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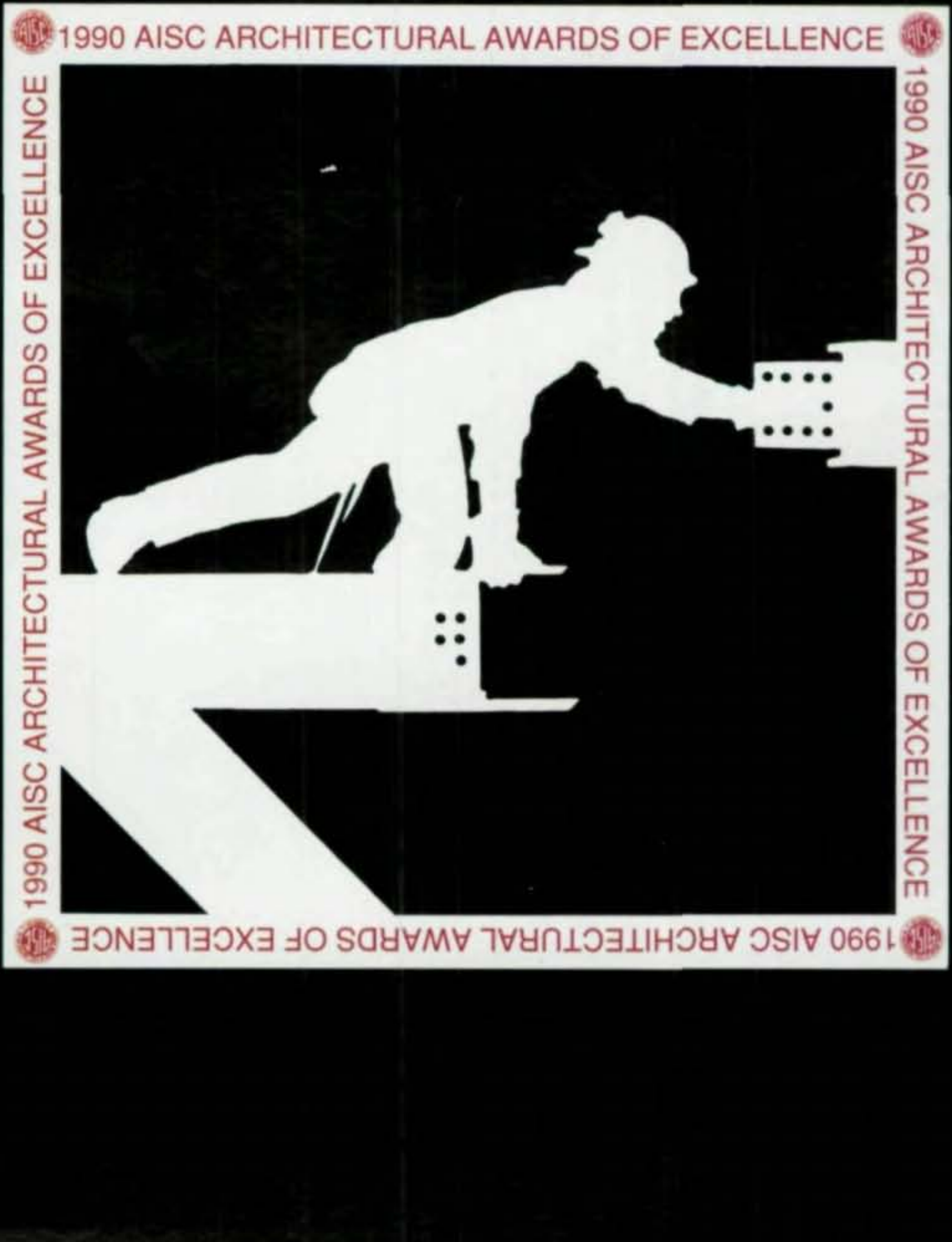
MODERN STEEL CONSTRUCTION

November-December 1990 $3.00



UNITED STEEL DECK, INC. DECK DESIGN DATA SHEET No. 15

DIAPHRAGM INFORMATION

TYPICAL FLOOR DECK WITH CONCRETE DIAPHRAGMS

GAGE	SPAN	WELD PATTERN	SHEAR plf
28	2.0′	30/4	1780
26	4.0′	36/3	1670
24	6.0′	36/3	1700
22	6.0′	36/3	1760
22	8.0′	36/4	1710
20	8.0′	36/4	1750
20	10.0′	36/4	1750
18	8.0′	36/4	1820
18	10.0′	36/4	1820
18	12.0′	36/4	1770
16	10.0′	36/4	1890
16	12.0′	36/4	1830

NOTES

1. THE G′ (STIFFNESS) VALUE OF 2450 KIPS/INCH CAN BE USED FOR ALL COMBINATIONS IN THE TABLE.
2. SIDELAPS ARE WELDED OR SCREWED (28 TO 24 GAGE) AT A MAXIMUM OF 36″ ON SPANS GREATER THAN 5′; i.e. A 6′ SPAN WOULD HAVE ONE SIDELAP ATTACHMENT, AN 8′ SPAN WOULD HAVE TWO.
3. STRENGTH VALUES ARE BASED ON 2.5″ COVER OF NORMAL WEIGHT CONCRETE (f′c = 3 ksi) OVER THE RIBS; FOR LIGHT WEIGHT (STRUCTURAL) CONCRETE MULTIPLY THE TABLE VALUES BY 0.7. DECK DEPTHS UP TO 3″ ARE COVERED.
4. IT MAY BE NECESSARY TO INCREASE THE NUMBER OR STRENGTH OF THE PERIMETER CONNECTIONS TO UTILIZE THE STRENGTH SHOWN IN THE TABLE.

WELD PATTERNS


30/4
(UFS)


36/3
(B)


36/3
(UFX)


36/4
(B)


36/4
1½″, 2″, 3″ LOK FLOOR


36/7
(B)

TYPICAL ROOF DECK DIAPHRAGMS

B DECK WITH ⅝″ WELDS TO STEEL AND #10 SIDELAP SCREWS.

GAGE	SPAN	SIDELAP SCREWS	36/3 PATTERN		36/4 PATTERN		36/7 PATTERN	
			q	G′	q	G′	q	G′
22	6.0′	1	165	7	180	13	240	51
20	6.5′	2	220	12	240	21	310	71
18	7.0′	2	270	22	295	38	380	95

"q" IS POUNDS PER FT. G′ IS IN KIPS PER INCH.

STEEL DECK INSTITUTE *DIAPHRAGM DESIGN MANUAL 2ND EDITION* IS THE BASIS FOR BOTH FLOOR AND ROOF DECK TABLES.

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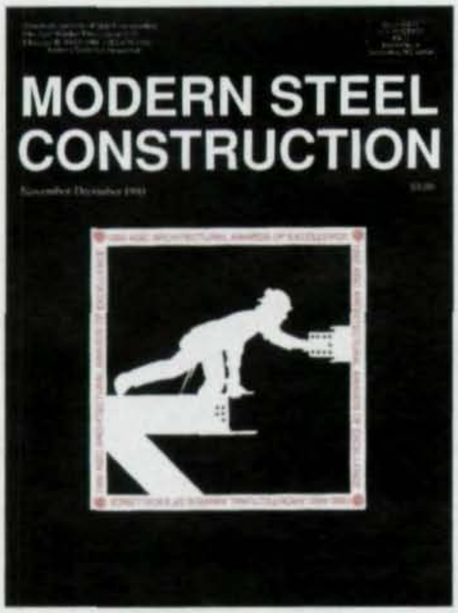


The nine winners of the 1990 AISC Architectural Awards of Excellence are presented beginning on page 15.

FEATURES

NEWS AND DEPARTMENTS

Competitive Thoughts

Late one evening in early August, several AISC staff members were still at the office, feverishly logging in entries for the 1990 Architectural Awards of Excellence competition. Each entry had to be examined to make sure it met all of the criteria for the competition—no small feat when there were more than 100 entries, most of which arrived at the deadline wire, just days before the judging.

I'm always amazed at an architectural firm that will take the trouble to put together an entry for a competition, but doesn't take the trouble to read the rules. The most common reason for eliminating an entry was that it was not completed during the required time period.

Most of the entries were fabulous. But there were some that, while they met the minimum criteria, clearly suffered during the judging because they were not well put together.

The judges particularly disliked projects that were not photographically well documented. For example, several entries showed pictures of the front of the building, but ignored the rear. And pictures detailing the connections between various building elements were few and far in between. Yet those are the type of details for which judges look. While slides were not required, they were recommended, and the judges found them very helpful. With slides, when the judges were jointly discussing a project, they could all view it together.

Some submitters also had the annoying habit of trying to substitute color photocopies for true photographs. While this demonstrated access to the latest reproduction technology, the relatively poor quality of these copies did little to endear the entry to the judges.

For some reason, in this particular competition, written descriptions of both program and design intent were from the minimalist school. While pictures are definitely more valuable than written text, an explanation of a complicated project often is helpful. Entries should describe what was needed, what alternatives were considered, and what was ultimately done.

The next AAE competition will be held in 1992. All U.S. designed and constructed projects completed between Jan. 1, 1987 and December 31, 1991 are eligible. So save those photographic records (or if your project is not yet complete, start documenting it now). **SM**

Software Review: The Answer To The Connection Dilemma

By Philip Terry and James Manley

CONXPRT is a highly interactive knowledge-based microcomputer program for designing steel building connections. It was developed by Structural Engineers Inc. (SEI), Radford, VA, and is marketed by AISC. SEI is a small firm (two employees), but 15 structural engineers acted as knowledge experts during development.

CONXPRT module I (version 1.0) designs double-angle, shear end-plate or single-plate simple framing (Type II) connections according to the ninth edition of AISC's *Manual of Steel Construction*, Allowable Stress Design (ASD). Framing angle connections can be bolted, welded or both.

Possible framing configurations include beam-to-column flange, beam-to-column web and beam-to-girder web. Single or double beam copes, bolt stagger and offset beam elevations can be specified. Designs can be made for specified shear values or for a maximum number of bolt rows or angle length. CONXPRT's database includes most of the standard structural shapes and material properties for the various steels, welds and bolts listed in ASD. This database cannot be modified or used by other programs.

Getting Started

Our evaluation program came on 3½" media, but 5¼" also is available. CONXPRT must be installed on a hard disk; it will not run from a floppy disk.

We didn't find the install screen intuitive. It's best to read the manual as you go through the simple installation procedures.

CONXPRT is copy protected by limiting installation to three times. In effect, you can create three working copies, so CONXPRT can run on three machines simultaneously. This is more generous than limiting use to one machine and much better than a key disk method. CONXPRT can be uninstalled and moved to other machines. You cannot make working backup copies.

Documentation

The manual is not long (14 single-sided pages), so read it twice: once before you try a sample program and again while running a sample problem. The manual does not contain a tutorial and has only one example design problem. There should be more than one, but then again, creating your own sample problems is a good way to become familiar with the program. You should allow several hours to investigate all the program's nooks and crannies. CONXPRT is so interactive that, after a few sample problems, you will probably never use the manual again.

> It doesn't do anything that a competent experienced structural engineer couldn't do. It just does it faster—lots faster—and maybe more accurately

The manual is not a text on connection design. It does not describe all the rules, algorithms or logic CONXPRT uses for design. SEI provides Trace and Advice features for learning about a specific design problem.

Screens/Windows

CONXPRT uses pop-up windows to display menus and prompts. After quickly bypassing the title and license screens, the main command screen appears. Thirteen command fields are listed across the top of the screen and perform four different functions:

- Provide information such as the date, current design identification, current design (page) number and total number of designs (pages).
- Accept data such as job identification or user initials.
- Turn features off and on.
- Open windows for functions such as maintaining the trace variable list, beginning or changing the design (page), reconfiguring the design, and configuring the system.

Prompts for six keyboard function keys are at the bottom of the screen. These include Advice, Design, Help, Quick Input, Reports and Files.

Command Fields/Graphics

CONXPRT includes a set of user definable defaults for most connection variables, including dimensions, angle sizes and overstress limits.

The program looks best in color, but monochrome is acceptable. The graphics are made up of ASCII characters, so CONXPRT should work on any monitor. Bolt rows are displayed as rectangular blocks, and weld symbols are made up of dashes and slashes.

Entering Data

Selection fields are not highlighted until you move the cursor to them. This means you have to use the arrows keys or the tab key to find the fields. It's a little confusing at first, but you get used to it. Once the appropriate field is highlighted, you either enter data or press Enter to open a window.

Some data such as coping dimensions are entered directly as values; some, like bolt sizes, are selected from menus. You can enter values with or without decimal points or as fractions (1½ or 1.5). The program rounds all input to the nearest 1⁄16". All input and output is in English units.

For the novice and occasional user, the menu system is great, but experienced users will want to enter data quickly. SEI anticipated this problem and provided a Quick Input window. In this window, the input items are in order. All you have to do is enter data or request a menu.

SEI also provided a way for fast movement through the shape menu, but here they did not go far enough. Even using the Quick Input window, sizes and materials for beams, columns, girders, bolts, welds and angles, and bolt type can only be selected from menus. Experienced users would probably prefer to type sizes and materials directly rather than go through menus. Such direct input would require the program to verify that the size or type is valid before accepting it or issue an error message.

CONXPRT should check some input values for reasonableness. During one design, it allowed us to enter a web plate thickness of 1,084 in. It concluded that the design was acceptable and a ¾" by 1,086 ½" bolt was required. Although it allowed us to enter negative dimensions and thicknesses, these errors were discovered when the failed to satisfy minimum dimensions contained in the rules.

Design

You can design for a specified shear value or for a maximum number of bolt rows (or maximum angle length for framing angles welded on both sides). When you design for maximum number of bolt rows, CONXPRT ignores the specified shear force. ASD (page 4-9) states: "For economical connections, beam reactions should be shown on the contract drawings. If these reactions are not shown, connections must be selected to support one-half of the total uniform load capacity shown in the Allowable Uniform Load Tables, Part 2 of this manual, for the given beam, span, and grade of steel specified." To comply with this criteria, a fabricator or engineer could look up and use the appropriate shear value from these tables. However, it would be more convenient if CONXPRT could advise if the user-specified shear value meets these criteria.

Bolt connection types can be slip critical (friction, class A) or bearing with bolt threads included or excluded from the shear plane. Bolt holes can be standard, short slotted, long slotted or oversized. Angles can have long legs back-to-back or short legs back-to-back.

Time

The developers report that a design may take 1-2 minutes on a machine without a math coprocessor. Design times can exceed 30 sec for PC or PC-XT machines with math coprocessors. We experienced almost instantaneous response with a 386 (20 MHz) machine and acceptable response on a small laptop without a math coprocessor.

Output

Size and dimension information is reported on the screen. A summary report showing input values, appropriate stress limits and comments can be shown on the screen or printed. Unfortunately, the report cannot be output to an ASCII file. CONXPRT does not interface with other programs (CAD, databases, spreadsheets or word processors). Output is acceptable for including in design notes or giving to a detailer.

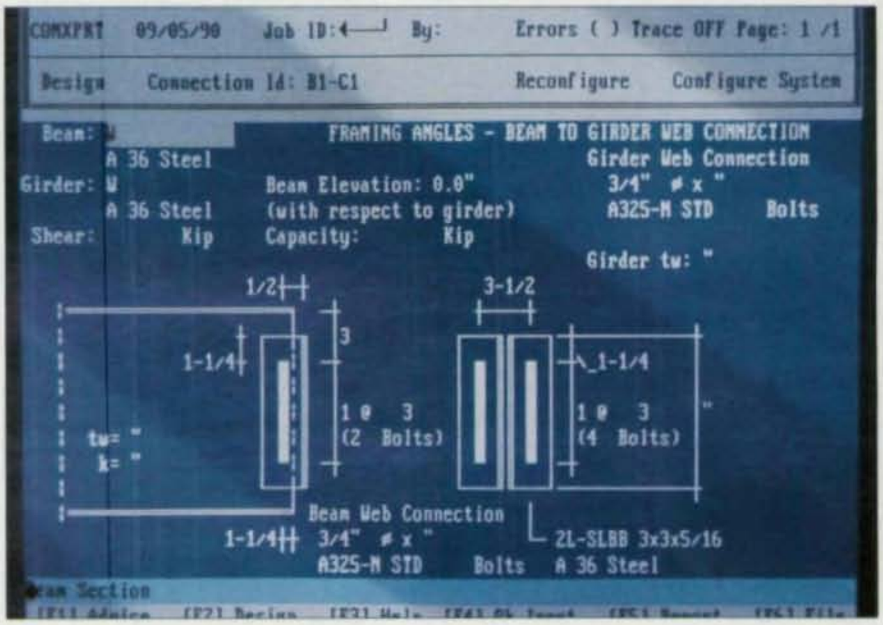
CONXPRT supports several printers. It is convenient to have the printer available as you design, but engineers without compatible printers will be disappointed with the output. Text is fine, but letters are used in place of graphics characters. We had excellent results with a Panasonic KXP-1592. CONXPRT does not support any plotters.

Conclusion

CONXPRT Module I version 1.0 has limited value. It does not handle multiple bolt rows, eccentric connections, (single-angle) tension connections, etc. The developers plan to release additional modules that will include all of the connection types found in ASD and LRFD.

SEI's goal is to satisfy 90% of the steel industry's connection design requirements. Hopefully, the modules will have similar user interfaces and be able to share design data. SEI should consider input and output in metric units. The design screen and output already indicate which module and version are being used, but they should also indicate which edition of AISC's ASD or LRFD rules are being followed.

Our evaluation was not intended to verify the numerical accuracy or appropriateness of the solution. We leave this to the developer and purchasers of the program. However, from our use of the program, the developers appear to have a thorough knowledge of Type II connection design, and they have put that knowledge into a very useful program.



CONXPRT designs three types of simple shear connections, including this double-angle bolted connection.

CONXPRT helps structural engineers through the time-consuming, error-prone connection design process. It doesn't do anything that a competent experienced structural engineer or connection designer/detailer couldn't do. It just does it faster—lots faster—and maybe more accurately. CONXPRT is a worthwhile aid to design accuracy and productivity. Once the initial training is over and the user is comfortable with the menus and messages, connection design goes very quickly. CONXPRT is a real productivity tool (unless you are tempted to try hundreds of schemes).

There's a danger, too: As the CONXPRT developers remind us on page 1 of the user's manual, "Although this software has been prepared in accordance with recognized engineering principles, it should not be used or relied upon for any specific application without competent professional examination and verification of its accuracy, suitability and applicability by a licensed professional engineer."

With such a powerful tool, there's also the danger of abuse or complacency. In the initial learning period and whenever a new feature is tried, users should check input and results thoroughly. Later, they should spot-check individual calculations. This is especially true for designers unfamiliar with LRFD. An unprofessional and unsafe act would be to use CONXPRT on projects without understanding the basis for ASD or LRFD connection design.

Every structural engineer and steel fabricator should consider investigating this software. We look forward to evaluating new products from SEI.

