MODERN STEEL CONSTRUCTION

June 1993

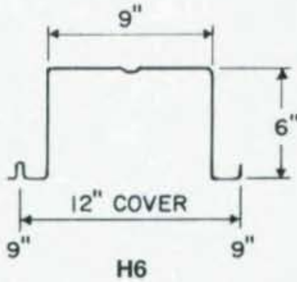
$3.00

Lev Zetlin

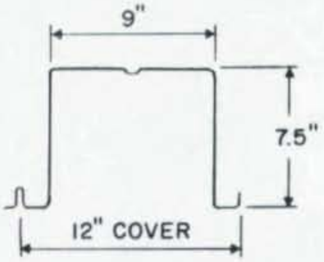
UNITED STEEL DECK, INC. DECK DESIGN DATA SHEET

No. 19

DEEP DECK – 6" and 7.5" H



H6



H7.5

32' Maximum piece length.

Profile	Gage	Wt., psf	Section Properties			Allowable End Reaction, lbs. Bearing Width		
			Ip	Sp	Sn	3"	4"	5"
H6	18	4.5	7.28	2.24	2.36	690	780	870
	16	5.5	9.79	2.90	2.99	1210	1350	1480
H7.5	18	5	12.17	3.02	3.15	640	720	810
	16	6	16.22	3.92	4.04	1140	1270	1400

SINGLE SPAN TOTAL LOADS, PSF

Profile	Gage	Span 18'	19'	20'	21'	22'	23'	24'	25'	26'	27'	28'	29'	30'	31'	32'
H6	18	77	73	69	*62*	*55*	*49*	*45*	*41*	*37*	*34*	*32*	*30*	*28*	*26*	*25*
	16	119	107	*95*	*84*	*75*	*68*	*61*	*56*	*51*	*47*	*44*	*41*	*39*	*36*	*34*
H7.5	18	71	67	64	61	58	56	53	51	49	47	46	44	43	41	39
	16	127	120	114	109	104	99	91	*83*	*76*	*69*	*64*	*59*	*54*	*51*	*48*

Notes: Loads controlled by 3" end bearing are underlined.
Loads controlled by deflection (L/240) are shown in *italics.*
All other loads are controlled by bending. 10 psf has been added to deflection loads to account for roofing dead load. The designer is urged to check the fastener uplift resistance.

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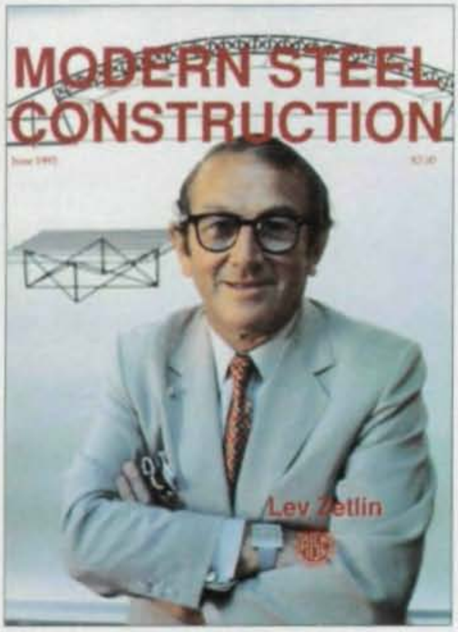
MODERN STEEL CONSTRUCTION

Volume 33, Number 6 June 1993



Lev Zetlin stated: "We know that if we limit ourselves to conventional construction, we limit both our activity and our contribution to construction." A profile of this remarkable engineer and educator begins on page 14.

FEATURES

NEWS AND DEPARTMENTS

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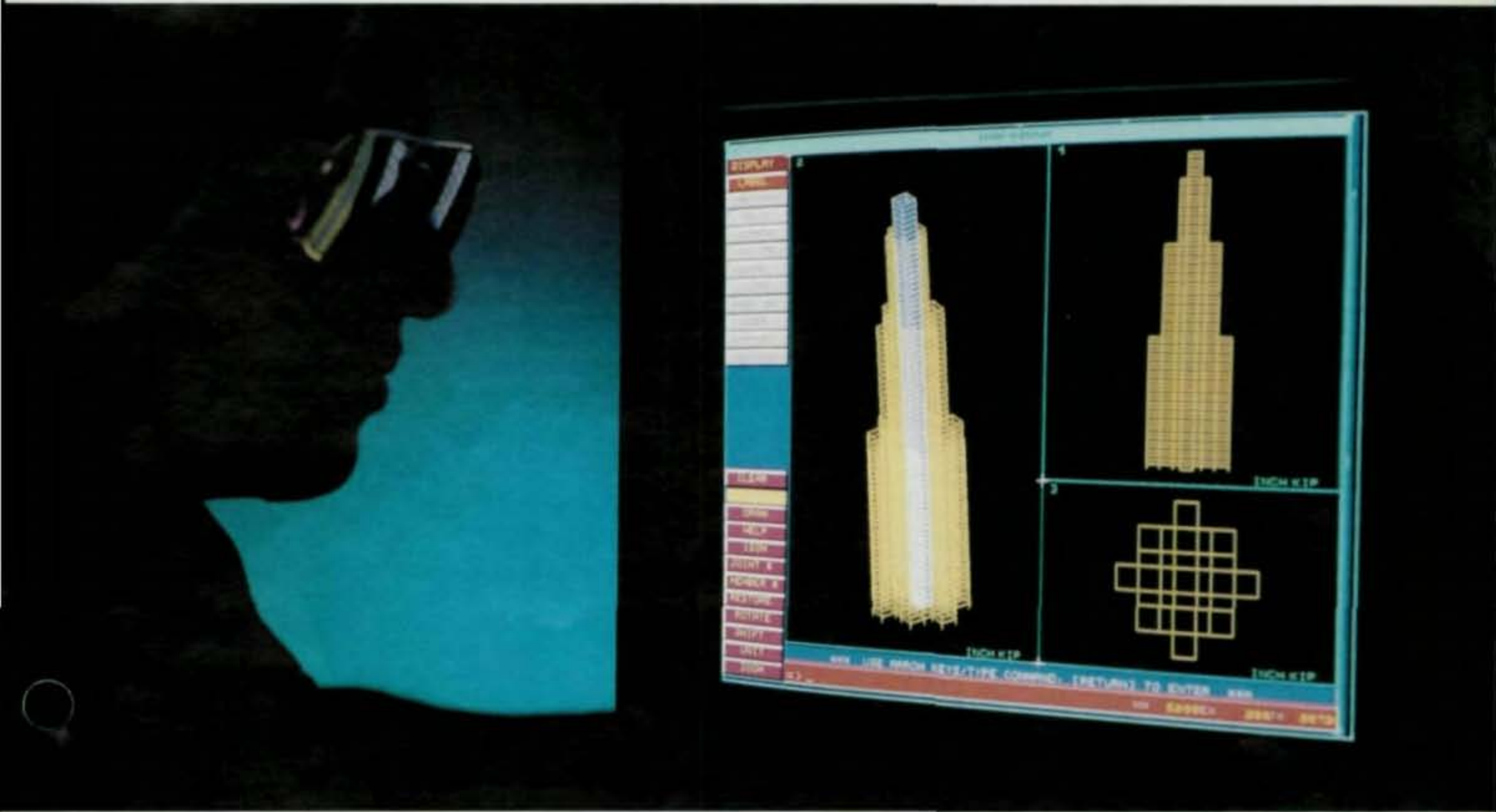

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Looking Beyond What We Know

We heard an interesting presentation on paradigms yesterday. For those of you not familiar with the term (join the club), it refers to the border around our perceptions that influences the way we look at the world. Data that fits our world view is readily accepted, but data askew of our perceptions is rejected. For example, in 1960 no one thought of the Japanese as serious competitors. The goods they manufactured were not just inexpensive, but cheap. As a result of preconceived notions and despite mounting evidence to the contrary, it was difficult for many companies to gear up to meet the challenge of improved—and in some cases superior—Japanese imports in the 1970s and 1980s.

Closer to home, when many structural engineers are faced with a low floor-to-floor height, they believe the only solution is concrete. In this issue we present two projects where the designers went beyond their preconceived notions and gave steel a serious look despite the horrendous height limitations. The two solutions are radically different from each other, but in each case steel resulted in a superior product at a lower cost.

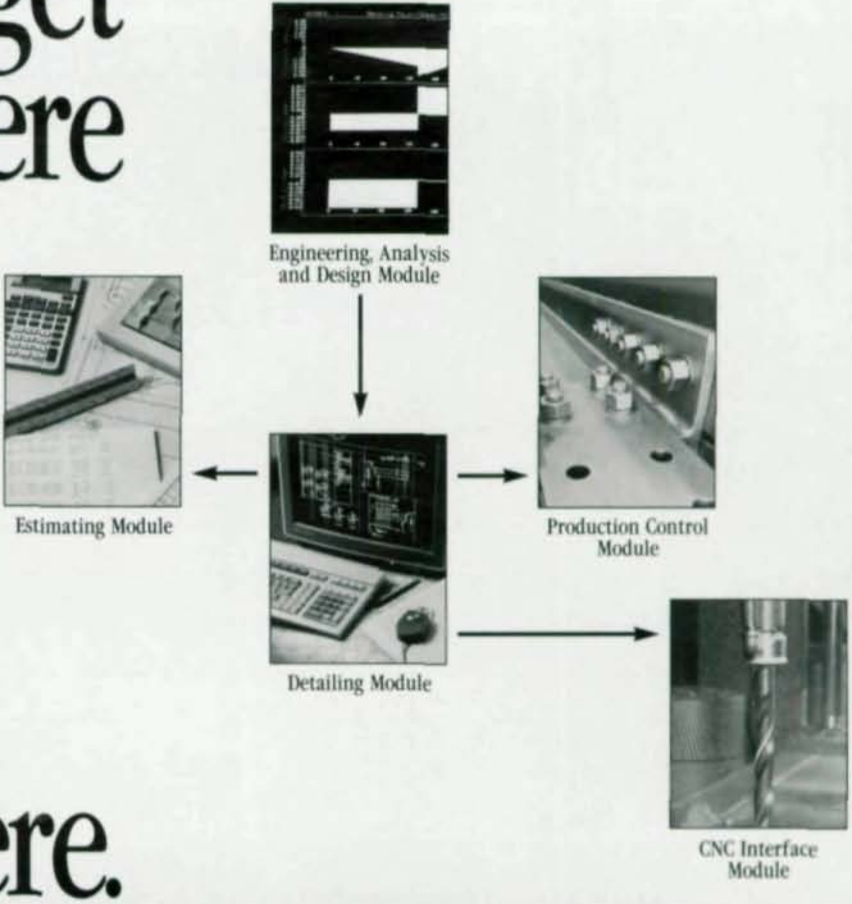
We're also trying something a little bit different in this issue. For the past 33 years, we've always focused on projects and techniques. This month we decided to take a look at the person behind the project. Lev Zetlin was always a believer in trying something new and so it only seems fitting that we kick off our proposed series of profiles with him. If you get a chance, drop me a note and let me know what you think of the profile. If the response is positive we'll print more.

