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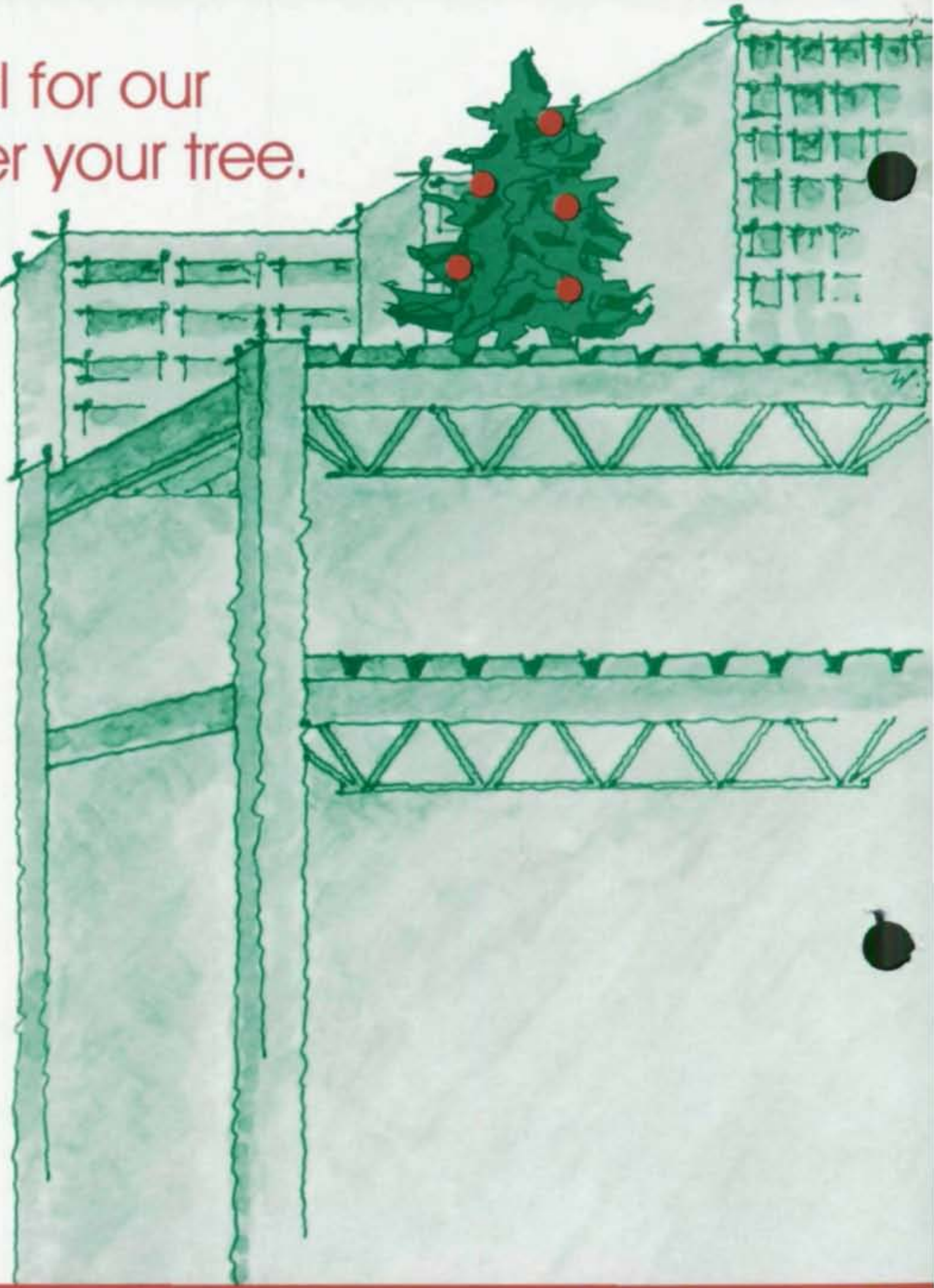

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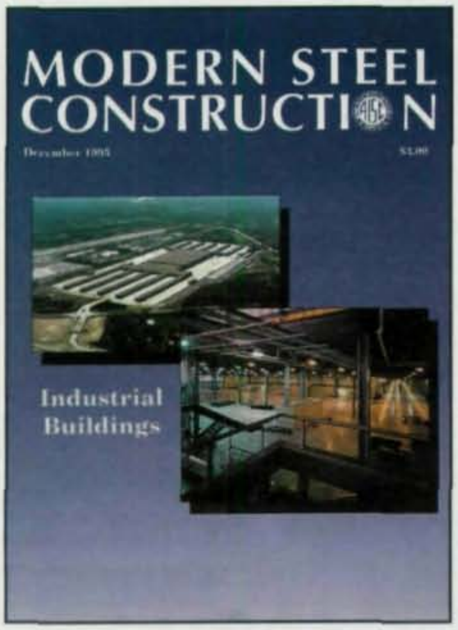
MODERN STEEL CONSTRUCTION

Volume 35, Number 12 December 1995



UPS's new 1.9 million-sq.-ft. sortation facility is just one of two recent industrial facilities constructed for this company. The story behind both of these massive buildings begins on page 26.

FEATURES

DEPARTMENTS

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Observations

A RECENT ISSUE OF THE *CHICAGO TRIBUNE* TALKED ABOUT THE CLOSING OF ONE OF BETHLEHEM STEEL'S structural mills and contained an interesting retrospective on that company's history. It talked about different factors that hurt Bethlehem, such as the downturn in structural activity in the early 1990s. And it concluded with the observation that the biggest problem Bethlehem faced was the growth of the mini-mills. Coincidentally, I had returned from a visit to the largest of these mini-mills—Nucor-Yamato's Blytheville, AR, plant—only a few days earlier. A few observations from that trip:

- "Mini" is definitely a misnomer. The company's two rolling mills occupy two gigantic steel buildings and produce some 1.8 million tons of structural shapes annually. And "mini" doesn't refer to the size of the shapes either; Nucor-Yamato rolls wide flange up to 40-in. deep.
- The company is extremely efficient. Although the mills churn out 1.8 million tons of structural shapes each year, they appear almost devoid of people. Only slightly more than 600 people work in Nucor-Yamato's two Blytheville rolling mills—a prime reason that the company is one of the lowest cost producers of steel.
- Steel is the most recycled material. The mill buildings were surrounded by mounds of scrap, all divided into piles of differing grades. Nucor-Yamato and all the other mini-mills are almost completely dependent on scrap for the production of new structural shapes.
- Steel making has become a progressive industry. NYS1 came on-line in 1988 and NYS2 came on-line in 1993. Both utilize steel from electric arc and ladle metallurgy furnaces. While both are extremely efficient, the difference in automation between the two is dramatic—and the new technology is helping to make steel production more efficient and less expensive. Both rolling mills are continuous beam blank casting mills, another way the company increases production while holding the line on costs. One other example of cutting edge technology: While most company's are only beginning to experiment with Windows 95, Nucor-Yamato has already switched to it as a de facto operating system.
- Finally, cotton is a remarkable plant. The 75-mile drive from Memphis to Blytheville takes you through cotton country, which consists primarily of stick-like plants covered with white, fluffy balls.

If Nucor-Yamato is an example of the future of steel making, then the industry should prosper. The mill is making a tremendous effort to hold down costs while increasing availability—a tremendous boon to fabricators and engineers alike. **SM**

STEEL QUIZ, A NEW MONTHLY FEATURE IN MODERN STEEL CONSTRUCTION, allows you to test your knowledge of steel design and construction.Unless otherwise noted, all answers can be found in the *LRFD Manual of Steel Construction*. To receive a free catalog of AISC publications, circle #10 on the reader service card in the back of this magazine.

1. The increase in bolt tension due to deformation of the connected part is known as what?

2. When a beam web penetration requires reinforcement, the most efficient location for that reinforcement is:
  a) around the entire periphery of the opening
  b) horizontal reinforcement above and below the hole only
  c) vertical reinforcement on both sides of the hole only

3. When a bolt is indicated as ASTM A325T, what does the T indicate?
  a) that the bolt is threaded for the full length of the shank
  b) that the bolt is suitable for high temp. applications
  c) that the bolt has weathering characteristics similar to that of ASTM A588 (weathering) steel
  d) that the bolt is a tension-control or twist-off bolt

4. The purpose of a weld access hole is to:
  a) allow the welder to start and stop the weld beyond the plane of the beam web
  b) minimize restraint to allow for shrinkage in the welded joint
  c) eliminate intersection of welds in orthogonal directions
  d) all of the above

5. Which of the following material specifications would not be appropriate for a hooked anchor rod?
  a) ASTM A572
  b) ASTM A449
  c) ASTM A325
  d) ASTM A687

6. A transversely loaded fillet weld is 50 percent stronger in shear than the same fillet weld loaded longitudinally, True or False?

7. Generally speaking, wide-flange (W) shapes differ from American standard (S) shapes in what way?

8. Paint is not permitted on the faying surfaces of slip-critical connections, True or False?

9. Through-plates are required for single-plate shear connections to tubular columns, True or False?

10. A structural member that resists both axial compression and strong-axis bending is known as what?

Answers on PAGE 13

STEEL INTERCHANGE

Steel Interchange is an open forum for *Modern Steel Construction* readers to exchange useful and practical professional ideas and information on all phases of steel building and bridge construction. Opinions and suggestions are welcome on any subject covered in this magazine. If you have a question or problem that your fellow readers might help you to solve, please forward it to *Modern Steel Construction*. At the same time, feel free to respond to any of the questions that you have read here. Please send them to:

Steel Interchange
Modern Steel Construction
One East Wacker Dr., Suite 3100
Chicago, IL 60601-2001

Answers and/or questions should be typewritten and double-spaced. Submittals that have been prepared by word-processing are appreciated on computer diskette (either as a Wordperfect file or in ASCII format).

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

Information on ordering AISC publications mentioned in this article can be obtained by calling AISC at 800/644-2400.

The following responses from previous Steel Interchange columns have been received:

Given a wall of sheet metal or plate subjected to fluid pressure and stiffened by same size parallel members spaced regularly, what section (or width) of the wall shall be used that contributes to the section of a stiffener? The stiffening member may be a flat bar, an angle, a channel (see figure) or any other section.

The effective width of the plate to be used in computing design properties (i.e. moment of inertia and section modulus, etc.) Of the section may be determined based on the limiting width-thickness ratio for compression elements formula:

$\frac{b}{t} = \frac{95}{\sqrt{F_y}}$, as $b_e = 2b$ and $t = t_2$, $b_e = \frac{190t_2}{\sqrt{F_y}}$

where t_2 = thickness of the plate.

For the channel used as a stiffener, $b_e = t_1 + \frac{190t_2}{\sqrt{F_y}}$,

where t_1 = flange width of the channel section.

It may be noted that be is independent of the value of the thickness of the stiffener.

Another independent reference source, USS Steel Design Manual, 1974, page 86 (Authors: R.L. Brockenbrough and B.G. Johnston), uses the following formula for a similar situation:

$$b = \frac{6000t}{\sqrt{F_y}}$$

where $b = b_e$ = effective width of the plate.

t = plate thickness, in.

F_y = yield strength of the plate steel, psi

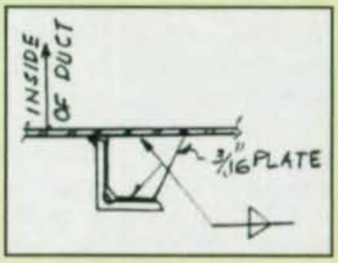
It may be noted that this formula is derived from the same AISC requirements for b/t. When the unit for F_y is changed from psi to ksi, it is noticed that the formula becomes:

$$b = \frac{6000t}{\sqrt{F_y \times 1000}} = \frac{190t}{\sqrt{F_y}}$$

which is the same as given in AISC Allowable Stress Design Table B5.1.

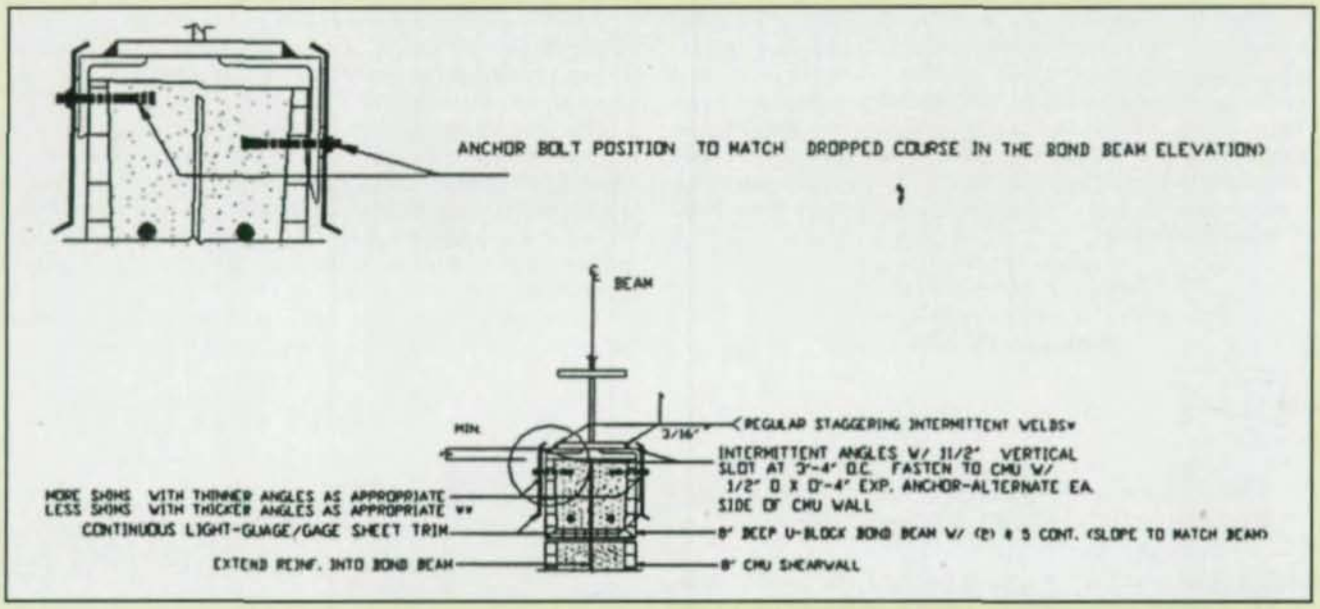
The above formula is widely utilized for the design of duct stiffeners. However, a 4 in. limit for be is conservatively used by design engineers to compensate and account for the two way bending in the plate.

For negative pressure in the duct or wind load acting on the duct surface, stiffener's outstanding leg will become the compression flange. This will require that either the allowable stress be reduced in accordance with AISC provisions or additional lateral support be provided at required spacing not exceeding the calculated L_u for the effective section. The suggested lateral support detail is shown.



L. Sundar
Raytheon Engineers and Constructors
Tampa, FL

Is there a more efficient and cost-effective way to connect a masonry shear wall to structural steel framing? The most common problem with the following detail is that once the masonry is built up to the bottom flange of the beam, there is not enough room to install the grout and continuous reinforcing bars in the bond beam at the top of the wall. If the bond beam is dropped a course in elevation, the masonry to steel beam connecting angle vertical leg or bent plate vertical leg becomes excessively long.



The above detail might be somehow more efficient and cost-effective.

Hu, Fang
Butler Manufacturing Company
Shanghai P.R.C.

Are there special requirements for the design of high-strength A325 or A490 bolts that are going to be used in a high temperature service?

The term "high temperature" requires more definition in order to answer this question. The A325 and A490 bolts are not intended for high-temperature service., however, the A193 specification is specifically for high-temperature service. The allowable stresses will vary with temperature no matter what type of bolting material is selected.

The Manufacturers Standardization Society publishes SP-58 which serves as a guide for high-temperature pipe hanger design. Table A1 lists various bolting materials and allowable stresses at various temperatures.

