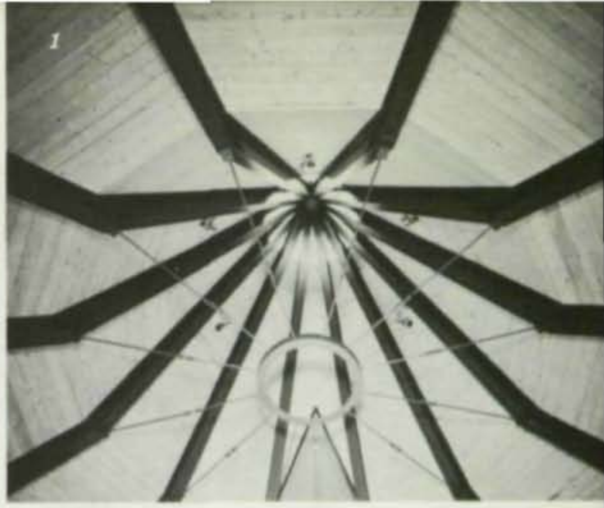
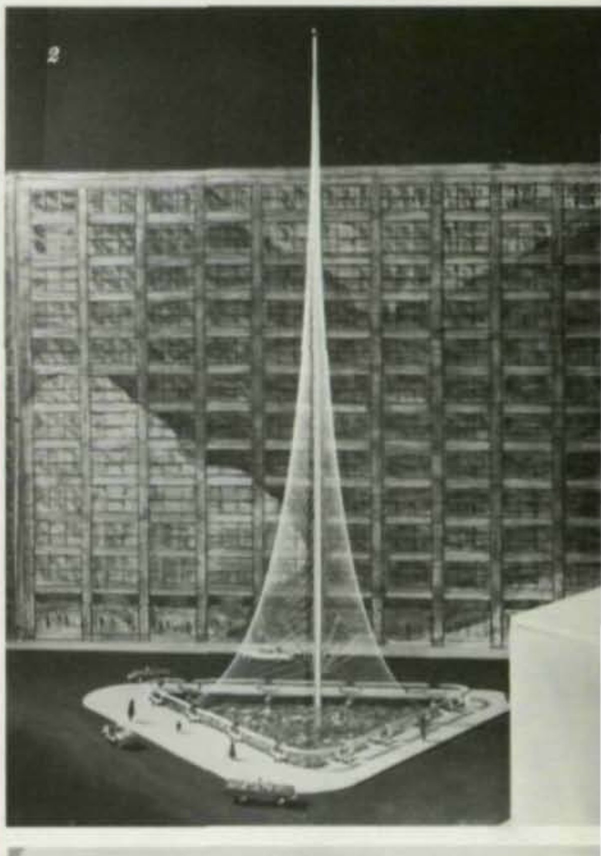
VOLUME VII / NUMBER 2 / SECOND QUARTER 1967

MODERN STEEL CONSTRUCTION





MODERN STEEL CONSTRUCTION

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CONTENTS

1967 PRIZE BRIDGE COMPETITION

Entries are invited for the 39th annual AISC Prize Bridge Competition to select the most beautiful steel bridges opened to traffic during the the calendar year 1966.

The Competition will be judged by a panel of five distinguished engineers and architects. The members of the 1967 Prize Bridge Jury are:

***Dr. Nathan M. Newmark, F.ASCE** Head, Department of Civil Engineering, University of Illinois, Urbana, Illinois*

***Louis G. Rossetti, FAIA** Giffels & Rossetti, Inc., Architects and Engineers, Detroit, Michigan*

***Richard H. Tatlow, III, F.ASCE** President-elect, ASCE and President, Abbott, Merkt & Co., New York, N. Y.*

***W. Jack Wilkes,** Chief, Bridge Division, Bureau of Public Roads, Washington, D.C.*

***Jonathan G. Wright, F.ASCE** Partner, Earl & Wright, San Francisco, California*

Steel bridges of all types located in the U.S. are eligible. Entries must be post marked prior to September 5, 1966. Competition rules and entry forms are available from AISC.

AISC FELLOWSHIP AWARDS

Four engineering students have been awarded $2,500 research fellowships in the fifth annual AISC Fellowship Awards Program. The program is designed to encourage research in the field of structural engineering.

***Rene M. Dupuis** University of Wisconsin, Madison, Wisc. will investigate stiffened steel domes.*

***Charles J. Granade, Jr.** University of Alabama, University, Ala. will study composite beams having large openings in their webs.*

***Aldo J. Messulam** University of Miami, Coral Gables, Fla., will study inelastic buckling of multiple bay or multiple story steel frames.*

***William R. Morris** University of Michigan, Ann Arbor, Mich., will investigate the structural behavior of high strength bolted connections with varied hole clearances.*

Awards were granted on the basis of the potential value of the research project, undergraduate scholastic performance, and the recommendation of college authorities.

UCLA'S STEEL SPACE FRAME: BEAUTY ON A BUDGET

by Welton Becket, FAIA
President, Welton Becket and Associates
Los Angeles, California

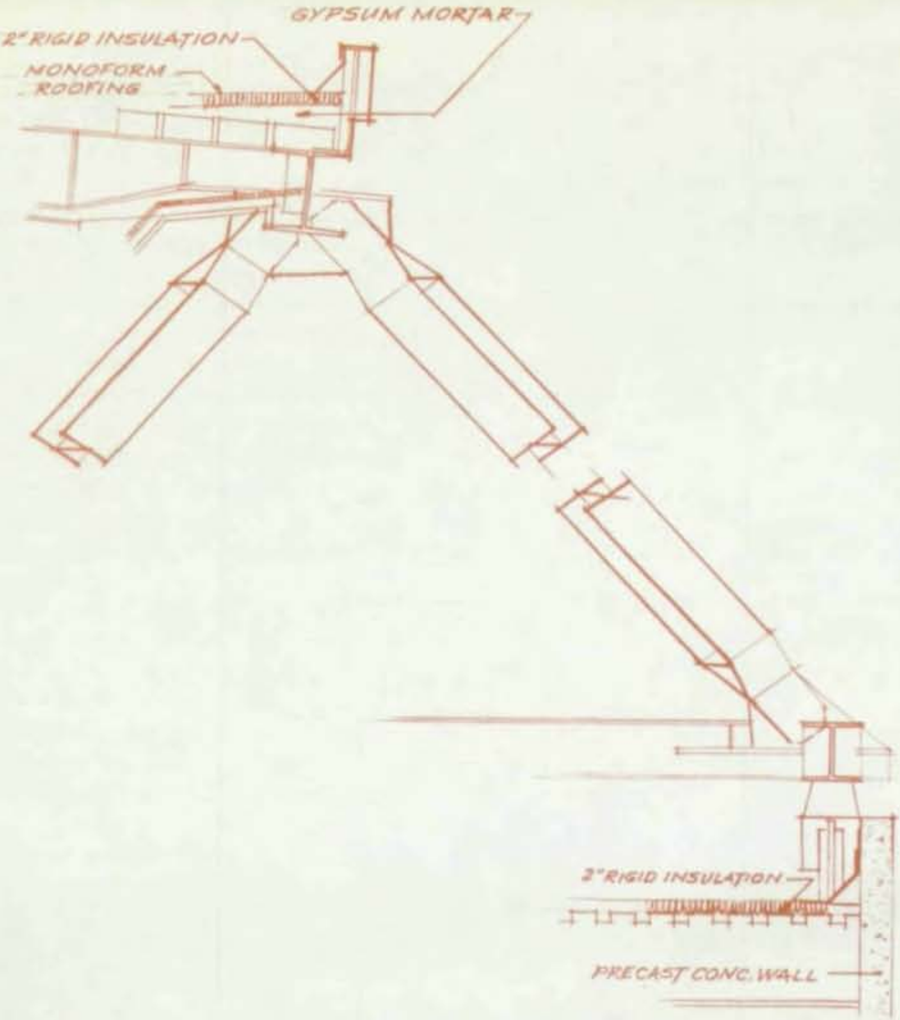
Universities are not famous for having unlimited building funds. When the University of California at Los Angeles needed a new, multi-purpose activities center to accommodate large numbers of students for the growing school's many academic and recreational functions, the situation was a familiar one — the budget was extremely tight.

