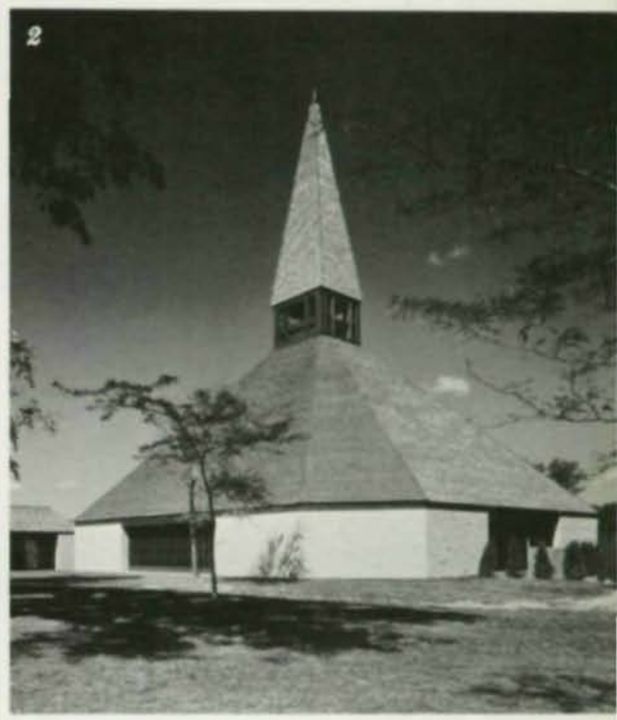
VOLUME XII / NUMBER 2 / SECOND QUARTER 1972

MODERN STEEL CONSTRUCTION



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Steel

MODERN STEEL CONSTRUCTION

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CONTENTS

PROBLEMS AND SOLUTIONS FOR STRUCTURAL STEEL DETAILING

A 2-unit set of exercise booklets, specially prepared for use in technical schools or on-the-job training of structural steel draftsmen, is now available from AISC.

The problems and their solutions are keyed to the 2nd Edition of AISC's Structural Steel Detailing and to the 7th edition AISC Manual of Steel Construction. They are designed to provide supplementary exercises in the analysis, procedures, and calculations frequently required in detailing practice. Numerous sketches of partial details illustrate both the problems and solutions.

The pages of both the Problems booklet (Part 1) and the Solutions booklet (Part 2) are 3-hole punched and are easily detachable for transfer to a ring binder as class assignments are issued by the instructor.

Problems and Solutions for Structural Steel Detailing is distributed through book stores, and also at AISC, 101 Park Avenue, New York, N. Y. It is sold only in sets, each containing a Problems booklet and a Solutions booklet. Each 2-booklet set is priced at $5.00 postpaid in the U. S., plus appropriate sales tax.

1972 ARCHITECTURAL AWARDS OF EXCELLENCE

All registered architects practicing professionally in the United States are invited to enter steel-framed buildings of their design constructed anywhere in the 50 states and completed after January 1, 1971 and prior to August 26, 1972. Each building must have been designed, detailed, and fabricated in the U.S., and all structural steel and plate must have been produced in the U.S.

The distinguished Jury of Awards includes:

S. Scott Ferebee, Jr., FAIA *First Vice President, The American Institute of Architects, President, Ferebee, Walters & Associates, Charlotte, North Carolina*

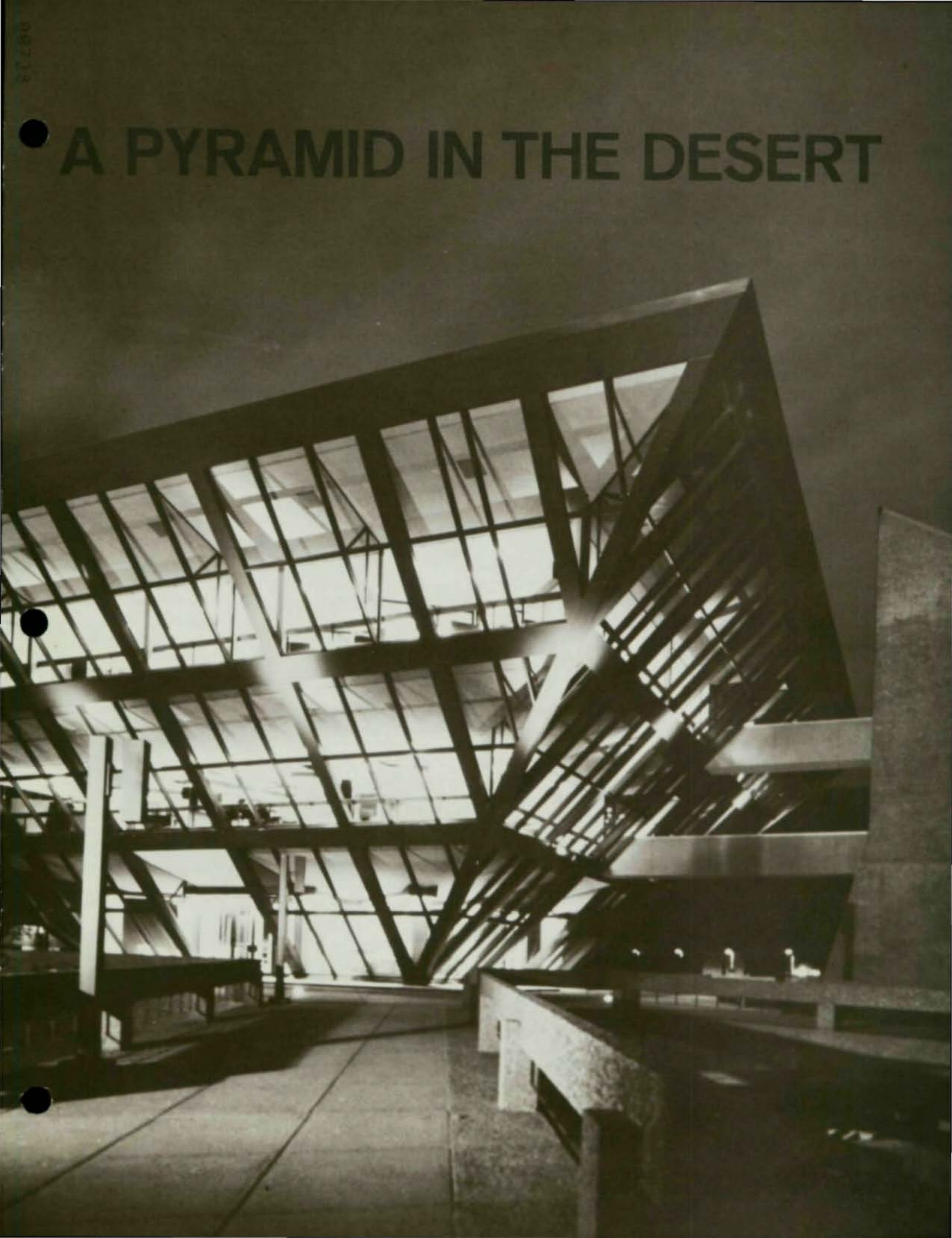
Vincent G. Kling, FAIA *Managing Partner, Vincent G. Kling & Partners, Philadelphia, Pennsylvania*

