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NOTES FROM THE EDITOR



Scott L. Melnick

The Professional Practice of Engineering

Delegates from 34 local structural engineering associations gathered in Chicago recently for the annual meeting of the National Council of Structural Engineers Associations (NCSEA). If you're looking for information on the structural engineering profession, there's no better place than this gathering (likewise, if you're looking for practical steel design information, there's no better place than the North American Steel Construction Conference; and if you're looking for highly academic presentations there's no better place than the ASCE/SEI Structure's Congress).

While most of the presentations were generally interesting, the real meat of the meeting focused on the controversial issue of certification for structural engineers. Supporters of certification believe it is a method of self-regulation that will help elevate the stature of the profession—and will ultimately lead to separate S.E. licensure in all states (currently, 10 U.S. jurisdictions provide licensure for structural engineers). Opponents say that since there would be no legal backing behind certification it is simply an unnecessary expense—and judging by certification programs in other professions, it won't come cheaply.

For me (and remember, I'm simply an interested observer and not a structural engineer), the issue will partly come down to the engineering community's financial support for the program. First, will NCSEA devote the dollars needed to develop both the testing and training material needed to initiate the program? Second, will NCSEA devote the dollars to market the program—not just to structural engineers, but also to owners, contractors, architects, and even the general public?

Delegates to the annual meeting voted to "accept the certification committee's consensus model as the basis for further development of a certification program"—in other words, to keep looking at the possibility of certification. That's probably the right decision for now—at least until a solid proposal is presented that answers the question of what the program will cost and who will pay for it.

Dangerous Speech

While everyone is in favor (or at least claims to be in favor) of free speech, the Supreme Court recognizes that some speech is prohibited (such as falsely shouting "fire!" in a crowded theater). But lately, my

belief in free speech has been challenged by some pretty stupid journalism.

The most outlandish piece originated in the *New York Post*, which falsely claimed that an MIT study blamed the World Trade Center collapse on the use of a single-bolt connection between the floor framing and exterior wall framing (MIT has sent a response to the *Post* blasting them for erroneous reporting). As AISC's V.P. of Engineering and Research pointed out in his letter to the *New York Post*, "it has been clearly and conclusively established that the structural connection between the floor framing and the wall framing was a more-than-adequate welded gusset plate. The bolts were present only for the purposes of a temporary connection during construction. Criticisms of the bolted connection and depictions of the trusses and floor collapsing individually, though widely depicted early on, are simply distractions from the truth." Normally I wouldn't be all worked up by an article in a trashy tabloid; unfortunately, the story was picked up by the AP News Service and reprinted in publications throughout the country. Please, when you speak with a reporter from a newspaper, be aware that they don't have a technical background and will often pick one item from your statement to report—often distorting the meaning of what you're saying.

If you speak to the press, make sure you present the information clearly. Otherwise, you might end up making statements such as a recent one from a well-known blast researcher. He reported that buildings designed to the current seismic code could fail when attacked with explosives. Yes, and cars designed for highway use often sink when driven into a river. His irresponsible statements neglect to inform reporters that engineers today are designing for blast resistance—when the owner puts that in the project criteria. They are not just blindly applying seismic design criteria in the hopes that the blast effects will somehow be handled.

Don't stop talking to the press. The public needs to hear from the technical community. But take the time to make sure the reporter understands what you're talking about. And if you are misrepresented, follow up with a letter to the editor. It's important that the engineering community leads in any technical discussion.

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Steel Quiz, a monthly feature in *Modern Steel Construction*, allows you to test your knowledge of steel design and construction. All references to LRFD specifications pertain to the 1999 *LRFD Specification for Structural Steel Buildings*, available as a free download at

www.aisc.org/lrfdspec

ASD references pertain to the 1989 *ASD Specification for Structural Steel Buildings*. Where appropriate, other industry standards are also referenced.

If you or your firm are interested in submitting a *Steel Quiz* question or column, contact:



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The content of this month's *Steel Quiz*, written by the Steel Solutions Center, has been taken from the FAQ portion of AISC's web site, www.aisc.org/faq. If you don't know the answer to these questions, the Steel Solutions Center encourages you to find them (and hundreds more like them) on AISC's web site. Question 1 is from Section 1 of the FAQs, Question 2 is from Section 2, Question 3 is from Section 3 and so on.

QUESTIONS

1. Which material specification is most appropriate for hollow structural sections when atmospheric corrosion resistance is desired?
 - a. ASTM A992
 - b. ASTM A500, Grade B
 - c. ASTM A847
 - d. ASTM A500, Grade C
2. Which of the following are acceptable methods for making bolt holes?
 - a. Sub-punching and reaming
 - b. Drilling
 - c. Flame piercing and reaming
 - d. All of the above
3. Can out-of-tolerance mill material be adjusted by the fabricator so that it conforms to the appropriate tolerances?
 - a. Yes, all of the time
 - b. No, never
 - c. Sometimes
4. When a beam with a web penetration requires reinforcement, what is the most efficient location for this reinforcement?
 - a. Above and below the hole, horizontally
 - b. To either side of the hole, vertically
 - c. Both a & b
 - d. Neither a nor b
5. True or False: Through-plates are always required for single-plate connections to HSS columns.
6. When is paint permitted on the faying surfaces of bolted connections?
 - a. For all snug-tight bolted connections
 - b. For all slip-critical bolted connections that have paint with qualified slip resistance
 - c. For all pretensioned bolted connections
 - d. All of the above
7. Which of the following is an incorrect anchor rod specification?
 - a. ASTM F1554, Grade 36
 - b. ASTM F1554, Grade 105
 - c. ASTM A325
 - d. ASTM A449
8. When are plug and slot welds used?
 - a. To transfer compressive forces
 - b. To transfer tensile forces
 - c. To transfer shear forces
 - d. Both a and b
9. Which is the most commonly used non-destructive examination method in structural steel fabrication?
 - a. Visual
 - b. Dye penetrant
 - c. Magnetic particle
 - d. Ultrasonic
10. Which does not need to be included in contract documents when steel is to be painted?
 - a. The type and manufacturer of the specified paint
 - b. The required level of surface preparation
 - c. The desired dry film thickness
 - d. Ventilation requirements

TURN PAGE FOR ANSWERS

STEEL QUIZ

ANSWERS

All FAQs refer to www.aisc.org/faq.

1. c. See FAQ 1.3.4.
2. d. See FAQ 2.4.1.
3. c. See FAQ 3.1.1.
4. a. See FAQ 4.4.4.
5. False. See FAQ 5.2.2.
6. d. See FAQ 6.7.1.
7. c. See FAQ 7.1.2.
8. c. See FAQ 8.4.1.
9. a. See FAQ 9.1.1.
10. d. See FAQ 10.1.3.

AISC Quality Certified Fabricators



In an ideal world, an owner's representative would inspect the shop of every fabricator bidding on a project. Obviously, in the real world, such a time-consuming task is not practical. Fortunately, there is an alternative. The AISC Quality Certification Program can act as a pre-qualification system for structural steel fabricators.

The purpose of the AISC Quality Certification Program is to confirm to the construction industry that a Certified structural steel fabricating plant has the personnel, organization, experience, procedures, knowledge, equipment, capability, and commitment to produce fabricated steel of the required quality for a given category of structural steel certification.

Each December, *Modern Steel Construction* publishes a list of AISC Quality Certified fabricators as of press time. The list is updated frequently, so be sure to check the AISC web site for the latest listings at:

www.aisc.org/quality.html

Certification Categories

- **Conventional Steel Building Structures (SBD):** The certification is typically specified for small public service and institutional buildings (schools, etc.), shopping centers, light manufacturing plants, miscellaneous and ornamental iron work, warehouses, low-rise beam/column/light truss structures.
- **Simple Steel Bridge Structures (SBR):** The certification is typically specified for un-spliced rolled beam bridges.
- **Complex Steel Building Structures (CBD):** The certification is typically specified for high-rise buildings, large public service and institutional buildings, heavy manufacturing plants, powerhouses, and petro/chemical processing facilities.
- **Major Steel Bridges (CBR):** The certification is typically specified for large span bridges. Main members are typically fabricated girders that must be spliced with a welded or bolted connection.
- **Metal Building Systems (MB):** Pre-engineered metal building systems including cold-formed members and panels.

Fabricators certified for Complex Steel Building Structures are automatically certified for Conventional Steel Building Structures and those certified for Major Steel Bridges are automatically certified for Simple Steel Bridge Structures

- **Sophisticated Paint System Endorsements (P1, P2, P3):** There are currently three Paint Endorsements available:

P1—Sophisticated Paint Endorsement-Enclosed

P2—Sophisticated Paint Endorsement-Covered

P3—Sophisticated Paint Endorsement-Exposed

- **Fracture Critical Members Endorsement (F):** Familiarity with procedures required to produce fracture critical members in accordance with a fracture control plan as defined by AASHTO or AREA.

AISC Quality Certified Fabricators (By State/Country)

Alabama

CBD P1	Alfab, Inc.
CBR FP1	Carolina Steel Corp.
CBD	Covenant Steel Warehouse, Inc.
SBR	Deb Corp.
CBD	E & H Steel Corp.
CBD	FabArc Steel Supply
CBD CBR FP1	G&G Steel, Inc.
CBD	Gentry Steel Fabrication
CBR F	Hardie-Tynes Co. Inc.
CBD	M & J Materials, Inc.
CBD SBR P1	Qualico Steel Co., Inc.
CBD	Southern Monopole & Utilities Co.
SBD CBR FP1	Steadfast Bridge Co.
CBD P2	SteelFab, Inc.
CBD CBR FP2P3	Steward Machine Co., Inc.
SBD SBR P1	Walpar, Inc.
CBD CBR FP1	Warrior River Steel, LLC
CBR FP1	Williams Bridge Co., Inc.

Alaska

SBD	Sampson Steel Co.
CBD CBR FP1	STEELFAB

Arizona

CBD	Able Steel Fabricators, Inc.
SBR	Sandvick Equipment & Supply
CBD SBR P3	Schuff Steel - Gilbert

CBD CBR FP3	Schuff Steel Co.
CBR F	Stinger Welding, Inc.
CBD	Strocal, Inc.

Arkansas

CBD CBR FP1	AFCO Steel
CBD CBR F	Arkansas Steel Processing, Inc.
SBD SBR	Hodge Fabrication, Inc.
CBD CBR FP1	Prospect Steel Co.
CBD P1	Roy Case Construction
CBD	Russellville Steel Co., Inc.
CBD CBR FP1	Van Buren Bridge Co.

California

CBD CBR P3	Ameron, Int. - Steel Fabrication Div.
SBD	Anvil Steel Corp.
CBR P1	C & K Johnson Industries, Inc.
CBD CBR F	Cavanaugh Machine Works, Inc.
SBD	Cowelco
CBD	Duncan Brothers Inc.
SBR	Excel Sheet Metal dba Excel Bridge
SBR	Excel Sheet Metal Inc./Excel Bridge
SBD	Fresno Fab-Tech Inc.
SBD	FTS
CBD	Gayle Manufacturing Co.
CBR	Global Fabricators
CBD	Golden State Steel
CBD CBR FP1	Herrick Corp.

CBD CBR F	Herrick Corp.
CBD	Junior Steel Co.
CBD	Kasco Fab, Inc.
CBD SBR	KCB Towers, Inc.
CBD CBR F	NESCO Fabricators div. of XKT Eng.
CBR	Northwest Pipe Co.
CBD P1	NOVA Group, Inc.
CBD	Production Steel Co., Inc.
SBD	Richardson Steel, Inc.
SBD	Sierra Nevada Steel Corp.
CBD	Strocal Inc.
CBR F	Trans Bay Steel Corp.
CBR	Votaw Precision Technologies, Inc.
CBD	West Coast Iron, Inc.
SBD SBR	Western Steel

Colorado

CBD	BAAB Steel, Inc.
SBD	Beller Fabrication Corp.
CBR	Big R Manufacturing, LLC
SBD	Consolidated Steel Services, Inc.
CBD CBR FP1P2P3	Grand Junction Steel Co.
CBD	Myers & Co. Architectural Metals
CBD	Pikes Peak Steel
CBD CBR P1	Platte River Steel Co.
CBD	Ripsam Steel Co.
CBD	Steel Fabricators, Inc.
CBD	Western Slope Iron & Supply, Inc.

AISC Quality Certified Fabricators

(By State/Country)

CBD	Zimkor LLC.	Illinois		Michigan	
CBD CBR FP1	Zimmerman Metals Inc.	CBD	Arlington Structural Steel Co., Inc	SBR P1	Cardinal Fabricating, Inc.
Connecticut		SBD	Byus Steel, Inc.	SBR	Cox Brothers Machining, Inc.
CBD	Coastal Steel Corp.	CBD	Carlo Steel Corp.	SBD SBR	Gerace Construction Co., Inc.
CBD	Erection & Welding Contractors, LLC	CBD	Garbe Iron Works	CBD	Ideal Steel & Builders' Supplies
SBR	Highway Safety Corp.	CBD	Hanley Steel Inc.	CBD	Moore Flame Cutting Co.
CBD CBR FP1	International Bridge & Iron Co.	CBD FP1	Industrial Steel Construction, Inc.	SBD SBR	Moran Iron Works Inc.
CBD CBR FP1	National Eastern Corp.	SBD	K & K Iron Works, Inc.	SBR	Union Fabricators & Fitters, Inc.
CBD	Shepard Steel Co.	CBD	Shelco Steel Works, Inc.	Minnesota	
SBR	Southington Metal Fabricating Co.	SBD	South Shore Iron Works, Inc.	CBD SBR	American Structural Metals, Inc.
CBD	Steel Fab, Inc.	CBD	Swift Steel/Div. Jones & Brown Co.	CBD CBR	BendTec, Inc.
CBD	SteelTech Building Products, Inc.	CBD SBR	Waukegan Steel	CBD FP1	Continental Bridge
CBD	Topper & Griggs, Inc.	Indiana		CBD FP1	D.S. Brown-Chaska Operations
CBD SBR	United Steel, Inc.	CBD SBR FP1	Almet, Inc.	CBD SBR FP1	LeJeune Steel Co.
Delaware		CBD	Benchmark Fabricated Steel	CBD	Standard Iron & Wire Works, Inc.
CBD P1	Crystal Steel Fabricators, Inc.	SBD	C & C Iron, Inc.	SBR	Wheeler Consolidated, Inc.
CBD CBR FP1	Helmark Steel Inc.	CBD P1	Cives Steel Co. Mid-West Division	Mississippi	
SBD	RC Fabricators, Inc.	CBD	Ferguson Steel Co., Inc.	CBD	City Welding & Fabrication Inc.
SBR	Sigma Industries	CBD	Fort Wayne Structural Products	CBD P1	Cives Steel Co. Mid-South
Florida		CBD SBR P1	Geiger & Peters Inc.	CBD	Delta Steel Co., Inc.
CBD P2	Addison Steel, Inc.	CBD CBR P1	Indiana Steel & Engineering Corp.	CBD	Ellis Steel Co., Inc.
CBD	Allstate Steel Co. Inc.	CBD FP1	Industrial Steel Construction, Inc.	CBD	Gipson Steel, Inc.
CBD	Bell Steel	CBD	Interstate Welding & Fabrication Inc.	CBD SBR P1	Steel Service Corp.
CBD CBR	Canam Steel Corp.	CBD	Jack K. Elrod Co., Inc.	CBD P1	Structural Steel Services, Inc.
CBD	Copeland Steel Fabricators	CBD	McGovern Steel Fabricators	CBD F	Struthers Industries, Inc.
CBD P2	Fabco Metal Products, LP	CBD CBR FP1	Munster Steel Co. Inc	Missouri	
CBD SBR	Florida Structural Steel	CBD SBR P1	United Steel Fabricators, Inc.	CBD CBR FP1	Acme Structural, Inc.
CBD SBR P2	Industrial Steel, Inc.	SBD P1	Valmont Industries, Inc.	CBD	Apex Steel Fabrication, Inc.
CBD SBR P2	Met-Con, Inc.	CBD FP1	Vincennes Steel Corp.	CBD SBR	Blattner Steel Co.
CBD P1	Mid Florida Steel Corp.	Kansas		CBD SBR	Bratton Corp.
CBD CBR FP1P2	PDM Bridge, LLC	CBD	Central Steel, Inc.	CBD SBR	Brookfield Fabricating Corp.
SBD SBR	Southeast Fabricators, Inc.	CBD	Doherty Ornamental Iron	CBD	Builders Steel Co., Inc.
CBD P3	Southeastern Constr. & Maint., Inc.	CBD CBR FP1	Havens Steel Co.	CBD	Canam Steel Corp.
CBD CBR FP1	Steel Fabricators, L.L.C.	SBD	HME, Inc.	CBD	Chillicothe Iron & Steel, Inc.
CBD	Steel Systems of Pensacola, Inc.	CBD	Lacy Steel Co.	CBD	Custom Steel Fabrication
CBD CBR FP3	Tampa Steel Erecting Co.	SBD	Maico Industries Inc.	CBD CBR FP1	DeLong's Inc.
CBD	Trinity Fabricators, Inc.	CBD	Midland Steel Co.	SBR	DeLong's Inc.
SBD	Unlimited Welding	CBD SBR P1	Pinsker Steel Inc.	CBD SBR	Doing Steel, Inc.
SBR	Vulcan Steel	CBD SBR P2	PKM Steel Service, Inc.	CBD CBR	Hammers Iron Works, Inc.
CBD	Whitley Steel Co., Inc.	CBD P1	Southwest Steel Fabricators, Inc.	CBD CBR FP1	Havens Steel Co.
Georgia		SBD SBR	Unique Metal Fabrication, Inc.	CBD P1	Hillsdale Fabricators an Alderici Ent.
CBD P1	Addison Steel, Inc.	Kentucky		SBR	Hurt Fabricating Corp.
SBR	Augusta Bearing Works	CBD CBR FP1	Stupp Bridge Co.	CBD	International Fab. & Erectors, Inc.
CBD FP1	Augusta Iron & Steel Works, Inc.	Louisiana		CBD CBR FP1	Missouri Fabricators
CBD P1	Cives Steel Co. Southern Div.	CBD CBR FP2P3	Manufab, Inc.	CBD	Ozark Steel Fabricators, Inc.
CBD	Em-Co Metal Products, Inc.	CBD	Mar-Con Mfg., Div. Of Mar-Con, Inc.	CBD	St. Louis Fabrication Services, Inc.
SBD	May Specialty Fabricators	CBD CBR F	Orleans Materials & Equipment	CBD SBR P1	Steward Steel, Inc. (Structural Div.)
CBD	Ogeechee Steel, Inc.	CBD	Southland Steel Fabricators Inc.	Montana	
CBD	Presco Steel, Inc.	CBD SBR P1	Steel Fabricators of Monroe, Inc.	CBD CBR FP1	Allied Steel
CBD	Steel, Inc.	Maine		SBD	Midwest Industries, Inc.
CBD	SteelFab of Dublin	CBD SBR P1	Advanced Resources & Constr.	CBD CBR FP1	Roscoe Steel & Culvert Co.
SBD	Steel-Span Inc.	CBD CBR FP1	Casco Bay Steel Structures, Inc.	CBD SBR	Roscoe Steel & Culvert Co.
CBD	Stein Steel & Supply Co.	CBD CBR FP1	Cianbro Corp.	CBD P1	Selway Corp.
CBD CBR FP2	Steward Machine Co., Inc.	CBD SBR P1	Cives Steel Co. New England Div.	Nebraska	
Idaho		CBD CBR P1	Megquier & Jones, Inc.	CBD F	Capital Contractors, Inc.
CBD F	Eaton Metal Products Co.	SBD SBR	Newport Industrial Fabrication, Inc.	CBD CBR FP1	Drake-Williams Steel Inc.
CBD	Gayle Manufacturing Co.	Maryland		CBD CBR FP1	Lincoln Steel Co.
CBD	K&T Steel Corp.	CBD	B&B Welding Co., Inc.	SBR	Oden Enterprises, Inc.
CBD	Lundahl Ironworks Co.	CBD P1	Canam Steel Corp.	SBD P1	Valmont Ind., Inc. Ind.Const Prods
CBD	Rule Steel Tanks	Massachusetts		SBD SBR	Woerner Wire Works, Inc.
CBD	SME Steel Contractors	CBD SBR	Auciello Iron Works Inc.	New Hampshire	
CBD SBR	Steel West, Inc.	CBD SBR	Berkshire Bridge & Iron Co., Inc.	SBD	American Steel Fabricators, Inc.
CBD	Western Steel Manufacturing Co.	SBD	C & I Steel, Inc.	CBD FP1	Eastern Bridge, LLC
Iowa		SBD	Columbia Metal Service Co.	CBD P1	Famm Steel
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CBD CBR FP1	Johnson Machine Works, Inc.	SBR	Franklin County Fabricators	SBR	Merrimack Sheet Metal, Inc.
SBD	Katelman Foundry, Inc.	SBR	New England Bridge Products, Inc.	CBD SBR P1	Novel Iron Works, Inc.
SBD	Mag Welding Inc.	CBD SBR P1	Ryan Iron Works, Inc.	New Jersey	
CBD	Mid- States Steel Corp.	CBD CBR FP1	Tuckerman Steel Fabricators, Inc.	SBD SBR	Able Fab Co.
CBD SBR P1	Missouri Valley Steel Co.	SBD SBR	Westwood Systems, Inc.	SBR	Amscot Structural Products
CBD CBR FP1	Paxton & Vierling Steel Co.			CBD	Arnold Steel Co., Inc.
SBD	Ramark Holdings, LLC			CBD CBR FP1	Cornell & Co., Inc.

AISC Quality Certified Fabricators

(By State/Country)

CBD CBR FP1 Harris Structural Steel Co.
 CBD Interstate Iron Works Corp.
 SBD J. C. MacElroy Co., Inc.
 SBD J.V. Palmonari, Inc.
 SBD SBR Lehigh Utility Associates
 SBD SBR Schiavone Construction Co. Inc.
 SBD Selco Manufacturing Corp.
 SBD SBR Wel-Fab, Inc.
 SBD SBR WT Welding & Contracting Co., Inc.

New Mexico

CBD Amfab Incorporated
 CBD GLENCO, Inc.
 CBD Western Fabrication LLC

New York

CBD CBR F Canon Construction Corp.
 CBD SBR P1 Cives Steel Co. Northern Div.
 CBD Delhi Steel Corp.
 CBD CBR Franbilt, Inc.
 CBD SBR Francis A. Lee Co., A Corp.
 CBD General Steel Fabricators Inc.
 SBD Jeffords Steel & Engineering Co.
 CBD JPW Structural Contracting, Inc.
 CBD Raulli & Sons, Inc.
 SBR Seibel Modern Manufacturing
 CBD CBR FP1 STS Steel, Inc.
 SBR Watson Bowman Acme Corp.

Nevada

CBD Blue Mountain Steel, Inc.
 CBD SBR Martin Iron Works Inc.
 CBD CBR FP1 Reno Iron Works Co., Inc.

North Carolina

SBD Basic Metal Products, Inc.
 CBD Burton Steel Co.
 CBR FP1 Carolina Steel Corp.
 CBR FP1 Carolina Steel Corp.
 CBD SBR Carolina Steel Corp.
 SBD Charlotte Miscellaneous Steel
 CBD Contract Steel Sales, Inc.
 CBD Dave Steel Co., Inc.
 CBD Davis Steel & Iron Co., Inc.
 CBD Hercules Steel Co.
 CBD Lyndon Steel Co.
 CBD McCombs Steel Co., Inc.
 CBD North State Steel Inc.
 SBD North State Steel, Inc.
 CBD P1 Southern Engineering
 CBD P1 SteelFab, Inc.
 CBR FP1 Structural Steel Products Corp.
 SBD Triad Steel Co.

North Dakota

CBD Mandan Steel Fabricators
 CBD Mid America Steel Inc.
 CBD Mid America Steel, Inc.

Ohio

CBD Affiliated Metal Industries, Inc.
 CBR FP1 Alliance Machine Co.
 CBD Art Iron, Inc.
 CBD P1 Atlas Fabricating and Machining
 SBD Avenue Fabricating, Inc.
 CBD P1 Burger Structural Steel Co.
 SBD Champion Bridge Co.
 CBD P1 Comm Steel, Inc.
 SBR Con-Serv Inc.
 SBR P1 D. S. Brown
 CBD Dover Tank and Plate Co.
 SBD Edwards Steel
 SBD SBR Fletcher Machine, Inc.
 SBD G. L. Nause Co.
 CBD SBR J. A. McMahon, Inc.
 CBD CBR P1 Kard Welding Inc.
 CBD Kenton Struct. & Orn. Iron Wks.
 SBD Lake Building Products, Inc.

SBD LIVI Steel Inc.
 CBD Marysville Steel
 CBD P1 Mound Steel Corp.
 CBD Mull Iron
 CBR FP1 Ohio Bridge Corp.
 CBD CBR P1 Ohio Steel Industries, Inc.
 CBD CBR P1 Ohio Structures, Inc.
 CBD SBR P1 Southern Ohio Fabricators, Inc.
 SBD Specialty Fab, Inc.
 SBD Tech Dynamics, Inc.
 CBD P1 Thomas Steel, Inc.
 SBR Trinity Industries, Inc.
 SBD Union Metal Corp.
 CBD SBR V&S Schuler Engineering Inc.
 CBD Viking Fabricators, Inc.

Oklahoma

SBD Ameron Int. - Pole Products Div.
 CBD CBR FP1 Capitol Steel & Iron
 CBD P1 H & M Steel, Inc.
 CBD SBR Tulsa Steel Manufacturing Co., Inc.
 CBD P1 W & W Steel Co.