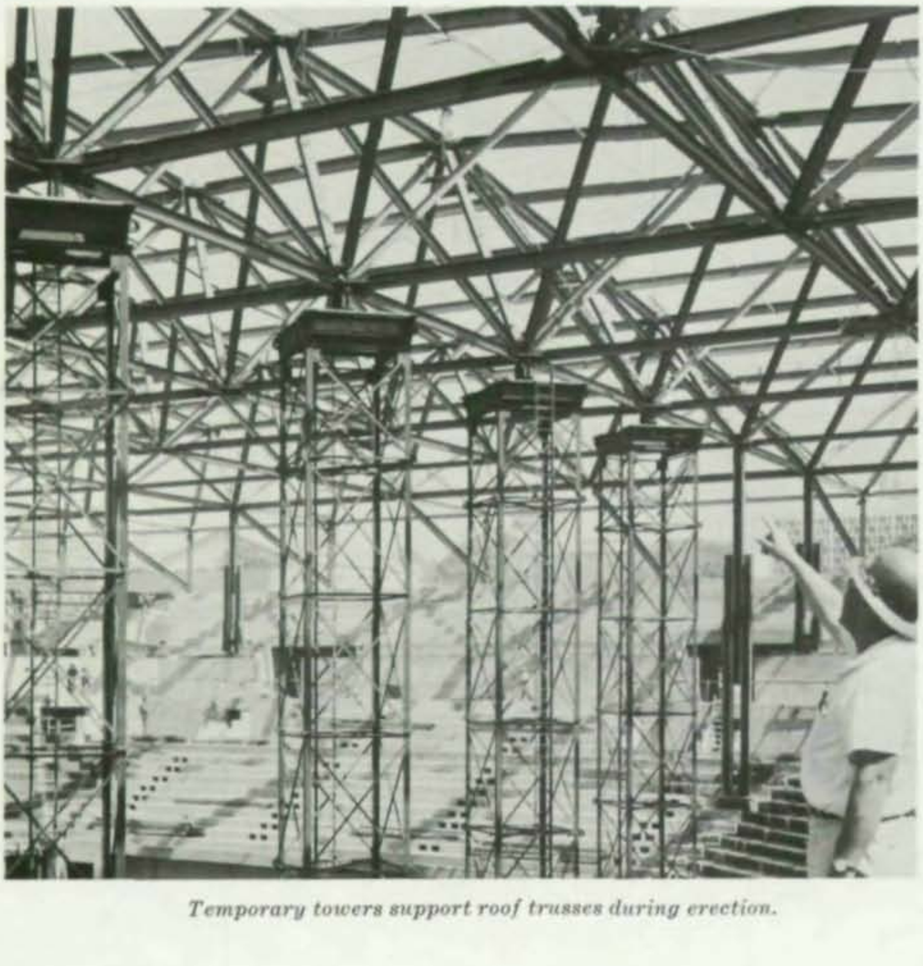
Needed was a space that could function as a huge auditorium (for major convocations, guest speakers, forums, dances and exhibits), and which could also serve for intercollegiate and intramural athletic events. Many alternate means of construction and design were considered. Excitement and economy were the objectives.

What finally became the plan for the $5 million dollar Memorial Activities Center were three buildings rather than one. Focal point of the three is the 13,000 seat Edwin W. Pauley Pavilion, a combined auditorium-sports arena. Flanking it are small twin satellite buildings (one still to be built) for offices, handball courts, and a variety of gymnasium facilities. Separating these activities into secondary structures was one means of reducing costs. It also made it possible to employ a steel space frame as a roof on the Pavilion. The space frame not only trimmed roof costs by about 10 percent, it added the quality of architectural drama essential in making the Pavilion an attractive and stimulating environment.

Interior Design

The interior design of the Pavilion arranges 10,300 permanent theater-type seats on two levels. In addition, 2,500 portable bleacher seats are installed so they completely recess into coves on the





Temporary towers support roof trusses during erection.

four sides of the floor and can be pulled out as needed. When used for commencement and convocations, additional folding chairs are placed on the floor, bringing the total auditorium capacity to 13,500.

The 126 ft x 226 ft floor provides space for three basketball courts, as well as facilities for volleyball, tennis, badminton and gymnastic events. Immediately off both ends of the arena floor are dressing rooms and showers. The two satellite buildings, with their handball courts, a wrestling room and offices, will stand on either side of the Pavilion entrance, creating a large, landscaped court which will serve as a student rally area.

Steel Space Frame

Decision to use the steel space frame was made after studying various possible structural systems, including the conventional truss, the dome and even a catenary. The space frame was the only system that could provide the kind of 300 ft x 400 ft clear span area we wanted and meet other demands of simplicity, speed of construction and architectural interest.

As designed, it is the largest steel horizontal space frame ever built in the United States. We exploited its possibilities as an architectural feature both inside and out. Inside, the completely exposed frame, 63 ft above floor level, creates an expressive ceiling pattern. From it hang the Pavilion's major lighting fixtures. Over it is a combination deck, acoustical and thermal roof, its underside a warm beige, as are the walls in most areas.

Outside, its first bay exposed, the open tracery of the space frame's steel truss work imparts a light quality to the massive, low-lying structure beneath. The frame and its supporting structure overhang the building on all sides, making it possible to have major circulatory areas outside the Pavilion, feasible in a mild climate such as ours in Southern California. This in itself was a significant saving. All told, the cost of the 120,000 sq ft space frame, which weighed 15 psf, was \$448,000, or \$3.75 per sq ft.

Geometrically, the space frame consists of 108 four-sided pyramids with their tops connected by members running parallel to the sides of the building. The interconnected pyramids are identical in plan but vary in height, so the roof slopes from a 30 ft height at center to 17 ft at the perimeter. This creates a hip-roof configuration, and provides drainage. It is expected the frame will expand and contract with temperature changes. As it moves, the columns on which it rests will rotate about their bases. The lower chord members of the pyramid, being in tension, are A441 steel. All other members are A36 steel.

Design of a space frame is exacting, but with a computer is not difficult. We approximated member sizes by conventional methods, then used the computer to check our analyses. We then readjusted our figures to come closer to the correct solution. After three runthroughs, we had our final answers. The space frame has 238 connections. To solve for vertical, thermal and seismic forces required the simultaneous solution of 714 equations, a job only for a computer.