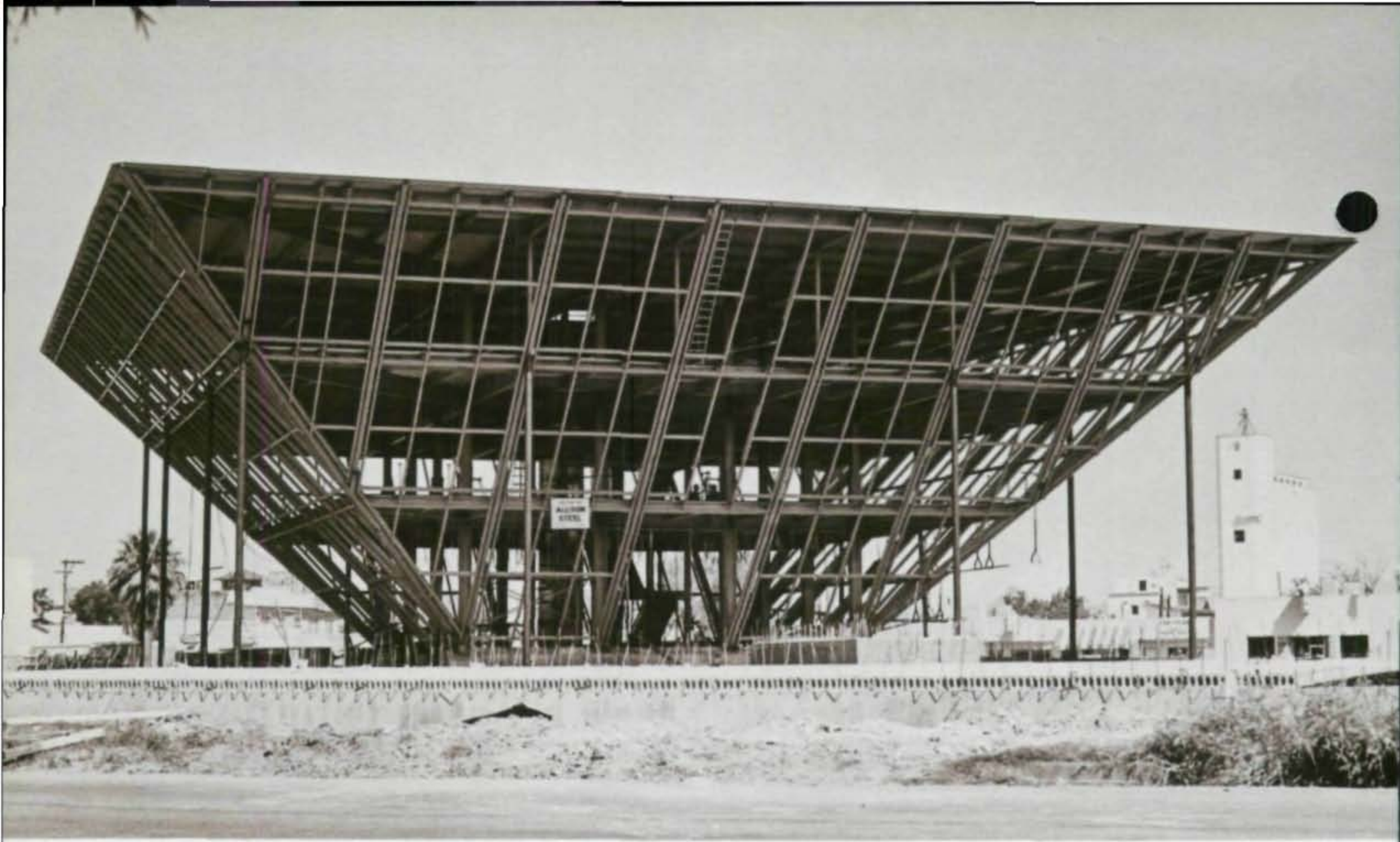
John O. Merrill, Jr., AIA *Partner, Skidmore, Owings & Merrill, San Francisco, California*

Leo Plofker *Partner, The Office of James Ruderman, New York, New York*

Mario G. Salvadori, F.ASCE *Chairman, Division of Architectural Technology, School of Architecture, Columbia University, New York, New York*

