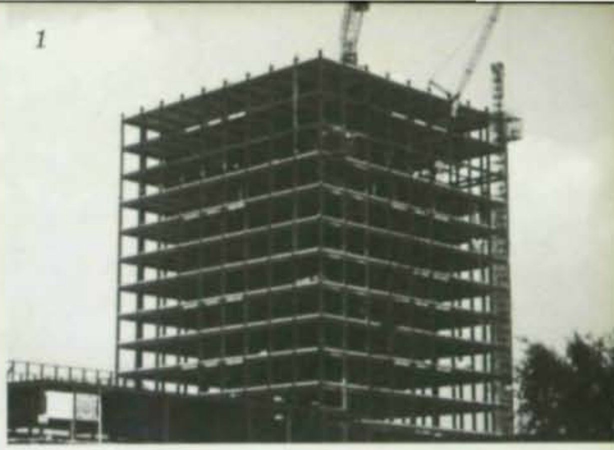
VOLUME XVI / NUMBERS 3 & 4 / THIRD & FOURTH QUARTER 1976

MODERN STEEL CONSTRUCTION



MODERN STEEL CONSTRUCTION

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CONTENTS

NEW LECTURE SERIES

AISC is conducting a new lecture series on "Practical Steel Design for Buildings/2-20 Stories." Lectures are now being scheduled in cities throughout the United States. For more information, see outside back cover of this issue of Modern Steel Construction.

THE SEVENTH ANNUAL T. R. HIGGINS LECTURESHIP AWARD

The T. R. Higgins Lectureship Award Program will select the principal author of the technical paper judged to have made the most significant contribution to engineering literature related to fabricated structural steel within a five year eligibility period ending January 1, 1976. The award winner will receive a $2,000 prize during a ceremony at the 1977 AISC National Engineering Conference in Washington, D.C., where he will present his paper.

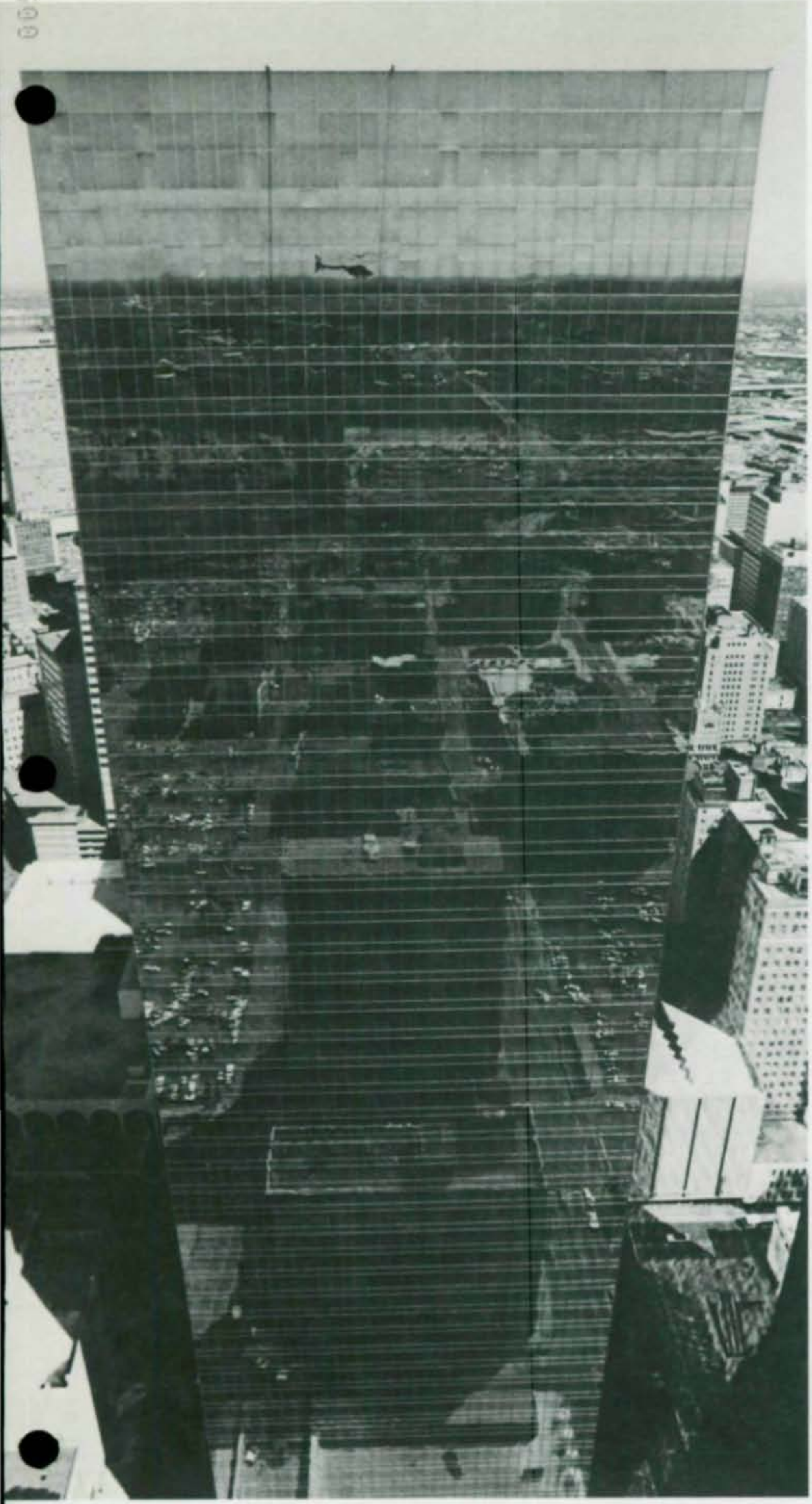
A jury of six eminent engineers from the fields of education, design, and industry will select the award winner. They are:

Lionel F. Currier *Louisville & Nashville Railroad Company*
Wallace W. Sanders, Jr. *Iowa State University*
A. C. Van Tassel *Pittsburgh-Des Moines Steel Company*
Ivan M. Viest *Bethlehem Steel Corporation*
Cornelius Wandmacher *University of Cincinnati*
Othar Zaldastani *Zaldastani Associates Inc.*

1977 FELLOWSHIP AWARDS PROGRAM

Four $3,500 awards will be granted to Master's degree candidates pursuing a course of study related to fabricated structural steel. $3,000 is for the student's use, and $500 is for the department chairman's use in administering the grant.

Students interested should contact their department chairmen or the Committee on Education, AISC, 1221 Avenue of the Americas, New York, N.Y. 10020.



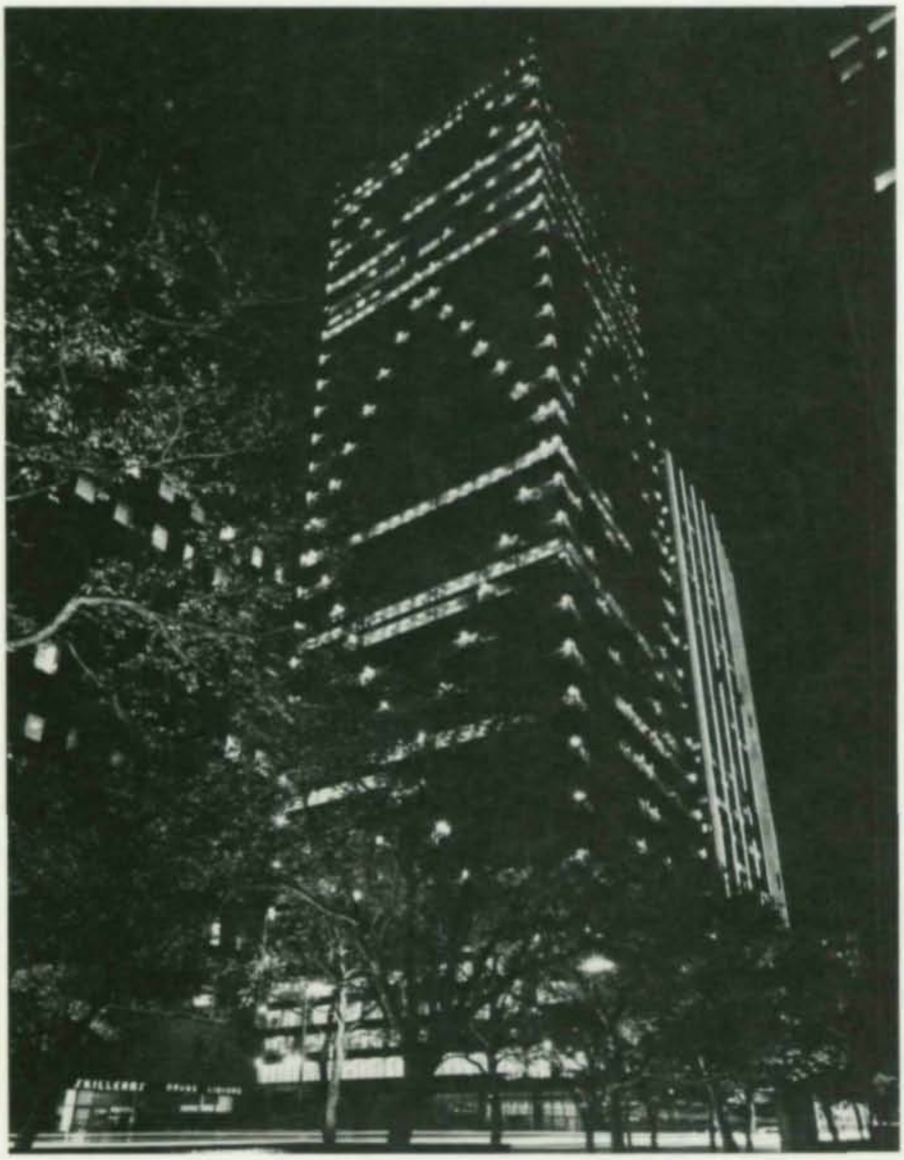
"Trussed Tube" for Landmark Building

Dallas' tallest building, the landmark 56-story First International office tower, incorporates a wind bracing and floor framing system that led to substantial savings in the amount of structural steel required for construction.