Philip Terry, ASCE is a structural engineer with Burns and McDonnell, Kansas City, MO, and a member of CE Computing Review's editorial board. Jim Manley, ASCE, is a structural engineer with Burns and McDonnell. This critique was excerpted from an article that first appeared in CE Computing Review, ASCE, September 1990. □

LRFD Lecture Series Announced For 1991

Practical Steel Design Using LRFD

REGISTRATION FORM

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Name of City ____________ Date ____________

Company Name ____________ Area Code & Phone Number ____________

Street Address Only (No P.O. Box) ____________

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Fee Schedule

Non-member	$95
Including Manual	$145
AISC Member	$65
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List of Attendees

	Lecture Only	Lecture and Manual	AISC Professional Member Number	Fee(s) Enclosed
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name	☐	☐	#	$
name	☐	☐	#	$
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Mail this form with your check (Payable to AISC) or credit card number to: AISC-LRFD Lectures, P.O. Box 806286, Chicago, IL 60680-4124 or FAX 312-670-5403

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A new lecture series, *Practical Steel Design Using LRFD*, is scheduled for 1991.

The four-lecture program is based on the need of structural designers to become more closely involved with the routine procedures of using the Load and Resistance Factor Design techniques. The program consists of the design of a steel frame for a four-story office building. A set of design notes, including pertinent calculations, outline the LRFD process. The first lecture gives a description of the project as well as a short review of principles. The subsequent three lectures cover the topics of roof and floor design, framing systems and connections, respectively.

The design notes handout provides realistic design solutions not found in manuals and textbooks. The analysis includes evaluation of various load combinations as required for the 100′ x 150′ building and the utilization of design limit loads for components and frames.

Fees are $65 ($110 with Manual) for AISC members and $95 ($145 with Manual) for non-members. To register, fill out the adjacent form and send it, along with payment, to: AISC-LRFD Lectures, P.O. Box 806286, Chicago, IL 60680-4124. For more information, call (312) 670-5422.

Seminar Schedule

West

San Diego (1/17); Sacramento (1/22); San Francisco (1/23); Los Angeles (1/31); Denver (2/7); Phoenix (2/28); Salt Lake City (3/7); Irving, (3/28); Seattle (4/24).

Midwest

Cleveland (1/15); Chicago (2/27-28); Milwaukee (3/21); St. Louis (4/2); Minneapolis (4/4); Grand Rapids (4/9); Detroit (4/10); Kansas City (5/2); Indianapolis (5/7); Cincinnati (5/8); Columbus (5/9);

South

Houston (1/15); Dallas (1/29); Atlanta (2/12); Miami (2/14); New Orleans (2/26); Orlando (3/6); Greenville (3/12); Charlotte (3/14); Knoxville (3/20); Birmingham (3/26); Raleigh (4/9); Richmond (4/11); Oklahoma City (4/16); San Antonio (4/23); Albuquerque (4/25); San Juan (5/21);

East

Pittsburgh (1/17); Boston (1/29-30); Portland (1/31); Albany (2/12); Meriden (2/14); Baltimore (3/6); Washington, DC (3/7); Harrisburg (3/12); Philadelphia (3/13-14); New York (3/19-20); Newark (4/24); Buffalo (5/14); Rochester (5/15); Syracuse (5/16).

The 1990 AISC

Architectural Awards Of Excellence

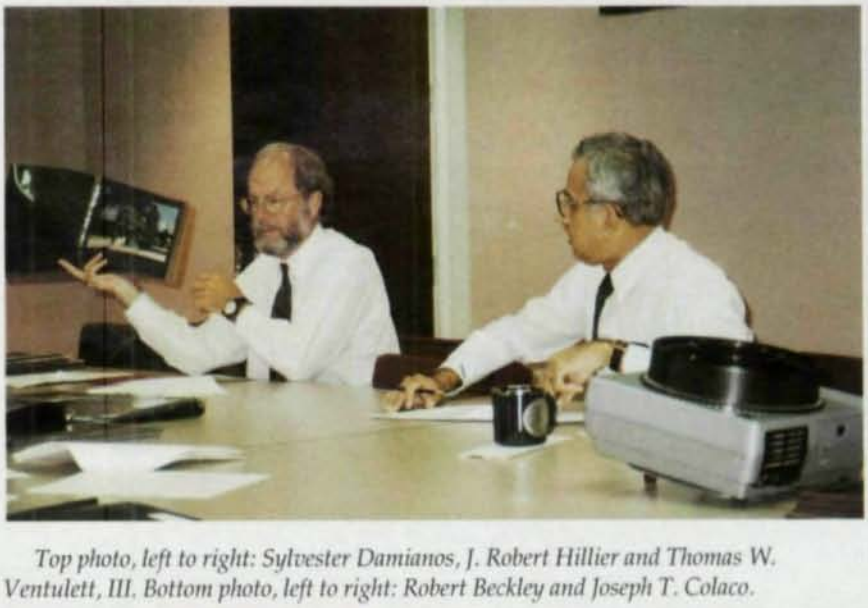
Every two years the AISC presents awards to the best designed steel-framed buildings in the U.S. This year's nine winners were completed during 1987-1989 and ranged from a small office building on an industrial site to a college's new swimming pool.

Though the projects varied widely in size and function, they were all carefully detailed and architecturally striking. The competition's five judges carefully sifted through more than 100 entries, arguing back and forth about relative merits, before picking their winners.

This year's judges were:

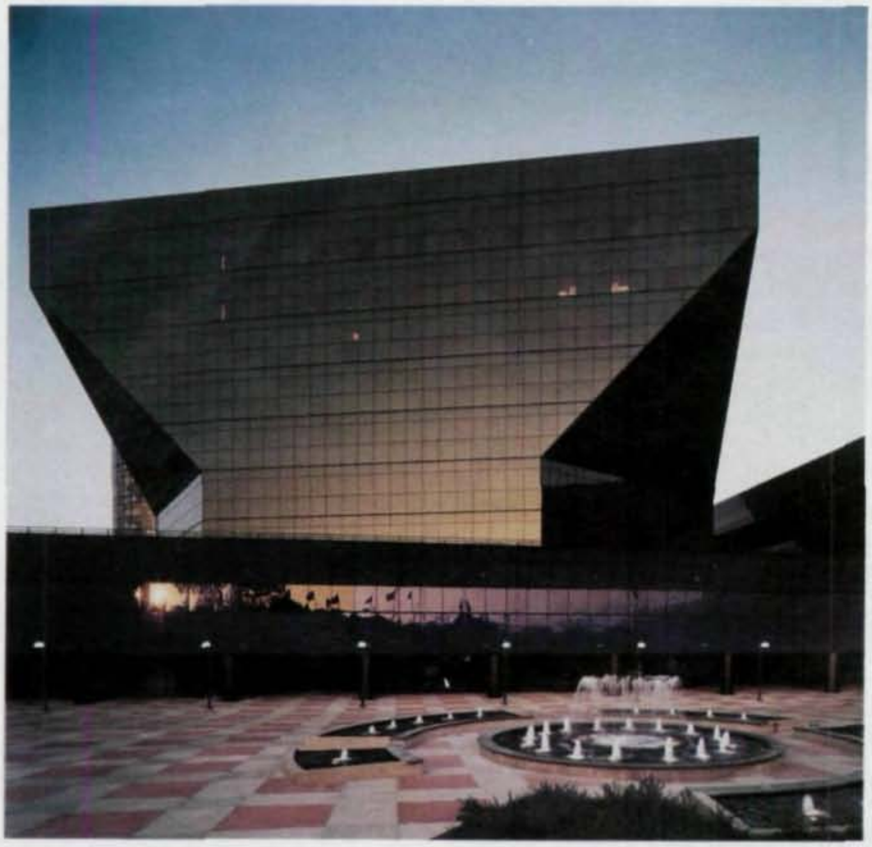
- Robert Beckley, FAIA, dean of the College of Architecture and Urban Planning, University of Michigan in Ann Arbor;
- Joseph T. Colaco, PE, president of CBM Engineers, Houston;
- Sylvester Damianos, FAIA, president of the American Institute of Architects and president of Damianos Brown Andrew, Inc., Pittsburgh;
- J. Robert Hillier, chairman, The Hillier Group, Princeton, NJ; and
- Thomas W. Ventulett, III, FAIA, vice president and principal of Thompson, Ventulett, Stainback & Associates, Atlanta.

The next AISC Architectural Awards Of Excellence competition will be held in 1992. All buildings designed by U.S. architects, built in the U.S., and completed from 1987-1991 will be eligible.



Top photo, left to right: Sylvester Damianos, J. Robert Hillier and Thomas W. Ventulett, III. Bottom photo, left to right: Robert Beckley and Joseph T. Colaco.

Putting The Pieces Together



The architecture of the green-glazed second phase of the Pacific Design Center is strong enough to stand alone, but Cesar Pelli's design also integrates it into a larger whole. The massing, shape, and orientation of the building is designed to make it one element in an interesting composition.

The second phase building resembles an inverted pyramid (above). Because of the sloping walls and the skewed orientation in relation to the first phase building, every view of the project creates a unique geometric design (opposite above).

The Pacific Design Center houses numerous showrooms for manufacturer's of interior design products. Pelli designed crisp, clean lines on the interior both to highlight the display areas and to complement the exterior design (opposite below).

Photography by Joe C. Aker

Cesar Pelli's addition to the Pacific Design Center created a new composition that enhanced his earlier design

One of the toughest jobs in architecture is to design an addition to an acknowledged masterpiece. Often—as in the case of the Guggenheim Museum in New York City—the controversy can be intense enough to substantially delay the project.

The decision to more than double the size of the Pacific Design Center in West Hollywood, CA, almost led to such a problematic situation. While stirring little public reaction, the initial expansion plan was so widely disparaged by Los Angeles' design community that the project's owners went back to the drawing board.

Fortunately, the property's owners had one advantage that others in similar straits did not have: they could turn to the original architect. Cesar Pelli, FAIA, principal of Cesar Pelli & Associates, New Haven, CT, had designed the building as a partner with Gruen Associates but later moved to the East Coast and started his own firm.

Renowned Architecture

The original Pacific Design Center is a blue-glazed, abstract sculptural form. As *Architecture* magazine stated: "It's startling color, unusual form, and sharp break in scale from its residential surrounding, the very qualities that once made it so controversial, are also what made it memorable. In a city where most of the good buildings are small, domestic, and removed from easy view, this pristine, freestanding object is one of the few large and easily visible buildings to achieve both professional and popular recognition."

"Architecturally, Phase I is like an extrusion," according to Allen Rubenstein, Pelli's former partner at Gruen Associates, which did the working drawings and construction administration on the addition. "How do you add to a unique building? The solution was to treat Phase I as an architectural fragment and add other fragments that would create an interesting composition."

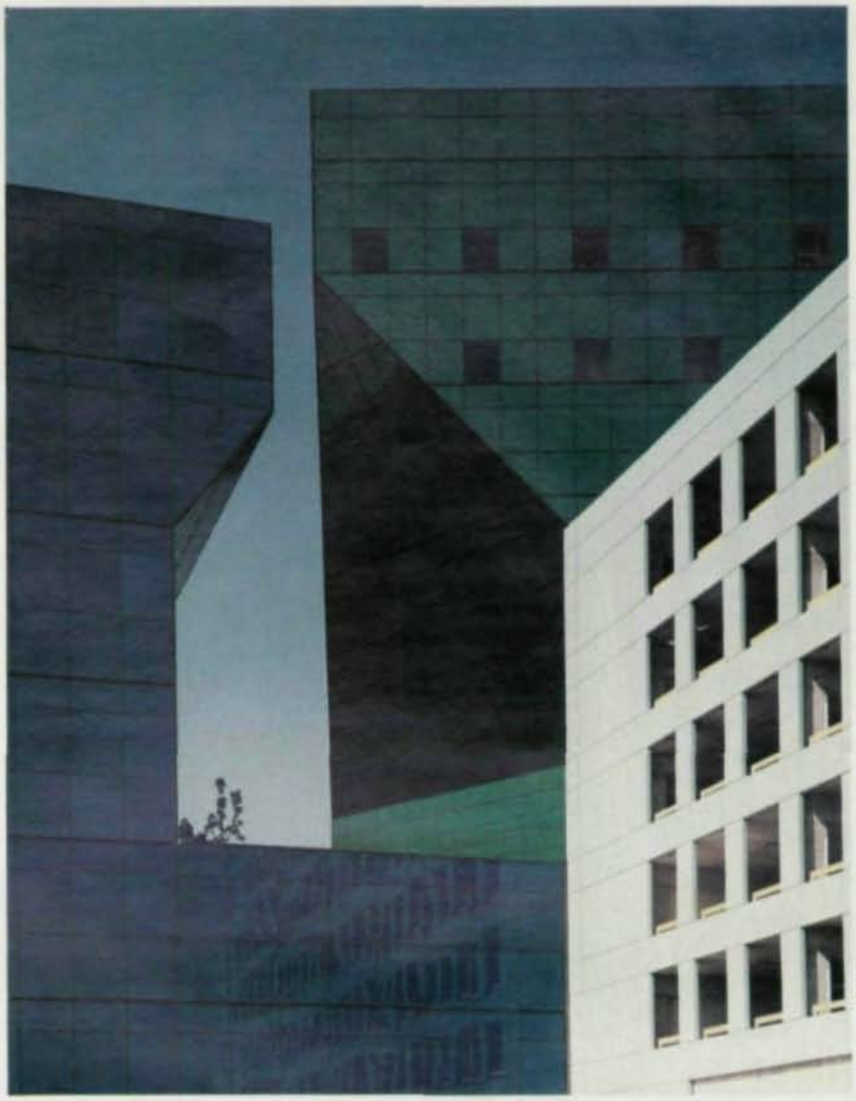
Inverted Pyramid

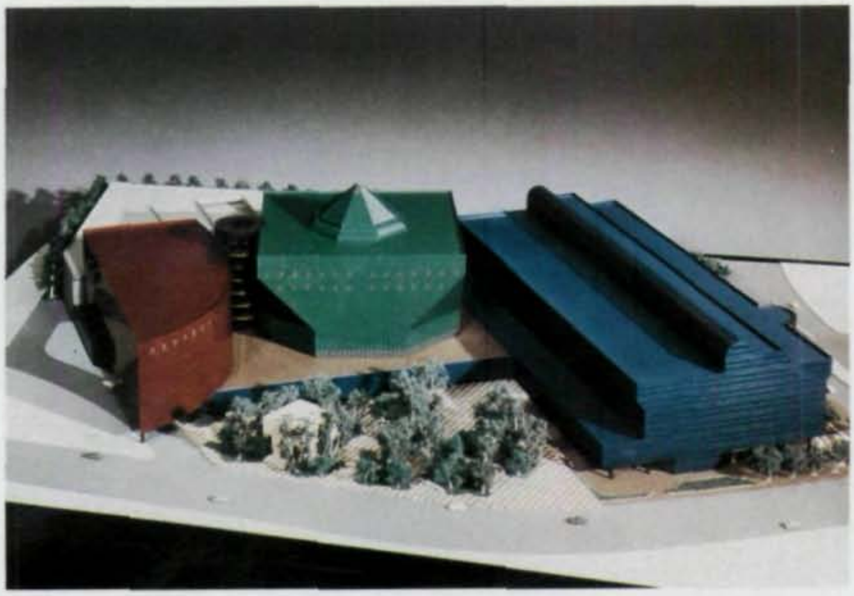
The recently completed 450,000-sq.-ft. Phase II is designed as an inverted pyramid, while the 375,000-sq.-ft. Phase III, which is not yet built, is shaped like a pie wedge.

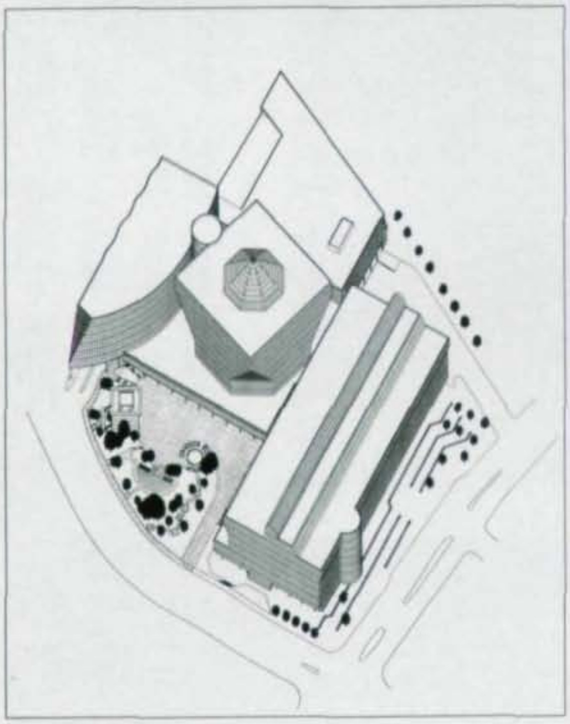
"The massing and angle between the buildings is crucial," Rubenstein explained. The second building is offset 15 degrees from the first structure, and the third building is offset from both its predecessors.

Further differentiating the buildings is the use of vivid colors. "The blue color of the original structure was chosen for its ability to reflect the sky in an interesting manner," Rubenstein said. "The green color went well with the blue, and the red provided a strong variation."

While the inverted-pyramid design of Phase II presented a marvelous architectural solution, for the structural engineer it created a tremendous headache. The building rises from a generally square two-story base. From level three to level five, the corners of the square are cut off at a 45 degree angle, and from the sixth level to the eighth level, the floors cantilever out from the truncated corners forming a







The massing and the siting of the three buildings was crucial to Pelli's concept of creating a composition based on architectural shapes. An examination of some of the building's floorplans (opposite) shows the effect of designing an inverted pyramid.

sloping vertical wall. At the ninth floor, the plan resumes a square shape.

As if a 60' cantilever on each side of the building was not enough of a problem, for leasing reasons unusually large bay sizes were required, explained Mohammed Hayat Khan, S.E., project engineer with Cygna Consulting Engineers, Marina del Rey, CA. While a typical building would have 30' bays, this project required 40' to 44' bays.

"We also had a problem because of the project's proximity to three faults," Khan added. The building is less than 1 mile from the Santa Monica fault, less than 3 miles from the Newport-Inglewood fault and less than 35 miles from the San Andreas fault. Based on computer analysis of ground conditions, earthquake data and the building's shape and massing, Cygna predicted the building could experience base shear four times greater than what the code requires it to resist.

"The building is modeled as a steel ductile moment with a rigid floor diaphragm to resist earthquakes," Khan said. To determine the optimal structural design, Cygna utilized three different analytical approaches:

- Static analysis per UBC 1982. Checked that the stress ratio of each member is less than 1.33 (1978 AISC Specification Part 1) and that the relative story displacement is less than .67(0.005h);
- Probable earthquake analysis. Dynamic analysis was performed based on the response spectra with the soil engineer to check that the stress ratio was less than 1.0 (1978 AISC Specification Part 2) and that the relative story displacement was less than 0.0075h;
- Credible earthquake analysis. Dynamic analysis was performed using 5% damping and a ductility factor of 4 to check that the relative story drift is less than 0.015h.