And finally, keep in mind that two important deadlines are fast approaching.

First, deadline for entries in the AISC 1993 Prize Bridge Competition is June 18. There is no entry fee and winning projects will be published in the November issue of *Modern Steel Construction*.

Second, abstracts of papers to be presented at the 1994 National Steel Construction Conference are due by July 15. Topics of interest include (but are not limited to): innovative steel bridge and building design; composite members and frames; residential construction; eccentrically braced frames; economical fabrication and erection practice; fire protection; and case studies of unique projects. **SM**

How to get from here



to here.

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Call For Papers

1994 NATIONAL STEEL CONSTRUCTION CONFERENCE

David L. Lawrence Convention Center
Pittsburgh — May 18-20, 1994

Title Of Paper: ______________________________

Primary Author's Name: ______________________________
(First) (Middle Initial) (Last) (Professional Suffix-Degree)

Position/Title: ______________________________

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Home Phone: ______________ Preferred Mailing Address: ( )Business ( )Home

Co-Author(s):
1. Name: ______________________________
(First) (Middle Initial) (Last) (Professional Suffix-Degree)

2. Name: ______________________________
(First) (Middle Initial) (Last) (Professional Suffix-Degree)

Invitation/Call For Papers:

The 1994 National Steel Construction Conference will be held at the David L. Lawrence Convention Center in Pittsburgh from May 18 through May 20, 1994. Participants include structural engineers, fabricators, erectors, educators, and researchers. Potential authors may submit abstracts of papers on *design, fabrication and erection of steel-framed buildings and bridges.*

Topics of interest include:

- Practical application of research;
- Advances in steel bridge design and construction;
- Composite members and frames;
- Heavy framing connections;
- Steel-framed housing;
- Partially restrained connections;
- Eccentrically braced frames;
- Economical fabrication and erection practice;
- Quality assurance and control;
- Innovative management techniques;
- Case studies of unique projects;
- Computer-aided design and detailing;
- Material considerations;
- Fire protection;
- Coatings and material preparation;
- Innovative structural systems.

Guidelines for abstract submittals:

Abstracts for papers must be submitted before July 15, 1993. They should be approximately 250 words in length and should be submitted on a separate sheet of 8½" x 11" white paper attached to this form.

Authors will be informed of the Organizing Committee's decisions by October 1, 1993. The selected authors must then submit their final manuscripts, in a form suitable for publication in the 1994 Conference Proceedings, by February 1, 1994.

Preparation of paper:

Final manuscripts for publication in the official 1994 Conference Proceedings are expected to be aproximately *20 pages in length. Copy (including* photographs and drawings) must be camera-ready. Complete instructions will be forwarded to authors upon acceptance of Abstract Proposals.

Poster Session:

Papers not accepted for presentation at the Conference may, at the author's expense, be presented at the Conference Poster Session. Guidelines for the Poster Session will be provided upon request.

Return your abstract with this submission form before July 15, 1993 to:
American Institute of Steel Construction, Inc., One East Wacker Dr., Suite 3100, Chicago, IL 60601-2001 Attention: 1994 NSCC Abstracts
Phone: 312/670-2400; Fax: 312/670-5403

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 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
1 East Wacker Dr.
Suite 3100
Chicago, IL 60601

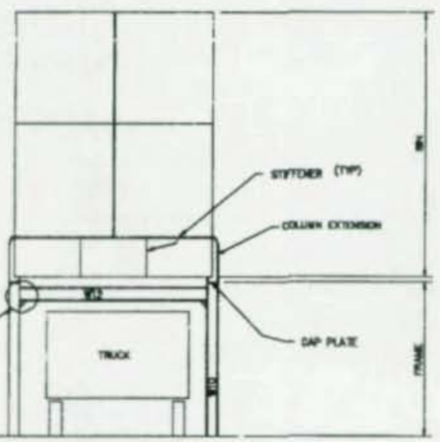
Answers and/or questions should be typewritten and double spaced. Submittals that have been prepared by word-processing are appreciated on computer diskette (either as a Wordperfect file or in ASCII format).

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 principles 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 to questions from previous Steel Interchange columns have been received:

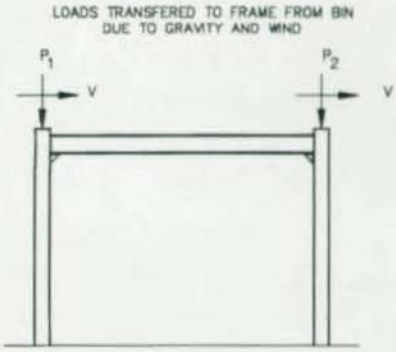
Are there other applications of the bracket connection carrying moment shown in the February 1993 Steel Interchange?



Elevation of rectangular bin

I believe the connection pictured in the February Issue of *Modern Steel Construction* has a practical application in bin construction. The rectangular bin shown is supported by a rigid frame such that trucks may drive under the bin to be loaded. Typically, the bin is prefabricated in sections that are either field welded or bolted together along the stiffeners. These sections are set on top of a previously erected frame.

The bottom portion of the bin is designed as a plate girder which supports the entire gravity load of the stored material and the dead load of the bin. The reactions from this plate girder are transferred to the frame columns through the column extensions as shown in the reaction diagram. These column extensions also transmit any lateral load to the frame. The forces are then transferred to the ground through



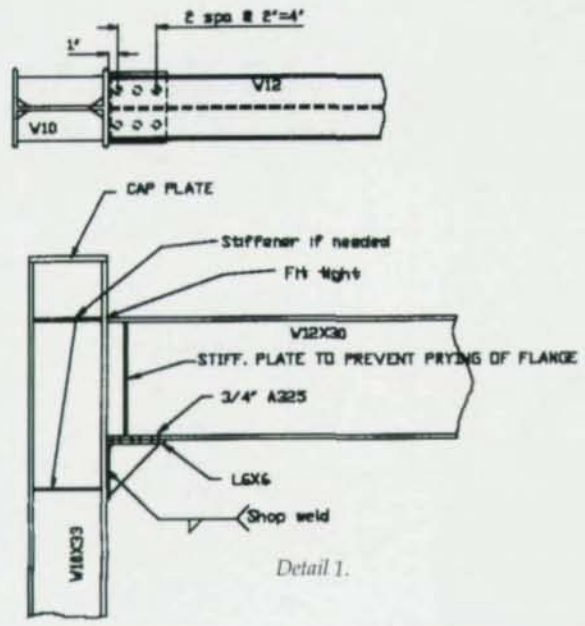
rigid frame action. The maximum moment that occurs at the connection is caused by both the lateral shear and shear due to the sidesway associated with unsymmetrical gravity loading.

The connection shown in Detail 1 can be designed using an approach similar to the design of a connection with an eccentrically applied shear load. This procedure is discussed in *Manual of Steel Construction - Volume II Connections* by AISC.

This connection is slightly different than the one pictured in *Modern Steel Construction*. The full end plate on the girder has been eliminated, and the stiffened bracket has been shop welded to the column. This allows for the use of the bracket as an erection seat as well as the major component of the connection detail. The upper web stiffener on the column was moved to the level of the top flange of the girder. If the fit between the column and the girder is tight, positive moment would cause compression in the top flange of the beam. This would be transferred to the column through bearing of the top flange against the flange of the column. Finally, a web stiffener was added to the girder to prevent local bending of the bottom flange.

The following figure shows the assumed stress distribution on the stiffened bracket. The end moment in the girder is developed by bearing between the bottom flange of the girder and the horizontal leg

Steel Interchange



Detail 1.

of the angle, and tension in the bolts. The moment is then transmitted to the column by shear stress in the shop weld.

To analyze the connection, one should allow the compression stress to equal the allowable bearing stress of the steel. Next, one assumes a neutral axis depth. Computation of the total compressive force is made by the following:

$$C = \frac{b_f F_c c}{2}$$

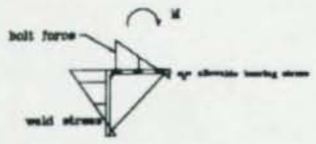
where:

C =compressive force
b_f =flange width of the column
F_c =allowable bearing stresses
c =assumed neutral axis distance.

Equilibrium and similar triangles can then be used to solve for the tension force in the bolts to the left of the neutral axis. After computing the tensile force, a summation of the moments of the bolt forces is made about the centroid of the compression block. This moment is compared to the applied moment and the assumed neutral axis location is adjusted if necessary.

The angle thickness should be selected based on shear and bending stresses between the stiffener plates. This could be computed by assuming that a the horizontal leg of the angle is simply supported between stiffeners.

John F. Ruff, Jr.
Bergmann Associates



Assumed stress distribution on the bracket

New Questions

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

If you have an answer or suggestion please send it to the Steel Interchange Editor, Modern Steel Construction, One East Wacker Dr., Suite 3100, Chicago, IL 60601-2001.

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.

Can an inflection point in a continuous beam be considered a brace point?

Byron Dietrich
Teter Consultants
Visalia, CA

Where is the best place to get information on foriegn specifications and requirements?

Correction

Numerous readers have asked for a clarification of an equation given in the April 1993 Steel Interchange on page 9.

The second equation under the heading "For fully fixed frame (Figure 2)" should read:

$$K = \left(\frac{I_{BM}}{I_{COL}}\right)\left(\frac{h}{L}\right)$$

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Surface Burning	E84	Flame: 0 Smoke: 0	Flame: 0 Smoke: 0	Flame: 0 Smoke: 0	Flame: 0 Smoke: 0	Flame: 0 Smoke: 0	Flame: 0 Smoke: 0
Combustibility	E136	Noncombustible	Noncombustible	Noncombustible	Noncombustible	Noncombustible	Noncombustible
Density	E605	13 lb/ft³ (208 kg/m³)	16.5 lb/ft³ (264 kg/m³)	22 lb/ft³ (352 kg/m³)	17.5 lb/ft³ (280 kg/m³)	19 lb/ft³ (304 kg/m³)	40 lb/ft³ (640 kg/m³)
Cohesion/ Adhesion	E736	295 lb/ft² (14.2 kPa)	399 lb/ft² (19.1 kPa)	1146 lb/ft² (54.9 kPa)	399 lb/ft² (19.1 kPa)	333 lb/ft² (15.9 kPa)	1300 lb/ft² (62.2 kPa)
Deflection	E759	No Cracks or Delaminations	No Cracks or Delaminations	No Cracks or Delaminations	No Cracks or Delaminations	No Cracks or Delaminations	NA
Bond Impact	E760	No Cracks or Delaminations	No Cracks or Delaminations	No Cracks or Delaminations	No Cracks or Delaminations	No Cracks or Delaminations	NA
Compressive Strength	E761	828 lb/ft² (39.6 kPa)	1700 lb/ft² (81.4 kPa)	7340 lb/ft² (351 kPa)	959 lb/ft² (46 kPa)	1790 lb/ft² (85.7 kPa)	58,500 lb/ft² (2801 kPa)
Air Erosion Resistance	E859	0.000 g/ft² (0.000 g/m²)	0.000 g/ft² (0.000 g/m²)	0.000 g/ft² (0.000 g/m²)	0.000 g/ft² (0.000 g/m²)	0.000 g/ft² (0.000 g/m²)	0.000 g/ft² (0.000 g/m²)
Corrosion Resistance	E937	Does Not Promote Corrosion of Steel	Does Not Promote Corrosion of Steel	Does Not Promote Corrosion of Steel	Does Not Promote Corrosion of Steel	Does Not Promote Corrosion of Steel	Does Not Promote Corrosion of Steel
Sound Absorption	C423	0.85 NRC	0.75 NRC	0.65 NRC	0.50 NRC	NA	NA
Thermal Conductivity	C518	3.45 R Value	3.23 R Value	NA	2.33 R Value	1.85 R Value	NA

* Values represent laboratory tests on CAFCO Products. NA = Not Applicable

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Consortium Searches For Consensus

Fabricators may soon be able to use the same welding procedures and tests in several midwestern states. The North Central States Consortium, which includes representatives from the DOT's of ten midwestern states, met in April to discuss consensus positions on procedures for qualification of weld test reports, welder qualification testing, NDT weld requirements, and field welding requirements.

