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July 1994

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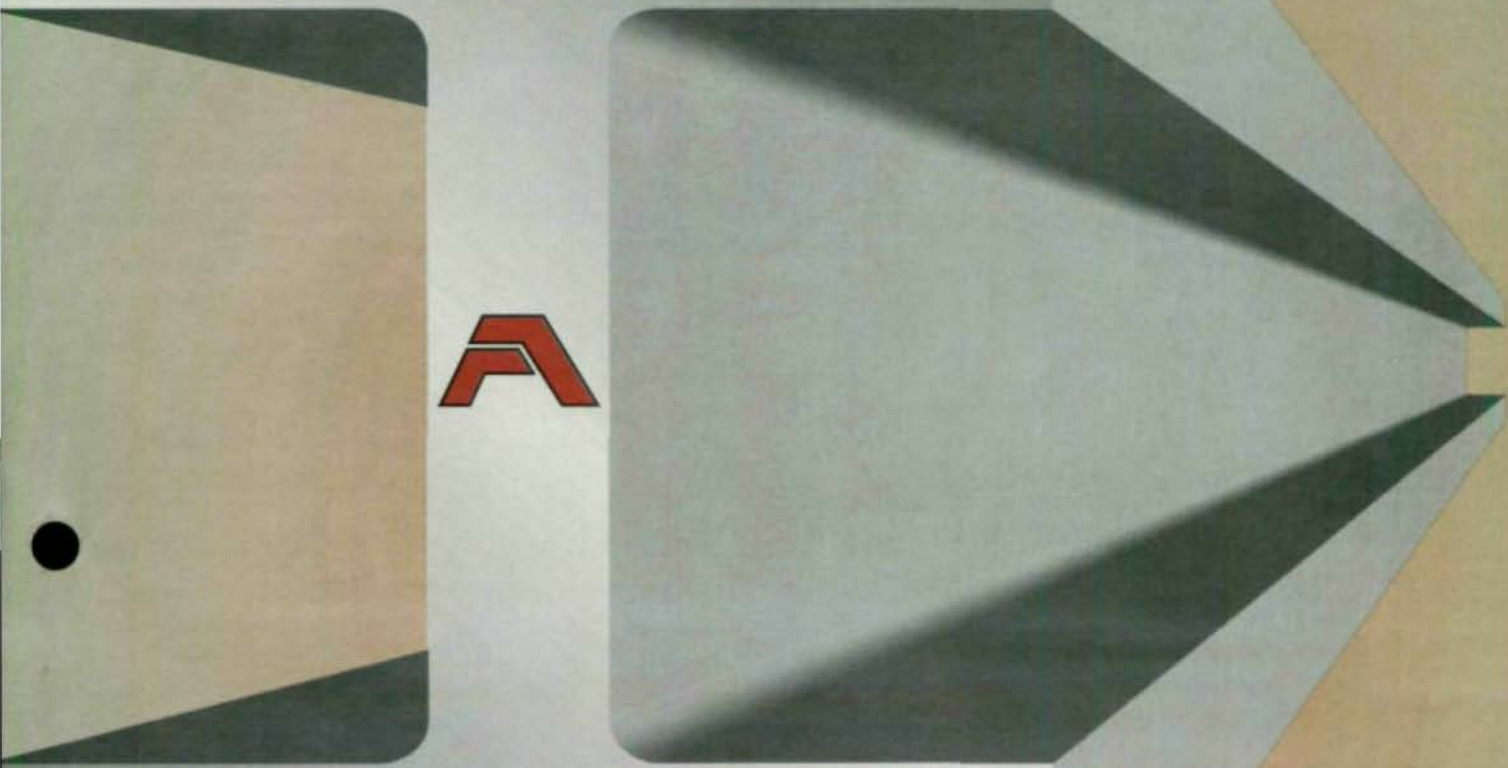

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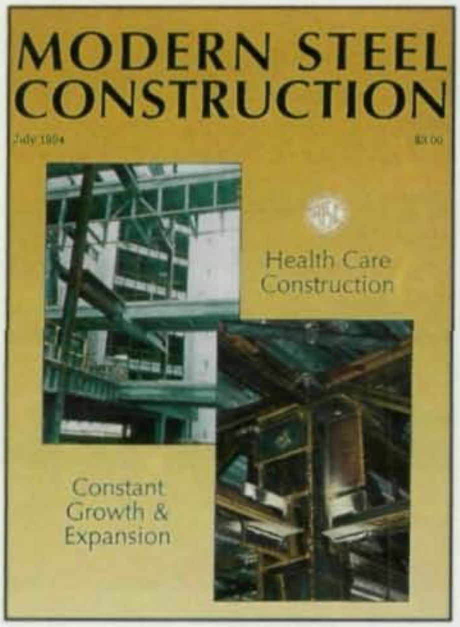
MODERN STEEL CONSTRUCTION

Volume 34, Number 7 July 1994



Many hospitals are continuously growing. These two Milwaukee hospitals illustrate some of the challenges faced by health care designers—tight sites, constant change orders, and the need to build without disrupting occupied spaces.

Features

Departments

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READER SERVICE

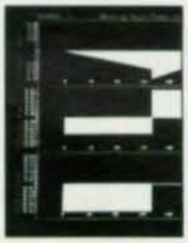
AS I WAS DEPLANING FROM MY TRIP TO PITTSBURGH AND THE NATIONAL STEEL CONSTRUCTION CONFERENCE, I grabbed a copy of the inflight magazine to take with me. Most people don't realize it, but the airlines actually want travelers to take the magazine with them. Magazines are only profitable if the advertisers are happy, and the best way to make advertisers happy is to generate a lot of response to their advertisements. To help increase (and to measure) responses, magazines often offer "Reader Service Cards" (bingo cards in publishing jargon). Airlines realize that if people take the magazines home with them, there's a far greater chance of travelers filling out and returning the cards.

Beginning with this issue, *Modern Steel Construction* will include a Reader Service Card near the back of each issue (its easy to find because it's printed on a different paper stock than the rest of the magazine). Included at the bottom of most ads and the descriptions of products mentioned in articles will be a number. To receive information on that particular product, simply circle the appropriate number on the Reader Service Card, clip it out of the magazine, and drop it in the mail. The card is postage-paid, so there's no cost to you. Feel free to circle as many as you want.

In addition, we'll occasionally run a Steel Survey in the news section (page 11 in this issue). This month we're asking for your opinion about future AISC Seminar Series topics. Responding to the survey is simple. Again, the responses are tied into the free Reader Service Card.

Oh, and by the way, the National Steel Construction Conference was great this year—from the T.R. Higgins lecture on composite construction to a connection question-and-answer session featuring Omer Blodgett and Geoffrey L. Kulak to the new products in the exhibit hall. But I'll write more about the show in next month's issue. And, if you're a real early bird about planning, keep in mind that next year's show will be in San Antonio in May. If any of the conversations I've been overhearing are an indication, it will be even better than this year's! Hope to see you there. **SM**

How to get from here



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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 312/670-2400 ext. 433.

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

Serviceability is a particular concern for crane systems in industrial buildings but is not clearly covered in standard code literature. What are deflection limits for crane runway systems?

In Industrial Buildings, AISC Design Guide series No. 7, 1993 by James M. Fisher, deflection limits are given as follows:

•Vertical deflection of the crane beam due to wheel loads (no impact);

•L/600 for Light and Medium Cranes (CMAA Classes A, B, C, and D)

•L/1000 for Mill Cranes (CMAA Classes E and F)

•Lateral deflection of the crane beam due to crane lateral loads:

•L/400 for all cranes.

Hussain Shanaa, Ph.D., P.E.
AEC Engineering
Minneapolis, MN

Another response:

Excessive deflections cause steep slopes on the runway and are a serious operating obstacle. Sometimes a crane cannot climb the slope caused by this deflection and will become stuck in midspan. Conversely, the crane can increase speed dangerously on the downhill portion of the trip.

The Crane Manufacturers Association of America (CMAA) recommends vertical deflections (from dead load plus rated load) not to exceed 0.00125 inch per inch of span of bridge girders. This limit could be applied to runway girders as well.

Horizontal deflections are not so critical but excessive deflection can cause excessive wear on wheel flanges and on the rail. Horizontal deflection of girder should be limited to half the difference between width of rail head and the inside flange-to-flange dimension of the wheel. Expressed differently, the center-to-center dimension of runway rails must not vary more than the difference of the inside flange-to-flange wheel less the width of rail head.

Gerald A. Reed, P.E.
Kennecott Utah Copper Corp.
Bingham Canyon, UT

Another response:

There is no consensus among designers and engineers regarding crane runway deflection limits. However, there is general agreement that these limits should be considerably less than, for example, the L/360 deflection limit normally adhered to for members supporting plaster ceilings.

Deflection limits recommended in the literature vary from L/600 for light cranes up to L/1200 for heavy, fast cranes. Stone & Webster's procedures require runway vertical deflection limits of from L/800 to L/100. Generally, lateral deflection is limited to L/400. These limits may be marginally exceeded when re-rating existing runways. We have been using these criteria for simple span girders on cranes in CMAA Classes A1, A2, B, and C with no apparent problems.

The deflection limit is only one of several important aspect of crane runway design. There are many other concerns to be addressed by the crane runway designer. To note all of them is impractical in this type of response. A very good introduction to crane runway design is the article, *Tips for Avoiding Crane Runway Problems* by David T. Ricker, AISC Engineering Journal, 4th Quarter 1982.

G. Jeffrey Ashworth, P.E.
Stone & Webster Engineering Corp.
Boston, MA

Another response:

Excessive crane beam deflection is the underlying cause of many crane runway problems, such as: weakening and eventual fracture of the crane beam-to-column connections, bending in the crane column, cracking of the crane beam web, creeping of the crane rail leading to loosening of the rail clips or hook bolts, yawing of the crane bridge resulting in binding wheels with subsequent wear of rails, wheel flanges, and bearings, etc. Historically, stiffer crane beams have a better performance record. The design profession, however, is not in agreement as to the desired degree of stiffness. For example:

SOURCE	MAX. VERT. DEFL. (IN.)
F.S. Merritt	L/750
Gaylord & Gaylord	L/960 for light, slow cranes L/1200 for heavy, fast cranes
AISE Tech Report #13	L/1000
AISC Design Guide #7	L/600 for light & medium cranes (CMAA classes A, B, C, and D) L/1000 for mill cranes (CMAA classes E and F)

Since the benefits of crane beam stiffness far outweigh the costs of attainment this writer suggests using L/1000 for CMAA classes A, B, and C and L/1200 for CMAA classes D, E, and F. For all cranes lateral deflection should be limited to L/400.

As a word of caution, never use multi-span crane or knee braces as a means to reduce deflection. Crane beams should be designed as single spans.

David T. Ricker, P.E.
Payson, AZ

In a structure that has tubular columns, should weep holes be added at the bottom of the columns in order to drain any water in the column?

If water is present inside tubular columns, internal corrosion is likely. An ultrasonic thickness examination can be performed without removing the water. The Engineer can then determine the structural adequacy of the columns based on the amount of metal loss. From electrochemistry,

$$\underset{\text{(iron)}}{4Fe} + \underset{\text{(air)}}{3O_2} + \underset{\text{(moisture)}}{2H_2O} \rightarrow \underset{\text{(hydrated red iron rust)}}{2Fe_2O_3 \bullet H_2O}$$

In the above expression, moisture (water or humidity) is required for steel to rust in the presence of oxygen (air). If one of the above elements or compounds is removed, the reaction will stop. For example, steel will not rust in dry air.

If a column is structurally adequate, it should be drained and seal welded airtight. Equilibrium between the air, moisture and rust will be reached and rust formation will stop. The exterior of the column can then be protected with an approved coating. If seal welding is not possible, vents should be added for drainage and the column protected with a properly designed cathodic protection system.

If a column is judged inadequate, there are two fabrication options available. A new column seal welded airtight and painted or a column with vents and hot dip galvanized for adequate interior corrosion protection. Special vent details and recommendations for proper drainage during the galvanizing process are available from the American Galvanizers Association. Vents in the base plate are undesirable when dry packing is specified.

Ron E. Campos, S.E.
La Habra, CA

New Question

Listed below is a question 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.

Questions and responses will be printed in future editions of Steel Interchange. Also, if you have a question or problem that readers might help solve, send these to the Steel Interchange Editor.

What is the best location for providing cover plates to strengthen a W section if the beam compression flange is fully braced:

- **a) At top flange before erection.**
- **b) At top flange after erection.**
- **c) At bottom flange before erection.**
- **d) At bottom flange after erection.**
- **e) Does not matter.**

A.Z. Piracha
Miami

Steel Seminars

AN INTRODUCTION TO THE NEW MANUAL OF STEEL CONSTRUCTION, LRFD, 2ND EDITION, highlights AISC Marketing's continuing four-part seminar series, "Innovative Practices In Structural Steel."

The lecture includes a discussion and explanation of the changes, including such items as the stability of unbraced frames, web crippling equations, and slip critical joints at factored loads.

The seminar also includes a session on steel design software, the latest NEHRP Seismic Regulations, and a review of semi-rigid composite connections. The seven-hour seminar costs $90 ($75 for AISC members), including dinner. The lecture has a CEU value of 0.4. For more information, call 312/670-2400 or circle no. 3 on the reader service card.