The core of the steel frame is

centered on eight box columns that rise from ground level to the ninth floor. "The structure is an eight-sided polygon with moment connections between the beams and columns," Khan said. The combination of extra large bays, the unusual building shape, and seismic conditions required larger-than-normal box columns—some of which are as large as 34" X 34" with 2½" plates.

5,000 Tons Of Steel

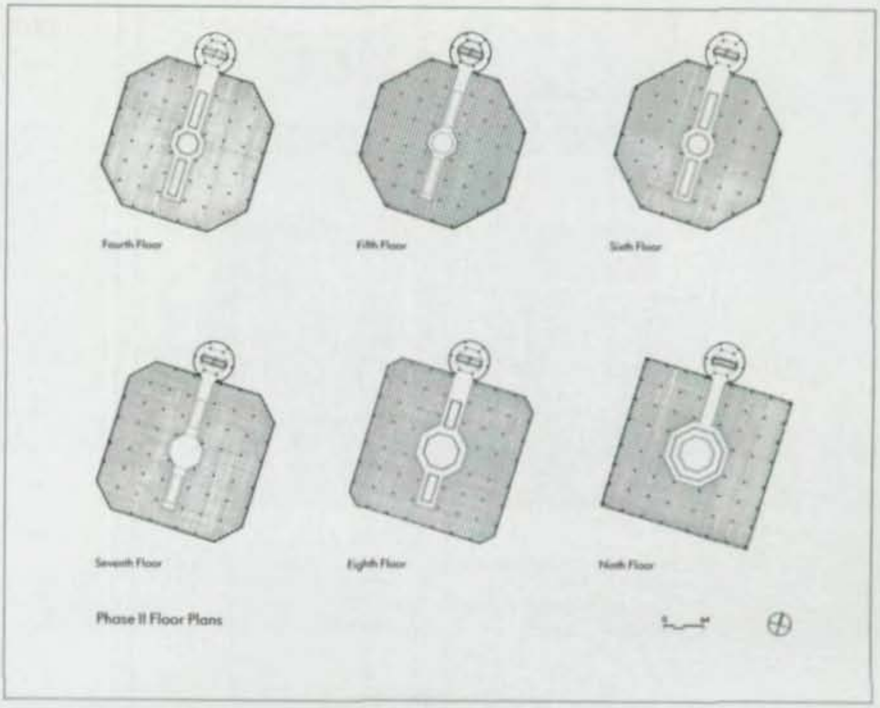
For the columns and heavier girders, the design called for A572 Grade 50 steel, while A36 steel was used on most of the beams and girders. In total, 5,000 tons of steel were used. The connections were a combination of bolted and welded with full-penetration welds. Steel fabricator and erector on the job was AISC-member American Bridge, Long Beach, CA.

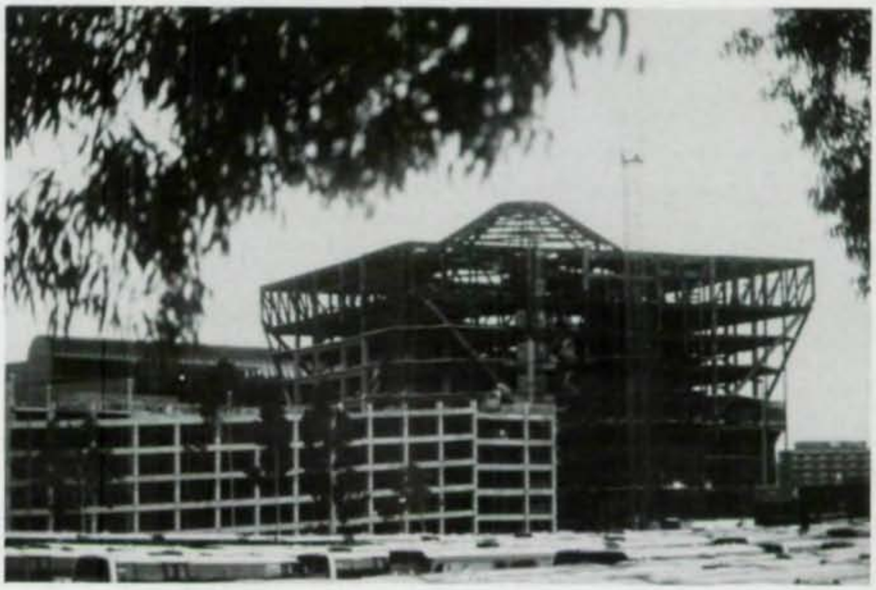
The columns support a 24'-deep truss that frames the building's ninth floor and transfers the cantilever loads back to the main core of the building. Because the corners of the sixth, seventh and eighth floors extend as much as 60' beyond the intermediate floors, the corners of these higher floors are suspended from the truss by columns and diagonal beams. "We had to use a large amount of steel—about 22 psf—to achieve the unusual design," Khan said.

Because of the outwardly sloped vertical walls, a tremendous amount of falsework was required during the steel erection. "We erected the columns, beams and girders as though it was a square building, but in the corners we used falsework," explained Alexander Fattaleh, senior vice president with American Bridge. "Then we put the trusses up and took the falsework down."

Falsework Supports

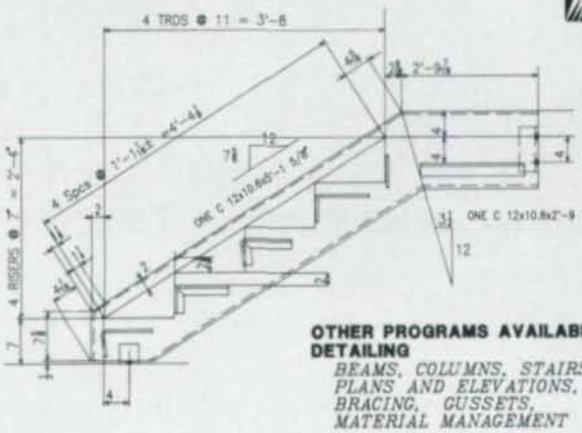
The entire frame was erected up to the ninth floor with falsework supporting the overhanging corners until the ninth-floor truss was in place, explained Joseph Borowitz, project manager with HCB Contractors, City of Commerce, CA, the project's general contractor. To erect the truss, falsework was placed at the midpoint of the corner overhang and the diagonal beams were erected to that point. The truss sections were placed on top of the falsework and bolted and welded. Finally, the falsework was removed and the truss, which was cambered upward 1½" at the corners, was deflected into a level position as the composite floors were poured.





Additional seismic insurance is provided by a raker beam between the midpoint of the fifth floor and the bottom of the ninth floor. "It supports some of the curtainwall, but it's mainly there to lend continuity to the structure," Borowitz said. The beam uses slip connections to allow for movement.

The crowning touch on top of the building was a 100'-diameter, 45'-high skylight supported on a



20-ton tension ring. Again, the erection involved a tremendous amount of falsework. "Starting at the third level, we erected falsework nearly 100' up in the air and put the tension ring on it.," Fattaleh said. "Then we built the roof structure. When the purlins and connections were attached to the tension ring, we pulled out the falsework.

"It was a piece of engineering art," Fattaleh added. □

Jurors Comments:

"Sometimes when you add something to a strong building you wonder how the two can sit compatibly with one another, but these two really do work well. Both the color and the form contribute to a dynamic statement."

"It's the most appropriate container for a design center that I've seen. What I really like about the design is that the space between the two structures is as important as the building itself."

"There's a lot of buildings that try to be sculpture; this building is sculpture."

Project Principals:

Architect: Cesar Pelli & Associates, Inc., New Haven, CT
Associate Architect: Gruen Associates, Los Angeles
General Contractor: HCB Contractors, City of Commerce, CA
Steel Fabricator/Erector: American Bridge, Long Beach, CA
Owners: Birtcher, Laguna Niguel, CA; Catellus Development Corp., San Francisco; and The World Wide Group, New York City

A Grand New Entrance

Converting an urban plaza into a two-level retail center helped revitalize a connecting office building

Skylights played an important role in the Galleria at Erieview in Cleveland both by letting in a tremendous amount of natural light and because the steel superstructure created a rich textural appearance. Above photograph courtesy of Anthony Belluschi Architects, Ltd.

Even at dusk the skylights create an interesting view. Note that as visitors walk the length of the retail space they can look up and see the connecting office building through the glass skylights. Opposite photograph by Gregory Murphey.

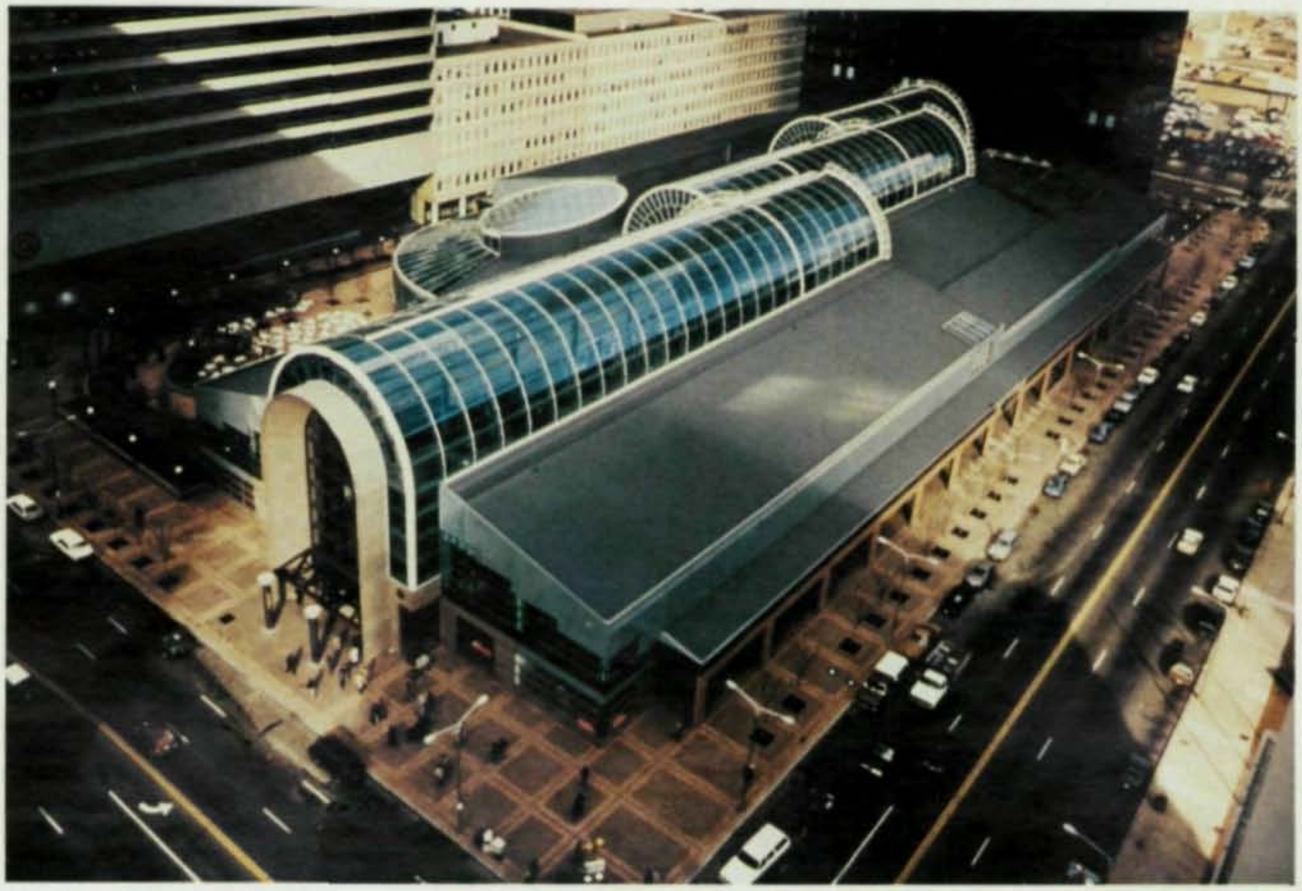
During the 1960s, urban renewal advocates mistakenly imagined that creating downtown plazas would automatically spur redevelopment activity and interest.

An example of this misguided urban planning occurred in Cleveland where a 40-story office building set far back from 9th Street with a large plaza in the intervening space. The plaza had one-level of parking below and an ice skating rink on top.

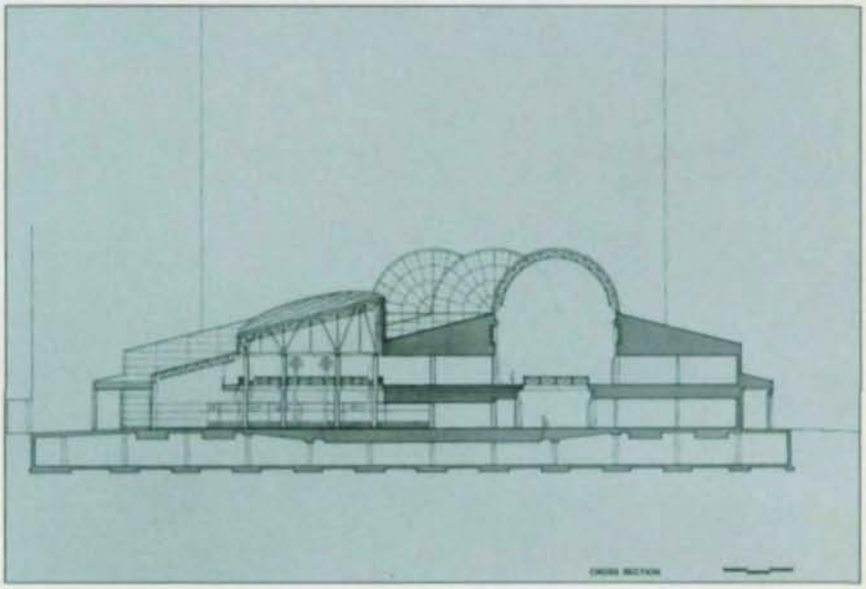
While the project was initially successful, by the early 1980s the building's occupancy rate was beginning to slip and the plaza was widely ignored. Before Cleveland real estate developer Jacobs, Visconsi & Jacobs Co. agreed to buy the office building, it first considered what could be done with the plaza. After careful consideration, the developer decided to add retail space.

The retail space serves two purposes, according to Anthony Belluschi, AIA, president of Anthony Belluschi Architects, Ltd., Chicago. First, the former plaza is a good site for stores. Second, and most important, attaching retail space to the office building enabled the developer to create an entrance to the building on 9th Street.

"The retail space acts as a glass-enclosed pedestrian street," explained Belluschi. "It adds vitality to the plaza and creates a dynamic entrance to the complex." Originally, 100,000-sq.-ft. of retail on one level was planned. "But it worked



One of the concerns of the designers was that the Galleria not only look attractive from street levle, but that it would also make a good impression on people looking down at it from the surrounding office buildings. Note the outdoor seating on the far left side of the Galleria. Photograph by Mort Tucker.



out so well that we went to a two-level, 207,600-sq.-ft. center."

The entire structure is designed to be eye-catching, both from the street level and when viewed from the surrounding tall buildings. The most striking feature of the project is the 85'-high, offset, barrel-vaulted glass skylight that forms the roof of the walkway.

While the use of three offset barrel vaults was visually striking, the design was as much for pragmatic reasons as for aesthetic, Belluschi explained. The designer wanted the main entrance to the retail center to be centered, but because of the size and shape of the old plaza site, that location did not line up on the same axis as the entrance to the office building. "So we had to jog the walkway," he said.

The offset barrel vaults also allowed for the creation of a new, smaller outdoor plaza that would be sheltered from the wind. "It's a very windy site and an ideal solution was to put the new outdoor cafe in a vest-pocket site," Belluschi explained. Also, by partially surrounding the outdoor cafe with the retail center, the cafe becomes more noticeable from the offices looking down at the site from the surrounding buildings.

Because the top of the low-rise retail center is so readily visible from the surrounding buildings, all of its mechanical equipment was concealed beneath a metal roof. The equipment is accessible from a complex system of catwalks using light gage steel grating to minimize weight. The metal roof was painted green and green-tinted glass was used for the skylights to create a psychological impression of life and to reflect back to the earlier use of the site as a landscaped plaza.

The exterior of the building also is enhanced by a colonnaded walkway on one side and a dramatic front entrance including a main entry arch composed of Taivassalo, a red granite quarried in Finland and fabricated in Verona, Italy.

Aesthetics also played a significant role on the interior design of the structure. The glass skylights provide magnificent views of the surrounding buildings, while also providing a tremendous amount of natural light. The 500'-long, two-level galleria is finished with high-quality, durable materials including brass, glass and marble.

One of the most notable features are tall columns capped with artificial ferns. In addition to softening the space, the planters cause visitors to look up. "As you walk, your eyes follow the vertical line of the planters," Belluschi said. And when you look up, you see the office building for which the retail space serves as a grand entrance.

To accommodate this unique view, the skylight support system was carefully designed to provide a lacy, airy effect, but yet be strong enough to carry severe wind and snow loads. The solution was a space frame of pipe trusses braced with a stressed bar bracing system, according to John Nyitray, P.E., president of Bliss & Nyitray, Inc., Miami. The trusses are structurally independent from the skylight framing in order to accommodate large differential movements caused by the various thermal loading conditions, he explained.

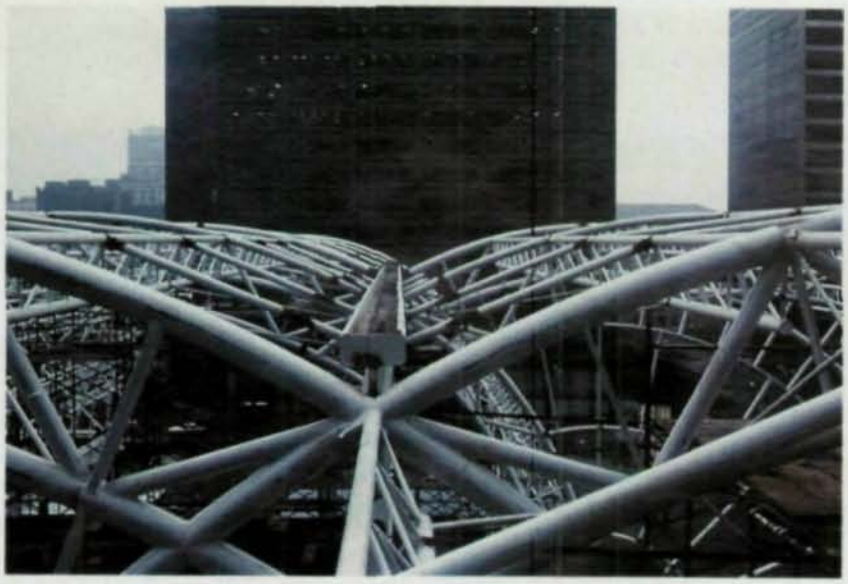
Uniform stressing of the tension bars was critical and was achieved by threading the ends of the bars with opposing threads and literally "tuning" each bar by sound. Other bar braces were heated to a prescribed temperature to achieve elongation, then welded in place before cooling to ensure residual tension under all loading conditions.