Oregon

CBR F Addison Corp.
 CBD CBR P1 Canon Construction Corp.
 CBD Columbia Wire & Iron Works, Inc.
 SBD SBR Ebony Iron Works, Inc.
 CBD CBR FP1 Fought & Co.
 SBR Hamilton Construction Co.
 SBR Hogan Fab, Inc.
 CBD P1 Medford Fabrication
 CBD CBR FP1 Oregon Iron Works, Inc.
 CBD S&M Steel Fab, Inc.
 CBD Stevens Equipment Co.
 SBD The Lynch Co., Inc.
 SBR Vaughn's, Inc.

Pennsylvania

CBD CBR FP1 American Bridge Manufacturing
 SBR Amity Industries, Inc.
 CBD Anthor Steel Co.
 CBD CBR FP1 Bridges & Towers, Inc.
 CBD Buffalo Structural Steel, Inc.
 CBD Carrara Steel Co.
 CBD Cherry Steel Corp.
 CBD CBR FP1 Colonial Iron Works
 CBD SBR Dura-Bond Steel Corp.
 CBD Erie Steel Products Co.
 CBD Greiner Industries
 CBD CBR FP1 High Steel Structures Inc
 CBD CBR FP1 High Steel Structures, Inc
 CBD SBR Highland Steel, Inc.
 CBD Industrial Fabricating Systems, Inc.
 SBR Interlocking Deck Sys. Int., LLC
 CBD J.W.F. Industries, Inc.
 CBD SBR P1 Kinsley Manufacturing
 SBD SBR L. B. Foster Co.
 SBD Landis, Inc.
 CBD CBR FP1 Leonard Kunkin Associates, Inc.
 CBD CBR FP1 Littell Steel Co.
 SBD Logue Industries, Inc.
 CBD Luzerne Iron Works Inc.
 CBD SBR Madden Steel Fabrication
 CBD P1 Metropolitan Steel Industries, Inc.
 CBD CBR F Michelman-Cancelliere Iron Works
 CBD SBR Moore & Morford, Inc.
 CBD SBR Oakdale Iron Works, Inc.
 SBD Pelet Welding, Inc.
 SBD PennSummit Tubular, LLC.
 CBD CBR FP1 Powell Steel Corp.
 CBD Rees Industrial Inc..
 CBD CBR F Reynolds Manufacturing Co.
 SBD CBR FP1 RPS Machinery Sales
 SBD SBR P1 Safety Guard Steel Fabricating
 SBD Salvino Steel & Iron Works, Inc
 CBD Samuel Grossi & Sons, Inc.

CBD Schlosser Steel, Inc.
 CBD CBR FP1 Shane Felter Industries, Inc.
 CBD Sippel Steel Co., Inc.
 CBD Standard Iron Works
 CBD Stewart-Amos Steel, Inc.
 CBD Strait Steel Inc.
 SBD SBR Swiss Fabricating, Inc.
 SBD Szoke Bros., Inc.
 SBD SBR F Value Structures, Inc.
 CBD Western Pennsylvania Steel Fab.
 CBD Woolf Steel, Inc.

Rhode Island

CBD CBR F American Welding Co., Inc.
 CBD SBR Capco Steel Corp.

South Carolina

CBD Division Five, Inc.
 SBD Dixiana Steel
 CBD P1 Kline Iron & Steel Co., Inc.
 CBD CBR FP1 Owen Steel Co., Inc.
 CBD Prioleau Steel, Inc.
 CBD Sanders Bros., Inc.
 CBD South Carolina Steel Corp.
 CBD P2 Steel Fab of SC
 CBD TechnoSteel LLC - Structural Div.
 CBD Watford Industry Inc.

South Dakota

CBD CBR FP1 Egger Steel Co.

Tennessee

CBD CBR FP1 Beverly Steel Inc.
 CBD P3 Dynasteel Corp.
 SBD Industrial Fabricators, Inc.
 CBD Quality Machine & Welding Co., Inc.
 CBD SBR Skaggs Steel Fab. & Erection
 CBR P3 Stud Welding, Inc.
 CBD Superior Steel, Inc.
 CBD Tate Fabricating Inc.
 CBD SBR F Williams Steel Co.
 CBD Wylie Steel Fabricators, Inc.

Texas

CBD Alamo Steel Co.
 CBD American Steel & Aluminum Co., Inc.
 CBD Beck Steel, Inc.
 SBR Capitol City Steel Co., Inc.
 CBD Cen-Tex Marine Fabricator
 CBD P1 Central Texas Iron Works
 CBD Crown Steel, Inc.
 CBD Gonzales Manufacturing Co.
 CBD CBR F Hirschfeld Steel Co. Inc.
 CBD CBR FP1 Hirschfeld Steel Co. Inc.
 CBD CBR FP1 Hirschfeld Steel Co. Inc.
 CBD P1 Industrial Mechanical Co.
 CBD Ironhorse Ironworks, Inc.
 CBD Jackson Steel Co.
 CBR FP2 Kiewit Offshore Services, LTD.
 CBD P3 King Fabrication
 CBD Markle Manufacturing Co.
 CBD Mobil Steel Corp.
 SBD MTS Wireless Components
 CBD Myrex Industries
 CBD NCI Building Systems
 SBD Newmark International, Inc.
 CBD North Shore Supply Co.
 CBD CBR F North Texas Steel Co.
 CBD Orizon Industries, Inc.
 CBD SBR Palmer Steel Supplies Inc.
 CBD P2 PSP Industries
 CBD Ramsey Steel Co., Inc.
 CBD Safety Steel Service Inc.
 CBR FP1 Trinity Industries
 CBD CBR FP2 Trinity Industries Inc.
 CBR P1 Trinity Industries Inc.
 CBD Trinity Steel Fabricators, Inc
 CBD Trinity Steel Fabricators, Inc.
 CBD Trinity Steel Fabricators, Inc.

AISC Quality Certified Fabricators

(By State/Country)

SBD	P1	Valmont Industries Inc.	CBD	Metals Fabrication Co., Inc.	CBD	Les Aciers Canam Laval	
CBD		Vital Link Inc.	CBD	Nordahl Metal Fab	CBD	Les Constructions Beauce Atlas, Inc.	
CBD		W & W Steel Co.	SBD	Olympic Iron Works	CBD F	Louisbourg Construction Serv., Inc.	
CBD		Wilborn Steel Co.	CBD	Pederson Bros. Inc.	CBD CBR F	Maritime Steel and Foundries Ltd.	
SBD SBR		Wyatt Resources, Inc.	CBD	Prometco, Inc.	CBD	Marsh Steel Ltd.	
Utah			CBD F	Rainier Welding, Inc.	CBD	Metacor International Inc.	
CBD		B&L Steel Co., Inc.	SBD	SIS Northwest, Inc.	CBD P1	Ocean Steel & Construction Ltd	
CBD		D&H Steel Fabricators	SBD	ST Fabrication, Inc.	CBD CBR	Quali Metal Inc.	
CBD F		Eaton Metal Products Co.	CBD	Standard Steel Fabricating Co., Inc.	CBD	Radian Comm. Services Corp.	
CBD		Golden Empire Manufacturing, Inc.	CBD CBR FP1	Thompson Metal Fab, Inc.	CBD CBR F	Rapid Span Structures, Limited	
SBD		H.A. Fabricators	CBD	United Iron Works, Inc.	SBD	Schurman Steel Fabrication	
CBD CBR FP1		Mark Steel Corp.	CBD CBR FP1	Universal Structural, Inc.	CBD	Supermetal Structures, Inc	
CBD CBR FP1		Mountain States Steel Inc.	SBD	Western Steel Fabricators	CBD P1	Supermetal Structures, Inc.	
SBD		Niederhauser Orn. & Metal Wks.	West Virginia			SBD	WesTower Communications Ltd.
CBD CBR FP1		S & S Steel Fabrication	CBD SBR P1	Mineral Fabrication & Machine Co.	CBD P1P2P3	World Fabricators Ltd.	
CBD		SME Steel Contractors	CBD SBR	West Virginia Steel Corp.	CBD	X.L. Ironworks Co.	
CBD CBR FP1		St. George Steel Fabrication	Wisconsin			Chile	
CBD		T & M Manufacturing Inc.	CBD P1	Construction Supply & Erection Inc.	CBD P1	Edyce S.A.	
CBD		Tech-Steel, Inc.	CBD SBR P1	Merrill Iron & Steel, Inc.	CBD	Sociedad Metalurgica Arrigoni Hnos.	
CBD CBR FP1		Utah Pacific Bridge & Steel Corp.	SBR	Mid-City Steel Fabricating, Inc.	China		
Vermont			SBR	Paper, Calmenson & Co.	CBD	China Railway Turnout Bridge Inc.	
CBD		Bennington Iron Works, Inc.	CBD CBR FP1	PDM Bridge	CBD	Shanghai Matsuo Steel Struct. Co.	
Virginia			CBD CBR FP1	PDM Bridge	CBD FP1	Shanghai Zhenhua Port Mach. Co.	
CBD CBR FP1		Banker Steel Co., LLC	CBD SBR P1	Wisconsin Structural Steel Co.	CBD CBR FP1	United Steel Structures Ltd.	
SBD		Bay Mechanical	CBD SBR P1	Zalk Josephs Fabricators, L. L. C.	Indonesia		
CBD F		Carolina Steel Corp.	Wyoming			CBD P2P3	PT. Hyundai Citra
SBD		Chesapeake Bay Steel, Inc.	CBD	Metals Technology Corp.	Japan		
CBD SBR P1		Cives Steel Co. Mid-Atlantic Div.	CBD SBR P1	Puma Steel	CBD FP1	Ishikawajima-Harima Heavy Ind.	
CBD SBR		FEI Ltd/Berlin Steel	International				
CBD CBR FP1		Globe Iron Construction Co.	Brazil				
SBD		Hallmark Iron Works, Inc.	CBD CBR FP1	Usiminas Mecanica SA	Korea		
SBD		Hamilton Iron Works, Inc.	Canada			CBD P1	Changwon Plant of Kyungdong Co.
CBD CBR FP1		Hirschfeld Steel Co. Inc.	CBD	A.I. Industries	CBD CBR FP1	Daewoo Shipbuilding & Marine Eng.	
CBD		Lynchburg Steel & Specialty Co.	CBD	Acier Lesfab, Inc. / Lesfab Steel Int.	CBD CBR FP1P2P3	Hanjin Heavy Ind. & Constr. Co.	
CBD		Lynchburg Steel & Specialty Co.	CBD CBR FP1	ADF Group, Inc.	CBD P1P2	Hyundai Eng. & Steel Ind. Co., Ltd.	
SBD SBR		M & S Fabricators, Inc.	CBD CBR FP1	ADF Group, Inc.	CBD CBR FP1P2	Hyundai Eng. & Steel Ind. Co., Ltd.	
SBD		Piedmont Metal Products	CBD CBR FP1	AMEC Dynamic Structures Ltd.	CBD P1P2	Hyundai Eng. & Constr. Co., Ltd.	
SBD		Pillar Enterprise/Berlin Steel	SBD	Benco Fabricators, LTD	CBD CBR FP1	Poong Lim Industries Co., Ltd.	
CBD		S. A. Halac, Inc.	SBD SBR	Breton Steel Corp. (Breton Struct.)	CBD CBR FP1	Samsung Heavy Industries Co. Ltd.	
CBD		Southern Iron Works, Inc.	CBD CBR FP1	Canam Steel Corp.	Mexico		
CBD		SteelFab of Virginia Inc.	CBD F	Canam/Structal	CBD	Aceros Lozano S.A. de C.V.	
SBD		Structural Steel Co., Inc.	CBD F	Canatal Industries	CBD CBR FP3	Corey, S.A. de C.V.	
SBD		Superior Iron Works, Inc.	CBD P1	Canron East	Saudi Arabia		
CBD SBR		Virginia-Carolina Steel, Inc.	CBD SBR P1	Canron West	CBD P1	Zamil Steel Industries (SS Division)	
CBD CBR FP1		Williams Bridge Co.	CBD CBR F	Cherubini Metal Works Limited	South Korea		
CBD CBR FP1		Williams Bridge Co.	CBD CBR F	Constructions Proco Inc.	CBD CBR FP1	Dongkuk S & C Co., Ltd	
Washington			CBD	Cougar Metal Industries Inc.	Thailand		
CBD SBR FP1		Brooklyn Iron Works, Inc.	CBD	Empire Iron Works Ltd	CBD	Thai Herrick Co., Ltd.	
CBD		Fabrication Products Inc.	CBD	GB Structures Ltd.	United Kingdom		
CBD		Graham Steel Corp.	CBD	George Third & Son	CBD CBR FP1	Cleveland Bridge UK Ltd.	
CBD CBR F		Jesse Engineering Co.					
CBD CBR F		Keiser Steel Fabricators					

AISC Quality Certified Fabricators

(Alphabetical by name with contact information)

Type	End.	Company Name	City	State	Contact	Phone
CBD		A.I. Industries	Surrey, British Columbia	Canada	J. S. Henriksen	604.583.2171
SBD	SBR	Able Fab Co.	Avenel	NJ	Paul DeVincentz	732.396.0600
CBD		Able Steel Fabricators, Inc.	Mesa	AZ	Charles Clark	480.830.2253
CBD		Aceros Lozano S.A. de C.V.	Benito Juarez, N.L.	Mexico	Jose Santos Guerra Herrera	83.26.15.85 x99
CBD		Acier Lesfab, Inc. / Lesfab Steel International	Terrebonne, Quebec	Canada	Claire Gignac	450.477.8123
CBD	CBR FP1	Acme Structural, Inc.	Springfield	MO	Kenny McCoy	417.865.6691
	CBR F	Addison Corporation	Bend	OR	James Tyvand	541.388.1329
CBD	P2	Addison Steel, Inc.	Orlando	FL	Glen Davis	407.295.6434
CBD	P1	Addison Steel, Inc.	Albany	GA	James Harrell	407.295.6434
CBD	CBR FP1	ADF Group, Inc.	Terrebonne, Quebec	Canada	Andre Giroux	800.263.7560
CBD	CBR FP1	ADF Group, Inc.	Lachine, Quebec	Canada	Andre Giroux	514.634.2287
CBD	SBR P1	Advanced Resources & Construction	Kingfield	ME	Walter Kilbreth	207.265.2646
CBD	CBR FP1	AFCO Steel	Little Rock	AR	Robert Nelson	501.340.6200
CBD		Affiliated Metal Industries, Inc.	Cleveland	OH	Nora Murphy	216.267.0155
CBD		Alamo Steel Co.	Waco	TX	Marvin Turner	254.799.2471

AISC Quality Certified Fabricators

(Alphabetical by name with contact information)

Type	End.	Company Name	City	State	Contact	Phone
CBD	P1	Alfab, Inc.	Enterprise	AL	Tom Danley	334.347.9516
	CBR	Alliance Machine Company	Alliance	OH	Scott Harold	330.823.6120
CBD	CBR	Allied Steel	Lewistown	MT	Benjamin O'Brien	406.538.2374
CBD		Allstate Steel Company Inc.	Jacksonville	FL	Gary Sodek	904.781.6040
CBD	SBR	Almet, Inc.	New Haven	IN	Lamont King	260.493.1556
CBD	CBR	AMEC Dynamic Structures Ltd.	Port Coquitlam, BC	Canada	Ursula Rajtar	604.941.9481 x631
CBD	CBR	American Bridge Manufacturing	Coraopolis	PA	Randy Wilson	412.631.3000
CBD		American Steel & Aluminum Co., Inc.	Grand Prairie	TX	Rob Beason	972.264.1533 x115
SBD		American Steel Fabricators, Inc.	Greenfield	NH	Mark Carter	603.547.6311 x119
CBD	SBR	American Structural Metals, Inc.	Hugo	MN	Gary Domrose	651.429.4338
CBD	CBR	American Welding Company, Inc.	West Greenwich	RI	Richard Silva	401.821.7186
SBD		Ameron International - Pole Products Division	Tulsa	OK	Andy Kirk	918.585.5611
CBD	CBR	Ameron, International - Steel Fabrication Div.	Fontana	CA	David Calentine	909.822.1280
CBD		Amfab Incorporated	Bernalillo	NM	Mark Mosher	505.867.6737
	SBR	Amity Industries, Inc.	Douglassville	PA	G. Kappenstein	610.385.6075
	SBR	Amscot Structural Products	Dover	NJ	Peter Somogyi	973.989.8800
CBD		Amthor Steel Co.	Erie	PA	Pat Carrara	814.452.4700
SBD		Anvil Steel Corporation	Gardena	CA	Michael Fulcher	310.329.5811
CBD		Apex Steel Fabrication, Inc.	Fulton	MO	Jeffery Hayes	573.592.0333
CBD	CBR	Arkansas Steel Processing, Inc.	Armored	AR	Robert Hale	870.762.1000
CBD		Arlington Structural Steel Co., Inc	Arlington Heights	IL	Rick Clarbour	847.577.2200 x224
CBD		Arnold Steel Company, Inc.	Howell	NJ	Leon Pflaster	732.363.1079
CBD		Art Iron, Inc.	Toledo	OH	James Lucas	419.241.1261
CBD	P1	Atlas Fabricating and Machining	Columbus	OH	Andy Hoy	614.841.4500
CBD	SBR	Auciello Iron Works Inc.	Hudson	MA	Anthony Auciello	978.568.8382
	SBR	Augusta Bearing Works	Augusta	GA	Bob Burhoe	706.774.0308
	CBR	Augusta Iron & Steel Works, Inc.	Martinez	GA	Charles Denany	706.860.7719 x209
SBD		Avenue Fabricating, Inc.	Batavia	OH	Robert Nichols	513.752.1911
SBD	SBR	B&B Welding Company, Inc.	Baltimore	MD	Samuel Drumm	410.388.1100
CBD		B&L Steel Co., Inc.	Lindon	UT	Larry Randall	801.785.7749
CBD		BAAB Steel, Inc.	Colorado Springs	CO	Arnold Simon	719.634.5511
CBD	CBR	Banker Steel Company, LLC	Lynchburg	VA	Donald Banker	434.847.4575
SBD		Basic Metal Products, Inc.	Siler City	NC	Clyde Dowd	919.663.2244
SBD		Bay Mechanical	Virginia Beach	VA	Chris Comar	757.468.6700
CBD		Beck Steel, Inc.	Lubbock	TX	James Beck	806.762.3255
CBD		Bell Steel	Pensacola	FL	Daniel Davis	850.432.1545
SBD		Beller Fabrication Corporation	Pueblo West	CO	Glenn Beller	719.547.3582
CBD		Benchmark Fabricated Steel	Terre Haute	IN	Ted Hazledine	812.238.2691
SBD		Benco Fabricators, LTD	New Westminster, BC	Canada	Mike Whitla	604.522.6851
CBD	CBR	BendTec, Inc.	Duluth	MN	Robert Meierhoff	218.722.0205
CBD		Bennington Iron Works, Inc.	Bennington	VT	William Hendery	802.442.3145 x108
CBD	SBR	Berkshire Bridge & Iron Co., Inc.	Dalton	MA	Patrick Shepardson	413.684.3182
CBD	CBR	Beverly Steel Inc.	Knoxville	TN	David O'Dell	865.687.7921
	CBR	Big R Manufacturing, LLC	Greeley	CO	James Corbin	970.356.9600
CBD	SBR	Blattner Steel Co.	Cape Girardeau	MO	Charles Blattner	573.339.1129 x11
CBD		Blue Mountain Steel, Inc.	Carson City	NV	Mark Drahos	775.246.7770
CBD	SBR	Bratton Corporation	Kansas City	MO	Michael Long	816.363.1014
SBD	SBR	Breton Steel Corp. (Breton Struct. Inc.)	St-Bruno, QC	Canada	Mark Breton	450.653.9999 x202
CBD	CBR	Bridges & Towers, Inc.	New Castle	PA	Richard Koonse	888.273.9496
CBD	SBR	Brookfield Fabricating Corporation	Brookfield	MO	Stan Watson	660.258.2214
CBD	SBR	Brooklyn Iron Works, Inc.	Spokane	WA	Ray Johnson	509.468.2310 x105
CBD		Buffalo Structural Steel, Inc.	Titusville	PA	Thomas Latona	716.639.7714
CBD		Builders Steel Company, Inc.	North Kansas City	MO	Wayne Baltzell	816.471.1626
CBD	P1	Burger Structural Steel Company	Akron	OH	Al Shanower	330.253.5121 x240
CBD		Burton Steel Company	Castle Hayne	NC	Paul Burton	910.675.9241
SBD		Byus Steel, Inc.	Batavia	IL	Bruno Gentile	630.879.2200
SBD		C & C Iron, Inc.	Merrillville	IN	Michael Crist	219.769.2511
SBD		C & I Steel, Inc.	Hyannis	MA	Peter Mulvey	508.775.2022
	CBR	C & K Johnson Industries, Inc.	Arcata	CA	Ashley Southerland	707.822.7687
CBD	CBR	Canam Steel Corporation	Jacksonville	FL	Russ Rocco	904.781.0898
CBD	P1	Canam Steel Corporation	Point of Rocks	MD	Dan Custer	301.874.5141
CBD		Canam Steel Corporation	Washington	MO	Steve England	636.239.6716
CBD	CBR	Canam Steel Corporation	St-Gedeon, QC	Canada	Pierre Bourque	418.582.3331
	CBR	Canam/Structal	Quebec	Canada	J. Warren	418.683.2561
CBD		Canatal Industries	Thetford Mines, QC	Canada	Richard Gilbert	418.338.6044
CBD	CBR	Canron Construction Corp.	Conklin	NY	Jay Guiles	607.723.4862 x131
CBD	CBR	Canron Construction Corp.	Portland	OR	Darrell Turner	503.255.8634
CBD	CBR	Canron East	Rexdale, ON	Canada	Tim Gillies	416.675.6400
CBD	SBR	Canron West	Delta, BC	Canada	Manfred Frank	604.524.4421
CBD	SBR	Capco Steel Corporation	Providence	RI	Marc Guernon	401.861.1220
	CBR	Capital Contractors, Inc.	Lincoln	NE	Curtis Smith	402.476.1021
	SBR	Capitol City Steel Company, Inc.	Buda	TX	Larry Gross	512.282.8820
CBD	CBR	Capitol Steel & Iron	Oklahoma City	OK	Steve Williams	405.632.7710
	SBR	Cardinal Fabricating, Inc.	Williamston	MI	Michael Kavanagh	517.655.2155
CBD		Carlo Steel Corporation	Chicago	IL	Charles Weyant	773.375.9600

AISC Quality Certified Fabricators

(Alphabetical by name with contact information)