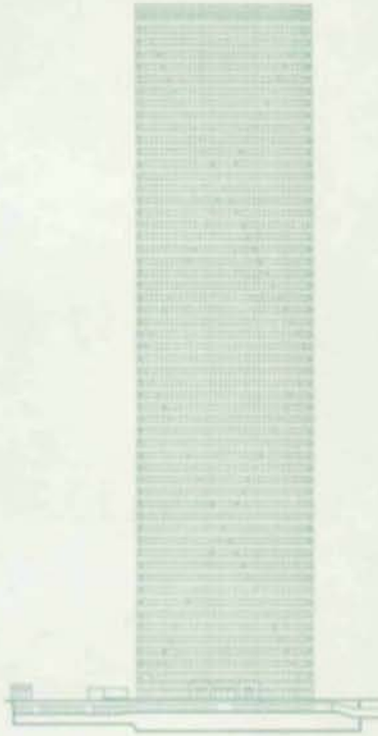
Located in the Southwest's largest financial complex on a 2.5-acre parcel, the building reaches 710 ft above street level. Totalling 1.9-million sq ft of space, the entire complex includes the office tower, a drive-up banking facility, and an 11-story detached parking garage accommodating 1,000 vehicles. Underground tunnels link the project with nearby buildings comprising the city's financial district. The building also features tandem elevators (two cabs per shaft) to handle vertical passenger movement more efficiently during peak traffic periods.

Structural Concept

Use of a "trussed tube" system at the perimeter of the building to resist lateral wind forces and some gravity loads eliminated the need for wind bracing within the building. Core columns could be designed for gravity only and a column-free interior span of 40 ft from core to exterior columns was produced, thus reducing overall steel requirements. A built-up stub girder system reduced floor-to-floor height in the building and provided additional economies in materials for the curtain wall system. Both systems produced savings of $1.50 per sq ft.



The highly visible X-bracing is seen from both exterior and interior.



South elevation showing location of night lighting

Structural concept

Trussed Tube Wind Bracing System

The "trussed tube" design is in the form of diagonal X-bracing. Each X spans 28 floors, with two braces on each side of the building. This system is particularly efficient in resisting wind load in that the faces of the "tube" perpendicular to the wind direction also participate in resisting the wind load. In effect, the trussed tube acts as a solid tube cantilevered out of the foundations except for the "shear lag" effect. On the interior, diagonal braces of the X appear in perimeter offices as slanting columns, providing an attractive and interesting design feature.

There were several items of architectural/structural coordination associated with the trussed tube concept. Because the diagonals had to intersect columns at spandrel beams, a 12 ft-6 in. floor-to-floor height was selected, along with a 25 ft-0 in. column spacing. The design team decided to locate the vertical bracing within the curtain wall to avoid both problems associated with fireproofing the exterior structure and problems with temperature effects on the exposed steel. Another architectural ramification is that interior column flexibility permits efficient planning of the core and interior office space.

The components of the exterior framing — beams, columns, and diagonals — were fabricated from high-strength W14 shapes, except for a few near the bottom which were built-up shapes. The W14 shapes were selected because of the wide range of available sections and because all shapes had the same nominal inside dimension between flanges, thus facilitating the connection details. Diagonals were fabricated four stories in length. Where diagonals intersect columns at every fourth floor, gusset assemblies were used to connect the diagonals, columns, and beams. The gusset plate

Located in the heart of the financial center, the First International office tower is Dallas' tallest office building.

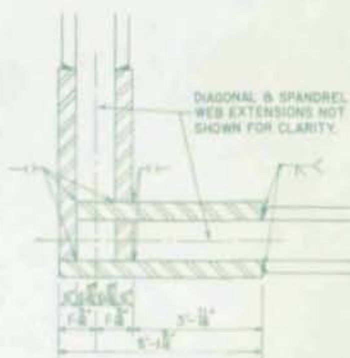
Interior column flexibility permitted maximum space efficiency

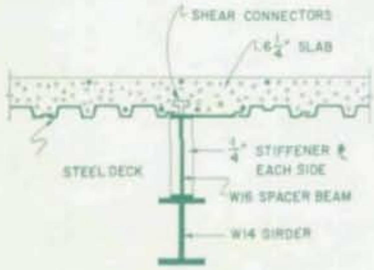
connections were fabricated from two plates, each up to six inches thick, of high-strength steel. The diagonals were field welded at one end to reduce gusset and splice plate material and high-strength bolted through splice plates at the other end to provide necessary tolerances for erection.

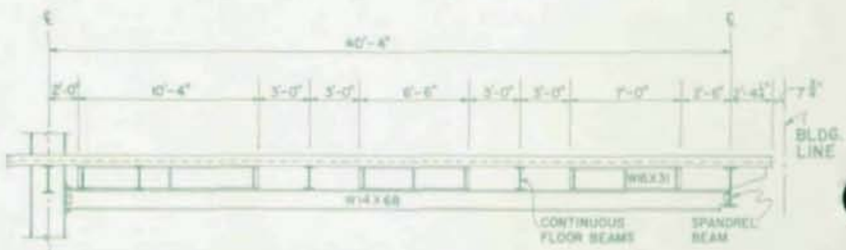
Corner gusset assemblies were required where diagonal bracing met at the corners of the building (at the roof, mid-height, street, and basement levels). These corner gusset assemblies were fabricated from four plates, two in each of two directions. The four plates were joined by electroslag welds (full penetration) and were stress-relieved after fabrication. Elevation dimensions of the gusset assemblies were selected based on the number of bolts required and the bolt pattern. Gusset plate thicknesses were sized based on finite element analysis of the gusset assemblies.

Stub-Girder Floor System

The built-up girder is considered functionally to be analogous to a vierendeel truss. The bottom chord of the vierendeel is the W14 girder, the top chord is the metal deck/concrete slab, and the verticals of the analogous truss are the W16 stub pieces. As in a vierendeel truss, the bottom and top chords (girder and floor slab) are designed for combined bending and axial load.