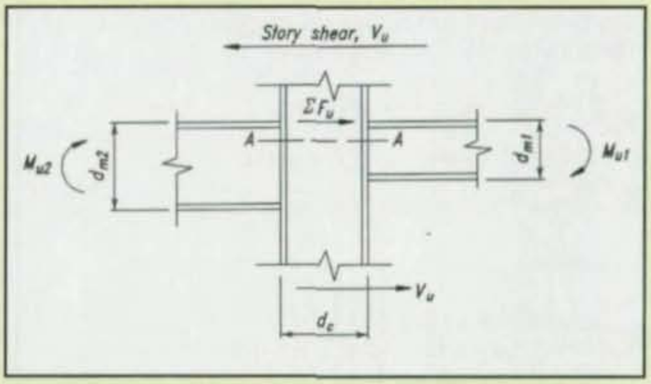
Uncoated bolts designated as A325 or A490 can be used to their full capacity if the service temperature is within the range of -29 degrees C to 325 degrees C. Galvanized bolts should be limited to 120 degrees C to avoid problems with corrosion inhibiting properties. Corrosion inhibiting properties of alloy materials also vary with temperature and corrosive concentration, and should be investigated.

Harold O. Sprague
Black & Veatch
Kansas City, MO

New Questions

Listed below are questions that we would like the readers to answer or discuss.

If you have an answer or suggestion please send it to the Steel Interchange Editor, Modern Steel Construction, One East Wacker Dr., Suite 3100, Chicago, IL 60601-2001. If you have a question or problem that readers might help solve, send these to the Steel Interchange Editor.



In checking panel zone web shear in a column member why is M_1 defined as the sum of the lateral load and gravity load moments on the leeward side of the connection, and M_2 defined as the difference between the lateral load and gravity load moments on the windward side of the connection? It seems to us that the difference of moments apply on the leeward side and that the sum of the moments should apply on the windward side.

Stuart Snyder, P.E.
Snyder Associates
West Chatham, MA

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STEEL QUIZ

The answers to this month's steel quiz are as follows:

1. Prying action. This additional tension can be reduced by selecting a thicker connected part, as necessary.

2. b. For more information on this subject, check out the AISC Design Guide *Steel And Composite Beams With Web Openings*.

3. a. The shank of an ASTM A325T bolt is fully threaded; it may be ordered in lengths up to and including four times the bolt diameter.

4. d.

5. c. ASTM A36, A572, A588, and A687 are available for use as unheaded rod material, ASTM A354 and A449 are available as headed bolt or unheaded rod material, and ASTM A307, A325, and A490 are available as headed bolt material only. Therefore, specification of a hooked anchor rod as ASTM A307, A325, or A490 would imply that a head is required. Note that the strength equivalent of these grades is available in unheaded rod material as ASTM A36, A449, and A354, respectively.

6. True. 1993 LRFD Specification Appendix J2.4 recognizes the increase in strength of fillet welds in shear due to load angle.

7. The flange surfaces on W-shapes are parallel, while the inner flange surfaces on S-shapes are at an approximate 2:12 slope.

8. Trick question. The answer is both true and false. True because unqualified paint is not permitted on the faying surfaces of slip-critical connections. False because paint systems that offer a Class A or B slip coefficient and have been qualified by RCSC Specification Appendix A are permitted on the faying surfaces of slip-critical connections.

9. False. A paper ("The Design of Shear Tabs with Tubular Columns") in the *Proceedings of the 1991 AISC National Steel Construction Conference* by Sherman and Ales presented research that showed a single-plate shear connection welded directly to the face of the tube wall is acceptable as long as the punching shear check outlined in that paper is satisfied.

10. A beam-column.Columns in moment frames and floor beams in braced frames commonly fall into this category of structural member.

UPDATE: WIDE FLANGE SHIPPING TIMES IMPROVE

LEAD TIMES FOR SHIPMENTS OF WIDE FLANGE are still running longer than the historical average, but the condition is fast improving.

The shipment slowdown began earlier this year when a confluence of events—primarily Bethlehem Steel's decision to eliminate production on many larger sections combined with a gradual increase in demand for structural shapes—created a scheduling problem for mills and their customers. This scheduling headache was then exacerbated when fabricators, reacting to a perceived potential shortage, began places orders even before they received any commitments on projects. In addition, some supply centers began stockpiling popular shapes, reportedly hoping that a shortage would drive up prices. The problem became so bad that over the summer there were rumours that some builders were concerned enough that they switched their projects from steel to concrete.

Fortunately, by the end of the summer most of the steel mills had taken action to correct the situation. Chaparral, for example, added additional shifts and began using 30% of its rolling capacity to build inventory. In addition, the company has increased wide flange beam production for the North American market by 35% from a year ago. Likewise, Nucor-Yamato Steel Co., which many fabricators were depending on to pick up the slack left by Bethlehem's departure from the heavy shape market, began adding capacity. Also, Northwestern Steel and Wire Co. has increased production by adding a fourth crew to its 48-in.

mill Houston, adding additonal shifts to its 24-in. mill in Sterling, IL, and made capitol expdenditures, all of which will add 80,000 tons annually to the company's production. In addition, despite a strong market in Europe, British Steel and TradeARBED increased their availability of jumbo column sections in the U.S. British Steel is offering a full range of jumbo column sections (426-730), with most sizes supplied from continuous cast feed-stock, which provides a cleaner, defect-free product. And TradeARBED is helping to alleviate the problem by limiting shipments to non-traditional markets to improve delivery to fabricators in the U.S.

A recent mill survey suggests that while the problem has not been completely solved, the situation has improved substantially and the industry will be back to normal shipping times in the first quarter of 1996. By October, Nucor-Yamato was generally on time with its large section mill (24-in. and deeper sections), with lead times dropping from 12 weeks in July to eight weeks in October. However, Nucor-Yamato's medium/small section mill was still running behind, with 12 week lead times continuing into December.

Bethlehem Steel's final rollings for "heavy" wide flange shapes was completed in October. Smaller wide flange sections (W4-24 x 55/62) have lead times of 10 to 12 weeks, due primarily to an outage on the company's Combination (44-in.) mill for maintenance and modernization beginning in mid-November. Foreign producers, however, already have slightly shorter lead times. TradeARBED's lead times range from two to six weeks for most shapes (for example, W14x145-730 shapes are rolling at least bi-weekly, with special priority being given to W14x426-730), though some of the less frequently ordered shapes require up to eight weeks.

National Steel Construction Conference To Expand In 1996

SIX TRACKS WILL BE OFFERED AT NEXT YEAR'S NATIONAL STEEL CONSTRUCTION CONFERENCE. New in 1996 will be sessions on computers and erection. In addition, specialized tracks will be offered on: engineering—technical; engineering—management; fabrication; and construction management.

"There was a lot of enthusiasm generated last year when we first introduced specialized tracks," explained Franklin B. Davis, chairman of AISC's NSCC Committee. "The two new tracks are designed to continue and expand on that excitement.

"There has long been a feeling in the engineering consulting community that the erection of steel buildings has not received as much attention as it should. Adding a track on erection should help bring some key issues to the forefront. And adding a computer track is a natural for the show, given its wide attendance from all segments of the steel industry. The advances being made in software have been tremendous during the past few years. The NSCC is an ideal forum where the user and the producer can get together to interface for the benefit of all parties," Davis concluded.

March 27-29 In Phoenix

The 1996 Conference will be held in Phoenix on March 27-29. Hot seminar topics include:

- "Selection of Bolted Joint Criteria" with Robert O. Disque, a former long-time AISC engineer and currently a consulting engineer with Besier Gibble Norden in Old Saybrook, CT, and Michael A. Gilmor of CISC and current chairman of the Research Council on Structural Connections;
- "Industrial Building Design" with Jules Van de Pas of Computerized Structural Design in Milwaukee, Duane Ellifrit of University of Florida, and Bob MacCrimman of Acres International, Niagara Falls, Ontario
- "Bar Coding—Fabrication Shop Connections" with Richard Bushnell of Quad II, Shalfont, PA
- Computer Program Usage (MathCAD and Beyond)
- Problem Connections
- "Architectural Fabrication: What is Involved" with David Sailing of Zalk Josephs, Stoughton, WI, and Jim McCrae of Nieder Hauser, Salt Lake City
- "How to evaluate Detailing Software"
- "Steel Erection Awareness"

In addition to more than 30 technical sessions, there will be an exhibit hall with nearly 70 product exhibitors. The sessions qualify for CEU credit and time also is available for extensive industry networking. Also, an extensive package spouse/family activities are scheduled.

As an added benefit, AISC will offer a Short Course on Bolting on Saturday, March 30, 1996. The course is separate from the National Steel Construction Conference and requires a separate registration.

To receive an information and registration packet, please call 800/787-0052 ext. 110.

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NATIONAL STEEL BRIDGE ALLIANCE APPOINTS DIRECTOR

ARUN M. SHIROLE, P.E., FORMER DIVISION DIRECTOR AND DEPUTY CHIEF ENGINEER FOR THE STATE OF NEW YORK, has been named director of the National Steel Bridge Alliance. The mission of the newly formed NSBA, a division of AISC, is to increase steel's bridge market share through marketing, technology, education and legislative action supported by a strong regional and national organization. Membership in the NSBA includes steel fabricators and plate producers. Also involved are representatives from AASHTO, FHWA, and state DOTs, as well as bridge consultants, erectors and people representing the paint, fastener and welding industries.

"We feel fortunate to have [Arun Shirole] on board with the National Steel Bridge Alliance," stated Robert P. Stupp, NSBA chairman. "He's got a fine educational background, he's been very involved in DOT affairs which, coupled with his FHWA involvement, leads us to believe he can be a fast starter in the affairs of the NSBA. He's also very well known for his papers and publications, presentations and committee work."

While with the NYSDOT, Shirole directed and supervised management of a network of bridge structures with a more than $600 million annual capital budget.His responsibilities included setting design and construction policies and development and implementation of cost effective management. Shirole is well known within the bridge community and has participated in many symposia and panels, including for the Transportation Research Board, American Association of State Highway and Transportation Officials, Federal Highway Administration, ASCE and the American Public Works Association.

Arun M. Shirole, P.E.,(pictured on the right) the new director of the National Steel Bridge Alliance, meets in Chicago with Robert P. Stupp, NSBA chairman and president of Stupp Bros., Inc., a steel fabricator headquartered in St. Louis.

Prior to his tenure with NYSDOT, Shirole was employed by the Minneapolis Department of Public Works. In addition to a master's degree in civil engineering from the South Dakota School of Mines and Technology, Shirole has an MBA from the University of Minnesota and has participated in Harvard's Program for Senior Executives in State and Local Governments.

The heart of the NSBA is a strong network of regional steel fabricator associations. Currently, four regional organizations, closely aligned with the AASHTO regions, are organized and are recruiting new fabricator members. These groups are expected to be involved in educating their members in cost effective steel design, specifications, marketing and promotional activities. They also will be active in transferring the technology and innovative programs developed by the NSBA into specific projects.

NATIONAL STEEL BRIDGE-BUILDING COMPETITION HEADS TO BUFFALO

THE NATIONAL STEEL BRIDGE-BUILDING COMPETITION will be held May 24-25, 1996, at the State University of New York-Buffalo. The competition features teams of students from universities around the country who design, fabricate and erect a scale model bridge.

Winners of the more than 30 regional competitions scheduled for 1996 are invited to compete in the national competition.

For more information, contact Fromy Rosenberg at 312/670-5408.

ADAPTIVE REUSE ADDS TECHNICAL CENTER

Rather than construct a new building, a Maine paper mill opted to renovate part of an existing mill

Some of the paper mill's existing trusses were in very bad shape.

BY BRUCE A. WARD, P.E., AND PAUL D. NOEL, P.E.

TO HELP INCREASE ITS MARKET SHARE, Otis Specialty Paper Co., Inc., a paper producer in Chislholm, ME, decided to construct a new technical center. The center would be used to check paper quality, develop improvements in paper grades and develop new paper grades. However, rather than build an entirely new structure, the company opted to locate the enclosed office and laboratory space in an existing mill building.

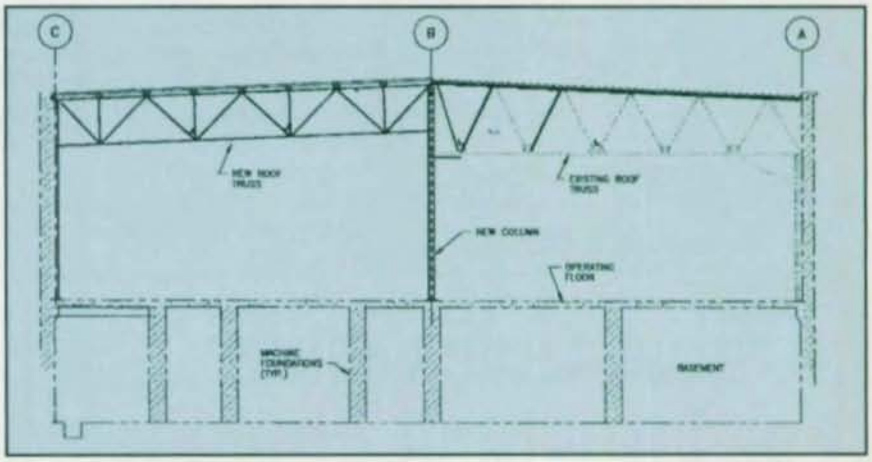
The company's original mill buildings were built between the late 1890s and early 1900s to house paper machines and pulp digesters. The mill consisted of five paper machine buildings and ancillary buildings. The paper machine buildings were 93-ft. wide by 145-ft. long, with the long direction along the east-west building axis, and consisted of two levels. The upper level was the paper machine hall, approximately 26 ft. from the operating floor to the underside of the roof. The lower level basement, approximately 14 ft. from slab-on-grade to the finished operating floor level, was used for support equipment servicing the paper machine.

The paper machine buildings included steel roof trusses, spaced 8-ft. on center and spanning approximately 93 ft. Brick masonry bearing walls supported the trusses and were in turn supported on granite foundation walls. The operating floors were steel frame supported concrete slabs. The roof was a reinforced concrete roof slab with a built-up roof system. The buildings were constructed side by side, sharing the brick masonry walls for truss support and operating floor exterior support.

Two paper machines were installed per building. The paper machines and operating floors were supported at the operating floor level by machine foundations, constructed of brick masonry pillars and arches. The pillars were supported on granite foundation blocks below the basement slab-on-grade. The granite blocks were supported on dense gravel.

The area selected for the new technical center was in one machine hall. The north half of the area had been used for a color kitchen and the south half had been used for miscellaneous storage. The center was located in the storage area. At the west end of the storage area were five abandoned stock tanks, constructed of steel plate. The tanks extended from the basement floor through the operating floor to the underside of 12 steel roof trusses.

The trusses above the tanks had been enclosed to form a room. The room was composed of a concrete slab supported from the bottom chords of the trusses and light framed infill walls. The room covered approximately one quarter of the trusses, extending from the south wall to the building center line and from the west wall approximately 70 ft. toward the east wall.



The renovation included built-in-place trusses spanning from the south wall to the support columns. The transfer truss supported the intermediate north truss ends, and joists spanned between the new north/south trusses.

Existing Conditions

The trusses on the north half of the building were in good condition. The trusses had been constructed of A9 steel and had been painted periodically over the life of the structure. The original paper machines had been removed decades ago, removing the moisture and heat sources that could cause corrosion.

Unfortunately, the trusses in the south half of the building were in poor condition. The trusses enclosed in the room above the stock tanks had deteriorated badly. Vertical and inclined web members had corroded to the extent that they were no longer attached to gusset plates. The top chord and web members were razor thin and had buckled laterally at several locations. The trusses had sagged and the concrete slab was supported by the tops of the steel stock tanks.

Corrosion in the top chords of the south ends of five trusses, to the east of the room, was discovered as part of the project field inspection. The corrosion was severe enough to require repair or replacement of the south half of these trusses.