Type	End.	Company Name	City	State	Contact	Phone	
	CBR	FP1	Carolina Steel Corp.	Colfax	NC	R.G. Stobaugh	336.275.9711
	CBR	FP1	Carolina Steel Corp.	Nashville	NC	R.G. Stobaugh	336.275.9711
	CBR	FP1	Carolina Steel Corp.	Abingdon	VA	R.G. Stobaugh	336.275.9711
	CBR	FP1	Carolina Steel Corporation	Montgomery	AL	Jerry Stobaugh	336.275.9711
CBD	SBR		Carolina Steel Corporation	Winston Salem	NC	William Youngblood	804.239.6650 x316
CBD	SBR		Carolina Steel Corporation	Greensboro	NC	William Youngblood	804.239.6650
CBD			Carrara Steel Co.	Erie	PA	Pat Carrara	814.452.4700
CBD	CBR	FP1	Casco Bay Steel Structures, Inc.	Saco	ME	Bryon Tait	207.282.7360
CBD	CBR	F	Cavanaugh Machine Works, Inc.	Long Beach	CA	Ric Brewer	562.437.1126
CBD			Cen-Tex Marine Fabricator	Smithville	TX	Billy Duty	512.237.2496
CBD			Central Steel, Inc.	Wichita	KS	Les Aaby	316.265.8639
CBD		P1	Central Texas Iron Works	Waco	TX	David Harwell.	254.776.8000
SBD			Central Western Fabricators, Inc.	Atlantic	IA	Carlo Zenti	712.243.4000
SBD			Champion Bridge Company	Wilmington	OH	Marvin Beasley	937.382.2521
CBD		P1	Changwon Plant of Kyungdong Co., Ltd	Gyeongnam	Korea	Sun-Woo Lee	82.55.296.9606 x701
SBD			Charlotte Miscellaneous Steel	Charlotte	NC	Peter Grana	704.394.6626
CBD			Cherry Steel Corporation	Langhorne	PA	R. McMahon	215.757.1511
CBD	CBR	F	Cherubini Metal Works Limited	Dartmouth, NS	Canada	Steve England	902.468.5630
SBD			Chesapeake Bay Steel, Inc.	Norfolk	VA	Ronald Baskins	757.622.2520
CBD			Chillicothe Iron & Steel, Inc.	Chillicothe	MO	Armand Peterson	660.646.2250
	CBR		China Railway Turnout Bridge Inc.	Shaanix P.R.	China	Chai Boajian	86.917.335.3555
CBD	CBR	FP1	Cianbro Corporation	Pittsfield	ME	Chet Guilford	207.679.2343
CBD			City Welding & Fabrication Inc.	Jackson	MS	Barry Eubanks	601.922.2909
CBD	SBR	P1	Cives Steel Co. Mid-Atlantic Div.	Winchester	VA	John Goode	540.667.3480
CBD		P1	Cives Steel Co. Mid-South	Rosedale	MS	Larry McIntosh	662.759.6265
CBD		P1	Cives Steel Co. Mid-West Division	Wolcott	IN	Jerry Simpson	219.279.4000
CBD	SBR	P1	Cives Steel Co. New England Div.	Augusta	ME	Curt Huber	207.622.6141
CBD	SBR	P1	Cives Steel Co. Northern Div.	Gouverneur	NY	Timothy Reed	315.287.2200
CBD		P1	Cives Steel Co. Southern Div.	Thomasville	GA	Kyle Delaney	229.228.9780
CBD	CBR	FP1	Cleveland Bridge UK Ltd.	Darlington, Durham Co.	UK	Ken Wise	44 13.25.38.11.88
CBD			Coastal Steel Corp.	Salem	CT	Glenn Ahnert	860.859.1200
CBD	CBR	FP1	Colonial Iron Works	Canonsburg	PA	Jeff Greene	724.745.1423
SBD			Columbia Metal Service Company	Halifax	MA	Christopher Keough	781.293.5650
CBD			Columbia Wire & Iron Works, Inc.	Portland	OR	Robert Park	503.973.6062
CBD		P1	Comm Steel, Inc.	Cleveland	OH	Michael Ciofani	216.881.4600 x201
	SBR		Con-Serv Inc.	Brunswick	OH	Ricky Eldreth	843.546.1044
SBD			Consolidated Steel Services, Inc.	Englewood	CO	Ron Applehans	303.781.4588
CBD		P1	Construction Supply & Erection Inc.	Germantown	WI	Thomas Henke	262.255.3003 x12
CBD		P1	Constructions Proco Inc.	St-Nazaire, QC	Canada	Andre Gagnon	418.668.3371
	CBR	FP1	Continental Bridge	Alexandria	MN	Gary Westphal	320.852.7500
CBD			Contract Steel Sales, Inc.	Butner & Staley	NC	John Bundren	336.273.9704 x113
CBD			Copeland Steel Fabricators	Zephyrhills	FL	Josh Twardosky	813.715.0404
CBD	CBR	FP3	Corey, S.A. de C.V.	Talquepaque, Jalisco	Mexico	Javier Salas	650.327.8705
CBD	CBR	FP1	Cornell & Company, Inc.	Westville	NJ	Marian Craig	856.742.1900 x3026
CBD			Cougar Metal Industries Inc.	Surrey, BC	Canada	Rodel De Chavez	604.594.4114
CBD			Covenant Steel Warehouse, Inc.	Dothan	AL	Kelly Colbert	334.794.2326
SBD			Cowelco	Long Beach	CA	Michael Gumm	562.432.5766
	SBR		Cox Brothers Machining, Inc.	Jackson	MI	Russell Cox	517.796.4662
CBD			Crown Steel, Inc.	San Antonio	TX	Raymond Orozco	210.674.5931
CBD		P1	Crystal Steel Fabricators, Inc.	Delmar	DE	John Lo	302.846.0613 x19
CBD			Custom Steel Fabrication	St. Louis	MO	Jim Robertson	314.385.4270
CBD			D&H Steel Fabricators	Salt Lake City	UT	Jim Krantz	801.262.3301 x308
	SBR	P1	D. S. Brown	N. Baltimore	OH	James Connor	419.257.3561
	CBR	FP1	D.S. Brown-Chaska Operations	Chaska	MN	James Connor	952.368.3000
CBD	CBR	FP1	Daewoo Shipbuilding & Marine Eng. Co., Ltd.	Kyoungnam	Korea	Young-Wook Kim	82.55.680.3641
CBD			Dave Steel Company, Inc.	Asheville	NC	Jeffrey Dave	828.252.2771
CBD			Davis Steel & Iron Co., Inc.	Matthews	NC	R. Bramhall	704.821.7676
	SBR		Deb Corporation	Trussville	AL	James Shay	205.655.7435
CBD			Delhi Steel Corporation	Kirkville	NY	Eugene Keppeler	315.656.2234
CBD	CBR	FP1	DeLong's Inc.	Jefferson City	MO	Darrin Kelly	573.635.6121
	SBR		DeLong's Inc.	Sedalia	MO	Darrin Kelly	573.635.6121
CBD			Delta Steel Company, Inc.	Jackson	MS	Jeff Geiger	601.956.4141
CBD			Division Five, Inc.	Hollywood	SC	Roy Prescott	843.889.1199
SBD			Dixiana Steel	West Columbia	SC	Reta Ellisor	803.794.5452
CBD			Doherty Ornamental Iron	Paola	KS	Craig Davis	913.557.9200
CBD	SBR		Doing Steel, Inc.	Springfield	MO	Alan VienHage	417.866.5020
CBD	CBR	FP1	Dongkuk S & C Co., Ltd	Pohang	South Korea	Kang-Kun Lee	82.54.271.0532
CBD			Dover Tank and Plate Co.	Dover	OH	David Lawless	330.343.4443
CBD	CBR	FP1	Drake-Williams Steel Inc.	Omaha	NE	Kerry Black	402.342.1043
CBD			Duncan Brothers Inc.	Bloomington	CA	Paul Trawnack	909.877.1904
CBD	SBR		Dura-Bond Steel Corporation	Export	PA	Brad Norris	724.327.0280 x16
CBD		P3	Dynasteel Corporation	Memphis	TN	Charles Vance	901.358.6231
CBD			E & H Steel Corporation	Midland City	AL	Scott Quattlebaum	334.983.5636 x137
	CBR	FP1	Eastern Bridge, LLC	Claremont	NH	Steven Crowell	603.542.8404
	CBR	F	Eaton Metal Products Company	Pocatello	ID	Kelly Archibald	208.237.9362

AISC Quality Certified Fabricators

(Alphabetical by name with contact information)

Type	End.	Company Name	City	State	Contact	Phone	
SBD	CBR	F	Eaton Metal Products Company	Salt Lake	UT	Douglass Neilsen	801.973.9056
SBD	SBR		Ebony Iron Works, Inc.	Portland	OR	Edward Holmes	503.224.3038
SBD			Edwards Steel	Columbus	OH	David Edwards, Jr.	614.274.6800
CBD		P1	Edyce S.A.	Talcahuano	Chile	Osvaldo Herrera	56.41.507300
CBD	CBR	FP1	Egger Steel Company	Sioux Falls	SD	Fred Hlebichuk	605.336.2490
CBD			Ellis Steel Company, Inc.	West Point	MS	Frank Hopper	662.494.5955
CBD			Em-Co Metal Products, Inc.	Twin City	GA	Ray Braddy	478.763.2158
CBD			Empire Iron Works Ltd	Delta, BC	Canada	Yasser Elmasri	604.946.5515
CBD			Erection & Welding Contractors, LLC	New Milford	CT	Lewellyn Isaacs	860.354.4622
CBD			Erie Steel Products Co.	Erie	PA	Gary Renaud	814.459.2715
	SBR		Excel Sheet Metal dba Excel Bridge Mfg., Inc.	Olancha	CA	Brian Moorhouse	562.944.0701
	SBR		Excel Sheet Metal Inc./Excel Bridge Mfg. Co.	Santa Fe Springs	CA	Brian Moorhouse	562.944.0701
CBD			FabArc Steel Supply	Oxford	AL	Wade Pugh	256.831.8770
CBD		P2	Fabco Metal Products, LP	Daytona Beach	FL	Shane King	386.252.3730
CBD			Fabrication Products Inc.	Vancouver	WA	Thomas Ball	360.696.1324
CBD		P1	Famm Steel	Rindge	NH	Paul Gavin	603.899.3304
CBD	SBR		FEI Ltd/Berlin Steel	Natural Bridge Station	VA	Clayton McIntyre	860.828.3531
CBD			Ferguson Steel Company, Inc.	Indianapolis	IN	Mike Mauris	317.872.4747 x222
SBD	SBR		Fletcher Machine, Inc.	Weston	OH	Dave Veller	419.669.2063
CBD	SBR		Florida Structural Steel	Tampa	FL	David Hale	813.241.4261 x206
CBD			Fort Wayne Structural Products	Fort Wayne	IN	Kenneth Snyder	219.422.6433
CBD	CBR	FP1	Foster-Precise, A Division of L.B. Foster Co.	Georgetown	MA	Jack Klimp	978.352.2591 x12
CBD	CBR	FP1	Fought & Company	Tigard	OR	Steve Fugate	503.639.3141 x217
CBD	CBR		Franbilt, Inc.	Lockport	NY	Francis Licata	716.434.5866
CBD	SBR		Francis A. Lee Company, A Corporation	Hicksville	NY	Kent Findley	516.938.2000 x227
	SBR		Franklin County Fabricators	Greenfield	MA	John Campbell	413.774.3518
SBD			Fresno Fab-Tech Inc.	Fresno	CA	Chris Kisling	559.252.1977
SBD			FTS	Santa Maria	CA	A.S. Fitzgerald	805.925.1007
CBD	CBR	FP1	G&G Steel, Inc.	Russellville	AL	Terry Springer	256.332.6652
SBD			G. L. Nause Company	Loveland	OH	Jim Clifton	513.722.9500
CBD			Garbe Iron Works	Aurora	IL	Terry Peshia	630.897.5100
CBD			Gayle Manufacturing Company	Woodland	CA	Glen Holmes	530.662.0284
CBD			Gayle Manufacturing Company	Nampa	ID	Gary Glenn	208.468.0400
CBD			GB Structures Ltd.	Rimouski, QC	Canada	Jean-Pierre Belzile	418.724.9433
CBD	SBR	P1	Geiger & Peters Inc.	Indianapolis	IN	Don Peterson	317.359.9521
CBD			General Steel Fabricators Inc.	Latham	NY	William Minchin	518.785.3221
CBD			Gentry Steel Fabrication	Prattville	AL	Robert Nance	334.365.8244
CBD			George Third & Son	Burnaby, BC	Canada	Colin Harrison	604.526.2333
SBD	SBR		Gerace Construction Company, Inc.	Midland	MI	Michael Gaffke	989.496.2440
CBD			Gipson Steel, Inc.	Meridian	MS	E. Gipson	601.482.5131
CBD			GLENCO, Inc.	Clovis	NM	Charlie Brandon	505.763.4414
	CBR		Global Fabricators	Bakersfield	CA	Bill Chaney	661.589.2774
CBD	CBR	FP1	Globe Iron Construction Co.	Norfolk	VA	Thomas Stunda	757.625.2542
CBD			Golden Empire Manufacturing, Inc.	Brigham City	UT	Kevin Roundy	435.723.5000
CBD			Golden State Steel	Fowler	CA	Douglas Shollenbarger	559.834.6209
CBD			Gonzales Manufacturing Co.	Gonzales	TX	Joe Medina	830.672.9541
CBD			Graham Steel Corporation	Kirkland	WA	Kevin Larsen	425.823.5656
CBD	CBR	FP1P2P3	Grand Junction Steel Co.	Grand Junction	CO	Dennis Moser	970.242.4015 x161
CBD	CBR	FP1	Greiner Industries	Mount Joy	PA	Robert Bybel	717.653.8111
CBD		P1	H & M Steel, Inc.	Luther	OK	John O'Day	405.277.3055
SBD			H.A. Fabricators	Logan	UT	Mark Murray	435.750.5050
SBD			Hallmark Iron Works, Inc.	Newington	VA	Charles Mercer	703.550.9560
	SBR		Hamilton Construction Company	Springfield	OR	David Weiland	541.746.2426
SBD			Hamilton Iron Works, Inc.	Woodbridge	VA	C. Isaac Hamilton	703.690.2900 x11
CBD	CBR		Hammerts Iron Works, Inc.	St. Louis	MO	Richard Lacavich	314.389.0666
CBD	CBR	FP1P2P3	Hanjin Heavy Ind. & Construction Co., Ltd.	Incheon	Korea	J.S. Chun	82.32.761.2634
CBD			Hanley Steel Inc.	Peoria	IL	Pete Hanley	309.692.5250
	CBR	F	Hardie-Tynes Company Inc.	Birmingham	AL	Michael Morton	205.252.5191
CBD	CBR	FP1	Harris Structural Steel Company	Piscataway	NJ	Bill Butrico	732.752.6070 x104
CBD	CBR	FP1	Havens Steel Company	Ottawa	KS	Viji Kuruvilla	785.242.6068
CBD	CBR	FP1	Havens Steel Company	Kansas City	MO	Viji Kuruvilla	816.231.5724
CBD	CBR	FP1	Helmark Steel Inc.	Wilmington	DE	Lee Roth	302.652.3341
CBD			Hercules Steel Company	Fayetteville	NC	Robert Petroski	910.488.5110
CBD	CBR	FP1	Herrick Corporation	Stockton	CA	Roger Ferch	925.484.2900
CBD	CBR	F	Herrick Corporation	San Bernardino	CA	Roger Ferch	925.484.2900
CBD	CBR	FP1	High Steel Structures Inc	Williamsport	PA	Russ Panico	570.390.4245
CBD	CBR	FP1	High Steel Structures, Inc	Lancaster	PA	Russ Panico	717.390.4245
CBD	SBR		Highland Steel, Inc.	St. Marys	PA	Vince Vicere	814.834.9456
	SBR		Highway Safety Corporation	Glastonbury	CT	Frank Luszczyk	860.633.9445
CBD		P1	Hillsdale Fabricators an Alderici Enterprise	St. Louis	MO	Ed Osaben	314.261.2611
CBD	CBR	F	Hirschfeld Steel Co. Inc.	Midland	TX	Kendell Hirschfeld	915.653.3211
CBD	CBR	FP1	Hirschfeld Steel Co. Inc.	Abilene	TX	Kendall Hirschfeld	915.653.3211
CBD	CBR	FP1	Hirschfeld Steel Co. Inc.	San Angelo	TX	Kendell Hirschfeld	915.653.3211 x404
CBD	CBR	FP1	Hirschfeld Steel Co. Inc.	Lynchburg	VA	Kendall Hirschfeld	915.486.4201
SBD			HME, Inc.	Topeka	KS	Jon Haas	785.235.1524

AISC Quality Certified Fabricators

(Alphabetical by name with contact information)

Type	End.	Company Name	City	State	Contact	Phone	
SBD	SBR	Hodge Fabrication, Inc.	North Little Rock	AR	Mark Hodge	501.945.1390	
	SBR	Hogan Fab, Inc.	Portland	OR	David Smith	503.774.4940	
	SBR	Hurtt Fabricating Corp.	Marceline	MO	Robert Walton	660.376.3501	
CBD		P1P2	Hyundai Engineering & Steel Ind. Co., Ltd.	Cheonan City	Korea	Seon-Yeob Kim	82.41.560.1840
CBD	CBR	FP1P2	Hyundai Engineering & Steel Ind. Co., Ltd.	Seosan-City	Korea	Seon-Yeob Kim	82.41.560.1840
CBD		P1P2	Hyundai Engineering & Constr. Co., Ltd.	Jung-Ku, Incheon	Korea	Seon-Kim Kim	82.41.560.1840
CBD			Ideal Steel & Builders' Supplies	Hamburg	MI	Dan Waligora	517.548.6565
CBD	CBR	P1	Indiana Steel & Engineering Corp.	Bedford	IN	Joseph Elliott	812.275.3363
CBD			Industrial Fabricating Systems, Inc.	Coraopolis	PA	Kathleen Kerr	412.269.1795
SBD			Industrial Fabricators, Inc.	Chattanooga	TN	Kenneth Byrd	423.698.1917
CBD		P1	Industrial Mechanical Company	San Antonio	TX	Barry Keller	210.661.4251
	CBR	FP1	Industrial Steel Construction, Inc.	Hodgkins	IL	Larry Samulson	708.482.7500
	CBR	FP1	Industrial Steel Construction, Inc.	Gary	IN	Terry Staley	219.885.7600 x430
CBD	SBR	P2	Industrial Steel, Inc.	Mims	FL	Tom Slovick	321.267.2341
	SBR		Interlocking Deck Systems Int., LLC	Pittsburgh	PA	Ed Coholich	412.682.3041
CBD	CBR	FP1	International Bridge & Iron Co.	Newington	CT	Ronnie Seeley	860.953.6550
CBD			International Fabricators & Erectors, Inc.	Kansas City	MO	William Niday	816.231.3328
CBD			Interstate Iron Works Corp.	Whitehouse	NJ	H. Steven Freed	908.534.6644 x146
CBD			Interstate Welding & Fabrication Inc.	Terre Haute	IN	John Von Dielingen	812.232.0474
CBD			Ironhorse Ironworks, Inc.	Lorena	TX	Bobby Meador	254.857.3160
CBD	SBR	P1	Isaacson Structural Steel, Inc.	Berlin	NH	John Jones	603.752.2044
	CBR	FP1	Ishikawajima-Harima Heavy Ind. Co., Ltd.	Chita-shi	Japan	Masatsugu Doi	81.562.31.8200
CBD	SBR		J. A. McMahon, Inc.	Niles	OH	Sue McMahon	330.652.2588
SBD			J. C. MacElroy Company, Inc.	Jersey City	NJ	Doug Chappell	732.572.7100
SBD			J.V. Palmonari, Inc.	Milmay	NJ	Joseph Palmonari	609.476.2642
CBD			J.W.F. Industries, Inc.	Johnstown	PA	Terry Weaver	814.539.6922 x19
CBD			Jack K. Elrod Company, Inc.	Mooreville	IN	Jeffrey Elrod	317.615.4300
CBD			Jackson Steel Company	San Antonio	TX	Robert Jackson	210.633.0100
SBD			Jeffords Steel & Engineering Co.	Plattsburgh	NY	Mark Millett	518.561.4061
CBD	CBR	F	Jesse Engineering Co.	Tacoma	WA	Ken Foster	253.922.7433
CBD	CBR	FP1	Johnson Machine Works, Inc.	Chariton	IA	Jeff Johnson	641.774.2191
CBD			JPW Structural Contracting, Inc.	Syracuse	NY	John Wozniczka	315.432.1111 x108
CBD			Junior Steel Co.	City of Industry	CA	Scott Bustrum	626.968.4671
SBD			K & K Iron Works, Inc.	McCook	IL	David Niklewicz	708.924.0000
CBD			K&T Steel Corporation	Twin Falls	ID	William Koch	208.733.2554
CBD	CBR	P1	Kard Welding Inc.	Minster	OH	Kenneth Osterloh	419.628.2375
CBD			Kasco Fab, Inc.	Fresno	CA	Thomas Hancock	559.442.1018
SBD			Katelman Foundry, Inc.	Council Bluffs	IA	Ed Kiper	712.323.3131
CBD	CBR	FP1P2	Kawada Industries, Inc.	Kagawa Prefecture	Japan	Hideaki Seki	81.3.3915.4617
CBD	SBR		KCB Towers, Inc.	Highland	CA	Larry Bogh	909.862.0322
CBD	CBR	F	Keiser Steel Fabricators	Kent	WA	Bruce Keiser	253.852.1910
CBD			Kenton Structural & Orn. Iron Wks., Inc.	Kenton	OH	Ora Winzenried	419.674.4025
	CBR	FP2	Kiewit Offshore Services, LTD.	Ingleside	TX	Joe Fleming	361.775.1440
CBD		P3	King Fabrication	Houston	TX	Ella Miller	281.209.0811
CBD	SBR	P1	Kinsley Manufacturing	York	PA	Raymond Guzzetti	717.815.6926
CBD		P1	Kline Iron & Steel Co., Inc.	West Columbia	SC	Larry Dowd	803.251.8000
SBD	SBR		L. B. Foster Company	Bedford	PA	John Paczan	412.928.7819
CBD			Lacy Steel Company	Lawrence	KS	Phillip Lacy	785.841.2470
SBD			Lake Building Products, Inc.	Euclid	OH	Patrick Neer	216.486.1500
SBD			Landis, Inc.	Mt. Holly Springs	PA	Steven Capuano	717.486.7533
SBD	SBR		Lehigh Utility Associates	South Plainfield	NJ	William Butrico	908.561.5252
CBD	SBR	FP1	LeJeune Steel Company	Minneapolis	MN	Brian Calley	612.861.3321
CBD	CBR	FP1	Leonard Kunkin Associates, Inc.	Souderton	PA	Matthew Kunkin	215.723.6744
CBD			Les Aciers Canam Laval	Laval, QC	Canada	Serge Vigneault	514.334.7110
CBD			Les Constructions Beauce Atlas, Inc.	Ste-Marie de Beauce, QC	Canada	Germain Bisson	418.387.4872
CBD	CBR	FP1	Lincoln Steel Co.	Lincoln	NE	Bud Thomsen	402.474.3030
CBD	CBR	FP1	Littell Steel Company	New Brighton	PA	James Zaqorski	724.843.5212
SBD			LIVI Steel Inc.	Warren	OH	Dell Gray	330.373.1181
SBD			Logue Industries, Inc.	Montoursville	PA	James Tanner	570.368.2639
	CBR	F	Louisbourg Construction Services, Inc.	Winnipeg, Manitoba	Canada	Lucien Charriere	204.633.1118
CBD			Lundahl Ironworks Company	Franklin	ID	Robert Jensen	208.646.2600
CBD			Luzerne Iron Works Inc.	Luzerne	PA	Michael Piekanski	570.288.1950
CBD			Lynchburg Steel & Specialty Co.	Monroe	VA	Robert Garrett	434.929.0951
CBD			Lynchburg Steel & Specialty Company	Abingdon	VA	Bill Fuller	434.929.0951
CBD			Lyndon Steel Company	Winston Salem	NC	Michael Carcier	336.785.0848
CBD			M & J Materials, Inc.	Trussville	AL	Lavon Drake	205.655.7451
SBD	SBR		M & S Fabricators, Inc.	Altavista	VA	Melvin Allbeck	434.369.1170
CBD	SBR		Madden Steel Fabrication	Hollidaysburg	PA	F. Madden	814.695.4461
SBD			Mag Welding Inc.	Council Bluffs	IA	Greg Albertus	712.323.1162
SBD			Maico Industries Inc.	Ellsworth	KS	David Cox	785.472.5390
CBD			Mandan Steel Fabricators	Mandan	ND	David Meyers	701.663.0321
CBD	CBR	FP2P3	Manufab, Inc.	Kenner	LA	Brian Mallette	504.466.2368
CBD			Mar-Con Mfg., A Div. Of Mar-Con, Inc.	Delcambre	LA	Richard Bickle	337.893.5459 x3056
CBD	CBR	F	Maritime Steel and Foundries Limited	Dartmouth, NS	Canada	Dale Robertson, P.E.	902.468.2467 x101
CBD	CBR	FP1	Mark Steel Corporation	Salt Lake City	UT	Vaughn Schoenfeld	801.303.2053

AISC Quality Certified Fabricators

(Alphabetical by name with contact information)