"We're looking for mutual positions from the state DOT's," explained Jon Edwards, an engineer with the Illinois DOT and chairman of the Consortium's welding committee. Reaching a consensus position will help both fabricators and state DOT's. "If a fabricator works on a project in one state, it's unreasonable to expect him to use different procedures in a neighboring state," Edwards said.

Edwards reported that he expects a formal consensus paper on at least one welding issue to be issued at the groups next meeting in October, though he doubts that all 10 states will sign off on it at that time. The states involved are Missouri, Nebraska, North Dakota, South Dakota, Illinois, Michigan, Wisconsin, Minnesota, Kansas and Iowa.

Discussions also revolved around what constitutes acceptable edge grinding and what changes can be expected in the welding code as a result of the recent AWS and AASHTO meetings. In addition to discussing welding issues, Consortium members heard presentations on painting from Inorganic Coatings and Carboline, and Bethlehem Steel presented information on weathering steel.

Dear Editor:

The tragic accident "Case Study: Four Story Computer Facility" discussed in the March issue occurred at the Prime Site Facility in Columbus, OH. SOFCO Erectors, Inc., was the steel erection contractor. Several of Mohammad Ayub's observations, statements, and/or assumptions as presented in this article are incorrect.

Mr. Ayub infers that the cantilevered sections as erected were unstable. Calculations performed by an outside consultant, computer modeling, actual scale model testing, as well as on-site inspections confirm that an acceptable erection safety factor was present in the "as erected condition." A significant factor completely ignored by Mr. Ayub is that the bottom flanges of the cantilevered beams were in contact with column web stiffener plates, thereby increasing the moment arm and increasing the safety factor.

Mr. Ayub implies, moreover, that SOFCO approved the use of a come-a-long in an "end to end" connection to level the cantilevers. The cantilever leveling procedure that our employees were instructed to use required that the come-a-long be attached *diagonally* to the beam being leveled and to the connecting column. Two-ton cable and six-ton chain come-a-longs were available for use. This procedure had been used successfully on the floors below. It is not known why the deceased employees chose to violate this established procedure.

Sincerely,

James W. Ludwig
President
SOFCO Erectors, Inc.

People

Fred Eisen, AISC Board Member and president of AISC-member Fought & Company, Tigard, OR, passed away February 25. Replacing him on the Board is Clark B. Olsen, president of AISC-member Utah Pacific Bridge & Steel Corp. Pleasant Grove, UT.

Charles R. "Chick" Dollinger, former AISC Board Member and president of AISC-member Dollinger Steel Company, Beaumont, TX, passed away February 28.

Andrew G. Sharkey, previous president of the Steel Service Center Institute, will succeed Milton Deaner, 68, who is retiring as president of the American Iron and Steel Institute on August 1.

AISC Lecture Series Attracts Big Crowds

Attendance has been excellent for AISC Marketing's latest lecture series on *New Ideas In Structural Steel*. "I was surprised that so many people wanted to here about such advanced subjects, but the response has been very positive," according Charles Carter, an AISC Staff Engineer.

The seminars, which often attract more than 100 attendees, present information on eccentrically braced frames, partially restrained connections, low-rise buildings, and connection design.

Registration is only $60 ($45 for AISC members). Included in the registration fee are a dozen handouts and publications plus a meal. For more information, contact: Colleen Hays, American Institute of Steel Construction, Inc., One East Wacker Dr., Suite 3100, Chicago, IL 60601-2001 (312) 670-2400; fax (312) 670-5403.

WEST	Date	MIDWEST	Date	NORTHEAST	Date
Irvine	6/10	Chicago	6/3	Newark	6/22
Sacramento	6/23			Rochestor	9/22
San Francisco	6/24			Albany	9/23
SOUTHWEST	**Date**	**SOUTH**	**Date**	**MID-ATLANTIC**	**Date**
San Antonio	6/1	Birmingham	9/9	Philadelphia	6/23
Houson	6/8	Miami	9/14	Cleveland	10/19
		Orlando	9/16	Columbus	10/20
		Atlanta	9/28	Cincinatti	10/21
		Richmond	9/30		

Structural Engineers Association of Southern California Computer Show (June 7-10 in Anaheim, CA) help in conjunction with **A/E/C Systems '93**. Seminar series targeted at practicing structural engineers. Sessions include: practical aspects of dynamic analysis using standard finite element analysis software; benefits of marketing an automated structural engineering office; and spreadsheet software. For more information, contact: SEAOSC, 2550 Beverly Blvd., Los Angeles, CA 90057 (213) 385-4424; fax (213) 389-7514.

1993 Symposium on Computer Integrated Building Sciences (June 10-11 in Anaheim, CA) sponsored by the International Council for Building Research and Documentation. Topics will include: automated construction (using no people); automated fabrication; robotic tools for constructoin; and 3D modeling. An additional session will feature the new Disney Concert Hall Project, which has been designed on 3D CAD and has used NC for the cutting of stone and structural steel. For more information, contact: Harold Jones, SCIBS'93, 1700 Asp Ave., Norman, OK 73037-0001 (405) 325-1947; fax (405) 325-7968.

Call For Papers: Structural Materials Technology/Non-Destructive Testing. Authors are invited to submit concise abstracts of presentation papers of no more than 300 words outlining key technical points without use of equations or figures. Papers will be selected based on the abstract. Topics include: Sonic NDE of bridges; measurement of corroded bridge steel; ultrasonic testing of fillet welds; monitoring bridge performance; NDE of cable stayed bridges; new developments in NDT of structural steel; achieving uniformity in structural fabrication with NDT. Abstract deadline is **August 1, 1993**. The conference will be held February 23-25 in Atlantic City, NJ. For more information, contact: Robert Scancella, Conference Program Committee, P.O. Box 77352, Trenton, NJ 08628 (609) 292-5619; fax (609) 633-6924.

Steel Design Seminar Series—Design of Steel Connections (conducted by the Steel Structures Technology Center). The one-day, professional level program will discuss joint analysis methods, design criteria and methods, constructability and economical design will be covered. Recent developments and changes to connection design procedures will be emphasized. Seminars are scheduled for:

Detroit.......9/13
Chicago.......9/15
Minneapolis.......9/16
New York.......10/4
North Haven, CT.......10/5
Boston, MA.......10/6
Portland, ME.......10/7
Portland, OR.......10/25
Seattle.......10/26
Kansas City.......11/4
Costa Mesa, CA.......11/29
Los Angeles.......11/30
San Francisco.......12/2
Sacramento.......12/3

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Lev Zetlin

Creativity Through Applied Science

Lev Zetlin's progressive philosophy of structure design stressed innovation firmly rooted in cost-effective technology

By Robert Levine

When Lev Zetlin died last December, his legacy went beyond his numerous innovative projects to encompass an enviable design philosophy. The strength of that philosophy, that nothing is impossible, is evidenced not only from his personal success, but of his firm's, which continued to grow and attract premier clients and projects even after Zetlin's retirement.

Zetlin believed that structural engineers, rather than duplicating traditional structural forms, should strive to design innovative systems that not only enhance performance but also reduce costs.

> We know that if we limit ourselves to conventional construction, we limit both our activity and our contribution to construction.

He once summed up the philosophy of his firm for *Building Design & Construction* magazine by stating that: "Providing a solution for the project that serves the client best is the prime point. We know that if we are to limit ourselves to conventional construction, we limit both our activity and our contribution to construction."

And Zetlin didn't just pay lip service to his philosophy. His innovations include a cable suspension roof, portable abutments for prestressing cast-in-place concrete pavement, and a space-frame roof; examples of his imaginative design work include the Tent of Tomorrow at the New York State Pavilion at the 1964 World's Fair, the Salt Lake City County Civic Auditorium, and the American Airlines hangars in San Francisco and Los Angeles.

Traveling Man

Zetlin was born on July 14, 1918, in Namangan, Russia, but his family moved to Palestine in 1921 due to the civil war in the then-emerging Soviet Union. He grew up in Palestine but was educated at an American high school in Tehran, Iran. He then studied civil engineering at the prestigious Technion in Tel-Aviv.

After graduating in 1939, Zetlin held several engineering jobs, first with the British Army, then with the Israeli transitional government, and finally with the Israeli Air Force.

In 1951, he entered Cornell University in upstate New York to pursue graduate studies in mathematics. While financial restraints limited his original plans to a single year of study, the university persuaded him to stay longer and appointed him a research associate in structural engineering.

After receiving his Ph.D. in 1953, Zetlin moved to New York City and began working for the prestigious Ammann & Whitney firm, where his first assignment was to design complex cantilevered folded plate hangar structures at JFK International Airport.

His career—and reputation—began growing after he designed a medical center in Jerusalem. For that project, he developed a way to reduce the torsional movements of flat-plate slabs.

Building A Reputation

In 1956, Zetlin formed Lev Zetlin & Associates. While working on the medical center in Jerusalem, he so impressed the project's architect, that he reported to a colleague that Zetlin's attitude was that nothing was impossible. That same colleague gave Zetlin's fledgling company one of its first notable projects: The Utica Municipal Auditorium.

The building was originally planned with a domed roof and a basement housing mechanical equipment. But, applying his philosophy of always searching for more efficient structural systems, Zetlin devised the idea of a roof suspended from two layers of cables that could contain the mechanical equipment within it and thus save the cost of a basement. The project helped define Zetlin's structural philosophy; it was guided by what was best for the building and most economical for the client. He was an outspoken critic of his peers in the engineering and architectural professions, chastising them for being too conservative and too hesitant to experiment with new structural systems.

In order to supplement what was then an uncertain income, the same year Zetlin opened his own firm he began teaching courses in advanced structures at Manhattan College Engineering School in Riverdale, NY.

He continued teaching long after his firm was a proven success, and it turned into a "long-term relationship," according to Charles Thornton, P.E., a student and eventual colleague. Thornton was not alone, however. Among the other students who went to work for Zetlin was Richard Tomasetti, who, along with Thornton, would eventually purchase the firm.