Special Problems

Two things were of particular importance in the building of the Pauley Pavilion space frame. One was the development of a simple connection at joints. As many as eight members meet at one point. Since they are large H sections with wide flanges, this could have presented a serious problem of congestion. To eliminate the difficulty, we tapered member ends and used smaller-sized stubs to attach them to a specially designed three-dimensional gusset plate. Attachment was with high tensile bolts. Since gusset plates are a standard construction item, familiar to workmen, our variation required a minimum of learning adjustment.

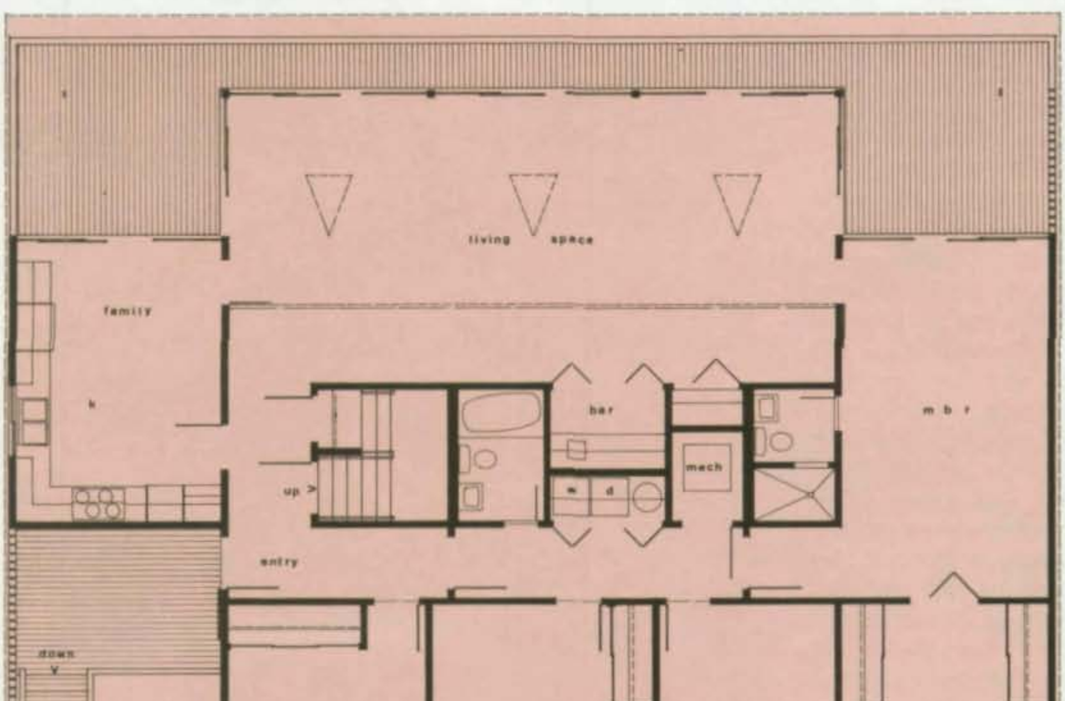
Also important was devising a simple system of erection. Unlike the conventional two-dimensional truss, the spaceframe can't be assembled in just any order. Without the right sequence, it would be possible to become stymied and not be able to complete the erection. To determine which system of erection would work, we built a model of a portion of the space frame and erected it piece by piece. Then we were ready to go to work.

To perform the actual erection, temporary towers were built at the 100 ft and 200 ft points of the 300 ft span. Trusses for the two outside thirds of this span, erected outside the building, were then picked up by a crane and placed between the temporary towers and exterior columns. The middle third of the span was then erected, piece by piece. Finally, the remaining members in the 400 ft span direction were inserted, piece by piece, between the 300 ft trusses.

The temporary towers were then removed. The space frame deflected a maximum of 2½ in., comparing closely with our theoretical figures.

Architects for the project were Welton Becket and Associates, Architects-Engineers, Los Angeles, Calif. Structural engineer was Richard R. Bradshaw, Inc., Van Nuys, Calif. General contractor was Miller-Davis Company, Beverly Hills, and the steel fabricator was the American Bridge Division of United States Steel Corp., Pittsburgh, Pa.

Arena lighting system is supported by exposed steel space frame 63 ft above floor.


living space
family
k
bar
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entry
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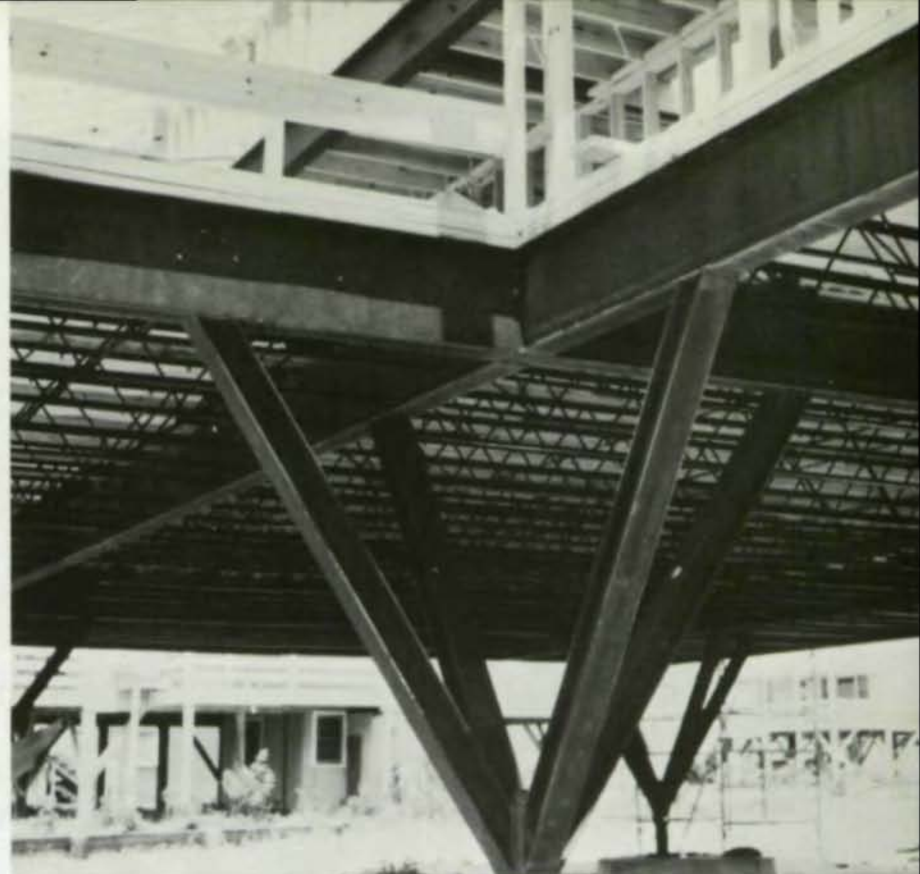
dress

A house to withstand *HURRICANES*



by John R. Oxenfeld, AIA
and Haywood H. Newkirk, AIA

Beach houses have special problems of water, wind and exposure. In this house we designed for Mr. and Mrs. Thomas L. Avery at Wrightsville Beach, North Carolina, steel was a decided asset in countering these hazards. Further, it offered substantial savings from speed and ease of construction.