The concrete roof deck over the building was sagging between trusses. The concrete and reinforcing steel had been eroded by moisture and corrosion, causing the slab to settle between supports.

Structural Design

The new technical center, approximately 75-ft. by 40-ft., was to be located in the southwest corner of the paper machine building, in the area occupied by the stock tanks and under the corroded trusses. To provide space for the new facility, the stock tanks would have to be removed, leaving 12 roof trusses unsupported and a large hole in the floor. To ensure that the roof was safe, the remaining 5 corroded truss halves were to be repaired or replaced and the roof deck for the entire building was to be replaced. The floor area where the stock tanks were located had to be infilled to provide a floor for the new center.

Mohlin & Company was retained by Otis Specialty Papers to design a floor infill and to design a repair for the existing roof system. The new center was to be designed by a separate consultant. Mohlin & Company worked with the onsite contractor, Sullivan & Merritt, to develop preliminary pricing and evaluate design alternatives.

Since the machine room space had been modified from its original use, the open span of 93 ft. was no longer required. Therefore, a limited number of columns could be installed along the east-west centerline of the building to support the roof structure, reducing the truss spans. The column locations had to be coordinated with the tech center walls. During construction the color kitchen had to remain operating; thus, no columns were allowed in the north half of the building.

The site was very constrained, limiting material delivery. The building was an interior building surrounded by other buildings in all directions. Hence, crane access from the building exterior was not possible. Interior crane access was also limited to a small, light, rubber tired, propane driven hoist. Long, wide and heavy pre-fabricated units could not be carried through adjacent buildings to the construction area due to the indirect travel routes available.

The design of the project was divided into three areas; the roof system, bearing wall supports, and the floor infill for the stock tanks.

Roof Design

Three alternatives for the roof were developed. The first was to rebuild the south half of the trusses in place, maintaining the center to center truss spacing of 8 ft. The north half of the truss would be shored up and the south half would be demolished. The south half of the trusses would be constructed in place. This alternative was rejected because of high labor costs, extensive shoring requirements that would limit access to the color kitchen, and the difficult connection between the new and old truss halves at the truss center line, the point of highest chord forces.

The second alternative consisted of joist girders running north-south, spaced at approximately 24-ft. on center.

Columns would be installed at 24-ft. on center, matching the girder spacing, along the east-west building center line. The columns would be supported on the old paper machine foundation and would support the north ends of the girders and the south ends of every third remaining half truss . Spanning east-west between the columns, a transfer truss was proposed, supporting the two intermediate north truss halves, allowing removal of the south truss halves. Steel bar joists were proposed to span between the joist girders.

The advantage to this alternative was the light construction, the use of pre-fabrication pieces, and the east/west transfer truss that could be erected to support the south end of the north truss halves prior to demolishing the south truss halves, reducing the staging requirements. The disadvantage of this alternative was the inability to move the joist girders into the building. No access route had sufficient width. (A route for the smaller bar joists was available.) As a result, this alternatve was rejected.

The third alternative was a combination of alternatives one and two. The joist girders were replaced with built-in-place trusses spanning from the south wall to the support columns. The transfer truss supported the intermediate north truss ends, and joists spanned between the new north/south trusses. This alternative was selected for final design.

Since Sullivan & Merritt had to build the trusses in place and preferred to field weld the connections, the design of the new north/south trusses had to simplify the panel point connection and limit the amount of miscellaneous material to make field fabrication easy.

Mohlin & Company modeled the new trusses on a computer program to optimize member sizes and locations. A comparison of 50 ksi yield steel and 36 ksi yield steel was done and the results indicated that a 5-ft.-6-in.-deep modified Warren Truss, designed with 50 ksi yield steel, was the most economical truss type.

The member shapes were selected based on the building environment. The environment was conducive to corrosion because of the humidity from the color kitchen. Consequently, back to back double angles were not used because of the difficulty in maintaining and painting the angles. WT sections were used for all members.

The detailing of the connections had to consider the orientation of the WT web members. To reduce the geometric eccentricities, the WT webs had to be vertical, requiring the coping of one side of the WT flanges. This

allowed the WT webs to be welded together to form the panel point joints without designing for a large second order moment

The final member sizes were governed by the panel point weld length. The weld lengths were designed to resist the web forces at the panel points. Consequently, the depths of the WTs were increased. This resulted in a design that did not require gusset plates or bolting and made field erection easy. WT4s were used for all web members of the truss, WT8s were used for the top chord, and WT7s were used for the bottom chords.

The transfer truss was designed using similiar details. A 7-ft.-10-in.-deep modified Warren Truss with WT sections using 50 ksi yield steel also was found to be the most economical truss type. The transfer truss fit within the top and bottom chords of the north half of the existing truss and the panel point locations for the new truss were set by the locations of the existing trusses.

The web member at the existing truss center was moved and the top chord reinforced to bear on the new transfer truss. The bottom chord of the existing truss was connected to the bottom chord of the new transfer truss. Stability of the bottom chord connection was provided by a horizontal truss at the bottom chord elevation spanning between column lines.

The north half of the existing truss was analyzed using a computer model. The results indicated that the existing truss support at the new columns and the transfer truss overloaded the web member adjacent to the support point. The existing angle member was replaced with a stronger WT member.

Truss Bearing

The second area to be designed was the truss bearing on the brick masonry walls. The walls had deteriorated and the new trusses were spaced further apart than the existing trusses, resulting in larger end reactions.

The brick masonry walls were three wythes thick, but the mortar was crumbling and the bricks could be pulled from the wall. Mohlin & Company analyzed the wall and determined that the wall could not be used to support the trusses with the higer end reactions. New columns were designed to support the truss ends and frame to the concrete floor. New steel was designed to transfer the column loads to existing steel beams, bearing on sound brick masonry walls.

New Floor Infill

The third area to be designed was the floor infill where the stock tanks were removed. The floor live load used for design was 100 psf. Due to deflection sensitive laboratory equipment, a deflection criteria of L/480 was used. Two alternatives were evaluated, composite steel and concrete design and non-composite steel and concrete design. The evaluation included a comparison of 36ksi yield steel and 50 ksi yield steel. The composite design with the 36ksi yield steel was selected to minimize the number and weight of the steel members. The 36 ksi steel was used because deflection control goverened the steel design. A three inch deep metal deck was used to maximize beam spacing.

Roof Construction

The roof construction was started in the summer of 1994. The raw steel was supplied by American Steel and Aluminum Co. and the joists were supplied by AISC-member Canam Steel. Sullivan and Merritt began by removing the roof over the south half of the building. The columns were installed at the new truss locations and the south half of the trusses were removed. The columns supported the north half of the existing truss. The new trusses were built, using high lines from each building corner to lift steel pieces into place and custom made jigs supported off the adjacent existing trusses. The transfer truss was constructed and the south half of the remaining trusses were removed. The joists were installed and the remainder of the existing roof deck was removed. The new roof deck and roof was installed.

The structural work was completed in the fall of 1994. The tech center was then constructed and dedicated in June, 1995.

Bruce A Ward, P.E. is chief engineer and Paul D. Noel, P.E., is a project engineer for Mohlin & Company. Mohlin & Company provides consulting engineering services to the pulp and paper industry.

GIANT CONSOLIDATION

UPS's new 1.9 million sq. ft. facility near Chicago is the company's major sortation facility for east-west traffic

The 1.9-million-sq.-ft. Chicago Area Consolidation Hub houses UPS's major east-west sortation facility.

By Michael A. West, P.E.

(Computerized Structural Design recently completed two projects for United Parcel Service. Featured below is a consolidation/distribution facility near Chicago; the second story is about new air hub in Rockford, IL.)

UNLIKE HIGH-RISE BUILDINGS, WIND PROVISIONS DO NOT NORMALLY DOMINATE the design of low-rise buildings, but when UPS required a minimum 52-ft. clear height, lateral bracing became an important issue for company's new Chicago Area Consolidation Hub (CACH) in Hodgkins, IL. Built along the Interstate Highway 294 and adjacent to a major rail yard, the building houses a sortation facility that will be the principal hub for all of UPS's east-west traffic. To help accommodate all of the expected traffic, a new exit and entrance interchange was added to the interstate.

The facility, which houses sorting and conveying equipment and support activities, encloses 1.9 million sq. ft., primarily on a single level. The building's footprint is 3,225-ft. by 1,170-ft. The facility consists of three functional areas: inbound (primary), connectors and outbound. The inbound (primary) is a rectangular building measuring 600-ft. by 1,170-ft.. It was sub-divided by one longitudinal expansion joint and two transverse expansion joints. In addition to the main level, there is a 494-ft. by 728-ft. mezzanine, divided into four sections by two of the expansion joints, one longitudinal and one transverse.

Two connector buildings tie the inbound (primary) area to

neering staff prior to contracting with Computerized Structural Design for the structural engineering and McClier Corp. for the architectural design as preliminary design consultants.

Two primary framing sources were considered: pre-engineered metal building frames/components and conventional fabricated steel columns with steel joists and joist girders. For the roofing, metal standing seam and ballasted EDPM membrane were evaluated. Finally, four wall types were considered, both individually and in combination: sheet metal siding, concrete masonry, precast concrete wall panels and cast-in-place concrete walls.

For both the inbound (primary) structure and the connector buildings, ballasted EDPM membrane was chosen for the roofing, precast concrete panels with sheet metal panels above were used for the walls, and conventional steel framing with fabricated columns and steel joists, joist girders and metal deck was used for structural system. The outbound (fingers) structure also use ballasted EDPM membrane for the roof, but use load bearing precast panels for the walls and clear span joists supporting steel deck for the framing.

Both the inbound (primary) and connector buildings are rigid frame/braced frame structures. The precast concrete panels are supported from the structure at their tops. These panels bear directly on the footings, producing a semi-fixed base, since they are buried for their first 30-40 in. The anticipated frame drifts were provided in the specification so that the forces induced by frame drift could be accounted for in the panel design.

The outbound structures were braced in the transverse direction by cantilevering the precast panels from the foundation. In the longitudinal direction, the panels were used as shear walls.

The final decisions on the structural systems were based on: cost; a preference for internal roof drains; a desire for flatter roof pitch, which reduced building volume and eave height; and a need for integrating the frame with the exterior masonry.

Perimeter columns in the primary section typically were W24x176 sections, while first interior columns were W14x283 sections, with the TS12x12 tubes used for the remainder columns. The roof consists of galvanized 1-1/2-in.-wide rib steel deck supported on steel joists (30k) spaced at 5-ft. on center and spanning 36-ft. Joist girders (60G) were spaced at 36 ft. and span 58-ft.

Lateral stability is achieved by rigid frames in both directions. Double connection angle type as well as single plate connections were used. The rigid frame connections between the joist girders and columns were made using field welded tie plates. In these locations, the joist girders bear on seat connections attached to the face of the column flange.

The mezzanine section is a concrete slab on galvanized steel form deck. The mezzanine is supported on steel joists (36LH) spaced at 5 ft. and spanning 36 ft. and W24x55 beams spaced at 36 ft. and spanning 29 ft. continuous over intermediate W12x50 wide flange columns between the main columns.

The roof of the connector buildings consists of galvanized $1^{1}/_{2}$-in., wide rib steel deck supported on steel joists (22k) spaced at 5.3-ft. and spanning 36 ft., as well as joist girders (84G) spaced at 36 ft. and spanning 75 ft. Lateral stability is achieved by rigid frames in the joist girder direction and X-braced frames in the perpendicular direction.

The outbound structures roof is galvanized $1^{1}/_{2}$-in.-wide rib steel deck supported on steel joists (30k) spaced at 6 ft. and spanning 60 ft.

Michael A. West, P.E., is a vice president with Computerized Structural Design, Inc., a Milwaukee-based consulting engineering firm.

EXPANDED DELIVERY

Steel helped deliver a new 530,000-sq.-ft. air hub for UPS in only 263 days

By Michael A. West, P.E.

ACCORDING TO AN ANCIENT ROMAN SAYING, "Well done is quickly done." It could just as well be the philosophy of the team responsible for the design and construction of United Parcel Service's new 530,000-sq.-ft. UPS Rockford (IL) Air Hub. The building had to be up and running in time for the peak shipping season in December. Fortunately, though difficult, the schedule could be met: Only 263 days elapsed between the signing of the purchase order for the initial structural design and the ribbing-cutting ceremony on October 17, 1994. The project features precast concrete perimeter walls with steel interior columns and a steel-framed roof structure. Steel, of course, was the logical choice for the project, both because of its speed of erection and its flexibility in column layout.

While the process was jumpstarted by UPS, which had prepared an initial process layout that located the building's columns, that initial concept quickly evolved into a more efficient design. One of Computerized Structural Designs first recommendations was to eliminate some of those columns to increase the amount of repetition in the framing.

BUILDING LAYOUT

The 1,010-ft. x 527-ft. structure primarily consists of two basic bay sizes: 24-ft. by 48-ft. and 72-ft. by 48-ft. The 48-ft. dimension is spanned by joists (28K) spaced at 4.5 or 4.8 ft. on center depending on the transverse span. The joist girders

To accommodate the expected Christmas package rush, UPS's air hub in Rockford, IL was built in just 263 days The structure primarily consists of steel columns, beams and joists.

span 24 ft. (36G) and 72 ft. (72G).

While most of the building is operations space, there is an office mezzanine on the south side of the facility. This area was framed with joists and beams. At the roof, the joists (22K) span parallel to the rigid frame beams (W27x84) and are supported, as well, by beams (W18x40). At the mezzanine, the joists (18K) span between the rigid frame beams (W27x84).

The basic east-west grid is a repeating pattern of alternating bays measuring 72-ft. and 24-ft. Lateral bracing in the east-west direction was provided by rigid frames in the 24-ft. bays. The roof member in the 24-ft. bay is a pin-ended joist girder. The rigid frame is created with an end-plated wide flange beam located to align with the bottom chord of the deeper joint girder in the adjacent 72-ft. bays. This arrangement shortened the effective height of the rigid frame column and simplified the connections of both the joist girder and the wide flange beams, without limiting the 30-ft. clear height in the building, a crucial requirement given the structure's function. A572 Gr. 50 steel was used for the majority of the structure, with A36 used for some detail material, angles and small wide flange sections.

The basic north-south module is 48-ft. with some variation to account for process layout. In this direction, the lateral load resistance was achieved using fabricated steel rigid frames at the north end, where an 80-ft.-wide mezzanine ran for 864-ft. in the mezzanine, both the beam of the floor and the beam at the roof were moment connected to the columns. The beam was end-plated at the roof, while top and bottom moment plates were shop welded to the column and field bolted to the beam at the floor. A bolted single plate shear connection was used at the floor beam. The lateral force was transferred to these frames by roof joist struts. The tie plates for truss struts were the only loose detail material in the structural frame.

Concrete spread footings were used for the foundations. The steel columns were set on pre-grouted steel setting plates. The exterior walls were precast concrete, which were field welded to the perimeter of the roof structure for top lateral support. A perimeter channel was provided to allow down-hand welding of the connection plate with the steel roof deck fully installed. The base of the precast wall rested directly on the perimeter footing, eliminating the need for a foundation wall.

Three column sections were used in the building: A572 Gr. 50 W12x65 columns supporting the roof only (in east-west rigid frames); A572 Gr. 50 W12x87 columns supporting roof and mezzanine (in north-south rigid frames); and A36 W12x65 pin ended columns supporting the roof only.

