but when done correctly and with a compatible paint system, will provide a longer service life than other systems. No surface contaminants may be visible. In a 9-sq.-in. area, 5% rust staining can be present.

SSPC-SP11 – Power Tool Cleaning to Bare Metal. This method utilizes power tools to remove all adherent contaminants on the surface of the steel. It also has a required surface profile that must be produced. It usually requires impact-based tools rather than rotary-based tools. It is more rigorous than power tool cleaning. It is generally specified if the preparation is to be performed on spot areas in the field where there is no blasting equipment available.

What about steel that is not exposed or painted?

Section 6 of the COSP states that structural steel that does not require shop paint shall be cleaned of oil and grease with solvent cleaners.

Will it help my paint system to specify a more rigorous surface preparation than noted in product standards?

No. It will add to the cost of your project and not increase the surface life of the product.

What other resources are out there?

The Rocky Mountain Steel Construction Association (RMSCA) developed a model specification that addresses some common surface preparation and coatings concerns. This specification goes beyond the COSP guidelines as an example of a

A member exits a rotary blast machine. Photo courtesy of Zimmerman Metals, Denver.

specification that can be adapted to a job with high-end requirements. A cost matrix is included at the rear of this specification that provides guidelines as to the impact that a certain action might have on the fabrication cost of the member. You can find the model specification online at **www.modernsteel.com/aess2003**. The *Journal of Protective Coatings and Linings* (**www.sspc.org/books/journal.html**) and AISC's online Engineering FAQs (**www.aisc.org/faq**) are another couple of resources to search.

How does this affect my project's bottom line?

Higher levels of surface preparation incur more costs. Costs vary across the country and even from fabricator to fabricator, depending on the equipment available and the level of experience of shop employees. Many shops don't have commercial blasting equipment available and send out pieces that must be blasted. The cost matrix included in RMSCA's model specification indicates that commercial blast cleaning (SSPC-SP6) will typically incur a 10% to 20% cost increase on the fabrication of those members. Preparing and painting a typical shop prime coat will incur a cost increase of 5% to 10%. Blasting to Category SSPC-SP5 (White Metal) is 4-5 times more expensive than preparing to Brush-Off Blasting (SSPC-SP7) or Power Tool (SSPC-SP3). (JCPL Applicator Training Bulletin, Jan. 2005.)

And finally, a word about unspecified standard shop paint...

A "shop coat" is a lower-end primer intended to provide temporary protection to the steel. A good rule of thumb is that if you aren't specifying a final paint coat, you don't need a shop primer coat. Steel that will remain enclosed for its service life does not need to be shop coated. In the Commentary of Chapter M of the Specification for Structural Steel Buildings, it is noted that upon studying long-standing steel frames, the presence of a shop coat is irrelevant. Specifying a shop primer for aesthetic reasons is unnecessary and will add to the schedule and cost of your project. If the steel is unprotected in the field during erection, there is the chance that it will develop a thin film of "flash" rusting (iron oxide). This is not harmful to the strength or serviceability of the steel. MSC

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Coatings for Sustainable Structures

BY TODD ALWOOD

When choosing coatings for exposed structural steel—and especially when designing for LEED—make sure they don't negatively affect indoor air quality.

THE GREEN MOVEMENT is coming to the forefront of the design community, and sustainable steel coatings are just one of the areas that illustrate this trend. Within LEED-NC 2.2, interior coatings for steel are governed by the Indoor Environmental Quality Credit 4.2, entitled *Low-Emitting Materials*, whose intent is to "reduce the quantity of indoor air contaminants that are odorous, irritating, and/or harmful to the comfort and well-being of installers and occupants." Anti-corrosive and anti-rust coatings applied to steel that is exposed to an indoor space cannot have a VOC content level greater than 250 g/L.

When I heard that, I thought, "Great, but who set that limit? What is VOC? What does that mean for me?"

Setting Limits

The limit was established in Green Seal Standard GC-03, *Anti-Corrosive Paints*. Green Seal (**www.greenseal.org**) is one of several nonprofit groups in the sustainability field that research standards and certify products/services based on these standards. Green Seal was established in 1989, and the above-mentioned standard was issued in 1997. Research in this field is ever-advancing, and adoption of limits and standards tends to occur from west to east across the country.