Philip Johnson described Zetlin's work on the New York World's Fair as "very professional with a lot of imagination. It was quite a feat. I thought he was an architect—he had a great imagination. Pictured above is the umbrella-shaped Travelers Pavilion during construction, and shown below is the completed project. By using a series of boomerang frames he was able to reduce the steel requirement from the 40 psf that would have been used with steel trusses to just 9 psf.

"I still remember hearing him lecture," said Thornton. "He was very charismatic and very innovative." Zetlin encouraged his students to seek creative solutions, but also stressed the importance of a firm foundation in math and science. "Science, not intuition, is the tool to creativity," he lectured to his students.

The Niagara Falls Convention Center featured eight steel arch-rib space trusses spanning 365' (111m) (shown under construction in the upper photo and completed in the lower photo). Zetlin developed quite a reputation for his work on long-span structures, starting with an Airplane Hangar at JFK International Airport in 1953 and continuing with his work on such notable structures as the Utica Auditorium and the Salt Lake County Civic Auditorium. In fact, it was the Utica Auditorium that first brought natinal attention to his fledgeling design firm. Zetlin had a very creative mind, according to Max Abramovitz, FAIA, an architect who worked with him on several projects. "If you had a problem, he brought up creative answers to the problem, not the same old ordinary answers."

In 1968, Zetlin became a Professor of Architecture and Engineering at the University of Virginia, where he taught a few advanced classes and—in keeping with his overall design philosophy—directed the Interdisciplinary Center for Research and Innovation in Buildings. During this time, he continued living and working in New York City.

The job that established Zetlin as a giant in the field was the structural design he and his firm did for 14 of the pavilions at the 1964-65 World's Fair in New York. The Travelers Insurance and New York State Pavilions, two of the fair's most impressive, required innovative steel structural systems to make them economically feasible.

Early on, it was decided that the Travelers Insurance pavilion would have a steel roof in the shape of an umbrella—the company's logo. Unfortunately, traditional truss systems would have required that the dome be in compression, which would have required expensive scaffolding during erection.

Zetlin sought and found a better solution. He used a series of boomerang steel frames with a tension belt of cables to cause the opposite stress pattern to what would be expected in a conventional system. Zetlin was able to design the roof with only 9 psf of steel, an amazing reduction from the 40 psf that would have been used in a steel truss system.

For New York State's "Tent of Tomorrow" pavilion, Zetlin designed an innovative cable suspension roof. Philip Johnson, the noted architect, called it "an unengaged free space as an example of the greatness of New York, rather than as a warehouse full of exhibit material." The main pavilion features a 350'-span (107m), cable-hung roof with 16 supporting columns. The columns support a ring girder, which acts as a truss and carries a double layer of cables. Due to the arrangement of the 96 cables, the roof does not vibrate in the wind and instead behaves as though it's a much heavier structure. Because little work had previously been done in this area, Zetlin was forced to develop his own theory on the behavior of elliptical tension rings and patented the self-damping cable system.

Johnson described Zetlin's work as "very professional with a lot of poetic imagination. It was quite a feat. I thought he was an architect—he had a great imagination."

In 1969, Zetlin was awarded a gold medal from the Societe Arts, Sciences, Lettres, mainly for his work on the World's Fair pavilions. Those project's garnered great national and international attention, and led the way for future notable commissions.

For example, working with Philip Johnson, Zetlin designed the Niagara Falls Convention Center. This project featured eight steel arch-rib space trusses spanning 365' (111m). Another exciting was the Salt Lake County Civic Auditorium, which borrowed from his innovative design for the Utica Auditorium and featured a 360'-diameter (110m), lightweight cable-suspension roof.

Zetlin continued to pursue innovative designs throughout his career, winning the respect of architects and as well as clients. Max Abramovitz, an architect who worked with Zetlin on several projects, including the Krannert Center for the Performing Arts at the University of Illinois at Urbana, said he thought Zetlin had a "very interesting mind." Although one structure, the beautiful Krannert Center features five separate theaters. "If you had a problem, he brought up creative answers to the problem, not the same old ordinary answers," Abramovitz said.

While the pavilions at the New York World's Fair are Zetlin's best-known works, Thornton said he considers the American Airlines hangars in San Francisco and Los Angeles to be his teacher's most innovative structures.

Working with the architectural firm of Conklin & Rossant, Zetlin again came up with an award-winning innovative design that achieved his two main goals: flexibility and economy.

Zetlin's student and colleague, Charles Thornton, considers the American Airlines Hangars in San Fransisco and Los Angeles to be his teacher's most innovative structures. The hangars have modular roof sections with cantilevers that extend 230' (70mm) from the core structure. The parabolic shape of the roof allowed room for airplanes to be raised off the ground during maintenance work.

Science, not intuition, is the tool to creativity

The hangars have modular roof sections with cantilevers that extend 230' (70m) from the core structure. Modules curved into the shape of hyperbolic parabaloids and welded into the core truss system steady the cantilevers by introducing energy to the module's surface. Post-stressed cables take about 15% of the design load. The hyperbolic shape created enough space for an airplane to be raised from the ground for maintenance. According to Thornton, this was the first time a hyperbolic parabaloid had been used on a structure in this fashion.

Working Through Retirement

In 1971, Zetlin sold Lev Zetlin & Associates to the Gable Company, though he remained a vital force in the firm. Six years later, despite the firm's continued success, Gable sold the company, this time to Thornton and Tomasetti.

In 1978, Zetlin began teaching an advanced technical course for selected students at the Pratt Institute. As he had done in his earlier teaching assignments, he continued to emphasize creativity tempered with technical expertise.

"His philosophy was mathematically esoteric," said Sidney Shelov, then an associate dean. "He was very innovative but very rooted in science. He challenged students to understand the theoretical stuff."

Around the same time, Zetlin returned to his consulting work and formed Zetlin/Argo, which specialized in the study of structural failures. He analyzed the collapse of the Mianus Bridge in Connecticut, as well as the roof collapses of the Hartford Coliseum, the Hyatt Regency Hotel in Kansas City, and the L'Ambiance Plaza in Bridgeport, CT. He didn't completely abandon new construction, however, and served as a consultant on the design and construction of the Jacob Javits Convention Center in New York City, one of the largest space-frame structures ever built.

Zetlin's work on the New York World's Fair established him as a giant in his profession. Philip Johnson called his New York State Pavilion "an unengaged freee space as an example of the greatness of New York, rather than a warehouse full of exhibit material. The main pavilion, as pictured at left, features a 350'-span (107m), cable-hung roof with 16 supporting columns. The columns support a ring girder, which acts as a truss and carries a double layer of cables.

Zetlin continued to be a sought-after and active consultant until his death. His bold philosophy of innovation, as well as his completed projects and creative design theories, live on after him. Thornton, attempting to sum up Zetlin's design philosophy, stated: "He would reach way beyond the existing edge in order to develop structural concepts and end up between the present and what he reached for."

Robert Levine is a freelance writer based in Evanston, IL. ■

AISC 1993 Prize Bridge Competition

Rules

Eligibility
To be eligible, a bridge must be built of fabricated structural steel, must be located within the United States (defined as the 50 states, the District of Columbia, and all U.S. territories), and must have been completed and opened to traffic between *May 1, 1988* and *April 30, 1993*.

Judging Criteria
Judging will be based upon aesthetics, economics, design and engineering solutions. Quality of presentations, though not a criterion, is important.

Award Categories
Entries may be judged in one or more categories, but can receive only one award.

Long Span One or more spans more than 400 ft. in length.

Medium Span, High Clearance Vertical clearance of 35 ft. or more with longest span between 125 and 400 ft.

Medium Span, Low Clearance Vertical clearance less than 35 ft. with longest span between 125 and 400 ft.

Short Span No single span greater than 125 ft. in length.

Grade Separation Basic purpose is grade separation.

Elevated Highway or Viaduct Five or more spans, crossing one or more traffic lanes.

Movable Span Having a movable span.

Railroad Principal purpose of carrying a railroad, may be combination, but non-movable.

Special Purpose Bridge not identifiable in one of the above categories, including pedestrian, pipeline and airplane.

Reconstructed Having undergone major rebuilding.

Entry Requirements
All entries must contain an entry form, photographs and a written description of the project. A separate binder must be submitted for each entry. No entry free is required; submission materials will not be returned. The use of any entry's submitted data, detail and/or photographs by AISC shall be unrestricted. **Note:** Projects not receiving an award still may be used in *Modern Steel Construction* magazine or other AISC marketing materials.

1. *Entry form:* The complete and accurate entry form and one copy must be enclosed.

2. *Photographs:* A minimum of four professional quality 8x10 color prints of various views showing the entire bridge, including abutments as well as selected details, are required. 35 mm slides are strongly recommended. Photographs will not be returned.

3. *Description:* Explanation of design concept, problems and solutions, aesthetic studies, project economics and any unique or innovative aspect of the project. Include no larger than 11x17 drawings showing elevation, framing system and typical details.

Method of Presentation
Each entry should be submitted in an 8½" x 11" binder, containing transparent window sleeves for displaying inserts back to back. The entry form included in the brochure must be easily removable, so that the identification of the entry can be concealed during judging.

Awards
The winners will be notified shortly after the mid-August judging. Public announcements of the winners will be made in the November issue of *Modern Steel Construction* magazine. Award presentations will be made to the winning designers at the National Symposium on Steel Bridge Construction, November 11, 1993, in Atlanta, GA.

Deadline for Submission
Entries must be postmarked on or before ***June 18, 1993***, and addressed to: American Institute of Steel Construction, Inc., Attn: Awards Committee, One East Wacker Drive, Suite 3100, Chicago, IL 60601-2001. For further information, call 312/670-5432.

AISC 1993 Prize Bridge Competition

Entry Form

Entry Date________________

Name of Bridge________________ Completion Date________________

Location________________ Date opened to traffic________________

Category in which entered________________ Approx. total cost________________

Span lengths________ Roadway widths________ Steel wt./sq. ft. of deck________

Vertical clearance________ Steel tonnage________ Painted: Yes________ No________

Structural system(s) (describe briefly here)________________

Innovative Concepts________________

Descriptive data: Attach separate sheets (see entry requirements)

No. of photographs enclosed: Color prints________________ 35 mm slides________________

Design Firm:________________ Phone

Address:________________ Street | City and State | Zip

Person to contact:________________ Title

Consulting Firm (if any):________________ Phone

Address:________________ Street | City and State | Zip

Person to contact:________________ Title

General Contracting Firm:________________ Phone

Address:________________ Street | City and State | Zip

Person to contact:________________ Title

Steel Fabricating Firm:________________ Phone

Address:________________ Street | City and State | Zip

Person to contact:________________ Title

Steel Erecting Firm:________________ Phone

Address:________________ Street | City and State | Zip

Person to contact:________________ Title

Owner:________________ Phone

Address:________________ Street | City and State | Zip

Person to contact:________________ Title

This entry submitted by:

Name:________________ Title

Firm:________________ Phone

Address:________________ Street | City and State | Zip

(ADDITIONAL ENTRIES MAY BE SUBMITTED ON COPIES OF THIS FORM)

Vertical Expansion Adapts To Changing Needs

A two-story addition allowed a growing hospital to add needed outpatient space

By James W. Kestner, P.E.