Type	End.	Company Name	City	State	Contact	Phone
CBD		Markle Manufacturing Company	San Antonio	TX	Siegfried Friesse	210.655.7130
CBD		Marsh Steel Ltd.	Surrey, BC	Canada	David Powley	604.888.0242
CBD	SBR	Martin Iron Works Inc.	Reno	NV	Keith Lake	775.329.8631 x111
CBD		Marysville Steel	Marysville	OH	Eugene Clayman	937.642.5971
SBD		May Specialty Fabricators	Register	GA	Jeff May	912.852.9573
CBD		McCombs Steel Company, Inc.	Statesville	NC	John Payne	704.873.7563
CBD		McGovern Steel Fabricators	Indianapolis	IN	Edward Carroll	317.899.7650
CBD	P1	Medford Fabrication	Medford	OR	Mike Deavilla	541.779.1970
CBD	CBR	Megquier & Jones, Inc.	South Portland	ME	John MacGregor	207.799.8555
CBD	SBR	Merrill Iron & Steel, Inc.	Schofield	WI	Roger Hinner	715.355.8924 x101
	SBR	Merrimack Sheet Metal, Inc.	Concord	NH	James Dussault	603.224.7766
CBD		Metacor International Inc.	Repenigny, QC	Canada	Robert Bilodeau	450.582.1810
CBD		Metals Fabrication Co., Inc.	Spokane	WA	Todd Weaver	509.244.2909
CBD		Metals Technology Corporation	Evanston	WY	Clifford Huggins	307.789.0016
CBD	SBR	Met-Con, Inc.	Cocoa	FL	Rick Proulx	321.632.4880
CBD	P1	Metropolitan Steel Industries, Inc.	Sinking Spring	PA	Anthony Panariello	610.678.6411
CBD	CBR	Michelman-Cancelliere Iron Works	Bath	PA	John Canelli	610.837.9444
CBD		Mid America Steel Inc.	Fargo	ND	Donald Clark	701.232.8831 x202
CBD		Mid America Steel, Inc.	Bismarck	ND	Rod Seibel	701.258.9600
CBD	P1	Mid Florida Steel Corp.	Cocoa	FL	Sam Gerace	321.632.8228
CBD		Mid-States Steel Corp.	Boone	IA	Doug Kollbaum	515.432.1646
	SBR	Mid-City Steel Fabricating, Inc.	La Crosse	WI	Jeanne Colsch	608.782.0770
CBD		Midland Steel Company	Wathena	KS	Ellen Jordan	785.989.4442
SBD		Midwest Industries, Inc.	Bozeman	MT	Kevin Brownlee	406.587.5417
CBD	SBR	Mineral Fabrication & Machine Co.	Keyser	WV	Kevin Staggs	304.788.5855
CBD	CBR	Missouri Fabricators	Fulton	MO	Ted Kettlewell	573.642.3418
CBD	SBR	Missouri Valley Steel Co.	Sioux City	IA	Robert Jacobson	712.255.1616
CBD		Mobil Steel Corporation	Houston	TX	Matthew Symank	713.991.0450
CBD	SBR	Moore & Morford, Inc.	Greensburg	PA	James Morford	724.834.1100
CBD		Moore Flame Cutting Co.	Sterling Heights	MI	Gary Nadlicki	586.978.1090
SBD	SBR	Moran Iron Works Inc.	Onaway	MI	Thomas Moran	989.733.2011
CBD	P1	Mound Steel Corp.	Springboro	OH	Thomas Miller	937.748.2937
CBD	CBR	Mountain States Steel Inc.	Lindon	UT	Jeffrey Peery	801.785.5085
SBD		MTS Wireless Components	Fort Worth	TX	Joseph DeCrescenzo	817.540.9450
CBD		Mull Iron	Rittman	OH	Bill Mull	330.927.6855
CBD	CBR	Munster Steel Company Inc	Munster	IN	Ronald Robbins	219.924.5198
CBD		Myers & Co. Architectural Metals	Basalt	CO	Steve Batterman	970.927.4761
CBD		Myrex Industries	Houston	TX	James Moffa	713.691.5200
CBD	CBR	National Eastern Corp.	Plainville	CT	Chester Wojtaszek	860.747.3700
CBD		NCI Building Systems	Houston	TX	David Fulton	713.466.7788
CBD	CBR	NESCO Fabricators div. of XKT Eng., Inc.	Vallejo	CA	Dave Wiley	707.562.2500
	SBR	New England Bridge Products, Inc.	Lynn	MA	John Conti	781.592.2444
SBD		Newmark International, Inc.	Mansfield	TX	Eddie Lair	817.473.0226
SBD	SBR	Newport Industrial Fabrication, Inc.	Newport	ME	Daniel Gerry	207.368.4344
SBD		Niederhauser Ornamental & Metal Wks	Salt Lake City	UT	Val Smith	801.973.8310
CBD		Nordahl Metal Fab	Puyallup	WA	Richard Nordahl	253.845.3201
CBD		North Shore Supply Company	Houston	TX	Clyde Rushing	713.453.3533
CBD		North State Steel Inc.	Greenville	NC	Thomas Trevathan	252.830.8884
SBD		North State Steel, Inc.	Louisburg	NC	Rick Fleming	919.496.2506
CBD	CBR	North Texas Steel Co.	Fort Worth	TX	William Gigl	817.927.5333
	CBR	Northwest Pipe Company	Adelanto	CA	Gregory Shepherd	760.246.2260
CBD	P1	NOVA Group, Inc.	Napa	CA	Guy Rothrock	707.257.3200
CBD	SBR	Novel Iron Works, Inc.	Greenland	NH	William Gallant	603.436.7950
CBD	SBR	Oakdale Iron Works, Inc.	Oakdale	PA	William Divito	724.693.9040
CBD	P1	Ocean Steel & Construction Ltd	Saint John, NB	Canada	Bill Gates	506.632.2600
	SBR	Oden Enterprises, Inc.	Wahoo	NE	David Blankenship	402.443.4502
CBD		Ogeechee Steel, Inc.	Swainsboro	GA	Brandi Perossa	478.237.2770 x23
	CBR	Ohio Bridge Corporation	Cambridge	OH	Richard Beldyk	740.432.6334
CBD	CBR	Ohio Steel Industries, Inc.	Summit Station	OH	Robert Eaton	740.927.9500 x11
CBD	CBR	Ohio Structures, Inc.	Berlin Center	OH	Sean Giblin	330.533.0084
SBD		Olympic Iron Works	Olympia	WA	Michael O'Rear	360.491.2500
CBD	CBR	Oregon Iron Works, Inc.	Clackamas	OR	Robert Beal	503.653.6300
CBD		Orizon Industries, Inc.	Brookshire	TX	Charlie O'Hara	281.375.7700
CBD	CBR	Orleans Materials & Equipment	New Orleans	LA	John Housey	504.288.6361
CBD	CBR	Owen Steel Company, Inc.	Columbia	SC	John Myers	803.251.7541
CBD		Ozark Steel Fabricators, Inc.	Farmington	MO	Robert Laut	573.756.5741
CBD	SBR	Palmer Steel Supplies Inc.	Mc Allen	TX	Palmer Thompson	956.686.6575
	SBR	Paper, Calmenson & Co.	LaCrosse	WI	Vern Lorenz	608.784.1030 x226
CBD	CBR	Paxton & Vierling Steel Company	Carter Lake	IA	Steven Riddell	712.347.5500
CBD	CBR	PDM Bridge	Wausau	WI	Ben Bristol	715.848.1119
CBD	CBR	PDM Bridge	Eau Claire	WI	Buck Roberds	715.835.2250
CBD	CBR	PDM Bridge, LLC	Palatka	FL	Ken Cox	386.328.4683
CBD		Pederson Bros. Inc.	Bellingham	WA	Steve Peterson	360.734.9180
SBD	CBR	Pelet Welding, Inc.	Coatesville	PA	Douglas Pelet	610.384.5048
SBD		PennSummit Tubular, LLC.	West Hazelton	PA	Ron Skasko	570.454.8730 x1801

AISC Quality Certified Fabricators

(Alphabetical by name with contact information)

Type	End.	Company Name	City	State	Contact	Phone
SBD		Piedmont Metal Products	Bedford	VA	Harvey Johnson	540.586.2739
CBD		Pikes Peak Steel	Colorado Springs	CO	Glen Carter	719.471.8811
SBD		Pillar Enterprise/Berlin Steel	Winchester	VA	Clayton McIntyre	860.828.2415
CBD		Pinsker Steel Inc.	Wichita	KS	Ron Gagne	316.838.4246
CBD	SBR P1	PKM Steel Service, Inc.	Salinas	KS	Blake Orr	785.827.3638
CBD	CBR P1	Platte River Steel Company	Greeley	CO	Ted Woodard	970.356.2326
CBD	CBR FP1	Poong Lim Industries Co., Ltd.	Choong Nam	Korea	S. Park	82.41.862.7315
CBD	CBR FP1	Powell Steel Corporation	Lancaster	PA	Stephen Powell	717.464.2030
CBD		Presco Steel, Inc.	Gainesville	GA	Steve Hatch	770.532.6560
CBD		Pringleau Steel, Inc.	Columbia	SC	Oscar Pringleau	803.783.9823
CBD		Production Steel Company, Inc.	Gardena	CA	Ronald Bernhard	310.324.4921
CBD		Prometco, Inc.	Woodinville	WA	Mark Harrison	425.486.0759 x214
CBD	CBR FP1	Prospect Steel Company	Little Rock	AR	Mike Colvin	501.490.5142 x5146
CBD	P2	PSP Industries	Schertz	TX	Bill Lunsford	210.651.6350
CBD	P2P3	PT. Hyundai Citra	Riau	Indonesia	Hai Dong Kim	62.778.391.501
CBD	SBR P1	Puma Steel	Cheyenne	WY	James Phillips	307.637.7177
CBD	CBR	Quali Metal Inc.	Quebec	Canada	Francois Parrot	418.626.0007
CBD	SBR P1	Qualico Steel Co., Inc.	Webb	AL	Jed Downs	334.793.1290
CBD		Quality Machine & Welding Co., Inc.	Knoxville	TN	Jeffrey Roth	423.524.2162
CBD		Radian Communications Services Corp.	Oakville, ON	Canada	Marc Dunham	905.844.1242 x3291
	CBR F	Rainier Welding, Inc.	Redmond	WA	Rick Forster	425.868.1300
SBD		Ramark Holdings, LLC	Dexter	IA	Mike Chafa	515.789.4411
CBD		Ramsey Steel Company, Inc.	El Paso	TX	Guillermo Guerrero	915.532.2686
CBD	CBR F	Rapid Span Structures, Limited	Armstrong, BC	Canada	Paul King	250.546.9676
CBD		Raulli & Sons, Inc.	Syracuse	NY	Robert Slifka	315.479.2516
SBD		RC Fabricators, Inc.	Wilmington	DE	Raymond Hayes	302.573.8989 x114
CBD		Rees Industrial Inc..	Collegeville	PA	Bob Laubmeier	610.489.9007 x221
CBD	CBR FP1	Reno Iron Works Co., Inc.	Reno	NV	Andrea Pelter	775.329.1111
CBD	CBR F	Reynolds Manufacturing Co.	Avonmore	PA	John Martin	724.697.4522 x226
SBD		Richardson Steel, Inc.	Spring Valley	CA	John Richardson	619.697.5892
CBD		Ripsam Steel Company	Loveland	CO	John Ripsam	970.669.8330
CBD	CBR FP1	Roscoe Steel & Culvert Co.	Billings	MT	Carl Solheim	406.656.2253
CBD	SBR	Roscoe Steel & Culvert Co.	Missoula	MT	Robert McCoskery	406.542.0345
CBD	P1	Roy Case Construction	Little Rock	AR	Roy Case	501.897.4061
SBD	CBR FP1	RPS Machinery Sales	Jersey Shore	PA	Robby Fisher	570.398.7456
CBD		Rule Steel Tanks	Caldwell	ID	Dominique Cotet	208.585.3031
CBD		Russellville Steel Company, Inc.	Russellville	AR	Grover House	479.968.2211
CBD	SBR P1	Ryan Iron Works, Inc.	Raynham	MA	John Cauley	508.822.8001 x229
CBD	CBR FP1	S & S Steel Fabrication	Hurricane	UT	Jeffrey Staples	435.635.9801
CBD		S&M Steel Fab, Inc.	Beaverton	OR	Mark Sutherland	503.627.0755
CBD		S. A. Halac, Inc.	Sterling	VA	Ahmet Halac	724.406.4766
SBD	SBR P1	Safety Guard Steel Fabricating	Millvale	PA	David Campbell	412.821.3533
CBD		Safety Steel Service Inc.	Victoria	TX	Bobby Fajkus	361.575.4561 x244
SBD		Salvino Steel & Iron Works, Inc	Franconia	PA	Kevin Mozzone	215.723.0915 x4
SBD		Sampson Steel Company	Anchorage	AK	Bruce Morgan	907.561.5626
CBD	CBR FP1	Samsung Heavy Industries Co., Ltd.	Kyungnam	Korea	Y.H OH	82.558.630.3550 x5340
CBD		Samuel Grossi & Sons, Inc.	Bensalem	PA	Eugene Grossi	215.638.4470
CBD		Sanders Bros., Inc.	Gaffney	SC	Kent Oliver	864.489.1144
	SBR	Sandvick Equipment & Supply	Phoenix	AZ	Jeff Stroud	602.276.0403
SBD	SBR	Schiavone Construction Co. Inc.	Newark	NJ	Ronald Marshall	973.483.0722
CBD		Schlosser Steel, Inc.	Hatfield	PA	John Much	215.723.9883
CBD	SBR P3	Schuff Steel - Gilbert	Gilbert	AZ	Keith Landwehr	480.892.4257
CBD	CBR FP3	Schuff Steel Company	Phoenix	AZ	Keith Landwehr	602.252.7787
SBD		Schurman Steel Fabrication	Summerside, PEI	Canada	Andrew Walker	902.436.4291
	SBR	Seibel Modern Manufacturing	Lancaster	NY	Mark Seibel	716.683.1536
SBD		Selco Manufacturing Corp.	West Caldwell	NJ	Art LaPierre	973.244.1177
CBD	P1	Selway Corporation	Stevensville	MT	John Morris	406.777.5471
CBD	CBR FP1	Shane Felter Industries, Inc.	Uniontown	PA	Ed Stitzer	724.439.2403
	CBR	Shanghai Matsuo Steel Structure Co., Ltd	Shanghai	China	Xiao Jie Wang	86.215.5715.8080
	CBR FP1	Shanghai Zhenhua Port Machinery Co.	Shanghai	China	Chen Bin	86.21.5839.6666
CBD		Shelco Steel Works, Inc.	South Holland	IL	Bernard Zeller	708.333.5380
CBD		Shepard Steel Company	Hartford	CT	Craig Boudle	860.525.4446
SBD		Sierra Nevada Steel Corporation	San Fernando	CA	T.E. Ivey	818.365.4571
	SBR	Sigma Industries	Selbyville	DE	David Speier	302.436.9610
CBD		Sippel Steel Co., Inc.	Ambridge	PA	John Sippel	724.266.9800 x812
SBD		SIS Northwest, Inc.	Sedro-Woolley	WA	Edwin Shannon	360.854.0074
CBD	SBR	Skaggs Steel Fabrication & Erection	Memphis	TN	Joseph Johnson	901.947.3109
CBD		SME Steel Contractors	Pocatello	ID	Shane Kynaston	801.280.0711
CBD		SME Steel Contractors	West Jordan	UT	Shane Kynaston	801.280.0711
CBD		Sociedad Metalurgica Arrigoni Hnos. S.A.	Santiago	Chile	Mauricio Parraguez	56.2.603.2223
CBD		South Carolina Steel Corporation	Taylors	SC	Charles Wall	864.244.2860
SBD		South Shore Iron Works, Inc.	Chicago	IL	Fred Hartmann	773.264.2267
SBD	SBR	Southeast Fabricators, Inc.	Sanford	FL	Jeffrey Burkett	407.688.0611 x3541
CBD		Southeastern Construction & Maint., Inc.	Mulberry	FL	John Lowe	863.428.1511 x234
CBD	P1	Southern Engineering	Charlotte	NC	Al Metzger	704.399.8331

AISC Quality Certified Fabricators

(Alphabetical by name with contact information)

Type	End.	Company Name	City	State	Contact	Phone
CBD		Southern Iron Works, Inc.	Springfield	VA	Barry Barger	703.354.5500
CBD		Southern Monopole & Utilities Company	Steel	AL	Bruce Herbitter	256.538.8842
CBD	SBR P1	Southern Ohio Fabricators, Inc.	Batavia	OH	Richard Pater	513.732.6033
	SBR	Southington Metal Fabricating Co.	Southington	CT	Norman Beland, Jr.	860.621.0149
CBD		Southland Steel Fabricators Inc.	Greensburg	LA	William Schmidt	504.289.7545
CBD	SBR P2	Southwest Steel Fabricators, Inc.	Bonner Springs	KS	Floyd Wohlrab	913.422.5500
SBD		Specialty Fab, Inc.	Leetonia	OH	David Hughes	330.427.1004
SBD		ST Fabrication, Inc.	Auburn	WA	Sandra Todd	253.735.2000
CBD	CBR FP1	St. George Steel Fabrication	Saint George	UT	Rick Bird	435.673.4856
CBD		St. Louis Fabrication Services, Inc.	St. Louis	MO	Andrew St. Johnston	314.385.4180
CBD		Standard Iron & Wire Works, Inc.	Alexandria	MN	Harold Ramsey	763.295.8710
CBD		Standard Iron Works	Scranton	PA	Mark Dennebaum	570.347.2058
CBD		Standard Steel Fabricating Co., Inc.	Seattle	WA	W. James Duthie	206.767.3314
SBD	CBR FP1	Steadfast Bridge Company	Fort Payne	AL	Fred Presley	256.845.0154
CBD	P2	Steel Fab of SC	Florence	SC	Jerry DeWitt	843.664.1811
CBD		Steel Fab, Inc.	Manchester	CT	Maurice Grenier	860.645.0022
CBD	SBR P1	Steel Fabricators of Monroe, Inc.	Monroe	LA	John Hunter	318.387.9426
CBD		Steel Fabricators, Inc.	Fort Collins	CO	Paul Scherrer	970.484.2752
CBD	CBR FP1	Steel Fabricators, L.L.C.	Ft. Lauderdale	FL	Kurt Langsenkamp	954.772.0440
CBD	SBR P1	Steel Service Corporation	Jackson	MS	Stanley Pruitt	601.939.9222
CBD		Steel Systems of Pensacola, Inc.	Pensacola	FL	Curtis Smith	850.479.2980
CBD	SBR	Steel West, Inc.	Pocatello	ID	Mike Hoehner	208.237.1580
CBD		Steel, Inc.	Scottdale	GA	Paul Tancraitor	404.401.1763
CBD	CBR FP1	STEELFAB	Anchorage	AK	Paul Lott	907.276.4303
CBD		SteelFab of Dublin	Dublin	GA	Michael Ahearn	478.275.9777
CBD		SteelFab of Virginia Inc.	Emporia	VA	Major Hatchell	919.828.9545
CBD	P2	SteelFab, Inc.	Roanoke	AL	Russell Barngrover	334.863.7311
CBD	P1	SteelFab, Inc.	Charlotte	NC	Bruce Lanier	704.394.5376
SBD		Steel-Span Inc.	Tifton	GA	Steve Wilson	800.987.3386
CBD		SteelTech Building Products, Inc.	South Windsor	CT	Bob Denton	860.290.8930
CBD		Stein Steel & Supply Co.	Atlanta	GA	Bert Stein	404.523.2711
CBD		Stevens Equipment Co.	Salem	OR	Carolyn Beutler	503.581.2511
CBD	CBR FP2P3	Steward Machine Co., Inc.	Birmingham	AL	Jerry Shivers	205.841.6461
CBD	CBR FP2	Steward Machine Co., Inc.	Bainbridge	GA	Larry Welsh	229.243.0702
CBD	SBR P1	Steward Steel, Inc. (Structural Div.)	Sikeston	MO	Don Moore	573.471.2121
CBD		Stewart-Amos Steel, Inc.	Harrisburg	PA	Eckhard Schulz	717.564.3931
	CBR F	Stinger Welding, Inc.	Coolidge	AZ	Gary Gardner	520.723.5383
CBD		Strait Steel Inc.	Greencastle	PA	William Calhoun	717.597.3125
CBD		Strocal Inc.	Stockton	CA	Steve Clarkson	209.948.4600
CBD		Strocal, Inc.	Eloy	AZ	Jeremy Duncan	209.948.4600
SBD		Structural Steel Company, Inc.	Roanoke	VA	Richard Jamison	540.345.1531
	CBR FP1	Structural Steel Products Corporation	Clayton	NC	Trudy Hales	919.553.3034 x13
CBD	P1	Structural Steel Services, Inc.	Meridian	MS	Tony Dean	601.483.5381
	CBR F	Struthers Industries, Inc.	Gulfport	MS	Richard McNulty	228.864.5410
CBD	CBR FP1	STS Steel, Inc.	Schenectady	NY	Glenn Tabolt	518.370.2693
	CBR P3	Stud Welding, Inc.	Centerville	TN	Jim Sears	931.729.3571
CBD	CBR FP1	Stupp Bridge Company	Bowling Green	KY	Kenneth Lloyd	270.393.5000
SBD		Superior Iron Works, Inc.	Sterling	VA	F. Leith Boggess	703.471.5500
CBD		Superior Steel, Inc.	Knoxville	TN	Joe Farris	865.522.0253
CBD		Supermetal Structures, Inc.	Sherbrooke	Canada	Mario Tremblay	819.566.2965
CBD	P1	Supermetal Structures, Inc.	Saint Romuald, QC	Canada	Mario Tremblay	418.834.1955
CBD		Swift Steel/Div. Jones & Brown Company, Inc.	Addison	IL	Ron Krupa	630.543.0300
SBD	SBR	Swiss Fabricating, Inc.	Cranberry Township	PA	Jim Harper	724.772.3733
SBD		Szoke Bros., Inc.	Slatining	PA	Tom Szoke	610.760.0588
CBD		T & M Manufacturing Inc.	Tremonton	UT	Travis Scott	435.257.1400
CBD	CBR FP3	Tampa Steel Erecting Co.	Tampa	FL	Robert Clark	813.677.7184
CBD		Tate Fabricating Inc.	White House	TN	Ronnie Tate	615.672.4909
SBD		Tech Dynamics, Inc.	Perrysburg	OH	David Fielding	419.666.1666
CBD		TechnoSteel LLC - Structural Division	Darlington	SC	Brad Goodwin	800.676.2720 x3513
CBD		Tech-Steel, Inc.	Clearfield	UT	Michael Merback	801.936.0349 x18
CBD		Thai Herrick Co., Ltd.	Bangna Bangkok	Thailand	Robert Hazelton	662.361.8231.6
SBD		The Lynch Company, Inc.	Portland	OR	Rex Nelson	503.236.3825
CBD	P1	Thomas Steel, Inc.	Bellevue	OH	Daniel Thomas	419.483.7540
CBD	CBR FP1	Thompson Metal Fab, Inc.	Vancouver	WA	Steven Lawton	360.696.0811
CBD		Topper & Griggs, Inc.	Plainville	CT	Donald Chamberlain	860.747.5737
	CBR F	Trans Bay Steel Corp.	Napa	CA	William Kroplin	707.259.0777
SBD		Triad Steel Company	Thomasville	NC	Douglas Wentz	336.476.3105
CBD		Trinity Fabricators, Inc.	Green Cove Springs	FL	Mike Ginther	904.284.9657
	CBR FP1	Trinity Industries	Denton	TX	J. Haskell Ray	713.861.8181
CBD	CBR FP2	Trinity Industries Inc.	Houston	TX	Haskell Ray	713.861.8181
	CBR P1	Trinity Industries Inc.	San Antonio	TX	J. Haskell Ray	713.861.8181
	SBR	Trinity Industries, Inc.	Girard	OH	Gary Lallo	330.545.6613
CBD		Trinity Steel Fabricators, Inc.	Trinity	TX	Roy Karnes	936.594.3513
CBD		Trinity Steel Fabricators, Inc.	Tomball	TX	Roy Karnes	936.594.3513
CBD		Trinity Steel Fabricators, Inc.	Lufkin	TX	Roy Karnes	936.594.3513 x225

AISC Quality Certified Fabricators

(Alphabetical by name with contact information)

Type	End.	Company Name	City	State	Contact	Phone	
CBD	CBR	FP1	Tuckerman Steel Fabricators, Inc.	East Boston	MA	Joseph Burm	617.569.8373
CBD	SBR		Tulsa Steel Manufacturing Company, Inc.	Tulsa	OK	Larry Carr	918.227.0110
	SBR		Union Fabricators & Fitters, Inc.	Jonesville	MI	Linda Schupbach	517.524.7203
SBD			Union Metal Corporation	Canton	OH	David Hazen	330.456.7653
CBD		P1	Unique Metal Fabrication, Inc.	Pittsburg	KS	Adam Endicott	620.232.3060
CBD			United Iron Works, Inc.	Seattle	WA	Joe D'Amico	206.767.3630
CBD	SBR	P1	United Steel Fabricators, Inc.	Indianapolis	IN	Jim Smyth	317.241.1600
CBD	CBR	FP1	United Steel Structures Ltd.	Guangzhou	China	Charles Xiong	86.20.8159.0658
CBD	SBR		United Steel, Inc.	East Hartford	CT	Kenneth Corneau	860.289.2323
CBD	CBR	FP1	Universal Structural, Inc.	Vancouver	WA	David Harkama	360.695.1261
SBD			Unlimited Welding	Winter Springs	FL	Brian Smith	407.327.3333
CBD	CBR	FP1	Usiminas Mecanica SA	Ipatinga, MG	Brazil	Paulo Yoitii Saito	55.31.829.3615
CBD	CBR	FP1	Utah Pacific Bridge & Steel Corp.	Lindon	UT	Clark Olsen	801.785.3557
CBD	SBR		V&S Schuler Engineering Inc.	Canton	OH	George Cook	330.452.5200
SBD		P1	Valmont Ind., Inc. Ind.Const Prods	Valley	NE	Larry Watzke	402.359.2201 x3712
SBD		P1	Valmont Industries Inc.	Brenham	TX	Kenny Moore	979.836.9395
SBD		P1	Valmont Industries, Inc.	Elkhart	IN	Steven Wirgau	219.295.6942
SBD	SBR	F	Value Structures, Inc.	Ellwood City	PA	James Wild	724.758.5510
CBD	CBR	FP1	Van Buren Bridge Company	Van Buren	AR	Robert Nelson	479.474.1975
	SBR		Vaughn's, Inc.	Salem	OR	David Vaughn	503.371.0258
CBD			Viking Fabricators, Inc.	Marietta	OH	Patrick Lang	740.374.5246
	CBR	FP1	Vincennes Steel Corp.	Vincennes	IN	Kevin Day	812.882.4550
CBD	SBR		Virginia-Carolina Steel, Inc.	Norfolk	VA	Sidney Martin	757.853.7403
CBD			Vital Link Inc.	Sealy	TX	Gary Gamble	979.885.4181
	CBR		Votaw Precision Technologies, Inc.	Santa Fe Springs	CA	Ed Martinez	562.944.0661
	SBR		Vulcan Steel	Jacksonville	FL	Thomas Fitzpatrick	904.731.2041
CBD		P1	W & W Steel Company	Oklahoma City	OK	Rick Cooper	405.235.3621
CBD			W & W Steel Company	Lubbock	TX	David Webb	806.765.5781
SBD	SBR	P1	Walpar, Inc.	Birmingham	AL	Henry Parker	205.925.4990
CBD	CBR	FP1	Warrior River Steel, LLC	Cordova	AL	Terry Springer	256.332.6652
CBD			Watford Industry Inc.	Kingstree	SC	Harold Watford	843.382.8611
	SBR		Watson Bowman Acme Corp.	Amherst	NY	Wayne Walter	716.691.7566
CBD	SBR		Waukegan Steel	Waukegan	IL	Yakov Glozshsteyn	847.662.2810
SBD	SBR		Wel-Fab, Inc.	Mt. Holly	NJ	Daniel O'Connor	609.261.1393
CBD			West Coast Iron, Inc.	Spring Valley	CA	Hermann Kopf	619.464.8456
CBD	SBR		West Virginia Steel Corporation	Charleston	WV	S. Smith	304.346.0601
CBD			Western Fabrication LLC	Las Cruces	NM	Joe Lackey	505.526.1616
CBD			Western Pennsylvania Steel Fabricating	New Castle	PA	Fred DeFiore	724.658.8575
CBD			Western Slope Iron & Supply, Inc.	Grand Junction	CO	Frank Mitchell	970.243.9770
SBD	SBR		Western Steel	San Diego	CA	James Galley	619.235.0171
SBD			Western Steel Fabricators	Tacoma	WA	Craig Sundstrom	253.383.4091
CBD			Western Steel Manufacturing Co.	Boise	ID	Ron Allen	208.344.5548
SBD			WesTower Communications Ltd.	Surrey, BC	Canada	Jens Henriksen	604.576.4755
SBD	SBR		Westwood Systems, Inc.	Bellingham	MA	Joseph Sestito	508.966.4455
	SBR		Wheeler Consolidated, Inc.	Shakopee	MN	Michael Cromie	952.496.1043
CBD			Whitley Steel Co., Inc.	Jacksonville	FL	Odis Dickey	904.289.7471
SBD	SBR		Wichita Steel Fabricators, Inc.	Wichita	KS	Fred Quintana	316.838.3301
CBD			Wilborn Steel Company	San Antonio	TX	Ernest Wilborn	210.532.6852
CBD	CBR	FP1	Williams Bridge Company	Manassas	VA	Rocky Snellings	703.257.4021
CBD	CBR	FP1	Williams Bridge Company	Richmond	VA	Norman Snellings	703.257.4021
	CBR	FP1	Williams Bridge Company, Inc.	Bessemer	AL	Skip Mitchell	205.425.5100
CBD	SBR	F	Williams Steel Company	Jackson	TN	James Campbell	901.423.4900
CBD	SBR	P1	Wisconsin Structural Steel Co.	Barronett	WI	Larry Kloiber	612.861.3321
SBD	SBR		Woerner Wire Works, Inc.	Omaha	NE	Daniel Scanlan	402.451.5414
CBD			Woolf Steel, Inc.	Middletown	PA	Bill Woolf	717.944.1423
CBD		P1P2P3	World Fabricators Ltd.	Surrey, BC	Canada	J. Dale Anaka	604.580.3337 x120
SBD	SBR		WT Welding & Contracting Co., Inc.	Mt. Laurel	NJ	William Twaddell	856.235.3668
SBD	SBR		Wyatt Resources, Inc.	Fulshear	TX	Bill Snyder	281.391.6444
CBD			Wylie Steel Fabricators, Inc.	Springfield	TN	George Wallace	615.373.2875
CBD			X.L. Ironworks Company	Surrey, BC	Canada	Rick Hounslow	604.596.1747
CBD	SBR	P1	Zalk Josephs Fabricators, L. L. C.	Stoughton	WI	Gerald Hamptom	608.873.6646
CBD		P1	Zamil Steel Industries (SS Division)	Dammam Sec. Ind. City	Saudi Arabia	S. Akilan	966.3.812.1120
CBD			Zimkor LLC.	Littleton	CO	William Zimmerman	303.791.1333
CBD	CBR	FP1	Zimmerman Metals Inc.	Denver	CO	George Zimmerman	303.294.0180