VOCs

Now that we know where the limit came from, what's a VOC? VOC stands for "volatile organic compound." In simple terms, a VOC is a compound or material that vaporizes at typical room temperatures. If the VOC level in the surrounding air is high enough, it can be harmful to vegetation or individuals. To minimize the risk of harm, LEED and Green Seal restrict VOC content on a project level.

In Practice

All heavy-duty, non-water-based coatings for structural steel contain at least some VOCs, and this becomes a consideration when working on a LEED project that is trying to tackle LEED credit 4.2 and reduce the VOC level. Credit 4.2 focuses only on VOCs that affect people occupying a space, so for steel this would apply to interior exposed structural steel. If you use a coating on steel that is exposed to an indoor space such as a lobby, then be sure to specify a coating that does not exceed the 250 g/L VOC limit—the limit for metal primers in LEED credit 4.2. The overall percentage of coated surface area for steel compared to that of walls and flooring may be extremely small, but if the project is going after credit 4.2, even the primer for the exposed steel has to meet this limit. There are numerous manufacturers that produce coatings and primers to achieve this limit, so be sure to specify the limit clearly on your construction documents. This requirement does not apply to steel members that are enclosed by building finishes such as suspended ceilings or column covers, because any VOCs in the primer would not be exposed to people occupying the space.

Jessica Sladek

And speaking of primers, probably the greenest decision is not to use primers at all where the structural steel will be enclosed within the building envelope. Such steel does not typically need to be coated or primed, because steel does not rust (beyond a thin surface layer) when it is in a stable environment and not subjected to moisture.

So, when designing structural steel for exposed interior locations, be sure to follow the correct VOC limits—from primer to finish coat—to help achieve your LEED rating and ensure a more sustainable building. MSC

Todd Alwood is the Upper Midwest regional engineer with AISC.

Each month, MSC's product section features items from all areas of the steel construction industry.

In general, these products have been introduced within the past six months. If you're looking for a specific product, visit MSC's online product directory at **www.modernsteel.com/products**. You can browse by product categories or search on any term to help find the products you need, fast.

Organized for Convenience

UNIST, Inc. has published a comprehensive new resource for metalforming companies. The company's complete family of metalforming lubrication systems is now presented in a single, easy-to-use catalog. Since introducing its first roller system for coil stock lubrication in 1993, UNIST has developed an extensive line of components for use in nearly every type of metalforming application, and the entire product line is displayed in this 56-page full-color publication.

Serving as a product overview, system planning tool, and ordering guide, the distinct feature of the new catalog is the way it is organized. A color-coded section is dedicated to each group of components, including supply systems, spray nozzles, four types of uni-Roller systems, and two types of controllers. Each section describes the system and its applications, explains how it works, and lists available options. It also illustrates the relationship of each system to the other components and directs the reader to additional equipment necessary to complete their configuration. Dimensional drawings for installation planning conclude each section. This all-inclusive guide can be used to easily customize a stock or blank lubrication system for metalforming applications.

UNIST plans to have each section of the catalog available for use on the company web site later this year. A free copy of the new catalog can be obtained immediately from UNIST's headquarters or through a UNIST representative.

For more information, visit www.unist.com or call 800.253.5462.

Increased Range of Motion for Drill

Hougen Manufacturing's new Model HMD904S Swivel Base Portable Magnetic Drill marks a major performance improvement to its HMD904 model. The S series features a new drill body-to-magnetic base coupling that provides both a pivot axis for up to a 1⅛-in. arc of side-to-side motion and a straight-line axis that permits up to 1⅜ in. of front-to-back movement. After the magnetic base has been engaged, the added axes allow operators to fine-tune the drill position and precisely locate hole center points. The unit incorporates a lock-down mechanism that makes releasing and securing the pivot and slide coupling simple, fast, and virtually effortless. A single-actuation handle with short-stroke travel both unlocks and securely retightens the swivel base coupling.

The HMD904S is ideal for applications where hole position accuracy is critical, or for challenging fabrication, maintenance, and on-site installation/erection jobs involving horizontal or overhead/inverted drilling where supporting and energizing the magnet while locating the drill can be awkward.

The drill weighs just 30.5 lb and measures 16⅜ in. x 7 3/16 in. x 8¼ in. long, yet provides drilling capacities of from 7/16 in. up to 1½ in. diameter and a 2-in. depth of cut. For versatility, the drill also includes Hougen's new hex drive arbor, which can be easily removed for installation of drill chucks and other Hougen Portable Machine Shop accessories.