Dates & Locations

WEST

Phoenix	Oct. 20
Portland, OR	Nov. 15
Las Vegas	Nov. 17

MIDWEST

Detroit	Oct. 11
Indianapolis	Oct. 13
Cleveland	Oct. 25
Columbus	Oct. 26
Cincinnati	Oct. 27

NORTHEAST

Albany	Sept. 13
Rochester	Sept. 14

SOUTHWEST

Oklahoma City	Sept. 8

SOUTH

Atlanta	Sept. 20
Richmond	Sept. 22
Memphis	Oct. 18
Miami	Nov. 1
Orlando	Nov. 3

MIDATLANTIC

Edison, NJ	Oct. 4
Philadelphia	Oct. 6

QUICK STEEL SURVEY

BEGINNING THIS MONTH, *MODERN STEEL CONSTRUCTION* will print a monthly survey. To make it easier for you to respond, you can use the postage-paid Reader Service Card in the back of this magazine (between pages 42 & 43). Simply circle the appropriate numbers on the Card, cut it out of the magazine, and drop it in the mail.

1. FOR MANY YEARS, AISC has offered an inexpensive annual seminar series dealing with such topics as eccentrically braced frames and seismic design. Which topics would you be interested in if they were included in next year's seminar series (circle all that interest you):

Actual project examples	circle 11
Bracing	circle 12
Computer software	circle 13
Connections	circle 14
Industrial bldg. design	circle 15
Inspection	circle 16
LRFD	circle 17
Load analysis	circle 18
Metric conversions	circle 19
New design methods	circle 20
Retrofit of old buildings	circle 21
Seismic design	circle 22
Semi-rigid connections	circle 23
Torsional analysis	circle 24

Improving Structural Design

A workshop on the "Improvement of Structural Design and Construction Practices in the U.S. and Japan" will be held September 19-21 in Victoria, British Columbia. Sponsored jointly by the Applied Technology Council and the Japan Structural Consultants Association, the bi-annual workshop will include panel discussions and presentations on the following topics:

- Recorded ground motions (Northridge and Hokkaido Earthquakes)
- Performance of building structural and nonstructural systems and elements during the Northridge and Hokkaido Earthquakes
- Comparisons and updates of U.S. and Japan building codes
- Current practical dynamic analysis methods and drift limits in both countries
- Current developments in foundation seismic design, response control systems, and passive energy dissipation
- Quality control and education

For more information, contact: Applied Technology Council, 555 Twin Dolphin Dr., Suite 550, Redwood, CA 94065; phone: 415/595-1542; fax: 415/593-2320.

Steel Coatings

The Steel Structures Paint Council's Annual International Conference and Exhibition will be held November 11-17 in Atlanta. The seven-day conference will include 50 papers and 14 seminars exploring the theme of "Managing Costs and Risks for Effective and Durable Protection." In addition to the seminars, the program will include 15 tutorials and an exhibit of approximately 250 indoor booths and 30 outdoor booths.

Other upcoming SSPC meetings include:

- July 28-29 "Industrial Lead Paint Removal and Abatement" tutorial in Denver
- Sept. 17-18 "Industrial Lead Paint Removal and Abatement" tutorial in Los Angeles
- Sept. 19-23 "Specifying and Managing Protective Coatings" Projects in Los Angeles
- Oct. 4-5 "Industrial Lead Paint Removal and Abatement" tutorial in Dallas
- Oct. 18-19 "Industrial Lead Paint Removal and Abatement" tutorial in Baltimore

For more information, contact: Steel Structure Painting Council, 4516 Henry St., Ste. 301, Pittsburgh, PA 15213-3728; phone: 412/687-1113; fax: 412/687-1153.

Movable Bridges

THE FIFTH BIENNIAL SYMPOSIUM ON "HEAVY MOVABLE STRUCTURES/MOVABLE BRIDGES" will be held Nov. 2-4 in Clearwater Beach, FL. For information, contact: HMS, Inc., P.O. Box 398, Middletown, NJ 07748; phone/fax: 908/957-9753.

Advanced Technology

Technological Advance in Japanese Building Design and Construction, a new book from the Columbia University Graduate School of Architecture, offers a look at the latest Japanese technology for design and construction.

The 109-page book, the first in a planned trilogy, addresses such topics as vibration control, environmental control, building enclosure, disaster prevention, construction team techniques & technology, building use & maintenance, and research & development.

A section on construction automation touches on such diverse topics as construction robots for steel-welding and concrete finishing and Fujita Corp.'s well-reported "automated vertical transport system" for material delivery within a construction project. An entire chapter is devoted to future R&D projects, including intelligent office systems, tensegrity structures and nonstructural vibration control.

To purchase a copy of the $26 book, contact: ASCE, Publications Dept., 345 East 47th St., New York, NY 10017. For more information, circle no. 95 on the reader service card.

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M. SMI Steel Inc.
N. Nucor-Yamato Steel
R. Roanoke Steel
S. North Star Steel
T. TradeARBED
U. Nucor Steel
W. Northwestern Steel & Wire
Y. Bayou Steel Corp.

Section Weight Per Ft.	Producer Code
W44 x 230-335	T
W40 x 431	T
W40 x 397*	N
W40 x 371*	T
W40 x 362*, 324*	N
W40 x 321	T
W40 x 297	N
W40 x 199-277	N, T
W40 x 174	T
W40 x 278, 331	T
W40 x 211-264	B, I, T
W40 x 183	B, I, N, T
W40 x 149, 167	B, I, N, T
W36 x 439-798	T
W36 x 393	B, N, T
W36 x 230-359	B, I, N, T
W36 x 256	B, I, N
W36 x 232	B, I, N
W36 x 135-210	B, I, N, T
W33 x 318, 354	B, T
W33 x 201-291	B, N, T
W33 x 118-169	B, I, N, T
W30 x 261-326	B, I, N, T
W30 x 284*	I
W30 x 173-235	B, I, N, T
W30 x 99-148	B, I, N, T
W30 x 90	B, N
W27 x 368-539	I
W27 x 307	I, T
W27 x 258	I, N, T
W27 x 235	I, N
W27 x 146-217	B, I, N, T
W27 x 132*	I
W27 x 84-129	B, I, N, T, W
W24 x 335-492	T
W24 x 279	I, T
W24 x 250	B, I, N
W24 x 229	B, I, N, T, W
W24 x 207	B, N, W
W24 x 104-192	B, I, N, T, W

Section Weight Per Ft.	Producer Code
W24 x 100*, 120*, 160*	N
W24 x 103	B, N, W
W24 x 84, 94	B, I, N, W
W24 x 68, 76	B, C, I, N, W
W24 x 56*, 61*	N
W24 x 55, 62	B, C, I, N, W
W21 x 182, 201	I, W
W21 x 101-166	B, I, N, W
W21 x 83, 93	B, I, N, W
W21 x 62-73	B, C, I, N, W
W21 x 48*, 55*	N
W21 x 44-57	B, C, I, N, W
W18 x 258-311	B
W18 x 175-234	B
W18 x 130-158	B, W
W18 x 130*	N
W18 x 76-119	B, N, W
W18 x 65, 71	B, I, N, W
W18 x 50-60	B, C, I, N, W
W18 x 35-46	B, C, I, N, W
W16 x 67-100	B, N, W
W16 x 57	B, I, N, W
W16 x 36-50	B, C, I, N, W
W16 x 26, 31	B, C, I, N, W
W14 x 808	B
W14 x 455-730	B, I, T
W14 x 370-426	B, I, T
W14 x 311, 342	B, I, N, T, W
W14 x 145-283	B, I, N, T, W
W14 x 90-132	B, I, N, T, W
W14 x 82	B, N, W
W14 x 74	B, C, N, W
W14 x 61, 68	B, C, N, W
W14 x 43-53	B, C, N, W

Notes: Maximum lengths of shapes obtained vary with producer, but typically range from 60 ft to 75 ft. Lengths up to 100 ft are available for certain shapes. Please consult individual producers for length requirements.

* Shapes not currently listed in *Manual of Steel Construction*

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M. SMI Steel Inc.
N. Nucor-Yamato Steel
R. Roanoke Steel
S. North Star Steel
T. TradeARBED
U. Nucor Steel
W. Northwestern Steel & Wire
Y. Bayou Steel Corp.

Section Weight Per Ft.	Producer Code
W14 x 38	B, I, N, W
W14 x 30, 34	B, C, I, N, W
W14 x 22, 26	B, C, I, N, W
W12 x 252-336	B, I
W12 x 210, 230	B, I
W12 x 170, 190	B, I, T, W
W12 x 65-152	B, I, N, T, W
W12 x 53, 58	B, C, N, I, W
W12 x 50	B, C, N, I, W
W12 x 40, 45	B, C, N, W
W12 x 26-35	B, C, N, W
W12 x 16-22	B, C, N, W
W12 x 14	B, C, W
W10 x 88-112	B, I, N, W
W10 x 49-77	B, C, I, N, W
W10 x 33-45	B, C, N, W
W10 x 22-30	B, C, I, N, W
W10 x 15-19	B, C, I, U, W
W10 x 12	*B, C, U, W*
W8 x 31-67	B, C, I, N, W
W8 x 24, 28	B, C, N, W
W8 x 18, 21	B, C, N, W, Y
W8 x 15	B, C, U, W, Y
W8 x 10-13	B, C, M, U, W, Y
W6 x 15-25	B, C, I, N, U, W
W6 x 12, 16	B, C, U, W, Y
W6 x 9	B, C, J, U, W, Y
W6 x 8.5*	C, J, M, U, Y
W5 x 16, 19	B, U
W4 x 13	B, C, M, U, Y
M12 x 10.8, 11.8	C, J
M12 x 10.0*	J
M10 x 8, 9	C, J, U
M10 x 7.5*	J

Section Weight Per Ft.	Producer Code
M8 x 8.2*	J
M8 x 6.5	C, J, U
M5 x 18.9	B
M4 x 6*	C, U
S24 x 106, 121	B, W
S24 x 80-100	B, W
S20 x 86, 96	B, W
S20x 66, 75	B, W
S18 x 54.7, 70	B, W
S15 x 42.9, 50	B, W
S12 x 40.8, 50	B, W
S12 x 35	B, W
S12 x 31.8	B, C, W
S10 x 35	B, S
S10 x 25.4	B, C, S
S8 x 18.4, 23	C, S
S6 x 12.5, 17.25	C, S, Y
S5 x 10	C, Y
S4 x 9.5	C
S4 x 7.7	C, Y
S3 x 7.5	C, J, Y
S3 x 5.7	C, J, M, Y
HP14 x 73-117	B, I, N, W
HP12 x 53-84	B, I, N, W
HP10 x 42, 57	B, C, I, N, W
HP8 x 36	B, C, I, N, W
C15 x 33.9-50	B, N, W
C12 x 30	B, W
C12 x 20.7, 25	B, C, S, W
C10 x 25, 30	B, S, W
C10 x 15.3, 20	B, C, S, U, W
C9 x 20	B
C9 x 13.4, 15	B, S
C8 x 18.75	S, W, Y
C8 x 11.5, 13.75	C, M, S, U, W, Y
C7 x 12.25	S, U, W
C7 x 9.8	M, S, U, W
C6 x 13	M, S, U, W, Y
C6 x 10.5	C, M, S, U, W, Y
C6 x 8.2	C, F, M, U, W, Y,
C5 x 9	M, U, W, Y
C5 x 6.7	F, M, U, W, Y
C4 x 5.4, 7.25	F, M, U, W, Y
C3 x 6	M, U, W, Y
C3 x 4.1, 5	F, M, R, U, W, Y
C3 x 3.5*	R, U

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Principal Producers Of Structural Shapes

B. Bethlehem Steel Corp.	J. J&L Structural Inc.	R. Roanoke Steel	U. Nucor Steel
C. Chaparral Steel	M. SMI Steel Inc.	S. North Star Steel	W. Northwestern Steel & Wire
F. Florida Steel Corp.	N. Nucor-Yamato Steel	T. TradeARBED	Y. Bayou Steel Corp.
I. British Steel			

Section Weight Per Ft.	Producer Code
MC18 x 42.7-58	B, N
MC13 x 31.8-50	B, N
MC12 x 31-50	B, N
MC12 x 10.6	J, S
MC10 x 28.5-41.1	B
MC10 x 22, 25	B
MC10 x 8.4	J, S
MC10 x 6.5	J
MC9 x 23.9, 25.4	B
MC8 x 21.4, 22.8	B, S
MC8 x 18.7, 20	B, S
MC8 x 8.5	J, M
MC7 x 19.1, 22.7	B
MC6 x 18	B
MC6 x 15.1, 16.3	B, S
MC6 x 12	B, S
MC4 x 13.8*	S
MC 3 x 7.1*	S

Section by Leg Lengths & Thickness		Producer Code
L8 x 8 x	1 1/8	B, T
	1	B, S, T
	7/8	B, S, T
	3/4	B, S, T
	5/8	B, S, T
	9/16	S
	1/2	B, S
L6 x 6 x	1	B, U, Y
	7/8	B, U, Y
	3/4	B, M, U, Y
	5/8	B, M, U, Y
	9/16	M, U, Y
	1/2	B, M, S, U, Y
	7/16	B, M, U, Y
	3/8	B, M, S, U, Y
	5/16	M, U, Y
	1/4*	U
L5 x 5 x	7/8	U, Y
	3/4	M, U, Y
	5/8	M, U, Y
	1/2	M, U, W, Y
	7/16	M, U, Y
	3/8	M, U, W, Y
	5/16	M, U, W, Y
	1/4*	U
L4 x 4 x	3/4	M, U, Y
	5/8	M, U, Y
	1/2	F, M, R, U, W, Y
	7/16	F, M, U, Y
	3/8	F, M, R, U, W, Y
	5/16	F, M, R, U, W, Y
	1/4	F, M, R, U, W, Y
L3 1/2 x 3 1/2 x	1/2	F, M, U, W, Y
	7/16	U, Y
	3/8	F, M, R, U, W, Y
	5/16	F, M, R, U, W, Y
	1/4	F, M, R, U, W, Y
L3 x 3 x	1/2	F, M, U, W, Y
	7/16	U, Y
	3/8	F, M, R, S, U, W, Y
	5/16	F, M, R, S, U, W, Y
	1/4	F, M, R, S, U, W, Y
	3/16	F, M, R, U, W, Y
L2 1/2 x 2 1/2 x	1/2	F, U
	3/8	F, R, S, U
	5/16	F, R, S, U
	1/4	F, R, S, U
	3/16	F, R, U
L2 x 2 x	3/8	F, R, S, U
	5/16	F, R, S, U
	1/4	F, R, S, U
	3/16	F, R, S, U
	1/8	F, R, S, U
L8 x 6 x	1	B, S
	3/4	B, S
	9/16	S
	1/2	B, S
	7/16	B, S
L8 x 4 x	1	B, S
	7/8	S
	3/4	B, S
	5/8	S
	9/16	S
	1/2	B, S
	7/16	S
L7 x 4 x	3/4	B, Y
	5/8	B, Y
	1/2	B, S, Y
	7/16	Y
	3/8	B, S, Y

Notes: Maximum lengths of shapes obtained vary with producer, but typically range from 60 ft to 75 ft. Lengths up to 100 ft are available for certain shapes. Please consult individual producers for length requirements.