The semi-circular trusses were shop-fabricated in jigs to ensure uniformity. To reduce the skylight's weight, lighter pipe trusses were framed between the semi-circular trusses. The trusses are 30' long and 1½' deep. "The trusses were similar [in design] to bar joist but were made of pipe," Nyitray said. To reduce the cost of testing, the trusses were load tested prior to shipping instead of weld tested. "It was cheaper and quicker," he explained. The weight testing was done by the fabricator under the supervision of a testing laboratory.

Weight Considerations

One reason that weight was so important is that the entire new structure is constructed on top of the existing plaza deck structure over the subterranean parking garage and its existing foundations. The existing structure is concrete and the new steel columns were swedge-bolted into the existing concrete and connected with drilled anchors. The structure used 1,235 tons of A36 steel.

"We designed the structure to require minimal reinforcing," Nyitray said. "We tried to keep the weight down as much as possible, which was one reason we used steel." The structural engineer did



specify some underpinning of foundations at four locations beneath retail spaces containing mezzanine levels. "We used compaction grouting underneath the existing footings to improve the soil capacity," he said. The use of compaction grouting minimized differential settlement and permitted the parking garage to remain fully operational during construction, which was critical to the tenants of the office building.

Other weight saving devices was the use of steel sandwich wall panels, steel deck, and lightweight concrete floor slabs using composite design. The ground floor of the retail structure is elevated since the existing plaza was not flat. "In order to keep the weight down, we filled the space with polystyrene foam and put a deck over it instead of filling the entire space with concrete," Nyitray said. The same technique was used in the landscaped outdoor plaza to minimize soil depth.

Building over the existing plaza was complicated by the location of the food court. The food courts siting was predetermined by its location to the nearby buildings—which would provide its clientele. Further complicating the design was the food courts complex truncated cylindrical shape. Because of these two factors, the expansion joint for the new building could not be made to coincide with the existing expansion joint of the parking structure.

"Our solution was to offset the expansion joint," Nyitray explained. Offsetting the expansion joints by one bay resulted in a 30′ portion of the new building that literally slides on Teflon pads located strategically on the existing garage roof. The same solution is repeated in the last bay, where the new building meets the existing 40-story office building. The procedure eliminated the need for an additional expansion joint and the resultant extra cost.

Jurors Comments:

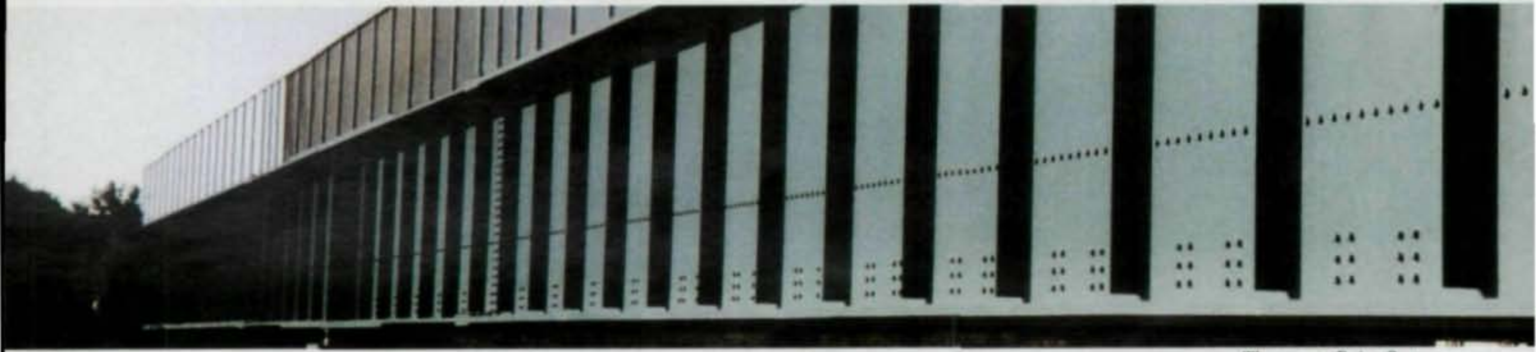
"This project creates a real gathering space—and one that's in the sunlight throughout the year despite Ohio's climate. It draws the public in. It looks like a happy space."

"The steel frame is light and delicate, and it fills the space with beautiful shadow patterns. It's inviting, and it's constantly changing throughout the day and evening, so the space doesn't tire you out. The simplicity and elegance of the structure was left to dominate the space. The design is admirable in that everything else takes a back seat to the structure, which is unusual in this age of overly detailed and overly wrought buildings."

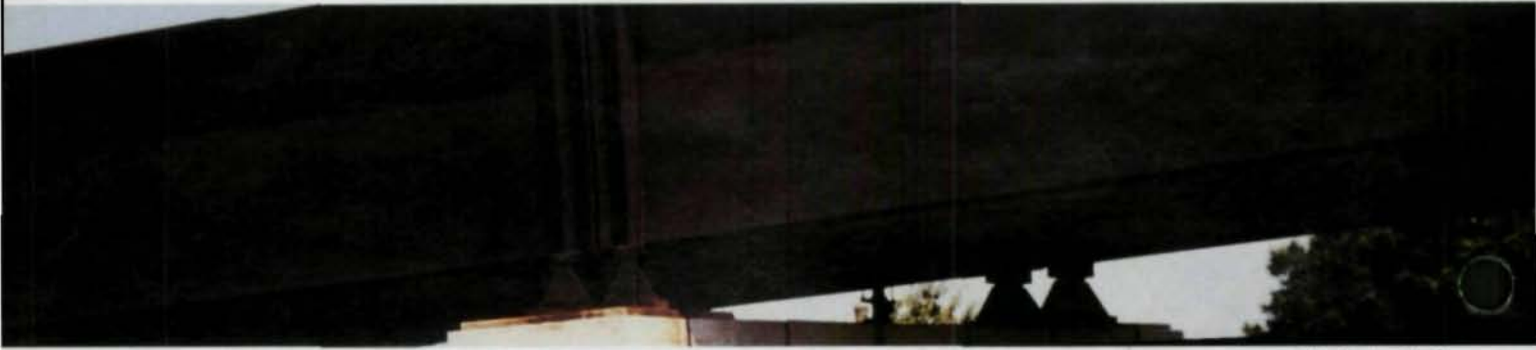
Project Principals:

Architect: Anthony Belluschi Architects, Ltd., Chicago
Structural Engineer: Bliss & Nyitray, Inc., Miami
General Contractor: Turner Construction Co., Cleveland
Owner: Richard E. Jacobs and David H. Jacobs, Cleveland

Concrete



Three-coat Paint System



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A New Vision For Airport Design

Airline travel may be commonplace, but the new United Airlines Terminal in Chicago is anything but common

Glass, steel, and natural light combine to create a vision of the future in the new United Airlines Terminal at O'Hare Airport in Chicago.

With one bold stroke, the United Airlines Terminal Complex at Chicago's O'Hare Airport changed forever the design of airline terminals. No longer will a strictly utilitarian structure be tolerated. Instead, airports have now matured into modern versions of the grand pre-war railroad terminals.

But where the old railroad terminals emphasized ornate detailing in traditional materials, architect Helmut Jahn, FAIA, designed his "Terminal For Tomorrow" using glass and steel.

The terminal includes 42 gates in two parallel concourses, a ticketing pavilion, baggage handling areas, and an 800'-long connecting spine.

"The spatial sequences, materials, finishes and lighting are orchestrated in the building design to produce the appropriate scale and image for the carrier's flagship terminal," according to Jahn, president of Murphy/Jahn, Chicago.

The most dramatic features of the new airport are the 1,730'-long vaulted gate areas; the exposed steel, folded-plate roof trusses over the 120' x 810' column-free ticketing pavilion, and the 800'-long underground passageway connecting the two concourses.

The ticketing pavilion serves as the entrance to the structure. The area spans 120' and features 54 exposed steel, folded-plate trusses. Each fold of the trusses is set an angle of 37 degrees and is 14'-4⅞" in depth, the maximum depth that can be shipped, according to Charles Thornton, P.E., president of Thornton-Tomasetti Engineers, New York City, the project's structural engineer. The trusses were shop-welded, with 8⅝" diameter pipe top and bottom chords and 6⅝" diameter pipe diagonals. At the ridges, the top chords of adjacent trusses are spaced 5' apart. At the valleys, the bottom chords of adjacent trusses are space 2'-6" apart.

A series of 8" wide-flange members spaced at 10' intervals undulate up and down directly over the folded trusses in a direction perpendicular to the span of the trusses. The W8 members make the individual planar trusses act as a folded plate system. This combination of flexural W8 members and the planar trusses allows for the components to be easily shipped. In addition, the W8 members simplified the connections of the architectural cladding by providing a planar surface.

The connection of the W8 mem-

bers to the pipe trusses are all bolted connections to simplify erection. Structural steel fabricator was AISC-member Trinity Industries, Inc., Houston, and steel erector was AISC-member Broad, Vogt and Conant, Inc., Cleveland. (For a complete description of the structural system used on this project, refer to pages five through 12 of *Modern Steel Construction* Issue Number 5, 1987.)

Natural Brightness

"The skylights in the 120′ free-span roof provide natural light, which in combination with the folded truss steel superstructure and terrazzo floors, produces a technically articulate environment," Jahn explained. "A major accomplishment was to demonstrate that the steel could be exposed, even though this would not be in accordance with the governing building code. Specific fire data demonstrated the effectiveness of sprinklers to provide the required protection. This was the primary justification of the code variance, however, analytical fire models later showed that size and volume of building would prevent the development of critical temperatures. This type of rational approach to engineering fire protection will give greater flexibility in the future for the contribution exposed steel can make to architecture."

Just as dramatic as the ticketing area are the two concourses. The roofs of Concourses B and C are formed from welded steel arches. Because the structure is exposed, strict attention was paid to the connection details.

The main support system for the corridor roof is a series of steel-vaulted arches spaced 30′ on center. In Concourse B, the arches span 40′ to form a 1,730′-long corridor, while in Concourse C, the arches span 50′ to form a 1,610′-long corridor.

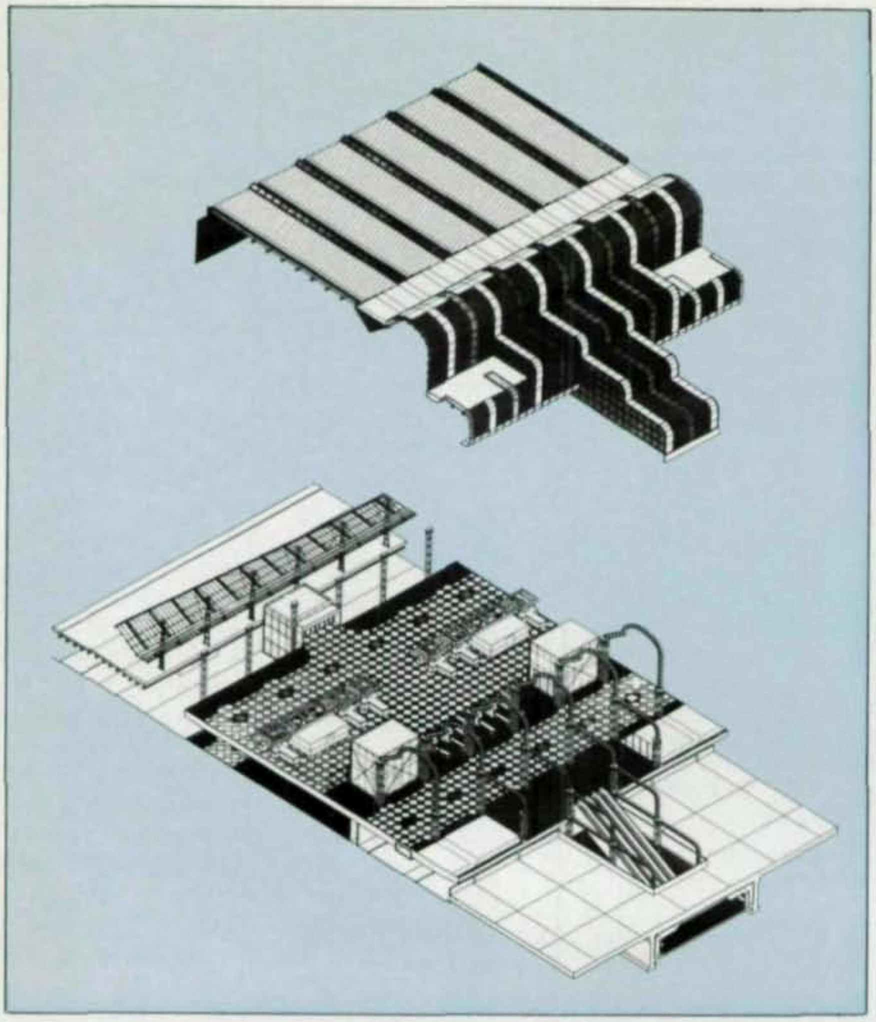
Aesthectic Perforations

The vaulted arches were shop-fabricated in an I-shape cross section, with continuous welds between flanges and web. Because of the size of the vaults, two splices are fully welded and ground so as not to detract from the architecture. For purely aesthetic reasons, the 24"-deep vault girders are perforated with 12" holes 24" on center.

"Daylight is used throughout the ticketing pavilion and the concourses both to improve the quality of space and to take advantage of significant savings in energy costs," Jahn said.

To support the glass mullion system, purlins spaced 5′ on center span between the vaulted girders. The purlins are built-up members on 8⅝"-diameter pipe and a WT5. The WT web is oriented perpendicular to the plane of the glass to improve the flexural strength of the purlins.

Parallel to the segmental planes of the glass are a series of 1⅞"-diagonal sag struts that stiffen the pipe purlins about their weak axis and transmit unsymmetrical loads through the structure. Cross-bracing members are placed intermittently within the planes of the sag struts to stabilize laterally the vaulted arches. Five expansion joints were required in each con-



Large expanses of glass allow travelers to see into the concourse as they approach, creating an inviting view of action and life. (opposite above). From the inside, the glass creates a more comfortable atmosphere while reducing energy costs (left). One of the most exciting parts of the terminal is the sculptural underground passageway (opposite below).

course to reduce thermal expansion movements. The vaulted arches are supported on a series of clustered pipe columns similar to those at the folded-plate trusses.

One area that does not have access to any natural light is an underground walkway connecting the two concourses. Passing through an 800'-long passageway would normally be boring and tedious, but the architect instead succeeded in making it one of the most exciting public spaces in Chicago. The walls are formed of undulating back-lit translucent panels. Running the length of the ceiling is a kinetic neon sculpture that sequentially flashes on and off. And as travelers are whisked along a moving walkway, appropriately futuristic music serenades them. While the music and lights were at first controversial, the walkway has since become the first tourist attraction seen by many visitors to Chicago. □

Jurors Comments:

"It's a great structure, a great piece of architecture. To me it's music and it's a lot of fun. Its scale, height, daylight, detail and the originality of the structural form contribute to making it an exciting place. And the sculpture walk in the underpass is like a gift to the people, something that didn't have to be done, but contributes to make a most memorable experience."

"The thing I liked most about it was the correctness of its structural form. The members and diagonal bracing is elegantly expressed on the outside. The holes in the structural members make it light and airy and give you a feeling of wanting to be in that space. I think the building is a classic. We'll look back 25 years from now and still consider this to be a world class, elegant building."

Project Principals:

Architect: Murphy/Jahn, Chicago
Associate Architect: A. Epstein & Sons International, Chicago
Structural Engineer: Thornton-Tomasetti, New York City
General Contractor: Turner Construction, Chicago
Steel Fabricator: Trinity Industries, Houston
Steel Erector: Broad, Vogt and Conant, Inc., Cleveland
Owner: City of Chicago

Fujitsu Interview

with Dave Hutchinson, Vice President/Structural Engineer, Buehler & Buehler Associates, Sacramento, CA

Q: "Tell me a little about your job at Buehler & Buehler."

A: "At Buehler & Buehler, we are retained by architectural firms to design structural framing for buildings. We create plans for the construction of foundations, columns, beams and bracing. We prepare calculations and material specifications showing actual versus allowable member stresses. The art of what we do is taking a building concept and converting it into practical construction documents. My job is to see that it gets done quickly and efficiently."

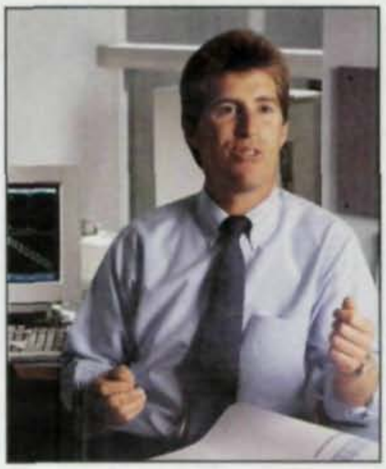
Q: "Why did you select Fujitsu's ElmAnalysis® over other FEA programs?"

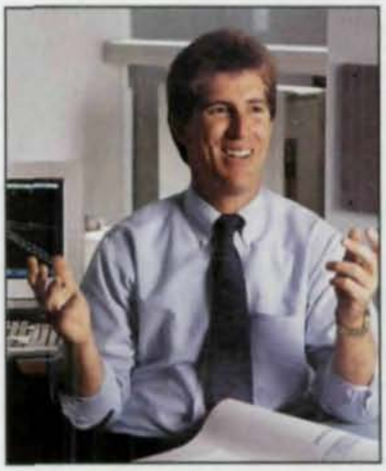
A: "It was the only powerful yet easy-to-use FEA program available on the market. Plain and simple. We required a package that could be used by everyone in the office. We have other FEA programs for specialized projects, but most are so complicated that one person must use them constantly just to stay tuned.

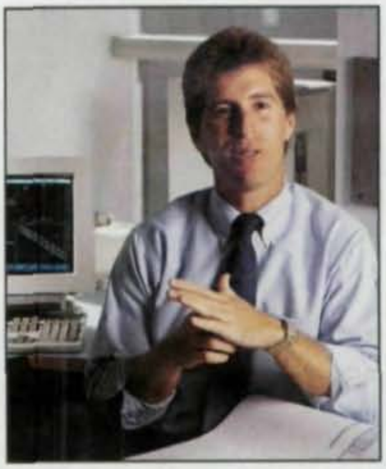
Speed was also critical. Entering data can be a painstaking process that takes hours. ElmAnalysis allows you to create a model of the structure on screen—graphically—in minutes. Which means that you can get more jobs done in less time and with more reliable results."

Q: "What do you mean by 'more reliable results'?"