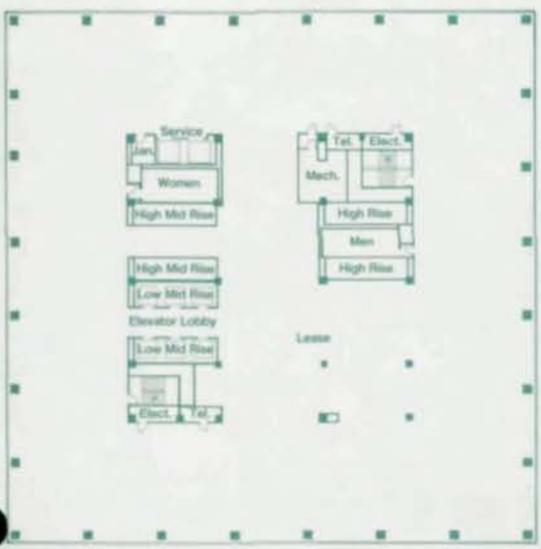
Miscellaneous details

This floor system permits integration of the mechanical system through the structural frame and assists in minimizing floor-to-floor height and in reducing floor framing weight (21.6 psf). The system consists of a high-strength W14 girder with intermittent W16 stub pieces welded on top of the girder. The girder and stub pieces act compositely with the 6¼-in. metal deck/lightweight concrete floor slab through headed stud shear connectors on top of the stub pieces. W16 floor beams are semi-continuous over the top of the girder.

Design Concept

The office tower is clad in a glass window wall, with the entire structural frame and diagonal bracing within the building. This permits a more constant temperature and minimizes thermal expansion of the frame. It also simplified the detailing of the exterior skin.

The generating design idea of the office structure was to recognize the varying moods and sensitivities of the daylight and nighttime hours in a reflective glass concept. During the day the building is a monolithic reflective glass tower and mirrors its external environment. In the evening hours, the character changes as interior lighting permits views into the lower parts of the building, and as the structural concept is revealed by a lighting system applied to the tube members, making the tower visible for miles in all directions.



Typical Floor Plan
19th-32nd Floors

Architects:
Hellmuth, Obata & Kassabaum, Inc., St. Louis, Mo.
Harwood K. Smith and Partners, Inc., Dallas, Texas

Structural Engineer:
Ellisor & Tanner, Inc., Dallas, Texas

General Contractor:
Henry C. Beck Company, Dallas, Texas

Steel Fabricator:
Mosher Steel Company, Dallas, Texas

Welded Mini-Tube Economically

by Horatio Allison and Michael S. McCormac
Partners, Horatio Allison–Robert L. Meyer
Structural Engineers
Rockville, Md.

A variation on the tubular design concept, most often used in very tall buildings, can be seen in the 23-story Town Center Office Building, Rockville, Maryland. This "mini-tube" system, in combination with practical welding techniques, resulted in an economical, modern, innovative design that met the requirements of the owner.

The 101-ft square building is flanked on each side by three parking levels

Solves Multi-Faceted Problems

with 62 ft-0 in. clear spans and a plaza level. The framed areas of the parking and plaza levels, typical floors, and roof total 337,700 sq ft.

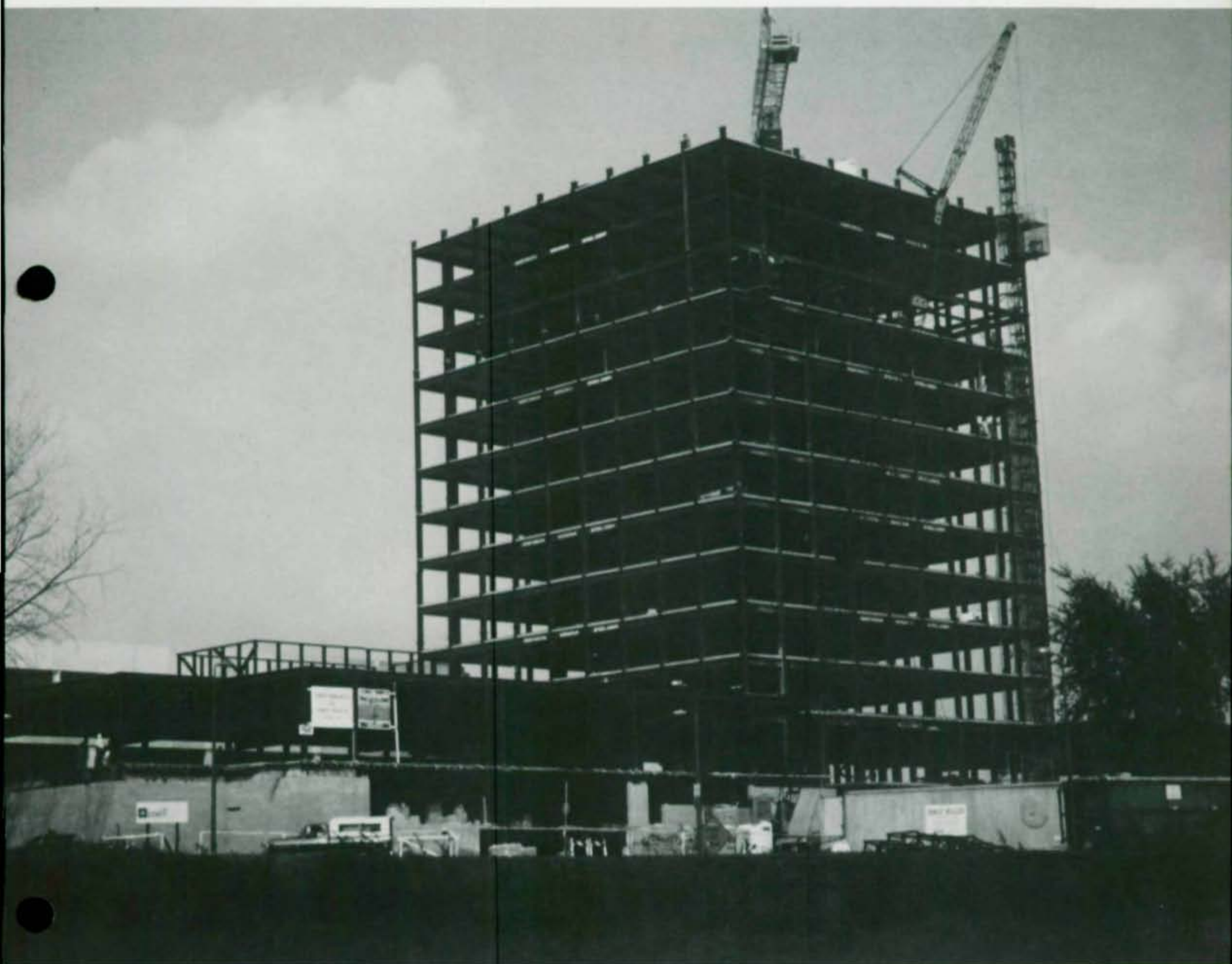
To conserve headroom, a floor-framing system of lightweight 3¼-in. concrete slab with 1½-in. composite metal deck on composite beams and girders was selected. The exterior spandrel beams and columns carry the lateral loads by "mini-tube" action.