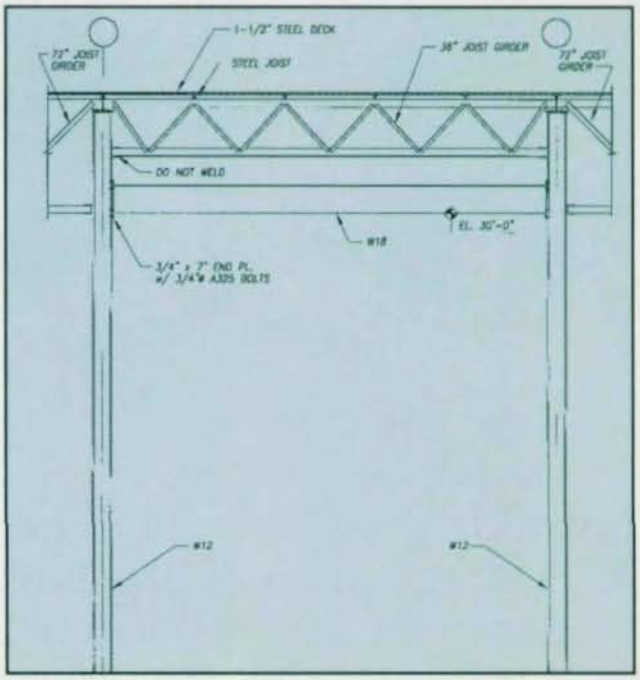
Every aspect of the structural design was done in a way to promote repetition and simplicity in the detailing, to ease erection, and to minimize field detail work and field welding.

Examples include:

- loose material was limited to joist tie plates
- Use of end-plate moment connections
- Use of Field bolted, shop welded moment connections in the flange plates
- Single-plate shear connections were utilized
- Use of pin-ended A36 steel above the wind flange strut members
- Use of grouted setting plates
- The number of different column sizes were minimized

The steel framework was designed and bid in advance of the remainder of the building. This was facilitated by the repetitious layout of the framing, but also by the fact that UPS assembled the same design and construction team that had worked together on the UPS Chicago Area Consolidation Hub in Hodgkins, IL (see accompanying story). Lastly, UPS recognized that in a fast-track process, it is inevitable that field revisions will be required. In fact, the field rework was limited to the removal of one footing that had to be placed deeper to accommodate an added dropped loading dock and ramp. Steel erector on the project was Area Erectors, Inc., architect was McClier Corp., and general contractor was Power Contracting and Engineering, Inc.

In spite of the schedule pressures, there was no deviation from UPS's high quality control standards. This was facilitated by the simplicity in the design and the selection of contractors who knew what was expected and how to accomplish it. At all times, all parties worked together to resolve the inevitable field problems so that there was no delay in the work.



The roof member in the 24-ft. bay is a pin-ended joist girder. The rigid frame is created with an end-plated wide flange beam located to align with the bottom chord of the deeper joint girder in the adjacent 72-ft. bays. This arrangement shortened the effective height of the rigid frame column and simplified the connections of both the joist girder and the wide flange beams, without limiting the 30-ft. clear height in the building, a crucial requirement given the structure's function.

Michael A. West, P.E., is a vice president with Computerized Structural Design, Inc., a Milwaukee-based consulting engineering firm.

QUALITY CERTIFICATION

By Stephen E. Egger

EGGER STEEL COMPANY HAS BEEN A CERTIFIED FABRICATOR SINCE 1977—just one year after the program began. Traditionally, the certification program has included a three-year audit cycle, with a very inclusive audit in the first year and reviews of weak areas in the second and third years. In 1995, not only were we scheduled for the intensive first-year audit, but we also were scheduled to be one of the first companies audited after major changes were made in the AISC Certification program. Despite some initial trepidation about how these changes would affect my company, I actually found this year's audit the most meaningful inspection in which we have ever participated.

The most dramatic change in the certification program was the hiring of a new auditing company, the Quality Auditing Company (QAC) of Bristol, VA. The auditors are all experienced in structural fabrication and have received additional training from AISC. A majority are AWS Certified Weld Inspectors. As in the past, fabricators are audited in the areas of general management, engineering & drafting, procurement, operations, and quality control. However, this year AISC has adopted a simplified, yet more comprehensive, quality checklist. In addition, rather than relying on records and interviews as was done in the past, the program now emphasizes examining actual work in both the shop and the drafting room—a process that will be continued in the second- and third-year audits. But most importantly, the use of auditors who are actually familiar with the structural steel industry has definitely improved communications between the auditors and shop personnel.

Another major change involved revising the certification categories. Previously, fabricators could be certified in one of three categories: Conventional Steel Structures (which included simple bridges); Complex Steel Building Structures; and Major Steel Bridges. However, recognizing that bridge fabrication often has different requirements than building fabrication, AISC has created a Simple Steel Bridge category. Uncoupling these categories allows the program to emphasize issues important in each market, such as weld procedure qualifications and traceability of material in the bridge business, without burdening fabricators in the other market with issues that are not common in their work.

Tom Schlafly, AISC's Director of Fabricating Operations and Standards, stresses that: "The categories of certification are intended to coincide with the market the fabricator is capable of participating in. The different categories are not intended to designate a ranking of quality levels, but rather they designate appropriate quality systems for given types of structure." The four categories are: Conventional Steel Building Structures; Simple Steel Bridge Structures; Complex Steel Building Structures; and Major Steel Bridges. If you're certified for Complex Steel Buildings, you're automatically certified for Conventional Steel Buildings; likewise, if you're certified for Major Steel Bridges, you're automatically certified for Simple Steel Bridges. In addition to the four certification categories, the program includes two endorsements: Fracture Critical and Painting.

Over the years, certification has proven to be very important to Egger Steel. As a bridge fabricator, we have seen a steady increase in the number of states requiring certified fabricators. Today, only a handful don't have this requirement. During the 18 years that we have been certified, our quality control department has grown in size from one part-time person to a three-person department consisting of a QC Manager and two inspectors. We have always prided ourselves on producing a quality product and AISC's Quality Certification Program has definitely helped us achieve this goal.

Stephen E. Egger is president of Egger Steel Company.

Certification Categories

- **Conventional Steel Buildings (CnBg):** Includes 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):** Includes highway sign structures, parts for bridges (such as cross frames), unspliced rolled beam bridges.

- **Complex Steel Buildings (CxBg):** Includes large public service and institutional buildings, heavy manufacturing plants, powerhouses, metal producing/rolling buildings, crane girders, bunkers and bins, stadia, auditoriums, high-rise buildings, pertro/chem processing.

- **Major Steel Bridges (MBr):** All bridge structures other than unspliced rolled beam bridges.

- **Metal Building Systems (MB):** Pre-engineered (supplier supplied) metal building systems including cold-formed members and panels.

Fabricators certified for Complex Steel Buildings are automatically certified for Conventional Steel Buildings and those certified for Complex Steel Bridges are automatically certified for Simple Steel Bridges.

AISC Quality Certified Fabricators

Type	Company Name	Location		Contact	Phone #
CxBg	A. Spadafora Iron Works, Inc.	Everett	MA	Frank Spadafora	(617) 387-4020
CxBg	Able Iron Works, Inc.	Charleston	SC	George Bigbee	(803) 571-2253
CxBg P	Acme Structural, Inc.	Springfield	MO	Hugh Wiley	(417) 865-6691
CxBg	Addison Steel, Inc.	Albany	GA	Glen Davis	(407) 295-6434
CxBg	Addison Steel, Inc.	Lockhart	FL	Dan Ohlheres	(407) 295-6434
CxBg	ADF International Inc.	Quebec	Canada	Pierre Paschini	(514) 625-1911
CnBg	Advanced Resources & Construction Ent., Inc.	Kingfield	ME	Walter Kilbreth	(207) 265-2646
CxBg MBr F	AFCO Steel	Little Rock	AR	Grady Harvell	(501) 340-6285
CxBg	Alamo Steel Co.	Waco	TX	Ron Merritt	(817) 799-2471
CxBg	Alert Steel Fabricators, Inc.	Chicago	IL	Russell Pavlock	(312) 375-9600
CxBg	Alfab, Inc.	Enterprise	AL	M. Brown	(205) 347-9516
CxBg	Allstate Steel Company, Inc.	Jacksonville	FL	Yancey Montgomery	(904) 781-6040
CxBg P	Almet Inc.	New Haven	IN	Thom Bada	(219) 493-1556
CxBg	American Steel & Aluminum Co., Inc.	Grand Prairie	TX	Ken Teel	(214) 264-1533
CnBg	*American Steel Fabricators, Inc.*	*Milford*	*NH*	*Mark Carter*	*(603) 547-6311*
CxBg MBr F	American Welding Company, Inc.	West Greenwich	RI	Richard Silva	(401) 821-7186
CxBg MBr	Amthor Steel Co.	Erie	PA	Richard Carrara	(814) 452-4700
CnBg	Antenna Products Corp.	Mineral Wells	TX	Sam Risner	(817) 325-3301
CxBg SBr	Arlington Structural Steel Co., Inc.	Arlington Heights	IL	Ralph Clarbour	(708) 577-2200
CxBg MBr FP	Atlas Machine & Iron Works, Inc.	Gainesville	VA	Werner Quasebarth	(703) 754-4171
CxBg MBr	Auciello Iron Works Inc.	Hudson	MA	Mike Auciello	(508) 568-8382
CxBg MBr F	Augusta Iron & Steel Works, Inc.	Augusta	GA	G. Bovard	(706) 722-0721
CxBg MBr F	Avondale Industries, Inc.	Avondale	LA	John Simpson	(504) 436-5192
CnBg	BAAB Steel, Inc.	Colorado Springs	CO	Arnold Simon	(719) 634-5511
CxBg	Beck Steel, Inc.	Lubbock	TX	John Beck	(806) 762-3255
CxBg P	Bell Steel Company	Pensacola	FL	Daniel Davis	(904) 432-1545
CxBg MBr	Berlin Steel Construction Co., The	Berlin	CT	John Holcomb	(203) 828-3531
CxBg MBr	Bethlehem Contracting Co.	Bath	PA	John Cancelliere	(610) 837-9444
CxBg MBr FP	Beverly Steel, Inc.	Knoxville	TN	Clarence Nelson	(615) 687-7921
CnBg	Blattner Steel Co.	Cape Girardeau	MO	Whitney Calvin	(314) 339-1129
CxBg	Bratton Corporation, The	Kansas City	MO	Paul Arnsmeyer	(816) 363-1014
CxBg	Brenner Companies	Winston-Salem	NC	Thomas Underhill	(910) 725-8333
CnBg	Brookfield Fabricating Corporation	Brookfield	MO	Charles Woods	(816) 258-2214
CxBg	Burger Stuctural Steel Company	Akron	OH	George Hascher	(216) 253-5121
CnBg	Burtman Iron Works, Inc.	Readville	MA	Charles Burtman	(617) 364-1200
SBr	*Byus Construction Steel Fabrication*	*Batavia*	*IL*	*Jack Doyle*	*(708) 879-2200*
CnBg	C & C Iron, Inc.	Merrillville	IN	Gerry Chandler	(219) 769-2511
CxBg	Canam Steel Corporation	Washington	MO	Gregg Baldwin	(314) 239-6716
CxBg MBr F	Canron Construction Corp. (Eastern Div.)	Conklin	NY	Jeff Gannett	(607) 723-4862
CxBg MBr F	Canron Construction Corp. (Western Div.)	Portland	OR	Michael Eckstein	(503) 255-8634
CxBg	Capco Steel Corporation	Providence	RI	Micheal Caparco	(401) 861-1220
CxBg MBr F	Capital Steel Co.	Lincoln	NE	Curtis Smith	(402) 476-1021
CxBg MBr F	Capitol Steel & Iron Company	Oklahoma City	OK	John Nesom	(405) 632-7710
CnBg	Carlan Mfg. Co., Inc.	Holbrook	NY	Graham Scaife	(516) 567-2050
CxBg MBr F	Carolina Steel Corp.	Colfax	NC	Bob Rice	(910) 275-9711
CxBg MBr F	Carolina Steel Corp.	Nash County	NC	Bob Rice	(910) 275-9711
CxBg MBr F	Carolina Steel Corp.	Abingdon	VA	John Brewer	(910) 275-9711
CxBg MBr	Carrara Steel	Erie	PA	Richard Carrara	(814) 452-4700
CxBg MBr	Carter Steel and Fabricating Co.	Bellefontaine	OH	Marvin Silverstein	(513) 593-3010
CxBg	Cen-Tex Marine Fabricators Inc.	Smithville	TX	Gene Hinnant	(512) 237-2496
CxBg	Central Steel, Inc.	Wichita	KS	Les Aaby	(316) 265-8639
CxBg P	Central Texas Iron Works	Waco	TX	David Harwell	(817) 776-8000
CnBg	Central Western Fabricators, Inc.	Atlantic	IA	Carl Zenti	(712) 243-4000
CxBg	Chillicothe Iron & Steel, Inc.	Chillicothe	MO	Kent Peterson	(816) 646-2250
CxBg MBr F	Cianbro Corporation	Pittsfield	ME	Leroy Vanadestine	(207) 487-3311
CnBg	City Welding & Fabricating Inc.	Jackson	MS	Danny Lee	(601) 922-2909
CxBg P	*Cives Steel Co. (Mid-South Div.)*	*Rosedale*	*MS*	*Edwin Montgomery*	*(601) 759-6265*
CxBg P	Cives Steel Company (Mid-Atlantic Div.)	Winchester	VA	Duncan McGilvray	(703) 667-3480
CxBg MBr F	Cives Steel Company (New England Div.)	Augusta	ME	Barry Brackett	(207) 622-6141
CxBg MBr	Cives Steel Company (Northern Div.)	Gouverneur	NY	Dominic Centofanti	(315) 287-2200
CxBg P	Cives Steel Company (Southern Div.)	Thomasville	GA	James Jackson	(912) 228-9780
CxBg MBr F	Colonial Iron Works, Inc.	Canonsburg	PA	Joseph Barravecchio	(412) 745-1423
CxBg MBr P	Colorado Bridge & Iron	Fruita	CO	Ralph Seeley	(970) 858-4496