AISC Quality Certified Fabricators Metal Buildings

Company Name	City	State	Contact	Phone
A & S Building Systems	Caryville	TN	Fred Schubert	865.426.2141
Alliance Steel, Inc.	Oklahoma City	OK	Larry Thomas	405.745.7500
American Buildings Company	Carson City	NV	Jay Settle	775.882.2900
American Buildings Company	El Paso	IL	Terry Kruper	309.527.5420
American Buildings Company	Columbus	GA	Paul Klim	334.687.2032
American Buildings Company	Jamestown	OH	Mike George	937.675.9031
American Buildings Company	Columbus	GA	Frank Mims	706.562.8020
American Buildings Company	LaCrosse	VA	John Hinthorne	434.757.2220
American Buildings Company	Modesto	CA	Mike Seifert	209.578.4200
Behlen Manufacturing Co.	Columbus	NE	Charlie Mundorf	402.563.7311
Bigbee Steel Buildings, Inc.	Muscle Shoals	AL	Roy Rudolph	256.383.7322
Butler Manufacturing Co.	Annnville	PA	Wally Stephenson	717.867.3260
Butler Manufacturing Co.	Birmingham	AL	Kevin Logsdon	205.791.6313
Butler Manufacturing Co.	Galesburg	IL	Dana Wilson	309.345.6727
Butler Manufacturing Co.	Kansas City	MO	Michael Schneider	816.968.4702
Butler Manufacturing Co.	Laurinburg	NC	Ralph Gaitley	910.277.1125
Butler Manufacturing Co.	San Marcos	TX	Jerry Rademacher	512.353.6101
Butler Manufacturing Co.	Visalia	CA	Greg Stolze	559.651.5311
Butler Manufacturing Co.	Burlington, ON	Canada	Andy Ghadban	905.332.7786
CBC Steel Buildings	Lathrop	CA	Walt Lewis	209.983.0910
Ceco Building Systems	Columbus	MS	Ernie Smith	601.328.6722
Ceco Building Systems	Mt. Pleasant	IA	Curt Rude	319.385.8001x139
Ceco Building Systems	Rocky Mount	NC	Randall Wiggins	919.977.2131
Chief Buildings	Grand Island	NE	Roger Bullington	308.389.7446
Chief Buildings	Janesville	WI	Roger Bullington	308.389.7288
Chief Industries, Inc.	Rensselaer	IN	George Groom	219.866.4121
Garco Building Systems	Airway Heights	WA	Glen Morris	509.244.5611
Gulf States Manufacturers	Starkville	MS	C. Irving Pylate	601.323.8021x415
HCI Steel Building Systems	Arlington	WA	Bruce Willenbrink	360.435.8871
Inland Buildings	Cullman	AL	Keith Shedd	256.739.6827
Inland Buildings	Waukesha	WI	Keith Shedd	800.438.1606
Kirby Building Systems, Inc.	Portland	TN	Michael Herrin	615.325.4165x2248
Kirby Building Systems, Inc.	Columbus	GA	Mike Herrin	706.569.8405
Ludwig Buildings, Inc.	Harahan	LA	Sharon Delaneuville	504.733.6260
MBCI/NCI Buildin Components	Omaha	NE	Dave Fulton	402.451.7000
MBCI/NCI Building Components	Lubbock	TX	Dave Fulton	806.747.4291
MBCI/NCI Building Components	Rome	NY	Dave Fulton	315.339.9701
MBCI/NCI Building Components	Salt Lake City	UT	Dave Fulton	801.530.4975
MBCI/NCI Building Components	Tolleson	AZ	Dave Fulton	602.907.4616
MBCI/NCI Building Components	Colonial Heights	VA	Dave Fulton	800.777.9378
MBCI/NCI Building Components	Oklahoma City	OK	Dave Fulton	405.672.7676
MBCI/NCI Building Components	Converse	TX	Dave Fulton	713.466.7788
MBCI/NCI Building Components	Lithia Springs	GA	Dave Fulton	713.466.7788
MBCI/NCI Building Components	Shelbyville	IN	Dave Fulton	317.398.4400
MBCI/NCI Building Components	Hernando	MS	Dave Fulton	601.429.4009
MBCI/NCI Building Components	Adel	GA	Dave Fulton	713.466.7788
MBCI/NCI Building Components	Houston	TX	Dave Fulton	281.445.8555
Mesco Metal Buildings	Southlake	TX	Dave Fulton	817.488.8511
Metallic de Mexico/NCI Building Systems	Monterrey	Mexico	Dave Fulton	713.466.7788
NCI Building Systems	Tallapoosa	GA	Dave Fulton	713.466.7788
NCI Building Systems	Atwater	CA	Dave Fulton	713.466.7788
NCI Building Systems, Inc.	Houston	TX	Dave Fulton	713.466.7788
NCI Building Systems, Inc.	Mattoon	IL	Dave Fulton	217.258.8541
NCI Building Systems, Inc.	Ennis	TX	Sammy Adams	972.875.6586
Nucor Building Systems	Waterloo	IN	Ronald Kuenkler	219.837.7891
Nucor Building Systems	Swansea	SC	Al Behr	803.568.2100
Nucor Building Systems	Terrell	TX	Mark Hoar	972.524.5407
Pinnacle Structures, Inc.	Cabot	AR	Johanna Levenstein	501.941.3929
Ruffin Building Systems	Oak Grove	LA	Mark Barnett	318.428.2305
Southern Structures	Youngsville	LA	Joseph Diliberto	337.856.5981
Star Building Systems	Elizabethton	TN	Mark Fritz	423.542.5047
Star Building Systems	Monticello	IA	Patrick Toney	319.465.3595
Star Building Systems	Oklahoma City	OK	Patrick Toney	405.636.2269
Star Building Systems	Lockeford	CA	Patrick Toney	209.727.5504
United Structures of America, Inc.	Houston	TX	Thomas Escobar	281.442.8247
United Structures of America, Inc.	Portland	TN	Wilroy Cheyne	615.325.7351
Varco-Pruden Buildings	Memphis	TN	Greg Bava	901.748-8000
Varco-Pruden Buildings	Van Wert	OH	Tim Washburn	419.238-9533
Varco-Pruden Buildings	Evansville	WI	Rod Huse	608.882-5000
Varco-Pruden Buildings	Pine Bluff	AR	Lynn Harwood	501.534-6030
Varco-Pruden Buildings	St. Joseph	MO	Gerry Schmitt	816.238-7550
Varco-Pruden Buildings	Turlock	CA	Gary Mitchell	209.667-4951
Varco-Pruden Buildings	Rainsville	AL	Mike Dendy	256.638-2264
V-P Buildings	Kernersville	NC	Tom Reebe	336.996-4801
Whirlwind Building Systems	Houston	TX	John Keating	713.946-7140



AT THE MOVIES

Richard M. Byrd, S.E.
and Jesus Torres, P.E.

The construction of a multi-screen theater in Anaheim, CA required careful design, timing and coordination—and the innovative use of structural steel.

The AMC Theatre in Anaheim, CA, was designed to incorporate 14 movie auditoriums with seating for 3,012 guests, with successful integration into the Downtown Disney entertainment experience. The project encompassed 61,000 square feet and was constructed with a total construction budget of \$15 million.

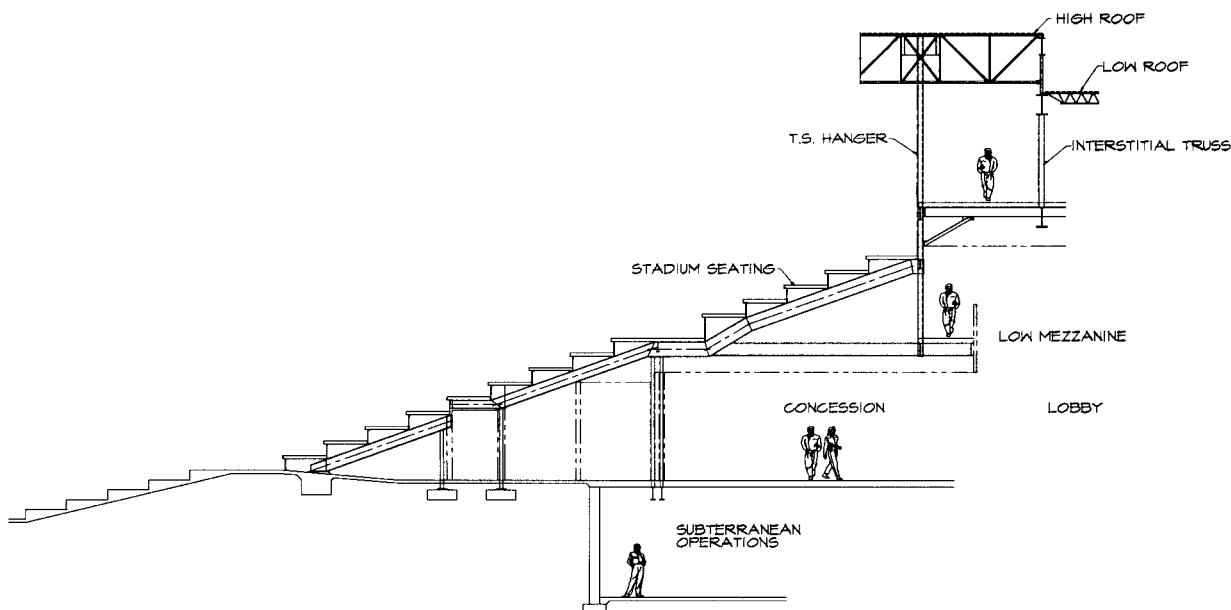
This project faced several unique challenges. First, property-line configuration and simultaneous construction on adjacent properties resulted in a compact construction site. Second, the design and construction of the theater was to reflect the high-impact materials associated with the Downtown Disney project, while staying within the budget constraints associated with a successful cinema project. The theater needed to accommodate support services and staff via subterranean construction, which was a variance to normal operations criteria. Individual auditoriums required full stadium

seating for the best possible movie-going experience. A column-free lobby and concession area were necessary despite the integration of two separate mezzanines and two theaters of stadium seating over the lobby. Finally, an exposed structural steel entry feature was to be designed to present a significant architectural statement and reflect the image and purpose of the primary structure.

One of the structural challenges revolved around the column-free lobby. Typical steel solutions include incorporation of conventional long-span design, but the architectural configuration of the lobby and stadium seating precluded simple resolution. A roof discontinuity, two mezzanines, and auditorium stadium seating located over the lobby complicated the framing.

SEATING SOLUTIONS

Numerous solutions were considered, including multiple long-span steel members at various levels to carry



Section through the theater area. Stadium-style seating is supported by broken-back steel stringers (members that are “kinked”) to maximize the headroom under the seats. The low mezzanine level is supported by hangers from roof trusses above. The roof trusses, in turn, are supported by a one-story interstitial truss at the projection booth level.

their respective gravity loads. The costs, difficulty of construction sequencing, and column locations that impacted subterranean levels made this option unavailable.

The chosen option was to support the seating by suspending it from the roof structure, which in turn was supported by a 104’ steel interstitial truss. The top chord of the truss was incorporated into the roof system, and the bottom chord was incorporated into the high-projection mezzanine. The truss was located so as not to interfere with projection operations. In addition, the truss web members were designed to transfer tributary lateral loads to the lateral system.

Due to tight construction conditions, there was no staging area available to construct the truss at the site. The steel subcontractor chose to shop-fabricate the truss and transport it 30 miles under special permit. The permitted travel time was 4:00 a.m., which allowed only a narrow window for erection because the crane had to be located on a neighboring construction site. The erection, crane dismantle, and field-welding of the end-web members had to occur within a narrow window.

At the request of the owner, stadium seating was incorporated into all auditoriums. Framing was accomplished with a complex incorporation of broken-back



The ribs of the entry dome consist of double-channel sections that reduce member depths and provide visual interest.

stringers supporting steel-plate fabricated risers with metal deck and concrete infill. Broken-back stringers were required to increase usable square footage under the stadium seating.

GRAND ENTRANCE

Structural steel was chosen as the appropriate structural system for the

entry feature to make a statement of permanence and elegance. A wooden feature would not have met the building’s fire rating, and a concrete design would not have been compatible with the long-span roof. The span of the entry feature was to be 80’, with cantilevered eyebrows of 15’ on two sides, for a total diameter of 110’.



The architect was concerned that conventional framing schemes would generate member sections too large for the desired elegant, open feel. By using a dome structure, designers were able to limit member profiles and let the entire space be the focus instead of large individual members. For greater visual interest and detail, tandem or multiple members were used instead of larger single members.

At the dome rib, double channels were used to satisfy the architect's visual intent and allow the wedge-shaped panels to be shop fabricated. Erection was accomplished by supporting the compression ring on scaffolding and individually erecting the dome panels.

Due to seismic considerations, the initial column design produced large

members that would not satisfy the architect's visual criteria. Using four columns at each column cluster instead of a single, large column achieved the desired look. To meet strength and drift criteria, the columns were attached as a group with web plates to emulate a vertical vierendeel truss. The web plates were designed for the shear flow necessary to achieve the desired stiffness. The shear plates were concealed behind architectural fenestrations and light fixtures so as not to compromise the architectural intent of four slender columns grouped together.

The structural system of the AMC 14 in Anaheim satisfied the client's intent and was well-integrated into the Downtown Disney environment. Creative solutions in structural steel were instrumental to the project's success.

Richard M. Byrd, S.E., is the president and C.E.O. of R.M. Byrd and Associates, Inc., Consulting Structural Engineers, in Ontario, CA. Jesus Torres, P.E., is Senior Associate and Project Engineer.

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GENERAL CONTRACTOR

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PROJECT OWNER

American Multi-Cinema, Inc.,
Kansas City, MO

ENGINEERING SOFTWARE

Risa 3-D and RAM International



Braced for Action

Beth S. Pollak

Exposed HSS chevron
braces add interest to
the interiors of the
VA Outpatient Clinic at
Travis Air Force Base,
Fairfield, CA.

The VA Outpatient Clinic in Fairfield, CA is a model for how steel can effectively combine function and aesthetics in a single-story, state-funded structure. Located at the former Travis Air Force Base and managed by the Department of Veteran Affairs, the \$8-million project architecturally reflects its surroundings, while accommodating the climatic and seismic requirements of the zone and the

functional needs of doctors and patients.

CLINICAL FLEXIBILITY

The 38,000-square-foot outpatient clinic was designed in two zones that are unified by a central lobby. The first zone is a modular clinical block, which is built as a primary care section with patient examination rooms and doctors' offices. The second is an ancillary support block, where a radiology lab, a pharmacy, a stat lab, and physical



Left and above: Braced frames were left exposed in the central lobby. In the office wings on either side of the lobby, moment frames were used in the longitudinal direction to accommodate the window arrangement. Braced frames were used in the transverse direction where there are no windows.

desirable in a health-care facility where you will have changes and modifications over time. To be able to make those changes within the floor plan, without any structural changes, and to avoid being restricted by load-bearing walls makes for a much more flexible organization of space."

AESTHETIC CLARITY

Steel was also chosen to meet the aesthetic goals of the clinic. "We're mandated by the survey master plan of materials and colors that are used on the air force base," said Rostenberg. "On the exterior, we used the same materials as the other buildings. But because this was an air force base, we chose to use steel to convey an aeronautic image."

The steel screens on the roof and the exposed steel canopy over the entrance are designed to represent a bird or an airplane landing from flight. "The architectural expression of the steel couldn't have been achieved with other materials," said project manager Patrick Ryan, of Rutherford and Chekene Structural Engineers in Oak-

land, CA. "It creates an industrial image that fits the industrial architecture at the airport. It is not glamorous, but it looks sleek."

The exterior canopies over the entrances are designed with beam members cut from standard wide-flange beams to create the tapered shape. The roof is made of steel decking.

The canopy and screens also provide an effective means of managing the region's harsh sunlight. To provide a bright and comfortable waiting area, the raised roof in the center of the building permits daylight to filter through the lobby through clerestories. At the same time, the canopy roof and sun shades on the building's south side provide screening to prevent exposure to direct sun.

SEISMIC SAFETY

The use of steel also helped meet California's seismic requirements. The structure utilized reduced-beam-section (RBS) moment connections in accordance with FEMA 350. Moment frames were used in the longitudinal direction to accommodate the window

and occupational therapy centers are located.

"The intention was to make it flexible to change, and easy to get around for older patients and patients with disabilities," said Bill Rostenberg, a vice president of SmithGroup architects in San Francisco, CA.

Flexibility is one of the reasons that steel was chosen for the structure, he said. "With steel, it's easy to achieve spans with very few load-bearing partitions in between," he said. "That's

pattern, and braced frames were used in the transverse direction where there were no windows. “Part of our approach was to express the braced frames that provide seismic stability,” Rostenberg said. “The braced frames identify the main entrance and the entrances to the different zones.”

Seismic separation joints between the lobby and the separate sides of the building also work to prevent seismic problems. “The central lobby is higher than the two sides, and doesn’t align with them,” Ryan said. “The seismic separation joints on both sides of the lobby are separated in one building direction and connected in the other.”

On the interior, braces are 5” HSS. Columns are 8” W-shapes, and the beams are 21” W-shapes. A total of 310,000 tons of steel was used on the project.

“We determined from the outset that steel was the preferable material for this building due to schedule and

cost concerns,” Ryan said. “If we had used a concrete building with a concrete shear wall, it would have been more expensive since erection and construction would have taken longer.”

The erection was done in two pieces, and it took less than a week to install each side. Ryan says that the speed of construction with steel was key to the success of the project. “The owners wanted it to be up and for the doors to open on schedule, because of political pressure and funding concerns,” he said. “The number one cost advantage was getting it up fast so you could bring in the other trades and get them working,” he said.

Ryan says the detailing work also went smoothly. “Because we were going for that industrial look, we kept the detailing fairly simple. In some exposed-steel structures, you might spend more time welding in cut plates to get a certain look. Here we didn’t have to do that — we paid attention to

brace connections, but there weren’t a lot of added pieces welded on just for looks.”

Using steel as a simple, swift and sleek solution, the Travis V.A. outpatient center was able to meet its schedule and budget requirements while adhering to functional and aesthetic goals.

ARCHITECT

SmithGroup, San Francisco, CA

STRUCTURAL ENGINEER

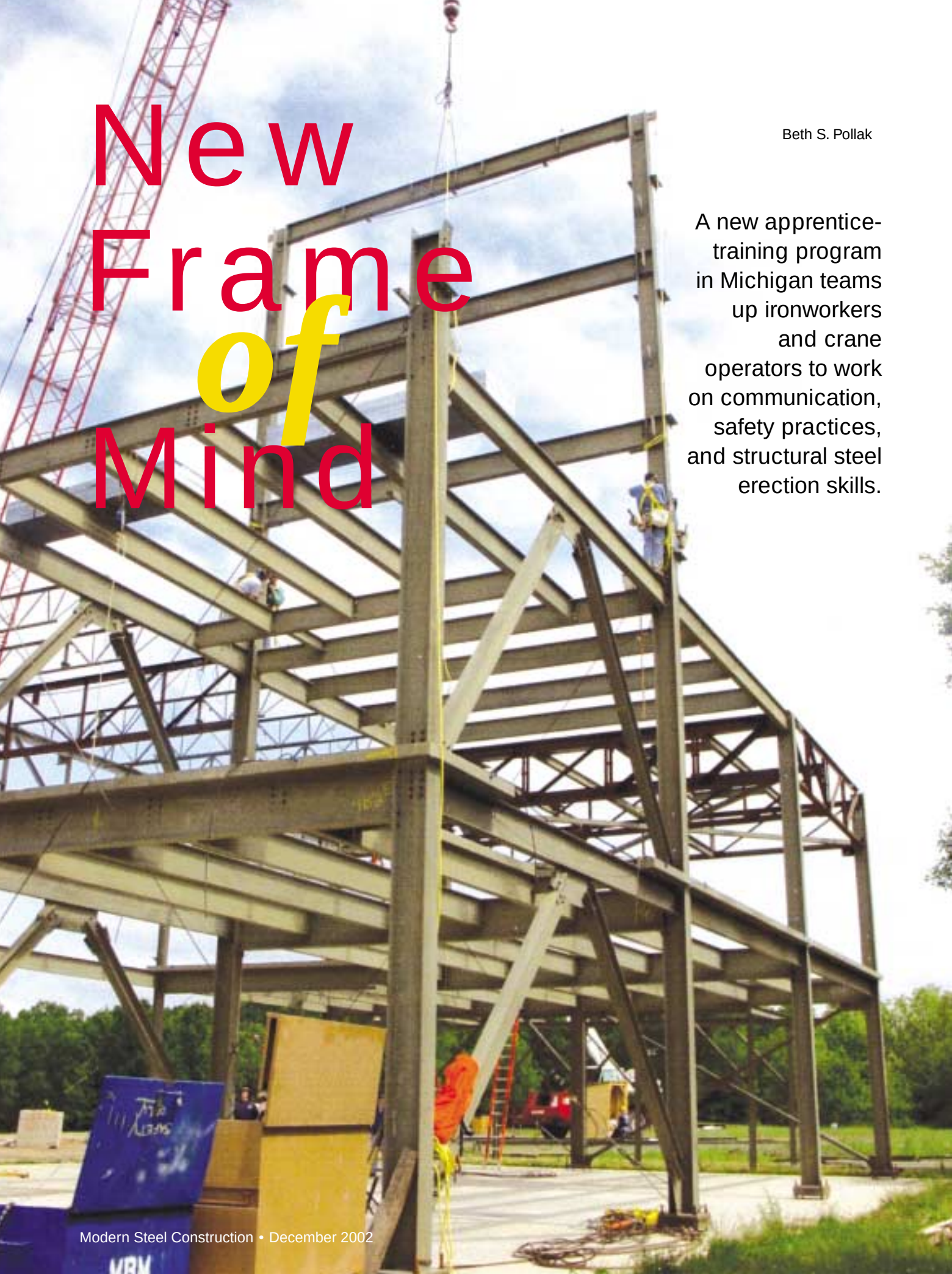
Rutherford and Chekene Structural Engineers, Oakland, CA

ENGINEERING SOFTWARE

SAP 2000

ERECTOR

Mid-State Steel Erectors, Inc., Stockton, CA (NEA member)



Beth S. Pollak

A new apprentice-training program in Michigan teams up ironworkers and crane operators to work on communication, safety practices, and structural steel erection skills.

New Frame *of* Mind

Apprentice ironworkers and crane operators don't usually train together to learn safety and erection techniques—but thanks to Michigan's new Raising Gang Training Program, apprentices now can spend a week learning tricks-of-the-trade from experts—and from each other.

Iron Workers Local 25 teamed up with International Union of Operating Engineers (IUOE) Local 324 and the Great Lakes Fabricators and Erectors Association (GLFEA) to create the program, which teaches apprentice ironworkers and crane operators structural steel erection techniques as they raise a five-story practice frame. The 50'x75'x60' frame features about 150 tons of structural steel, which organizers say is the largest training frame in use today.

The program began in May at IUOE 324 Journeyman & Apprenticeship Training Fund Education Center in Howell, MI, where the training frame is located. On October 23, GLFEA members joined representatives from both unions for a dedication ceremony. After speeches and a reception, apprentices demonstrated their new skills on the frame.

CLASSIC TRICKS MEET MODERN STANDARDS

One reason the program was implemented was so older workers could share their skills and knowledge with apprentices.

"When we went through apprenticeship, we were taught by older men who knew the tricks-of-the-trade," Local 25 Apprentice Coordinator Doug Levack said. "Similarly, with this program, four recent retirees, who gave their whole life to steel erection, have returned with no compensation to give something back to their trade."

The four retirees, all journeymen ironworkers and operators, helped develop the program, design the practice frame, and mentor the apprentices. Apprentices spend eight hours a day for one week, in class and on the practice frame, to learn the essentials of structural steel erection. The apprentices work in "raising gangs," which consist of four apprentice ironworkers and one apprentice operator. Ironworkers rotate between ground and air positions to gain an all-around appreciation of rigging, hooking and detailing work.