Design Problems

Meeting the owner's requirement — producing a building that would satisfy maximum occupancy and/or wind loads most economically — presented several design problems.

As in many instances, a zoning code height restriction problem required a very low story-to-story dimension of 10 ft-4 in. for a 23-story structure. The contractor for the project helped in preparing comprehensive cost analyses for various structural schemes that would meet this requirement.

The mechanical engineer determined that, for a steel framing system, 1 ft-2 in. ± was needed from the bottom of construction to the ceiling line for the most part, but that 1 ft-6 in. was required in other instances. The solution was to use 8-in. maximum depth composite floor beams and girders, except



Architect:
James Cosgrove Associates
Rockville, Maryland

Structural Engineer:
Horatio Allison - Robert L. Meyer
Rockville, Maryland

General Contractor:
Robert Whalen Construction Corp.
Rockville, Maryland

in the core area, where 4-in., 5-in., and 6-in. beams were used to allow more clearance for larger air ducts.

Three Schemes Considered

From the contractor's estimates, it became apparent that a steel framed building would be most economical, provided an inexpensive way could be found to resist the lateral forces. Three different schemes for wind load design were considered.

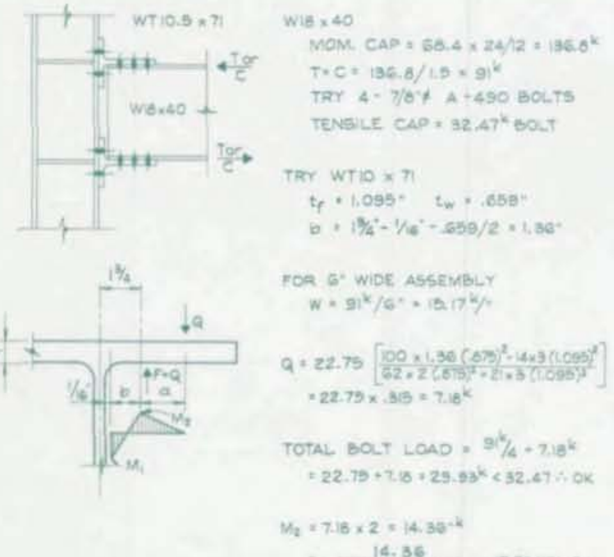
First, for a 23-story building, it would not be unusual to expect to find a moment resisting welded frame. However, the extremely low story heights make such a solution impossible since the 8-in. maximum girder depth would not provide adequate stiffness.

Next considered was the vertical cantilever truss. This method also proved to be impractical. However, in the perpendicular direction, the maximum obtainable depth for the cantilever truss is about 8 ft-0 in., or a depth-to-span ratio of about 28.

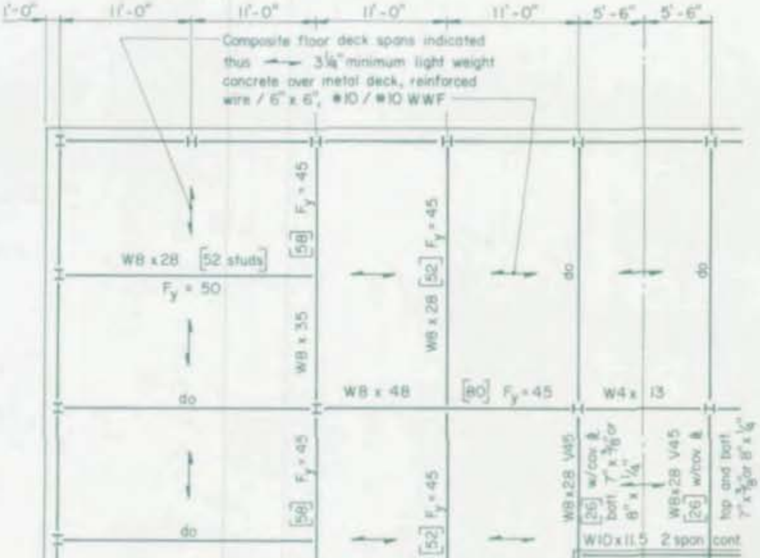
The scheme which did prove to be the solution was to increase the number of columns on the exterior walls by adding columns at mid-bay to achieve an 11 ft-0 in. uniform column spacing. By using these closely spaced columns with stiff floor beams, a rather stiff frame was created. If all sides of the building are considered to act together as a single unit, the action can be described as being similar to that of a tube with openings in the walls. For this project, the use of a complete tube analysis proved unnecessary. In effect, only part of the tube was used, that is, the tube walls parallel to the direction of the wind load. Thus, the phrase "mini-tube" was coined for the design concept. This design proved to be a stiff and economical solution, except for one problem.