* Shapes not currently listed in *Manual of Steel Construction*

Principal Producers Of Structural Shapes

B. Bethlehem Steel Corp.
C. Chaparral Steel
F. Florida Steel Corp.
I. British Steel
J. J&L Structural Inc.
M. SMI Steel Inc.
N. Nucor-Yamato Steel
R. Roanoke Steel
S. North Star Steel
T. TradeARBED
U. Nucor Steel
W. Northwestern Steel & Wire
Y. Bayou Steel Corp.

Section by Leg Lengths & Thickness		Producer Code
L6 x 4 x	7/8	B
	3/4	B, M, S, U, W, Y
	5/8	B, M, S, U, W, Y
	9/16	M, S, U, Y
	1/2	B, M, S, U, W, Y
	7/16	U, Y
	3/8	M, S, U, W, Y
	5/16	M, S, U, W, Y
L6 x 3 1/2 x	1/2	M, U, W, Y
	3/8	M, U, W, Y
	5/16	M, U, W, Y
L5 x 3 1/2 x	3/4	M, U, Y
	5/8	M, U, W, Y
	1/2	M, U, W, Y
	3/8	M, U, W, Y
	5/16	M, U, W, Y
	1/4	M, U, W, Y
L5 x 3 x	1/2	F, M, U, W, Y
	7/16	F, Y
	3/8	F, M, U, W, Y
	5/16	F, M, U, W, Y
	1/4	F, M, U, W, Y
L4 x 3 1/2 x	1/2	F, M, U, W
	3/8	F, M, R, U, W
	5/16	F, M, R, U, W
	1/4	F, M, R, U, W
L4 x 3 x	5/8	M, U, Y
	1/2	F, M, U, W, Y
	7/16	U, Y
	3/8	F, M, R, U, W, Y
	5/16	F, M, R, U, W, Y
	1/4	F, M, R, U, W, Y
L3 1/2 x 3 x	1/2	U, W
	3/8	M, U, W
	5/16	M, U, W
	1/4	M, U, W
L3 1/2 x 2 1/2 x	1/2	U
	3/8	U, W
	5/16 *	U, W
	1/4	U, W
L3 x 2 1/2 x	1/2	U, W
	3/8	U, W
	5/16	U, W, Y
	1/4	R, U, W
	3/16	U

Section by Leg Lengths & Thickness		Producer Code
L3 x 2 x	1/2	F
	3/8	F, S, U
	5/16	F, S, U
	1/4	F, R, S, U
	3/16	F, R, U
L2 1/2 x 2 x	3/8	R, S, U
	5/16	S, U
	1/4	R, S, U
	3/16	R, S, U

Designations, Dimensions & Properties

W shapes have essentially parallel flange surfaces. The profile of a W shape of a given nominal depth and weight available from different producers is essentially the same except for the size of fillets between the web and flange.

HP bearing pile shapes have essentially parallel flange surfaces and equal web and flange thickness. The profile of an HP shape of a given nominal depth and weight available from different producers is essentially the same.

American Standard Beams (S) and American Standard Channels (C) have a slope of approximately 17 percent (2 in 12 in.) on the inner flange surfaces. The profiles of S and C shapes of a given nominal depth and weight available from different producers is essentially the same.

The letter M designates shapes that cannot be classified as W, HP, or S shapes; MC designates channels that cannot be designated as C shapes. M and MC shapes may or may not have slopes on their inner flange surfaces, dimensions for which can be obtained from the respective producing mills.

Because some shapes are only produced by a limited number of producers, or are infrequently rolled, specifiers should consult rolling schedules from the respective mills for availability information.

Information about dimensions and properties of individual shapes is contained in the AISC *Manual of Steel Construction* (both LRFD and ASD).

Notes: Ma x imum lengths of shapes obtained vary with producer, but typically range from 60 ft to 75 ft. Lengths up to 100 ft are available for certain shapes. Please consult individual producers for length requirements.
* *Shapes not currently listed in Manual of Steel Construction*


Big Bend
36"
Rolls a 36-Inch Beam
Largest Angle Roll
in the Western Hemisphere
CAPACITIES TYPE A-36 STEEL
10" x 10" x 1" Angle Iron Leg Out and Leg In
9" Solid Round Bar
8" Solid Square Bar
4" x 14" Flat Bar on Flat (the easy way)
2¾" x 12" Flat Bar on Edge (the hard way)
16" Pipe and Tubing (square, round and rectangular)
36" Beams and Channels
12" Tees Stem In and Stem Out
CHICAGO METAL
ROLLED PRODUCTS COMPANY
3715 South Rockwell, Chicago, Illinois 60632
FOR INQUIRIES & ORDERS
CALL 312-523-5757
FAX 312-650-1439

Principal Producers Of Structural Tubing

A. Acme Roll Forming Co.
B. Bull Moose Tube Co.
C. Copperweld Corp.
D. Dallas Tube & Rollform
E. Eugene Welding Co.
H. Hanna Steel Corp.
I. Independence Tube Corp.
J. Vest Inc.
L. LaClede Steel Co.
M. Maruichi American Corp.
N. Hannibal Industries, Inc.
P. IPSCO, Inc.
R. Standard Tube Co.
S. Sonco Steel Tube
T. Atlas Tube
U. UNR- Leavitt, Div. of UNR Inc.
V. Valmont Industries
W. Welded Tube Co. of America
X. EXLTUBE
Z. Welded Tube of Canada Ltd.

Nominal Size and Thickness	Producer Code
12x10x1/2, 3/8, 1/4	B, S, U, V*
12x8x5/8	C, S,W
12x8x1/2, 3/8, 5/16, 1/4	B, C, S, T, W
12x8x3/16	B, C, S, U
12x6x5/8	S
12x6x1/2, 3/8, 5/16, 1/4	B, C, S,U,W
12x6x3/16	B, C, S, U
12x4x5/8	S
12x4x1/2, 3/8, 5/16, 1/4, 3/16	B, C, S, U, W, Z
12x3x5/16, 1/4, 3/16	B, Z
12x2x1/4, 3/16	B, S, U, Z
10x8x1/2, 3/8, 5/16, 1/4, 3/16	B, C, S, U, W
10x6x1/2	B, C, S, T, U, W, Z
10x6x3/8, 5/16, 1/4, 3/16	B, C, D, P, S, T, U, W, Z
10x5x3/8, 5/16, 1/4, 3/16	B, C, D, S
10x4x1/2	B, C, P, S, T, U, W, Z
10x4x3/8, 5/16, 1/4, 3/16	B, C, D, P, S, T, U, W, Z
10x3x3/8, 5/16	B, D
10x3x1/4	B, D
10x3x3/16	B, D, Z
10x2x5/16	D, P, S, T, U, W, Z
10x2x1/4, 3/16	B, D, P, S, T, U, W, Z
9x7x1/2, 3/8, 5/16, 1/4, 3/16	C, W
9x5x1/2, 3/8, 5/16, 1/4, 3/16	C, W
9x3x1/2, 3/8, 5/16, 1/4, 3/16	C
8x6x1/2	B, C, P, S, T, U, W, Z
8x6x3/8, 5/16, 1/4, 3/16	B, C, D, P, S, T, U, W, Z
8x4x5/8	B, S
8x4x1/2	B, C, P, S, T, U, W, Z
8x4x3/8, 5/16	B, C, D, H, I, J, P, R, S, T, U, W, Z
8x4x1/4, 3/16	B, D, H, P, S, W, X
8x4x1/8	B, D, I, J, P, S, Z
8x3x1/2	C, P, T, U
8x3x3/8, 5/16	B, C, D, H, I, P, U, W, Z
8x3x1/4, 3/16	B, C, D, H, I, P, S, U, W, Z
8x3x1/8	B, C, D, I, P, S, Z
8x2x3/8	H, J, S, T, U, Z
8x2x5/16	H, I, J, P, S, T, U, W, Z
8x2x1/4, 3/16	B, D, H, I, J, P, S, T, U, W, Z
8x2x1/8	B, D, I, J, P, S, T, Z
7x5x1/2	B, C, P, S, T, U, W, Z
7x5x3/8, 5/16	B, C, H, I, P, R, S, T, U, W, Z
7x5x1/4, 3/16	B, C, H, I, P, R, S, T, U, W, Z
7x5x1/8	B, I, P, S, T, X, Z
7x4x3/8, 5/16	C, D, H, I, P, S, U, W, Z
7x4x1/4, 3/16	C, D, H, I, P, S, U, W, Z
7x4x1/8	C, I, P, S, Z
7x3x3/8, 5/16	B, C, D, H, I, P, S, W, Z
7x3x1/4, 3/16	B, C, D, H, I, P, S, W, X, Z
7x3x1/8	C, D, H, I, P, S, Z
6x4x1/2	B, C, P, S, T, U, W, Z
6x4x3/8, 5/16	B, C, D, H, I, J, P, R, S, T, U, W, Z
6x4x1/4	B, C, D, H, I, J, P, R, S, T, U, W, X, Z
6x4x3/16	B, C, D, H, I, J, P, R, S, T, U, W, X, Z
6x4x1/8	B, C, D, I, J, P, S, T, V, X, Z
6x3x1/2	P, S, T, U, Z
6x3x3/8, 5/16	B, D, H, I, P, S, U, W, Z
6x3x1/4	B, D, H, I, P, S, U, W, X, Z
6x3x3/16	B, D, H, I, P, S, W, X, Z
6x3x1/8	B, D, H, I, S, P, U, X, Z
6x2x3/8	H, I, S, W, Z
6x2x5/16	B, H, I, J, P, S, T, W, Z
6x2x1/4, 3/16	B, C, D, H, I, J, P, N, R, S, T, W, X, Z
6x2x1/8	B, C, D, H, I, J, N, P, R, S, T, W, X, Z
5x4x3/8, 5/16	I, P, T, W, Z
5x4x1/4, 3/16	B, C, D, I, P, T, W, Z
5x3x1/2	C, P, S, T, U, Z
5x3x3/8, 5/16	C, D, H, I, J, P, R, S, T, U, W, Z
5x3x1/4, 3/16	C,D,E,H,I,J,N,P,R,S,T,U,W,X,Z
5x3x1/8	C, D, E, H, I, J, N, P, S, T, U, W, X, Z
5x2x5/16	I, J, P, R, S, T, W
5x2x1/4, 3/16, 1/8	B,C,D,E,H,I,J,N,P,R,S,T,U,W,X,Z
4x3x3/8	B, L, S, T
4x3x5/16	I, P, S, W
4x3x1/4, 3/16	B,C,D,H,I,J,E,L,N,P,R,S,T,U,W,X,Z
4x3x1/8	B, C, D, E, H, J, L**, N, P, R, S, T, U, W, X, Z
4x2x3/8	H, S, T
4x2x5/16	H, I, J, P, S, T, W, Z
4x2x1/4	B, C, D, E, H, I, J, N, P, R, S, T, U, W, X, Z
4x2x3/16	A, B, C, D, E, I, J, P, R, S, T, U, W, X, Z
4x2x1/8	A, B, C, H, I, N, P, S, T, W, X, Z
3x2x5/16	I, S, T
3x2x1/4	B, C, D, E, H, I, J, L, N, P, R, S, T, U, W, X, Z
3x2x3/16	A, C, D, E, I, J, L, P, R, S, T, U, W, X
3x2x1/8	A, B, C, D, E, H, I, J, L**, N, P, R, S, T, U, W, X, Z
3x1 1/2x3/16, 1/8	C, W
2 1/2 x1 1/2 x1/4	A, B, C, E, I, S, U, X
2 1/2 x1 1/2 x3/16	B, C, E, H, I, R, S, U, X
1 1/2 x1 1/2 x1/4	L

Notes: *Size is manufactured by Submerged Arc Welding (SAW) process and are not stocked by steel service centers (contact producer for specific requirements). All other sizes are manufactured by Electric Resistance Welding and most are available from steel service centers.
**LaClede does not produce the 1/8; instead, it produces a .120 size.

Principal Producers Of Structural Tubing (Round)

A. Acme Roll Forming Co.
B. Bull Moose Tube Co.
C. Copperweld Corp.
D. Dallas Tube & Rollform
E. Eugene Welding Co.
H. Hanna Steel Corp.
I. Independence Tube Corp.
J. Vest Inc.
L. LaClede Steel Co.
M. Maruichi American Corp.
N. Hannibal Industries, Inc.
P. IPSCO, Inc.
R. Standard Tube Co.
S. Sonco Steel Tube
T. Atlas Tube
U. UNR- Leavitt, Div. of UNR Inc.
V. Valmont Industries
W. Welded Tube Co. of America
X. EXLTUBE
Z. Welded Tube of Canada Ltd.