For more information, visit www.hougen.com or call 810.635.7111.

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

Expanded Joist Information

Discussions of ASD/LRFD design, composite joists, and updated design tables are featured in Canam Steel Corporation's newest joist catalog, including the Steel Joist Institute's 42nd edition specifications.

The first 35 pages of the catalog aid the designer with typical joist applications, including photos, reference charts, design tips, and discussion. Other highlights of the free catalog include the following:

- The diagonal bridging chart has been expanded to cover deeper joists, wider spacings, and larger bridging.
- The user can find a discussion and chart for end anchorage for uplift.
- The catalog covers the idea, advantages, and appropriate use of a 3½-in.-deep seat for certain K- and LH-joists.
- There are new charts for sloped seat depths, which are now standard throughout the joist industry.

For more information, visit www.canam.ws or call 301.874.5141.

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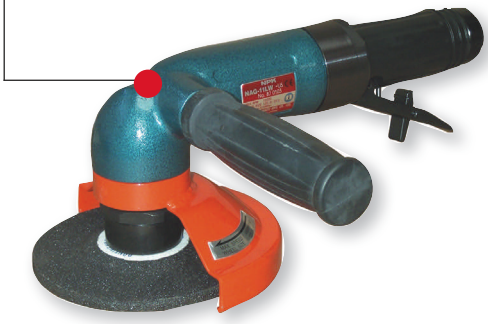

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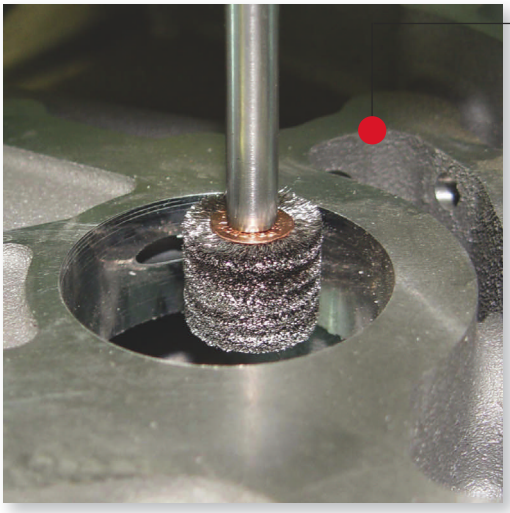

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ESTIMATOR/PROJECT MANAGER

Ahlborn Structural Steel, Inc., a structural and miscellaneous steel fabricator and erector, is seeking an Estimator/Project Manager at our Santa Rosa, CA location. 5 years experience in the steel industry and commitment required.

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Ahlborn Structural Steel, Inc.
1230 Century Ct.
Santa Rosa, CA 95403
Attn: Lance Ballenger
707-573-0788 (fax)
Lance@ahlborncompanies.com

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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- **Estimators** – Minimum 5 years structural steel estimating experience required

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

PROJECT MANAGERS. Minimum 5 years experience in project management, particularly in structural and ornamental metal fabrication and erection. Excellent skills in computer, organizing, scheduling, documentation, communication and customer care.

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

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

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

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

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We currently have the following openings:

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- Estimating Manager

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Please send resume with cover letter to:

Charles Hentzell
Human Resources Manager
chentzell@cives.com

Structural Engineer

Providence Engineering Corporation, located in Central Pennsylvania, is a consulting structural design firm specializing in the design of industrial and commercial building projects as well as providing construction engineering support to contractors. We are a mid-sized firm looking to grow in 2008. We are currently accepting resumes for the following positions:

Design Engineer
-Entry Level, Bachelors in Architectural (Structural) or Civil (Building) Engineering required. Will work as part of a team under the direction of senior engineers.

Project Engineer
- Professional Registration required. Will occasionally work as part of a team under the direction of senior engineers, however will primarily work with autonomy and self direct on smaller projects.

Senior Structural Engineer
- Professional Registration and 10 years experience required. Will direct the efforts of engineers on multiple projects and be responsible for fiscal project management of assigned projects.

All engineers will be engaged in the design process from conceptual work, through assembling Construction Documents to assisting in Construction Administration phases. Ability to collect existing building information as part of site visits as well as excellent communication skills are a must for all applicants.