Raising Gang Committee Chair Patrick "Shorty" Gleason, President of Local 25, says the retirees' expertise is what brought the program to life. "The construction industry is about how to learn hands-on and by experience," he said. "In the field, not everything works as well as it does on paper. If the retirees hadn't brought their experience from the field to our program, it would never have arrived at this level," he said.

At the dedication ceremony, organizers also unveiled the Raising Gang Best Practice Book. The booklets will serve as a quick reference of "Dos and Don'ts" for ironworkers and operators.

Retired ironworker Gary Montie says it's crucial for retired workers to pass-on their pride and knowledge to the next generation. "During the 1960s and 1970s, supervision was gentlemen who had studied in an era without hats and gloves; they had to improvise," he said. "When you worked with them, it rubbed off on you, and at the end of the day you were proud of your accomplishments. Today, equipment is set up for you, but you still need to know the tricks. With the new practice frame and manual, we are able to put back into the trade what we learned 50 years ago."

FOUNDATION AND FRAME DESIGN

The four retired ironworkers prepared the concrete foundation for the training frame last April. A concrete slab about 12" thick was already lo-

cated at the education center. Ironworkers core-drilled through the concrete to install 84 anchor bolts with a stiff epoxy grout system. The epoxy was placed approximately to the top 2" of the 12" deep cores, and the rest was filled with lean concrete.

"These were threaded rods, and we were afraid that somebody would knock them over if we left them sticking out," said William Treharne, P.E., joint-apprenticeship chair of Local 25 and GLFEA past president. "So we put a sleeve over them and attached another anchor bolt to stick through. In the winter, the top anchor bolts will be removed to allow the slab to be free and to prevent the bolts from rusting and bending. Next spring, when training begins again, we'll take the fill material out, and add the extensions."

David I. Ruby, S.E., P.E., president of Ruby & Associates, Inc., in Farmington Hills, MI, helped design the training frame. "Our goals were to create a frame that could be used to simulate the erection of a high-rise-like structure and also an industrial structure," he said. "We needed a crane runway, joists and floor systems."

The five-story frame features different training scenarios on each level. Different floors have different frames, connections and floor systems. Walls feature different truss sizes and different combinations of columns, beams, brackets and struts.



The final pick for the initial erection of the new Ironworkers Local 25/Operating Engineers Local 324/Great Lakes Fabricators and Erectors Association training frame.



Apprentices get practice in beam-picking procedures.

“With some parts of the structure, you might want to use the crane, and with others you might not,” Ruby said. The frame can be used to simulate “christmas-treeing,” or multiple-lift rigging techniques, and “blind pick” situations.

The \$250,000 cost to engineer and fabricate the frame was split between the GLFEA and Local 25’s Joint-Apprenticeship Training Fund. Both groups contributed to the cost of the training program, extra tools and machines, and the publication of the Best Practice manual. IUOE Local 324 lent their training facility and expertise to the project, as well as approximately \$1 million in cranes and equipment for erection.

Douglas Steel Inc., of Lansing, MI, MBM Fabricators of Romulus, MI, and Midwest Steel Inc., of Detroit contributed materials to the project. Utica Steel Inc., of Chesterfield Township, MI fabricated the structure under contract to Gallagher-Kaiser Corp. of Detroit. Ojibway Industrial, LLC of Escorse, MI blasted and painted steel members with a high-friction zinc system for walking safety.

SAFETY FIRST

One emphasis of the program was for apprentices to master new federal and state safety procedures for structural steel erection.

“Safety is a win-win situation,” Treharne said. “We want our people to come back home in the same condition they came in.”

The raising gangs focused on the use of personal protection equipment, tie-off fall protection, static lines, crane-rigging procedures, beam-hooking procedures and emergency rescues and responses.

Doug Levack says practicing on the training frame before heading to a real construction site is important for safety education. “On-the-job is not the best place to learn safety—schedule pressures often get in the way,” he said. “This is an ideal site, so that if someone is in a situation that they can’t get out of, we stop and help them work through it.”

Michigan OSHA Chief of Construction Safety Richard Mee was on-hand at the dedication ceremony. He praised the Raising Gang program for its safety-training methods. “The most frequently cited violation in OSHA is lack of an accident prevention program,” he said. “The Raising Gang program is an example of how the union building trades faced the challenge, and I hope it’s a paradigm for future training programs.”

Retired ironworker Mark Morton says that by participating in the program, he also learns new safety procedures. “There’s a right and wrong way to do things to save time,” he said. “We didn’t grow up with specific safety procedures—and that’s why this training program is so important. Your job is twice as hard. You have to be productive and safe.”

COOPERATION FROM THE GROUND UP

Another key to the Raising Gang Training Program was the cooperation between ironworkers and crane operators. Organizers say that training together is a means of achieving safe and productive steel erection practices.

“You can’t do a job unless you know all of its aspects,” said Gary Ganton, coordinator of OE 324 Education Center. “An operator can make an ironworker’s job easy or hard. This way the ironworker appreciates what the operator does in the crane. They respect each other’s duties.”

Establishing camaraderie between ironworkers and operators can be a big part of what makes a project run smoothly. “When you’re working several hundred feet in the air, you need the trust of the guy who’s operating the levers,” said Patrick “Shorty” Gleason. “The respect needs to be there. The whole pace of a project is set with the ironworkers and operators, and if they can meet time and budget needs, other crafts can too.”

Apprentices who participated in the program say that it succeeded in establishing positive relationships between ironworkers, operators and their mentors.

“It was fun to work with ironworkers,” said Ross Eaton, a third-year apprentice operator from Laingsberg, MI. “Since it’s not a job site, they have time to sit and show you what they’re doing. I’m now more confident and know more about what’s going on during erection.”



Erectors learn how to safely perform multiple-lift rigging techniques, also known as “Christmas-treeing.”

“There aren’t too many jobs in the field where you get to know you’re operators,” said Dan Fodd, a third-year apprentice ironworker from Leslie, MI. “Your life depends on the guy sending steel to you and you have to have a rapport with him.”

Fodd says the week of training was an important step on the way to a solid career as an ironworker. “The retired workers are phenomenal,” he said. “Everyone has different experiences in the trades, and teaches different tricks that work for them.”

The cooperation between trade unions was also recognized as an important milestone.

“I believe the trade union context is the most effective way to train apprentices,” said William Treharne. “Everyone was dedicated to the result of good craftspeople. No politics—we focused on what we could do to make the apprentices the best they can be.”

“It’s a visionary and wise investment, that will make future partnerships more productive,” said Michigan District 25 State Senator Dianne Byrum, who spoke at the dedication ceremony.

Michael Fitzpatrick, general secretary of the International Association of Bridge, Structural, Ornamental and Reinforcing Iron Workers, also spoke during the ceremony. “Jurisdictional arguments prevent productivity,” he said. “In the future, there will be a point where some crafts might have to merge, or they will fall by the wayside. We’re not going by the wayside.”

KEEPING THE BALL ROLLING

The training frame will soon be used to educate engineers, architects, and students about structural steel erection, said GLFEA Executive Director D. James Walker. The site also will be expanded so workers can simulate equipment, siding and decking installations.

And the partnership between ironworkers and operators will extend beyond this project. Local 25 will soon acquire its own new training site, which will include hands-on facilities for the steel-reinforcing industry, the rigging industry, the pre-engineered steel industry and conveyer work. “We were fortunate that the operators shared their site for this project,” Doug Lemack said. “They needed ironworkers to train with them. On our new site, we’ll continue to work with the operators to train beyond major structural work.”

Other trade organizations hope to bring similar training programs to their apprentices. “We have jobs on mini scales, but it’s nothing like getting up there on the training frame,” said Dane Bowers, apprentice coordinator for Iron Workers Local 340, based in western Michigan. “We don’t yet have the funding for a program like this, but we’d like to create one.”

Gary Ganton says he’s happy to see the project win so much support. “I spent 26 years as an operator setting iron,” he said. “Cooperation in training was an area that I kept thinking about—and once we got the ball rolling, we could turn the idea into reality.”

Keeping that ball rolling is what could set this training program apart from any others. “Cooperation, training and education—that’s what distinguishes us,” said Sam Hart, business manager and general vice president of IUOE Local 324. “We’re the first one in the country, and we’re moving forward, not standing still.”

As operators and ironworkers move forward with the Raising Gang Training Project, it’s clear that the only things left standing will be the many frames and projects they will work on together.

Safety in Steel

John Martin, Lisa Rizzo, John Vincent and Margie Wolfe

Ergonomic and contemporary design—which helps to facilitate the use of personal protective equipment (PPE) and motivate employees to wear it consistently—is a primary focus of the latest PPE innovations. New product-design concepts also recently have solved significant technical, cost and administrative problems. As a result, more workers are taking advantage of easily installed, low-cost products to stay safe on the job. Combined with comprehensive training programs, products for improving safety in steel construction will help reduce accidents in the construction industry—the industry that continues to report the largest number of fatal work injuries.

FALL PROTECTION

Falls are the leading cause of construction industry deaths. Construction industry falls accounted for over half of all fatal falls in all industries in 2001, according to a September 2002 U.S. Bureau of Labor Statistics report. To help reduce fall fatality and injury numbers, PPE manufacturers are focusing on anchorage and fall-arrest systems that are easy to install and to use. These systems include lightweight stanchions that can be installed or removed with no special tools. Some have built-in shock absorbers that simplify horizontal lifeline systems for structural steel.

Combination equipment, such as traffic vests with built-in harnesses, and harnesses with permanently attached lanyards, reduces total weight, making it easier for workers to wear all required personal protective equipment.

HARD HATS

The second most common cause of death and injury during construction occurs when a worker is struck by an object—often in the head. Studies have shown that a high proportion of head injuries are due to the lateral impact of flying objects—not just the vertical impact of falling material. It is essential to assess whether workers require

ANSI Type I vertical-impact protection or Type II head protection against lateral and vertical impact, electrical shock, heat and sparks. Frequently, Type II protection is needed.

Secure fit, comfort and quality also influence the effectiveness of head protection—particularly during rapid or forceful work movements and windy conditions. New suspensions, level adjustments and chin-strap designs provide more secure and comfortable fits for adverse environments. Accessory slots in hats for hearing muffs and face shields make it easy to enhance head protection for different conditions.

HEARING PROTECTION

Active hearing protection, which is noise-responsive, is a new solution for workers who use equipment that makes intermittent impact noise, such as pile drivers. Noise deleting headsets cancel unwanted background sound and enhance the quality of audio delivered through the equipment. For those using jackhammers or other constantly loud equipment, brightly colored, disposable earplugs reduce noise and help safety supervisors spot wearers vs. non-wearers.

EYE PROTECTION

Risks to eyesight occur when workers remove protective eyewear. Often safety goggles become fogged or scratched. Workers might develop a headache from an overly tight fit or remove unflattering glasses. Some workers use a faceshield or welding helmet without safety glasses or goggles, which are required to be worn underneath faceshields or helmets.

Given these challenges, new designs for safety glasses and goggles focus on functional and attractive styles. Many feature side shields that are part of a wrap-around sport-like design. Anti-fog, scratch-resistant, static-resistant, anti-UV-coated and tinted lenses greatly improve functionality for the steel construction worker. Many manufacturers provide options such as adjustable, straight or curved

temples with flexible or soft-touch ends to improve fit and comfort.

HIGH-VISIBILITY CLOTHING

Many accidents occur due to poor visibility in construction zones with moving vehicles. This has led to the recently revised ANSI standard for high-visibility clothing. The standard states that in areas where greater visibility is necessary because of inclement weather, complex background or traffic diversions, or where vehicles and equipment do not exceed 50 mph, an ANSI Class 2 vest is required.

HAND PROTECTION

New hand protection products focus on providing greater dexterity and durability as well as cost effectiveness. Welder's gloves, driver's gloves, and leather-palm gloves with abrasion resistance are some of the options for hand protection that are customized to specific steel construction jobs. Other specialized products include Kevlar®-coated cloth gloves for insulation, comfort and cut/slash protection, and bright orange PVC gloves that are highly visible when signaling crane operators. It pays to look for a comfortable, flexible fit and high-quality materials, with weight and durability appropriate to each particular job.

RESPIRATORY PROTECTION

New respiratory protective products provide greater comfort and protection with softer, lighter and more flexible facepieces to better accommodate workers' protection needs.

As safety becomes increasingly important on steel-construction sites, look for personal protective equipment that is more comfortable, more cost-effective and easier to use than ever before.

John Martin, North Safety sales specialist and W. H. Salisbury trainer/specialist for fall protection, and North Safety Product Managers Margie Wolfe (head and eye protection), Lisa Rizzo (hand protection) and John Vincent (respiratory protection) contributed to this article.

PRODUCT HIGHLIGHTS

Safety Products

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Preventing Ironworker injuries and deaths, and reducing material slippage is the purpose of a new self-contained beam grabbing system. The Connector™ is a hydraulic motor-driven, self-contained battery-powered "below-the-hook" crane attachment, that securely clamps onto a steel beam's top flange. Workers rigging the lift on the ground operate a remote control unit and magnetically lock The Connector™ to one end of the beam, allowing an ironworker overhead to release the device's hold from the beam once it has reached its placement position.

The unit, invented by Dan McDermott, a 3rd generation Ironworker, enters the market as OSHA's new steel erection regulations take effect. According to a safety study released by University of Tennessee researchers, falls from high structures accounted for nearly 20% of deaths in 1999. The study, conducted by the university's Construction Industry Research and Policy Center at Knoxville, reviewed fatal events investigated by the OSHA.

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DBI/SALA®, the world leader in fall arrest, restraint, and rescue equipment, has been protecting workers from potential fall hazards for more than 30 years. We not only design and manufacture quality safety equipment that meets or exceeds the most current OSHA and ANSI standards, but we are the fore runner in the development of new products that are engineered to bring complete safety to the worker.



Our product line is the broadest in the industry and includes full body harnesses, shock absorbing lanyards, self retracting lifelines, rope grabs, confined space equipment, ladder safety systems, anchorage connectors, and horizontal systems, just to mention a few. Our years of experience combined with the knowledge and expertise of our sister companies located throughout the world enables DBI/SALA to produce fall arrest, restraint and rescue equipment that is second to none.

The Exofit™ Harness from DBI/SALA introduces a new concept in harness design. Manufactured from a single piece of X-shaped fabric that wraps around the wearer like a lightweight vest, it allows maximum clearance for a worker's arms. The harness body is a complex layering of soft, lightweight webbing on the outside and padding and vents on the inside. The sub-assembly is constructed from AeroSpacer™ Dri-Lex®, a high-tech, three-layered, moisture-wicking material that is used in the backpacking and footwear industries.

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Gateway Safety, Inc., has been manufacturing cost-effective, dependable eye protection for over 50 years. In addition to a complete line of protective eyewear, Gateway Safety also offers hearing protection, goggles, visitor spectacles, lens-cleaning products, eyewashes, face shields, hard hats, welding goggles and more.

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ISEA is the trade association for manufacturers of personal protective equipment (PPE). It offers a comprehensive PPE buyers guide, a quarterly Protection Update Newsletter, a brochure making the cost-benefit case for safety at work, and product guides. ISEA also develops and publishes ANSI standards for hard hats, high visibility apparel, emergency eyewash and showers, first aid kits, gloves, disposable protective apparel, gas detector tubes and passive monitors. ISEA's Arlington, Virginia-based staff works through members and with their customers and government organizations to increase use and awareness of safety equipment. Key to this effort are safety equipment performance standards recognized by the American National Standards Institute (ANSI). Voluntary, consensus ANSI standards developed by ISEA help users select safety equipment that is designed to meet their needs and expectations.



The newest offering is "Making the Case for Safety Equipment," a communications tool kit that is ready to help safety officers convince their bosses and workers for whom they are responsible about the value of personal protective equipment (PPE) in preventing injuries, saving lives and importantly, reducing costs at the same time.

The comprehensive kit explains PPE's role in workplace safety; outlines steps an organization should take to make PPE part of its safety program; provides contact points at a host of private and public organizations involved with construction worker safety; and gives guidance on undertaking a job-site audit and equipping workers with proper PPE for tasks common to heavy construction.

It also provides information to make the business case for PPE, and includes a powerful formula to calculate the damage a seemingly minor workplace injury will do to a company's bottom line. The full-color kit comes in a binder and self-loading CD formats.

PRODUCT HIGHLIGHTS

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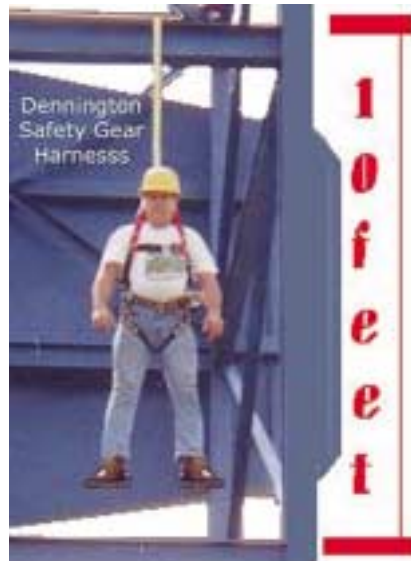
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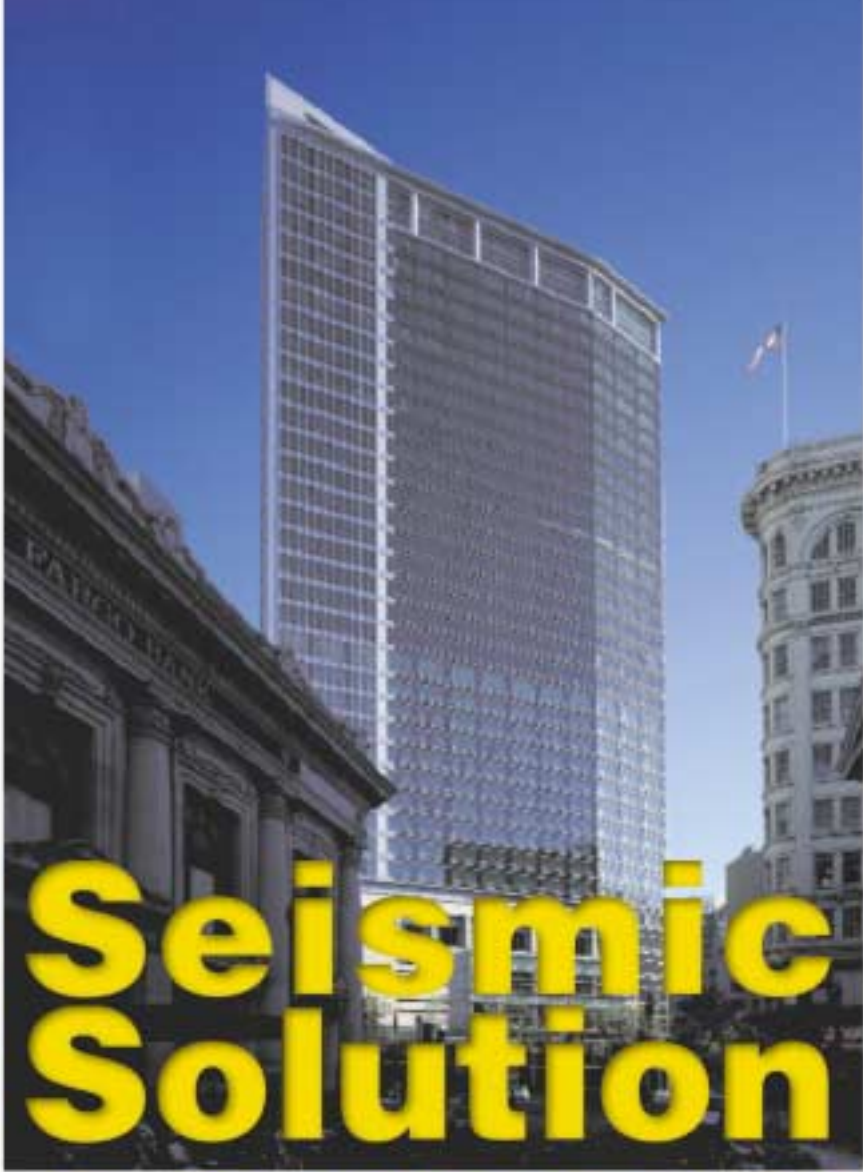
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Modern Steel Construction is seeking articles about innovative products that have important applications in the structural steel industry. If your company has a product that fits this description, and you'd like to see it in an upcoming issue of *MSC*, please submit a brief written description (no more than 500 words) of a real-life example of your product in action for *MSC*'s "Product Case Study" section. Photos should accompany all submissions. Stories, ideas, questions or concerns can be sent to Beth Pollak at pollak@modernsteel.com.



THE

Seismic Solution

Stephen DeSimone, P.E.
and Steven Bongiorno, P.E.

Long deck spans,
upturned spandrels and
toggle brace-dampers
meet the complex
seismic requirements of
the irregularly shaped
steel tower for San
Francisco's Four
Seasons Residences.

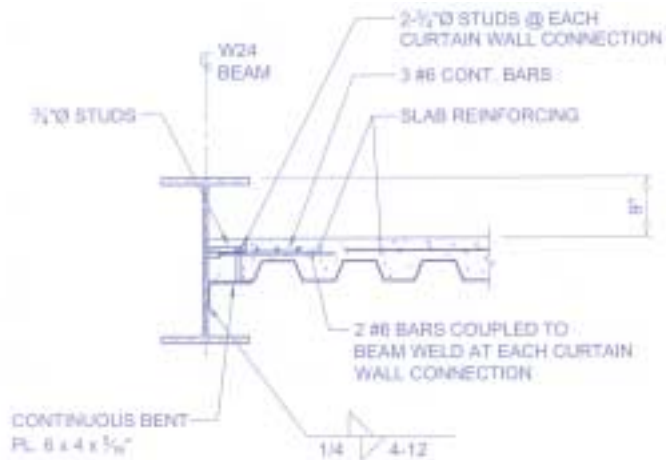
Amid San Francisco's elegant skyline stands an example of what innovations in tall building design can achieve in demanding engineering environments. The Four Seasons Residences is a 40-story, mixed-use building that opened in fall 2001. At over 400', it is one of the tallest and most irregular shaped steel-framed buildings built in San Francisco since the 1994 Northridge earthquake. The project is a joint venture development between Millennium Partners and WDG Partners.

This one-million-square-foot building houses 277 rooms for the prestigious Four Seasons Hotel, 136 luxury condominium units, The Sports Club/LA-SF and exclusive retail shops. Valet parking is provided in the basement levels. The hard cost for construction was approximately \$350 million. The building has five stories below grade and 37 stories and me-

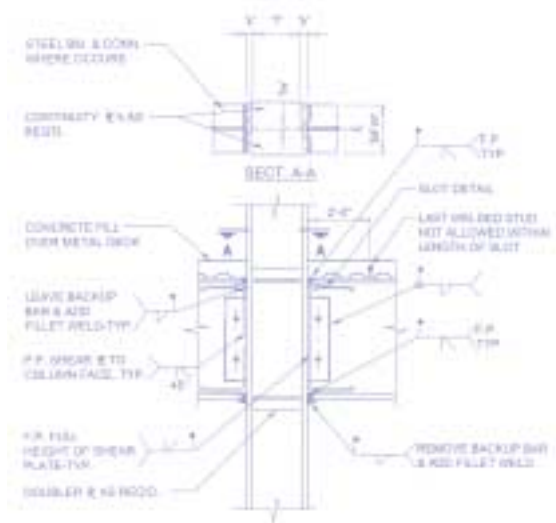
chanical penthouses above. The below-grade portions penetrate to a depth of 60', not including the 7'-6" mat foundation. The basement and podium levels fill the entire 55,000-square-foot footprint of the site, while the hotel and condominium floors encompass an area of 20,000 square feet.

FOUNDATION WORK

The site is located immediately south of the Bay Area Rapid Transportation train lines (BART) and the San Francisco Municipal Transit (MUNI) tunnel running along Market Street. A 3'-thick slurry wall constructed around the perimeter of the site and braced by large-diameter steel pipe sections provided the necessary shoring for the 70'-deep excavation. Site conditions, the depth of the excavation, the water table (at 36' below grade) and relationships to critical transit systems required the slurry wall to be extended down 100' from grade.



Typical "Upturned Spandrel" detail between columns. A modified detail was used within the panel zone to provide the necessary lateral bracing of the column.



Seismic Structural Design Associate's Slotted Web™ seismic moment-frame connection detail. Beam slot lengths varied based on beam size and length.

progress prior to completion of below-grade work.

During the conceptual stages of the project, the design team studied different alternatives for materials and framing systems. Several major parameters of comparison were: speed of construction, safety, weight, availability of materials and skilled labor, and cost. The most important requirement driving the choice of structural system and material was the maximization of free

The Bay area lacks available high-strength concrete ($f'_c > 6,000$ psi). This means that the wall, column and beam sizes in a comparable concrete structure would be too large to fit the archi-



Photograph of the rear of the building during construction. The irregular "boot" shape of the structure is evident from this angle. Also shown are the cantilevered ballroom and basketball levels as well as the three story voided area for the future museum.

tectural and other programming requirements of the building. In addition, the weight of a concrete structure and the equivalent lateral force would be approximately 50% greater than that of a steel building. With a vast labor pool of quality steel workers, an erection schedule of two floors per week, stringent architectural constraints and the seismic requirements for ductility, steel was the obvious structural material of choice for this project.