A PYRAMID IN THE DESERT





A PYRAMID IN THE DESERT

by Victor A. Walther
AISC Regional Engineer
Los Angeles, California

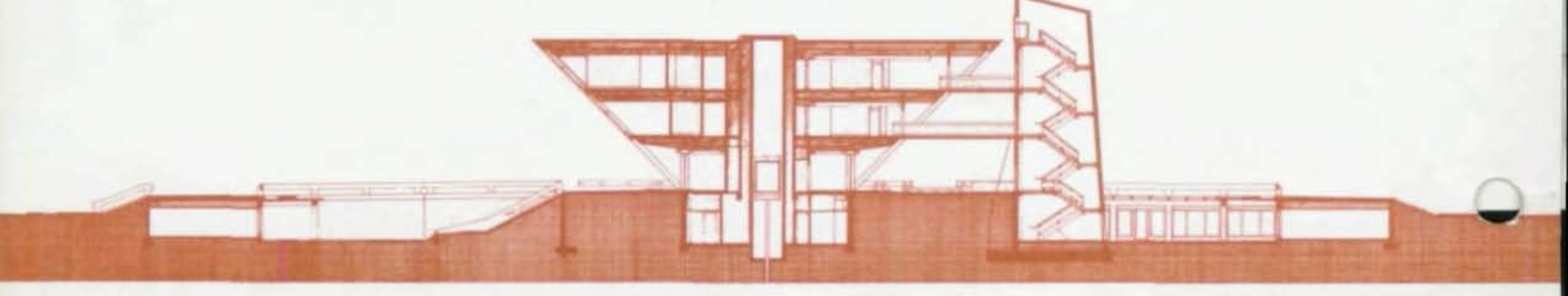
One of the most innovative and unconventional structures ever built in the State of Arizona is Tempe's new \$2.5-million Municipal Building. The *central tower is a three-story, inverted,* glass-walled pyramid, set on 2.5 acres of plaza and sunken gardens. Administrative offices are housed in the central tower. Perimeter offices containing citizen services are located in the garden areas, easily accessible from the street.

Design Criteria

Varied and complex architectural requirements were set for this project. Primarily, the new structure was to be a unique visual focal point for the expanding community of Tempe, located just outside of Phoenix. In addition, the site, located in the heart of the city, lent itself to a design that would retain a feeling of openness. But most important was the necessity of the build*ing to appear accessible and inviting to* Tempe residents. Finally, it was felt that the building should exemplify the progressive local government, yet retain a timeless beauty that would be compatible with future redevelopment.

Solar Heat — A Problem and Solution

A single consideration contributing most significantly to the resultant shape selected was the need to provide protection from the glaring summer sun and intense desert heat prevalent in the Southwest of the United States. The usual solution of solar screens or deeply



recessed windows was not consistent with the requirement for "openness."

The architects decided on a combination of sloping glass walls and special building orientation to reduce the solar heat load. The sloping glass walls were placed at 45° with respect to the horizon and the building itself was orientated so that its perimeter walls formed an angle of 45° with the north quadrant. This tilted wall, acting with the sun-bronze tinted glass, permits only 18 percent of the sun's rays to penetrate into the interior.

The building is three stories tall with a 45 ft-0 in. square first floor plan. Each succeeding upper floor overhangs the floor below by approximately 14 ft on each side. Extending this scheme up to the roof results in a 128 ft-0 in. square roof plan. By overhanging successive floor levels and enclosing the unusable space where the wall slopes outward to the floor above, an insulated heat transfer barrier was formed. Within this area, the solar heat entering the building is collected and carried away by the air circulating system housed in the ceilings of the building. The air conditioning is regulated by the heat load on each face of the building as the sun changes positions throughout the course of the day.

An Engineering Challenge

The unusual architectural shape of this building resulted in some interesting problems for the structural engineers. Much consideration was given to the choice of structural materials. Steel could best provide function and form, in that it has the necessary strength to frame the structure, as well as member sizes small enough so as not to distract from the panoramic effect of the glass walls.

Structural steel was A36 and interior floor framing connections were made with A325 high-strength bolts. Four rigid frames, two in each direction, were used to form a 45 ft square which became the central core of the building. These frames provided the necessary stability needed to resist lateral design loads, as well as overturning forces on the building due to unbalanced gravity loads. These moment frames, as well as the sloping wall members, were welded with E70 electrodes. A 3-in. hardrock concrete slab on metal deck completed the details.

Special attention to connection details, particularly on the sloping wall members, and close coordination with the fabricator-erector kept the total steel erection time to a mere 29 working days.

Architect: Michael and Kemper Goodwin
Tempe, Arizona

Structural Engineer: Mann and Anderson
Phoenix, Arizona

General Contractor:
M. M. Sundt Construction Co.
Phoenix, Arizona

Steel Fabricator:
Allison Steel Manufacturing Co.
Phoenix, Arizona

Flame Shield System Provides Fire Protection

Located on a 10-acre site outside of Chicago (near Glenview, Illinois), is the Central Division Headquarters Building of Moore Business Forms, Inc. The building houses the office, computer, and other service facilities for a staff of 350 professional and clerical employees.

Set into a primarily rural environment, the building design attempted first, to set a clean, sharply defined structure against a heavily wooded backdrop. The building was then related to the site in proportion, scale and the color values of its carefully selected materials. The subdued, earthy colors of the weathering steel girders, the brick piers, and the bronze glass complement the natural environment in its summer and fall foliage.

Steel Meets Criteria

A partially exposed structural steel framing system was selected after aesthetic, economic, construction time, and code criteria had been evaluated, and the determination had been made that this design met the criteria satisfactorily.

Designed as a rigid frame structure of 45 x 45 ft bays, the building contains about 75,000 sq ft of floor area on two floors and a partial basement.

The structural roof fascia girders and the spandrel girders were fabricated of weathering steel and their exterior faces are fully exposed. Fire protection of these members is achieved by "flame shields," rather than by conventional fireproofing means, usually requiring full encasement. No fireproofing is provided on the exterior faces of the steel *girders, but protection from intense heat* causing possible structural failure is provided by welding steel plate flame shields to the top and bottom flanges of the 45-ft structural steel members. The shields, combined with conventional spray-on fireproofing on interior web surfaces, keep the girders from reaching critical temperatures in the event of a fire.