Providence Engineering offers a flexible work environment and a competitive benefits package. Interested applicants should send resumes to:

Providence Engineering Corporation
Attn: David Bernhardt
117 S. West End Avenue
Lancaster, PA 17603

Or email to:
dwb@proveng.com

AISC Seeks Senior Engineer

Are you the person that fellow engineers come to with questions about the AISC Specification or AISC Seismic Provisions? If you are looking for the next step in your career, have excellent people skills, and like new challenges, AISC is the place for you.

AISC seeks a Senior Engineer in the AISC Steel Solutions Center. This is a unique opportunity to apply your design experience in helping other steel designers better understand the nuances of AISC documents and steel design and construction. You will work with the top engineers, fabricators, educators, and leaders in the North American steel design community and construction industry. You will provide technical assistance to the entire structural engineering community and structural steel industry. As you serve as the connection between people with questions and people with answers, you will become nationally known for your own expertise in steel design and construction.

Applicants should have a BS degree in architectural or civil engineering with structural emphasis; MS or M. Eng. preferred. A minimum of 5 years of design experience is required, and more is better; also, having experience in construction is a plus. AISC provides a great working environment offering professional development opportunities, flexibility, excellent resources, and a competitive salary with excellent benefits.

Send resumes to Janet Cummins at **cummins@aisc.org**.

JGM Inc.
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Downingtown, PA 19338
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610.873.0083 Fax

Contact: Joe Messner Jr., President
Email: jmessnerjr@jgminc.us

Sr Project Manager ($90-140K)
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Send resumes to: resume@aerosteel.net
or fax to 760-870-3025

ACTIVE MEMBER

LEARNING BY DOING

Students at one engineering school learn about steel erection—by actually doing it in class.

BY STEVE KURTZ, P.E., PH.D.

WHEN I WAS A STUDENT, I thought that beams and columns were just thin lines on a piece of paper. Today, many students think beams and columns are just thin lines on a computer screen, illustrating that not much has changed in structural steel education besides the medium. Yet designers need to understand fabrication and erection, and it is the educator's responsibility to prepare young designers for the profession.

One of the most effective and prolific ways of teaching students about fabrication and erection has been AISC's Steel Sculpture, a 35-piece, 1.4-ton structural sculpture that contains almost every imaginable connection in one compact location. The sculpture has been assembled on more than 135 campuses around the U.S. with the help of many generous donations from fabricators.

At Lafayette College in Easton, Pa., the students take the lesson a step further by *dis*assembling the sculpture three times each year. In the required junior-level course "Fundamentals of Structural Engineering," each of the three lab groups undergoes a hands-on activity in which they must re-assemble 15 pieces of the sculpture in about 45 minutes. When the exercise begins, the students are faced with a partially disassembled sculpture and the challenge of having to reassemble the puzzle. They are armed with a set of erection/shop drawings and an impact wrench.

Hands-on engineering education is strongly emphasized in the Lafayette College Civil Engineering program, which requires eight courses that contain three-hour labs. In Fundamentals of Structural Engineering, students devote roughly half of their laboratory time to fabricating structural steel. The overriding philosophy is that students cannot become creative designers if they have never created anything. Hence, every student in the program is expected to become proficient at welding, drilling, cutting, and fitting up structural steel. The unifying theme in the course is a term project in which teams of eight students compete against one another in a steel bridge competition that's modeled after ASCE/AISC's National Student Steel Bridge Competition (NSSBC). Devoting much of their lab time during the semester to designing and fabricating a 15-ft-long steel bridge from size-limited parts and loading it with 2,500 lb of weight, students combine all of their knowledge of structural analysis, steel design, detailing, and fabrication.

Steve Kurtz is an assistant professor at Lafayette College. Lafayette College is grateful to Slatington Fabricators (AISC Member) of Slatington, Pa. for donating the steel sculpture.

Why should students erect steel in class? One reason is that students enjoy the change of pace from their usual analytical work. But the main reason is that the process of erecting steel is valuable education for would-be engineers. It teaches students that erecting steel is a tough job that is only possible with precise fabrication. More technically, it trains students to read shop drawings in a much more serious and immediate way than could be simulated in a classroom, because they are presented with a serious and immediate job to perform. More subtly, they become aware of erection clearances, the problems of double-sided connections, and the myriad of connection types.

