VOLUME VIII / NUMBER 2 / SECOND QUARTER 1968

MODERN STEEL CONSTRUCTION

1


2


3


MODERN STEEL CONSTRUCTION

Published by

American Institute of Steel Construction

101 Park Avenue, New York, N. Y. 10017

VOLUME VIII / NUMBER 2 / SECOND QUARTER 1968

CONTENTS

1968 PRIZE BRIDGE COMPETITION

Entries are invited for the 40th Annual AISC Prize Bridge Competition to select the most beautiful steel bridges opened to traffic during the calendar year 1967.

The Competition will be judged by a distinguished Jury of Awards including:

***Kenneth Donahue**, Director, Los Angeles Museum of Art, Los Angeles, California*

***Frank H. Newnam, Jr., F.ASCE** President-elect ASCE; President, Lockwood, Andrews & Newnam, Inc., Houston, Texas*

***Joseph R. Passonneau, FAIA**, Dean, School of Architecture, Washington University, St. Louis, Missouri; Director, Crosstown Design Team, Chicago, Illinois*

***George S. Richardson, Hon. M. ASCE**, Richardson, Gordon and Associates, Pittsburgh, Pennsylvania*

***Arnold H. Vollmer, F.ASCE**, Senior Partner, Vollmer Associates, New York, New York*

Steel bridges of all types located in the U.S. are eligible. Entries must be post marked prior to August 25, 1968, and will be judged on September 12, 1968. Competition rules and entry forms are available from AISC.

A572 STEEL APPROVED FOR BUILDINGS

AISC has approved A572 high strength steels for use in building construction. Use of A572 will be in accordance with the 1963 AISC Specification, modified by supplementary provisions dealing with procedures for manual and submerged arc welding.

Use of economical, high strength A572 steels is expected to lower construction costs.

Engineers and architects interested in the use of these steels in current projects should contact their local AISC steel fabricator or Regional Engineer.

Largest academic-sports complex in the Southeast, the University of South Carolina Coliseum features a steel space frame roof spanning 322 ft x 322 ft between supports.

GIANT SPACE FRAME TOPS CAROLINA COLISEUM

by Russell Maxey, Asst. Chief Engineer
Kline Iron & Steel Co., Columbia, S. C.

One of the nation's largest steel space frame structures will soon be completed in Columbia, South Carolina. The University of South Carolina Coliseum, a $6.9 million athletic-academic complex, will contain 315,000 sq ft of floor space on three levels and will be the largest facility of its kind in the Southeast. The most significant growth element in the University's master development plan, the Coliseum is expected to become a campus, city, and state landmark.

The 322-ft x 322-ft structure has been designed primarily for sports events, but will be available for a variety of other University and public functions, such as convocations, exhibits, trade shows, concerts, circuses, ice shows, and similar activities. Seating capacity in the arena will be 12,200 for basketball games and 13,500 for other events.

The first and lowest of the three levels of the Coliseum will be the athletic level, consisting of business offices, coaches' offices, dressing rooms, and showers. The second level, consisting of 80,000 sq ft of floor space, is for academic endeavors and will house the School of

The huge roof is made up of 121 steel pyramids that act together as a single structural frame.

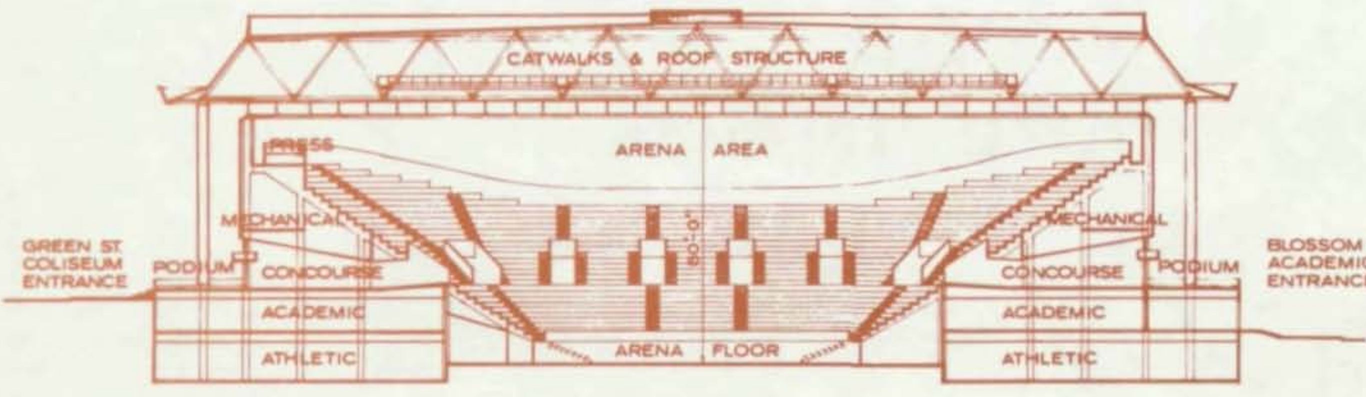
Journalism and the College of General Studies. The third, or concourse level, will contain a large promenade, refreshment areas, rest rooms and the main entrances to the arena. Aside from the arena, there will be 524 rooms in the complex.