The growth of healthcare has been so dramatic that in Green Bay, WI, it has surpassed the Paper and Pulp Industry as the largest employer.

But this growth has not been without accompanying complications. More procedures are handled on an outpatient basis, and those that are not often have shorter recovery periods than in the past—both of which combine to eliminate needed bed space. At the same time, increasing competition and cost containment requirements are forcing hospitals to consolidate or eliminate services and to become increasingly specialized.

As with most hospitals, Bellin Hospital of Green Bay is almost constantly remodeling and updating its facilities—and all the while planning for future projects.

Changing Plans Require Flexibility

When the hospital built a four-story addition in 1977, the structure was designed to accommodate a future four-story vertical addition. But, fittingly, when the first two stories of the vertical addition were finally constructed their function changed from the originally conceived long-term nursing units. Instead the new space will house outpatient services, heart catherization and gastro-intestinal labs, and surgical areas for same day procedures involving tonsils, cataracts, colonscopy, as well as arthroscopic and laparoscopic surgery.

The 350′ x 85′ (106.7m x 25.9m) building is primarily rectangular in plan. However, one long side of the building was "notched" to fit around an existing building of similar height. The typical bay size is 40′-6" x 21′-3" (12.3m x 6.5m). Floor-to-floor heights vary from 14′ to 16′-9" (4.3m to 5.1m). The ground floor is used for physician parking as well as containing a pass-thru for delivery trucks and access to the hospital's interior courtyard. The fourth floor was designed to house all of the building's mechanical equipment, with services feeding down to the existing space. This mechanical floor was retained and now also services the addition.

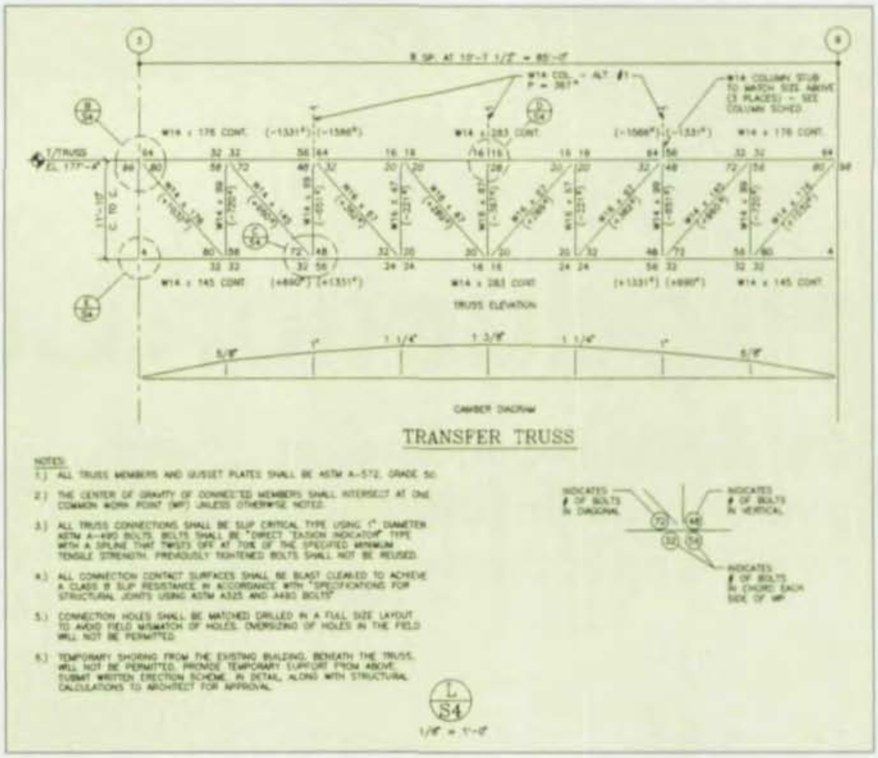
Wide Flange Proves Easier To Fireproof

The original building was framed with 5′ (1.5m) deep steel trusses spanning 40′-6" at 10′-7½" (12.3m at 3.2m) centers. The floor slab, composed of 4" (101mm) normal weight concrete over a 2" (51mm) composite metal deck with shear wires, spans between trusses.

The two story addition was framed with W14x22 steel beams and W30x99 steel girders designed for partial composite action. This framing system was chosen over the original since it provided significantly more mechanical space and was considerably easier to fireproof. A cementitious type spray-on fireproofing was used because the engineer's experience shows this type to be more durable than a fiber-type fireproofing. Floor framing and slab were fireproofed to achieve a three-hour rating and columns met a four-hour requirement.

Lateral Loads

Moment frames were provided in the east-west direction to resist wind forces on the long face of the building. The lower floors in the original building derive their resistance from the field welded connection of truss top and bottom chords to the columns. The upper floors in the new addition utilize knee braces.



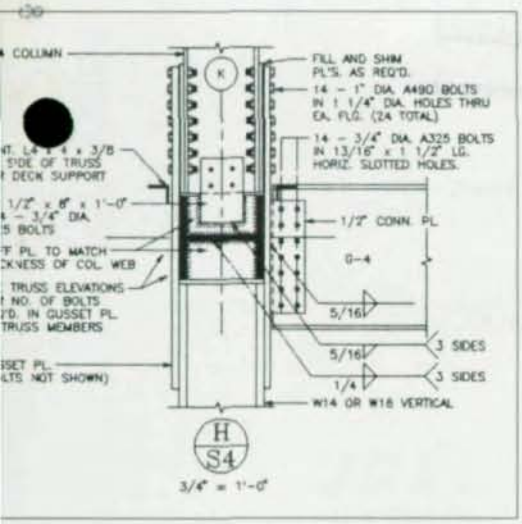
A large truss was needed to span an existing building since its structural system was not sufficient to carry the addition and the added snow loads.

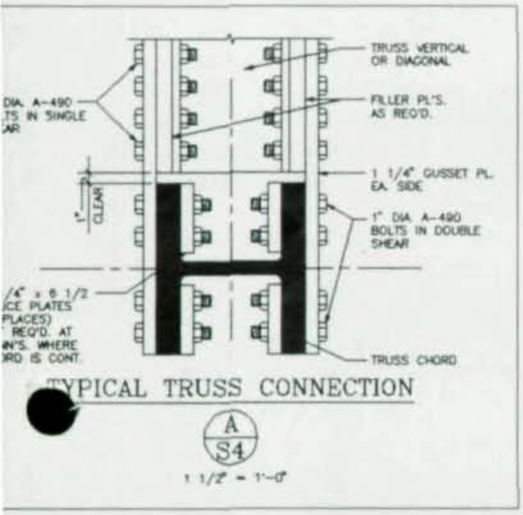
Wind was resisted in the north-south direction by a masonry shear wall from the ground level up to the top of the original construction. Conventional X-bracing was to transfer the wind loads on the new construction down to these shear walls. Horizontal trusswork ensures positive transfer of the forces from the X-bracing above to the shear wall below. General contractor on the project was Oscar J. Boldt Construction Co., Appleton, WI. Fabricator was AISC-member Phoenix Steel.

One of most difficult aspects of the project was spanning the new construction over the poured concrete "notch" building. That

Due to the its size and the lack of accessibility to its location, the large truss was installed in sections using bridge erection techniques (see photo at right).

building's existing structural system could not support the new loads and instead a 13'-3" (4m) deep transfer truss was provided. The truss spans 85' (25.9m) between columns and was designed





The hospital's vertical addition was constructed with wide-flange members instead of trusses largely to simplify fireproofing.

to support four floor levels, even though only two levels were currently being constructed. Because of the added height of the building, the engineers had to calculate the additional snow drift loads on the section of the notch building that extended beyond the new addition's footprint. Because the notch building's roof could not support this added load, it was reinforced with bar joists framed into the truss assembly.

All of the truss members and gusset plates were specified to be ASTM A572 Grade 50 steel. The top and bottom chords were W14x283, Group 4 structural shapes. Special material specification and fabrication procedures from the ASD *Manual of Steel Construction* A 3.1.C were followed to minimize the possibility of cracking of these jumbo shapes. All connections were made with pairs of 1¼" (32mm) gusset plates and 1" (25mm) diameter ASTM A490 bolts. Where smaller web members were required, W16x67 beams were used to minimize the size of the filler plates. The truss required 2,592 bolts. It was shop assembled to assure proper fit-up and then disassembled for shipping.

The truss was located on the backside of the building, away from the street. Because that location is mostly inaccessible, standard building erection techniques could not be used.

Adding to the difficulty was the location of surgery rooms in the area beneath the truss, which meant temporary shoring could not be used. Instead, the erector used techniques developed for bridge construction. After the columns were erected, a segment of the truss was erected on each end and tied back to the column with cables. Only then could the center portion be erected.

Supporting Mechanical Loads

Another complicated area occurred in the fourth floor of the existing structure. The new functions being installed in the addition required a large condenser tank to be installed on the existing mechanical floor.

Unfortunately, that floor's structure could not support the 37,000 lb. (16783kg) load and it would have been very costly and disruptive to reinforce that floor. Instead, W27x84 beams were installed in the ceiling of the mechanical room and a platform was hung from those members to support the tank.

In preparation for further vertical expansion, the tops of the columns were left projecting above the structure and were capped with plates. This technique was similar to that used by the original builders to prepare for the current addition.

James W. Kestner, P.E., is chief structural engineer at Somerville Associates, Green Bay, WI, the project's engineer and architect.