Type	Company Name	Location	Contact	Phone #	
CxBg	Comm Steel, Inc.	Cleveland	OH	Michael Ciofani	(216) 881-4600
CxBg MBr F	Conn Fabrication & Engineering Co.	New Castle	PA	William Branscome	(412) 654-6672
CxBg	Construction Supply & Erection Inc.	Germantown	WI	Bruno Henke	(414) 255-3003
SBr	Continental Bridge	Alexandria	MN	Bruce Leland	(612) 852-7500
CxBg	Contract Steel Sales, Inc.	Butner	NC	Phil Hudson	(910) 273-9704
CxBg	Contract Steel Sales, Inc.	Staley	NC	Phil Hudson	(910) 273-9704
CnBg	Contractors Service & Supply, Inc.	Winchester	KY	Michael Houlihan	(606) 744-4462
CxBg MBr P	Craft Machine Works Inc.	Hampton	VA	Richard Rea	(804) 380-8615
CxBg	Crown Steel, Inc.	San Antonio	TX	Adrian Augustin	(210) 674-5931
CnBg	Custom Iron Co., Inc.	Pacific	WA	Larry Schwindt	(206) 241-0659
CxBg MBr	D. S. Brown Co., The	N. Baltimore	OH	David Arps	(419) 257-3561
CxBg MBr	Daewoo Heavy Industries Ltd.	Kungynam	Korea	Y. Son	
CxBg	Dave Steel Company, Inc.	Ashville	NC	Tim Heffner	(704) 252-2771
CnBg	David Architectural Metals, Inc.	Chicago	IL	Richard Schneider	(312) 376-3200
CxBg	Davis Steel & Iron Co., Inc.	Matthews	NC	J. Brooks Davis	(704) 821-7676
CxBg MBr F	DeLong's Inc.	Jefferson City	MO	Jim DeLong	(314) 635-6121
CxBg P	Delta Steel Company Inc.	Jackson	MS	Sydney Geiger	(601) 956-4141
CnBg	DeNardi Corporation	El Cajon	CA	Dana DeNardi	(619) 258-7040
CxBg	Dialco Steel Fabricators Co.	Birmingham	AL	Daniel Shields	(205) 856-0117
CxBg	Dolphin Industries, Inc.	San Diego	CA	Prentis Davis	(619) 232-5984
CxBg MBr FP	Drake-Williams Steel Inc.	Omaha	NE	John Williams	(402) 342-1043
CxBg	E & H Steel Corporation	Midland City	AL	Shawn Evans	(205) 983-5636
CxBg MBr F	East Coast Steel	South Portland	ME	Maurice Luckern	(207) 773-1862
CxBg MBr F	East Coast Steel	Greenfield	NH	Walter Ohlson	(603) 547-3316
CxBg	East Hartford Welding, Inc.	South Windsor	CT	Kenneth Corneau	(203) 289-2323
CxBg MBr F	Egger Steel Company	Sioux Falls	SD	Doug Johnson	(605) 336-2490
CxBg	Ellis Steel Co.	West Point	MS	Frank Hopper	(601) 494-5955
CxBg	Em-Co Metal Products, Inc.	Twin City	GA	John Braddy	(912) 73-2158
CnBg	F.T.S., Inc.	Santa Maria	CA	A. S. Fitzgerald	(805) 925-1007
CxBg	FabArc Steel Supply Inc.	Oxford	AL	Steve Vinyard	(205) 831-8770
CxBg	Fabco Metal Products, Inc.	Daytona Beach	FL	Sammy Vaughn	(904) 252-3730
CxBg	FAMM, Inc.	Rindge	NH	David Richey	(603) 899-3304
CxBg	Fischer Steel Corp.	Memphis	TN	C. Caldwell	(901) 363-4986
CxBg MBr F	Flohr Metal Fabricators, Inc.	Seattle	WA	William Taylor	(206) 633-2222
CxBg	Florida Structural Steel	Tampa	FL	Jim Stephens	(813) 623-2675
CxBg MBr F	Fought & Company	Tigard	OR	Rex Smith	(503) 639-3141
CxBg MBr	Geiger & Peters Inc.	Indianapolis	IN	Don Peterson	(317) 359-9525
CxBg	General Steel Fabricators Inc.	Latham	NY	Terry Vallely	(518) 785-3221
CxBg P	Gipson Steel, Inc.	Meridian	MS	E. Gipson	(601) 482-5131
CxBg	GLENCO, Inc.	Clovis	NM	Randy Kelley	(505) 763-4414
CxBg MBr F	Globe Iron Construction Co.	Norfolk	VA	Morgan Steele	(804) 628-0124
CxBg	Grace and Wylie Fabricators, Inc.	Springfield	TN	Kenneth Petty	(615) 373-2875
CnBg	Graco Inc.	Chattanooga	TN	J. Hilbert	(615) 892-4484
CxBg	Graham Steel Corporation	Kirkland	WA	Kevin Larson	(206) 823-5656
CxBg MBr F	Grand Junction Steel Co.	Grand Junction	CO	Larry Beam	(303) 242-4015
CxBg	H & M Steel, Inc.	Luther	OK	Rick Pauley	(405) 277-3055
CnBg	Hamilton Iron Works, Inc.	Woodbridge	VA	Mike Lucks	(703) 690-2900
CxBg MBr	Hammert's Iron Works Inc.	St. Louis	MO	Robert Smith	(314) 389-0666
MBr FP	Harris Structural Steel Company	S. Plainfield	NJ	Frank Mikita	(201) 752-6070
CxBg MBr F	Havens Steel Company	Ottawa	KS	Tom Collins	(816) 231-5724
CxBg MBr F	Havens Steel Company	Kansas City	MO	Tom Collins	(816) 231-5724
CxBg MBr FP	Helmark Steel Inc.	Wilmington	DE	William O'Brien	(302) 652-3341
CxBg	Hercules Steel Company	Fayetteville	NC	Claude Scott	(910) 488-5110
CnBg	Herman Binz & Sons Iron Works, Inc.	Little Rock	AR	Phil Binz	(501) 490-1017
CxBg MBr F	Herrick Corporation, The	San Bernardino	CA	David Ogilvie	(510) 484-2990
CxBg MBr FP	Herrick Corporation, The	Stockton	CA	David Ogilvie	(510) 484-2990
CxBg MBr F	High Steel Structures Inc.	Lancaster	PA	Brad Mills	(717) 293-4068
CxBg MBr F	High Steel Structures Inc.	Williamsport	PA	Jay Mellinger	(717) 299-5211
CxBg MBr F	Hirschfeld Steel Co. Inc.	Abilene	TX	Sid Dickerson	(214) 541-1166
CxBg MBr F	Hirschfeld Steel Co. Inc.	San Angelo	TX	Sid Dickerson	(214) 541-1166
CxBg MBr F	Hirschfeld Steel Co. Inc.	Midland	TX	Sid Dickerson	(214) 541-1166
CxBg MBr F	Hirschfeld Steel Co. Inc.	Lynchburg	VA	Sid Dickerson	(214) 541-1166
CnBg	Hurtt Fabricating Corp.	Marceline	MO	Robert Walton	(816) 376-3501
CxBg MBr	Hyundai Heavy Industries Co., Ltd.	Ulsan	Korea	Y. Kim	
CnBg	IKG Greulich	Cheswick	PA	Darko Jurkovic	(412) 828-2223
CxBg P	Impero Construction Co.	Bellingham	WA	Jerry Madlung	(206) 733-7052

Type	Company Name	Location	Contact	Phone #	
CxBg MBr	Indiana Steel & Engineering Corporation	Bedford	IN	Troy Moyes	(812) 275-3363
CxBg	Industrial Steel Construction, Inc.	Hodgkins	IL	Karl Iwinski	(708) 482-7500
CxBg MBr	Industrial Steel Construction, Inc.	Gary	IN	Karl Iwinski	(708) 482-8549
CxBg	Industrial Steel Inc.	Mims	FL	Linda Townsend	(407) 267-2341
MBr FP	International Bridge & Iron Co.	Newington	CT	Joseph Bachta	(203) 953-6550
CxBg	Interstate Iron Works Corporation	Whitehouse	NJ	Robert Abramson	(908) 534-6644
CxBg	Interstate Welding & Fabrication Inc.	Terre Haute	IN	John Von Dielin	(812) 232-0474
CxBg	Ironhorse Ironworks, Inc.	Lorena	TX	Bobby Meador	(817) 857-3160
CxBg MBr	Isaacson Structural Steel, Inc.	Berlin	NH	Roger Jones	(603) 752-2044
CxBg MBr P	*J. S. Alberici Construction Co.*	*St. Louis*	*MO*	*William Beckerman*	*(314) 261-2611*
CxBg	Jack K. Elrod Company, Inc.	Indianapolis	IN	Timothy Elrod	(317) 632-4391
CxBg	Jackson Steel Company	San Antonio	TX	John Stampley	(210) 633-0100
CxBg MBr F	Jesse Engineering Co.	Tacoma	WA	Lanny Lawrence	(206) 922-7433
CxBg MBr	Johnson Machine Works, Inc.	Chariton	IA	M. Garton	(515) 774-2191
CnBg	K & P Machine Company	Cleveland	OH	John Hoffman	(216) 641-2570
CxBg MBr	Kard Welding Inc.	Minster	OH	Kenneth Osterloh	(419) 628-2375
CxBg	KCB Towers, Inc.	Highland	CA	Lynn Bogh	(909) 862-0322
CxBg MBr F	Keiser Steel Fabricators	Kent	WA	Bruce Keiser	(206) 852-1910
CxBg	Kilroy Structural Steel Co.	Cleveland	OH	Robert Krejci	(216) 883-3000
CxBg	Kinsley Fabrication	York	PA	Raymond Guzzetti	(717) 741-8326
CxBg	Kline Iron & Steel Co., Inc., The	Columbia	SC	David Easterling	(803) 251-8000
SBr	L. B. Foster Company	Norcross	GA	Richard Kelleher	(412) 928-3478
SBr	L. B. Foster Company	Pittsburgh	PA	Richard Kelleher	(412) 928-3478
CxBg	Lacy Steel Company	Lawrence	KS	Ed Hoadley	(913) 841-2470
CnBg	LeBlanc Communications, Inc.	Sioux City	IA	Mark Gothier	(712) 252-4101
CnBg	Lehigh Utility Associates	South Plainfield	NJ	William Butrico	(908) 561-5252
CxBg MBr FP	LeJeune Steel Company	Minneapolis	MN	Larry Kloiber	(612) 861-3321
CxBg	Lemke Industrial Machine, Inc.	Marathon	WI	Donald Lemke	(715) 842-3221
CxBg MBr F	Leonard Kunkin & Associates, Inc.	Line Lexington	PA	Leonard Kunkin	(215) 723-6744
MBr FP	Lewis Engineering Company	Chaska	MN	Gordon Lewis	(612) 368-3000

Type	Company Name	Location	Contact	Phone #	
CxBg MBr FP	Lincoln Steel Co.	Lincoln	NE	William Nessen	(402) 474-3030
CxBg MBr FP	Littell Steel Company	Fallston	PA	Robert Thaw	(412) 843-5212
CxBg	Lynchburg Steel & Specialty Co.	Monroe	VA	Kenneth Hudnall	(804) 929-0951
CnBg	M & S Fabricators Inc.	Altavista	VA	Siglinde Allbeck	(804) 369-1170
CxBg SBr	Madden Steel Fabrication	Hollidaysburg	PA	F. Madden	(814) 695-4461
CxBg MBr F	Maritime Steel & Foundries, Ltd.	New Glasgow	NS	Dale Robertson	(902) 752-1511
CxBg MBr F	Mark Steel Corp.	Salt Lake City	UT	L. Van Vleet	(801) 350-2092
CxBg	Martin Iron Works Inc.	Reno	NV	John Pieretti	(702) 329-8631
CnBg	Marysville Steel, Inc.	Marysville	OH	Eugene Clayman	(513) 642-5971
CxBg	Merrill Iron & Steel, Inc.	Schofield	WI	Tom Wisneski	(715) 536-9584
CnBg	Merrimack Sheet Metal, Inc.	Concord	NH	James Dussault	(603) 224-7766
CxBg	Met-Con, Inc.	Cocoa	FL	Merritt Hall	(407) 632-4880
CxBg MBr P	Metropolitan Steel Industries, Inc.	Sinking Spring	PA	Anthony Panariello	(610) 678-6411
CxBg	Mid America Steel Inc.	Fargo	ND	Donald Clark	(701) 232-8831
CnBg	Mid-Ohio Products, Inc.	Hilliard	OH	Doug Koch	(614) 777-2795
CxBg	Midco Manufacturing, Inc.	Airway Heights	WA	Joe Loomis	(509) 244-5611
CxBg	Midland Steel Company	Wathena	KS	Al Simonis	(913) 989-4442
CxBg MBr FP	Missouri Valley Steel Co.	Sioux City	IA	Robert Jacobsen	(712) 255-1616
MBr	Mitsubishi Heavy Industries, Ltd.	Yokohama	Japan	Yasuji Ogawa	(045) 629-1386
CxBg SBr	Moore & Morford, Inc.	Greensburg	PA	Richard Morford	(412) 834-1100
CxBg	Mound Steel Corp.	Springboro	OH	Russ Ballard	(800) 488-3957
CxBg MBr FP	Mountain States Steel, Inc.	Lindon	UT	Bruce Dastrup	(801) 785-5086
CxBg MBr F	Munster Steel Company Inc.	Munster	IN	Ronald Robbins	(219) 924-5198
CxBg	N. C. Steel, Inc.	Raleigh	NC	Mark Parrish	(919) 772-0676
SBr	National Bridge Co., Inc.	Buffalo	NY	Charles Marchese	(716) 876-1600
CxBg MBr F	National Eastern Corporation	Plainville	CT	Warren Kart	(203) 747-3700
CnBg	New England Bridge Products, Inc.	Lynn	MA	John Conti	(617) 581-2000
CxBg	Niederhauser Ornamental & Metal Works	Salt Lake City	UT	Butch Niederhauser	(801) 973-8310
CxBg	Nordahl Metalfab	Puyallup	WA	Richard Nordahl	(206) 840-2124
CxBg SBr P	North Shore Supply Company	Houston	TX	Lou Rossitto	(713) 450-6232

Type	Company Name	Location		Contact	Phone #
CxBg MBr F	North Texas Steel Co.	Fort Worth	TX	Barry Ennis	(817) 927-5333
CxBg	NOVA Group, Inc.	Napa	CA	Fred Thornhill	(707) 257-3200
CxBg	Novel Iron Works, Inc.	Greenland	NH	Keith Moreau	(603) 436-7950
CxBg	Ogeechee Steel, Inc.	Swainboro	GA	Janet Johnson	(912) 237-2770
MBr	Ohio Bridge Corporation	Cambridge	OH	Art Rogovin	(614) 432-6334
CxBg MBr F	Ohio Steel Industries, Inc.	Summit Station	OH	William McNary	(614) 927-9500
CxBg MBr P	Ohio Structures, Inc.	Berlin Center	OH	Sean Giblin	(216) 533-0084
CxBg MBr F	Oregon Iron Works, Inc.	Clackamas	OR	Terry Aarnio	(503) 653-6300
CxBg MBr F	Orleans Materials & Equipment	New Orleans	LA	John Housey	(504) 288-6361
CxBg	Ozark Steel Fabricators, Inc.	Farmington	MO	Gail Brister	(314) 756-5741
CxBg	Pace Iron Works	Albuquerque	NM	Tony Rooyakkers	(505) 823-2611
CxBg MBr	Palmer Industrial Supplies, Inc.	McAllen	TX	Jim Thompson	(210) 686-6575
CxBg MBr F	Paxton & Vierling Steel Company	Carter Lake	IA	Roger Woodwin	(712) 347-5500
CxBg MBr FP	PDM Bridge	Eau Claire	WI	John Grzybowski	(715) 835-2250
CxBg MBr FP	*PDM Bridge*	*Wausau*	*WI*	*John Grzybowski*	*(715) 835-2250*
CnBg	Pikes Peak Steel	Colorado Springs	CO	Glen Carter	(719) 471-8811
CxBg MBr FP	Pitt-Des Moines, Inc.	Melrose Park	IL	Larry Curtis	(708) 681-5181
CxBg	PKM Steel Service, Inc.	Salina	KS	Steve Hartsuff	(913) 827-3638
CxBg	Plas-Tal Mfg. Co.	Santa Fe Springs	CA	Larry Van Der Hoek	(310) 945-7620
MBr P	Platte River Steel	Greeley	CO	Ira Stone	(501) 340-6205
CxBg	Powell Steel Corporation	Lancaster	PA	Steve Powell	(717) 464-2030
CxBg MBr	Precise Fabricating Corporation	Georgetown	MA	Frank Davis	(508) 352-2591
CxBg MBr F	Production Steel Company, Inc.	Gardena	CA	Tom Drum	(213) 321-1061
CxBg	Prospect Steel Inc.	Little Rock	AR	Edward Wright	(501) 945-3625
CxBg MBr FP	Qualico Steel Co., Inc.	Webb	AL	John Downs	(205) 793-1290
CxBg	Queensboro Steel Corp.	Wilmington	NC	Craig Gilpin	(910) 763-6237
CxBg MBr F	R. A. Davis Co., Inc.	Ellwood City	PA	Reno Davis	(412) 752-2600
CxBg	Ramsey Steel Company, Inc.	El Paso	TX	Terry Robinson	(915) 532-2686
CxBg	Red Iron Corp.	Spokane	WA	Ray Johnson	(509) 468-2310
CxBg MBr	Reno Iron Works	Reno	NV	Andrea Pelter	(702) 329-1111
CxBg MBr F	Reynolds Manufacturing Co.	Avonmore	PA	Michael Perfetti	(412) 697-4522
CxBg	Richmond Steel & Welding, Inc.	Rockingham	NC	Thad Ussery	(919) 582-4026
CxBg SBr	Rome Iron Group Ltd., The	Rome	NY	Jeff Woldridge	(315) 337-9000
CxBg MBr	Roscoe Steel & Culvert Co.	Billings	MT	Dale Butterfield	(406) 656-2253
CnBg	Ross Technology Corp.	Leola	PA	George Clark	(717) 656-5600
CxBg	Roy Case Construction Company	Little Rock	AR	Roy Case	(510) 897-4061
CxBg MBr	RP's Machinery Sales, Inc.	Jersey Shore	PA	Robby Fisher	(717) 398-7456
CxBg MBr	RTW Industries Inc.	Muncie	IN	Terry Warner	(317) 741-4111
CxBg	Ryan Iron Works, Inc.	Raynham	MA	John Cauley	(508) 822-8001
CxBg MBr	S & S Steel Fabrication	Hurricane	UT	E. Staples	(801) 635-9801
CnBg	S. A. Halac, Inc.	Hyattsville	MD	Ahmet Halac	(301) 985-1230
CnBg	Safety Guard Steel Fabricating	Millvale	PA	David Campbell	(412) 821-3533
CxBg P	Safety Steel Service, Inc.	Victoria	TX	Rod Thompson	(512) 575-4561
CxBg MBr	Samsung Heavy Industries	Changwon Kyungnam	Korea	K. Won	(055) 160-6158
CxBg MBr F	Schlosser Steel Inc.	Hatfield	PA	James Morehouse	(215) 723-9883
CxBg MBr F	Schuff Steel Company	Phoenix	AZ	Keith Landwehr	(602) 252-7787
CnBg	Seaport Fabrication, Inc.	Tukwila	WA	Linda Smithies	(206) 763-6424
CxBg MBr F	Shane Felter Industries, Inc.	Uniontown	PA	Ronald Kaczynski	(412) 439-2403
SBr P	Sharon Manufacturing Inc.	Sharon Center	OH	Jerry Kostelny	(216) 239-1561
CxBg MBr F	Sheffield Steel Products	Palatka	FL	D. Welsh	(904) 328-4683
CxBg	Shelco Steel Works, Inc.	South Holland	IL	Al Voss	(708) 333-5380
CxBg	Shepard Steel Company, Inc.	Hartford	CT	Rick Beckerman	(203) 525-4446
CnBg	Sigma Industries	Selbyville	DE	David Speier	(302) 436-9610
CxBg	Sioux City Foundry Co.	Sioux City	IA	Michael Potash	(712) 252-4181
CxBg	Skaggs Iron Works	Memphis	TN	Mike Skaggs	(901) 947-3100
CxBg MBr	SME Industries, Inc.	Salt Lake City	UT	Hank Battaglia	(801) 280-0711
CxBg MBr FP	SMI-Owen Steel Company Inc.	Columbia	SC	William Saunders	(803) 251-7680
CxBg	Southern Iron Works, Inc.	Springfield	VA	Samuel Parker	(703) 354-5500
CxBg	Southern Ohio Fabricators, Inc.	Cincinnati	OH	Stephen Sundin	(513) 771-1600
CnBg	Southington Metal Fabricating Co.	Plantsville	CT	Tom Beland	(203) 621-0149
CxBg	Southwest Steel Fabricators, Inc.	Bonner Springs	KS	Bob Dill	(913) 422-5500
CnBg	ST Fabrication, Inc.	Auburn	WA	Sandra Todd	(206) 735-2000
CxBg MBr F	St. George Steel Fabrication	Saint George	UT	Kirk Mitchell	(801) 673-4856
CxBg	St. Louis Fabrication Services, Inc.	St. Louis	MO	Rich Schroeder	(314) 385-4180
CxBg	Stainless, Inc.	North Wales	PA	Peter Starke	(215) 699-4871
CnBg	Steel and Pipe Corp.	Sanford	NC	William Gupton	(800) 776-0752