To provide a totally column-free interior at maximum economy, architects-engineers Lyles, Bissett, Carlisle & Wolff have designed a unique 104,200 sq ft steel space frame. Their investigations showed that the use of a space frame resulted in considerable savings over conventional structural systems for the large clear-span area involved.

Steel Space Frame

Supported by 44 exterior columns spaced 29 ft-4 in. on center along the square perimeter of the building, the steel space frame roof spans 322 ft between supports and cantilevers 16 ft-8 in. beyond the columns on all four sides. The fixed-end steel columns rise 80 ft above grade.

The huge space frame roof is made up of 121 pyramidal steel pods, each 29 ft-4 in. square and varying in height from 20 ft at the periphery to 25 ft at the center. The pods were assembled on the ground into sections approximately 150 ft long. These sections, each weighing about 40 tons, were raised to the tops of the columns and bolted together into an integrated unit. Temporary steel shores supported the erected sections until the entire roof assembly was completed. A 5½-in. camber was provided at midspan of the assembled frame.



CROSS-SECTION PLAN

0 10 20 30 40
GRAPHIC SCALE

At each joint, four horizontal chords and four diagonals of the pyramidal pods intersect. The connection for these eight members, made with 1¼-in. diameter A490 high strength bolts, weighs ¾-ton. The entire frame required 40 tons of bolts and 2,150 tons of A36 and A440 structural steel.

Other Features

The sports arena will be 185 ft x 100 ft with a clear floor-to-ceiling height of 80 ft under the bottom chords of the space frame. It can be reconfigured within hours to accommodate the specific type of event to be presented. The basketball court is portable and can make way for portable stages and ice skating rinks. The basic flooring is provided with electrical grids and plumbing fixtures for service to exhibit booths and other displays.

The Carolina Coliseum will be one of the largest electrically heated buildings in the country, having communications systems in abundance and a vast array of lighting, including special color television illumination. The building will be fully air conditioned.

When completed, the Coliseum will have a monumental character, somewhat akin in feeling to a pyramid of Egypt. The design treatment is the same when viewed from any of the four sides of the square building. The fascia and roof enclosing the space frame are bronze decking. Overall height of the structure is 110 ft.

There are 120 exterior doors to permit capacity exit within a matter of minutes. A 30-ft wide walkway extends completely around the building. The building and grounds occupy a two-block area adjacent to the main campus, and will include parking areas on two sides.

The Carolina Coliseum has been a cooperative project between the University of South Carolina, the City of Columbia, and an advisory committee of interested private citizens. It is the fulfillment of a five year dream to provide the University and the State capital with a coliseum-type structure.