AISC ANNOUNCES

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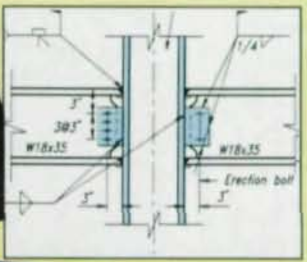

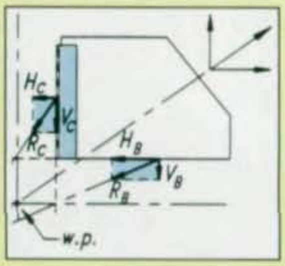

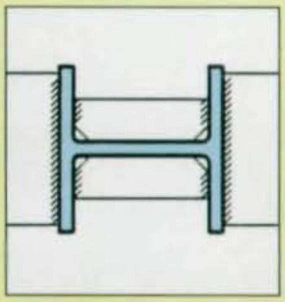

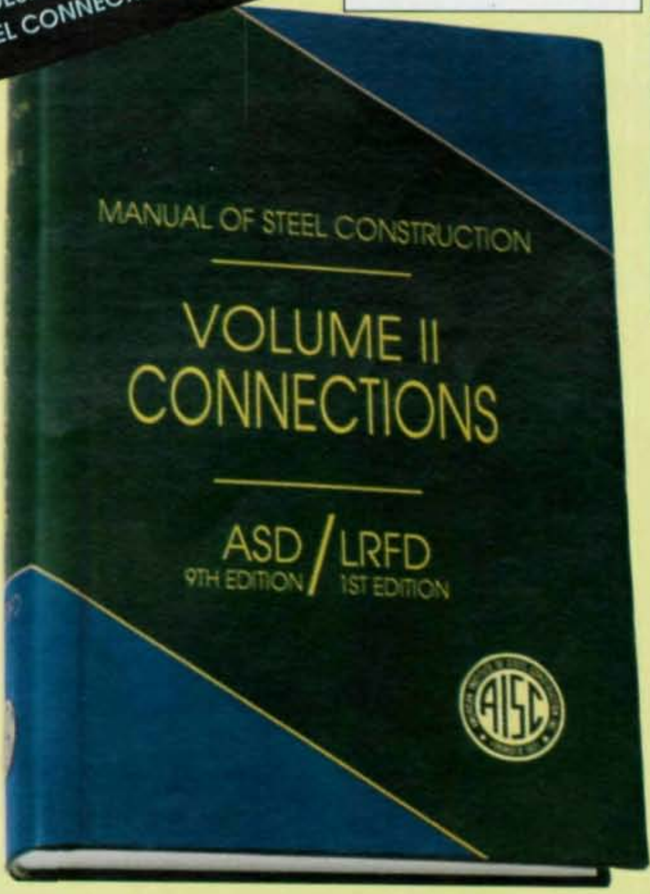

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Working Around Floor-To-Floor Height Restrictions

Designing an interstitial floor proved crucial for matching the existing floor heights

In addition to providing sorely needed space, the 80,000-sq.-ft. (7432m²) addition to the Asbury-Salina Regional Medical Center helped to create a new, more modern image. And as part of this change, the main entrance was relocated to the new space (above and right). Pictured opposite are construction photographs showing the scope of the project, including the attachment between the existing structure and the new construction.

The only thing constant in health care construction is change. As new technology develops, the physical layout of a facility must change to accommodate it.

As part of their upgrade from a community hospital to a regional medical center, the 204-bed Asbury-Salina Regional Medical Center needed to develop a more extensive emergency care service and outpatient facilities, as well as add intensive and coronary care space and medical-surgical/step-down beds. At the same time, the hospital administrators realized they needed to project a more modern image.

"Parts of the existing facility date back to the early 1900s," according to Bill Palmer, a project manager with HDR, the building's Omaha-based architect/engineer. "The hospital wanted to get away from the warehouse appearance of the older buildings."

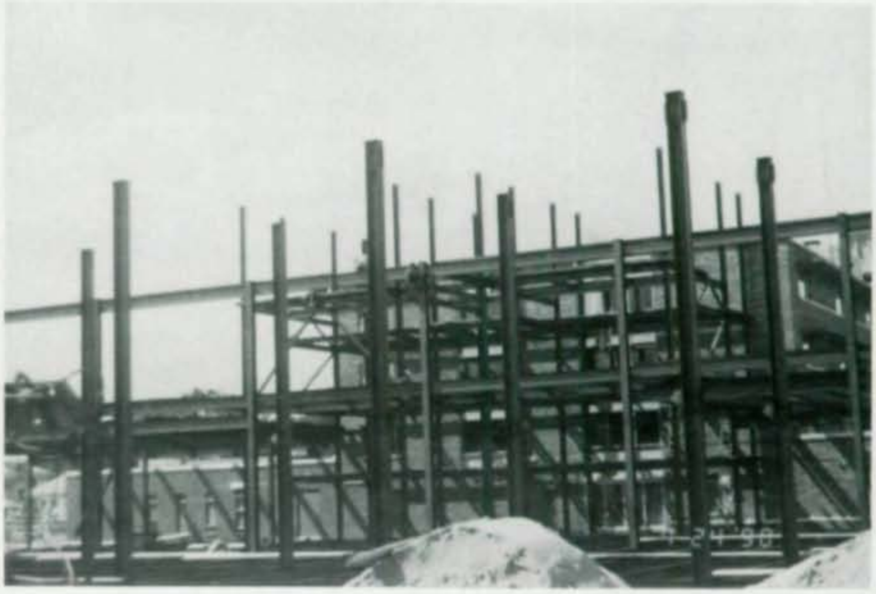
A new addition served to satisfy both goals. The 80,000-sq.-ft. (7432m²)addition could house the needed new services; in addition, the hospital's physical orientation was shifted so that the main entrance was re-sited to the front of the new structure.

Of course, shifting the main entrance to the new structure meant putting the main elevator lobby in the main entrance, which meant it was critical that the floor of the new structure aligned with the floors of the old building—a task made more difficult by the low 10′ (3m) to 12′ (3.7m) floor-to-floor heights in the existing structure. A greater floor-to-floor height was required to meet the mechanical and electrical needs of the services being installed in the new structure, such as surgery suites and laboratories.

The engineer's solution was to create an interstitial floor between the new first and second floors, so that the new first floor aligned with the old first floor, and the new second floor aligned with the old third floor. Since the new addition was only two levels, while the old structure was four stories, the elevator tower itself had to extend up above the rest of the new structure to provide access to the old building via an enclosed walkway.

Framing for the new structure was fairly straightforward and featured four rows of columns supporting wide flange beams and girders. The two outer rows of columns had simple connections using high-strength bolts. "We used bolts with twist-off ends because they make less noise and they don't need difficult inspection to verify correct installation," explained Leo Wutke, P.E., a structural engineer with HDR. In the long direction, the lower portion of the two inner columns have knee braces, while the upper portion utilizes welded moment connections. "On the upper level, the floor-to-floor height was inadequate for knee braces," Wutke said. Lateral loads are picked up by inverted V bracing in the short direction. Where the columns were taking moment loads, W12x120 members were used, while W12x53 members were used where the columns were only taking gravity load. The hospital is in a seismic zone 1 region and wind controlled in the long direction.

Composite W18x35 beams were used for most of the new structure. The diagonal bracing was formed from 5x5 tubes. The tubes were connected to the columns with a welded plate inserted into a split in the center of the tube. "We prefer using tubes for diagonal bracing because of their stability in all di-



The first floor of the new construction features a curved wall (above and top). However, the upper floors are rectangular, so no special structural design was required. Pictured at left are construction photos showing bolted construction.

rections," Wutke stated. The elevator tower has W8 columns with inverted V bracing in the E-W direction.

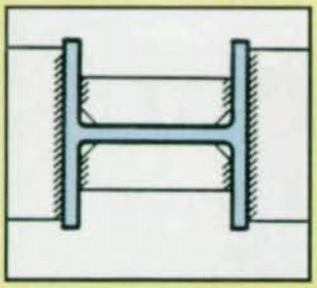
Steel fabricator on the project was AISC-member PKM Steel Serive, Inc., and the general contractor was Koehn & Associates.

The exterior of the new structure is clad in glass and brick and features a cantilevered canopy to clearly designate the new main entrance. Support columns were placed 37' (11.3m) from the building, and the canopy cantilevers 15' (4.6m) beyond the 10" square tube columns. The canopies themselves are composed of WT 7x19 sections and 2½x2x5⁄16 double angles covered with metal decking.

To add further visual interest, the lower level facade was curved. "We used a curving glass wall to create a more modern appearance," Palmer said. The curving facade did not affect the column placement since it was only on the first floor. "The roof line is rectangular above it," Wutke explained.

The addition was designed with further vertical expansion in mind. "We provided a place to attach new columns for the addition of one more floor," Wutke said. Essentially, the columns rise 5½" (140mm)above the girder line and are topped with a steel plate. "We can just take the roof off and put new columns on top of the plate."

STRUCTURAL STEEL DESIGN SOFTWARE FROM AISC



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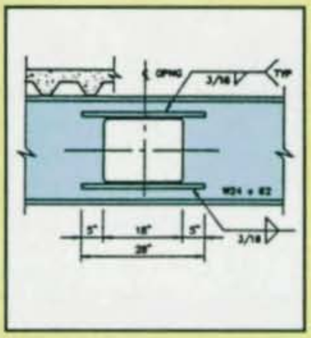

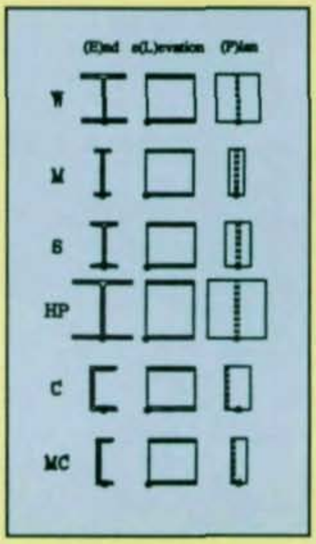

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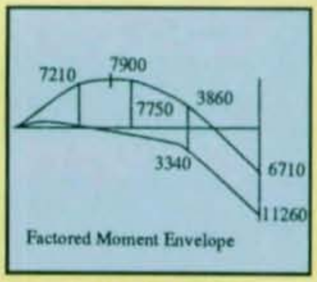

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Solving The Height Restriction Problem

A New Jersey hospital has exploded the myth that only concrete construction can deal with limits on floor-to-floor heights

Switching from concrete to a steel frame saved Centrastate hospital approximately $1.3 million on its 135,000-sq.-ft. (12542m²) addition.

By Joel Person

While hospital construction remains the healthiest segment of the building market, tightening government reimbursement policies are making administrators more cost conscious than ever. But even with decreasing budgets, hospitals are still expanding.

Unfortunately, the growth process is rarely easy. For Centrastate Hospital, a 20-year-old, 240-bed facility in Centrastate, NJ, the problem revolved around the need to match floor-to-floor heights between an existing building and a new six-story addition. Following the conventional wisdom that an 11′ (3.35m) floor-to-floor height would not allow steel construction given the large number of mechanical ducts required, the project's engineers chose a flat slab reinforced concrete design.

However, when initial cost estimates for the 27′ x 25′ (8.23m x 7.62m) bay configuration required by the architects pushed the project over the state mandated budget, the owner began looking for another solution—even though the engineer had already completed 60% of the design work. The hospital and its consultants recognized that a steel frame would reduce costs, but they were unconvinced that a steel system could accommodate the required ductwork given the required floor-to-floor heights.

After careful consideration, they determined that a proprietary composite joist and composite truss girder system from Vescom International would meet both requirements. Superstructure costs were reduced from approximately $3.7 million for the original concrete scheme to about $2.4 million, which more than paid for the engineer's redesign.

The system chosen utilizes a joist with inverted top chord angles that go into the concrete to form a composite connection. The top chord also forms a flush seat that sits on a similar top chord in the composite truss girders. For this project, the joists were placed approximately 5'3" (1.6m) on center with 1½" (38mm) metal deck. The concrete slab on the system was reinforced with welded wire mesh that goes over each top chord and no cracks formed in the slab on the whole project.

Both the joist and truss girders were fabricated with a ¼" to ⅜" camber, so no bridging is required. The lack of bridging contributes significantly to the easy placement of mechanical elements in the plenum.