Nominal Size and Thickness	Producer Code
20x.500, .375	P*, W
20x.250	P*
18x.500, .375	P*, W
18x.250	P*
16x.500	P*, W
16x.375	P*, W
16x.250	P
16x.188	P
14x.500, .438, .375, .250	P, W
14x.188	P
12.75x.500, .406, .375	P, W
12.75x.188	P, W
12.75x.125	P
12.5x .625, .500, .375, .312, .250, .188	C
10.75x.500, .365, .250	P, W, Z
10x.625, .500, .375, .312	C
10x.250, .188	C
10x.125	V
9.625x.500	C, U, Z
9.625x.375, .312, .250, .188	C, P, U, Z
8.75x.500, .375, .312, .250, .188	C
8.625x.500	P, S, U, Z
8.625x.375	P, S, U, Z
8.625x.322	P, S, U, W, Z
8.625x.250, .188	P, S, U, Z
8.625x.125	P, S
7.5x.500, .375, .312, .250, .188	C
7x.500	C, P, U, Z
7x.375, .312, .250	C, P, R, S, U, Z
7x.188	C, P, R, S, U, Z
7x.125	C, P, Z
6.875x.500, .375, .312, .250, .188	C
6.625x.500, .432	P, U, Z
6.625..375, .312	P, R, U, Z
6.625x.280	P, R, U, W, X, Z
6.625x.250, .188	P, R, U, W, X, Z
6.625x.125	P, Z
6.125x.500, .375, .312, .250, .188	C
6x.500	S, Z
6x.375, .312	R, S, Z
6x.280	S, X, Z
6x.250, .188	R, S, Z
6x .125	Z
5.563x.375	P
5.563x.258	P, R, W, X, Z
5.563x.134	P, R, Z
5.5x.375, .258	U
5x.500, .375, .312	C, P, T, Z
5x.258	P, R, T, U, X, Z
5x.250, .188	C, L, P, R, S, T, U, Z
5x.125	C, L*, P, R, S, T, U, Z
4.5x.237, .188	L*, P, R, S, U, W, X, Z
4.5x.125	L*, P, R, S, U, Z
4x.337	R, S, U
4x.250, .188	C, R, S, U, W, Z
4x.237	R, S, W, Z
4x.125	C, R, S, U, Z
3.5x.300	P, S, X, Z
3.5x.250, .203, .188, .125	P, S,
3.5x.216	P, S, W, X
3x.250, .203, .188, .152	L, R, S, U, Z
3x.300	S, X
3x.216	R, S, U, W, X
2.875x.250	L*, P, U, Z
2.875x.203, .188	L*, P, U, W, Z
2.875x.125	L*, P, U, Z
2.375x.250, .218, .188	L, P, S, Z
2.375x.154	L, P, S, U, W, X, Z
2.375x.125	P, R, S, U, W, Z

Notes: *Size is manufactured by Submerged Arc Welding (SAW) process and are not stocked by steel service centers (contact producer for specific requirements). All other sizes are manufactured by Electric Resistance Welding and most are available from steel service centers.
**LaClede does not produce the 1/8; instead, it produces a .120 size.

Structural Steel Shape Producers

Bayou Steel Corp.
P.O. Box 5000
Laplace, LA 70068
(800) 535-7692

Bethlehem Steel Corp.
501 East Third St.
Bethlehem, PA 18016-7699
(800) 633-0482

British Steel Inc.
475 N. Martingale Rd. #400
Schaumburg, IL 60173
(800) 542-6244

Chaparral Steel Co.
300 Ward Road
Midlothian, TX 76065-9501
(800) 529-7979

Florida Steel Corp.
P.O. Box 31328
Tampa, FL 33631
(800) 237-0230

J&L Structural Inc.
111 Station St.
Aliquippa, PA 15001
(412) 378-6490

Northwestern Steel
& Wire Co.
121 Wallace St.
P.O. Box 618
Sterling, IL 61081-0618
(800) 793-2200

North Star Steel Co.
1380 Corporate Cntr. Curve
P.O. Box 21620
Eagan, MN 55121-0620

Nucor Steel
P.O. Box 126
Jewett, TX 75846
(800) 527-6445

Nucor-Yamato Steel
P.O. Box 1228
Blytheville, AR 72316
(800) 289-6977

Roanoke Electric Steel Corp.
P.O. Box 13948
Roanoke, VA 24038
(800) 753-3532

SMI Steel, Inc.
101 South 50th St.
Birmingham, AL 35232
(800) 621-0262

TradeARBED
825 Third Ave.
New York, NY 10022
(212) 486-9890

Structural Tube Producers

ACME Roll Forming Co.*
812 North Beck St.
Sebewaing, MI 48759-1120
(800) 937-8823

Atlas Tube*
200 Clark St.
Harrow, Ontario, NOR 1G0
CANADA
(519) 738-3541

Bull Moose Tube Company*
1819 Clarkson Road, Suite 100
Chesterfield, MO 63017-5040
(800) 325-4467

Copperweld Corporation*
4 Gateway Center, Ste. 2200
Pittsburgh, PA 15522
(412) 263-3200

Dallas Tube & Rollform
P.O. Box 540873
Dallas, TX 75354-0873
(214) 556-0234

Eugene Welding Co.*
P.O. Box 249
Marysville, MI 48040
(800) 336-3926

EXLTUBE
905 Atlantic
N. Kansas City, MO 64116
(800) 892-8823

Hanna Steel Corp.*
3812 Commerce Ave.
P.O. Box 558
Fairfield, AL 35064
(800) 633-8252

Hannibal Industries, Inc.*
P.O. Box 58814
Los Angeles, CA 90058
(213) 588-4261

Independence Tube Corp.*
6226 W. 74th St.
Chicago, IL 60638-6196
(708) 496-0380

IPSCO Steel, Inc.
P.O. Box 1670, Armour Rd.
Regina, Saskatchewan S4P 3C7
CANADA
(416) 271-2312

LaClede Steel Co.*
One Metropolitan Square
St. Louis, MO 63102-2739
(314) 425-1461

Maruichi American Corp.*
11529 S. Greenstone Ave.
Santa Fe Springs, CA 90670
(310) 946-1881

Sonco Steel Tube*
14 Holtby Ave.
Brampton, Ontario L6S 2M3
CANADA
(800) 268-3005

Standard Tube Company*
P.O. Box 430
Woodstock, Ontario N4S 7Y6
(519) 537-6671

UNR-Leavitt,
Div. of UNR Industries, Inc.*
1717 West 115th St.
Chicago, IL 60643-4399
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CONSTANT GROWTH

A nearly constant need for more room complicated on-going construction projects

Pictured at top is the new sixth floor framing with the columns spliced to the existing columns from below. The mechanical unit remained in place to allow the operating rooms below to continue functioning during the construction. When the building is nearly complete, the unit will be demolished and removed. Floor framing will be added to complete the floor. Shown above is a plate girder at each floor spanning 105 ft. over the existing four-story main hospital section.

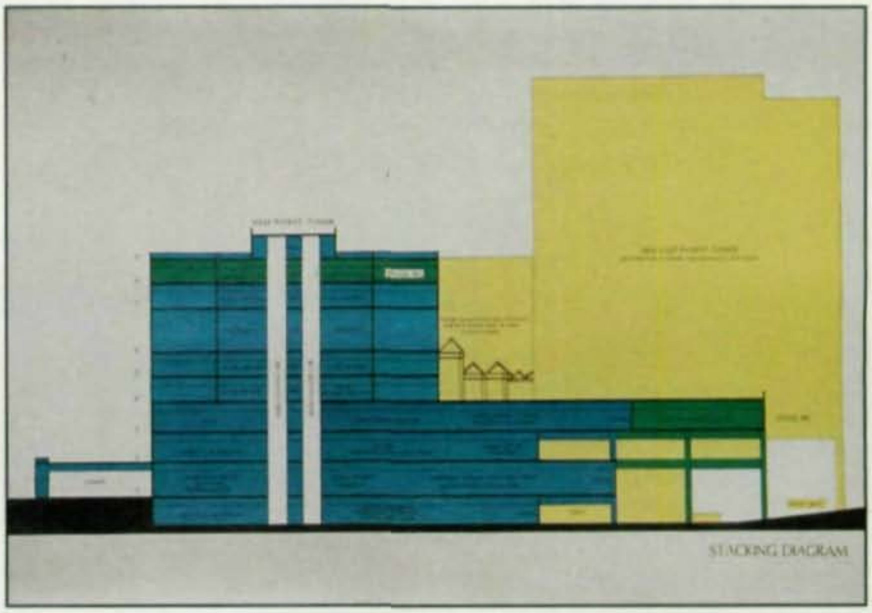
By Steve Punch, P.E., and Sidney S. Wall

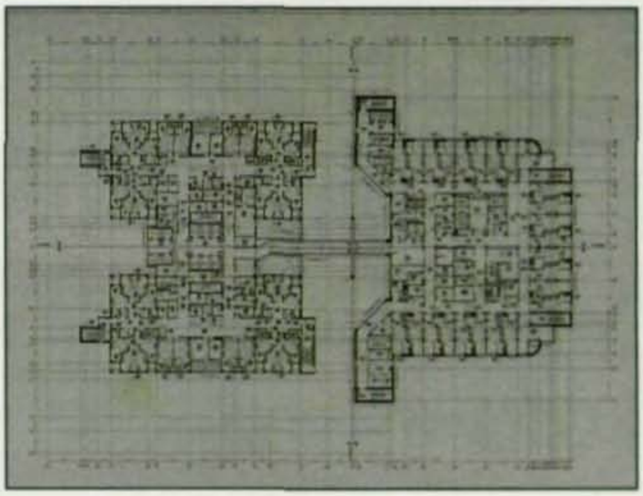
THE CITY OF MILWAUKEE HAS A LONG HISTORY OF PROVIDING HEALTH CARE FACILITIES specifically for children. It began a century ago with one nurse and a 10-bed hospital established in a small house. Decades of steady growth and expansion have culminated in today's Children's Hospital of Wisconsin, which is located on the Milwaukee Regional Medical Center Campus in Wauwatosa, eight miles west of downtown Milwaukee. In addition to providing state-of-the-art health care services for the young, the hospital is part of a prestigious cooperative teaching program known as the Medical College of Wisconsin.

When Children's Hospital relocated in late 1988 from its downtown hospital site to Wauwatosa, it quickly became evident that even more room would be needed. The hospital had moved into a 300,000-sq.-ft. facility designed by Henningson, Durham, and Richardson, Inc. (HDR), Dallas, which served as both architect and engineer on the project. Construction manager was McCarthy of St. Louis. The structural steel building had composite floor deck and lightweight concrete fill with exterior cladding consisting of architectural precast panels with punched window openings.

Although provisions were made in the original design for one additional floor, it was soon obvious that even more would be needed. Within two weeks after occupancy of the new building, the hospital census was running at nearly 100 percent. By early

1989, Children's Hospital determined that additional space was needed due to the rapid growth and would, therefore, embark on a building program to expand the recently opened facility with two additional floors.





Additional Growth

THE EXPANSION PLANS RESULTED IN HDR DESIGNING a ninth level floor, which was called for in the original plans, as well as starting design on a new east tower building to be located adjacent to the four-story ancillary portion of the main building and above the completed loading dock service area. While up to 17 stories is ultimately planned for the site, during the first phase only one floor of this new structure was to be built. What makes this project unique is that, because of programmatic requirements, only the fourth floor would be constructed during the first phase. This would allow the existing surgery and recovery floor of the existing building to expand by almost 23,000 sq. ft. Since the first, second and third levels would be built at an unknown future date, provisions were necessary for attaching the future floor framing to the columns supporting the new fourth floor.

It became readily apparent that a steel structure was the most appropriate and efficient choice to accomplish the hospital's requirements. Its lighter weight compared to concrete construction would result in smaller drilled pier costs. And even more importantly, connection of future framing would be vastly simpler. Also, since neither forming nor shoring are required, steel erection would be faster than concrete and unhindered by obstructions.

The east tower fourth floor and roof (future fifth floor) were designed with A36 composite beams supporting 2-in. composite deck and $4^{1}/_{2}$ in. of lightweight concrete fill. Concrete shearwalls formed by the elevator core and stairwell shafts were designed to provide overall stability and resistance to wind loads. Column loading was based upon the accumulated loads due to a maximum of 17 floors. During the first phase and until the lower three levels are built, columns would be unbraced for three stories. To provide fire protection and reduce the column slenderness, W14x398 and W14x257 sections were encased in concrete. The concrete encasements included blockouts to allow access for beam erection and connection of the future lower framing. The tops of the columns extended above the roof and were prepared to easily accept a column splice for the next construction phase.

Filled To Capacity

CONSTRUCTION FOR THE EXPANSION PROGRAM began in the summer of 1989. However, before completion in late 1992, Children's Hospital again realized they were running out of space, a remarkable growth rate attributable to the tremendous regional and national exposure

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Shown above is the nearly complete addition to the Children's Hospital of Milwaukee.

resulting from their move into the new facility at the regional medical center campus. Patients were coming to Children's Hospital in greater numbers than ever expected, and it was apparent that the hospital could not continue to effectively handle the patient census and provide required services without significant expansion of the medical support departments and an increase in the number of patient beds.

In early 1992, HDR was authorized to proceed with plans to renovate 70,000 sq. ft. of the existing hospital, construct 260,000 sq. ft. on nine new floors in the east tower, and add a connector link passageway between the main building and the new tower floors.