"Flame Shield" System

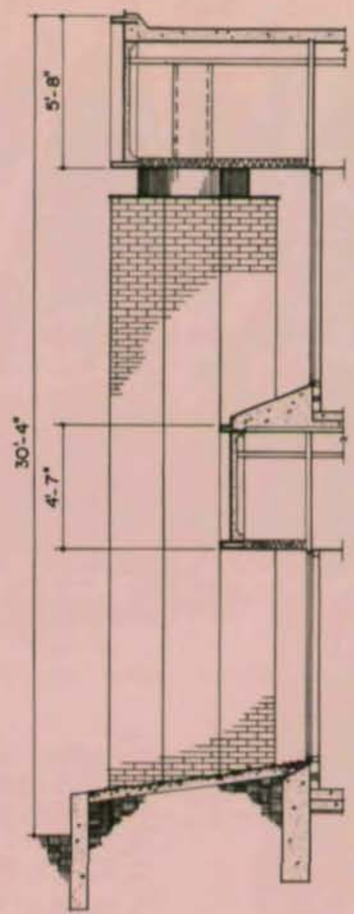
This is the first use in the Midwest of the "flame shield" system, which is based on the results of fire tests conducted by U. S. Steel in a high rise exposed steel building in New York.

Acceptance of this fire-protective system by the Cook County code enforcing agencies permitting this unique use of structural steel, resulted in much greater design freedom and honesty in truly expressing the structural elements of this multistory building, and offered an opportunity for efficient and economical use of structural steel.

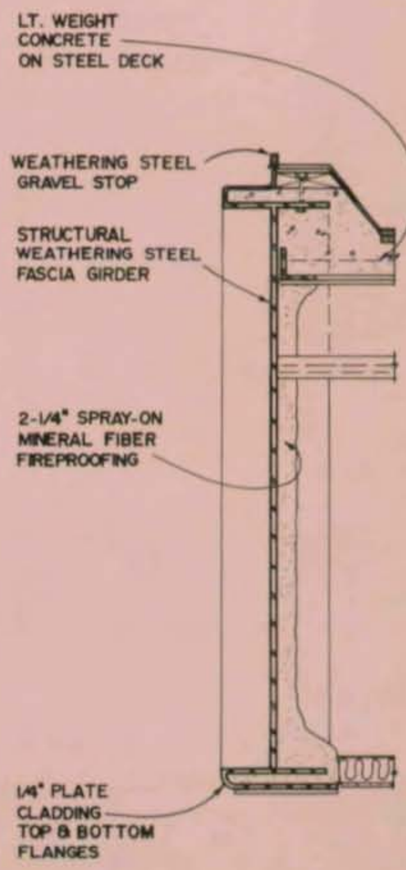
Architect-Engineer:
A. M. Kinney Associates, Inc.
Skokie, Illinois

General Contractor:
Chell & Anderson, Inc.
Chicago, Illinois

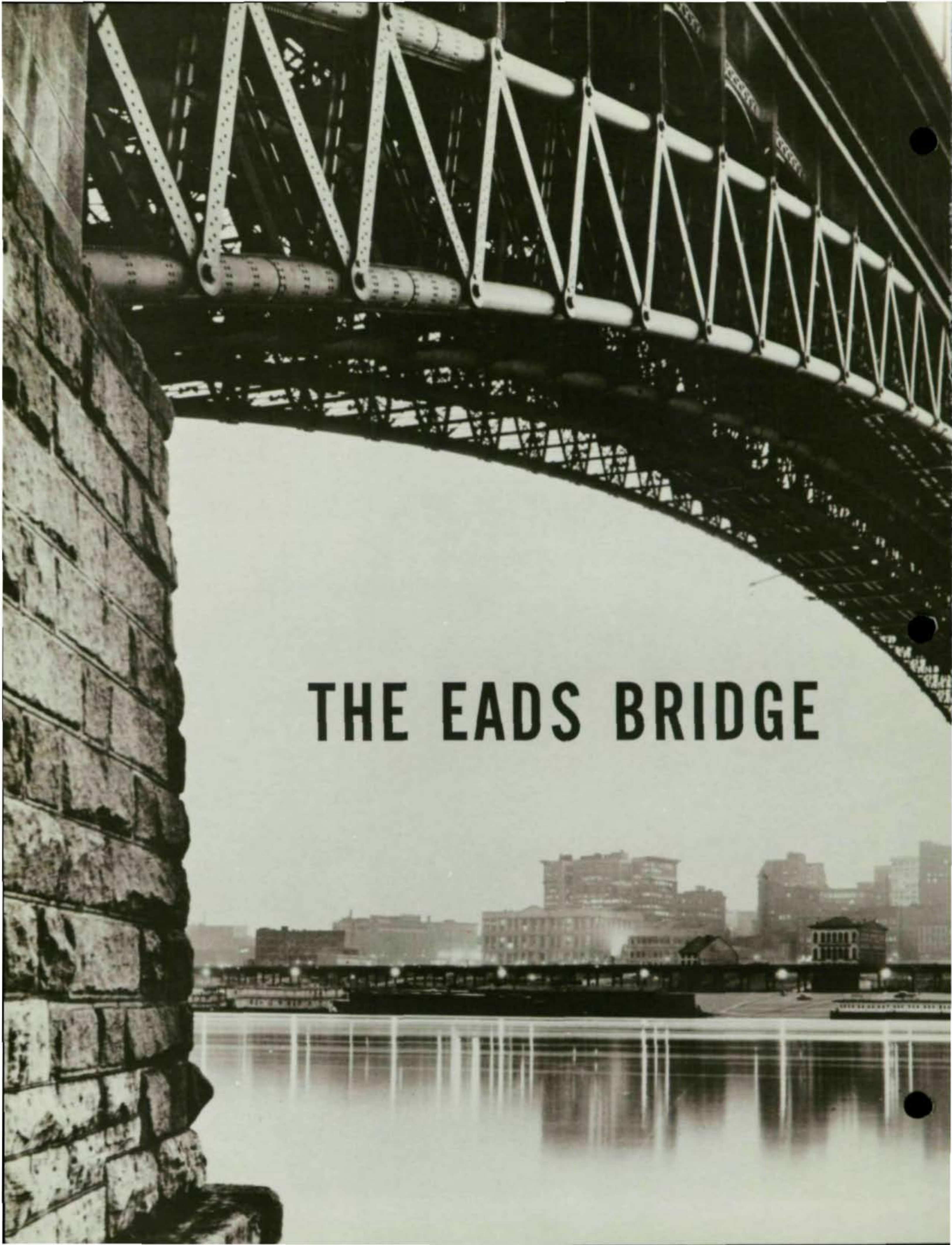
Steel Fabricator:
Wendnagel and Company, Inc.
Chicago, Illinois