At the plaza level and at the parking levels, it was necessary to eliminate columns to provide an open main entrance for the bank at the plaza level and driveways at the parking levels.

Bolt moment connection

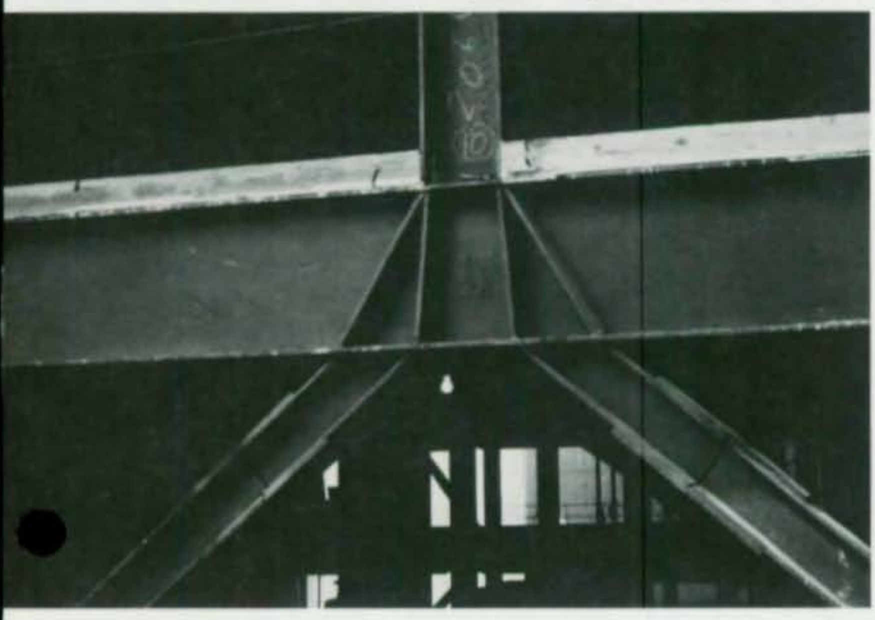


Partial framing plan



Mid-bay columns were added to Town Center to create an 11-ft uniform column spacing.

Temporary diagonal structural members were kept in place until the frame had been erected and floor slabs placed through 18th floor.



Again, the problem of severely restricted story heights becomes an immediate problem since there was no appreciable depth for a girder. It was also thought that the girders could be eliminated and the frame could span the two bays by vierendeel action. Or, as an analogy, it could be said that two larger holes were put in the wall of the tube. Subsequent computer analyses showed that selected columns could, with little increase in total weight, be eliminated.

In order to prevent excessive stresses and deflections in the lower story members when columns were omitted, temporary diagonal bracing members were installed and left in place until the steel frame had been completely erected and the concrete slabs had been placed through the 18th floor.

Practical Welding Techniques

Welding made this project practical. Without welding, the building would have had only 22 stories because of necessarily increased story height. This would have caused an annual loss in revenue to the owner of more than $60,000.

Welding also had considerable impact on the actual building cost. Nearly 800 full-moment-capacity connections were required at the perimeter column lines. In a bolted structure, these connections would have required approximately 14 tons of split tees and nearly 8,000 ⅞-in. dia. A490 bolts. By comparison, in the welded structure, these connections required just 396 lineal feet of simple downhand welding. The total saving in connection costs exceeded $56,000, more than 5 percent of the entire framing cost.

Welding goes hand in hand with modern innovative design. Welding along with new computer technology makes it possible for the structural engineer to take advantage of the increased strength and rigidity of highly indeterminate structures. Without this combination, the mini-tube could not have been designed.

1976 PRIZE BRIDGES

▲ **PRIZE BRIDGE 1976 — LONG SPAN**
Marquette — Prairie du Chien — West Channel Bridge
Across the Mississippi River
between Marquette, Ia. and Prairie du Chien, Wis.
Designer: State of Wisconsin, Division of Highways
Owners: State of Wisconsin and State of Iowa
General Contractors: Allied Structural Steel Company and INRYCO, Inc. (A Joint Venture)
Fabricators: Allied Structural Steel Company and INRYCO, Inc. (A Joint Venture)
Erector: Industrial Construction Division, Allied Structural Steel Company

PRIZE BRIDGE 1976 — MEDIUM SPAN, HIGH CLEARANCE ▲
White Bird Canyon Bridge
White Bird, Id.
Designer/Owner: Idaho Transportation Department, Division of Highways
General Contractor: Hensel Phelps Construction Company
Fabricator: Allied Structural Steel Company
Erector: Fought & Company, Division of Allied Equities Corp.