Type	Company Name	Location		Contact	Phone #
CxBg P	Steel Fab, Inc.	Florence	SC	William McCall	(803) 664-1811
CxBg	Steel Fabricators, Inc.	Ft. Collins	CO	John Shaw	(303) 484-2752
CxBg MBr P	Steel Fabricators, Inc.	Ft. Lauderdale	FL	Brian Kelley	(305) 772-0440
CxBg P	Steel Service Corporation	Jackson	MS	John Bear	(601) 939-9222
CxBg	Steel, Inc.	Scottdale	GA	James Burdette	(404) 292-7373
CxBg P	SteelFab, Inc.	Charlotte	NC	Don Sherrill	(704) 394-5376
CxBg	Stein Steel & Supply Co.	Atlanta	GA	H. Woodall	(404) 523-2711
CxBg	Stevens Equipment Co.	Salem	OR	Hans Bauer	(503) 581-2511
CxBg MBr F	Steward Machine Co., Inc.	Birmingham	AL	Hoyt Davis	(205) 841-6461
CxBg	Steward Steel Inc. (Structural Div.)	Sikeston	MO	Larry Steward	(314) 471-2121
CxBg	Stewart-Amos Steel, Inc.	Harrisburg	PA	Russell King	(717) 564-3931
CxBg	Strait Manufacturing & Welding, Inc.	Greencastle	PA	Greg Strait	(717) 597-3125
SBr	Structural Accessories, Inc.	Terryville	CT	Robert Colpitts	(203) 589-8826
CxBg MBr FP	Structural Steel Products Corp.	Clayton	NC	Trudy Hales	(919) 553-3034
CnBg	Stud Welding, Inc.	Centerville	TN	Lambert Lamberson	(615) 729-3571
CxBg MBr F	Stupp Bros. Bridge & Iron Co.	St. Louis	MO	Robert Stupp	(314) 638-5000
CnBg	Summit Manufacturing Inc.	West Hazelton	PA	Lewis Grant	(717) 454-8730
CnBg	Syro, Inc.	Girard	OH	Ronald Colapietro	(800) 321-2755
CxBg MBr F	Tampa Steel Erecting Co.	Tampa	FL	Robert Clark	(813) 677-7184
CxBg	Tate Fabricating Inc.	White House	TN	Rick Barnett	(615) 672-4900
CnBg	Tech Dynamics, Inc.	Perrysburg	OH	Dave Fielding	(419) 666-1666
CxBg	Tech-Steel, Inc.	Clearfield	UT	Scott Rosenlof	(801) 263-0068
CnBg	Templeton Steel Fabrication	Paso Robles	CA	Jeffrey McCaffrey	(805) 239-5641
CxBg	Thomas Steel Inc.	Bellevue	OH	Daniel Thomas	(419) 483-7540
CxBg MBr F	Tidewater Steel Co., Inc.	Chesapeake	VA	William Dunkley	(804) 545-0566
CxBg	Tips Iron & Steel Co.	Austin	TX	Steve Wimberly	(512) 478-8511
CxBg	Topper & Griggs, Inc.	Plainville	CT	Kenneth Fogg	(203) 747-5737
CxBg MBr F	Trinity Industries Inc.	Montgomery	AL	Tom Germanson	(205) 265-6702
CxBg MBr F	Trinity Industries Inc.	Houston	TX	John Gilliam	(713) 861-8181
CxBg MBr	TriState Steel & Fab. Co., Inc.	Tefft	IN	Fred Haas	(219) 828-4011
CnBg	Tuckerman Welding & Fabrication	East Boston	MA	Joseph Burm	(617) 569-8373
CxBg	Union Metal Corporation	Canton	OH	Tom Mueller	(216) 456-0163
CxBg	United Iron Works, Inc.	Seattle	WA	Joe D'Amico	(206) 767-3630
CxBg MBr F	Universal Structural Inc.	Vancouver	WA	Dave Williams	(206) 695-1261
MBr FP	Utah Pacific Bridge & Steel Corp.	Lindon	UT	Clark Olsen	(801) 785-3557
CxBg SBr	V & S Schuler Engineering Inc.	Canton	OH	Victor DiMargio	(216) 452-5200
CnBg	Valmont Industries, Inc. (Ind. Const. Prod.)	Elkhart	IN	Rick Sampson	(402) 359-2201
CnBg	Valmont Industries, Inc. (Ind. Const. Prod.)	Valley	NE	John Pleiss	(402) 359-2201
MBr FP	Van Buren Bridge Co.	Van Buren	AR	Tom Cole	(501) 474-1975
CxBg MBr F	Vincennes Steel Corporation	Vincennes	IN	Kevin Day	(812) 882-4550
SBr	Virginia-Carolina Steel, Inc.	Norfolk	VA	Stephen Nicholas	(804) 853-7403
CnBg	Vulcan Steel, Inc.	Jacksonville	FL	Ron Geiger	(904) 731-2041
CxBg	W & W Steel Company	Oklahoma City	OK	Rick Cooper	(405) 235-3621
CxBg	W & W Steel Company	Lubbock	TX	Robert Meador	(806) 765-5781
CnBg	Walpar, Inc.	Birmingham	AL	H. Parker	(205) 925-4990
CnBg	Wascot, Inc.	Wichita	KS	Dwayne Cotton	(316) 942-2238
CxBg MBr	Watson Bowman Acme Corporation	Amherst	NY	Wayne Walter	(716) 691-7566
CxBg MBr F	Waukegan Steel Hammond Division	Hammond	IN	Dave Ensleman	(219) 933-1430
CnBg	Waukegan Steel Sales	Waukegan	IL	Don Robison	(708) 662-2810
CxBg	Western Slope Iron & Supply, Inc.	Grand Junction	CO	Frank Mitchell	(970) 243-9770
CnBg	Western Steel Fabricators	Tacoma	WA	Creig Sundstrom	(206) 383-4091
CnBg	Wichita Steel Fabricators	Wichita	KS	Jim Smith	(316) 838-3301
CnBg	Wilborn Steel Corporation	San Antonio	TX	Tom Wilborn	(210) 532-6852
CxBg MBr F	Williams Bridge Company	Manassas	VA	Dick Geyer	(703) 361-5885
CxBg MBr	Williams Bridge Company	Richmond	VA	Dick Johnson	(804) 233-7694
CxBg	Williams Steel Company	Jackson	TN	James Campbell	(901) 423-4900
CxBg P	Wisconsin Structural Steel Co.	Barronett	WI	Larry Kloiber	(612) 861-3321
CnBg	Woolf Steel Inc.	Middletown	PA	Jerry Woolf	(717) 944-1423
CxBg MBr F	Zalk Josephs Fabricators, Inc.	Stoughton	WI	H. Gurthet	(608) 873-6646
CxBg	Zimkor Industries, Inc.	Littleton	CO	Denny Johnson	(303) 791-1333
CxBg MBr F	Zimmerman Metals Inc.	Denver	CO	Dave Denney	(303) 294-0180

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Company Name	Location	Contact	Phone #
A & S Building Systems, Inc.	Caryville TN	B. Ellison	(615) 426-2141
American Buildings Co.	Eufaula AL	Joel Voelkert	(205) 687-2000
American Buildings Co.	Phenix City AL	Paul Klim	(513) 675-9031
American Buildings Co.	Pine Bluff AR	Paul Klim	(513) 675-9031
American Buildings Co.	El Paso IL	Joel Voelkert	(205) 687-2000
American Buildings Co.	Carson City NV	Joel Voelkert	(205) 687-2000
Behlen Manufacturing Co.	Columbus NE	John Bowes	(402) 563-7275
Butler Manufacturing	Birmingham AL	C. Simmons	(205) 798-6300
Butler Manufacturing	Galesburg IL	Terry Blank	(309) 345-6800
Butler Manufacturing	Kansas City MO	Steve Shearer	(816) 968-4700
Butler Manufacturing	Laurinburg NC	CharlieBrown	(910) 276-7676
Butler Manufacturing	AnnvillePA	David MacQueen	(717) 867-4606
Butler Manufacturing	San Marcos TX	MikeBruns	(512) 396-3636
Butler Manufacturing Co.	Visalia CA	Alan Goddard	(209) 651-5316
Butler Manufacturing Co.	Burlington ON	Harry Ragetlie	(416) 332-7786
Ceco Building Systems	Mt. Pleasant IA	Jeff Saunders	(319) 385-8001
Ceco Building Systems	Columbus MS	John Scarbrough	(601) 328-6722
Ceco Building Systems	Rocky Mount NC	Donald Conley	(919) 977-2131 x256
Chief Industries Inc.	Rensselaer IN	George Groom	(219)866-4121
Chief Industries Inc.	Grand Island NE	Marion Alley	(308) 382-4557 x219
Garco Building Systems	Airway Heights WA	William Savitz	(509) 244-5611
Gulf States Manufacturers Inc.	Columbus GA	Floyd Patterson	(601) 323-8021
Gulf States Manufacturers Inc.	StarkvilleMS	Thomas Southerland	(601) 323-8026
Kirby Building Systems, Inc.	Portland TN	Roy Price	(615) 325-4165
NCI Building Systems	Houston TX	Eric Masterson	(713) 466-7788
NCI Building Systems, Inc.	Mattoon IL	Fred Hensey	(800) 777-9378
Nucor Building Systems	Waterloo IN	Danny Coggins	(219) 837-7891
Pascoe Building Systems, Inc.	Columbus GA	Leonard Grabia	(706) 324-3562
Star Building Systems	LockefordCA	Faron Moyers	(209) 727-5504
Star Building Systems	Monticello IA	Bud Warford	(800) 654-3921
Star Building Systems	Oklahoma City OK	BudWarford	(800) 654-3921
Star Building Systems	Hamilton OT	Bud Warford	(800) 654-3921
Steelox Systems	Mason OH	Ed McQueen	(513) 573-5200
Steelox Systems	Washington Crt Hse OH	FrankTerrell	(614) 636-2218
United Structures of America, Inc.	Portland TN	Ron Fletcher	(713) 442-8247
United Structures of America, Inc.	Houston TX	Ron Fletcher	(713) 442-8247
Varco-Pruden Buildings	Rainsville AL	Bobby Sparks	(205) 638-2264
Varco-Pruden Buildings	Pine Bluff AR	Britt Skrivanek	(501) 534-6030
Varco-Pruden Buildings	Turlock CA	Kurt Rorick	(209) 667-4951
Varco-Pruden Buildings	La GrangeGA	Charles Van Huss	(706) 883-8888
Varco-Pruden Buildings	St. Joseph MO	Lonny Loiselle	(816) 238-7550
Varco-Pruden Buildings	KernersvilleNC	Greg Bava	(910) 996-4801 x210
Varco-Pruden Buildings	Van WertOH	Tim Gorske	(410) 757-2016
Varco-Pruden Buildings	Memphis TN	Tom Elledge	(901) 762-6000
Varco-Pruden Buildings	Evansville WI	Mike McLain	(608) 882-5000
Whirlwind Building Systems	Houston TX	Jim Roundtree	(713) 946-7140

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ALABAMA
CxBg Alfab, Inc.
CxBg Dialco Steel Fabricators Co.
CxBg E & H Steel Corporation
CxBg FabArc Steel Supply Inc.
CxBg MBr FP Qualico Steel Co., Inc.
CxBg MBr F Steward Machine Co., Inc.
CxBg MBr F Trinity Industries Inc.
CnBg Walpar, Inc.

ARKANSAS
CxBg MBr F AFCO Steel
CnBg Herman Binz & Sons Iron Works, Inc.
CxBg Prospect Steel Inc.
CxBg Roy Case Construction Co.
MBr FP Van Buren Bridge Co.

ARIZONA
CxBg MBr F Schuff Steel Company

CALIFORNIA
CnBg DeNardi Corporation
CxBg Dolphin Industries, Inc.
CnBg F.T.S., Inc.
CxBg MBr FP Herrick Corporation (Stockton)
CxBg MBr F Herrick Corporation (San Bernardino)
CxBg KCB Towers, Inc.
CxBg NOVA Group, Inc.
CxBg Plas-Tal Mfg. Co.
CxBg MBr F Production Steel Company
CnBg Templeton Steel Fabrication

COLORADO
CnBg BAAB Steel, Inc.
CxBg MBr P Colorado Bridge & Iron
CxBg MBr F Grand Junction Steel Co.
CnBg Pikes Peak Steel
MBr P Platte River Steel
CxBg Steel Fabricators, Inc.
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CxBg Zimkor Industries, Inc.
CxBg MBr F Zimmerman Metals Inc.