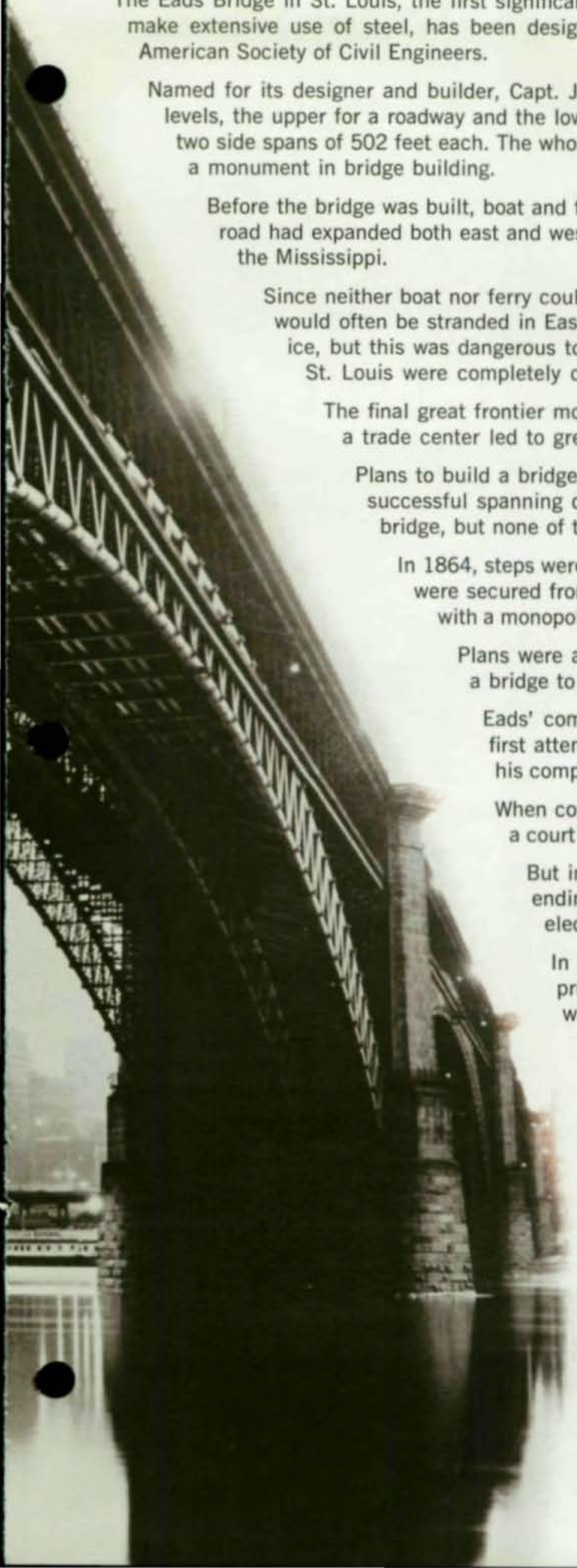
TYPICAL WALL SECTION
0 1' 2' 3' 4' 5' 6'



ROOF GIRDER DETAIL
0 6" 12" 18"



THE EADS BRIDGE



The Eads Bridge in St. Louis, the first significant railroad link over the Mississippi River and the first bridge to make extensive use of steel, has been designated a National Historic Civil Engineering Landmark by the American Society of Civil Engineers.

Named for its designer and builder, Capt. James Buchanan Eads, the bridge, opened in 1874, has two levels, the upper for a roadway and the lower as a railroad crossing. It has a center span of 520 feet and two side spans of 502 feet each. The whole achieved considerable architectural beauty and is structurally a monument in bridge building.

Before the bridge was built, boat and ferry were the only means of crossing the Mississippi. The railroad had expanded both east and west from St. Louis, but there was no connection of the rails across the Mississippi.

Since neither boat nor ferry could be used once the river was frozen, vast numbers of people would often be stranded in East St. Louis during the winter. At times people crossed over the ice, but this was dangerous to even the most daring footman. Sometimes communications in St. Louis were completely cut off from the east.

The final great frontier movement after the Civil War and St. Louis' subsequent growth as a trade center led to greater demands for a bridge.

Plans to build a bridge were first drawn up as early as 1839. Before Eads made his successful spanning of the river in 1874, four noted engineers developed plans for a bridge, but none of the plans got very far.

In 1864, steps were taken to form the St. Louis and Illinois Bridge Co. Charters were secured from both states. Strong opposition by friends of a ferry company with a monopoly on transfer privileges caused legal problems for the company.

Plans were also complicated because Illinois had issued a charter to build a bridge to two companies, Eads' and a rival company.

Eads' company began construction in August, 1867. The rival group at first attempted to discredit Eads' plans and then tried to gain control of his company.

When construction of the East abutment of the Illinois side was started, a court injunction stopping construction was issued against Eads.

But in March, 1868 the two companies were ordered to consolidate, ending the feud. The company regrouped, and the board of directors elected Eads engineer-in-chief.

In addition to its great use of steel, the Eads Bridge set several precedents in design and construction that have been followed widely in this country and abroad:

- It was the first bridge to use hollow tubular chord members. These tubular chrome-steel members arch gracefully between the masonry piers.
- Its three spans of more than 500 feet were some 200 feet longer than any built previously. At the time of the bridge's construction, it was called the greatest engineering feat of its kind.
- It was the first bridge to use cantilever construction methods entirely, avoiding the need for falsework.
- It was the first bridge in the United States employing pneumatic caissons and represented the deepest submarine construction work then done.
- It was the first bridge designed so that any part could be easily removed for repair or replacement.