A: "The fact that it gives a real, visual representation of the project greatly reduces the possibility of error. Member orientation is critical. For example, if a column entered into a program is rotated 90° off its correct axis, the structural integrity is compromised.







And if it isn't caught, the result can be disastrous—not to mention expensive. ElmAnalysis was the only program that gave a clear, visual representation of potential mistakes. And under the pressure of deadlines, anyone can make mistakes."

Q: "Tell me about some of the jobs you've done."

A: "Like most structural engineering consultants, about 75% of our work consists of smaller projects—schools, warehouses, and office buildings—and a few very large projects like the Memorial Auditorium being built here in Sacramento. It is a large building with some very difficult framing. ElmAnalysis is the most practical solution—changes in the design can be viewed and identified graphically without compromising the schedule. And that's critical."

Q: "Do you think ElmAnalysis has improved the way structural and civil engineers work?"

A: "By making FEA programs easier, more engineers will be able to get more work done, and with ElmAnalysis' graphic interface to SAP90™, more options can be evaluated, resulting in better solutions."

Q: "How has Fujitsu's support been?"

A: "It's been great. They have experienced engineers available to answer real engineering questions, so I don't have to worry about being hung up in the middle of a job."

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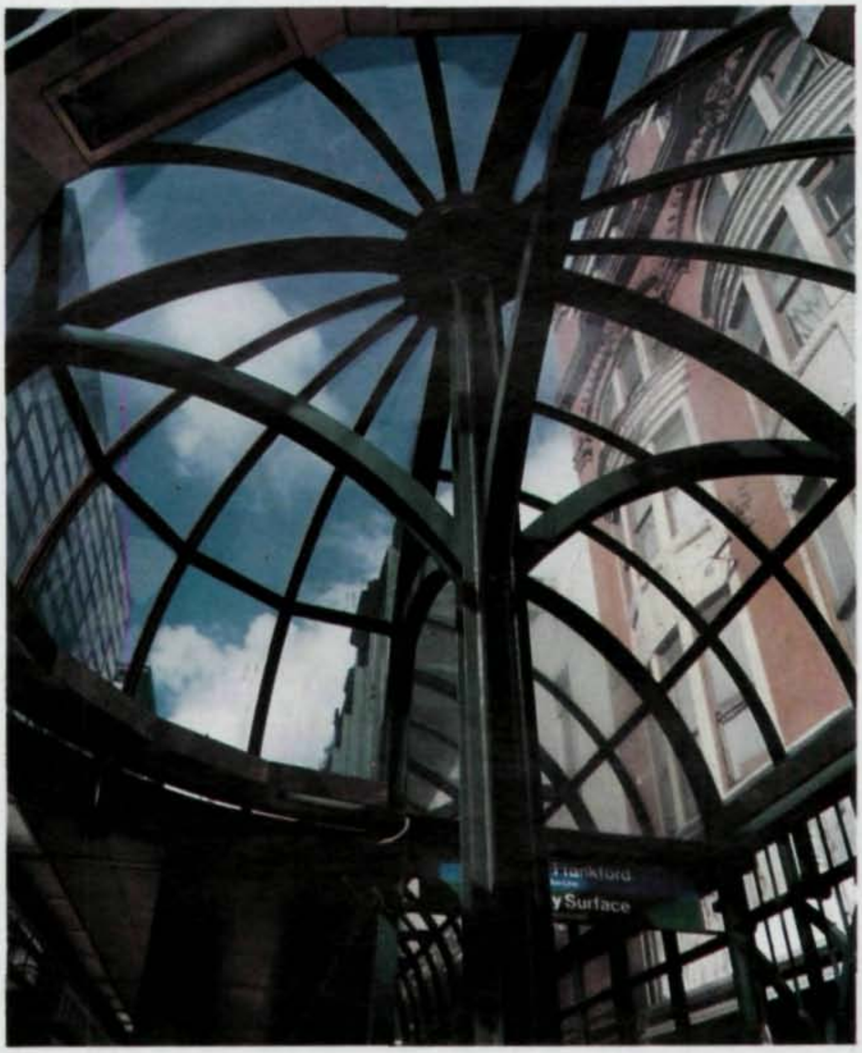

Philadelphia's new subway entrances are designed with a "welcoming" umbrella shape instead of a more common boxy look. Glass and steel were essential to the design in order to create an open, airy look.

Philadelphia takes a bold approach to new subway entrances

Subway entrances all too often are uninspired rectangles. Rather than duplicate this pedestrian approach, the architects of seven new entrances for Philadelphia's subway system opted for a dramatic combination of glass and steel.

"We used an umbrella design as a welcoming shape, as opposed to the box-like shapes found so often in public works," explained C. Anthony Junker, AIA, a partner with Ueland and Junker, the Philadelphia-based architects of the headhouses. "Our inspiration was Paris' Art Nouveau subway stations. We wanted a similar flower motif, something light and airy."

The seven new subway entrances stretch along Market Street, one of the city's major retail and office thoroughfares.

The architect's desire for a light and airy structure led to the use of curved steel columns covered with tinted glass. "We considered using aluminum columns, but the sections would have been heavier and more boxy," Junker said.

The designer also considered stainless steel, but the cost was too high, so painted A36 steel was specified instead, according to George Formanek, P.E., the project's structural engineer with Ang Associates, Philadelphia. "The weight of the main structure is 15 lbs./sq. ft., while we took a more conservative approach to the um-

brella, which is 24 lbs/sq. ft." The extra steel in the umbrella is designed to resist both inward and outward forces, especially wind, he explained.

The connections are all welded, and from an engineering standpoint, the design was very straightforward. "However, the curved members did require the fabricator to take extra care," Formanek noted. The frames were transported to the site in four sections and required very minimal field welding. The glazing was installed at the site.

The size and shape of the steel members were chosen both for beauty and to resist vandalism. The members were rolled into a highly irregular shape with many rounded protrusions. "We were trying to make use of the full potential of rolled steel, so we chose a shape that would cast a lot of shadows and make the structure visually interesting. We built decoration into the material itself," Junker said. The irregular shape also was designed to resist vandalism by making it very difficult to attach posters to the steel.

Vandalism also was a concern with the large expanses of glass. "We had to weigh the possibility of vandalism against the benefit of creating the desired effect," Junker said. "Often in subway work, you put in grillage or bars. But that's depressing. And we didn't want to use plastic because it hazes over the long-term." Instead, 1/2"-thick safety glass was specified. "So far, there's been almost no vandalism," according to Junker.

The glass' green tint and the steel's green paint were chosen as a color "with some life to it," Junker explained. "Also, green has an association with weathered bronze, which is a traditional material for outdoor fixtures but one that can very rarely be afforded today." □

Jurors Comments:

"It's a set of very elegant subway entrances that are very reminiscent of the iron subway entrances in both Paris and London. I think, given the nice pedestrian scale of Philadelphia, that these do an excellent job of decorating the street and making a suitable entrance to the subway."

"The thing I like about it is the two directionally curved umbrellas with their graceful curvilinear form that complements the curvilinear roof.

"It's delightful to find a little gem like this. To be a gem, all the little pieces have to come together. I think this structure with all its detail could really be called exquisite."

Project Principals:

Architect: Ueland and Junker, Architects & Planners, Philadelphia
Structural Engineer: Ang Associates (formerly Omega Consultants), Philadelphia
General Contracting Firm: Neshaminy Construction, Inc., Feasterville, PA
Owner: Southeastern Pennsylvania Transportation Authority, Philadelphia

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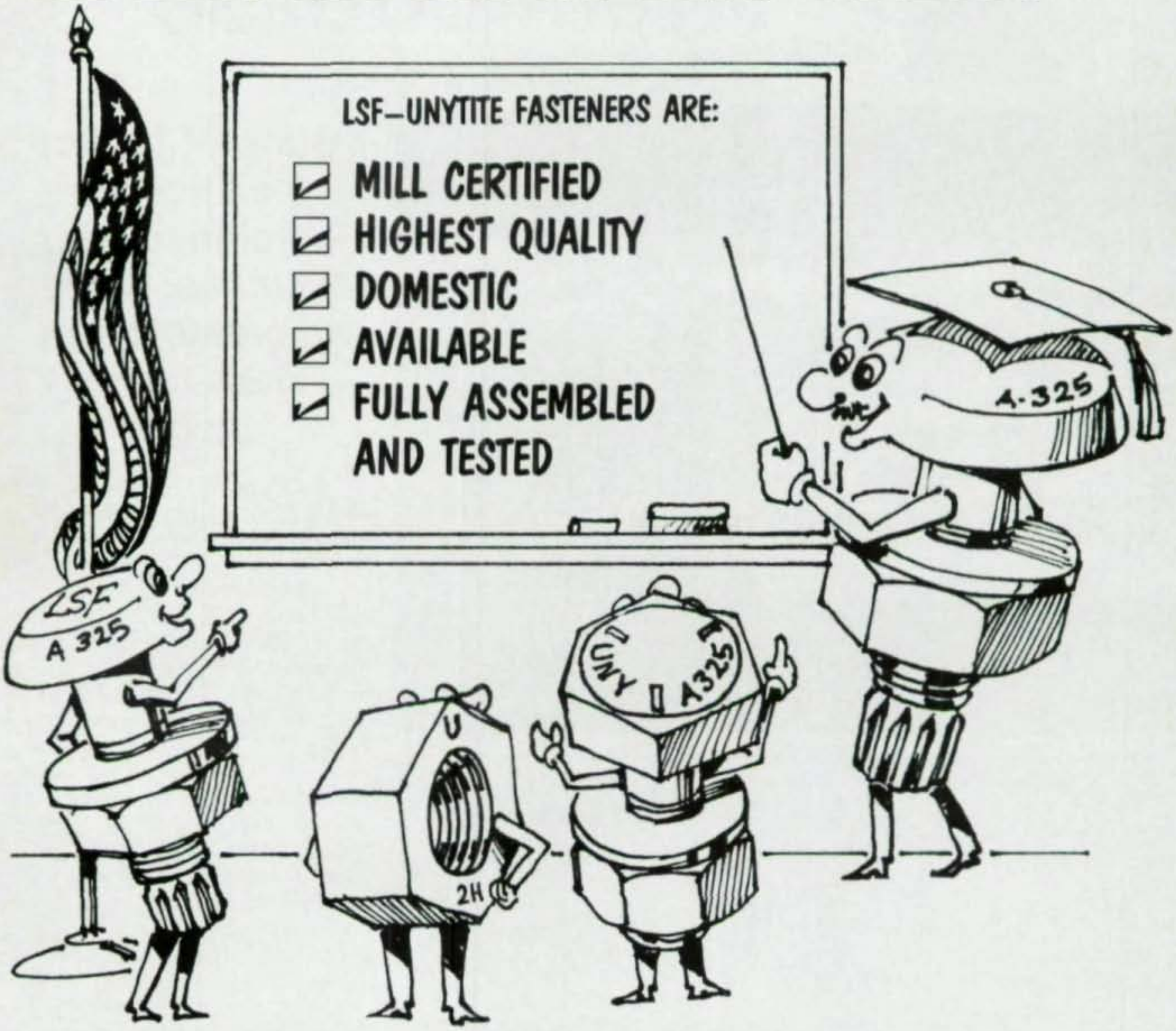

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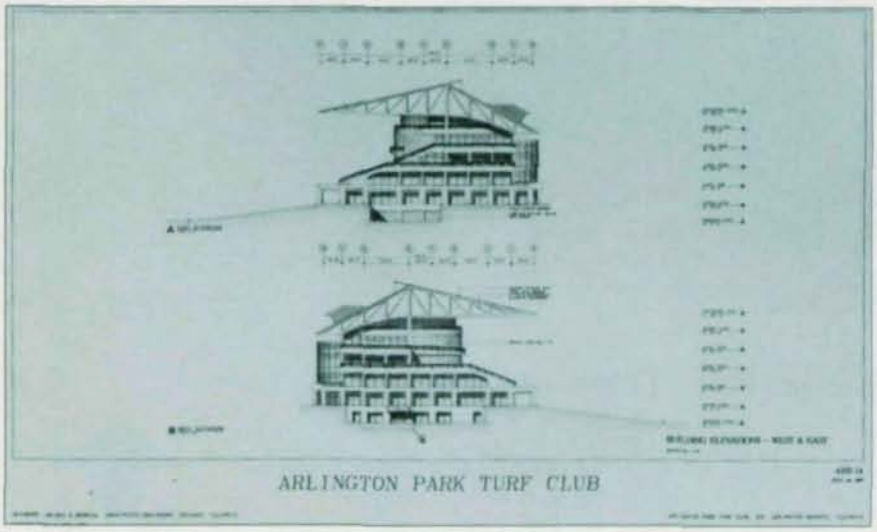


The grandstand at Arlington International Racecourse features a 120'-long cantilevered roof system. The articulation of the large trusses can be clearly seen in both the photograph and building elevations above.

State-of-the-art facilities are combined with traditional design to create a first class racing facility

When the old and beloved Arlington International Racecourse in Arlington Heights, IL, burned down in 1985, the owner vowed to rebuild an even better structure. But horseracing is a traditional sport, and while the new 700,000-sq.-ft. facility is modern and technologically up-to-date, it's design reflects traditional values.

"Architecturally, the client wanted a simple, yet traditional solution," explained Hal Iyengar, S.E., a partner with Skidmore, Owings & Merrill, Chicago, the project's architect and engineer. A traditional approach also helped the facility blend in with some of the older brick buildings.

The primary purpose of the facility is as a grandstand, though it also houses ancillary functions such as a clubhouse. "We considered various high-tech solutions, such as a cable-stayed roof, an exposed tetrahedral truss and a mast with cables, but we rejected them as untraditional. They were just too jazzy for such a tradition-rich sport," Iyengar said.

Instead, SOM designed a 200'-wide by 680'-long, six-level structure with a 120' cantilevered roof system. The roof truss cantilever is believed to be the longest span cantilever for such a facility in the United States, according to Iyengar.

"The roof form is traditional in shape and respectful of the traditions of horse racing," he explained.

The structure essentially consists of tapering triangular cantilever trusses that are approximately 27' deep at the support and narrow to only 2' at the ends.

The trusses are spaced 40' on the centers. The bottom of the cantilevered part is nearly horizontal with a slight camber upward while the top is tapered for a downward roof slope. The cantilevered truss is continuous with the back truss, which spans over a distance of about 80'. The columns over the back spans provide the necessary tiedowns, thus assuring the stability of the cantilever system. The articulation of the truss can be clearly observed in the end elevations (see diagram).

The columns and the back-span structure were erected first and the 120' cantilever part was prefabricated into a single unit and was connected to the back-span truss at the ridge column line.

Tight Tolerances

The trusses were assembled on the ground to very tight tolerances to achieve a uniformly cambered structure for a straight eave edge. "The engineer was shooting for a very low deflection," explained William Hanson, who was formerly a project manager with AISC-member Broad, Vogt & Conant, River Rouge, MI, the project's steel erector. "We measured the heck out of it on the ground and ended up with less than 5⁄8" deflection.

Each of the 18 trusses weighed 52 tons and were erected in two pieces. The entire project used 6,600 tons of structural steel. Steel fabricator was Pitt-Des Moines, Inc., Melrose Park, IL.

The trusses support a 3" metal deck on its roof with a 2" architec-

The large trusses were assembled on the ground to very tight tolerances. Safety nets were attached to the trusses with twin cables and pulled into position before the iron workers were allowed onto the trusses, which were erected 100' in the air.

Construction photos from the back of the facility show the basic construction sequence. The columns and the backspan of the grandstand structure were erected first and then the 120' cantilever part was connected to the back-span truss at the ridge column line. A rear view of the finished structure aptly illustrates some of the building's traditional design elements.

tural standing seam metal enclosure. This metal deck system spans 10' between W8 purlins that span 21' maximum to secondary girders spanning 40' between the trusses. Transverse trusses perpendicular to the main trusses are provided at several locations including one at the ridge line. This truss system provides lateral stability to the overall roof system, and the lateral system of vertical trusses is continued on framing at the bottom chord level of the trusses. The bottom chord also supports light framing with a metal ceiling system over the grandstand seating.

The client considered installing a glass wall the entire length and breadth of the grandstand area, but decided that it would hinder sightlines. However, provisions were made so a glass wall could be installed at a later date.

The new facility was constructed over the existing foundations of the old facility, which involved extensive consideration of imposed loads, and structural steel framing was therefore a natural selection. The primary truss members are wide flange sections with connections involving two gusset plates that are bolted to the members. The bolts are high-strength A490 in slip-critical connections and were generally 1" in diameter.

The design of the roof system involved studies of snow and wind forces including wind tunnel testing to appropriately evaluate the dynamic characteristics and the imposed loads. "We looked at the trusses at Wrigley Field [where the Chicago Cubs play] shortly after completing this job and the trusses at the racetrack are engineered to carry far greater loads, primarily because of snow considerations," Hanson said.

"The roof system in structural steel represents a highly efficient conventional truss system for an elegant, modern roof form for a state-of-the-art grandstand facility," Iyengar said. □

Jurors Comments:

"The grandstand has a unique from and a strong awareness of the landscape. It relates very well to the existing buildings. I think it's a socially inviting structure that offers a lot of opportunities for interaction between people, and the races, and the horses coming into the ring. There's a constant feeling of people all around the place."

"It's a heroic structure handled very well in a straight triangular truss form that comes down to a sharp point, which makes it very elegant in form."

Project Principals:

Architect: Skidmore, Owings & Merrill, Chicago
Structural Engineer: Skidmore, Owings & Merrill, Chicago
General Contractor: McHugh Construction Co., Skokie, IL
Steel Fabricator: Pitt-Des Moines, Inc., Melrose Park, IL
Steel Erector: Broad, Vogt & Conant, River Rouge, MI
Owner: Turf Club of Illinois, Arlington Heights, IL

Redefined Skyline

A 925'-tall architectural gem has forever altered Philadelphia's once conservative skyline

Landmark status is rarely given to a building immediately upon completion, but One Liberty Place is such a powerful architectural statement that it has forever altered Philadelphia's skyline.

For more than 100 years, City Hall—topped by its statue of William Penn—was Philadelphia's tallest building. In fact, for many years, a gentlemen's agreement between developers and the city precluded any design from topping the statue's height. But by proposing a 925'-tall, yet relatively thin building, Rouse & Associates persuaded the city that in the long run the quality of light and air at street level would be improved.

And Rouse's case was bolstered by Murphy/Jahn's Art Deco-influenced design that recalls the Chrysler Building's beauty.

"The design strives toward a synthesis between expression of the romantic yearnings of traditional skyscrapers and the display of modernist technological imagery," according to Helmut Jahn, FAIA, president of Murphy/Jahn, Chicago.