Continuous Operation

ONE OF THE BIGGEST CHALLENGES CONFRONTED BY HDR AND MCCARTHY was the requirement for the hospital to remain completely operational during virtually all of the construction work. The use of structural steel played a major role in minimizing disruption and maintaining schedules.

Conventional steel erection using cranes was not possible for the east tower second and third levels since equipment access at the first level was severely restricted by basement walls and loading dock height and accessibility from above was blocked off by the existing fourth level surgery floor. Instead, scissor-lifts were utilized to erect the steel framing and deck in a planned sequence that allowed the hospital uninterrupted use of the loading dock area. The construction manager chose to place the steel for the east tower's sixth through 11th floor with a self-climbing tower crane placed inside one of the central core elevator shafts.

The second and third floor framing was erected to existing columns that supported the fourth floor. Erection was planned to allow the first floor loading dock to maintain its operation.

A connector link was constructed to allow passage between the main building and the new east tower. Pictured opposite is one of the three existing footings which was enlarged in order to support a new connector link between the main building and the east tower.

Prior to the commencement of erection, HDR was notified of an interference condition at the existing roof. An air-handling unit serving the surgery floor below and located on the roof was physically higher than the next level of structural framing. The top would extend into several beams and delay construction progress of a sizeable floor area. The unit was intended to be in service only for the interim period until a mechanical penthouse level could be completed. Meanwhile, though, the air-handling unit had to remain operational.

Fortunately, a simple solution was found. The affected area was directly accessible along the north side perimeter. The steel beams and deck in the two bays of the sixth floor above the unit were planned to be left out until the new mechanical system was finished. At such time, the interim unit could be disassembled, removed and the remaining framing, precast wall panels and floor would be put in place.

Fabricator and erector on the project is AISC-member Construction Supply & Erection, Inc.

Connections

VITAL TO THE EAST TOWER VERTICAL EXPANSION SCHEME WAS A CONNECTOR LINK to the main hospital building at the fifth, sixth, eighth and ninth floors. The lower floor would be connected because of a larger footprint plan. Complicating the design was the need to support the connector structure on existing columns of the main hospital building that were not designed for any additional future floors or increased loading.

Framing for the 12-ft.-wide by 80-ft.-long connector link was accomplished using W12x14 beams, W24x68 composite girders and 2-in.-deep composite deck with 3 in. of lightweight concrete fill. In addition, each floor slab functions as a simple span horizontal diaphragm for transferring wind loads from the connector to the main hospital

building and east tower. Intermediate support was achieved by adding W14x132 columns to the top of existing W14x90 columns.

However, calculations showed that the existing W14x90 sections would be overstressed from the connector link loads. Furthermore, soil pressures under these existing footings would exceed allowable recommendations given by the geotechnical engineer. The most reasonable option was to reinforce the existing columns by welding coverplates to the flanges and web. This created greater cross-sectional area and reduced the column stresses caused by the new loading conditions. It also was necessary to enlarge three existing footings in order that soil bearing pressures not exceed permissible values.

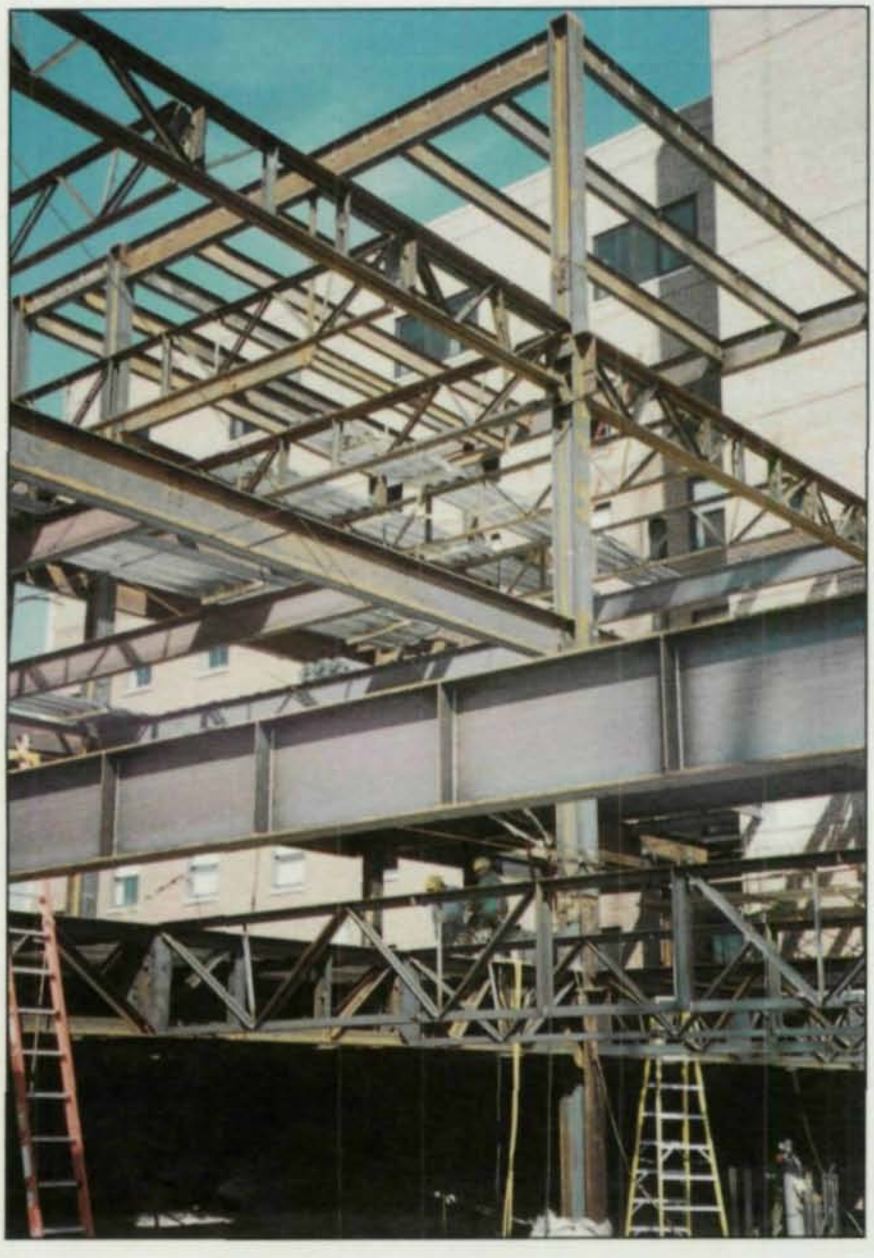
Dynamic Design

THE PROJECT AT CHILDREN'S HOSPITAL OF WISCONSIN illustrates the complexity and difficulty of hospital strategic planning and design. In response to the hospital's dynamic changes and growth, it has been demonstrated that structural steel provided the strength and versatility needed to solve simple and complex problems for both new and renovation work. Construction is currently ongoing and is expected to be complete in early 1995.

Steve Punch, P.E., is the structural section manager and Sidney S. Wall is vice president and senior project manager for the Dallas office of Henningson, Durham, and Richardson, Inc.

MATCHING HEIGHTS

A vertical addition to a Milwaukee hospital needed to match floor-to-floor heights with an adjacent building while accommodating massive mechanical ducts



The vertical addition at Columbia Hospital in Milwaukee included three stories plus a penthouse. Vierendeel trusses were used at the first and third levels of the addition.

By Steven J. Roloff, P.E.

UNLIKE OTHER TYPES OF OWNERS, WHEN HOSPITALS NEED MORE ROOM, they can't just pick up and move to a new building. Instead, they expand—both horizontally and vertically—their existing facilities. And even while they're planning one expansion, they're already anticipating another.

When Columbia Hospital in Milwaukee started construction on an Ancillary Building Addition (now part of The Clinical Building) back in 1982, they knew they'd one day outgrow the new space. So while they built a two-story structure, their engineers planned for a future four-story addition to the steel-framed building. By the early 1990s, their plan blossomed beyond expectations. Programming projections established that a new building was required in addition to a seven level vertical expansion of the existing Ancillary Building. However, due to uncertainty about the future of health care led the hospital to build only three of these floors now, while planning for four more floors in the future.

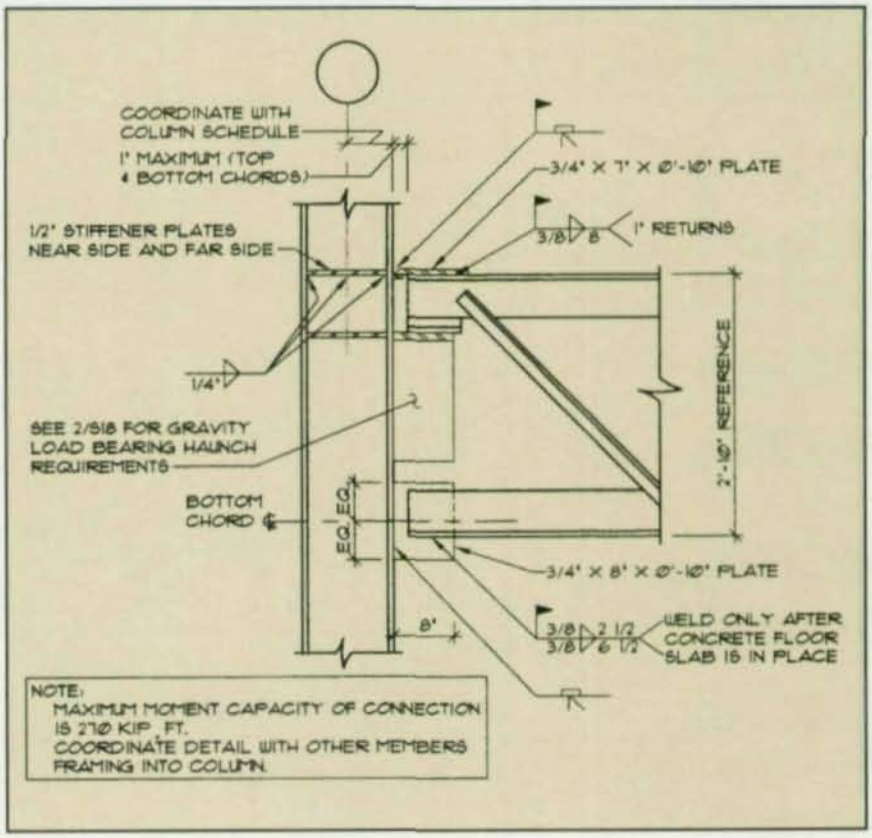
In addition, initial project planning directed that clinical and mechanical areas be incorporated in the new levels, thereby increasing structural floor loading requirements. The original two-story building featured a 13-ft.-high lower-level-to-ground elevation and a 14-ft.-high ground-to-first-level elevation to align with an adjoining building. Likewise, the floors of the vertical expansion also had to match those of an adjacent building. Unfortunately, this meant floor-to-floor heights as tight as 11-ft.-6-in.

Architectural requirements, including floor layouts with large open spaces and maximum future flexibility, did not permit vertical expansion of any of the original building's lateral load resisting K-braces or the use of any other similar diagonal member braces at any of the typical non-mechanical occupied floors. The large size of the required HVAC distribution system necessary to address the intense internal heat gains associated with high-tech medical equipment and stringent air exchange rates also played a significant role in the selection of the building's structural system.

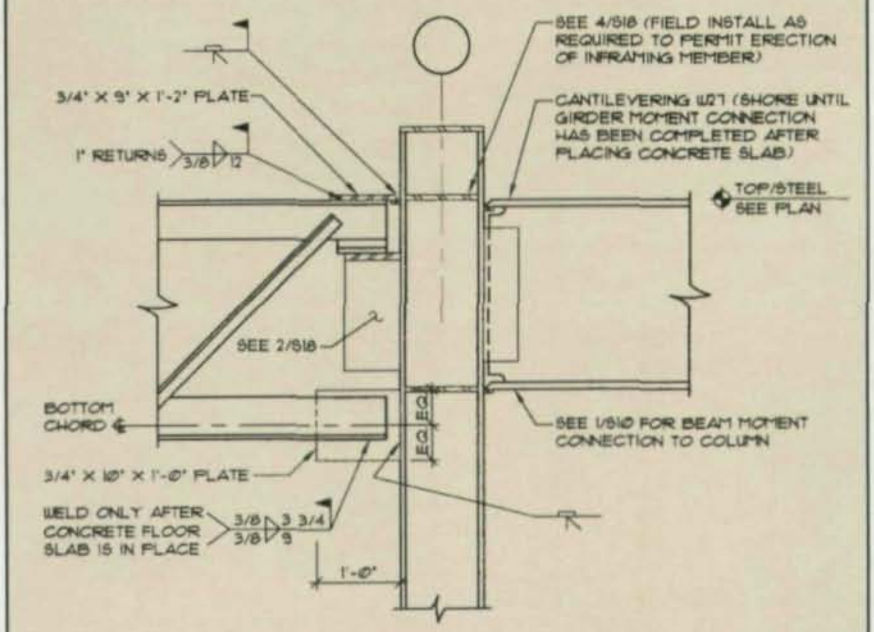
Design Challenges

The challenges inherent in the program were not that uncommon by themselves, but in combination they demanded a unique engineering solution. The approach was two-fold. First, the existing two-level structure had to be evaluated and reinforced for additional gravity and lateral loads from the levels not anticipated in the original design. Secondly, alternatives for the design of the new floors needed to be explored.