PRIZE BRIDGE 1976 — MEDIUM SPAN, HIGH CLEARANCE ▲
Brady's Run Park Bridge
Brighton Township, Pa.
Designer: Michael Baker, Jr., Inc.
Owner: Commonwealth of Pennsylvania, Department of Transportation
General Contractor: W. P. Dickerson and Son, Inc.
Fabricator: Fort Pitt Division of Spang Industries, Inc.
Erector: American Bridge Division, United States Steel

PRIZE BRIDGE 1976 — MEDIUM SPAN, LOW CLEARANCE ▲
Clarno Bridge over the John Day River
Southeast of The Dalles, Ore.
Designer: Bridge Section, State Highway Division, Oregon Department of Transportation
Owner: Oregon Department of Transportation
General Contractor: Hensel Phelps Construction Company
Fabricator/Erector: Fought & Company, Division of Allied Equities Corp.

▲ **PRIZE BRIDGE 1976 — SHORT SPAN**
Mounts Bay Road Bridge over Halfway Creek
James City County, Va.
Designer: Fraioli-Blum-Yesselman Associates, Inc.
Owner: Busch Properties, Inc., a subsidiary of Anheuser-Busch, Inc.
General Contractor: Sanford Construction Company
Fabricator/Erector: Globe Iron Construction Co.

◀ **PRIZE BRIDGE 1976 — GRADE SEPARATION**
Burlington Northern Railway over Beam Avenue
Maplewood, Minn.
Designer: Howard Needles Tammen & Bergendoff
Owner: City of Maplewood
General Contractor: Lunda Construction Company
Fabricator: Phoenix Steel Corporation
Erector: Lunda Construction Company

▲ PRIZE BRIDGE 1976 — ELEVATED HIGHWAYS OR VIADUCTS
Bigley Interchange
Charleston, W. Va.
Designer: Howard Needles Tammen & Bergendoff
Owner: West Virginia Department of Highways
General Contractor: Allied Structural Steel Company
Fabricator: Allied Structural Steel Company
Erector: Industrial Construction Division, Allied Structural Steel Company

PRIZE BRIDGE 1976 — MOVABLE SPAN
Back Bay Bridge
Biloxi, Miss.
Designer: Hazelet & Erdal
Owner: Mississippi State Highway Department
General Contractor: Michael Construction Company of Mississippi, Inc.
Fabricator: Tucker Steel, Inc.
Erector: Michael Construction Company of Mississippi, Inc. ▼

▲ PRIZE BRIDGE 1976 — SPECIAL PURPOSE
Moore's Run Pedestrian Bridge
Baltimore City, Md.
Designer: MCA Engineering Corporation
Owner: City of Baltimore
General Contractor: Interstate Bridge Company of Maryland, Inc.
Fabricator: Atlas Machine & Iron Works, Inc.
Erector: Interstate Bridge Company of Maryland, Inc.

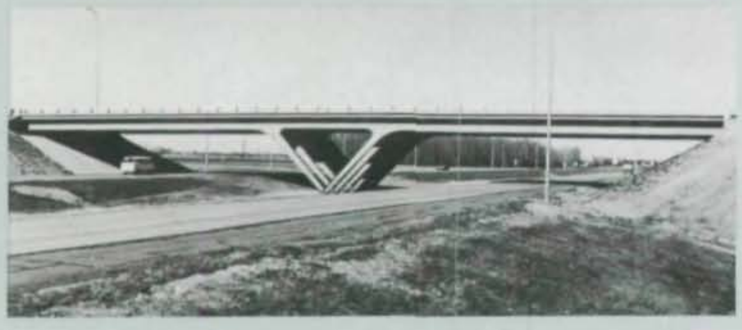
AWARD OF MERIT 1976 — LONG SPAN
I-24 Bridge over Tennessee River
Marshall and Livingston Counties, Ky.
Designers: Kroboth Engineers, Inc. and Sverdrup & Parcel and Associates, Inc. (A Joint Venture)
Owner: Commonwealth of Kentucky, Department of Transportation
General Contractor: Allied Structural Steel Company
Fabricator/Erector: Allied Structural Steel Company ▼

▲ AWARD OF MERIT 1976 — MEDIUM SPAN, HIGH CLEARANCE
New Emsworth Bridge
Emsworth Borough, Pa.
Designer: Michael Baker, Jr., Inc.
Owner: Port Authority of Allegheny County
General Contractor: Gerace Construction Corp.
Fabricator/Erector: American Bridge Division, United States Steel

AWARD OF MERIT 1976 — MEDIUM SPAN, HIGH CLEARANCE
Harry S. Truman Dam and Reservoir, St. Clair County Bridge No. SC-36
State Route C, St. Clair County, Mo.
Designer: U.S. Army Corps of Engineers, Kansas City District
Owner: Missouri State Highway Commission
General Contractor: Ted Wilkerson, Inc.
Fabricator: Kansas City Structural Steel Company
Erector: Ted Wilkerson, Inc. ▼

▲ **AWARD OF MERIT 1976 — MEDIUM SPAN, LOW CLEARANCE**
Pine Creek-Waterville Bridge
Lycoming County, Pa.
Designer: Tyo and Fleisher, Inc.
Owner: Commonwealth of Pennsylvania, Department of Transportation
General Contractor: Reed & Kuhn, Inc.
Fabricator/Erector: Williamsport Fabricators, Inc.