To escape the threat of high water, beach houses are commonly raised on wood piles, set 8 ft. o. c. in each direction. This clutters the underside of the house, blocks the view, and eliminates significant use of the underhouse area. To comply with code requirements, 36 piles would have been needed.

By use of steel, we reduced the number of support points under the house to four, saved the view, gained a sheltered parking space for three cars, and avoided the unsightly clutter. The steel-support system cost no more than wood piling, and much less than concrete. We found it faster than either. We currently are building a comparable but slightly smaller house with a concrete foundation. It has been under construction almost a year. The steel-support house was done in approximately 90 days, about one quarter the time.

We designed the four-bedroom, two-bath Avery house to withstand winds in the 125 miles-per-hour range. Continuously welded steel provided necessary bracing and a strong tie to the ground. In accordance with code requirements, we set the finished floor 8 ft. above grade, which is above the level water reached in Hurricane Hazel in 1954. This requirement provided side benefits. The elevation affords privacy in a development of closely spaced lots, and gives commanding views of salt water marsh areas and the Intracoastal Waterway.

The house is built on reclaimed land. Under each of the four concrete pads on which the street underpinnings rest are three 25-ft. wood pilings. From each of these concrete pads, four wide flange sections splay out to support the main girders of the house which intersect directly above them. At their base, the wide-flange support sections are beveled, and welded to a tubular section which fits on a 2-in. diameter stainless steel pin set into the concrete. The 45 x 61 ft. house cantilevers in two directions from the support points. They are long cantilevers which would not have been practical without steel.

The floor framing employs open steel joists. These are deeper than the span requires, but we made them that way to give plumbing drains the necessary slope and to accommodate ductwork between the webs.

The steel structure extends vertically. A series of columns bolted and welded to the main girders support 16B31 beams that span 36 ft. over the living area. These give the structure lateral bracing and provide support for the attic area planned for later development. It is this attic that accounts for the sculptural roof shape. Steel gave great flexibility in placing interior partitions. None of them had to be load-bearing.

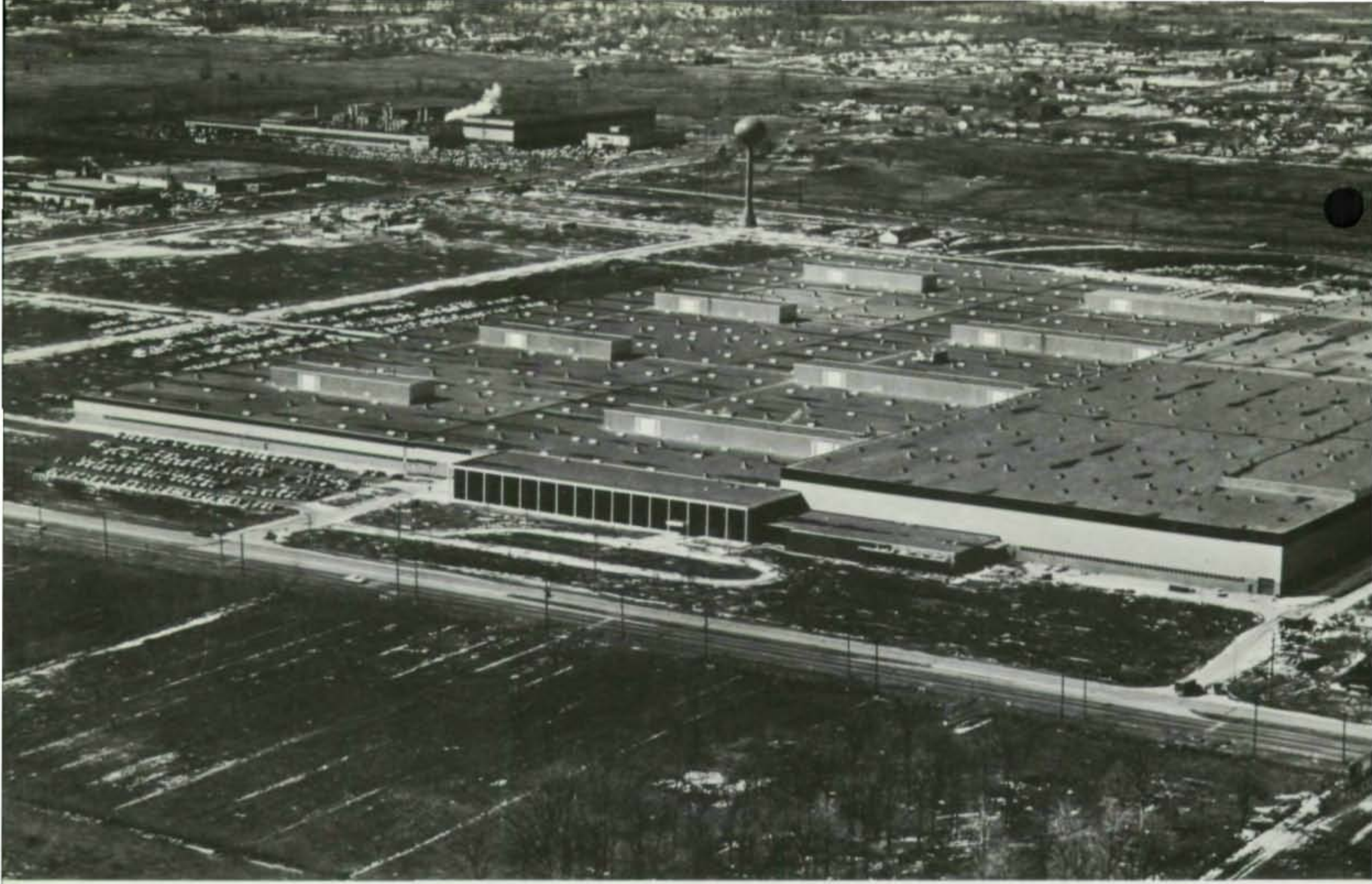
The salt-laden air at the shore can present severe problems of corrosion. To avoid these problems we selected sandblasted, unpainted ASTM A242 weathering type steel for all portions of the exposed structure. In a short time it oxidized to a deep russet color that has enhanced its appearance. All other exterior materials were selected to provide a similar maintenance-free quality.

Architect: Oxenfeld & Newkirk, AIA
Wilmington, N. C.

Structural Engineer: Thomas L. Avery
Wrightsville Beach, N. C.

General Contractor: J. W. Hunter Constr. Co.
Wilmington, N. C.

Steel Fabricator: Queensboro Steel Corp.
Wilmington, N. C.



57 Acre plant built in record time

From conception to completion, the world's largest and most modern automotive stamping plant — 2,600,000 sq ft of floor space — was designed and built in just eleven months. Two months later the plant was in operation. This amazing schedule for the Chrysler Sterling Stamping Plant in Sterling, Michigan, attests to the speed of steel construction and the close knit teamwork of architect-engineers Giffels & Rossetti, Inc., general contractor Huber, Hunt & Nichols, Inc. and the Chrysler Corporation personnel.