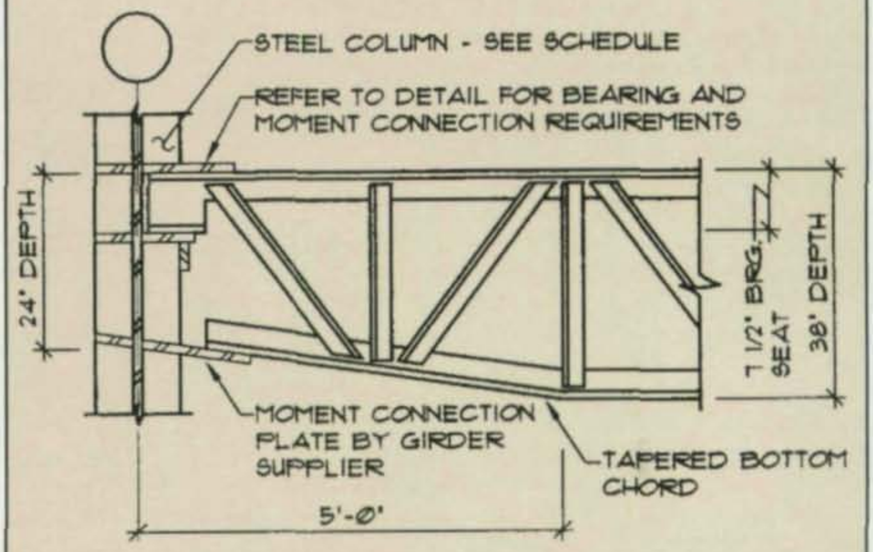
The foundation system for the original Ancillary Building construction consisted of concrete piers on 3-ksi concrete spread footings founded on 8-ksf allowable soil bearing pressure materials. One of the initial steps taken in the evaluation of the existing building was to determine the support characteristics of the insitu soils beneath the existing footings. The procedure used to complete this task was performed at two separate locations. The process consisted of coring through the existing footing pads and conducting pressuremeter testing. In addition, the cores collected from the footings were tested to evaluate their compressive strength. As a result of these tests, a net allow-



Pictured is a moment connection and similiar detail.



Section



Typical Tapered Joist/Girder End

able soil bearing capacity of 10.35 ksf was recommended with insitu concrete compressive strengths of about 5 ksi for the footing concrete. Using this information and the new anticipated footing loads, it was determined that all of the affected existing footings were structurally adequate.

Structural Design Alternatives

DURING THE CONCEPTUAL DESIGN OF THE NEW LEVELS, it quickly became apparent that there would be a conflict between the structural and

The detail at right shows the vertical reaction and moment connection between orthogonal inframing Vierendeel joist girders and a supporting column.

mechanical systems if the original structural system was simply duplicated. Because of the tight floor-to-floor heights, mechanical requirements and the 9-ft. ceiling heights desired by the architect in many locations, a new design solution was required.

In an effort to satisfy all of the design criteria, a cast-in-place concrete slab and column moment frame system was investigated and quickly eliminated. This approach would have required extensive foundation work to accommodate the additional structure dead weight. Also, too much work would have been required within the existing occupied spaces to make the transition from a steel frame to a concrete frame.

The next alternative considered was a stub-girder system. In this system, short lengths of rolled steel sections (stubs) are welded to the top of a steel beam and connected to the underside of a concrete slab by shear connectors. This system results in open areas between the stubs that can accommodate mechanical and distribution equipment. After preliminary study, however, it was determined that the stub-girder system would not provide large enough openings. Also, the magnitude of the negative moments produced by the lateral loads could not be easily accommodated by the system.

Another alternative considered was the use of deep beam sections with cut web openings to accommodate mechanical requirements. However, discussions with McCarthy Bros. Co., the project's construction manager, and with steel fabricators regarding preliminary pricing for this type of system revealed that it would be too expensive. However, it was determined that costs could be reduced by using a truss with a Vierendeel panel. Using this system meant the main mechanical duct chases would have to be provided in orthogonal directions and ducts would have had to be designed to

The photo above shows ductwork passing through the Vierendeel panel opening in a typical joist girder, as well as smaller ductwork passing through a variety of additional panel openings.

span across the Vierendeel panels. This system was chosen for two of the floors, with the third vertical expansion floor utilizing a conventional composite steel beam system to maximize head height at the floor containing the mechanical equipment room.

Since the project now consisted of only 108 custom fabricated trusses, it was decided that costs could be minimized by designing the trusses to meet Steel Joist Institute (SJI) specifications and typical manufacturing practices in order to facilitate fabrication by any SJI member manufacturer.

Type 1 Construction

SINCE THE BUILDING'S LATERAL LOAD RESISTANCE could not be accomplished using diagonal members, it was decided to go to a Type 1 rigid frame construction. Type 1 was chosen due to concerns the bottom chord of the truss may buckle under actual loads if only lateral loads were considered. But in an effort to reduce the negative moments to be designed for at the ends of the trusses, the final moment connection weldment was designed and detailed to be completed only after the slab's selfweight had been applied.

At some locations where wide flange beam sections cantilevered 10 ft. out from the column and had a truss member for the backspan, the end of the cantilever was required to be shored until the truss' end moment connection could be completed. To distinguish between trusses on a column line as part of a rigid frame and those trusses designed as simple span members framing between non-column supports, the terms Vierendeel girder and Vierendeel joist were adopted respectively.

A typical new unshored building bay consisted of $4^1/_2$ in. of lightweight concrete on 2 in. composite metal deck spanning between joists and girders typically at 10 ft. on-center. As the mechanical design advanced, it was established that a Vierendeel panel opening 1-ft.-10-in.-high by 3-ft.-2-in.-wide would be of sufficient size to accommodate the rectangular ducts and the required three-hour sprayed-on fireproofing material. It also was determined that on each side of the Vierendeel panel the system had to also allow for the passage of a 17-in.-diameter duct. Large scale layouts of the joists and girders with anticipated member sizes confirmed this additional opening could be satisfied between truss web members and would not require additional special provisions within the truss profile. Initial design loadings indicated trusses with double 5 x 5 angle top and bottom chords would satisfy structural requirements. With this information, initial girder section properties were estimated for the rigid frame analysis.

To properly model the relationship of the girder to the column, fictitious members having a high cross sectional area, a high moment of inertia and a length to match the depth of the girder were conceptualized at the ends of the girders. The ends of these fictitious members were then connected to the column at their respective heights with a simple pin connection at the top and a simple vertical slip connection at the bottom. Modeling the truss to column connection in this manner more accurately reflects the stiffness of the system and disbursement of the connection forces. To faithfully imitate the behavior of the new column to the top of the existing column, springs having a stiffness representative of the existing columns were modeled at the base of the new columns. The 2D and 3D models were generated and analyzed and sections designed by utilizing the STAAD-III program from Research Engineers.

The highest girder loadings were extracted from the output and forwarded to AISC associate member Vulcraft for their review and preliminary component design. Because of the relative stiffness of the girders and columns, the size of the top and bottom chords of the girders were increased to double 6 x 6 angles resulting in a final typical joist and girder depth of 34-in. In order to establish an architectural relationship between the new floor elevations with the elevations of the existing adjacent building, the top of many of the exterior wall openings extend above the bottom of the Vierendeel trusses. A sloped ceiling makes the transition from this point back to the typical ceiling height. To accommodate this architectural detail, special joists and girders with an end tapering from 34 in. to 24 in. at the end were employed within sloped ceiling spaces. In fact, space requirements within and below the trusses dictated horizontal bridging be placed within the depth of the truss top and bottom chord angles.

Connection Design

CONNECTIONS BETWEEN JOISTS AND GIRDERS were accomplished using 1 in. plate that also acted as a spacer between the truss section's top and bottom double chord angles. Although a similar connection was called for between joists and supporting wide flange beams, during shop drawing review this detail was modified at some locations to be a field bolted butt joint between a WT-section welded to the beam web and a pair of angles on the joist end in order to address erection considerations.

Connections between girders and columns were designed to transfer vertical end reactions of up to 64 kips and end moment connections varying from 0 to 380 kip ft. Typical vertical reaction connection to the face of a column flange was accomplished using a T-shaped haunch constructed of plates while a similar connection into the web of the column was achieved using a fitted seat plate welded to the column with a support bar placed directly underneath the seat plate extending past and welded to the tips of the column flanges. Moment connections were completed using a plate welded to the column and the top of the girder's top chord and welding the bottom chord to a specially designed stabilizer plate welded to the column. Special detailing provisions were made and consideration given to erection requirements from orthogonal in-framing girders at column locations.

Schedules containing joist and girder design loadings and minimum moment of inertia values to be met were supplied to the girder fabricator, AISC-member Zalk Josephs Fabricators, Inc. Minimum moment of inertia values were provided to assure parity between models upon which the design of the columns and other members were based and final fabricated members provided. Contrary to typical SJI member manufacturer procedures, contract documents required the submittal and approval of all calculations prior to any section fabrication. Typically, these calculations were performed just days prior to fabrication. Actual girder moment of inertia values were obtained from these calculations and used in the models originally generated. New girder end moment schedules were produced from the output of these revised models and were forwarded to the fabricator for integration into final girder design. Typically, the girder end moments increased due to a higher girder moment of inertia value then had originally been assumed. Final analysis of the models also permitted a code check on the column sizes specified. No adjustments of any of the column sizes was required as a result of the final model runs.

Zalk Josephs provided 250 tons of A36 and A572 Grade 50 steel for the project, while Vulcraft provided 90 tons of Vierendeel paneled steel joists and girders.

Steven J. Roloff, P.E., served as the structural engineer on this project and is director of structural engineering for Arnold & O'Sheridan, Inc., in Brookfield WI.

To receive information about any product listed in this section, please circle the appropriate numbers on the reader service in the back of this magazine.To receive information on all of the building software programs, circle number 100. To receive information on all of the bridge programs, circle number 101.

PROGRAM: SODA—STRENGTHENING OPTIMIZATION DESIGN & ANALYSIS
Type: Design/verify/analyze structural steel frames
Company: Acronym Software Inc.
Address: 22 King St. S. #302
Waterloo, Ontario N2J1N8 Canada
Phone: 519/885-2454
Fax: 519/746-7931
Info: **SODA** automatically and completely designs a least-weight 2D or 3D steel frame or truss from a library of commercial steel sections. The program designs for both strength and deflection requirements in accordance with ASD (1978 & 1989), LRFD (1986), and CISC CAN3-S16.1 M84 and includes First Order or P-Delta design and analysis. A design verification mode permits quick evaluation or revision of designs against codes and points out areas of over and/or under design. Also, the program is able to perform structural analysis as a separate operation. Version 3.2.5 was released in May 1994. A free demo disk is available.
Price: $495 (single user); $1,485 (multiple user)

For information, circle no. 81

PROGRAM: DISPAR
Type: Postprocessor for ETABS and SAP90
Company: Advanced Structure Concepts
Address: 1580 Lincoln, Ste. 550
Denver, CO 80203
Phone: 303/860-9021
Fax: 303/860-9537
Info: Using simple virtual work techniques, **DISPAR** works with ETABS or SAP90 to provide the user with detailed information on the sources of excess stiffness or flexibility, including: a frame-by-frame breakdown of each members' contribution to global flexibility in terms of axial, flexural, shear and torsional deformation sources as well as column, beam, diagonal and panel classifications; various options for assessing the effects of beam-column joint deformation; information on the overall efficiency of the structure; accurate structural steel tonnage; and an approximate but very accurate method of reanalysis that is 10 to 20 times faster than ETABS reanalysis. The program, which utilizes LRFD, was last upgraded in 1994. A free demonstration package is available.
Price: $495

For information, circle no. 82

PROGRAM: AISC SOFTWARE
Type: Ranges from floor framing to connections to bridge design
Company: American Institute of Steel Construction, Inc.
Address: One East Wacker Dr. Ste. 3100
Chicago, IL 60601
Phone: 312/670-2400
Fax: 312/670-5403
Info: The **Composite Column Computer Program (CMPOL)** is a companion computer disk to AISC Design Guide D806 (Load and Resistance Factor Design of W-Shapes Encased in Concrete) to generate supplementary composite column design tables in ASD or LRFD format.
The **Parametric Bay Studies** disk gives design guidance for composite and non-composite floor framing alternatives in the early planning stage of a project. Included are 2,400 composite beam and girder designs for quick estimating of the most economical floor design.
The **AISC Database** contains the properties and dimensions of structural steel shapes, corresponding to Part 1 of the LRFD and ASD Manuals of Steel Construction. LRFD-related properties such as X1 and X2, as well as torsional properties, are included. Both English and metric versions are available.
CONXPRT is based on the LRFD and ASD Manuals of Steel Construction and also combines the engineering knowledge and experience of respected fabricators and design engineers. The program provides the complete design of shear and moment connections, and column stiffeners and doublers. The software comes with preset guidelines, but can be modified to meet individual shop standards.
WEBOPEN designs unreinforced or reinforced, rectangular or round openings, concentrically or eccentrically located, in both composite and non-composite steel beams.
AISC for AutoCAD saves time by drawing the end, elevation and plan views of W, S, M and HP shapes, American standard channels (C), miscellaneous channels (MC), structural tees cut from W, M and S shapes, single and double angles, and structural tubing and pipe.
STEMFIRE is based on rational procedures developed by AISI for safe and economical fire protection for steel beams, columns and trusses.
SIMON Systems is a PC software system for the design of straight steel plate-girder bridges in accordance with AASHTO's Standard Specifications for Highway Bridges. The program will design I-shaped or multiple single-cell box-shaped girders wit up to 12 continuous spans that may contain hinges.
Price: CMPOL costs $80; Parametric Bay Studies costs $50; AISC Database costs

$60; CONXPRT costs $110 - $720; WEBOPEN costs $495; AISC for AutoCAD costs $120; STEMFIRE costs $96; SIMON Systems costs $300 per year (lease only)