Even though the joists' panel point were 36' (10.9m) on center, some of the duct work was so large that rectangular openings were required. One reason this system was chosen over other composite joists is the system's capability to accommodate Vierendeel openings.

On this project, the wide flange columns were fabricated by AISC-member Mulach Steel Inc., while the joists and truss girders were fabricated by a joist manufacturer. However, the design team discovered that the joist manufacturer had trouble meeting the required tolerances on the truss girders and in future projects Vescom reports that the structural steel fabricator will most likely also fabricate the truss girders. General contractor for this project was Torcon, Inc., Westfield, NJ, and architect was Taylor & Clark, New York City.

The new 135,000-sq.-ft. (12542m²) addition houses new emergency areas, operating room suites, office and examination rooms, patient rooms, and a mechanical area. One of the most difficult design problems occured in the plenum above the operating

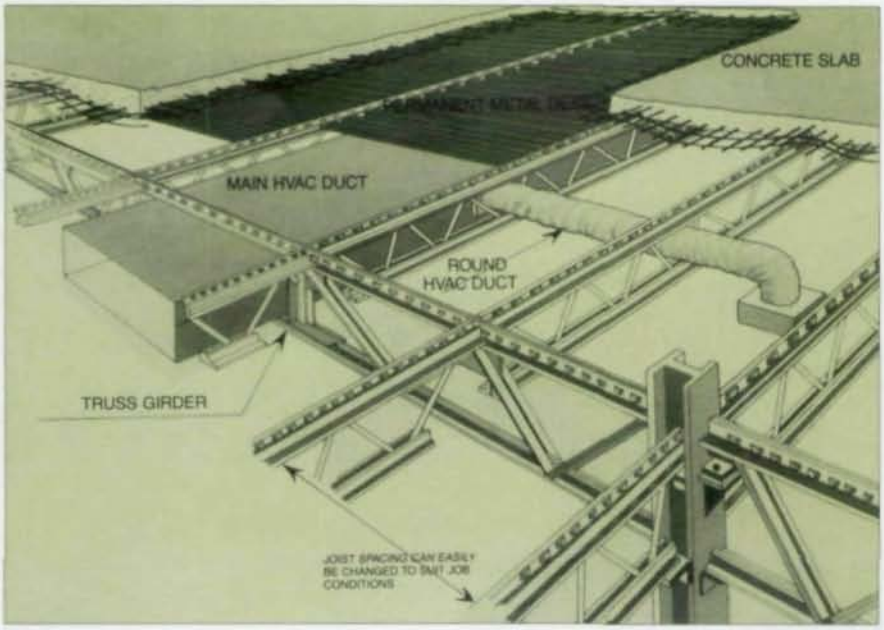
A composite joist system was used on the system because of its ability to handle the project's numerous large ducts while still maintaining a tight floor-to-floor height.

rooms. These areas had heavy lighting and mechanical requirements, and the size of the plenum was substantially reduced by the requirement for a 9′-high (2.7m) hung ceiling. After consultation between the Vescom designers, the mechanical engineer, the structural engineer, and the mechanical and electrical subcontractors, a solution was devised that left almost the entire plenum devoid of structural members. Only one Vierendeel truss girder occupies the space, with composite double angle top chords spanning the rest of the area.

Another difficult design situation occured in one area where a composite truss girder needed to pick up a W14 column for a set back condition. In addition, this truss girder required a large Vierendeel opening for a major duct and was restricted in depth to 16" (406mm). This was accomplished using 8"x4"x1" (203mm x 102mm x 25mm) double angles for top and bottom chords.

A three-hour fire rating was mandated by the state. It was achieved using a Monakote system from Grace. Nylon mesh was furnished in rolls and placed on one side of the composite joist. The spray-on fireproofing is concentrated on the diagonal members and the mesh prevents waste and overspray.

Because the orginal concrete design used no shear walls, there was no architectural consideration given to any diagonal braces. Wind and seismic loads were taken by moment connections at each of the columns. The truss girder column connections were required to take a moment of 270 kip/ft (3661kN/m). However, this re-



The framing system used on the project utilizes wide flange columns, conventional composite joists, and composite trusses, all of which combine for a low floor-to-floor height while accommodating a large quantity of ductwork.

quirement was reduced by ⅓ by tightening the bolts on the bottom chord after the concrete was poured. Where composite joists were used on the column lines, the moment capacity was between 70 and 100 kip/ft. (949 kN/m and 1356kN/m). Still, in some areas the moment was large enough to require as 12 bolts for one connection. While the project is in a seismic zone 1 area, it was upgraded to zone 2 because of its hospital use.

A second, smaller addition also was constructed at the same time. This 30,000-sq.-ft. ($2787m^2$) structure, however, had no headroom concerns and conventional beam-and-column construction was used. The entire project, including both areas of new construction and substantial renovation of the existing facility, had a $50 million budget.

Joel Person is president of Vescom Structural Systems, Inc.

Researchers attempted to burn down a building mock-up to test Australian fire protection requirements

Reducing Fire Protection Requirements

While this may look like a raging fire, surprisingly little structural damage was done, despite a lack of fireproofing on the steel members and inoperative sprinklers. The main reason for the minimal damage was the lack of combustible materials to feed the fire over an extended period. According to BHP Research, most office settings don't provide enough raw material to sustain a good fire for more than two hours.

Setting fires may seem excessive, but it's the only way to obtain a variance in Australia's strict fire safety provisions.

For many years, the growth of steel construction has been inhibited in Australia by the high cost of fire protection required by excessive legislation. As a result, BHP Research, the technology arm of Australia's main steel mill, has conducted extensive large-scale testing to examine the validity of the regulations.

The latest in this series of tests was conducted prior to the renovation of 140 William Street, a 41-story office building with a K-braced service core and a facade frame consisting of large steel columns and closely spaced steel mullions. All of the columns and bracing members are heavily encased in concrete, while the castellated steel beams framing between the primary beams and the perimeter of the building were fireproofed.

Unfortunately, the fireproofing used for the beams contained asbestos, and as part of the renovation project this fireproofing was to be removed. Equally unfortunate, the building code required new fireproofing to be installed on the structural members.

The building was sprinklered; however, the sprinkler system only complied with Australian requirements for extra light hazard (i.e., sprinkler heads at 15' (4.6m) centers and the pipes to the sprinkler heads are ¾" (20mm) diameter). During the renovation, the building code required the sprinklers to be upgraded to normal hazard (i.e., sprinkler heads at 11½' (3.5m) centers and the pipes to the sprinkler heads are 1" (25mm) diameter).

To test both of these requirements, BHP Research constructed a full-scale mock-up of part of the building, loaded it with typical office furniture and supplies, and then set several fires. For all of the tests, the structural beams were left unprotected.

Small Office Fire

The first test took place in a small, private office. The researchers started the fire by igniting papers in a waste paper basket placed partially under a desk and directly under an office chair. The drawers of the desk beside the waste paper bin were open and stacked with papers, and, in addition, loose papers were piled high in the bin and on the floor beside it. And to help fan the flames, the office door was left open.

About 30 seconds into the test flames were visible rising from the bin. After 90 more seconds, the flames appeared above the chair and desk adjacent to the bin, and five-and-a-half minutes into the test the chair caught fire. At 7 minutes 10 seconds into the test a single sprinkler head began operating. The fire was quickly contained and put out.

Fire damage was contained the desk and chair. Damage to the rest of the office was largely due to smoke and water (for example, the ceiling tiles above the fire area were slightly discolored). No windows were damaged. In this case, the extra light hazard sprinkler system was in use.

Open Plan Office Fire

The second test was similar to the first, except for its location in a large open plan office area and the fire was started mid-way between sprinkler heads. About five minutes after the fire was started a smoke detector sounded. About a minute later the four surrounding sprinkler heads opened and

Shown at top is the test structure prior to the fire. The photo above shows the results of the fire: While the ceiling system was destroyed, the steel structural system was largely unaffected.

The interior of the test structure was set up to closely resemble actual office conditions, including modular furniture and piles upon piles of papers, files, and other miscellaneous combustible items.

Water-filled drums were used to load the level 2 floor (top). A fire in the small office never spread beyond the room (bottom).

quickly extinguished the fire. Damage was similar to that observed in the first test.

No Sprinklers?

Tests three and four were similar to the first two tests, but in these tests the sprinkler systems were disabled until the fire was past its peak (for example, in test four the sprinklers were not turned back on until 118 minutes into the test when it was observed that the fire was burning at a decreasing rate the temperature of the steel members was actually decreasing). In both of these tests, the fire damage was much more severe, and in both instances windows shattered.

In both of these tests there was no signs of distress or damage to the structure of the building.

(Information in this article is adapted from a presentation at this year's National Steel Construction Conference from two reports issued by BHP Research: *The Effect of Fire in the Building at 140 William Street* and *Fire Tests of the 140 William Street Office Building.*)

Intumescent Fire Protection

PPG Industries has recently introduced PITT-CHAR XP fire protective coating, a 100% solids, flexible, epoxy-based intumescent material. This patented coating uses a flexible, crosslinked epoxy resin system, providing enhanced protection from physical, chemical and climatic exposures, resulting in long term corrosion and fire protection. The coating is designed for ease of application and rapid cure, allowing structural steel to be shop coated before assembly. The coated steel is typically ready to be hoisted and shipped after an overnight cure. It is applied by airless spray and presents no hazards from solvents, asbestos, heavy metal or known carcinogens. PITT-CHAR XP is fully UL listed and has passed both the UL1709 hydrocarbon fire test and the UL263/ASTM E-119 fire test.

For more information, contact: PPG Industries, Technical Sales Department, 151 Colfax St., Springdale, PA 15144 (800) 531-0264.

High-Quality Fire Protection

Albi high-performance fireproof coatings are engineered for structural steel exposed to weather, physical abuse, and other aggressive environmental factors. Albi products have undergone extensive UL hydrocarbon fire testing and meet stringent code and insurance requirements. The material is spray-applied and requires no troweling, tamping or other labor intensive application procedures. Albi Clads are thin, hammer-hard, smooth, durable intumescent fireproof coatings with exceptional aesthetic appearance. The coatings can be applied in a wide range of ambient temperatures, from below freezing to 100 degrees F. At thicknesses ranging from 1/8" to 3/4", they closely follow the contours of steel and offer up to a three hour fire protection.

For more information, contact: Albi Manufacturing, Division of StanChem, Inc., 401 Berlin St., East Berlin, CT 06023 (203) 828-0571; fax (203) 828-3297.

Photo by Scott Manning

Computerized Reference Tool

To facilitate the process of specifying CAFCO spray-applied products, Isolatek International now offers model specifications on computer diskette. Recently updated and formatted in conformance with industry standard practices, specification guides are available for Spray-Applied Thermal Insulation, Spray-Applied Fireproofing, and Spray-Applied Acoustical Treatment. The company's Blaze-Shield II fireproofing offers ease of application and is certified asbestos-free. The product is pneumatically applied and requires relatively little water, which means a faster drying time. It has a high bond strength and comprehensive strength and shows superior air erosion resistance. Ratings of up to four hours can be obtained.