Elegant And Optimistic Design

"Streamlined and powerful, the building's profile and structure represent a combination of boldness and refinement," explained Charles Thornton, P.E., president of Thornton-Tomasetti, P.C., the project's structural engineer. "The structure makes an elegant and optimistic statement about Philadelphia and its future. Consequently, it is a unique, dynamic design—influenced by the past but without duplication of all the forms, materials and structural systems. A building of this size designed in the 1920s or 30s would have had between 40 to 50 lbs. of structural steel per sq. ft.; not 23 psf as constructed."

The building's curtain wall is composed of glass and granite panels set in an aluminum grid of shaped members that reinforces the tower form with its articulated structure. "The building's verticality is emphasized by the gabled centerpiece on each face which express the eight main 'super columns'," Jahn explained. "The contrasting horizontal treatment of the corners emphasizes the effect, as does the gradual transition of the skin from stone at the podium to all glass at the top. The multiple gables on top of the tower create a visual image and logical conclusion to the building's geometry."

Steel Minimizes Member Size

Structural steel framing was chosen for its flexibility, high strength, and its ability to transmit large tensile and compressive forces efficiently and yet keep the size of members to a minimum, according to Thornton. Built-up wide-flange sections were used for all outrigger diagonals and core and outrigger columns because of the large forces and required thickness of plates. Their use also facilitated fabrication and erection. Steel fabricator was former AISC-member Steel Structures, Inc. (no longer in business) and steel erector was AISC-member Cornell & Co., Woodbury, NJ.

Superdiagonal Outriggers

The selected lateral load resisting system is a superdiagonal outrigger scheme comprised of a 70' X 70' braced core coupled with six four-story diagonal outriggers at each face of the core located at three points over the height of the building. "The system works in a similar manner to the mast of a sailboat, with the braced core acting as the mast and the outrigger superdiagonals and verticals forming the spreader and shroud system," Thornton explained.

Three sets of eight outriggers were found to be most efficient, with the outside end of the superdiagonals placed at the 20th, 37th, and 51st floors. To reduce uplift forces on corner core columns and the outrigger columns, most of the

One Liberty Place's distinctive Art Deco spire has quickly made it one of Philadelphia's most widely recognized buildings.

building's dead load was concentrated on the corner core columns and the outrigger columns. This was accomplished by introducing exterior transfer trusses at the 6th, 21st and 37th floors. The trusses span between the outrigger columns within the exterior face and thus funnel dead load into the outrigger columns to compensate for uplift due to wind pressure.

(For a complete discussion of the building's structural system, including alternatives considered, see *Modern Steel Construction*, Issue Number 2, 1987.)

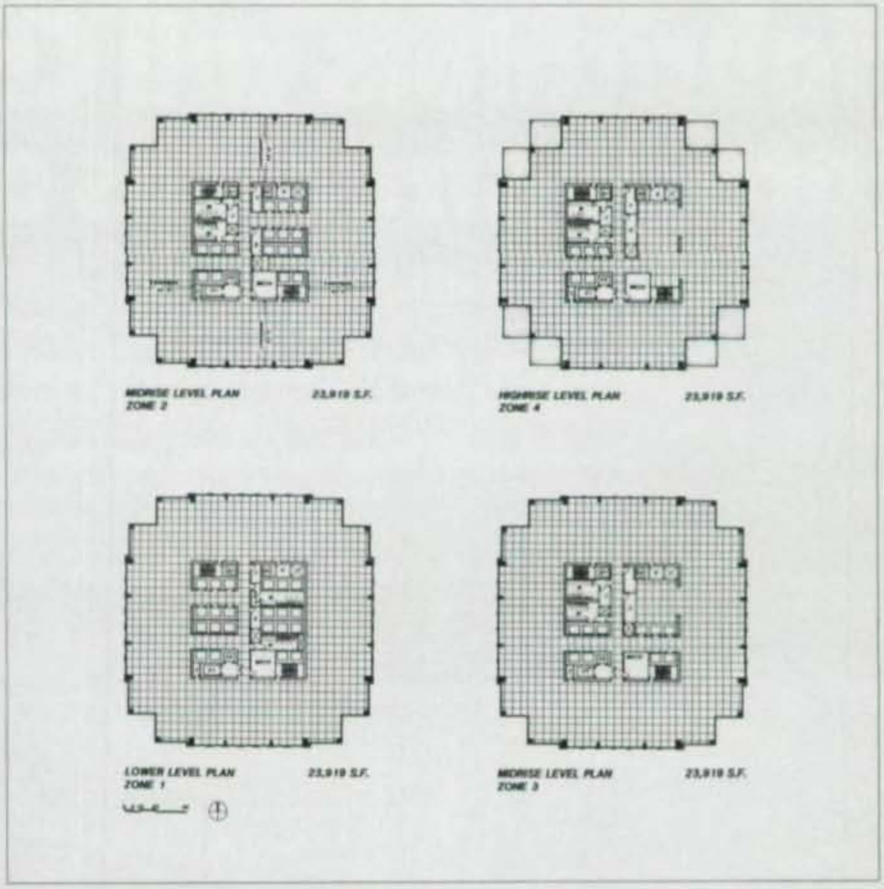
Re-entrant Corners

The tower is square with re-entrant corners, and the tower and podium merge through clear distinction of wall surfaces that either reach the ground or are setback, Jahn explained.

"There is a shift in plane between the building's shaft and the corners emphasizing the location of eight major columns that tie with outriggers to the building's braced central core at intermittent floor levels," he said. "This treatment creates a synthesis between the structural determinants and the figurative form of the tower's shaft and reinforces the structure as load-bearing and the nature of the skin as infill between."

In developing the superdiagonal outrigger system, the engineer and architect worked closely together to ensure that the presence of the diagonal outriggers pene-

The building's richly detailed base reinforces the Art Deco feel of it's roof line.



The tower is square with re-entrant corners, and the tower and podium merge through a clear distinction of wall surfaces that either reach the ground or are setback. Interior designers studied various layout plans to ensure that the floor shapes and sizes were conducive to leasing activity.

trating down through certain lease space at eight locations on 12 floors would not interfere with an efficient layout. "Interior planners made various layouts for full-floor and partial floor tenants and concluded the inclined superdiagonal columns would not hinder real estate leasability," Thornton said. ☐

Jurors Comments:

"The thing I liked about this building is the presence it has on the skyline and the way it attracts your eye upwards as the shape starts to diminish in form all the way up to the spire. The structure is very clean and straightforward."

"The real test of the success of this building is that even though it started out in controversy, in the end everybody has agreed that is was the right move and it truly does create a new landmark for the city. It has moved the center of Philadelphia and caused a resurgence in development in the city."

"This building has a particularly Modernist cast to it without being a throw back to the high-rises of the past. This building is a high-rise of the present."

Project Principals:

Architect: Murphy/Jahn, Chicago
Structural Engineers: Thornton-Tomasetti P.C. New York City
General Contractors: (Joint venture) Driscoll/Huber, Hunt and Nichols, Inc., Indianapolis
Steel Fabricator: Steel Structures, Inc.
Steel Erectors: Cornell & Co., Woodbury, N.J.
Owners: Rouse & Associates, Philadelphia

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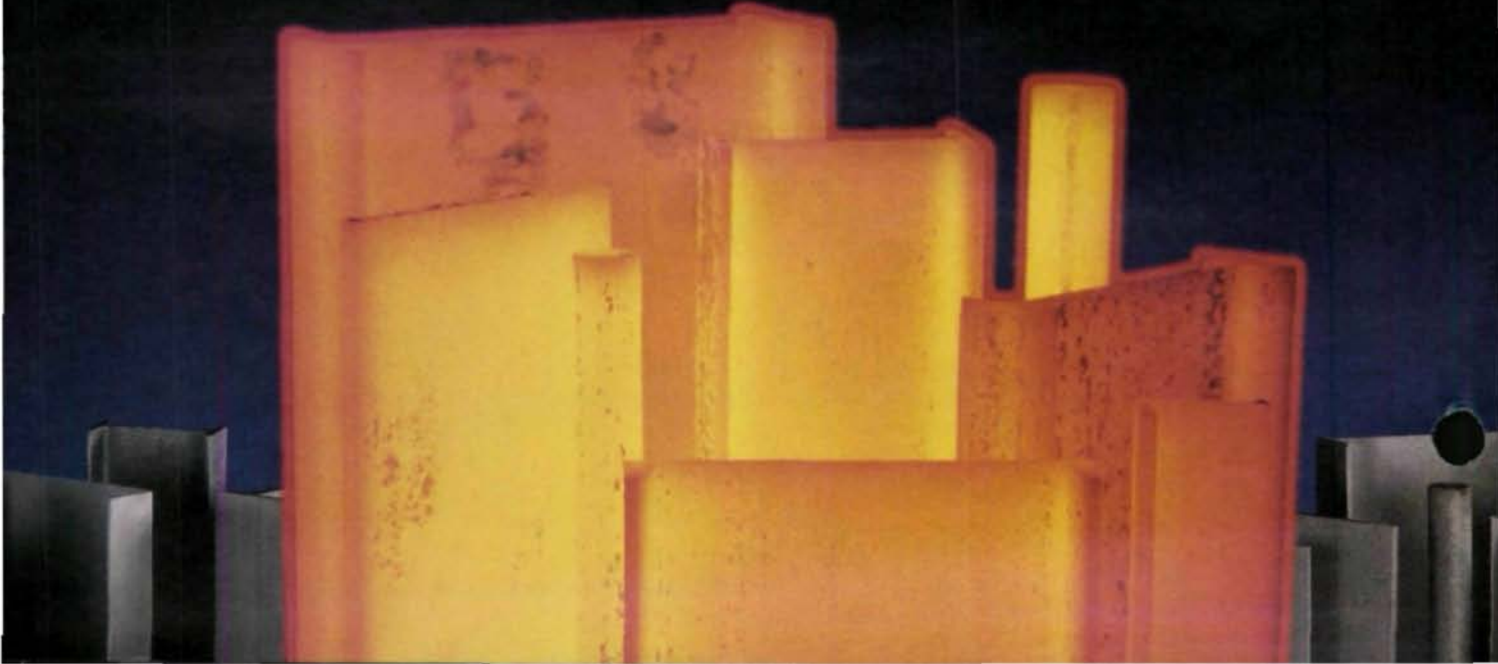


Industrial Context

The use of metal siding on Electro-Coal Transfer Corporation office building helps relate it to the surrounding industrial buildings. The architects designed large translucent panels and windows to let in a lot of natural light, but added overhangs to prevent excessive summer heat gain and glare. Photos by Alan Karchmer

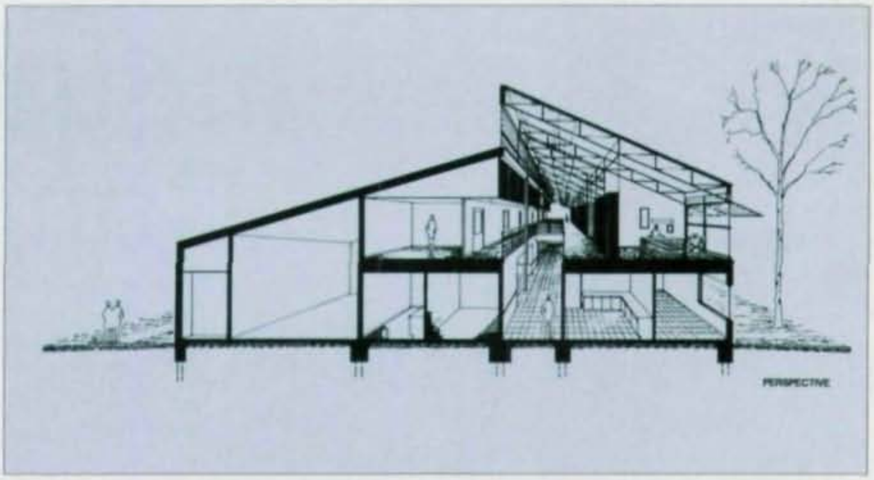
This small office building fits in with its industrial neighbors while still making a strong design statement

Industrial centers are not normally known for award-winning architecture. All too often they tend to be either huge, bulky structures or run-of-the-mill prefabricated buildings. But by adopting the basic design of the sites' existing metal buildings, the architect of a new office building for the Electro-Coal Transfer Corporation in Davant, LA, succeeded in creating a simple, yet elegant, structure.

"There are a lot of rectangular metal buildings on the site with their entrances on the short end," explained Peter Priola, AIA, project designer with The Mathes Group, New Orleans. "We wanted to keep the same linear feel, but also provide a space that would serve the needs of the building's various occupants." The building houses executive offices, field supervisory personnel and a meeting/training room for use by all employees.

The result is a 120' x 76', two-story linear building dominated on the lower level by metal cladding and on the upper level by glazing. And adding to the building's industrial feel is a partially exposed structural frame. As a consequence of the design, the structure at once relates to the other structures on the site and boldly announces itself as an office and not an industrial building.

In addition to relating contextually to the other buildings on the site, the linear shape optimized the views of an adjacent river. "Large windows were more important on the second level because the view of the river from the first story is blocked by the river's levee," Priola explained. Rather than install blinds or drapery to shield the offices from the sun, the architect designed a translucent canopy above the window wall.



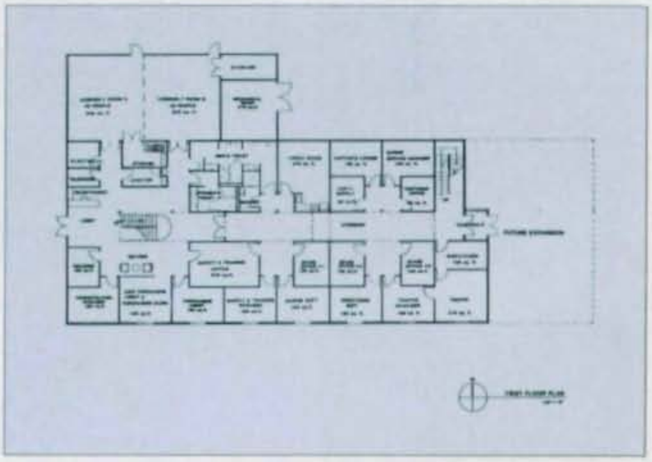
Natural Light Crucial

On the interior, the first floor features a double-loaded corridor. Most people's offices open directly off of this corridor, with a few offices grouped around alcoves. The floor of the second story above the corridor has been cut away, which allows a tremendous amount of natural light to penetrate down to the first floor.

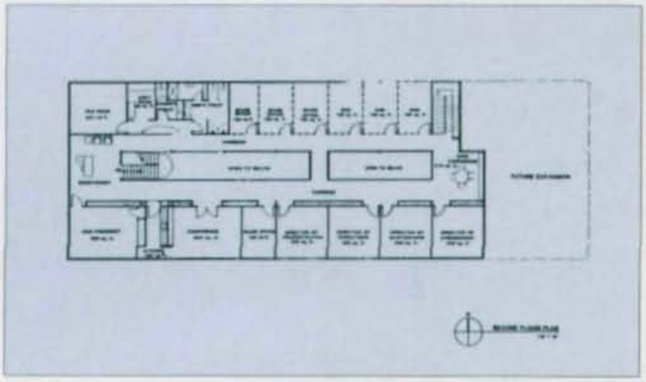
"We grouped the people who would be in-and-out of the building all day on the first floor," Priola said. "The second floor contains more executive space and the offices for the engineers. The vice presidents offices' received larger glass expanses."

Structurally, the building is fairly straightforward. "In the short direction, we had moment connections, while we had bracing in the long direction," explained William Cromartie, P.E. Cromartie is now with the Port of New Orleans, but when the project was designed he was an engineer with The Mathes Group.

The connections are a combination of bolted and welded connections. "A lot of the connections were dictated by architectural considerations. Because the some of the steel was exposed, it was a design decision as far as the number of bolts and whether the bolt heads were showing or not," Cromartie explained. Most of the steel is A36, but some of the exposed, columns were designed as A500 tubes. In total, the building used 90 tons of structural steel, 25 tons of bar joist, and 10 tons of miscellaneous steel.



Most of the offices are grouped around a central lightwell. The use of steel framing enabled the designers to allow for the contingency of adding bays on the east end at a later date.



While the structural design was relatively simple, fabrication and erection was made more difficult due to the required tight tolerances. On one side of the building, the columns extended 40'. The column depth was 6", and normally the erector would be given a 3/4" leeway. But because it was contained within a 6" wall cavity the tolerance was much tighter. Fortunately, the contractor, Claiborne Builders, Inc., New Orleans, did an excellent job of placing the anchor bolts within the foundation.

The building also had to be very plumb because of the window walls on the second story and due to the framing for the awnings.

Another complication was the sloping roof line, which created a lot of different angles. And finally,

A lot of natural light flows into the center of the building from an overhead skylight. Also, the exposed structure adds to the industrial feel of the building's architecture.

the stair rotated 180 degrees and was only supported at the top and bottom with moment connections. The stairs were shipped as one unit, and fabrication had to be very precise.

The total project cost was \$74.86/sq. ft., or just under \$1 million. □

Jurors comments:

"I like this building because, as opposed to a lot of the other ones where there's a lot of customization of the steel in a very sophisticated way, this one seems to use steel literally right off the shelf. These are a bunch of standard manufactured pieces that have been put together in a very elegant way and the detailing is extremely consistent."

"I think this is a real sleeper because it doesn't try to do anything overly exciting or make any high architectural gestures. It's just a very simple, utilitarian building that's quite elegantly done. It's not trying to be more than it is, and it's beautifully executed.

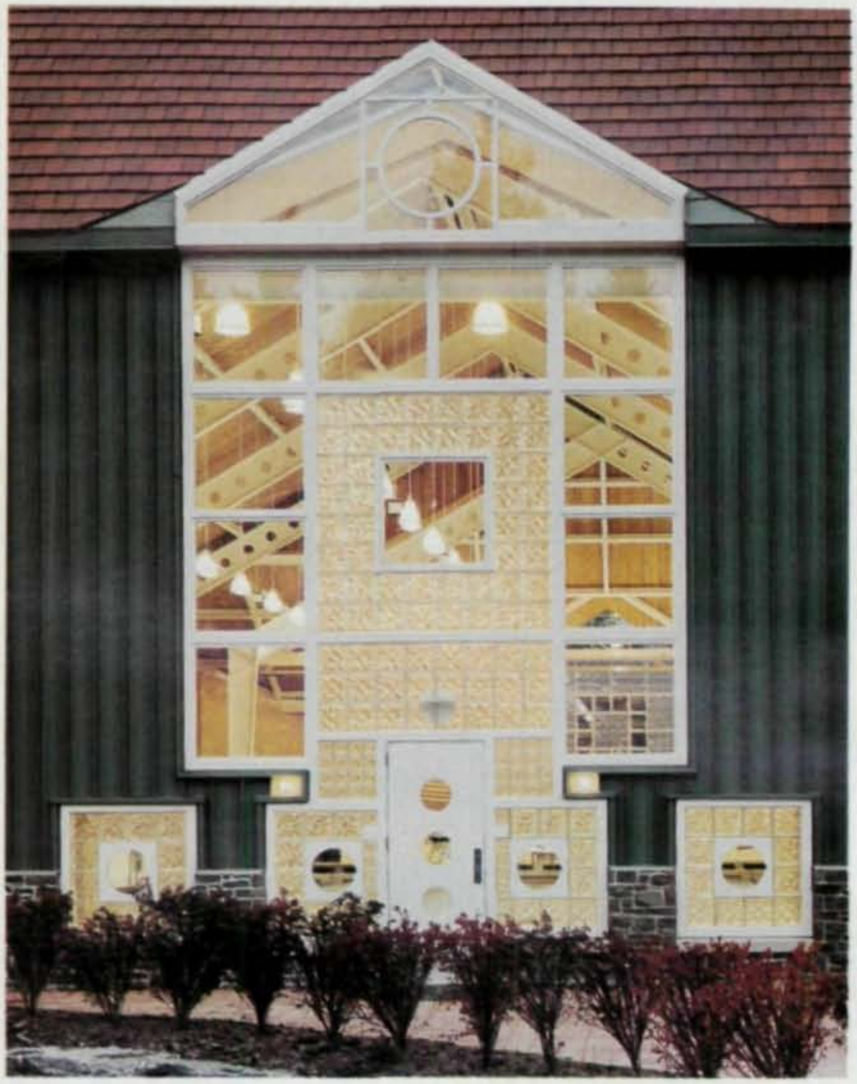
"I'd say this is the kind of building you wish you saw more often. It's a simple, modest program from a budget standpoint. it utilizes steel as a very expressive element by using the standard elements detailed elegantly."