For information, circle no. 1

PROGRAM: MERLIN-DASH
Type: Design & analysis of straight steel girder bridge systems
Company: BEST Center
Address: University of Maryland
College Park, MD 20742
Phone: 301/405-2011
Fax: 301/314-9129
Info: **Merlin-Dash V6.0** gives the user the choice of using WSD or LFD (or even LRFD DL+LL analysis) in either English or metric units. Flow control options include: DL analysis; DL+LL analysis; code check; rating; design; design+recycle+code check; DL staging; and DL staging + LL. Boundary modification includes fixed ends, elastic support (rotation and/or vertical springs) and support settlement. Both tapered and parabolic members can be used and the developers are working with MDSHA to include the automated design of a haunched girder. Latest upgrade was issued April 1994.
Price: $3,000

For information, circle no. 83

PROGRAM: STEELPLUS
Type: Structural shapes drafting/detailing
Company: Barry Bowen Associates
Address: 3394 Coleman Road
Memphis, TN 38128
Phone: 901/373-6468
Fax: 901/373-6468
Info: **SteelPlus** contains all of the shapes listed in the Manual of Steel Construction, ASD—9th Edition. The shapes are parametrically drawn and include W-shapes, channels, single/double angles, square & rectangular tubing, pipes, M, S, HP shapes, and tees. The program offers automatic toggles and is highly customizable. The program is compatible with AutoCAD R10/11/12 and both DOS and Windows. User can draw in plan, section, elevation, or single line and can generate both simple or complex shapes. Shapes are created as AutoCAD blocks.
Price: $89.95 + free bonus module

For information, circle no. 84

PROGRAM: WINSTRUDL
Type: Finite element program
Company: Computer Aided Structural Technology
Address: P.O. Box 14674
Freemont, CA 94539-4676
Phone: 510/226-8857
Fax: 510/226-7328
Info: **WinSTRUDL** is a general purpose finite element program that runs inside Microsoft Windows.The program includes: static, P-Delta and dynamic analysis and AISC (ASD & LRFD) code checks. Loads include: joint; member; linearly varied; temperature; moving; pressure; and prestress. Boundary conditions can be fixed, released or spring. Graphical output can be accepted by AutoCAD. The program's chief advantage is thatit is a true Windows program written in 32 bit C and C++ languages and can therefore take advantage of Window's virtual memory system for almost unlimited capacity. The program was upgraded in June 1994.
Price: From $390

For information, circle no. 94

PROGRAM: SAP90; ETABS; AUTOFLOOR
Type: 3D static and dynamic finite element analysis/design; 3D structural analysis and design; structural floor framing
Company: Computers & Structures, Inc.
Address: 1995 University Ave., Ste. 210
Berkeley, CA 94704
Phone: 510/845-2177
Fax: 510/845-4096
Info: **SAP90** is an efficient large capacity structural analysis PC program intended for use on projects such as bridges, dams, stadiums and industrial plants. Finite element based, this program offers both static and dynamic analysis (either response spectrum or time-history) and a wide range of element types. Additional modules are available to generate moving loads and influence lines for bridge analyses and perform AISC steel stress checks using either ASD or LRFD. Included are graphical pre- and post-processing programs, including a Windows interface.

ETABS provides sophisticated 3D analysis of multi-story buildings using either ASD or LRFD. The program is designed specifically for building design and includes AutoETABS, an integrated analysis and drafting program operating inside of AutoCAD.

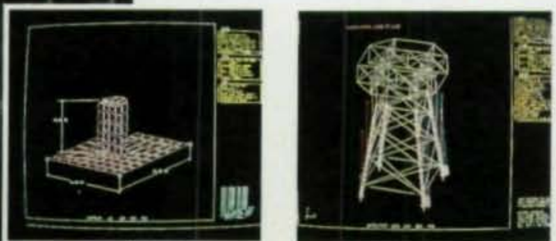
AutoFLOOR is an AutoCAD-based drafting, analysis and design optimization program for steel floor framing systems. It expedites the layout of framing schemes by automatically calculating the tributary load to each member, determining the design forces in each member, and then performing a member selection based on optimization techniques for either composite or non-composite, ASD or LRFD code recommendations. Last upgrade was April 1994.
Price: SAP90 costs $2,000; ETABS costs $3,000; and AutoFLOOR costs $1,500

For information, circle no. 31

PROGRAM: SES STEEL DESIGN PACKAGE
Type: Steel member analysis and design
Company: ECOM Associates, Inc.
Address: 8324 N. Steven Road
Milwaukee, WI 53223
Phone: 414/365-2100
Fax: 414/365-2110
Info: ECOM's steel design package for both ASD and LRFD includes: **SD1C** (steel beam design); **SD2C** (steel column design); **SD3C** (composite beam design); SD4C (beam/column design); and the newly introduced **QB2C** (quick steel design). SD1C is designed specifically for a quick check or design (including allowable stress or force) for a simple steel beam, while SD2C does the same for steel columns. SD3C designs or checks composite beams with composite or non-composite action. Short and long term deflections are calculated, as well as the number of shear connectors for partial or full composite action. SD4C designs steel sections and can calculate effective lengths for certain framing conditions and interface directly with other SES modules. Member choice can be governed by stress, deflection or size. The QB2C program quickly analyzes and designs continuous beams with cantilevers using wide flange shapes. The program will automatically pattern the live loads if desired. Comprehensive design or code checks include ICBO, SBCCI, BOCA and AISC. The program will design up to a six span continuous beam with optional cantilevers. SES was last updated in November 1993.
Price: $150 - $450

For information, circle no. 85

PROGRAM: COMSTRESS & AVANSSE
Type: COMSTRESS is a code check program for structural steel members; AVANSSE is a finite element analysis program
Company: Engineering Bulletin Board System
Address: 25439 Via Nautica
Valencia, CA 91355
Phone: 805/259-6902
Fax: 805/255-7432
Info: The **Combined Stresses in Structural Steel Members (COMSTRESS)** program investigates stresses for steel members subjected to both axial compression or tension and bending moments, M(x) & M(y). Equations H1-1, H1-2 and H2-1 (and other related equations) are investigated and results are are displayed. Included is a database of steel sections. In addition, any configuration of a built-up sections (non-ASTM) can be entered and examined.



A limited-number-of-executions version of the program is available at no charge. The program was last updated in April 1994.
Two linear analysis versions of **AVANSSE** are available (in both English and Spanish), one of which offers 1,360 nodes and the other 150 nodes. All versions: solve 2D and 3D structures; incorporate trusses, beams, plates and shell elements; provide self-weight calculations; allow elastic supports; permit 50 load cases and 20 load combinations; provide optimization of the stiffness matrix; allow prescribed displacements; and contain a complete AISC-1989 structural steel database. Frame members feature: concentrated forces and moments applied along the span; distributed loads with uniform and variable intensities; uniform and differential changes in temperature; shear deformation; rigid zone offsets; and end releases. The program was last updated in March 1994.

Price: $75 for COMSTRESS; $250 - $1,195 for AVANSSE

For information on COMSTRESS, circle no. 49 & for AVANSSE circle no. 48

PROGRAM: OPTIMIZER
Type: Frame analysis and steel design
Company: Engineering Design Automation
Address: 1600 Riviera Ave., Ste. 300
Walnut Creek, CA 94596
Phone: 510/933-2525
Fax: 510/933-1920
Info: **Optimizer** is a stand-alone computer-aided engineering program for 3D frame analysis and steel design. The program includes: a properties and component library (AISC, CISC and DIN); advanced static analysis (joint and member loads, support displacements, and temperature changes); dynamic analysis (mode shape and frequency due to an earthquake); post processing (both interactive and batch reporting procedures of displacements and forces at each structural joint); code checking (ASD 1978 and 1989, LRFD 1986, and CAN/CSA Limit States Design Code 1989); optimal member resizing (weight takeoffs by section type, functional group, and for the overall model); and CAD interfaces.
Price: Call

For information, circle no. 86

PROGRAM: GT STRUDL
Type: Finite element analysis and structural design CAE system
Company: Georgia Tech Research Corp.
Address: 790 Atlantic Dr.,
Atlanta, GA 30332-0355
Phone: 404/894-2260
Fax: 404/894-8014
Info: **GT STRUDL's** features for steel frame design include: member design and code checking (ASD, British Standard, ASCE Tower, ASME/NF17, API and AWS); a large number of prestored tables; user definable tables; special processing (design parameter specifications, geometric and relational constraints, and design smoothing); and detailed summary output. The program offers automatic data generation, frame and finite element analysis (more than 100 finite element shapes), nonlinear static analysis, linear dynamic analysis, and a graphics modeler, as well as extensive offshore structures analysis and design and database management and exchange. It was last upgraded in April 1994; a scheduled fourth quarter 1994 upgrade will add LRFD.
Price: Starting at $2,500

For information, circle no. 71

PROGRAM: MULTIFRAME 3D & 4D; SECTION MAKER; STEEL DESIGNER
Type: Multiframe 3D provides 3D analysis of frames & trusses; Multiframe 4D offers 3D and dynamic analysis of frames & trusses; Section Maker provides section properties calculations; Steel Designer provides steel code checking and design optimization of frames
Company: Graphic Magic
Address: 180 Seventh Ave., Ste 201
Santa Cruz, CA 95062
Phone: 408/464-1949
Fax: 408/464-0731
Info: All of the programs are Macintosh-based and support ASD.

Multiframe 3D models all types of structures and can include special structural features such as springs, prescribed displacements, member releases and pinned joints. The program provides: rescaling, generating and duplication features; user defined layout of results; display of moments, shear, deflection and axial forces; spring supports; prescribed displacements; moment releases in members; uniform, triangular or trapezoidal loads; factored combinations of load cases; built-in library of common structural sections; and English or metric units. The program was last upgraded in May 1994.

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- f. Architect
- g. Building owner/developer
- h. Steel mill
- i. Erector
- j. Steel product manufacturer
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Multiframe 4D provides a completely graphical approach to structural modeling, analysis and interpretation of results. CAD tools like automatic generation, duplication and rotation of structural elements simplify the process of constructing a frame model. Multiframe utilizes rendering, animation and color overlays to highlight critical areas of the structure after analysis. Dynamic modes of vibration can be visualized using a combination of color rendering and QuickTime compatible animation. Analysis options include springs, prescribed displacements, factored load cases, automatic self weight and thermal loading. Comes complete with a database of common U.S. and international structural shapes. The program was introduced this year.

Section Maker helps an engineer to quickly design and calculate the properties of custom shapes. It supports circular, rectangular or polygonal shapes and solid or hollow sections. The program allows voids and composite sections and provides automatic generation of I,C,T,L, box, tubular and circular shapes. The program was upgraded in May 1994.

Steel Designer optimizes a structure in accordance with the applicable codes and standards. It displays moments, shear, deflection and axial forces and allows the use of forces or stresses. Either English or metric units can be specified and ASD, CISC, AS1250 & BS449 code checks are available, with LRFD planned for the future. The program was last upgraded in May 1994.

Price: Multiframe 3D costs $1,495; Multiframe 4D costs $1,995; Section Maker costs $395; Steel Designer costs $695

For information, circle no. 87

PROGRAM: VISUALANALYSIS & ANALYSISGROUP
Type: VisualAnalysis is a finite element analysis program; AnalysisGroup is a suite of structural analysis tools
Company: Integrated Engineering Software
Address: 8840 Chapman Road
Bozeman, MT 59715
Phone: 406/586-8988
Fax: 406/586-9151
Info: **VisualAnalysis V1.0** is a full featured finite element analysis package designed specifically for structural engineers. It supports a complete array of structure types including 2D and 3D trusses and frames. A compact set of element types provides for a wide range of modeling problems: 1 node spring elements; 2 node

beam or truss elements; and 3 or 4 node plate/shell elements. There are no fixed limits on model size or loads. Loadings include both static and dynamic. Analysis includes static linear, dynamic mode shape, and response spectrum. The program, which utilizes LRFD load factors, was introduced in May 1994.
AnalysisGroup is a set of six tools for the solution of most common structural analysis problems. These tools are built on finite element methods and include the following analyses: rectangular plates; continuous beams; beams on elastic foundations; rectangular mat footings; circular tanks; and shear walls. The program was upgraded in May 1994.

Price: $295 introductory price for each

For information, circle no. 88

PROGRAM: (WIDE VARIETY OFFERED—SEE BELOW)
Type: 2D/3D steel frame—beams, columns, base plates, trusses, etc.
Company: Intrasoft, Inc.
Address: 555 South Federal Hwy., Ste. 220
Boca Raton, FL 33432
Phone: 800/793-6285
Fax: 407/391-8614
Info: This successor firm to Structural Analysis, Inc. (SAI) offers a large number of programs for structural analysis and steel design (utilizing ASD—9th Edition). Programs include: **BASEPL** (base plates); **BEAM**; **BEAMANAL** (single span beam analysis); **BEAMCOL** (combined compression and bending design); **BOLTGRP** (bolt group analysis); **COLOAD** (column loading analysis); **COMPBM** (composite steel beam design); **CONTBEAM** (continuous beam analysis); **DYNAM** (fundamental frequency of structures); **IDTRUSS** (indeterminate truss analysis); MICRO-**SPACE** (space frame and truss design); **MODREACT** (steel beam reaction database manager); **P-DELTA** (steel frame-shearwall interaction analysis); **PIPE** (steel pipe column section design); **PIPECOL** (multistory steel pipe column design); **PLANE** (plane frame analysis); **PLANEST** (steel plane frame/truss analysis and design); **SEISMIC** (seismic loading computation); **SPACE** (space frame and truss analysis); **STEEL** (steel frame analysis and design); **STEELBM** (steel beam analysis and design); **STEELCOL** (steel WF column design); **STLCOLX** (multistory steel WF column design); **STLDES** (steel member investigation or design); **SUPERPLANE** (planar frame and truss analysis); **TRUSS** (steel truss

analysis and design); **TUBE** (steel tube column section design); **TUBECOL** (multistory steel tube column design); **WIND** (wind forces on structures); and a variety of graphics utilities for its other programs.