AWARD OF MERIT 1976 — GRADE SEPARATION
Grand Forks AFB Interchange
Grand Forks, N. D.
Designer: Bridge Division, North Dakota State Highway Department
Owner: State of North Dakota
General Contractor: Northern Improvement Company
Fabricator: Egger Steel Company
▼ **Erector:** Swingen Construction Company



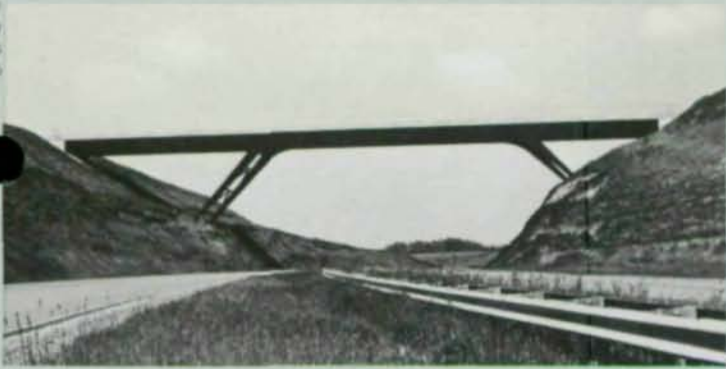
AWARD OF MERIT 1976 — GRADE SEPARATION
Shrine Pass Interchange
Summit County, Colo.
Designer: Meheen Engineering Co.
Architectural Consultant: Charles Montooth, AIA, The Frank Lloyd Wright Foundation
Owner: Colorado Division of Highways
General Contractor: H-E Lowdermilk Co.
Fabricator: The Midwest Steel & Iron Works Co.
▼ **Erector:** Kenney Construction Co., Inc.

◀ **AWARD OF MERIT 1976 — MEDIUM SPAN, HIGH CLEARANCE**
Peyton Bridge
Jackson County, Ore.
Designer: Federal Highway Administration, Office of Western Bridge Design
Owner: U.S. Army Corps of Engineers, Portland District
General Contractor: Hensel Phelps Construction Company
Fabricator/Erector: Fought & Company, Division of Allied Equities Corp.

▲ **AWARD OF MERIT 1976 — MEDIUM SPAN, LOW CLEARANCE**
Dirty Devil River Bridge
State Route 24, near Hanksville, Utah
Designer: Structures Division, Utah Department of Transportation
Owner: Utah Department of Transportation
General Contractor: L. A. Young Sons Construction Company
Fabricator/Erector: Western Steel Company, Inc.

▲ **AWARD OF MERIT 1976 — SHORT SPAN**
Byers Cañon Bridge
US 40, West of Hot Sulphur Springs, Colo.
Designer: Staff Bridge Design, Colorado Division of Highways
Owner: Colorado Division of Highways
General Contractor: Flatiron Paving Company
Fabricator: Western Steel Company, Inc.
Erector: Flatiron Paving Company

▲ **AWARD OF MERIT 1976 — GRADE SEPARATION**
Sample Bridge Road Overpass at I-81
Hampden Township, Pa.
Designer: Modjeski and Masters
Owner: Commonwealth of Pennsylvania, Department of Transportation
General Contractor: Hempt Bros., Inc.
Fabricator/Erector: High Steel Structures, Inc.



AWARD OF MERIT 1976 — GRADE SEPARATION
Blooming Rose Road over National Freeway
Friendsville, Md.
Designer: Ewell, Bomhardt & Associates
Owner: Maryland State Highway Administration
General Contractor: S. J. Groves & Sons Company
Fabricator: Cumberland Bridge Company
Erector: Aycock, Inc.

AWARD OF MERIT 1976 — MOVABLE SPAN
Smith River Bridge No. 195-0.0
Near Gardiner, Oregon
Designer: Oregon Bridge Engineering Co.
Owner: Douglas County
General Contractor: Holst Construction Co.
Fabricator: Northwest Steel Fabricators, Inc.
Erector: McKenzie Steel Co.

AWARD OF MERIT 1976 — SPECIAL PURPOSE
Fairview-St. Mary's Skyway System
Minneapolis, Minn.
Designer: Setter, Leach & Lindstrom, Inc.
Owners: Fairview Hospital and St. Mary's Hospital
General Contractor: Acton Construction Company
Fabricator: L. L. LeJeune Company
Erector: Vickerman Construction Co.

AWARD OF MERIT 1976 — MOVABLE SPAN
Stratford Avenue Bridge
Bridgeport, Conn.
Designer: Hardesty & Hanover
Owner: State of Connecticut, Department of Transportation
General Contractor: C. W. Blakeslee & Sons, Inc.
Fabricator/Erector: Harris Structural Steel Co., Inc.

AWARD OF MERIT 1976 — SPECIAL PURPOSE
Pedestrian Bridge
Brooklyn, N. Y.
Structural Engineers: Wiesenfeld & Leon
Architects: Davis, Brody & Associates/Horowitz & Chun
Owner: Long Island University, The Brooklyn Center
General Contractor: J. Baranello & Sons
Fabricator: Pecker Iron Works, Inc.
Erector: Atlas Steel Erectors Co., Inc.

AWARD OF MERIT 1976 — SPECIAL PURPOSE
42nd & Hillsdale Pedestrian Overpass
Omaha, Nebr.
Designer: Durand Associates, Inc.
Owner: City of Omaha
General Contractor: Lueder Construction Company
Fabricator: Drake-Williams Steel, Inc.
Erector: Lueder Construction Company

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Lectures are now being scheduled in cities throughout the United States. For details about the program in your area, contact your local AISC regional engineer or write to AISC Lectures, 1221 Avenue of the Americas, New York, N.Y. 10020.