FRAMING SYSTEM

The building is constructed of approximately 15,000 tons of structural steel. The contractor, PDM-Strocal of California, and detailer CanDraft of British Columbia, worked closely with the design team to accommodate the project's accelerated schedule. The mill order contained every section type available: standard wide flange, channel, angle, HSS, pipe, jumbo shapes, built-up wide flange and plate fabricated box sections. The majority of the steel used for the project was ASTM A572, Grade 50 meeting the special requirements of 1997 AISC Technical Bulletin No. 3. (*Editor's note: ASTM A997 is the current specification for this type of steel.*)

Several different framing systems responded to the various architectural constraints and requirements imposed

on the structure. In this respect, form followed function. The tower framing consisted of standard wide-flange floor beams and special moment-resisting frame (SMRF) spandrel beams. The typical floor beams were limited to W16 sections and smaller while the perimeter SMRF spandrel beams were typically W24 sections. The sizes of these spandrel beams varied from W24x76 to as large as W24x229.

Typical interior column sections were standard W14 shapes except for columns supporting the braced core. These heavily loaded columns required jumbo W14x605 shapes. The SMRF columns used in the perimeter frame varied in size from W24x176 to W24x370 and many required added cover plates at the lower floors. Due to re-entrant corners and jogs in the exterior frame, 24"-square box columns were needed to resist biaxial bending forces from intersecting frames. These box sections were comprised of 1"- to 3"-thick plates, and they featured continuity plates (web-stiffener plates) at the moment connections. Due to extreme variations in size between interior gravity columns and the exterior SMRF columns, and due to the differences in the stress distributions, engineers developed a schedule whereby column lengths were corrected during the fabrication process in order to compensate for differential and overall column shortening. Typical compensations varied between $\frac{1}{8}$ " to $\frac{1}{4}$ " per two-story column lift.

Typical floor slabs consisted of heavy-gauge metal deck filled with light-weight concrete. Important diaphragm floors were constructed of heavily reinforced thickened slabs.

THE PODIUM

As can be expected, the framing of the lower six "podium" or public floors was extremely complex due to double-height spaces for sports and recreation facilities, pools, ballrooms and basketball courts. In addition, an area 45' wide by 200' long by three-stories high was omitted at the southern end of the podium. The structure was left void to allow for future construction of a museum within the space.

Meshing the amenity and mixed-use spaced within the podium caused a lack of space. The design team had to locate an 11,000-square-foot, column-

free hotel ballroom directly over a 10,000 square foot column-free basketball court. This required that the entire ballroom structure span 90' over the basketball area below. This long span was accomplished by using W40x362 beams at 10' on center. The roof over the ballroom was framed with 4'-deep trusses spaced at 15' on center and composed of WT and double angle members.

To further complicate matters, one entire supporting edge of the basketball area, and hence the support of the ballroom, was cantilevered 15' over the building entrance below. To account for this stacking effect and the discontinuous load paths, a 3-D finite element analysis (FEA) of the structure was made. Using this FEA model, a state-of-the-art 3-D vibration analysis was performed to quantify and design for the effects of this stacking on the transmission of floor vibrations vertically through the structure. Ultimately, the solution contained a system of continuous bridging, or blocking, between the long span beams supporting the ballroom beams. This continuous connection engaged a larger extent of floor framing to resist the isolated vibration source, i.e. the dance floor. In addition, the full-depth bridging provided lateral restraint for the beam-bottom flanges, which we believe is a primary source of vibration in long span deep beams.

As functions within the building changed, the need to relocate or transfer columns became necessary. Transfer elements were generally in the form of trusses formed using the girders at two levels as chords and diagonal-compression web members. These A-frame trusses were composed of chord and web members as large as W14x605. As an alternate, a vierendeel configuration was also used. The vierendeel was formed by transfer girders at two adjacent floors linked with a vertical strut located under the terminated column, used mainly at exterior conditions.

PDM and CanDraft indicated early on that fabrication and construction of the large-truss gussets would be extremely difficult due to the design-weld lengths. DeSimone Consulting Engineers developed an innovative solution incorporating "slotted gusset plates" to allow for full-truss-member capacity development of the joint,

while minimizing the size of the gussets and hence providing more usable space. This slot, which creates eight weld lengths per connection instead of the usual four, also eliminated any potential lag effect in the large truss members. A finite element analysis (FEA) of these gussets was performed to account for the complex distribution of stresses in the plates and welds. The analysis results were used to determine optimum dimensions of the slot as well as the size and location of the end radius. The size and location of the radius was designed to allow ductile, non-linear, stress concentrations to form in the “sacrificial weld” material placed in this area prior to initiating fracture in the plate material.



Construction photo of the bent-knee toggle damper assembly. Note the deviation angle of the main diagonal struts.

STEEL RESIDENTIAL CONSTRUCTION

A minimal distance between ceiling and floor construction is an important factor in residential construction to allow the maximum number of levels within the height limits set by local planning codes. To facilitate this requirement, beam spacing in the hotel and condominium level was set at the typical hotel unit module of 14'-6", allowing coffered ceilings to extend up to the metal deck. A 3", 16-gage deck was used to span these long distances without requiring shoring. An exception was at the corner units, which required unobstructed spans of more than 20'; this could only be accomplished by using temporary reusable shoring beams.

Beams in the exterior special moment-resistant frames were further positioned with the floor slab located at the mid-depth to provide maximum window-head height within the unit. The projection of the floor beam above the finished floor line filled a void created by the code requirement of raised sills at high-rise windows. This up-turned spandrel arrangement was essential in meeting the architectural limitation of minimal floor height with maximum window areas.

LATERAL ANALYSIS—WIND AND SEISMIC

The building was analyzed to resist lateral forces from both wind and earthquake. Seismic forces were based on the provisions of the 1995 San Francisco Building Code (SFBC) (1994

UBC). Although the 1994 UBC was the basis for generating the lateral forces for the structure, some of the 1997 UBC requirements were implemented, particularly with regard to redundancy and SMRF detailing. Wind forces initially considered the provisions of the 1995 SFBC, but were ultimately based on wind tunnel tests conducted by RWDI of Canada. Generally, the earthquake forces governed the strength design of the building, but the wind-induced displacements and motions governed the serviceability requirements. The seismic design philosophy used by DCE incorporates a load/capacity pyramid. By this approach, no member is ever designed for load levels in excess of that which the surrounding structure, (i.e. connections, diaphragms, anchors, other members, etc.) can deliver to it.

The lateral analysis was performed using a three-dimensional computer model created with ETABS by CSI. Due to the structural irregularities and complexities of the project, a three-dimensional model representing the spatial distribution of mass and stiffness was created. This model accounted for the effects of mass offsets as well as seismic loading from any direction. Analysis of the building's substructures and diaphragms was accomplished using the finite element capabilities of SAP2000 by CSI. A dynamic response spectrum analysis was performed using the site-specific elastic response spectrum developed by the geotechnical engineer. This spectrum represents a ten percent

probability of being exceeded in one hundred years.

To achieve the required drift limitation of the structure, as well as redundancy, a dual system was implemented. A special concentrically braced frame extends up through the tower of the building at the elevator core, which has two parallel elevator banks. In one direction, two sets of braced bents were coupled together with a specially designed shear link beam, which is intended to absorb much of the energy that otherwise would be taken by the axial loaded columns and braces. Additional special concentrically braced frames were added within the podium levels.

The moment frames were designed using the special moment resistant frame (SMRF) provisions of the 1995 SFBC (1994 UBC). The frame provisions of the 1997 UBC were also considered, especially with regard to redundancy and detailing. The SMRF provisions were based on the failure of moment-frame connections in the 1994 Northridge earthquake. The new code provisions required that moment connection details be pre-qualified by special testing procedures.

"SLOTTED WEB" SEISMIC MOMENT CONNECTION

When the design team was considering which moment-frame connection to use, the structural engineering profession was well into the "Post-Northridge" (P-N) era. Virtually every type of accepted P-N connection was re-



24" diameter extra-strong steel pipe cross-lot braces with W36×182 spreaders were used for the lateral support of the slurry walls during excavation.

viewed, and two were given serious consideration: the reduced beam section, or dog bone; and the Seismic Structural Design Associates (SSDA) Slotted Web™ connection. The SSDA connection was chosen.

The Slotted Web connection had a number of benefits over the dog bone for this particular project. The first of these benefits was the elimination of the lateral-torsional mode of buckling required by the dog bone connection for effective hinge development. Also, architectural limitations driving the upturned-spandrel configuration, with perpendicular beams framing-in only at the columns, did not allow for bracing of girder flanges within the clear span. The factor that eliminated the use of the dog bone connection was the typical 12'-6" girder clear span. This short span has a moment gradient that is sufficiently steep to produce excessive moments at the column face due to full development of the plastic hinge moment at the reduced section.

Conceptually, the slotted-web connection resolves bending forces into two uniformly distributed axial forces at the beam flanges and directs nearly the entire shear force into the web connection. Although this load mechanism is assumed by most designers of moment connections, it does not reflect the true load path, as was evident during the 1994 Northridge Earthquake. By decoupling the flanges and the web, shear and bending forces go where they are supposed to go and not where they are assumed to go. The detachment, or decoupling, of the flanges also produces a more uniform distribution

of stresses across the width of the flange. This uniform distribution results in minimal stress concentration in the flange weld, normally occurring just above the web location. This in turn reduces the possibility of K-area fractures resulting from these stress concentrations.

WIND DAMPERS

While seismic forces governed the lateral design of the building, wind tunnel tests indicated there might be perceived lateral motion in the north-south direction of the building due to wind loading. To minimize this perceivable motion, DeSimone Consulting Engineers worked with RWDI and Taylor Devices to design dampers to be installed within certain portions of the building. These state-of-the-art, nonlinear-fluid, viscous wind dampers, arranged in a bent-knee "toggle" configuration, were used on alternate floors above the 17th floor. This arrangement, developed by Taylor Devices of Buffalo, amplifies the relative story movements by as much as four times. This increased sensitivity allows for dissipation of even the smallest wind-induced motions. The damping effect also reduces the seismic demand on the structure by changing the dynamic characteristics of the building. This effect was evaluated with a time-history analysis. Since the dampers are intended to limit service-level wind effects only, the lateral analysis and design of the structure was conducted assuming conditions of functioning dampers and subsequently destroyed dampers. In fact, Taylor devices estab-

lished the load at which the dampers would fail in a sacrificial manner during a seismic event. This project represents the first practical use of this damper arrangement in a building.

CONCLUSION

In addition to the above-noted technical advances, the building's structural design met the requirements of providing the greatest volume of space per vertical foot of height. All of these solutions made this building a great success, and it has been well received by the occupants and the surrounding community. Only by utilizing recent innovations such as upturned spandrels, slotted gussets, toggle-braced dampers, slotted-web moment connections and 3-D floor vibration analysis was it possible to design this highly complex project in the one of the most demanding engineering environments in the country.

Stephen V. DeSimone, P.E. is Executive Vice President and Steven J. Bongiorno, P.E. is Project Manager at DeSimone Consulting Engineers, P.L.L.C. in New York City and San Francisco

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Structural Fire Protection

***common
questions
answered***



Farid Alfawakhiri
Christopher Hewitt
Robert Solomon

AISC engineers and a representative from the NFPA provide answers to questions about the materials, components and systems designed to provide life safety and structural integrity during fires.

What is a fire load? Where do fire loads primarily come from in buildings?

Fire loads account for all combustible building contents, including furnishings, equipment, and combustible construction components. Most of a building's fire load results from contents that have been introduced after the construction is complete. The fire load is usually expressed in terms of the "wood-equivalent" weight of combustible building contents per unit building-floor area in psf. The actual weight of combustible contents is adjusted to the wood-equivalent weight based on the estimated potential heat of contents normalized to the potential heat of wood (8000 Btu/lb). Alternatively, the fire load could be expressed in terms of the potential heat of building contents per unit building-floor area in Btu/ft².

How fast does a conventional fire spread?

The rate at which a fire spreads and grows in a building depends on many factors:

- the combustion properties of the construction materials
- building furnishings and contents
- ventilation conditions
- room geometry and configuration
- timely detection and effectiveness of fire suppression response by occupants and/or firefighters
- availability and effectiveness of automatic fire detection and suppression systems
- availability and effectiveness of fire barriers

At what temperature does a typical fire burn?

The duration and the maximum temperature of a fire in a building compartment depend on the amount and configuration of available combustibles, ventilation conditions, properties of the compartment enclosure, and weather conditions. The maximum temperature of a fully developed building fire will rarely exceed 1800°F. The average gas temperature in a fully developed fire is not likely to reach 1500°F. Temperatures of fires that have not developed to post-flashover stage will not exceed 1000°F.

What is "thermal mass"?

Thermal mass is used sometimes for effective specific heat or heat capacity. Effective specific heat in Btu/(lb°F) is the amount of energy, per unit mass of material, required to raise the temperature of the material by one temperature unit. Similarly, effective-heat capacity in Btu/(ft³°F) is the amount of energy, per unit volume of material, required to raise the temperature of the material by one temperature unit. For most construction materials, specific heat and heat capacity values (as well as thermal conductivity values) are temperature dependent. This means that these values change in the temperature range associated with building fires (50°F to 1800°F), because many materials undergo physicochemical changes at elevated temperatures. These thermal properties are also sensitive to the testing method used, and different sources list varying values of material properties for the same material.

What is a heat sink? Where are they found?

A heat sink refers to anything absorbing large amounts of heat through physical and/or chemical processes. Materials containing large amounts of chemically combined water in their structure, like gypsum or concrete, can form heat sinks. They absorb significant amounts of heat due to the energy consumed in the water-evaporation process. Materials with high thermal conductivity and high effective-heat capacity will also act as heat sinks. Materials with low thermal conductivity will reflect and not absorb heat.

What is flashover?

Flashover is an abrupt transition from the burning of a small number of items in the room, or a small portion of the room, to full-room involvement in a fire. Room-fire flashover is a state in which all the combustible contents of the room experience a nearly simultaneous ignition. Most fires never reach flashover because they are extinguished before this can occur. Some fires self extinguish when the air supply is insufficient, or when the fire has a low-enough energy source to prevent ignition of multiple targets.

The time to flashover depends on many factors, such as the properties of

combustibles, the size of the room and ventilation conditions. In larger rooms, the time to flashover will usually be longer. In well-ventilated large premises, like open parking garages and large atriums, flashover is unlikely. Flashover is also unlikely to occur in sprinklered premises.

Where can one find the thermal conductivity or thermal resistance values of different fire-protective materials?

A good source is the third edition (2002) of the *SFPE Handbook of Fire Protection Engineering* by the Society of Fire Protection Engineers (www.sfpe.org). For some materials, information might be unavailable.

What is the meaning of "fire resistant"? Is it the same thing as "fireproof"?

Fire resistance is the ability of building components and systems to perform fire-separating and/or load-bearing functions under fire exposure. Fire-resistant building components and systems are those with specified fire-resistance ratings based on fire-resistance tests. These ratings, expressed in minutes and hours, describe the time duration for which given building components and systems maintain specific functions while exposed to simulated fire events. Various test protocols describe the procedures to evaluate the performance of doors, windows, walls, floors, beams and columns.

The term *fireproof* is a misnomer—nothing is truly fireproof. All construction materials, components and systems have limits and can be irreparably damaged by fire.

Is steel a fire-resistant system or material?

Fire-resistance ratings are assigned to construction components and systems, not materials. Materials are classified for their combustion properties, and steel is non-combustible. Steel also exhibits other valuable structural and durability properties. It is used in many fire-resistant building components and systems, where load-bearing structural-steel members are insulated from the thermal effects of a fire.

What are spray-applied fire-protective materials made of?

Spray-applied fire-protective materials fall into two broad categories: mineral fiber and cementitious. These materials are based on proprietary formulations, supplied in a dry form, and must be mixed and applied according to the manufacturer's recommendations.

The mineral-fiber mixture combines fibers, mineral binders, air and water. It is usually spray-applied. The dry mixture of mineral fibers and binding agents is fed to a spraying nozzle. Water is added to the mixture in the nozzle as it is sprayed onto the metal surface. In its final, cured form, the mineral-fiber coating is lightweight, non-combustible, chemically inert and a poor conductor of heat (a low thermal conductivity insulator).

Cementitious coatings incorporate lightweight aggregates, like perlite or vermiculite, in a heat-absorbing matrix of gypsum and/or Portland cement. Some formulations also use magnesium oxychloride, magnesium oxysulfate, calcium aluminate or ammonium sulfate. Various additives and foaming agents can be added to the mixture. Cementitious coatings are often classified by their density (as low, medium and high).

Other than spray-applied fire-protective materials, what other materials/methods can be used to fire protect steel?

Concrete and masonry encasements are traditional fire-protective materials that can be used. Gypsum-board and mineral-board products, ceramic-wool wraps, and various intumescent coatings are common alternatives. Steel itself is an effective fire-protective material when used in sheet form to provide a protective and reflective shield for other materials. Steel can also be used in the form of meshes or wraps to help other materials maintain their integrity under heat exposure. Other fire-protection methods for structural steel include using rain screens—water sprinklers that protect steel members—or filling tubular structures with concrete or water.

In general, structural fire-protection is achieved through one or more of the following mechanisms:

- Low thermal conductivity
- High effective-heat capacity

■ Heat-absorbing physical reactions, like transpiration, evaporation, sublimation and ablation; or heat-absorbing chemical reactions, like endothermic decomposition and pyrolysis

■ Intumescence, the formation of a thick foam upon heating

■ Radiation or reflection.

How do intumescent painting systems work?

An intumescent coating chars, foams and expands when heated. The compounds of intumescent systems generally can be placed into four categories:

1. inorganic acid or material yielding an acid at temperatures of 212°F to 570°F;
2. polyhydric material rich in carbon;
3. organic amine or amide, as a flowing agent; and
4. halogenated material.

Various binders and additives are mixed in to provide specific physical properties of the total system. The system often is made of several coats with different functions. For example, a top-coat will provide a durable finish surface, while the base coat will provide a strong bond to substrate. Extensive development over the last decade has led to improved formulations that do not use traditional compounds.

Can spray-applied fire-protection be applied to painted or galvanized steel?

In most cases, steel that is to be fire-protected should not be painted or galvanized. When such steel must be painted, additional measures can be taken to ensure adhesion. It is prudent to consult a fire-protection contractor and an authority having jurisdiction (AHJ) during early project stages if you expect your painted or galvanized steel to be fire protected by spray-applied materials.

Spray-applied fire-resistive materials can be applied to primed or painted steel shapes provided they have passed bond tests in accordance with ASTM E736 "Standard Test Method for Cohesion/Adhesion of Sprayed Fire Resistive Materials Applied to Structural Members." These tests should indicate a minimum average bond strength of 80 percent and a minimum individual bond strength of 50 percent,

compared to the bond strength of the same fire-resistive material when applied to a clean, unpainted/ungalvanized steel-plate surface. Some AHJs enforce similar requirements for galvanized surfaces. Producers of fire-resistive materials usually maintain a list of "pre-approved" paints that have passed the ASTM E736 tests. They can advise on the applicability of a product to galvanized surfaces. Additional tests are needed if a coated-steel surface is not pre-approved. If bond strength is found unacceptable, a mechanical bond can be obtained by wrapping the structural member with expanded metal lath (min. 1.7 lb/sq. yd).

How reliable are sprinkler systems?

Sprinkler systems have proven to be effective and reliable when properly designed, installed and maintained. Strict regulations in the United States enforce standard practices for sprinkler-system inspection, test and maintenance programs. The effectiveness of sprinkler-system performance is noted in the National Fire Protection Association's (NFPA) annual report: "The NFPA has no record of a fire killing more than two people in a completely sprinklered building where the system was properly operating, except in an explosion or flash fire, or where industrial fire brigade members or employees were killed during fire suppression operations."

Are there any structural systems that should be avoided when designing for an area of a building that contains a large fire load?

Building and fire codes usually restrict excessive fire loads or impose restrictions on the height and area of buildings with large fire loads. These restrictions are severe for buildings of combustible construction. Combustible construction is not always permitted for high-hazard occupancies. Even buildings that are deemed to have a minimal fire load, such as office buildings, are subject to codes that limit allowable-construction types and increase fire-resistance-rating requirements as building height and area increases.

What are the general rules-of-thumb for interpreting model building codes when it comes to fire ratings in mixed-use buildings?

Building codes have special requirements for buildings with more than one occupancy group. If different occupancies are separated by firewalls, fire-barrier walls and/or floors, each portion is considered a separate building when establishing allowable heights, areas and fire-resistance requirements (some conditions/exemptions apply).

Without this degree of fire separation, a building of mixed occupancy is limited by the most restrictive height and area requirements specified for any of the occupancies in the building (there are several exemptions). When establishing the fire-resistance requirements for non-separated uses, the regulations applicable to mixed occupancies govern the respective portions of the buildings. Where the requirements conflict, those that provide greater safety prevail.

When a building or system is said to have a two-hour fire rating, what does that mean?

It means that the system has satisfied the requirements for a two-hour rating specified in a relevant standard test. In the case of a building, it could mean that some of the construction elements and/or assemblies in that building have achieved a two-hour rating in a standard ASTM E119 fire-resistance test.

Does a two-hour fire rating mean that a building will last for two hours in a fire?

No. The ratings only reflect the ability of individual components and assemblies in a building to meet the required performance in the standard test. Buildings are classified by types of construction. Each has specific requirements pertaining to the combustibility of construction materials and the fire-resistance ratings required for building components (members, elements) and assemblies (systems). In some fire events, performance exceeds two

hours. In a severe-challenge fire, usually the result of an extreme, unanticipated event, performance can be less than two hours.

What is the difference between restrained and unrestrained ratings?

Restrained and unrestrained classifications pertain to ASTM E119 tests on beams, floors and roofs. They depend on whether the test arrangements allowed for free thermal expansion of the tested specimen (unrestrained test) or not (restrained test).

ASTM E119 tests on unloaded structural steel and composite steel/concrete beams can be restrained or unrestrained, but always require the longitudinal expansion of the applied fire-protection material to be restrained (this conservative requirement can result in earlier fall-off of the fire protection and faster heating of the tested steel beam). This test results in a single Unrestrained Beam Rating, based on the period of fire exposure where the average measured temperature at any section of the beam remains under 1000°F, and the measured temperature at any single location of the beam remains under 1200°F. This type of test is conducted only when the loading device has lower capacity than the required test load.

ASTM E119 tests on loaded structural steel and composite steel/concrete beams are always restrained and result in two ratings:

- the Restrained Beam Rating, based on the period of fire exposure where the beam sustains the applied design load, but NOT more than twice the corresponding Unrestrained Beam Rating, AND provided the latter is one hour or more; and
- the Unrestrained Beam Rating, based on the period of fire exposure where the average measured temperature at any section of the steel beam remains under 1100°F, and the measured temperature at any single location of the steel beam remains under 1300°F.

ASTM E119 tests on floor and roof assemblies are always loaded. The assemblies can be tested in the unrestrained or restrained condition around the floor/roof perimeter. Whenever the tested floor/roof assembly contains a structural-steel beam, both restrained

SPRAY-APPLIED FIRE-RESISTIVE MATERIALS, COMMONLY USED TO PROTECT STRUCTURAL STEEL, ARE TESTED FOR:

- ASTM E 84 "Standard Test Method for Surface Burning Characteristics of Building Materials"
- ASTM E 605 "Standard Test Methods for Thickness and Density of Sprayed Fire-Resistive Material Applied to Structural Members"
- ASTM E 736 "Standard Test Method for Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members"
- ASTM E 759 "Standard Test Method for Effect of Deflection on Sprayed Fire-Resistive Material Applied to Structural Members"
- ASTM E 760 "Standard Test Method for Effect of Impact on Bonding of Sprayed Fire-Resistive Material Applied to Structural Members"
- ASTM E 761 "Standard Test Method for Compressive Strength of Sprayed Fire-Resistive Material Applied to Structural Members"
- ASTM E 859 "Standard Test Method for Air Erosion of Sprayed Fire-Resistive Materials Applied to Structural Members"
- ASTM E 937 "Standard Test Method for Corrosion of Steel by Sprayed Fire-Resistive Material Applied to Structural Members"

and unrestrained assembly tests will result in an Unrestrained Beam Rating (based on the same temperature criteria specified for loaded restrained beam tests) in addition to Assembly Ratings. For any Assembly Rating period, the unexposed surface of the tested floor/roof should neither develop conditions that will ignite cotton waste, nor exhibit an average temperature rise in excess of 250°F. An unrestrained assembly test will result in an Unrestrained Assembly Rating, based on the period of fire exposure where the assembly sustains the applied design load. A restrained assembly test will result in two assembly ratings:

- the Restrained Assembly Rating, based on the period of fire exposure where the assembly sustains the applied design load, but NOT more than twice the corresponding Unrestrained Assembly Rating, AND provided the latter is one hour or more; and
- the Unrestrained Assembly Rating, based on the same temperature criteria specified for Unrestrained Beam Rating. This excludes steel structural members spaced 4' or less on center, where the criterion for the average measured temperature of all members remaining under 1100°F applies.

Are structural steel systems restrained or unrestrained?

Appendix X3 and Table X3.1 of ASTM E119 provide guidance on the classification of beams, floor and roof systems as restrained or unrestrained. Structural-steel beams and floor systems within steel-framed buildings are classified as restrained.

How can one determine a fire rating for a system that has not been prequalified, such as a concrete-encased steel column?

Concrete-encased steel columns have been "pre-qualified" by many fire tests. These columns are of generic design and are not listed in the Underwriters Laboratories (UL) directory. However, most building codes, such as IBC (Table 719.1(1) and Article 720.5.1.4), and ASCE/SFPE 29-99 (Article 5.2.4), contain specifications to determine the fire resistance of concrete-encased columns. These

specifications are based on extensive experimental data from standard (ASTM E119) fire-resistance tests.

Concrete-filled HSS columns are another example of generic construction that is not listed in the UL directory. Article 5.2.3 of ASCE/SFPE 29-99 specifies how to determine the fire resistance of concrete-filled hollow steel columns. The relevant background information can be found in:

V. K. R. Kodur, and D. H. MacKinnon, "Design of Concrete-Filled Hollow Structural Steel Columns for Fire Endurance", *Engineering Journal*, First Quarter, 2000, pp. 13-24.