Price: $60 - $800

For information, circle no. 89

PROGRAM: COMPBM

Type: Composite steel beam design & investigation

Company: Johnson Engineering Systems

Address: 43 East Ohio St., Ste. 906
Chicago, IL 60611-2744

Phone: 312/467-4700

Fax: 312/467-4771

Info: **COMPBM** is an interactive, DOS-based program for the design and investigation of simple span composite steel beams in accordance with AISC (1978, 1989 ASD and 1986 LRFD) Specifications. In Design Mode, the program finds several acceptable sections within specified depth limits and displays them in a list sorted by cost, or depth and weight. In Investigation Mode, the program investigates a beam span with a specific steel section and specified shear connector quantity and spacing, including non-uniform spacing on girders. It also can investigate sections with a bottom flange cover plate, which may be installed initially or "retrofitted" as reinforcing. In Section Property Mode, the program will compute composite section properties at 25, 50, 75, or 100% composite (it also can design or investigate simple span, fully braced, non-composite beams). Beams may be standard rolled shapes or custom non-symmetric hybrid plate girders. Beam span analysis is performed for up to 20 loads. Loads categories consist of initial dead load, composite dead load and live load. Load types include uniform, partial uniform, concentrated and trapezoidal. Deflection criteria may be specified as a dimension and/or as a fraction of the span length. The program was last updated in November 1993. A free demonstration is available (limited to 32.5-ft. span lengths).

Price: $495

For information, circle no. 90

PROGRAM: MDX CURVED AND STRAIGHT STEEL BRIDGE GIRDER DESIGN

Type: Curved and straight steel girder design

Company: MDX Software

Address: 1412 Ridgemont Court

Columbia, MO 65203
Phone: 314/446-3221
Fax: 314/446-3278
Info: **MDX** features: curved and straight steel bridge girder design and analysis; complex grid and roadway geometry; compliance with 1992 AASHTO Specification, including 1993 Interims and 1993 Curved Girder Guide Specification; I girders, box girders, and rolled shape, including web haunches, stiffeners and cover plates; composite action control and fatigue control; influence surface generation and lane loading (grid) or influence line approach (grid and line girder); allowable stress design or load factor design; and construction staging. The program was upgraded in March 1994 and now includes metric units, including a conversion capability.
Price: $2,000 - $6,000

For information, circle no. 47

PROGRAM: ROBOT V6
Type: Structural analysis and design
Company: Metrosoft, Inc.
Address: 332 Paterson Ave., East Rutherford, NJ 07073
Phone: 201/438-4915
Fax: 201/438-7058
Info: **ROBOT V6** is a fully integrated graphical system for structural analysis and design using both ASD and LRFD. It features a fully integrated, efficient work environment using switchable icon or text type menus. The program provides: linear and nonlinear static analysis; linear and nonlinear buckling; P-delta and dynamic analysis; and sophisticated moving load generation. The program can handle up to 32,500 nodes (196,000 degrees of freedom). Display includes: geometry; structural shapes; loading; deflected shape; force diagrams; and global charts. It interfaces with CAD programs through DXF files. A new feature is a built-in interface to AISC's connection design program, CONX-PRT. The program was last updated in May 1994.
Price: $495 - $8,070

For information, circle no. 51

PROGRAM: RAMSTEEL & RAMSTEEL COLUMN MODULE; RAMSBEAM
Type: Analysis, design and drafting of steel buildings; Steel beam/composite beam design
Company: Ram Analysis
Address: 5315 Avenida Encinas, Ste. M

Carlsbad, CA 92008
Phone: 619/431-3610
Fax: 619/431-5214
Info: **RAMSTEEL** is special-purpose structural engineering software for the analysis, design and drafting of steel-framed buildings. It provides an advanced level of design capability for the gravity load-resisting elements within a structure. New for V4.0 are numerous modeling features, including enhancements for beam layout and point load layout. Scaleable text on floor maps showing beam sizes, composite studs, camber and reactions is now available. The size limitations have been doubled and the DXF format CAD drawing capabilities have been enhanced to include even more user control over the drawing parameters. Also, new enhancements facilitate connection design, including an interface to the AISC CONXPRT software.

RAMSBEAM software is a single steel/steel composite beam program utilizing a Windows graphical interface. Features include: ASD or LRFD; permits virtually any loading condition; checks existing framing or optimizes new framing in any steel grade; interactive trial designs; cantilever beams; partial or full composite; shore or unshored construction; shear, moment and deflection diagrams with numeric output at any point; composite stud spacing accounts for concentrated loads; depth restrictions are permitted; and a library of AISC shapes and a metal deck data base.

Price: RAMSTEEL: $3,500 & $750; RAMSBEAM: $100

For information, circle no. 41

PROGRAM: STAAD-III/ISDS; AUTOSTAAD/MAX; STAAD-MATE
Type: Integrated structural analysis and design; analysis and design within AutoCAD; and design and analysis of structural components.
Company: Research Engineers, Inc.
Address: 22700 Savi Ranch Parkway
Yorba Linda, CA 92687-4613
Phone: 714/974-2500
Fax: 714/974-4771
Info: **STAAD-III/ISDS** addresses all aspects of structural engineering within a single software system. Analysis includes linear and non-linear 2D/3D static/dynamic/seismic/P-Delta, frame/plate/shell elements and all loading and support conditions. Design is per current American and international codes and specifications, including both ASD and LRFD. Extensive generation facilities are available, including moving loads (AASHTO and user provided), enhanced UBC seismic loads, wind loads, floor loads, response spectrum and time history loads. Graphics facilities include interactive model generation and elaborate verification capabilities.

AutoSTAAD/MAX offers all the features of STAAD-III/ISDS but runs entirely within AutoCAD. Interactive model generation capabilities include: copy, mirror, repeat commands, built-in steel shape libraries, and specification of loads, supports, shapes and section properties.

STAAD-MATE is a graphically interactive, fully menu-driven software for the design and analysis of structural components, including cantilever and continuous beams, single/multiple-bay portal frames, columns, retaining walls, footings, and slabs.

Price: $895 - $4,295

For information, circle no. 34

PROGRAM: RISA-3D
Type: 3D frame analysis/design
Company: RISA Technologies
Address: 26212 Dimension Dr. #200
Lake Forest, CA 92630
Phone: 800/332-7472
Fax: 714/951-5848
Info: **RISA-3D** offers complete steel design in accordance with the Manual of Steel Construction (ASD—9th Edition). It includes a popup window to a shape database, calculation of K, Cm and Cb values, member shape optimization and material takeoff report. Model size is as large as 2,500 joints and 5,000 members with unlimited stiffness matrix size. Analysis options include: complete static analysis; dynamic analysis; response spectra (CQC, 10%, SRSS); P-Delta; thermal; node slaving; springs (any joint and direction); member rigid end offsets; member end releases; enforced displacements; automatic bandwidth reduction; automatic self-weight calculation; inactive members option; envelope solution; and story drift report. Extensive graphics allow true scale rendering of all structural shapes as well as rotation and zoom in/out and panning of an image. The program was last upgraded in April 1994. Purchase includes one-year of free technical support and upgrades. Enhancements scheduled for this year include LRFD (2nd edition) and plate/shell elements.

The company also sells **RISA-2D**.

Price: $1,295

For information, circle no. 40

PROGRAM: SDI FLOOR
Type: Design
Company: Steel Deck Institute
Address: P.O. Box 9506
Canton, OH 44711
Phone: 216/493-7886

Fax: 216/493-7886
Info: **SDI Floor** is a set of expert system knowledge bases for the design of composite and non-composite bays, beams and girders using LRFD. Required input consists of bay size, material properties, uniform loadings, applicable building code for live load reductions, cost, deflection limitations and parameter ranges. Beam orientation in both bay directions along with beam spacing are considered in determining the most economical solution (typically, 10 designs are generated for each set of input data).
Price: $295

For information, circle no. 77

PROGRAM: FLOORVIB—FLOOR VIBRATION ANALYSIS
Type: Analysis of serviceability
Company: Structural Engineers Inc.
Address: 537 Wisteria Dr.
Radford, VA 24141
Phone: 703/231-6074
Fax: 703/639-0713
Info: **FLOORVIB** is a knowledge base for use with DESIGN ADVISOR, an expert system shell for structural engineers. The program provides vibration tolerance evaluation of steel member-concrete slab floor systems using the following six criteria: Murray (office/residential environments); Modified Reiher-Meister (office/residential); Wiss-Parmelee (office/residential); Canadian Standards Association (walking vibrations); Ellingwood & Tallin (commercial environments); and Allen (rhythmic). A complete final report is generated for each evaluation, including notes and warnings. The program was first introduced in December 1993.
Price: $250

For information, circle no. 93

PROGRAM: CBRIDGE/CB-DESIGN
Type: Straight or curved girder analysis and design
Company: Telos Technologies, Inc.
Address: 1201 E. Fayette St.
Syracuse, NY 13210
Phone: 315/471-0113
Fax: 315/471-8231
Info: The program performs a rigorous 3D analysis that determines all the forces and moments in every member of the structural system, including diaphragms and bracing. **CBridge's** 3D modeling accurately determines the effects of skewed supports and complex geometry. A mouse-driven graphical interface allows rapid building and editing of a design model. The user is allowed to define any standard or specialized vehicle for the live load and the analysis automatically locates and applies loads at critical locations on a 3D surface. Dead loads are computed automatically from dimensional and unit weight data. The analysis incorporates context-sensitive on-line help, extensive input error trapping and customized reports. The design module generates iterative comparisons to AASHTO allowables for working stress or load factor design. A May 1993 update added: an analysis feature that allows simultaneous placement of multiple vehicle types; placement of specialized vehicles in critical lanes while standard vehicles occupy additional lanes; and user defined vehicles up to 30 axles are automatically positioned on an influence surface. Currently under development is a metric version.
Price: Lease for $450/month; purchase for $8,400

For information, circle no. 91

PROGRAM: STRUCAD*3D
Type: Structural analysis and design program
Company: Zentech
Address: 8582 Katy Freeway, Ste. 205
Houston, TX 77024
Phone: 713/984-9171
Fax: 713/984-9175
Info: **StruCAD*3D** offers capacities of 6,000 joints, 12,000 members, 36,000 degrees of freedom, 200 basic and 200 combined load cases. The program features graphics preprocessing and postprocessing, a plotting module, static wave loading, soil structure interaction, wave dynamic response, joint analysis and design, detailed fatigue analysis, floatation and upending, and floating stability. The program generates the complete model geometry and loads in a 3D, CAD-style environment with: automatic joint mesh generation; joint X-brace, shifts, mirroring and scaling; line-plane intersection joints; projection of joints to a plane along selected direction; automatic generation of tubular intersection joints; wrapping and unwrapping of tubular sections and display of footprints; automatic joint renumbering; beam and plate generation, shifts, mirroring and scaling; partial, distributed and concentrated beam load generation; and computer generated wind loads in accordance with ASCE-7, API, and ABS. In addition, it calculates and displays: reactions, deflections and eigen vectors; member and plate forces and moments; member and plate stresses and unity checks; shear, moment, deflection, and unity check diagrams; and hidden line plots. The program was last updated in March 1994.
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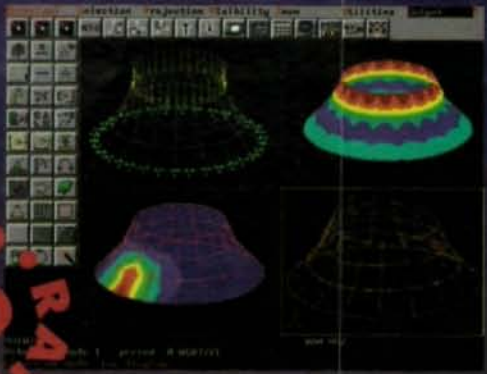

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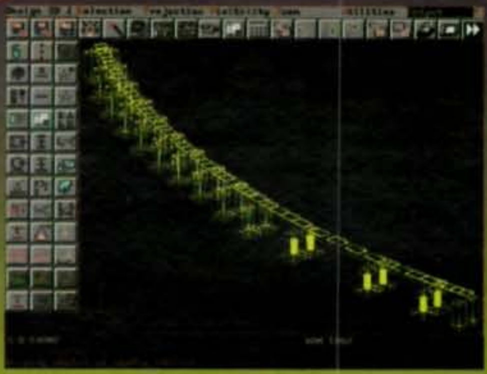

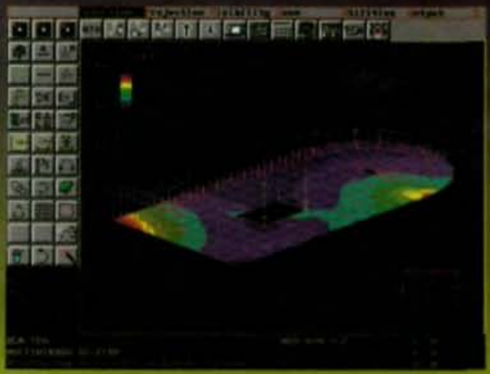

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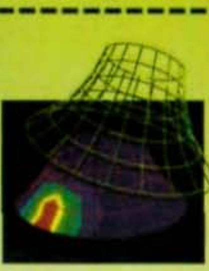

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