The Chrysler Sterling Plant produces automobile roofs, floor pans, quarter panels, deck lids, and a variety of other automobile components. The plant equipment includes 448 presses, with a stamping capacity of 40 to 2,000 tons compression. The largest press weighs 750 tons. The presses consume 2,000 tons of sheet steel coils per day at peak load operation.

Architectural Considerations

Judged the "Top Plant of the Year" by the editors of Factory Magazine, Chrysler Sterling reflects the most modern philosophies of industrial plant lay-

out and production flow. The raw material, coiled sheet steel, enters the plant on the north side, either by truck or rail, where it is unloaded and stockpiled by crane. A basement area extends under the entire press area, with the presses supported on a movable framing system. This basement arrangement permits the installation of underdrive presses and provides space for a conveyorized scrap system. The access area is used as storage space for dies, which are brought to the main press floor level on one of three 50-ton hydraulic elevators.

Scrap is collected on a conveyor system in the basement and is taken through a tunnel under the steel storage bay, without interference with the operation on the main floor. At this point the conveyor rises about 40 ft above grade as it enters the baler house and discharges directly into railroad cars.

Each press bay contains a 50-ton crane, used primarily for servicing the presses. The assembly area is essentially open space served by utility loops to permit maximum flexibility in arranging production operations.

The shipping area of the plant is served by two depressed railroad tracks and facilities for simultaneously housing 20 trucks in an enclosed dock. Bascule type bridges are provided across the depressed tracks at the main traffic aisles within the assembly area.

An administration building approximately 80 ft x 540 ft is attached to the east end of the plant. This unit includes a complete medical facility with X-ray and therapy equipment, as well as one of two cafeterias serving the plant.

The exterior walls of the plant consist of an 8-ft high masonry sill wall, a 4-ft continuous strip roof, power operated aluminum sash, and insulated aluminum siding with a baked enamel finish. The windows have no functional purpose as far as ventilation or light is concerned. Their only purpose is to provide employees with a visual check on the weather and a psychological breeze on a spring day.

The sloped roof consists of a metal deck, insulation, and built-up roofing. Floors throughout the plant are typically wood block. Pine is used in the general areas, oak in secondary aisles, and pecan in the main aisles. The floor around the presses consists of 3¾-in. thick panels of laminated pecan.

Structural Steel

Approximately 17,000 tons of structural steel were required to frame the one-story plant. An additional 17,000 tons were required to frame the press floor over the basement.

The assembly area is laid out in 40 x 60 ft bays. Steel roof trusses span 60 ft in the north-south direction, and 40 ft east-west. All trusses are designed for a maximum 2,000 lb hanging load from each panel point, and for a maximum of 6,000 lbs at any one panel point.

The framing system over the press floor is a modular bay of 40 x 80 ft. The framing consists of 80-ft trusses on 20-ft centers, framing into carrying trusses which span 40 ft. The press area has 50-ton, 80-ft span cranes with 15-ton auxiliary hooks servicing the 34 press lines. These cranes are designed for optimum flexibility in servicing the lines, with one crane handling the requirements of any two in the overall layout.

The press floor is framed in steel in such a manner that presses in each line may be moved from one location to another without major changes in the press floor system. This is achieved by

Looking up from press pit. Box girders, 54 in. deep, are supported by 20-in. deep I-beam rails.

Looking up from press pit. Box girders, 54 in. deep, are supported by 20-in. deep I-beam rails.

a steel "rail" system consisting of two 24-in. deep beam rails supported on concrete piers 13 ft-4 in. o. c. and spaced 32 ft o. c., with one pair of rails per press line and two pairs of rails for each press bay. Each of these 24-in. deep rails supports a system of 54-in. deep welded steel box girders spanning 34 ft between each pair of rails. Each pair of box girders is designed to support presses weighing from 300 to 750 tons. The box girders are bolted to the rails and may be adjusted to suit any type of press configuration.

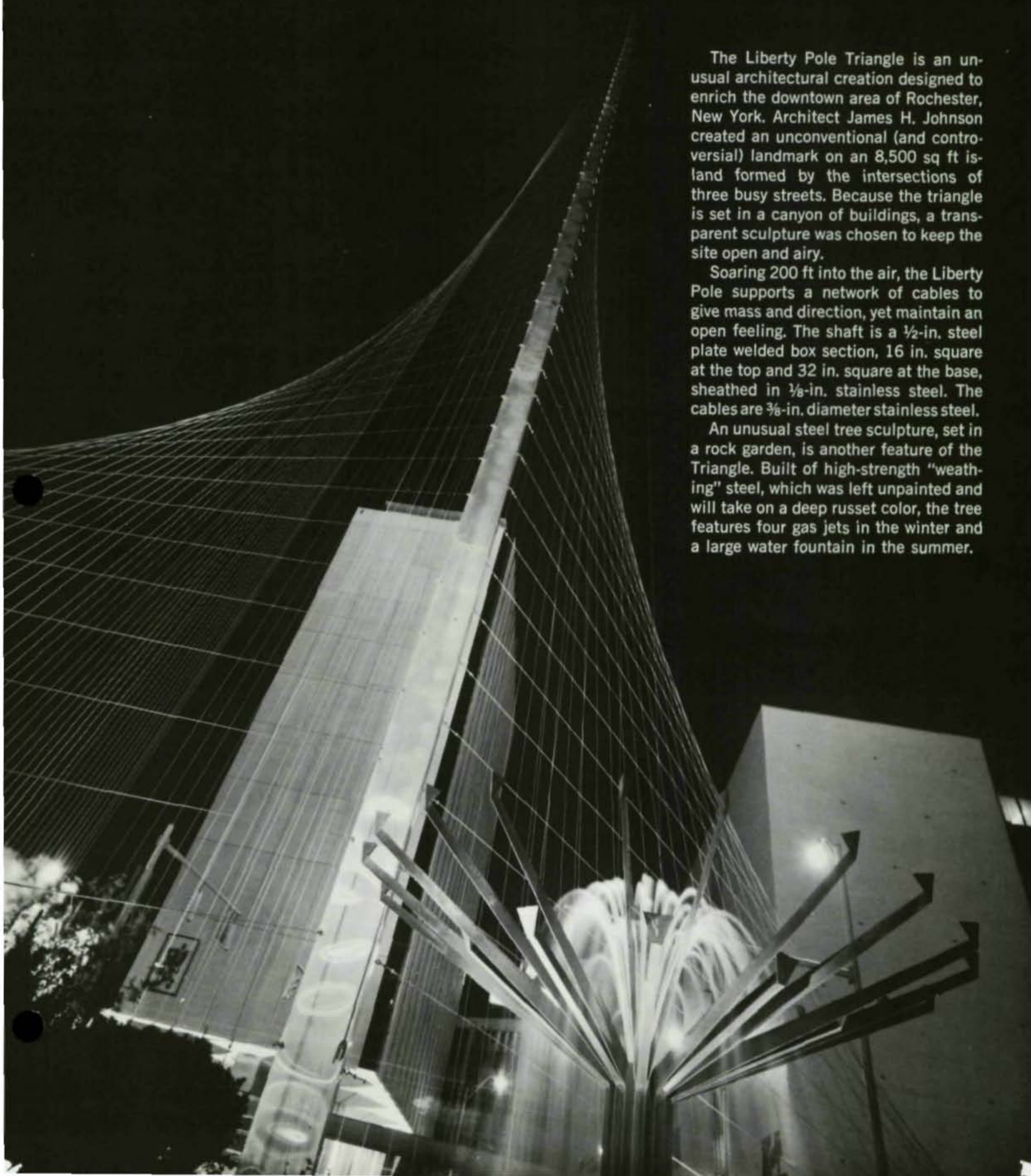
The press floor box girders also support two tiers of steel floor framing. The lower tier consists of 20-in. beams spanning 12½ ft, spaced 7 ft o. c. The upper tier, which supports the floor finish, consists of 10-in. steel beams which span 7 ft and are spaced at 2½ ft maximum, to support the 3¾-in thick flooring. This flooring system can handle uniform live loads of 4,000 psf from the presses. The overall press floor over the pit covers approximately 375,000 sq ft.