Project Principals:

Architect: The Mathes Group, A Professional Architectural Corp., New Orleans
Structural Engineer: The Mathes Group
General Contractor: Claiborne Builders, Inc.
Owner: Electro-Coal Transfer Corp., Davant, LA

Natural Light Enhances Pool

Steel arches proved the most economical and aesthetic method of creating a required 65' clear span



A view from inside and out: Letting in a huge amount of natural light was crucial to the designer's plan for the Hamilton College Pool. Just as important was the use of steel three-hinged arches for the structural system, which allowed both the required 53' head room and 65' clear span. Photography by Richard Mandelkorn © 1989

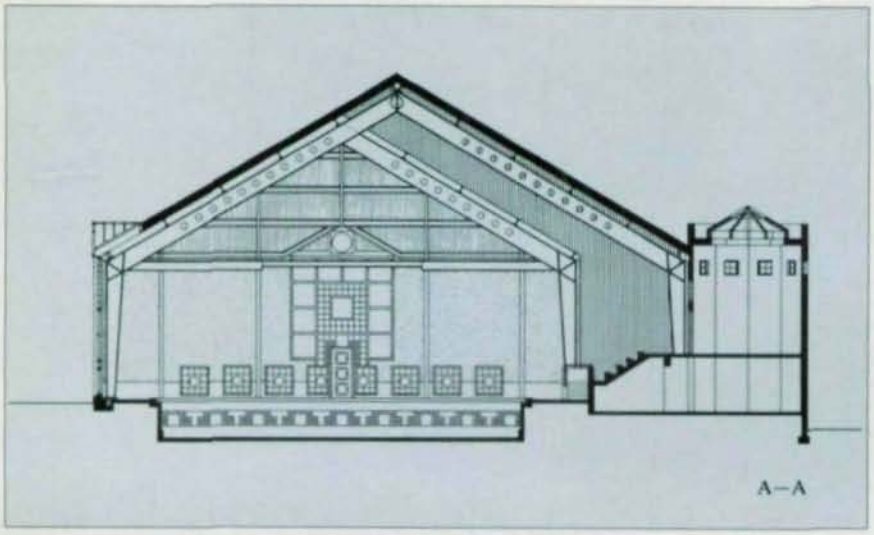
When movie producers envision a college campus, they usually picture something similar to Hamilton College in Clinton, NY. Founded in 1812, the campus features grassy knolls, stands of trees, and fine old buildings of locally quarried stone.

Though many of these old buildings can be readily renovated for use as modern classrooms, the college's pool was hopelessly outdated. In addition to being drafty and leaky, the building, which was built in 1838, was only large enough for a 25-yard pool—much too small by today's competitive standards.

While it was clear that a new building was needed, it was less obvious what form it should take. The program that was finally developed called for a pool facility that would be very modern in use, but would still be aesthetically appropriate to the campus and the adjacent buildings.

Stone Exterior

The architects met the aesthetic concerns by cladding most of the building in stone from the same quarry that produced stone for many of the other buildings on



The use of large glass block and vision glass windows not only let natural light into the pool area, but also created an attention-getting exterior. Photography by Richard Mandelkorn ©1989

campus. In addition, the sloped roof was covered with tile, with the exception of metal roofing on the gables.

Cost Savings

To reduce costs, however, one side of the building was finished with metal panels. This was not an aesthetic concern, however, because that face of the building is in a service courtyard area that is not generally accessible to the public. A green color was chosen for the metal panels to relate them to the copper that was used on the parapets of several neighboring buildings.

While the exterior is clearly traditional, once visitors enter the corridor leading to the pool area, they immediately become aware that this building is unlike any other on the campus. One wall of the corridor is simply painted wallboard over the existing wall of the neighboring gymnasium. But the other wall is a shimmering wave of glass block.

"We wanted to put people in the right mood as soon as they entered the facility," explained Charles Rogers, AIA, project principal with architect Perry Dean Rogers & Partners, Boston. "The curving glass block wall relates to the quality of light on water." It's the beginning of a nautical scheme that is all the more impressive for its subtlety.

The 60' x 100' pool is beautifully detailed—from the 6" floor tiles to the exposed steel structure to the natural cedar decking that is part of the roof assembly. But perhaps its most notable feature is the abundance of natural light.

"A big argument in designing pools is whether to have windows," Rogers explained. "We took a trip to Finland and examined their treatment of natural light in pool and sauna areas." As a result, it was decided to feature large window walls, again primarily featuring glass block, though there is some vision glass.

The pool's brightness is further enhanced by the beautiful deck and high ceiling, which reaches 53' at its zenith.

The roof deck is a sandwich panel of ¾" marine plywood, 2 x 12 joists, cedar planks and roof insulation and vapor barrier. "The roof deck acts as a lateral diaphragm designed to take the forces in that plane of the roof," explained Llewellyn S. Bolton, III, P.E., a principal with Bolton and DiMartino, Worcester, MA, the project's structural engineer.

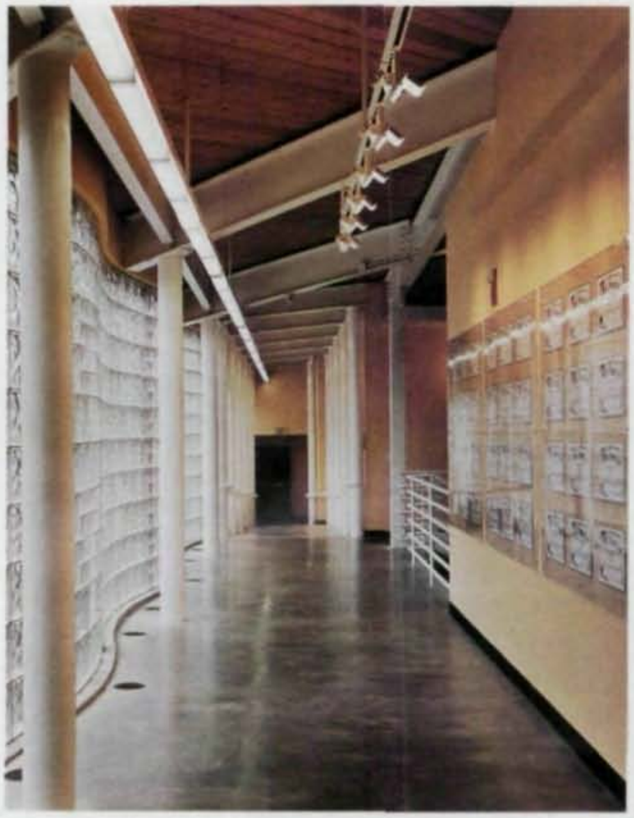
53'-High Ceiling

"The deck system is supported on 12"-wide flange purlins spanning 25'. The top flange has a variable moment of inertia and is supported on a three-hinged arch spanning 95'. The arches are 25' high at the eave and 53' high at the ridge line." The hip roof portion is framed with wide flange beams supported on 8" diameter pipe columns.

The arches have moment connections, while the other sections are all shear connections. The joints are a combination of shop welds and field bolts. All of the steel is blast cleaned and painted with a 3-mil-thick zinc rich primer at the shop. The second coat is a 4-mil high build epoxy.

"We considered using a truss system or a simple beam," Bolton explained. "But a simple beam at 95' would have meant using a plate girder, and that's very expensive. We didn't want to use a truss because of its depth." With a truss, in order to achieve the necessary headroom for divers, the roof would have had to be raised, which would have meant additional framing costs, as well as the expense of heating the larger space.

"The engineer and I went through a lot of structural options before deciding on this system," Rogers added. "This system gave us a lot of natural light and the roof line we wanted at no extra cost."



A wavy glass-block wall in the corridor leading to the pool creates a pyschological image of water. Photo by Richard Mandelkorn ©1989

Decorative Elements

For added decoration, the 3'-deep arch rafter beams are perforated with 1' diameter holes at 2' 9" on center. "The holes are purely decorative. The web takes the shear, while the flange takes tension and compression. The holes don't effect the strength of the member," Bolton said.

"The holes relate to the nautical environment," Rogers added. "They suggest portholes and also present the steel on a more human scale."

The use of 6" tiles also created a more inviting arena. But the tiles also were chosen in an attempt to create a faster swimming environment. One theory that was presented to the pool's designers contends that a larger tile has less surface resistance and contributes less to the pools turbulence than would a smaller tile.

The pool is adjacent to the old gymnasium and shares with it locker and shower facilities, as well as use of the gym's boiler plant. The pool does have a separate HVAC system, which utilizes large air handlers to maintain a comfortable and odor free atmosphere in the pool area. The air supply is introduced at the floor level through linear grilles and along the three exterior glass exposures. Exposed 12" stainless steel stacks blow hot air across the building's skylights. This sheet of warm dry air over the glass and walls is designed to effectively prevent condensation on these surfaces. □

Jurors Comments:

"The interior spaces are really quite a lot of fun. The way daylight comes into the space keeps it from ever being tiring. I think it's quite light-hearted, which fits this type of space. It has a great deal of consistency in the detailing and the expressions of the steel. It has a clarity and simple design that is carried throughout the whole concept"

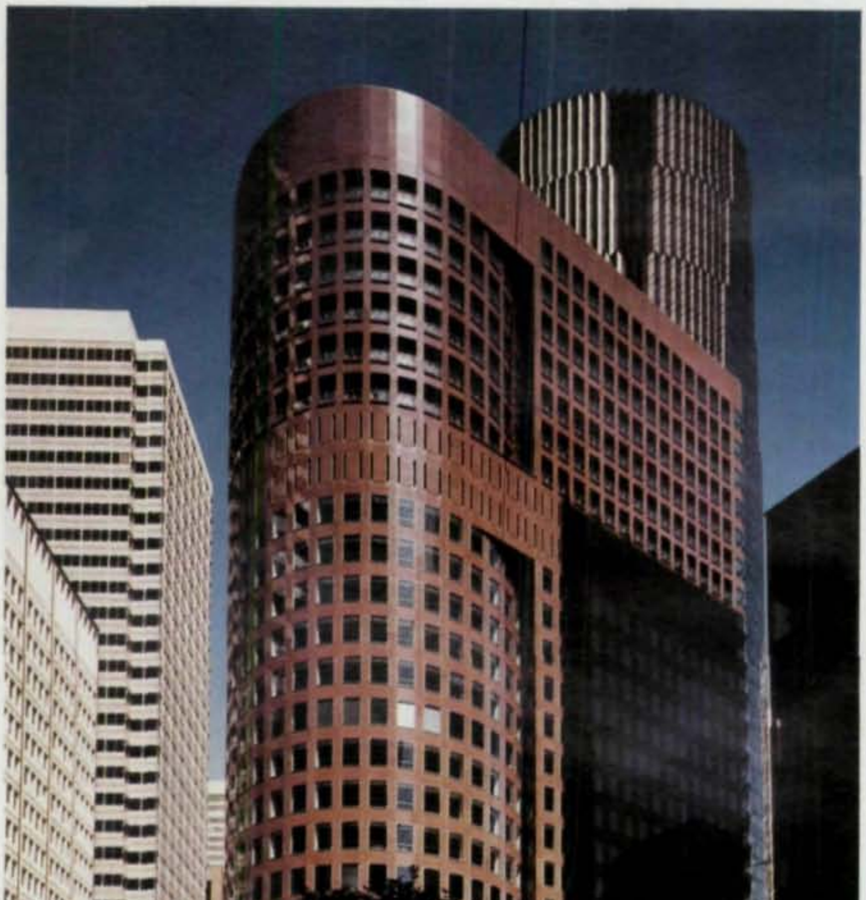
"I think this building has some exquisite details to it. It holds together as a building even though it's somewhat eccentric in some of its expressive elements."

"It's a joyous building that celebrates the activities and the spirit of its use. It says: "I'm a recreational facility. Enjoy me."

Project Principals:

Architect: Perry Dean Rogers & Partners, Boston
Structural Engineer: Bolton & DiMartino, Worcester, MA
General Contractor: Murnane Associates, Whiteboro, NY
Owner: Hamilton College, Clinton, NY

Reinterpreting The Past



388 Market Street's distinctive flatiron shape creates a breathtaking view from almost any angle. The triangular shape has historical precedents and clearly fit the site. The rounded portion was designed to conform to San Francisco's zoning size requirements. Photography by Jane Lidz Photography

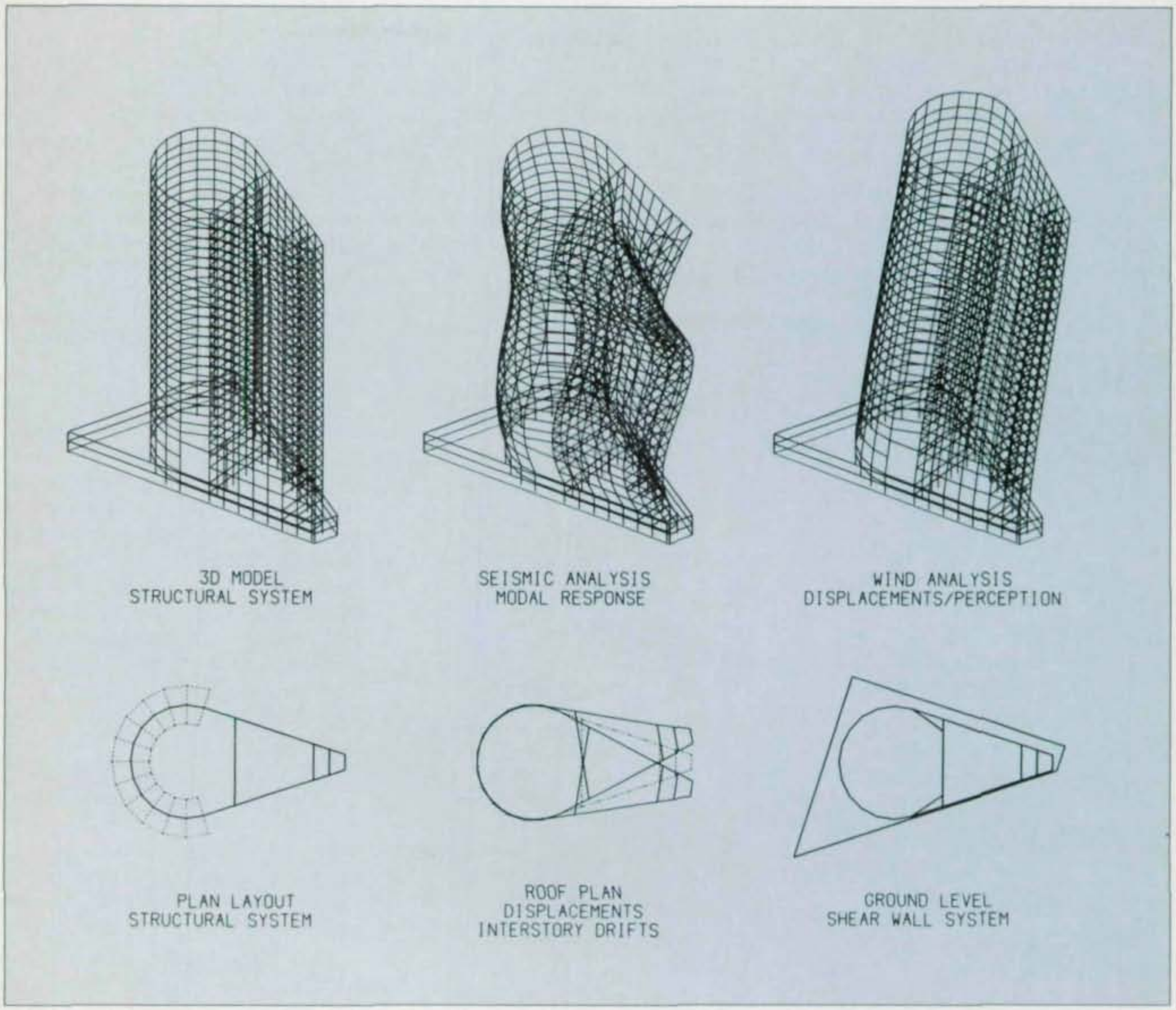
388 Market Street is a modern version of the famed flatiron buildings of a bygone age

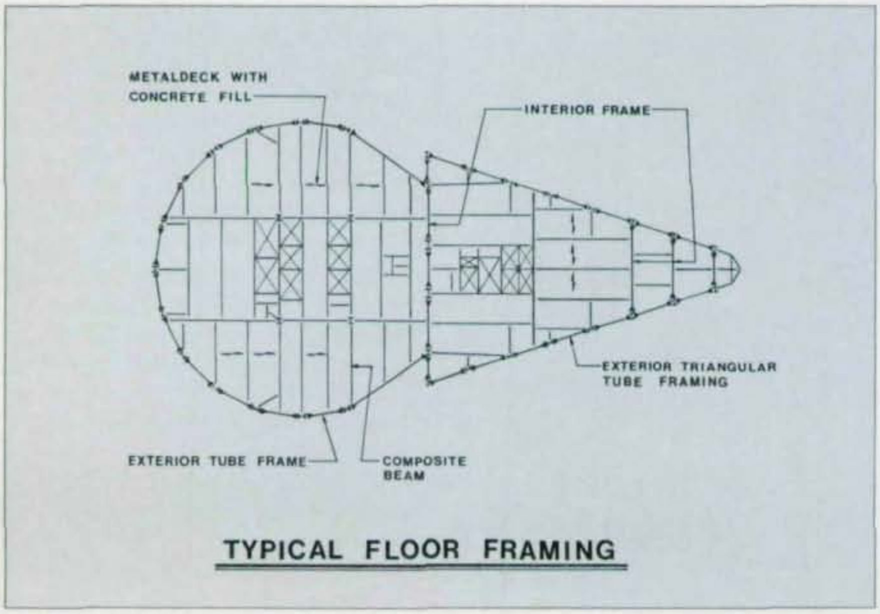
San Francisco's plethora of angled streets once led to the proliferation of flatiron buildings. As real estate values soared, these old buildings were gradually replaced with modern highrises. Unfortunately, in the name of leasing efficiency, these new structures were almost always rectangular in form.