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CxBg East Hartford Welding, Inc.
MBr FP International Bridge & Iron
CxBg MBr F National Eastern Corporation
CxBg Shepard Steel Company, Inc.
CnBg Southington Metal Fabricating Co.
Sbr Structural Accessories, Inc.
CxBg Topper & Griggs, Inc.

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CnBg Sigma Industries

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CxBg Addison Steel, Inc.
CxBg Allstate Steel Company, Inc.
CxBg P Bell Steel Company
CxBg Fabco Metal Products, Inc.
CxBg Florida Structural Steel
CxBg Industrial Steel Inc.
CxBg Met-Con, Inc.
CxBg MBr F Sheffield Steel Products
CxBg MBr P Steel Fabricators, Inc.
CxBg MBr F Tampa Steel Erecting Co.
CnBg Vulcan Steel, Inc.

GEORGIA
CxBg Addison Steel, Inc.
CxBg MBr F Augusta Iron & Steel Works,
CxBg P Cives Steel Company (Southern Div.)
CxBg Em-Co Metal Products, Inc.
SBr L. B. Foster Company
CxBg Ogeechee Steel, Inc.
CxBg Steel, Inc.
CxBg Stein Steel & Supply Co.

IOWA
CnBg Central Western Fabricators,
CxBg Mbr Johnson Machine Works, Inc.
CnBg LeBlanc Communications,
CxBg MBr FP Missouri Valley Steel Co.
CxBg MBr F Paxton & Vierling Steel Co.
CxBg Sioux City Foundry Co.

ILLINOIS
CxBg Alert Steel Fabricators, Inc.
CxBg Sbr Arlington Structural Steel Co.,
Sbr Byus Construction Steel Fabrication
CnBg David Architectural Metals,
CxBg Industrial Steel Construction,
CxBg Mbr FP Pitt-Des Moines, Inc.
CxBg Shelco Steel Works, Inc.
CnBg Waukegan Steel Sales

INDIANA
CxBg P Almet Inc.
CnBg C & C Iron, Inc.
CxBg Mbr Geiger & Peters Inc.
CxBg Mbr Indiana Steel & Engineering Corporation
CxBg Mbr Industrial Steel Construction,
CxBg Interstate Welding & Fabrication Inc.
CxBg Jack K. Elrod Company, Inc.
CxBg MBr F Munster Steel Company Inc.
CxBg Mbr RTW Industries Inc.
CxBg Mbr TriState Steel & Fab. Co., Inc.
CnBg Valmont Industries, Inc. (Ind. Const. Prod.)
CxBg MBr F Vincennes Steel Corporation
CxBg MBr F Waukegan Steel (Hammond)

KANSAS
CxBg Central Steel, Inc.
CxBg MBr F Havens Steel Company
CxBg Lacy Steel Company
CxBg Midland Steel Company
CxBg PKM Steel Service, Inc.
CxBg Southwest Steel Fabricators,
CnBg Wascot, Inc.
CnBg Wichita Steel Fabricators

KENTUCKY
CnBg Contractors Service & Supply,

LOUISIANA
CxBg MBr F Avondale Industries, Inc.
CxBg MBr F Orleans Materials & Equipment

MASSACHUSETTS
CxBg A. Spadafora Iron Works, Inc.
CxBg Mbr Auciello Iron Works Inc.
CnBg Burtman Iron Works, Inc.
CnBg New England Bridge Products, Inc.
CxBg Mbr Precise Fabricating Corp.
CxBg Ryan Iron Works, Inc.
CnBg Tuckerman Welding & Fabrication
CnBg S. A. Halac, Inc. MD

MAINE
CnBg Advanced Resources & Construction Ent., Inc.
CxBg MBr F Cianbro Corporation
CxBg MBr F Cives Steel Company (New England Div.)
CxBg MBr F East Coast Steel

MINNESOTA
Sbr Continental Bridge
CxBg MBr FP LeJeune Steel Company
MBr FP Lewis Engineering Company

MISSOURI
CxBg P Acme Structural, Inc.
CnBg Blattner Steel Co.
CxBg Bratton Corporation, The
CnBg Brookfield Fabricating Corp.
CxBg Canam Steel Corporation
CxBg Chillicothe Iron & Steel, Inc.
CxBg MBr F DeLong's Inc.
CxBg Mbr Hammert's Iron Works Inc.
CxBg MBr F Havens Steel Company
CnBg Hurtt Fabricating Corp.
CxBg MBr P J. S. Alberici Construction Co.
CxBg Ozark Steel Fabricators, Inc.
CxBg St. Louis Fabrication Services
CxBg Steward Steel Inc. (Structural Division)
CxBg MBr F Stupp Bros. Bridge & Iron Company

MISSISSIPPI
CnBg City Welding & Fabricating
CxBg P Cives Steel Co. (Mid-South Division)
CxBg P Delta Steel Company Inc.
CxBg Ellis Steel Co.
CxBg P Gipson Steel, Inc.
CxBg P Steel Service Corporation

MONTANA
CxBg Mbr Roscoe Steel & Culvert Co.

NORTH CAROLINA
CxBg Brenner Companies
CxBg MBr F Carolina Steel Corp.
CxBg MBr F Carolina Steel Corp.
CxBg Contract Steel Sales, Inc.
CxBg Contract Steel Sales, Inc.
CxBg Dave Steel Company, Inc.
CxBg Davis Steel & Iron Co., Inc.
CxBg Hercules Steel Company
CxBg N. C. Steel, Inc.
CxBg Queensboro Steel Corp.
CxBg Richmond Steel & Welding
CnBg Steel and Pipe Corp.
CxBg P SteelFab, Inc.
CxBg MBr FP Structural Steel Products

NORTH DAKOTA
CxBg Mid America Steel Inc.

NEBRASKA

CxBg MBr F	Capital Steel Co.
CxBg MBr FP	Drake-Williams Steel Inc.
CxBg MBr FP	Lincoln Steel Co.
CnBg	Valmont Industries, Inc. (Ind. Const. Prod.)

NEW HAMPSHIRE

CnBg	American Steel Fabricators,
CxBg MBr F	East Coast Steel
CxBg	FAMM, Inc.
CxBg Mbr	Isaacson Structural Steel, Inc.
CnBg	Merrimack Sheet Metal, Inc.
CxBg	Novel Iron Works, Inc.

NEW JERSEY

MBr FP	Harris Structural Steel Co.
CxBg	Interstate Iron Works Corp.
CnBg	Lehigh Utility Associates

NEW MEXICO

CxBg	GLENCO, Inc.
CxBg	Pace Iron Works

NEVADA

CxBg	Martin Iron Works Inc.
CxBg Mbr	Reno Iron Works

NEW YORK

CxBg MBr F	Canron Construction Corp. (Eastern Div.)
CnBg	Carlan Mfg. Co., Inc.
CxBg Mbr	Cives Steel Company (Northern Div.)
CxBg	General Steel Fabricators Inc.
Sbr	National Bridge Co., Inc.
CxBg Sbr	Rome Iron Group Ltd., The
CxBg Mbr	Watson Bowman Acme Corp.

OHIO

CxBg	Burger Stuctural Steel Co.
CxBg Mbr	Carter Steel and Fabricating
CxBg	Comm Steel, Inc.
CxBg Mbr	D. S. Brown Co., The
CnBg	K & P Machine Company
CxBg Mbr	Kard Welding Inc.
CxBg	Kilroy Structural Steel Co.
CnBg	Marysville Steel, Inc.
CnBg	Mid-Ohio Products, Inc.
CxBg	Mound Steel Corp.
Mbr	Ohio Bridge Corporation
CxBg MBr F	Ohio Steel Industries, Inc.
CxBg MBr P	Ohio Structures, Inc.
SBr P	Sharon Manufacturing Inc.
CxBg	Southern Ohio Fabricators,
CnBg	Syro, Inc.
CnBg	Tech Dynamics, Inc.
CxBg	Thomas Steel Inc.
CxBg	Union Metal Corporation
CxBg Sbr	V & S Schuler Engineering

OKLAHOMA

CxBg MBr F	Capitol Steel & Iron Co.
CxBg	H & M Steet, Inc.
CxBg	W & W Steel Company

OREGON

CxBg MBr F	Canron Construction Corp. (Western Div.)
CxBg MBr F	Fought & Company
CxBg MBr F	Oregon Iron Works, Inc.
CxBg	Stevens Equipment Co.

PENNSYLVANIA

CxBg Mbr	Amthor Steel Co.
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CxBg	KinsleyFabrication
SBr L. B.	Foster Company
CxBg MBr F	Leonard Kunkin & Associates
CxBg MBr FP	Littell Steel Company
CxBg Sbr	Madden Steel Fabrication
CxBg MBr P	Metropolitan Steel Industries
CxBg SBr	Moore & Morfod, Inc.
CxBg	Powell Steel Corporation
CxBg MBr F	R. A. Davis Co., Inc.
CxBg MBr F	Reynolds Manufacturing Co.
CnBg	Ross Technology Corp.
CxBg Mbr	RP's Machinery Sales, Inc.
CnBg	Safety Guard Steel Fabricating
CxBg MBr F	Schlosser Steel Inc.
CxBg MBr F	Shane Felter Industries, Inc.
CxBg	Stainless, Inc.
CxBg	Stewart-Amos Steel, Inc.
CxBg	Strait Manufacturing & Welding, Inc.
CnBg	Summit Manufacturing Inc.
CnBg	Woolf Steel Inc.

RHODE ISLAND

CxBg MBr F	American Welding Company, Inc.
CxBg	Capco Steel Corporation

SOUTH CAROLINA

CxBg	Able Iron Works, Inc.
CxBg	The Kline Iron & Steel Co.
CxBg Mbr FP	SMI-Owen Steel Company
CxBg P	Steel Fab, Inc.

SOUTH DAKOTA

CxBg MBr F	Egger Steel Company

TENNESEE

CxBg MBr FP	Beverly Steel, Inc.
CxBg	Fischer Steel Corp.
CxBg	Grace and Wylie Fabricators,
CnBg	Graco Inc.
CxBg	Skaggs Iron Works
CnBg	Stud Welding, Inc.
CxBg	Tate Fabricating Inc.
CxBg	Williams Steel Company

TEXAS

CxBg	Alamo Steel Co.
CxBg	American Steel & Aluminum
CnBg	Antenna Products Corp.
CxBg	Beck Steel, Inc.
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CxBg	Ramsey Steel Company, Inc.
CxBg P	Safety Steel Service, Inc.
CxBg	Tips Iron & Steel Co.
CxBg MBr F	Trinity Industries Inc.
CxBg	W & W Steel Company
CnBg	Wilborn Steel Corporation

UTAH

CxBg Mbr F	Mark Steel Corp.
CxBg MBr FP	Mountain States Steel, Inc.
CxBg	Niederhauser Ornamental & Metal Works
CxBg Mbr	S & S Steel Fabrication
CxBg Mbr	SME Industries, Inc.
CxBg MBr F	St. George Steel Fabrication
CxBg	Tech-Steel, Inc.
MBr FP	Utah Pacific Bridge & Steel

VIRGINIA

CxBg MBr FP	Atlas Machine & Iron Works,
CxBg MBr F	Carolina Steel Corp.
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CxBg MBr F	Globe Iron Construction Co.
CnBg	Hamilton Iron Works, Inc.
CxBg MBr F	Hirschfeld Steel Co. Inc.
CxBg	Lynchburg Steel & Specialty
CnBg	M & S Fabricators Inc.
CxBg	Southern Iron Works, Inc.
CxBg MBr F	Tidewater Steel Co., Inc.
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CxBg Mbr	Williams Bridge Company
CxBg MBr F	Williams Bridge Company

WASHINGTON

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CxBg MBr F	Keiser Steel Fabricators
CxBg	Midco Manufacturing, Inc.
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CxBg	Red Iron Corp.
CnBg	Seaport Fabrication, Inc.
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CnBg	Western Steel Fabricators

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CxBg MBr F	Maritime Steel & Foundries

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KOREA

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CxBg Mbr	Hyundai Heavy Industries
CxBg Mbr	Samsung Heavy Industries

INORGANIC ZINC-RICH COATINGS VS. GALVANIZING

Clearing up misconceptions about when and how to specify each type of corrosion protection

By Gordon H. Brevoort

A CONTINUING ARGUMENT IN THE FABRICATED STEEL INDUSTRY revolves around the merits of using untopcoated inorganic zinc-rich coatings or hot-dip galvanizing on new structures. Unfortunately, much of the discussion revolves around misconceptions and anecdotal stories.

In reality, both galvanizing and inorganic zinc-rich coatings have strengths—and limitations—and there are slight differences in performances. Choosing one over the other is not always simple and specifiers need to consider a variety of factors, including corrosion rates, environmental considerations, and ease of specifying and use.

COMMON GROUND

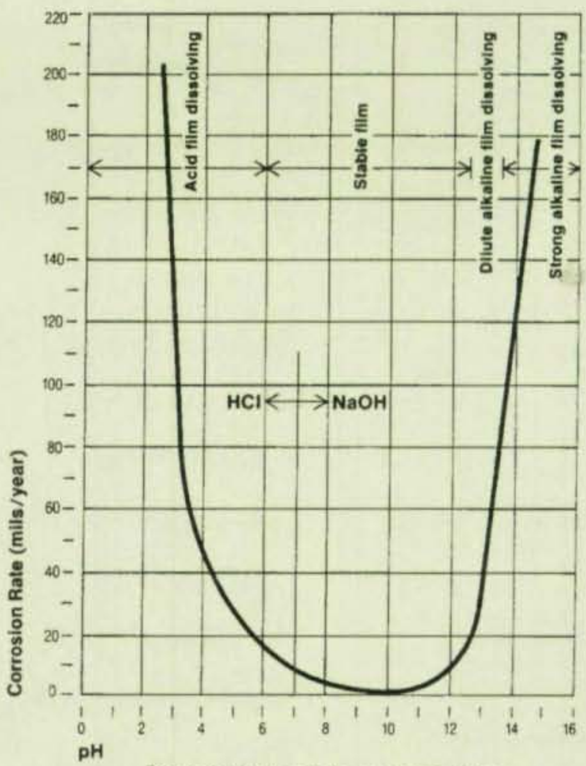
Zinc protects steel in several ways. It acts as a barrier coat between the atmosphere/environment and the steel substrate. When coupled to steel in the presence of an electrolyte, the zinc "sacrifices" itself and thereby protects the steel from corrosion. However, the rate of zinc destruction will depend on the amount of water present, the average temperature and the amount of zinc exposed. Zinc will not last very long in complete water immersion or in continuous high humidity. And zinc loss is even faster in hot water: temperatures between 140 and 250 degrees F can actually reverse polarity and cause the zinc to contribute to—rather than inhibit—the corrosion of steel.

Zinc produces protective corrosion products that result from

Corrosion Rates Of Zinc & Steel

Location	Environment	Two-year wt. loss in grams: Zinc	Two-year wt. loss in grams: Steel	Loss Ratio Steel: Zinc
Phoenix	Desert	0.13	2.23	17.0
Cape Kennedy, FL (60 years to ocean, ground level)	Tropic/Seacoast	1.83	215.0	117.0
State College, PA	Rural	0.51	11.17	22.0
Kure Beach, NC (800-ft. to ocean, ground level)	Marine/Seacoast	0.89	71.0	80.0
Middletown, OH	Moderate Ind.	0.54	14.0	26.0
Bayonne, NJ	Seacost Ind.	2.11	37.7	17.9

Source: Zinc Institute, Inc., 1971 "Zince Coatings for Corrosion Protection



Effect of pH value on the corrosion of zinc

Source: Zinc Institute, Inc., 1971 "Zince Coatings for Corrosion Protection

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reaction with oxygen, carbon dioxide and moisture, which produces zinc oxides, hydroxides and carbonate salts. To function properly as a protective coating, zinc must dry periodically. When zinc is utilized properly, though, the results are phenomenal: a corrosion rate just one-twentyfifth that of iron. Zinc also is "self-healing": When the protective layer is damaged—wears away or is scratched—a new layer of insoluble zinc salts forms. This protection actually extends beyond the coating border by as much as $^{1}/_{4}$-in.