Steel to Express a Soaring Spirit

A 29,000 sq ft facility represents the completion of the first phase of a long range development program for the Christ Church in Oak Brook, Illinois, a growing suburban community.

The dominant feature of this new interdenominational church is the sanctuary roof configuration, which is the culmination of a challenge to satisfy the congregation's desire to express the soaring spirit and structural integrity of Gothic architecture in a contemporary manner. To accomplish this feeling, it was determined that the roof structure for the 116-ft sanctuary should be a free span with a rise of 50 ft from side walls to the bell tower lantern at the center of the span. This structure also should provide the support for the bell tower and lantern 71 ft high and 16 ft-6 in. at the base.

Guided by aesthetic and economic considerations, several approaches were investigated.

Having resolved that structural steel framing systems would be economical and practical to erect, detailed studies of three framing systems using steel were undertaken:

1. Exposed beam system; exposed wood roof deck.
2. "Umbrella" system — exposed steel beams with a pattern of auxiliary struts arranged to incorporate visual appeal and allow reduction in size of main members required by the straight beam system; exposed wood roof deck.
3. Exposed trusses in place of beams; exposed wood roof deck.

Results of the study were as follows:

System	Weight of Steel	Lbs/sq ft Sanctuary Floor Area
1	201,120	15.5
2	162,640	12.5
3	115,000	10.1

The truss system, using A36 steel, was selected because of its cost advantage for material and reduction of dead load transferred from the roof to supporting steel pipe columns. Early in the structural design stage, it was determined that the trigonometry and complicated geometrics of connections of the trusses to the compression rings would make bolted connections extremely impractical. Accurate alignment of bolts and bolt holes would be almost impossible without costly mock-ups or trial procedures in the shop.

With these problems of fabrication accuracy and working tolerances in mind, it was decided that the alternate choice of field welded connections would be the best solution. Connections were designed to compensate for the potential inaccuracies. As a result of the flexibility provided by the welded connections, joint alignments were worked out on the job to the satisfaction of the structural engineer.

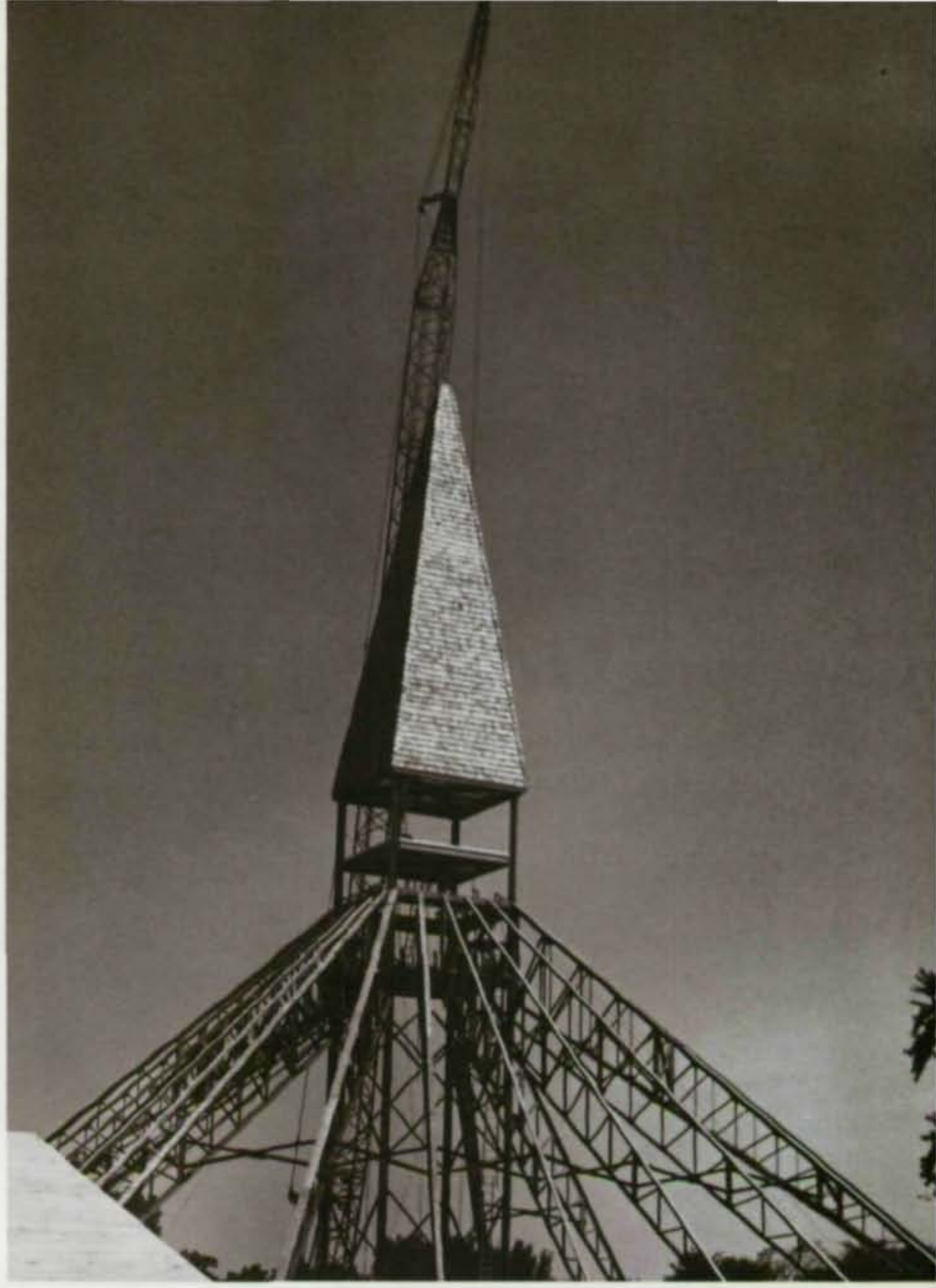
Trusses are 13 ft deep at the high point of the roof where they connect to the two tension rings, spaced 9 ft apart vertically, and taper to 1 ft-9 in. where they connect to the tension ring at eave level. This configuration of the trusses was chosen for aesthetic appeal, as well as to provide a rigid base for the tower. The four tower legs extend through the depth of the 13-ft end of the trusses and are welded into corners of the compression rings to give the tower horizontal stability.