When several small buildings were demolished on a triangular site in the heart of the city's commercial district, it was almost expected that another rectangular structure would be built.

"My first impression of the site, however, was that there should be a flatiron-type building on it," said Lawrence Doane, FAIA, a senior partner with Skidmore, Owings & Merrill, San Francisco, the project's architect and engineer. In addition to the aesthetic advantages and historic precedents of a flatiron building, the tight site enabled the designer's to construct a larger building. "I really wanted to do that shape, and the site is so small that it helped to justify it."

The desire for more floor space also dictated the usage of the building. San Francisco's interim development guidelines at that time allowed a greater density in return for specific uses and public





The building is designed with a multiple-tube structural system, with a tube forming the triangular portion and a second tube forming the circular portion. This unusual shape, as well as the need to join together the two sections of the building, required that the seismic design be carefully analyzed.

amenities. By designing the building as a mixed-use residential/office building, amongst other items, the design team was able to increase the site FAR from 14:1 to almost 19:1.

The 26-story, 422,000-sq.-ft. tower includes below-grade parking for 120 cars, ground floor retail space, office floors, and 63 residential condominium units.

The building's distinctive design most resembles a circular tower attached to a triangular tower. "We used the cylindrical shape because at the time the building was designed San Francisco had a 200' diagonal size limit," Doane explained. "The cylinder reduced the bulk, and it was pretty. Also, it helped the building work structurally."

The building is clad with a polished imperial red granite cladding that helps relate it visually to such nearby commercial San Francisco landmarks as the Bank of America World Headquarters. "Even though San Francisco is generally comprised of light-colored buildings, we chose a dark and rich color because we didn't want the windows to look like dark patches on a white background," Doane said.

Multiple-Tube Structural System

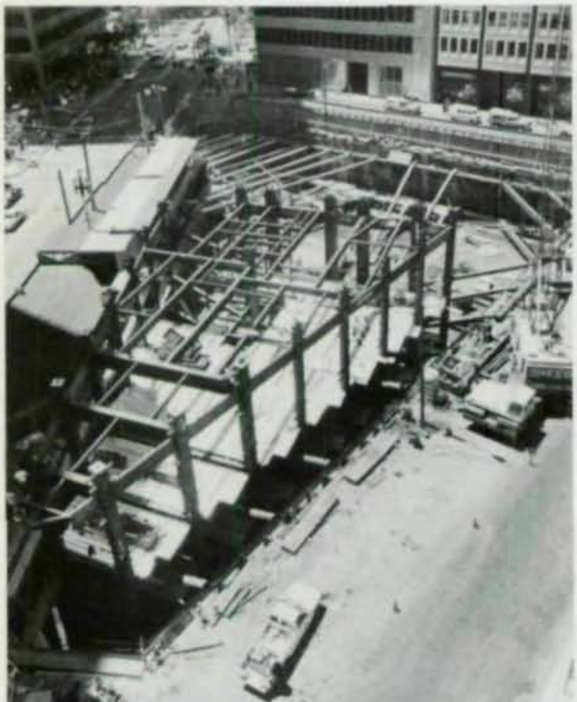
The building is designed with a multiple-tube structural system. "The system is comprised of a tube as the triangular portion of the building and a tube as the circular portion," said Navin Amin, S.E., chief structural engineer and associate partner with SOM. The two tubes share a common frame where they come together, and are further linked at the mechanical level and roof. In addition, there are additional cross frames at the tip of the triangle.

The tubes are ductile, moment-resisting structural steel frames with column spacings at 16'. Deep steel wide-flange sections are used as columns and spandrel beams for optimum stiffness and ductility with respect to seismic loading.

"We considered a concrete core with a steel moment frame, but that would have required a lot more coordination between the different trades," Amin said. "Also, it was generally a more expensive option and the concrete core would have occupied too much space."

Another consideration was whether to go with 8' or 16' column spacing, with the latter being chosen. While 8' would use about 1 lb./sq. ft. less steel, the 16' column spacing was more economical to erect and fabricate, which reduced the overall cost. Also, the 16' spacing meant there were fewer columns to interfere with views. "We normally would have used 36"-wide columns, but it would have interfered with the vision areas," Amin said.

To reduce sight obstruction, the columns were specified as jumbo



The multiple-tube design utilizes ductile, moment-resisting structural steel framing. The 18-deep columns are spaced 16′ on center to maximize vision lines and reduce fabrication and erection costs. Construction photography by Edwin T. Scott

shapes. "We wanted 18"-deep columns but with 300 to 400 lb./ft." Because of the 16′ column spacing, the design specified 24"- to 36"-deep spandrel beams. The structural system used nearly 5,000 tons of steel.

The use of an exterior steel frame tube also greatly simplified the task of erecting the exterior granite wall system. The curtainwall is a series of T-shaped panels which readily attached to the frame. The use of steel also facilitated the fast-tracked construction of the building and reduced the weight of the structure, which was important in reducing seismic loads.

"The building is symmetrical in

one direction, and asymmetrical in the other, so torsion was a large consideration. The tubular concept provided a structurally rigid building, which was confirmed in wind tunnel tests," Amin explained.

"One of the challenges was to make sure both parts moved together," he said. The major connections are at the 18th floor and at the roof level. "We designed a series of moment connections to make sure the building moved as a single structure."

Complex Seismic Design

The unusual shape complicated seismic design. "Because of the shape, one side was much stiffer," Amin explained. "We had to carefully proportion the stiffness and ductility that was required to absorb the earthquake energy." The need for additional stiffness was another reason to use the jumbo shapes. "If there ever was any damage, we wanted to make sure it would be to the spandrel beams and not the columns."

The floor system consists of a composite metal deck slab supported between the building core and exterior frame tube. This provides the column-free lease space required for flexible office/tenant space planning.

Because the building is surrounded by taller structures, the design of the roofscape was important. "The mechanical floor is located between the office and residential portions, and we fully concealed the cooling tower on the roof," Doane said.

Jurors Comments

"I think it's an elegant building and it's absolutely overwhelming when you come around the corner and see it. Even though its shape is quite simple as you walk around it, still it's very complex and distinctive. It's one of the more sophisticated buildings in a very sophisticated city."

"I like the elegant way in which the granite facade mirrors the structure that is behind it. The two are absolutely in harmony with one another. The idea of bringing a building to a sharp point with a very narrow dimension has been handled very elegantly. It makes a tremendous impact on the skyline and on the view from the sidewalk."

"It's a building that takes your breath away. It's so exquisitely detailed that you stop and look at the building and admire it the way you'd look at a fine piece of jewelry in a window. I particularly liked the articulation of the building, which reflects the different uses that it has, and yet it still hangs together as a single entity."

Project Principals:

Architect: Skidmore, Owings & Merrill, San Francisco
Structural Engineer: Skidmore, Owings & Merrill, San Francisco
General Contractor: Swinerton & Walberg, San Francisco
Owner: Honorway Investment Corp., San Francisco

Fire Proofing

Isolatek International provides a wide range of quality spray products for passive fire protection, thermal insulation and acoustical control under the Cafco brand name. Blaze-Shield and Deck-Shield are asbestos-free and vermiculite-free structural fireproofing materials. Both products can be used on floor/ceiling assemblies containing fluted steel deck and on steel beams and columns. In addition, Blaze-Shield can be used on cellular steel deck and Deck-Shield can be used on semi-flexible roof systems. Both offer superior thermal and acoustical performance, as well as conforming to SBCCI, ICBO and BOCA fire codes. Also available is Heat-Shield for high-humidity/cold storage facilities.

For more information, contact: Isolatek International, Flanders Road, P.O. Box 478, Netcong, NJ 07857 (201) 347-1200.

Bending Rolls

In addition to their three- and four-roll plate bending rolls, ROUNDO is now offering a full-line of structural section bending rolls, including beam benders to camber and roll up to 36" WF beams on X-X as well as Y-Y axis (these machines also can roll structural tubing of almost any size for special architectural applications) and a full line of structural section bending rolls (angle rolls) in 15 sizes ranging from 2" x 2" x 5⁄16" to 10" x 10" x 1" angle capacity.

For more information, contact: Comeq, Inc., Box 2193, Baltimore, MD 21203 (301) 325-7900.

Clamping System

The Lindapter girder clamp system from Linport is a proven rigid assembly enabling secure connections of secondary steelwork without drilling or welding. Typically, loads of up to 13,200 lbs. per four-bolt connection can be securely carried with a 5:1 safety factor using standard components and ¾"-diameter, grade 5 bolts. Higher unit loads can be accommodated using 6 or 8 bolt connections or larger diameter bolts.

For information, contact: Linport International, 106 Longwater Dr., Norwell, MA 02061 (617) 982-1400.

Steel Joists

The Steel Joist Institute has published its *50-Year Steel Joist Digest*. The digest is a compilation of the specification and load tables of SJI steel joists manufactured between 1928 and 1978. It includes information necessary for renovation of steel joists, including: required building documents; building site information; equipment needs; and step-by-step investigative procedures.

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

Long-Span Deck

Epic Metals Corporation is offering a combination roof and ceiling panel capable of spanning more than 30' between supports. The top surface is ready for standard rigid insulation and roofing, while the underside becomes a finished ceiling ready for decorator colors. The deep decks feature perforated steel plates and acoustic insulation for a state-of-the-art solution to sound control with minimal maintenance. They are widely used in churches, stadiums, convention centers, schools, airports and theaters.

For information, contact: Epic Metals Corp., Eleven Talbot Ave., Rankin, PA 15104 (412) 351-3913.

Steel Floor & Roof Deck

In addition to its steel joists and joist girders, Vulcraft also offers a complete range of steel floor and roof decks. Steel floor and roof decks have long been recognized for their economy because of their light weight and high strength-to-weight ratio. They provide a durable and attractive roof or floor system for fast, all-weather construction.

For more information, contact: Vulcraft, 4425 Randolph Road, Charlotte, NC 28211 (704) 366-7000.

Composite Decks

United Steel Deck, Inc., offers a complete line of composite floor decks, form decks and roof decks. The composite floor deck depths are 1½", 2" and 3"; roof decks are 2½", 3", 4½", 6" and 7½" deep; and non-composite (form) decks are 0.56", 1", 1.31" and 2". Most of the floor and form decks have rib widths that are suitable for use with composite beams and girders. Several of the roof deck sections are available with acoustical treatment to provide effective noise reduction. Also available are cellular decks.

Both galvanized and prime painted finishes are typically available, however, special finishes and colors can also be provided if needed.

For more information, contact: Nicholas J. Bouras, Inc., P.O. Box 662, 475 Springfield Ave., Summit, NJ 07901 (201) 277-1617.

Deck Design Manual

The Steel Deck Institute is offering an *LRFD Design Manual for Composite Beams and Girders with Steel Deck*. The manual offers composite design with steel beams and steel deck; example problems; quick selection charts; and look-up charts.

For more information, contact: Steel Deck Institute, P.O. Box 9506, Canton, OH 44711 (216) 493-7886.

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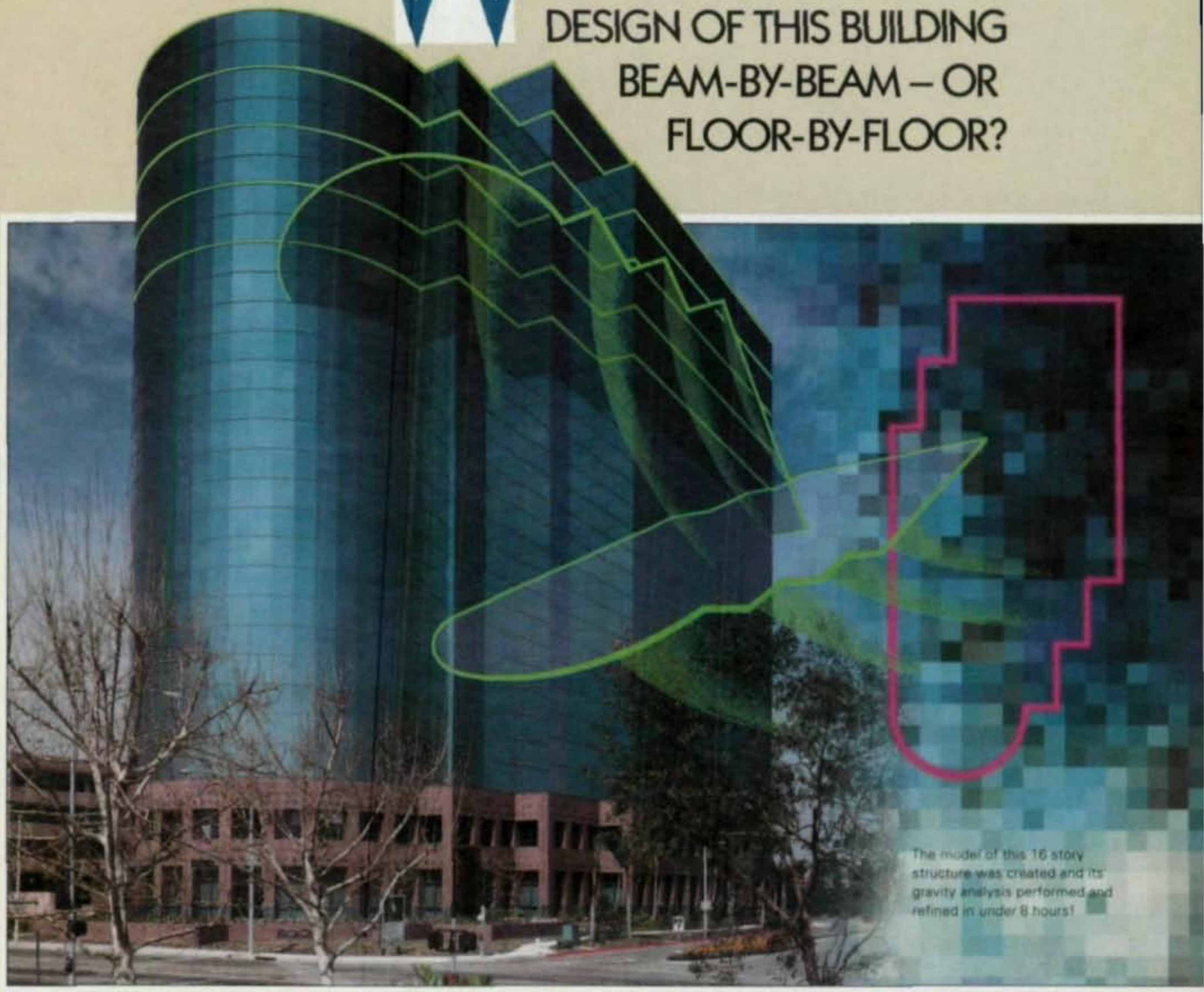

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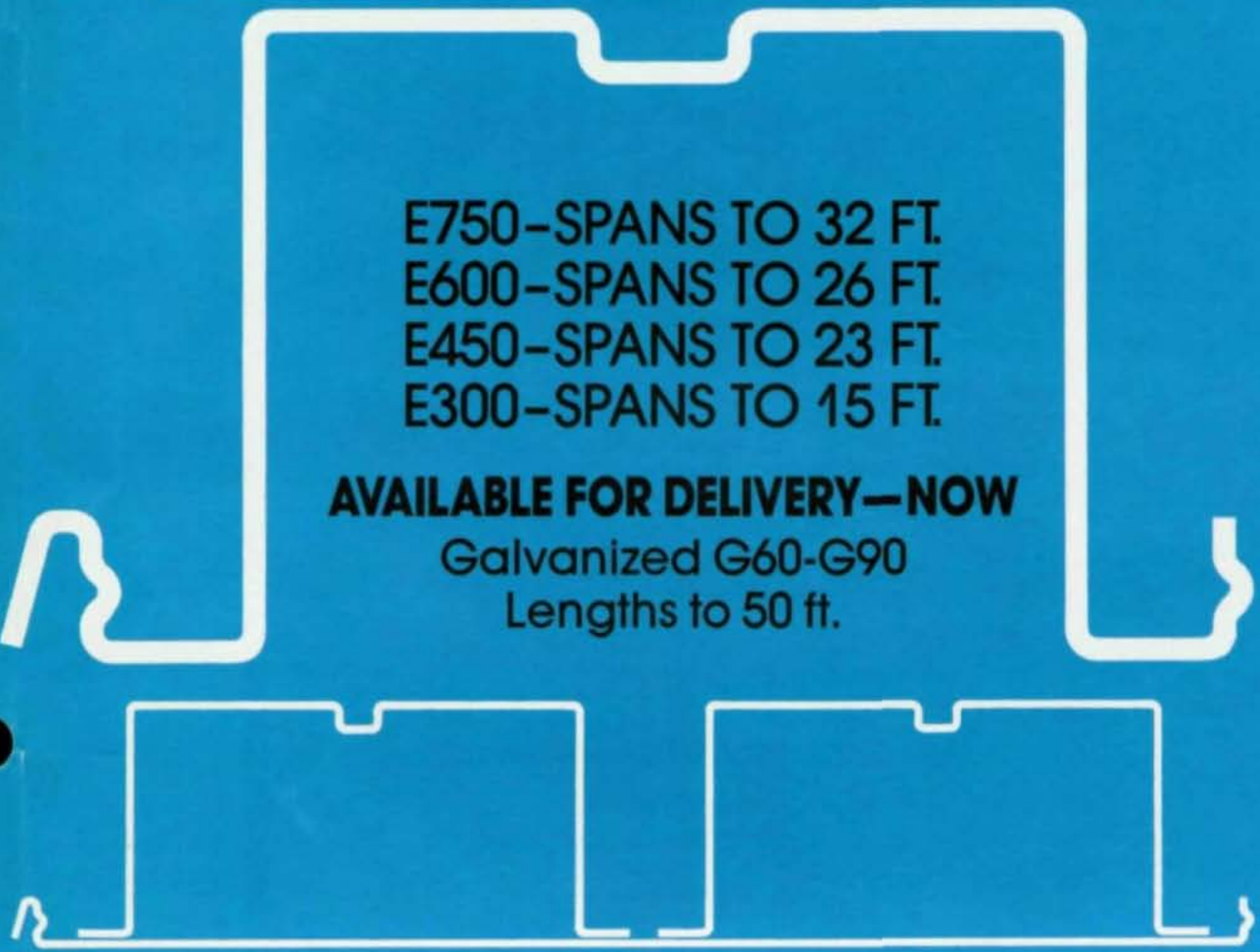

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