The environment plays an important role in the success of zinc protection. Zinc is amphoteric and performs best in neutral environments (pH 7), though it is more susceptible to acids (pH less than 6) than alkalis (pH greater than 10.5), according to R.E. Moore, Raytheon Eng. & Contractors, Philadelphia.

Though it will resist solvent fume or spill environments, zinc has limited resistance to chlorides, sulfides and alkali's. In these environments water soluble salts are formed that destroy the basic zinc protective mechanism.

One of the biggest misconceptions is that the performance characteristics of zinc is different depending on how it is applied. In actuality, an ounce of zinc properly applied to clean steel, whether via hot-dip galvanizing or inorganic zinc-rich coating, offers essentially the same protection, corrosion rate and life span. The voluminous data on corrosion rates and resistances supplied by The Zinc Institute do not differentiate in what form the zinc is present: galvanizing, zinc-rich coatings, or any other form.

In mild environments with a 6-10.5 pH range, both galvanizing and inroganic zinc-rich coatings have produced structures that have performed well without topcoating for more than 20 years.

ADVANTAGES & DISADVANTAGES

There are some clear differences, however, between galvanizing and using zinc-rich coat-

Corrosion Of Zinc In Various Atmospheres

Environment	Years To Corrode 1 Mil (25 microns)
Rural	22.0
SW Seacoast	14.0
Heavy Ind. Seacoast	4.6
Heavy Industrial	3.8

Source: Zinc Institute, Inc., 1971 "Zinc Coatings for Corrosion Protection"

Average Service Life
(years before first painting of galvanizied substations)

Environment	Years To Corrode
Suburban	21
Marine	19
Moderate Industrial	16
Heavy Industrial	9

Source: Zinc Institute, Inc., 1971 "Zinc Coatings for Corrosion Protection"

Hot-Dip Galvanizing

Advantages:
- Can be easily applied to small parts, bolts, nuts & fabricated steel members of a sufficient size to go into a galvanizing kettle
- On relatively small, complex shapes or objects, cost is lower than zinc-rich coatings
- Galvanizing bath produces a continuous zinc film over the surface, edges & angles
- Adhesion of the zinc film is chemical (an amalgamation of the zinc & steel surfaces)
- Zinc surface provides good abrasion resistance
- Zinc coating provides cathodic (galvanic) and corrosion protection to the steel

Disadvantages:
- Cannot be applied to large or existing structures (limited by kettle size)
- Structures may warp in the hot bath, requiring straightening
- A pure zinc surface is more sensitive to marine and chemical environments than either inorganic or organic zinc-rich coatings
- Zinc is reactive in pH range of less than 6 or greater than 10.5
- Heat resistance is somewhat below the melting point of zinc
- Must be roughened for use on faying surfaces (friction joints)
- "Double-dipping" may be required for large pieces
- Difficult to topcoat

Inorganic Zinc-Rich Coatings

Advantages:
- Can be easily applied to large or existing structures
- Unaffected by weather, sunlight, or wide variations in temperature
- High adhesion to clean steel; has a chemical bond & physical adhesion
- Inorganic binder partially insulates zinc particles & extends life
- As fire resistant as steel; heat resistnace higher than zinc alone
- Unaffected by most organic solvents
- Surface is metallic, strongly adherent & abrasion resistant
- Excellent undercutting resistance
- Can be used on faying surfaces (friction joints)
- More easily topcoated than galvanized structures
- Application in place to completed structures enhances protection since all flat surfaces, edges and joints are protected with continuous film

Disadvantages:
- Must be applied over bare, abrasive blasted clean steel
- Won't tolerate organic contamination of steel surface
- Will not adhere to all metals or alloys—performs best over steel or zinc
- Many types require medium range of appliction temperature and humidity to properly cure and attain optimum properties
- Not satisfactory for continuous immersion in electrolytes
- Sensitive to strong acid or alkali environments. Zinc is reactive in pH range of less than 6 or greater than 10.5

ings. Galvanizing is limited to new structures and the availability of galvanizers with adequate size galvanizing kettles or tanks. Most galvanizing is accomplished with fabricated pieces before erection or final fabrication. Small pieces—open-web floor grating, ladders and hand rails—are much more easily galvanized.

Zinc-rich coatings can be applied to new or old structures on the ground, in the shop, or in place. Their use is cost-effective on large structural pieces, pipe, plate steel, large vessels, and irregular shapes. The decision to use zinc-rich coatings on new construction can be made at any time without disrupting new construction schedules or incurring higher costs.

Organic Zinc

Organic zinc-rich coatings, which use an organic binder as epoxy, have some but not all of the desirable properties of inorganic zinc-rich coatings and, in some cases, have advantages. Depending on the binder used, organic coatings can have increased chemical resistance. Also, they have greater tolerance to surface preparation, may be applied under widely varying weather conditions and can be easily topcoated. Their adhesion characteristics are those of the organic binder used, but without a chemical adhesion or bond. Galvanic protection is reduced, since the organic binder greatly insulates the zinc particles from the atmosphere. The life of untopcoated organic zincs is substantially less than inorganic zinc. Also, they have all the weather resistance characteristics of the organic binder and may blister in areas of high humidity or water immersion; heat resistance is usually below 300 degrees F.

Cost Considerations

The comparative costs of galvanizing vs. inorganic zinc-rich coatings are not generally understood and often are misrepresented. Much of this confusion comes from the different pricing structures used by the two industries: galvanizers typically charge by weight; the coatings industry usually charges by sq. ft. Cost comparisons, however, should be made on the basis of shop application of both.

The most economical and practical choice depends on the size, weight and shape, on how much of the piece is to be coated, and on whether warping by the heat of the galvanizing is a consideration. It is generally less expensive to galvanize most small pieces and small irregular shapes such as handrails, small angles, open-type floor grating, ladders, bolts and nuts. Likewise, it is generally less expensive to abrasive blast and apply inorganic zinc to large structural pieces, pipe, tank plates, vessels and large irregular shapes of all types.

While there are always exceptions, there are some rules-of-thumb on pricing, according to a study by W.A. Woods Jr. of Courtaulds Coatings, Inc.: Galvanizing is usually less expensive if the piece is less than 6-in. wide, less than $^5/_8$-in. thick, lighter than 30 lbs./sq. ft., or over 375-sq.-ft./ton; otherwise, inorganic zinc is usually a better buy.

Cost Comparison: Galvanizing Vs. Inorganic Zinc

Weight/Linear Ft. of Steelwork in lbs.	5	10	20	30	40	50
Surface area sq. ft./ton	524	410	348	301	247	217
*Galvanizing ($/cwt.)	$15.79	$14.86	$13.32	$12.30	$11.73	$11.34
**Inorganic-Zinc ($/cwt.)	$17.63	$13.80	$11.71	$10.13	$ 8.31	$ 7.30
Cost Difference ($/cwt.) Galv. & Inorganic Zinc	($1.84)	$ 1.06	$ 1.61	$ 2.17	$ 3.42	$ 4.04

* based on "Hot Dip Galvanizing Costs Less And Lasts Longer," 1988 American Hot Dip Galvanizers Association (1986)

** based on NACE Paper 469 reporting an inorganic zinc average cost per sq. ft. of $0.74 with material cost of $0.133 per sq. ft., $0.30 for SP10 near-white abrasive blasting and $0.24/sq. ft. shop labor to apply the inorganic zinc. Manual field blasting would increase costs about $0.65 per sq. ft. and field labor about $0.06 per sq. ft. (1990)

The formula to converst $/sq. ft. to $/cwt. (according to "You Be The Judge" by D. Griffin, Courtaulds Coatings, Inc.) is: sq. ft./ton/20 x $/sq. ft. = $/cwt.

Practical Considerations

The use of galvanizing requires considerable attention to detail and the specifications to make sure favorable design criteria are built in to facilitate galvanizing application and construction scheduling. This includes such things as: selecting the type of steel; adequate thickness of steel or riveting of thin components prior to galvanizing to prevent warpage; bending, forming and punching/drilling prior to galvanizing to prevent cracking of the zinc coating; avoiding boxed-in sections and including notched fabrications with stiffeners in order to permit the free flow of zinc to and away from all surfaces; bending of plates and shapes to be done hot; and drilled/punched holes to be designed large enough to allow for the zinc coating on fasteners.

Inorganic-zinc coatings can be used on new or renovation projects, and while no design decisions need to be made, the steel does have to be abrasive blast cleaned.

Topcoating

Initially, when the coating is first applied, properly compounded zinc-rich coatings can be readily topcoated (either for aesthetics or increased protection) at the fabrication shop or on site. Galvanizing, however, requires brush-blasting or acid etching (e.g., vinyl wash primer) to remove the galvanizing contaminants and to provide adequate surface profile to achieve good adhesion.

Topcoating of either aged galvanized or inorganic zinc-rich coatings can be achieved by pressure water washing, acid etching or brush blasting (SP-7, NACE No. 4) and applying a suitable primer and protective coating system. Should water-soluble salts be present, their removal is very difficult and generally requires complete removal by abrasive blasting and application of a new protective system suitable for the specific environment.

The above procedures can be used regardless of whether the coating is galvanizing or inorganic zinc; however, it is always essential to follow the supplier's recommendations. Also, alkyds should never be used since they react with the zinc, saponify, and turn to soap with the result being a loss of adhesion.

Neither untopcoated galvanizing nor inorganic zinc-rich coating is the answer for all structures and situations. Specifiers must carefully consider the environment, weather conditions and size and nature of the structure and its components.

Gordon H. Brevoort is a 45-year veteran in the heavy-duty paint and protective coatings industry. He is well known for his work in creating the "Paint and Coatings Selection and Cost Guide," which is published biennially through NACE . He currently is president of Brevoort Consulting Associates, Inc., in North Beach, NJ.

Zinc Primer

Carboline 861 is a high solids, high zinc load primer for protecting structural steel in weathering environments. It meets class B slip co-efficient and creep testing criteria and has a quick recoat and cure time. It can be applied directly to connecting and faying surfaces without masking, resulting in fabrication time savings. Also, the VOC compliant primer can be applied at temperatures as low as 35 degree F.

For more information, contact: Carboline Co., 350 hanley Industrial Court, St. Louis, MO 63144; 314/644-1000; fax: 314/644-4617 or circle no. **91**

Lead Paint Removal

TPC Books has published Project Design, a comprehensive guide to planning and designing industrial lead paint removal projects. The book was written by Kenneth A. Trimber and Daniel P. Adley as Volume II of the Industrial Lead Paint Removal Handbook, which covers the basics of regulations, worker protection and methods of removal, containment & disposal. This new 324-page publication includes checklists and worksheets, test methods, procedures for cleaning containment, equipment, and scenarios for various jobs.

To order a copy of the $85 publication, contact: SSPC Publication Sales, 4516 henry St., Suite 301, Pittsburgh, PA 15213; 412/687-1113; fax: 412/687-1153 or circle no. **119**

Corrosion Resistant Coatings

Metal Coatings International has published a new 12-page brochure for its Dacrotizing and Dacrosealing metal finishing services. The coating compositions provide protection and enhance the performance of fasteners and other metal components.

For more information, contact: John A. Walsh, Metal Coatings International, 275 Industrial Parkway, Chardon, OH 44024-1083; 216/946-2064 or circle no. **86**

High-Performance Coatings

Ameron is offering a new brochure describing its PSX 700 protective coating for structures. The company claims the product offers a longer service life than the traditional epoxy/aliphatic polyurethane system it replaces, yet, when combined with an inorganic zinc primer, the two-coat system outlasts the best three-coat zinc silicate, epoxy, polyurethane systems.

For more information, contact: Ameron, 201 North Berry St., Brea, CA 92621; 714/529-1951; fax; 714/990-0437 or circle no. **22**

Corrosion Resistance

A high performance urethane coating from Wasser High-Tech Coatings eliminates most application restrictions for temperature, humidity and dew point. The company's coatings will cure as quickly as four hours in temperatures down to 15 degrees F, can be applied in humidities of 6 to 99 percent, and can be wetted or immersed after as little as 20 minutes after application. The coatings offer superior corrosion resistance and can be used to encapsulate red lead. They have been specified by more than a dozen state DOTs as well as more than 10 major utilities.

For more information, contact: Wasser High-Tech Coatings at (800) MC-PAYNT or circle no. **50**

Specialized Coatings

E-Poxy Industries, Inc., offers a variety of coatings for the construction industry. A full line of EVA-POX specialized coatings are available for both new construction and renovation. The company also produces Evazote 380 ESP, an expansion joint material which handles 60% compression and 30% tension.

For more information, contact: E-Poxy Industries, Inc., 14 West Shore St., Ravena, NY 12143 (518) 756-6193 or circle no. **25**

Environmentally Conscious Coatings

Southern Coatings, a subsidiary of Pratt & Lambert, Inc., is a leader in providing environmentally conscious primers and topcoats for the steel fabricator and joist manufacturer. The Enviro-Guard line offers lead- and chromate-free primers and coatings offering superior protection against rust and corrosion.

For more information, contact: Southern Coatings, Inc., P.O. Box 160, Sumter, SC 29151 (800) 766-7070; fax (803) 254-4833 or circle no. **30**

Coating Thickness Measure

A new range of Coating Thickness Gauges has been introduced by Elcometer Instruments Ltd. The Elcometer 345 is pocket-sized, yet offers a number of advanced features, including an angled screen with backlighting, so that even in the darkest corners these instruments can be easily read. Options include the entry of limits for tolerance checking and the ability to average readings. Also, one model offers memory for up to 10,000 readings.

For more information, contact: Elcometer Inc., 1893 Rochester Industrial Dr., Rochester Hills, MI 48309 (800) 521-0635; fax (313) 650-0500 or circle no. **109**

Fast-Curing Epoxies

Tnemec Co. has introduced Series 163 Varuse epoxy coating for steel that can be applied in a variable range of temperatures—including cool weather. It is available in a wide selection of colors and can be used as a primer, intermediate or finish coat.

For more information, contact: Tnemec Co., Inc., P.O. box 411749, Kansas City, MO 64141-1749 (816) 483-3400; fax (816) 483-1251 or circle no. **121**

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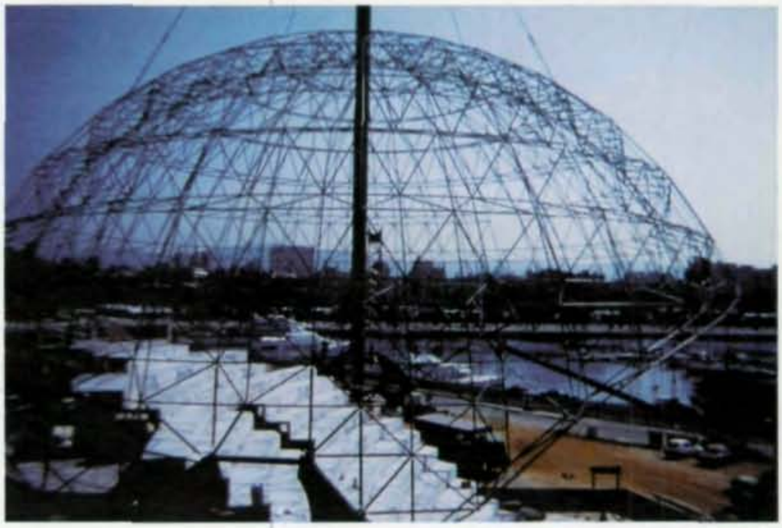

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