For more information, contact: Isolatek International, 41 Furnace St., Stanhope, NJ 07874 (201) 347-1200; fax (201) 347-9170.

Fire Protection Systems

Textron Specialty Materials offers a comprehensive array of fire protection systems. CHARTEK intumescent spray-on epoxy fireproofing features the patented Charlok mesh reinforcement system. This system offers long-lasting fire and corrosion protection for steel structures. During a fire, the epoxy coating converts to a cocoon-like char that provides insulation from intense heat. It can be easily applied to pre-erection structure, and has passed various fire and explosion tests (including UL 263/ASTM E-119 and UYL 1709). For applications where blasting or spray application is not possible, the company offers an interlocking epoxy-based panel system. CHARCAST panels provide quick, easy installation with a smooth, architecturally appealing finish. The system's unique interlocking design creates a barrier to moisture and enhances reliability. A hot-dipped galvanized metal substructure is used to add reinforcement and provides an isolated area for external fasteners. It also increases the system's impact and explosion resistance. The company offers a wide range of additional products, from spray-on intumescent fireproofing systems to pre-fabricated panel systems to bomb coatings.

For more information, contact: Textron Specialty Materials, 2 Industrial Ave., Lowell, MA 01851 (508) 452-8961; fax (508) 454-5273.

Cementitious Fireproofing

Grace has developed a high-density spray-applied cementitious fireproofing, Monokote Type Z-146, for industrial and manufacturing facilities as well as exterior uses. It is designed to exceed standards for in-place physical properties, ease of use and fire protection consistent with the needs of industrial fireproofing applications. It can be applied using a wide variety of common plaster pumping equipment, eliminating the need for specialty pumps typically required for other high density fireproofing products.

For more information, contact: W.R. Grace & Co., 62 Whittemore Ave., Cambridge, MA 02140-1692 (617) 876-1400.

Decorative Fireproofing

A thin film intumescent fire protection, A/D Firefilm, has been developed by A/D Fire Protection Systems to provide an aesthetic coating while protecting structural steel from fire. On the surface, the coating appears to be just a colorful paint. but hidden beneath is a thin film coating which can provide up to a two-hour fire rating. In a fire, however, the coating softens and then expands to form a meringue-like layer,up to 100mm thick, which insulates the structure from intense heat for up to two hours. The second component of the system, a decorative topcoat, acts as a protective layers and serves as the colorful finish. Application is by either brush, roller or spray and the coating is resistant to abrasion and most chemicals. A full range of decorative colors are available in a statin finish.

For more information, contact: A/D Fire Protection Systems, Inc., 420 Tapscott Road, Scarborough, Ontario, CANADA M1B 1Y4 (416) 292-2361; fax (416) 298-5887.

Interior Steel Fireproofing

Flame Control fire retardant Mastic No. 50-44 from FlameControl Coatings is an asbestos-free, reinforced intumescent thermal protective coating designed for application to interior structural steel. When applied at a wet film thickness of 3⁄16" it can provide a fire resistance rating of 1, 1½ and 2 hours, depending on the design and components used. The coating dries to a hard, flexible finish that withstands structural movement and vibrations, and does not dust, flake, spall or crack. Spray application yields a textured, stucco-like finish, or it can be lightly troweled to a relatively smooth finish. The material has been tested to ULC-723 (ASTM E-84, NFPA No. 255, ULC/CAN-S102).

For more information, contact: FlameControl Coatings, Inc., P.O. Box 786, 4120 Hyde Park Blvd., Niagara Falls, NY 14302 (716) 282-1399; fax (716) 285-6303.

Epoxy-Coating For Steel

Fire Research 477 is a two-component epoxy-coating designed to protect steel from heat and fire. It dries to a smooth finish that is resistant to most chemical. The coating is approved for interior, exterior and marine applications and is UL classified.

For more information, contact: Fire Research Laboratories, 5364 Pan American Freeway NE, Albuquerque, NM 87109 (800) 877-3473.

Steel Protection System

A structural steel fire protection system offering 1, 1½, 2 and 3 hour ratings per ASTM E119/UL263-8.1 fire test is now available from Thermal Ceramics. It also offers either a 1, 1½ and 2 hour rating per UL 1709 hydrocarbon fire test. The lightweight system won't crack or chip and requires no cleaning or coating of members to assure bonding. It installs at any temperature and eliminates overspray control and extensive cleanup.

For more information, contact: Thermal Ceramics, P.O. Box 923, Augusta, GA 30903 (706) 796-4328; fax (706) 796-4323.

Fire Alarms

Fire Control Instruments offers a complete system for fire detection featuring that include: drift compensation, which minimizes nuisance alarms by sensing changes in the environment and automatically compensating system sensitivities; self-test up to three times per day; and on-line telecommunications support.

For more information, contact: Fire Control Instruments, 269

Grove St., Newton, MA 02166-2295 (617) 965-2010; fax (617)-965-0659.

Fire Sprinkler Program

Hydronics Engineering is marketing a Windows-based and Macintosh-based computer program for fire sprinkler hydraulics. The programs use Newton-Raphson-Laguerre network convergence algorithms for calculating grids, trees, loops or hybrid piping systems. There are utilities for calculating hydrant flows, adjusted K-factors, pipe turbulence and velocity analysis.

For more information, contact: Hydronics Engineering, 34119 Fremont Blvd., Suite 609, Fremont, CA 94555 (800) 845-9819; fax (510) 475-8122.

Hydraulic Design Software

New versions of the widely used HP4M and HP6M Fire Sprinkler Hydraulic Design Programs have been introduced by MC2 Engineering Software. HP4M designs grid type sprinkler systems and the HP6M designs tree and loop systems. The new versions feature totally new screens for user inputs, allow the use of function keys, and have extensive default values.

For more information, contact: R.S. McClintock, President, MC2 Engineering Software, 8107 SW 72 Ave., Miami, FL 33143 (305) 665-0100; fax (305) 665-8035.

Sprinkler Control Software

HASS (Hydraulic Analyzer Sprinkler Systems) allows theuser to quickly calculate grids, trees, loops, fixed water spray systems, and any other arrangement of piping. for any arrangement, you can develop a piping layout, readily adjust pipe sizes to optimize the design, feed piping in one area from piping in another area, and calculate either minimum end head flow or the total supply available.

For more information, contact: HRS Systems, Inc., 2193 Ranchwood Dr., NE, Atlanta, GA 30345 (404) 934-8423; fax (404) 934-7696.

Coating Thickness Gauge

The Elcometer 345 is a truly shirt pocket-sized coating thickness gauge. It measures any non-magnetic coating on steel or all non-conductive coatings on non-ferrous substrates with a built-in or separate probe. Sizes range from a four-key keyboard with no record keeping to a nine-key keyboard with full statistical analysis and memory for up to 10,000 readings. Most models have a built-in RS232 output, enabling data to be sent to a data logger, printer or PC.

The 300S model has a number of advanced features, such as batch analysis, high-low limits, large memory (8K), a wide range of statistics (number of readings, highest, lowest, mean, and standard deviation), and a variety of calibration methods (incuding single point and two point). A variety of probes also are available.

For more information, contact: Elcometer Inc., 1893 Rochester Industrial Dr., Rochester Hills, MI 48309 (313) 650-0500; fax (313) 650-0501.

Fire Stop Products

Hilti Construction Chemicals has introduced a new line of fire stop products, including: FS 601 Elastomeric Firestop Sealant; FS 605 High Performance Firestop Sealant; FS 611A Intumescent Firestop Sealant; and FS 635 Trowelable Firestop Compound.

For more information, contact: Kenneth Walsh, Mgr. of Marketing Communications, Hilti Inc., 5400 South 122nd East Ave., Tulsa, OK 74146.

Fire Stop Sealant

A new self-leveling sealant has been introduced by Dow Corning to broaden the company's Fire Stop product line. Fire Stop Sealant-SL 2003 is a one-part, ready-to-use, silicone elastomer that is gunned into simple floor penetrations and construction joints. As with other Fire Stop products, the self-leveling sealant meets ASTM E814 and UL1479 requirements.

For more information, contact: Dow Corning Corporation, reference #P297, P.O. Box 1593, Midland, MI 48641-1593 (517) 496-4468.

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619 South Cedar Street / Studio A
Charlotte, NC 28202
fax (704) 358-1801

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Steel Joists Make It Easier To Build Well For Less

To make building design more efficient, the Steel Joist Institute has provided three new tools: a computer diskette to determine vibration characteristics, the SJI 60-Year Steel Joist Manual, and a Catalogue of Standard Specifications and Load Tables.

The Steel Joist Institute (SJI) has created a computer program to assist the qualified professional engineer in determining probable vibration characteristics of floor systems using open web steel joists. This program is designed for use in conjunction with the institute's Technical Digest #5 "Vibration of Steel Joist-Concrete Slab Floors."

This program allows the designer to calculate swiftly and easily the frequency and amplitude resulting from transient vibration caused by human activity on a joist-concrete floor. The "what if?" scenario—variations in slab thickness, concrete strength, joist size, joist spacing, floor decking, live and dead loads, span lengths—can be accomplished in seconds.

The program is user friendly, can handle spans up to 100 ft. and can accomplish in seconds calculations that previously required several hours. It is available on 5¼ and 3½-in. disks and is IBM PC compatible. A comprehensive user's manual is included.

Long-span joists provide broad, column-free expanses like the sanctuary of this Charlotte, N.C., church.

The SJI 60-Year Steel Joist Manual is also now available. The new, 318-page 60-Year Manual replaces the 50-Year Digest and features 98 more pages of information. The practical section in the Manual is designed to aid the professional by listing four helpful categories:

- The various building documents required and what use they can be.
- Building site information and equipment needed.
- Step-by-step investigative procedures.
- Time-saving data for use when analyzing existing structures.

Another helpful reference that's now available is the SJI 1992 Catalogue of Specifications and Load Tables. All of the 1992 revisions are prominently listed so that specifiers can review these changes quickly and easily.

The section of fire-resistive assemblies has been expanded and completely revised. It lists the requisite criteria for using K-series joists in an assembly and includes a simple, five-step procedure for selecting the proper and most economical joist. In addition, the catalogue contains over 75 floor and roof assemblies listed in an easy to use chart for quick reference, with specific UL designations for fire ratings from one to four hours.

Last year, Underwriters Laboratories, Inc. increased the allowable design stress of fire-rated steel joists by 36% for floors and 18% for roofs. The allowable tensile stress of joists used in most fire-rated assemblies has been increased to 30,000 psi for floors and 26,000 psi for roofs, as compared with the previous maximum stress level of 22,000 psi. The new standards now make it more economical to achieve desired fire resistance ratings without added expense for heavier joists.

For information contact the Steel Joist Institute, 1205 48th Ave. North, Myrtle Beach, SC 29577.

Steel Joist Institute Members:
Canam Steel Corp.
Delong's Inc.
East Coast Steel
Gooder-Henrichsen
John W. Hancock, Jr., Inc.
The New Columbia Joist Co.
Owen Joist Corp.
Quincy Joist Co.
SMI Joist Co.—A Commercial Metals Co.
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