Mostly, they benefit in ways that are not obvious or necessarily testable. The experience of having aligned holes with a spud wrench, torqued bolts with an impact wrench, and made physical connections between the thin lines drawn on paper may not help them on their next exam. But, they gain the kind of understanding that can only come from having physically done something. MSC

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

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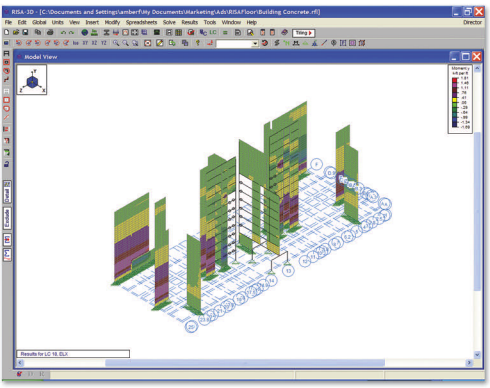
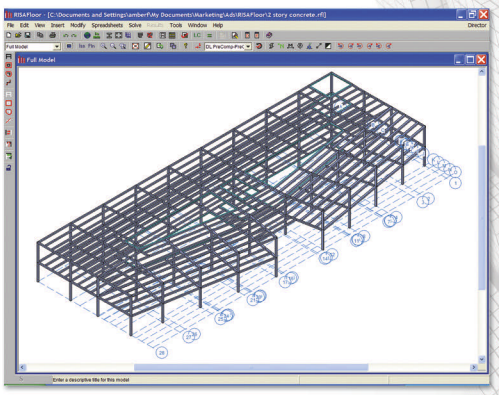
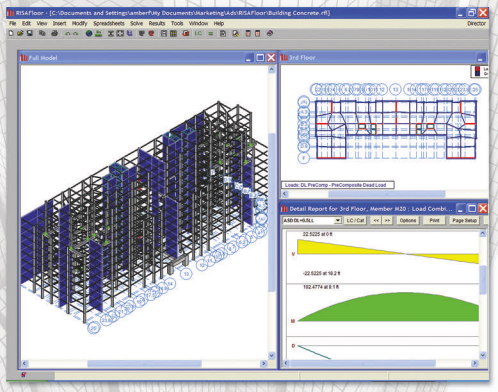
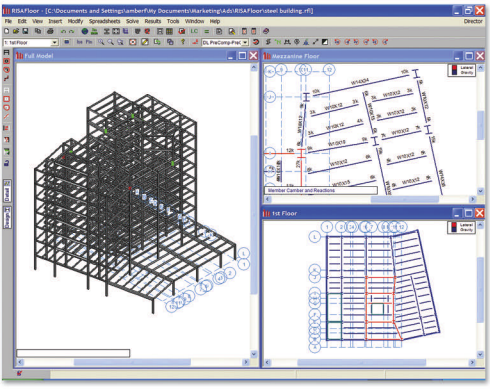
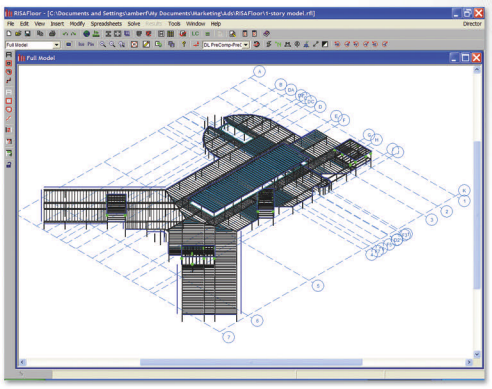
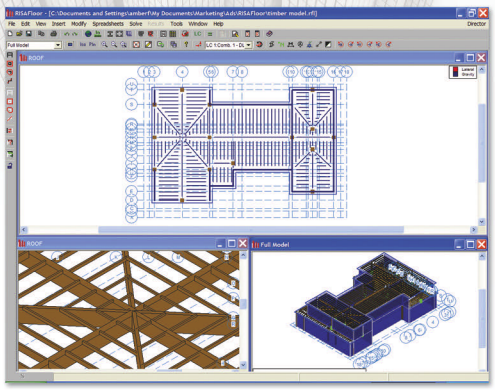

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