Architect-Engineer: Giffels & Rossetti, Inc., Detroit, Michigan

General Contractor: Huber, Hunt & Nichols, Inc., Indianapolis, Indiana

Steel Fabricators: Whitehead & Kales Co., and The R. C. Mahon Co., Detroit, Michigan

Imagination in Steel



The Liberty Pole Triangle is an unusual architectural creation designed to enrich the downtown area of Rochester, New York. Architect James H. Johnson created an unconventional (and controversial) landmark on an 8,500 sq ft island formed by the intersections of three busy streets. Because the triangle is set in a canyon of buildings, a transparent sculpture was chosen to keep the site open and airy.

Soaring 200 ft into the air, the Liberty Pole supports a network of cables to give mass and direction, yet maintain an open feeling. The shaft is a ½-in. steel plate welded box section, 16 in. square at the top and 32 in. square at the base, sheathed in ⅛-in. stainless steel. The cables are ⅜-in. diameter stainless steel.

An unusual steel tree sculpture, set in a rock garden, is another feature of the Triangle. Built of high-strength "weathering" steel, which was left unpainted and will take on a deep russet color, the tree features four gas jets in the winter and a large water fountain in the summer.

STEEL HELPS TO REMEDY

The design of an addition to an existing urban building complex is always a problem, and when that building complex is a hospital on a restricted and congested site with poor soil conditions, the difficulties increase tremendously. These were the problems Ellerbe Architects encountered in designing the new science and research buildings for Beth Israel Hospital in Boston. Steel framing was an essential element in the solution to these problems.

Beth Israel, one of the Harvard teaching hospitals, faced problems common to many long-established urban institutions. The hospital had an impressive record of achievement over its fifty-year history, and a sizeable physical plant had been built on what was originally an ample site. Medicine, however, is moving ahead faster than ever and hospital facilities need to be continuously improved. Even the steel-framed South Building with its 131 beds built as recently as 1950 was becoming outdated.

Renovation, however, was still not the entire answer. The progressive complexity of diagnostic and therapeutic medicine and the realization that prevention is the only way to deal with chronic illness led to the decision to construct an ultra-modern science and research building.

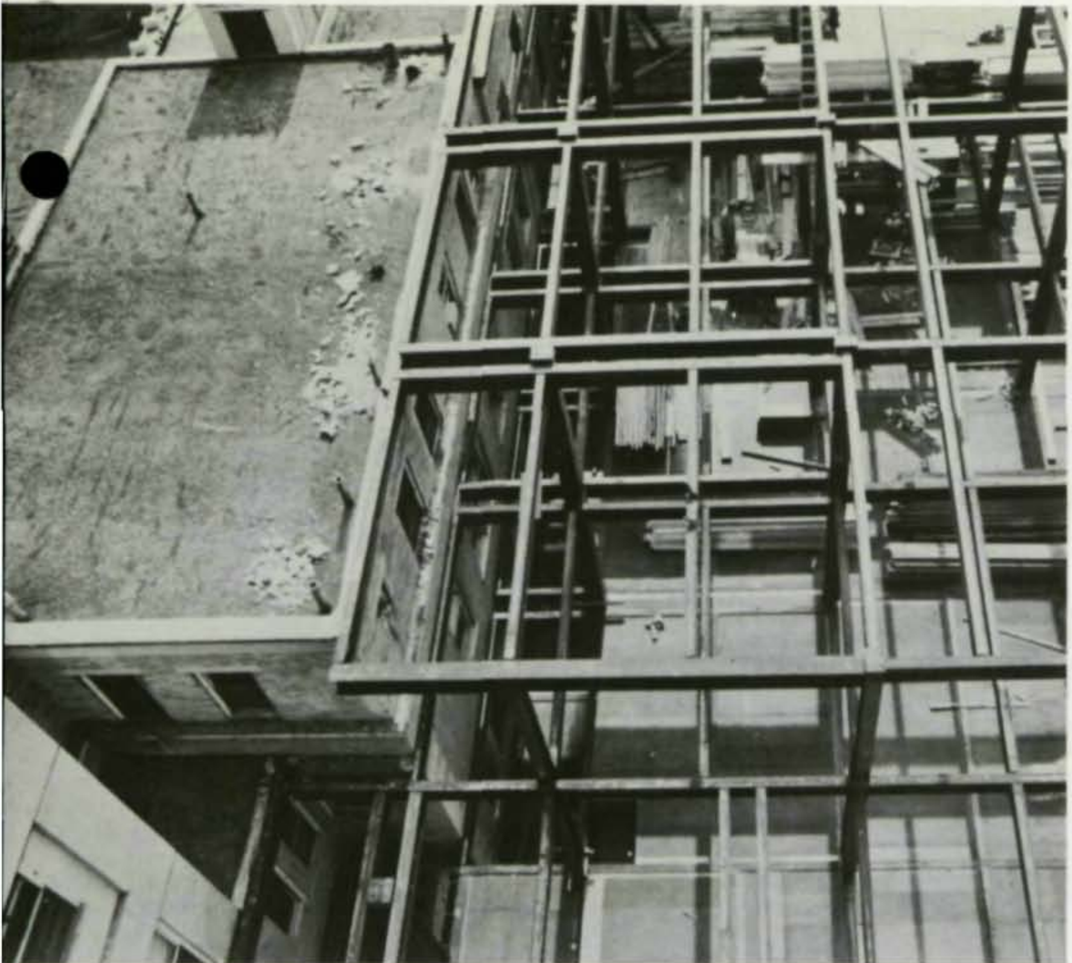
Functional efficiency demanded that these new facilities be located close to the existing inpatient and outpatient facilities. The only space available on the congested urban site was nestled between these patient facilities and the hospital power plant. The decision was made to build a four-story and basement structure with approximately 80,000 sq ft of space in this area.

After removing some existing one-story structures, a column layout had to be selected which would avoid the complex underground utility system connecting the power plant to the main hospital building. The architect spent weeks on the site determining the exact location of every pipeline. The maze of existing pipes made it necessary to "shoehorn" the columns into place. Dimensions were so critical that in some cases insulation was removed from the pipes to allow the steel columns to slide by.