The compression ring is designed so that the two trusses located at each hipped corner of the roof act as compression members. In addition to compression in the top chord, these trusses carry bending from the roof load. Intermediate trusses carry bending only, but are designed to the same depth dimensions as the corner trusses to produce the visual rhythm desired.

Architect: C. Edward Ware Associates
Rockford, Illinois

Structural Engineer:
Norman H. Meyer & Associates
Rockford, Illinois

General Contractor:
Sumner Sollitt Construction Co.
Chicago, Illinois



Gateway for an Airport

Simplicity and elegance mark the four new structures that serve as a gateway to the Irvine Industrial Complex at Orange County Airport in California. These four "mirror-image" buildings comprise two single-story banks and two four-story office buildings.

Framing System

The structures use a lightweight steel framing system with mullion columns 5 ft apart and floor beams framing from the core of the building to the perimeter columns. Each perimeter column is a 6 x 6 in. box shape weathering steel tube filled with water for fire protection. This method of fireproofing eliminates additional inches to maintain the light appearance of the system.

The bearing mullion units were prefabricated, which allowed the exterior walls of the banks to be erected in two days and the four-story walls in four days.

Increased Load on Corner Columns

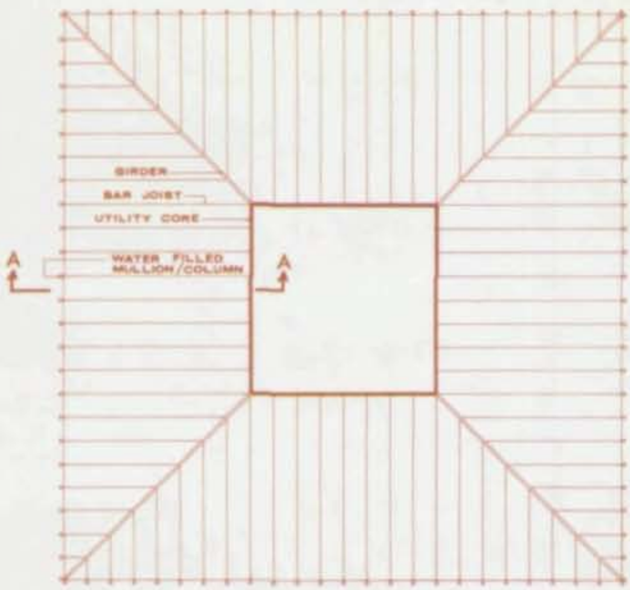
The four-story office buildings have a horizontal structural system of bar joists and girders. The girders run diagonally from the central core to the corner (double) column assemblies of the vertical support system. The bar joists run parallel from the vertical columns to the core. This means increasing the load on the corner columns.

The soffit design of the office structures slopes with the web pattern of the bar joists, resulting in very narrow spandrel details, but leaving enough space to accommodate the mechanical equipment between floor levels.

Dimensions

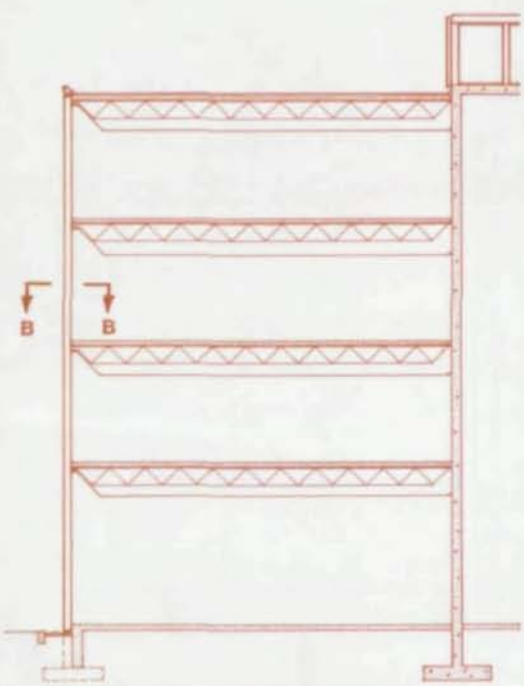
The single story structures are 60 x 120 ft of unobstructed space to be used as each bank owner desires. Each floor of the four-story building is 120 x 120 ft with a 40 ft square in the center. This means that all perimeter areas, which are open for leasing space, can be subdivided as required.

All exterior structural steel is left exposed and unpainted. The building finish is a natural weathering steel. Solar bronze glass is glazed into the structural mullions to complete the four enclosures.

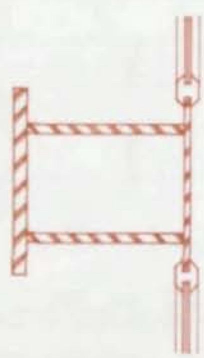


FRAMING PLAN

Architect: Craig Ellwood Associates
Los Angeles, California
Structural Engineer: Norman Epstein
Los Angeles, California
General Contractor: J. B. Allen & Company
Anaheim, California
Steel Fabricator: Lee & Daniel
Azusa, California