Does the grade of steel used affect its response to a fire?

Common structural-steel grades exhibit similar deterioration of mechanical properties at elevated temperatures, and all structural grades perform essentially the same way. There have been efforts in several countries to introduce a "fire-resistant" steel grade into construction. This steel reportedly exhibits improved properties at elevated temperatures. However, its use remains limited in construction because improved mechanical properties of steel at elevated temperatures do not translate into significant increases in the fire resistance of building elements and systems.

How does a fire impact steel connections? Does it affect connections differently than the members themselves?

Connections usually contain more material (additional plates, bolts, etc.) than connected members. Often connections also have less exposure to heat and a higher capacity for heat dissipation because of their proximity to other members. As a result, temperatures are likely to rise faster in members than in connections, making connections less critical for fire-protection design.

Can steel continue to be used in a building after it has been in a fire? How can you assess the capacity of steel that has been exposed to fire? Are there concerns about internal or residual stress effects that have to be considered?

Steel is born in a melting process that is significantly hotter than any building fire, and significant residual stresses are present in all newly manufactured steel members. A detailed discussion of post-fire steel assessment issues is provided in:

R. H. R. Tide, "Integrity of Structural Steel After Exposure to Fire", *Engineering Journal*, First Quarter, 1998, pp. 26-38.

A general rule of thumb: "If it is still straight after exposure to fire—the steel is okay." Straightening techniques are available for steel members that have been misaligned after fire exposure.

What percentage of its total capacity does a steel beam retain when subjected to the heat of a normal fire? At what temperature does steel lose all of its capacity?

The strength of steel remains essentially unchanged until about 600°F. Steel retains about half of its strength at 1100°F, and loses all of its capacity when it melts at about 2700°F. For design purposes, it is usually assumed that all capacity is lost at about 2200°F.

How do concrete- or water-filled tubular steel columns perform in a fire?

Water or concrete inside tubular-steel members act as heat sinks. They reduce temperature rise in the steel and significantly enhance fire resistance. In the case of concrete-filled tubular columns, the concrete also contributes to the load-bearing capacity when the outside steel shell deteriorates under heat exposure.

Compared to regular steel framing, how do steel joists, channels, tees or castellated beams perform in a fire? Are there any special procedures required to fire protect them effectively?

Open-web steel joists and castellated beams are proprietary system designs. For many of them, fire-resistance

ratings are listed in the UL and other fire-resistance directories.

Which document specifies the fire-resistance requirements for the structural system?

The building code of the jurisdiction, which is usually based upon the IBC or NFPA model building code, will specify the requirements.

Which ASTM Specifications relate to fire-protection and engineering?

The most relevant ASTM specifications pertain to combustibility, ignition and flammability characteristics, heat- and smoke-release parameters, and fire resistance.

ASTM E119 specifies standard test procedures to establish the fire-resistance (endurance) ratings for construction elements (beams, columns) and assemblies (walls, floors, roofs). There are several other ASTM tests that establish fire-resistance ratings for windows, doors, fire-stops, and other components. Many ASTM specifica-

tions ensure the quality performance of relevant products (See table).

I have heard that the ASTM fire specifications are undergoing revision. Is this because of the World Trade Center attacks?

ASTM specifications are revised routinely every few years. Like many codes and standards, revisions are promulgated on a periodic basis to recognize new technologies and methods as well as new materials.

I have heard that the 2005 AISI Specification is going to address fire protection and engineering. What kinds of issues is the Specification going to address?

The *Specification* will provide a general outline of procedures for engineered structural fire-protection design that will include steel properties at elevated temperatures, expected fire exposures, heat-transfer calculations, load combinations for fire-limit states, and analysis of heated structures.

What is performance-based design with respect to fire?

Performance-based design consists in part of well-defined performance goals, objectives and criteria for an expected fire event. Thereafter, a corresponding set of systems is designed to achieve these performance objectives and criteria. In many cases, performance-based designs include evaluations of candidate designs against a series of fire-design scenarios.

How prevalent have performance-based designs become in fire protection?

It is still a design option that is typically reserved for use on certain high-profile projects. At this point, it is best described as a design alternative rather than a prevalent design methodology.

What is AISI doing to help people design effectively for fire resistance?

AISC is currently developing a single-source design guide, for engineers and architects, on the fire resistance of structural steel. AISI is researching ways to make engineered fire protection for steel structures more accessible as an alternative to current prescriptive solutions.

Farid Alfawakhiri is Senior Engineer, Fire Design, and Christopher Hewitt is Staff Engineer, Structures, with AISI in Chicago. Robert Solomon is NFPA's Assistant Vice President for Building and Life Safety Codes.

WHERE CAN YOU FIND FIRE RATINGS?

Methods to determine fire-resistance ratings for generic designs can be found in most building codes.

- Chapter 7, "Fire-Resistance-Rated Construction", *International Building Code*, International Code Council, Falls Church, VA, 2000.
- Chapter 8, "Fire Resistive Materials and Construction", *NFPA 5000: Building Construction and Safety Code*, NFPA, Quincy, MA, 2002.
- ASCE/SFPE 29-99, *Standard Calculation Methods for Structural Fire Protection*, Structural Engineering Institute of the American Society of Civil Engineers, Reston, VA, 1998.

Fire resistance ratings for proprietary designs are found in directories published by testing laboratories.

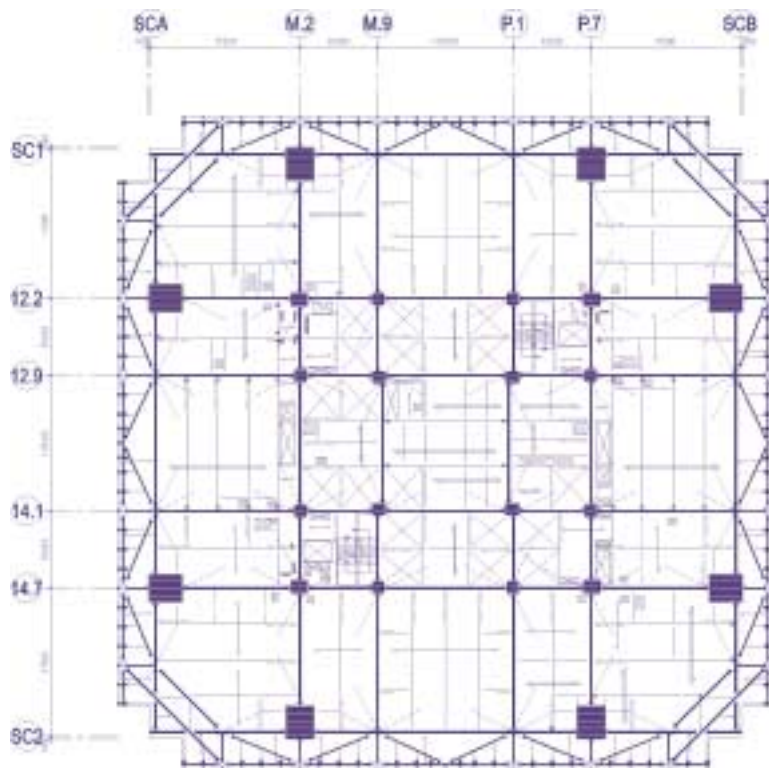
- *Fire Resistance Directory*, Volume I, Underwriters Laboratories Inc., Northbrook, IL, 2002 (updated annually), online directory at www.ul.com.
- *Directory of Listed Products*, Intertek Testing Services NA Inc., Cortland, NY, 2000, online directory at www.etlsemko.com.
- *Directory of Listed Building Products, Materials and Assemblies*, Volume II, Omega Point Laboratories Inc., Elmendorf, TX, 2002 (updated annually), online directory at www.opl.com.

the Sky's the Limit

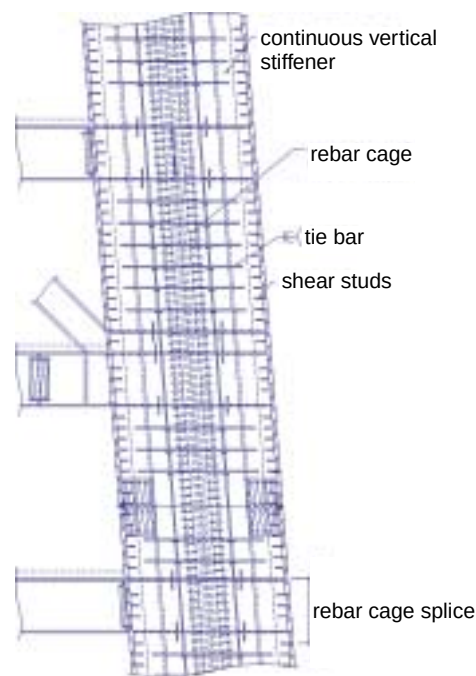
Dennis C. K. Poon, P.E.
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Leonard M. Joseph, P.E., S.E.
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Steel goes sky-high to meet the seismic challenge of Taipei 101, which will top out at 1666' in 2003.





Framing plan for level 50. Shear forces in perimeter frames traverse setbacks with in-floor bracing. Eight super-columns are filled with concrete to the 26th floor to add stiffness.



Section showing concrete-filled portion of a super-column.

Designing the world's tallest building is a challenge for any location, but some sites are more challenging than others. The 101-story Taipei 101 building is currently under construction in Taipei, Taiwan. In 2003 it will top out at 508 m (1666 ft) above grade, a new world record for buildings. Taipei 101 must address typhoon winds, large potential earthquakes and weak soil conditions. This article will focus on seismic challenges in Taipei 101's design and construction, and the use of structural steel as a solution.

The framing design had to solve five challenges. First was the unusual building shape. The lowest 25 floors taper gradually inward, forming a truncated pyramid. Above is a stack of eight, 8-story high modules with outward-sloping walls, creating a 'waist' at the 26th floor and setbacks at floors 34, 42, etc. The modules also have double-notched corners that minimize wind vortex shedding effects. A narrower tower segment and an architectural pinnacle top the eighth module. The overall effect is of a flower opening

to the sky. Façade slopes and setbacks would interrupt columns following the building face, and doubly-notched floor plans would reduce the efficiency of an exterior moment frame trying to 'turn the corner.' Therefore a perimeter tubular-frame system was not suitable for this project.

Second was the need for great lateral stiffness, to limit sway in high winds and earthquakes and reduce the potential for damage to non-structural elements. Third was minimizing overall building mass, to reduce the cost of the deep bored-pile foundation and to keep seismic forces as low as practical. Fourth was net column uplift in this tall, slender and comparatively lightweight structure. The fifth challenge was to provide a high level of safety in the enormous building for the large tenant population and public attention it would attract.

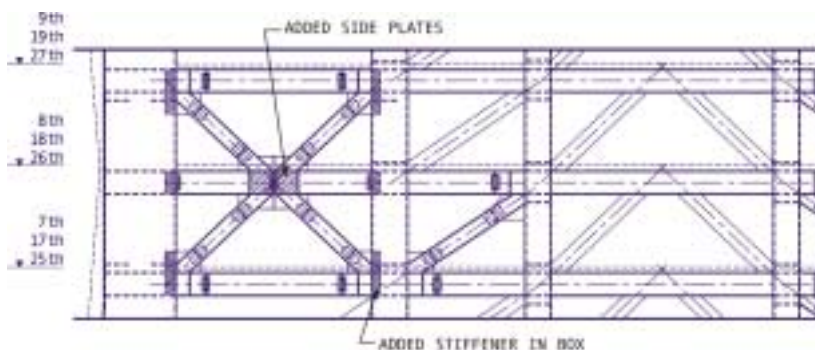
STEEL SOLUTION

The structural solution selected for Taipei 101 meets all of the above challenges. Structural steel framing provides great strength with minimal



View of super-column shell. At the base, the super-columns are 2.4 m by 3.0 m (approximately 8' by 10').

mass. A braced core offers high-shear stiffness with chevron and diagonal braces of I-shaped sections in four planes each way. Overturning stiffness is enhanced by outriggers in two directions. A mix of single-, double- and triple-story outriggers are distributed every eight to ten floors along the building height. On each building face



Elevation of typical braced frame.

they engage two vertical super-columns located to clear façade setbacks. Below the 26th floor, additional outriggers engage two more columns on each face, and belt trusses engage corner columns as well. Steel box-core columns and super-columns are filled with concrete to the 62nd floor, and the other engaged columns are filled to the 26th floor to add stiffness. Wind and seismic-uplift effects are mostly offset by concrete-fill weight and by belt trusses redirecting perimeter dead load to these columns. The small remaining net uplift that can occur in wind and seismic conditions is resisted by full-

penetration welded-column splices. For seismic safety, a dual system uses the braced core and outrigger system already mentioned. A perimeter moment frame follows each sloping building face, and core beams are designed and detailed to function as moment frame members.

Highly articulated façade planes, core bracing, outriggers, super columns, and perimeter frames complicated the flow of forces among these disparate elements under gravity and lateral loads. To size members and details for appropriate load distributions and ductilities, Structural Engineer of Record Evergreen performed multiple analyses using SAP90 and DRAIN-2D+. As structural consultant developing framing concepts with Evergreen, Thornton-Tomasetti's parallel analyses used SAP90 and ETABS. Both sets of studies showed local force concentrations related to the large flexural stiffnesses of the super columns. They willingly lean to follow overall building drift, but inter-story drift is less at outrigger floors. This creates local bending and large column shears. It also generates large axial forces in connecting members. The bracing members, column steel and concrete fill were designed to handle these large local forces.

for system ductility. For very tall buildings like Taipei 101, overall building stiffness is crucial to control wind and seismic drifts. Such links could make the framing too "soft." Instead, link regions were strengthened with web doubler plates, and box-out or cover plates across the tips of member flanges, so that CBF braces, not links, control system strength. Brace strength and favorable post-buckling behavior is provided by limiting slenderness per building code and design guidelines.

In a major earthquake with forces large enough to load braces well past elastic limits, the more flexible, but highly ductile, moment frames will act. Moment frames along each face and through the core provide the code-required 25 percent of overall seismic resistance. Shear forces in perimeter frames traverse setbacks with in-floor bracing. Since turning the corner was not necessary, these frames use straightforward "strong way" moment connections. Analysis showed moment frame locations where local conditions concentrated rotational demands. At locations where plastic rotation would exceed 0.005 radian in a 950-year return period earthquake, reduced beam sections ("dogbone" cuts) increase moment connection rotational capabilities. RBS details follow the tapers developed by the National Science Council, Taiwan, Republic of China. For further strength, beam-to-column connections within the braced core system are detailed as moment connections as well. The resulting details are somewhat more elaborate than for axial-only connections, but because the large brace forces require major connections in any case, the additional construction effort was considered reasonable. To mini-



Above and below: At locations where plastic rotation would exceed 0.005 radian in a 950-year return period earthquake, reduced beam sections ("dogbone" cuts) increase moment connection rotational capabilities.



CORE DESIGN AND FRAMING

The core was designed as a concentric braced frame (CBF). To clear architecturally required openings, some work points for adjacent braces were spread apart, creating eccentric links. But the system is not an eccentric braced frame (EBF). A true EBF limits the properties and proportions of link members to ensure link-shear yielding

mize the steel member sizes used, high strength steel with 60 ksi yield strength was specified, even for steel plate thicknesses up to 80 mm (3.15 inches). Ductility in the steel plates and framing members was ensured by specifying the yield ratio, through-thickness characteristics and weldability of this material.

The Taipei 101 building is a distinctive addition to the city's skyline and the exclusive group of the world's tallest buildings. As befits those distinctions, its structural design has addressed the demands of architectural form, typhoon winds and seismic safety through creative steel framing.

Dennis C. K. Poon, P.E. is the managing principal and Leonard M. Joseph, P.E., S.E. is the principal engineer for Taipei 101 at Thornton-Tomasetti Engineers, New York, NY. Ching-Chang Chang, P.E., S.E. is a project manager for Taipei 101 and Shaw-song Shieh, P.E., S.E. is the president of Evergreen Consulting Engineering, Inc., Taipei, Taiwan, Republic of China.

OWNER

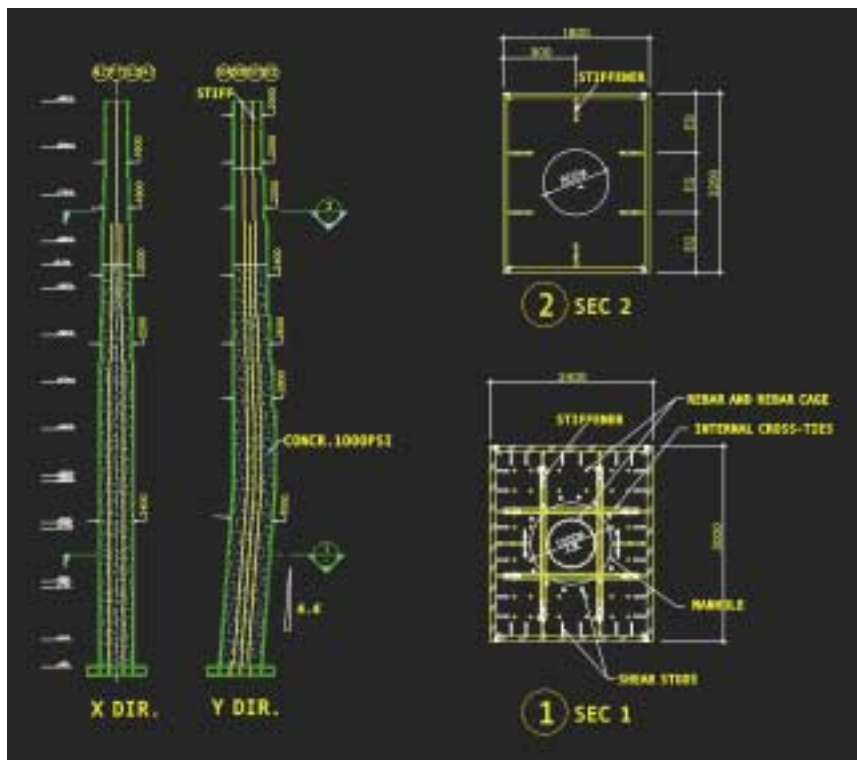
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Section through the super-columns. Section 1 shows the detail at the concrete-filled portion of the columns. Section 2 shows the detail at the unfilled portion of the columns.

NSBA Names New Executive Director

Conn Abnee, former Executive Director of the Geothermal Heat Pump Consortium (GHPC), has been named the new Executive Director of the National Steel Bridge Alliance (NSBA). Beginning December 1, he will be located at NSBA's Chicago headquarters.

An expert in political affairs, marketing and association management, Abnee is also an experienced construction manager for numerous industrial, commercial and electric generating facilities. Prior to joining the GHPC, he was the Marketing and Advertising Manager for the East Kentucky Power Cooperative.

"During the past five years, the NSBA has accomplished many of its technical goals, including the establishment of the AASHTO/NSBA Steel Bridge Collaboration and the growth of the World Steel Bridge Symposium," said John Grzybowski, CEO of PDM

Bridge and Chairman of the NSBA. "Now we need to redouble our marketing efforts to help inform designers, specifiers and owners about the many advantages of steel bridges. Conn Abnee has extensive marketing and association experience and we believe his talents will help us meet these goals."

During Abnee's tenure with the GHPC, geothermal heat pump technology utilization grew 30% annually. In addition, membership dues exceeded \$6 million and lobbying efforts saw

more than 20 members of congress swing support to geothermal heat pumps.

"I am looking forward to an outstanding opportunity to help the steel bridge industry increase their market share and make steel the predominant choice for bridge construction across the country and internationally," Abnee said. "After having the opportunity of meeting the executive council and staff, I look forward to a smooth transition and a dynamic future for the industry."

The National Steel Bridge Alliance, a division of the American Institute of Steel Construction, is a unified industry organization of businesses and agencies interested in the development, promotion and construction of cost-effective steel bridges. For more information on the NSBA, please visit their web site at www.nsbaweb.org.



2003 Modern Steel Construction Detailer Listing

Modern Steel Construction will be publishing a listing of structural steel detailers in its February 2003 issue. To be included in the listing, please go to www.aisc.org/detailerinfo and follow the instructions for the electronic form. Even if you have been included in the listing in previous years, you must fill

out the form every year to ensure we have the most current and accurate information for our readers. The deadline for this information is December 24, 2002. Please e-mail Beth Pollak at pollak@modernsteel.com if you have any questions or concerns.

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Call for Papers: 10th Nordic Steel Conference

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Authors are invited to submit 75-100 word abstracts (in English) of proposed papers for this international conference focusing on the latest innovations in steel construction. Papers are invited on the following topics: modern steel office buildings, future buildings-development, building façades, long span bridges, new bridge materials, energy and the environment, and modern steel production technologies. Complete conference and submittal information is available at www.steelinfo.dk.

FMA Names New President & CEO

The board of directors of the Fabricators & Manufacturers Association, International (FMA), has named Gerald M. Shankel as president and CEO. Shankel began his duties September 30 at FMA's Rockford, IL headquarters, succeeding John Nandzik, who has retired.

Shankel has spent much of his professional career in associations for the manufacturing industry. Most recently he served as executive director of The National Association of Corrosion Engineers (NACE) International. He has also served as associate executive director of finance and administration

for the American Society of Mechanical Engineers (ASME) in New York City. Shankel holds an undergraduate degree in business from Alma College, Alma, MI, and a master's degree in business from the University of Michigan, Ann Arbor.

As president and CEO, Shankel will oversee the educational and membership divisions of FMA, as well as its publishing affiliate, The Croydon Group, Ltd., publisher of The FABRICATOR® and other leading magazines for the metal-forming and fabricating industry.

STEEL NEWS & EVENTS

Get ready for NASCC 2003 in Baltimore!

The 2003 North American Steel Construction Conference (NASCC) is set for April 2-5 in Baltimore, MD—and will feature the newest innovations in structural steel engineering, fabrication, detailing and erection. This once-a-year event is an opportunity for design and construction professionals to learn how to apply the latest technology and techniques to everyday work; to discover new product offerings from leading industry vendors; and to network with peers, customers and future employees.

The conference features presentations by industry experts such as Tom Ferrell (on designing with single-plate connections), Linda Hanagan (on building floor vibrations), Jeffrey Packer (on HSS connections), Michael West (on erection stability issues), Emily Bailey (on managing EEO exposure), Michael Lederle (on cambering), and Janine Reid. See the advance program in this issue of MSC!



The NASCC is also the ideal place to view the tools you use everyday. This year's exhibit hall expects to feature more than 200 booths. Displays will include software (engineering, detailing and fabrication), fabrication equipment, bolts, safety equipment, coatings, and much more.

This year's NASCC features more than 40 technical sessions aimed at practicing structural engineers, fabricators, detailers, and erectors. In addition, the conference features six special events:

- SSRC Stability Tutorial, included with full registration

- Practical Steel Design Tutorial: a 4.5-hour program that provides instruction on basic design from wind and low-seismic conditions; included with full registration.
- Marketing Short Course: a four-hour program that focuses on successful techniques to help increase business, including internal auditing and presentation skills.
- Financial Management Short Course
- Short Course on Correcting/Preventing Common Design & Construction Problems: a four-hour program that focuses on solutions to common problems, and suggestions to prevent the problems from occurring.
- Short Course on Bolting and Welding: a seven-hour program that focuses on both welded connection design and the fundamentals of high-strength bolting.

Join 3,000 of your peers for the steel industry's biggest event! Register online at www.aisc.org.

Miller Introduces Free Online Courses

Miller Electric Mfg. Co. now offers free Basic MIG (wire welding) and Basic Electricity online training courses. Miller's Basic Electricity Online Training Course covers the basics of electricity, electricity generation and safety, and how these considerations relate to welding processes. Users can work at their own pace and return at any time to review information and concepts. Starting with a brief history of MIG welding, the course reviews the process' advantages, specific applications, and unit components and controls. Two series of exercises round out the program, quizzing users on what they've learned.

Interactive exercises and animated diagrams drive home important concepts and make the learning process entertaining. For information on the free Basic MIG and Basic Electricity online training courses, or Miller's other training programs and products, including their line of interactive training CD-ROMs, visit www.miller-welds.com.

Management Series Updated

Now available is a four-volume follow-up to the best-selling *Management Ideas That Work!* series. The set includes all-new insights from industry expert Mark Zweig, in a collection of his best articles from weekly management advisor *The Zweig Letter*. The books provide useful ideas and solutions to challenging problems in A/E firms.

The collection is an excellent resource for firm principals who want to see their firms grow and prosper. The set is available for \$125 at www.zweigwhite.com.

Correction

In the July 2002 issue of *Modern Steel Construction*, the architectural team for the Diamond Ranch High School (2002 I.D.E.A.S. merit award winner) should have been identified as Morphosis (Santa Monica, CA) in joint venture with Thomas Blurock Architects (Costa Mesa, CA). We regret the error. A corrected version of the article is available at www.modernsteel.com.

In Memoriam

William J. Tilley, Jr.

William J. (Bill) Tilley, Jr., former president and CEO of Bristol Steel and Iron Works, Inc. (Bristol, VA) died Thursday, October 3, 2002, at St. Vincent's Private Hospital, Dublin, Ireland. Tilley served on the AISC board of directors from 1963 to 1983. He was chairman of the board from 1980 to 1982.

Thomas M. Fitch

Thomas M. Fitch, a former president of the Central Fabricators Association (CFA) and a former member of AISC's board of directors, died on Sunday, October 20, 2002, in a Chicago area hospital. Fitch served as president of the Kansas City Structural Steel Company (Kansas City, MO), the Rio Grande Steel Company (Albuquerque, NM), and the Darbyshire Steel Company (El Paso, TX). He was CFA president from 1987-1979 and served on AISC's board of directors from 1980-1982.