The project was further complicated by soil conditions. Soil adequate to support piles or cassions was not available at a reasonable depth. There was also the everpresent danger that if the upper layer of impermeable clay was pierced, the excavation would be flooded by seepage from the Charles River. By using a lightweight steel frame, it was possible to support the building on spread footings founded on this clay.

Architecturally, the new building will function as an addition to the adjoining buildings, but, structurally, it is entirely independent.

The Ellerbe structural staff decided to use cantilever floor construction around the entire perimeter of the structure. This allowed them to design sym-



Framing for the new science and research buildings fits between existing facilities like a section of a jigsaw puzzle.

by Lawrence H. Kloiber
AISC Regional Engineer

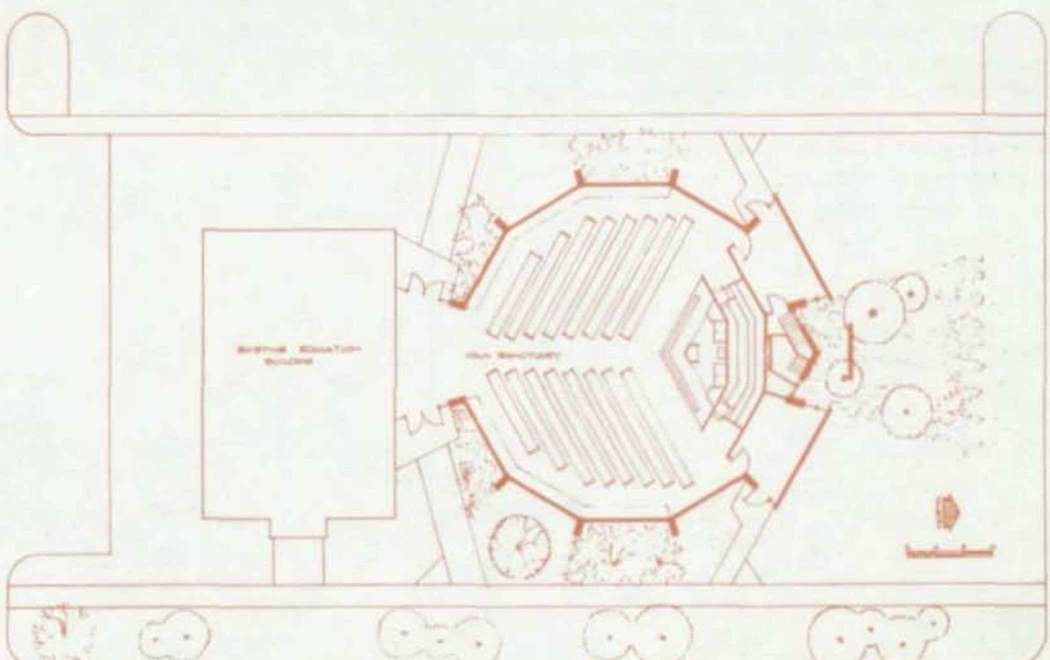
HOSPITAL ILLS...

metrically loaded footings which could be excavated without disturbing the existing buildings and still make the most efficient use of the site area.

Beth Israel's urgent need of these facilities made speed of construction a prime factor. The architect decided this could best be accomplished by taking steel bids prior to completion of the architectural plans and well in advance of awarding the general contract.

Albert Goldberg and Assoc., Boston, was associated with Ellerbe Architects on the structural design. The steel fabricator was West End Iron Works, Cambridge Mass. The Owen J. MacGarrahan Co. was the steel erector, and the J. S. Slotnik Co. was construction coordinator.

A WELL-EXECUTED



LOW COST CHURCH

Two attributes of this small church are well worth mentioning. From the parishioners' point of view, the most important is probably low cost. The entire project – materials, labor, pews and other furnishings and the carpeting amounted to less than $40,000. Although the structure is located in Enid, Oklahoma, where costs are certainly not as high as in Chicago or New York, this is still a notable achievement.

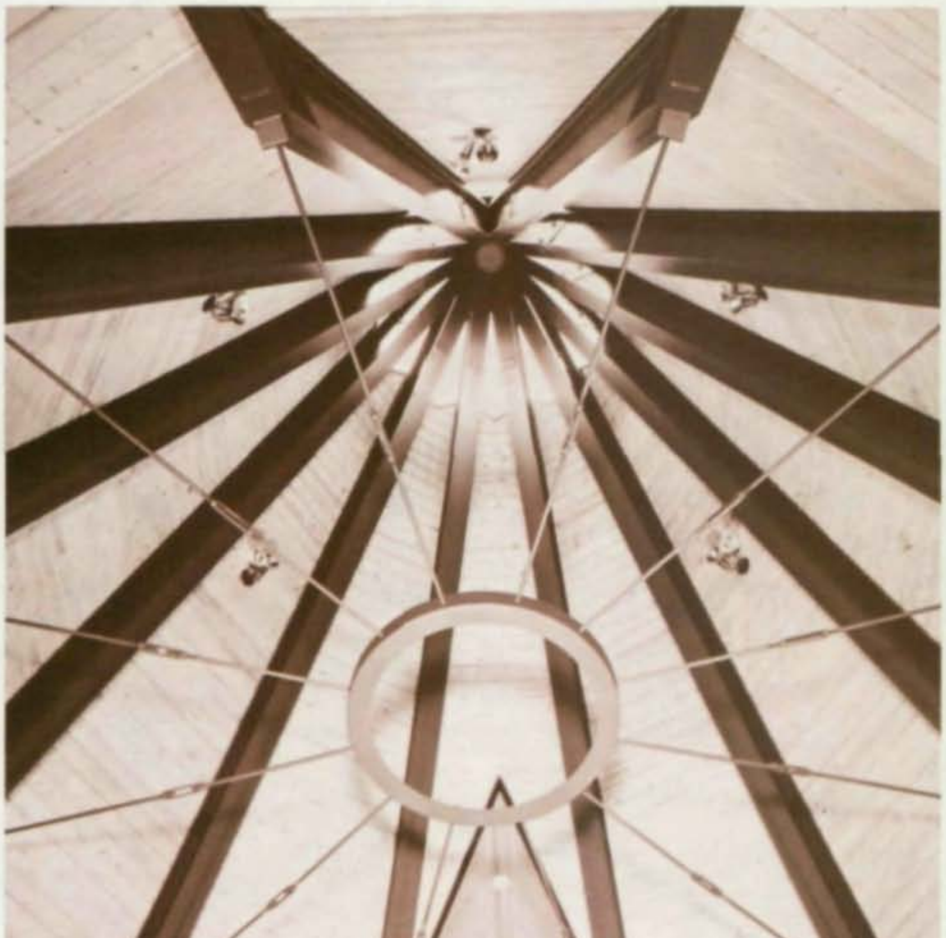
For the architect, it was gratifying to draw from the structural materials – notably the steel framing and wood decking – strong design values. The steel tension ring and rods seem almost decorative. The shape of the church (the Maine Church of the Nazarene), was dictated first by the need for describing the minimum space to seat 300 worshippers, including the choir. The near-circular dodecagon turned out to be the most sensible, economical choice. Beginning with that concept, the architect, Smith, Day & Davies of Enid, formed the interior space and steeple over a steel frame. Structural steel was selected, according to partner George E. Day, Jr., AIA, "because it was the only material that would do the job aesthetically and economically."