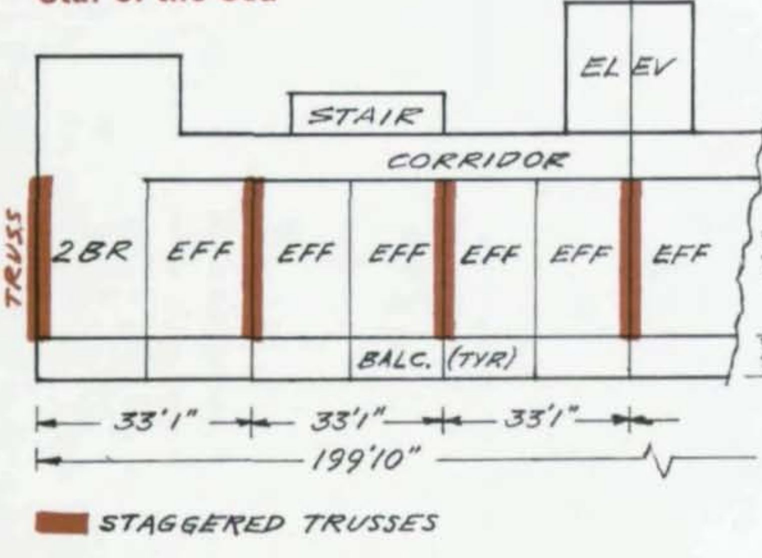
SECTION AA



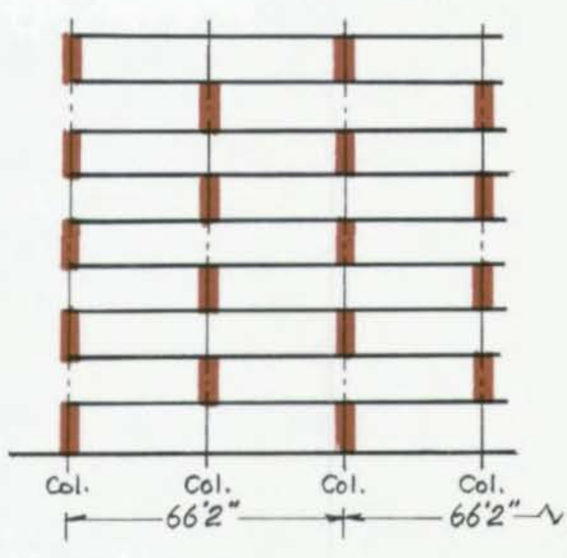
SECTION BB

STEEL FOR

Star of the Sea



Partial Plan



Schematic Elevation

SUMMERTIME SHOWPLACES

by Lawrence G. Adams, AISC Regional Engineer
Philadelphia, Pennsylvania

Diverse examples of steel's versatility are evident in two luxury condominiums now going up in Rehoboth Beach, Delaware, long a popular summer resort and fast becoming an area for year-round living.

Although the same architect, engineer, and owner are involved in both projects, the size, shape, and architectural layout of each building are quite different. Design studies showed that maximum economy would be achieved with totally different framing systems for each structure — a steel staggered truss system for one and plastically designed continuous steel framing for the other.

The staggered truss system is a relatively new framing method that has proved to be highly economical for many multistory residential structures. The system consists of a series of story-high trusses placed so that each floor of a structure alternately rests on the top chord of one truss and the bottom chord of the next. In this way, the clear span length of any bay is twice the distance between columns. In addition to reducing the weight and cost of structural steel required for conventional framing, the staggered truss system minimizes wind bracing requirements.

Plastic design — a highly efficient design method that significantly reduces the weight of steel framing — has been utilized for nearly 20 years in single-story structures, but only recently has been approved for braced multistory building construction. This design method recognizes that steel framing members have a "reserve strength" beyond the elastic stress range. This reserve "plastic" strength is a result of steel's ductility — its ability to redistribute internal forces in a rigid or indeterminate structure.

Star of the Sea

Located directly on the boardwalk, the nine-story condominium contains 97 ocean-view apartments, 10,000 sq ft of space on the first floor, and 37,000 sq ft of basement parking area. The building is basically rectangular in shape, 200 ft x 37 ft, with the long dimension fronting the boardwalk.

The main apartment area, located in the front, is spanned transversely by 29 ft-4 in. long story-high steel trusses spaced 33 ft on center. The 7 ft-8 in.

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wide rear area, which contains all hallways, stairs, and elevators, is built with conventional steel framing. The floor system consists of 8-in. deep hollow prestressed concrete plank with 2-in. topping, spanning the 33 ft between trusses. A bonus of the staggered truss system was the "double spacing" that permitted 66 ft of clear floor space in the commercial area on the first floor.

The transverse trusses transfer the wind load into the building columns. Six tie girders per floor, spanning the length of the structure, are bolted to the columns with end plate connections to resist the wind load in the longitudinal direction.

The structure contains 443 tons, of which 68 tons are in the trusses. The steel frame averages 7.3 lbs/sq ft. Completion of the project is expected in late 1972.

One Virginia Avenue

This 106-apartment condominium consists of two essentially rectangular structures — one eight stories high, 62 x 127 ft, and the other five stories high, approximately 39 x 157 ft — joined by a common elevator core. About 6,000 sq ft of commercial space is provided on the first floor, and there is 40,000 sq ft of basement parking.

Preliminary design studies showed that a plastically designed steel frame with an open web steel joist and steel deck floor system was most economical for the shape, size, and loading of this irregular structure.

The beams and the girders are both A36 steel and columns are high strength A572-50 steel. Diagonal bracing forming two vertical Warren trusses resists the wind moments. The girders are field bolted to the columns with end plate moment connections. Column splices are field welded.

There are 310 tons of structural steel members and 150 tons of steel joists in the structure. The average weight of the steel framing is 8.4 lbs/sq ft. The project will be completed in mid-1972.

In both One Virginia Avenue and Star of the Sea, every apartment has a cantilevered balcony overlooking the sea. Each project also contains a separate one-story structure, built with conventional steel framing, that houses exercise rooms, community rooms, paddle tennis and sauna facilities, and supports an outdoor swimming pool.

Architect: Duane, Duane & Cahill
Kensington, Maryland
Structural Engineer: Allison-Meyer
Rockville, Maryland
General Contractor: Anderson-Stokes, Inc.
Rehoboth Beach, Delaware

One Virginia Avenue