For example, considerable savings were made on the footings. This was attributed to the frame design, which doesn't impart a horizontal thrust to the columns. Instead, the horizontal thrust is picked up by the tension ring and turnbuckles half way up the frame. And there is a moment connection at the top of the frame. As a result, standard footings were used, and there was no need for tie rods below grade. Since the steel framing was definitely a part of the architecture, it was left exposed and painted.

In addition to the open spaces inside the church, there is a pastor's study and a combination choir-robing and general meeting room. The congregation feels that the new church will increase their effectiveness in the neighborhood.

Other materials included asphalt shingles over the 3-in. wood deck, textured plywood siding, an acrylic skylight at the top of the steeple, topped by a plate steel cap and galvanized pipe spire. Walls inside were finished with gypsum board, and behind the pulpit with mahogany paneling.

The architect also served as structural engineer on the project. General contractor was D. C. Bass & Sons Construction Co., also of Enid, and the steel fabricator was the Robberson Steel Co., of Oklahoma City, Oklahoma.



Steel tension ring and turnbuckles take horizontal thrust – are visible from interior.

TOPPING OUT

Today's "topping out" ceremony, which heralds the placement of the final structural steel beam for a new building, *represents a combination of old and new* traditions.

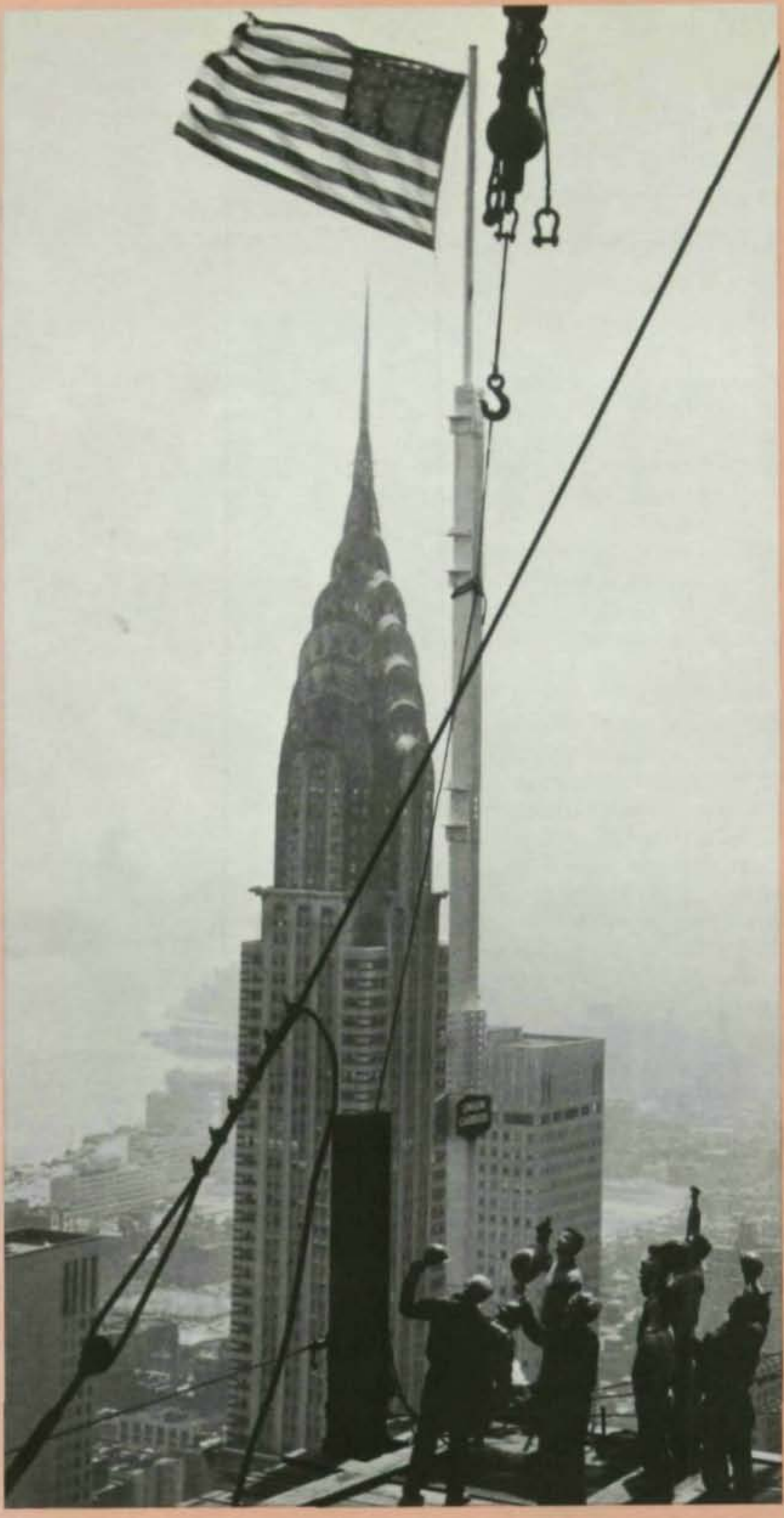
According to ancient history, the success or failure of Man's building ventures was usually attributed to the gods he worshipped rather than to the skill, or lack of it, of the builder.

To appease these spirits, sacrifices—human as well as other types—were offered by the builders to exorcise the evil spirits who might have taken residence in the building's framework during construction. In early China, chicken blood, as a substitute for human blood, was smeared on the ridgepole in the hope of fooling the gods.

Bridges posed special problems and goaded the fears and superstitions of the ancients. Xerxes, the famed Persian military leader, blamed recalcitrant river gods for the collapse of a pontoon bridge over the Hellespont. To punish and shackle these gods, the water was given 300 lashes and a pair of manacles was thrown into the strait. History records that during the weird religious ceremonies marking construction by the Romans of the Pons Sublicius over the Tiber in 621 B.C., human beings were thrown into the water as sacrifices to the gods.

Around A.D. 700, the practice in the Scandinavian countries was for all the neighbors to aid in the construction work up to and including the installation of a building's ridgepole. When the ridgepole was finally in place, an evergreen tree was attached to it as a signal for the beginning of a completion party—at the expense of the builder.

In later times in these same Scandinavian countries, and also in the Black Forest, it was customary to fasten a sheaf of corn to the gable. The corn was believed to serve as food for Woden's horse and as a charm against lightning. In more recent times, garlands of flowers or sheaves of corn were duplicated in wood, stone or terra-cotta on Gothic buildings. Such agrarian decoration is perhaps a survival of the ancient custom.



A popular custom in Europe—and still observed to some degree—is the practice of attaching a sapling to the uppermost point of the structure. This practice is believed to be descended from the ancient belief in the benign influence of the tree inhabiting spirit. In some places it was, and still is, the practice to decorate the bough with flowers, ribbons and strings of eggs to symbolize the life-giving power assumed to be the spirit's special attribute.

Through the years, the various forms of sacrifice and foliage were replaced by a handkerchief and then by a flag.

Today when the structural steel framework of a skyscraper is near completion, a flag is hoisted to the top of the structure. Ironworkers, who, of course, deny they are superstitious, say it brings "good luck."