Architect-Engineer:
Lyles, Bissett, Carlisle & Wolff
Columbia, South Carolina

General Contractor: McDevitt and Street
Charlotte, North Carolina

Steel Fabricator:
The Kline Iron & Steel Co.
Columbia, South Carolina

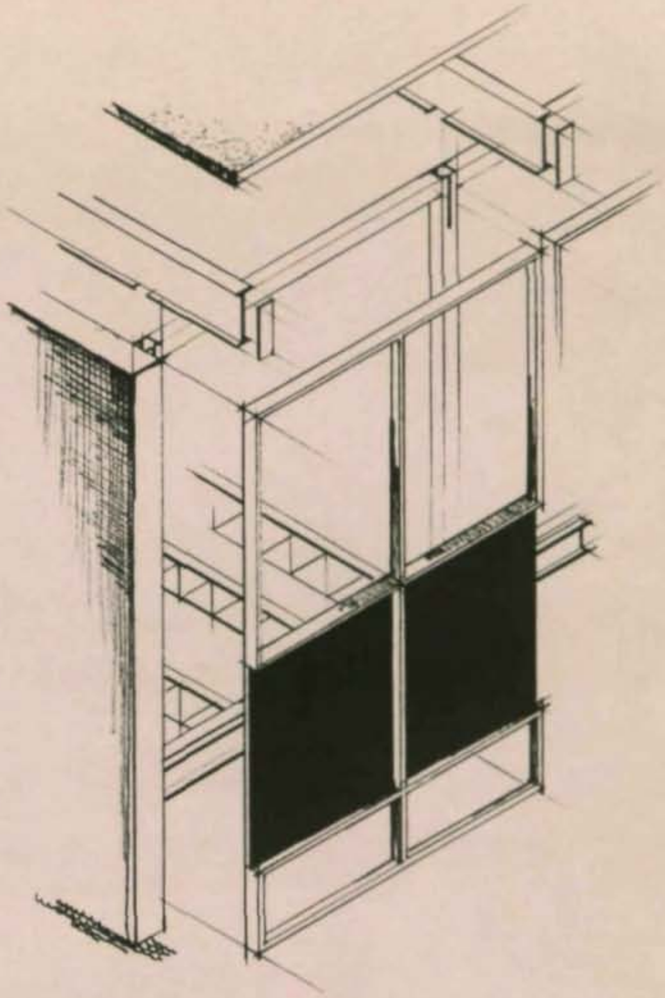
Subassemblies 150 ft long and weighing 40 tons were put together on the ground, then hoisted 80 ft above grade to be joined to supporting columns and to each other. Connections joined eight steel members, weighed ¾-ton each.

FLEXIBLE SMALL OFFICE BUILDING

When Architect Henry Sprott Long, AIA, of Birmingham, Alabama decided to design and build a new headquarters for his firm, he had three objectives in mind. The space was to meet his specific needs, express the dignity of a professional office, and retain a flexibility for investment purposes that would permit future rental of the space to other type tenants. He achieved these goals at minimum cost with careful planning and light steel framing.

Because the site is a small 50 ft wide lot in an old residential area, surrounded by apartments, large old houses, and neighborhood businesses, with no view other than toward a tree-shaded thoroughfare at the front, architect Long made an attractive interior court the focal point of the building. All major spaces except the drafting room get a view of the graveled court, which features a fountain and pool. The drafting room receives full benefit of natural light from its northern exposure, as does the lower level space which is designed as expansion space for the drafting room. The private office is used for most client consultations, with the conference room being used principally for meetings with salesmen, material representatives, and contractors.

Structural efficiency and aesthetics were equally important in the design. Steel framing was selected to allow maximum plan flexibility by eliminating bearing partitions, to achieve economy through speed and simplicity of erection, and to permit completion of the project on an accelerated time schedule. By using standard warehouse stocked shapes, all three of these objectives were accomplished, with the desired design effect.



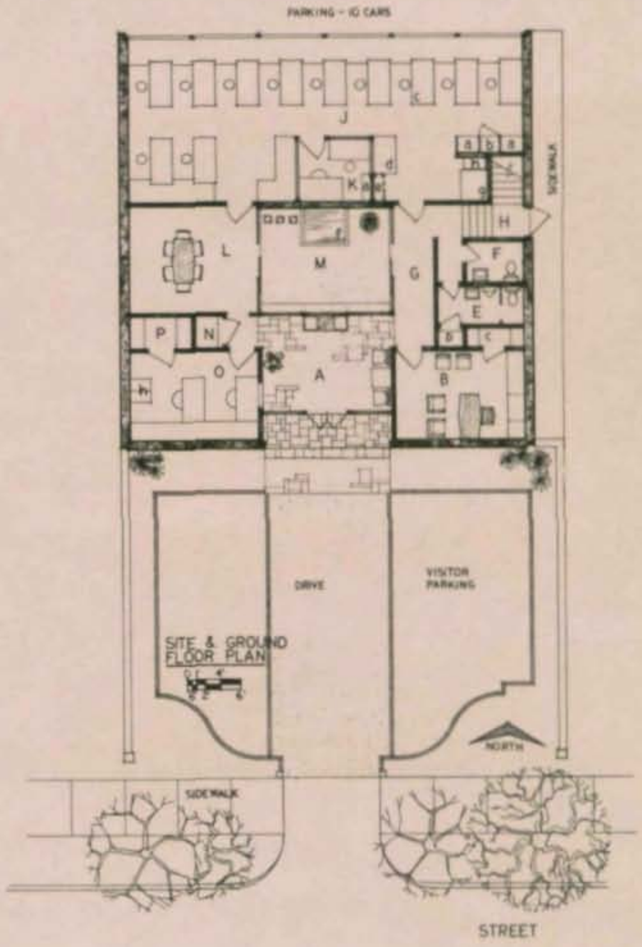
The framing system was unusually simple and easy to erect. The basic framing consisted of 4 in. x 4 in. tubular steel columns and 14 in. junior beams. The columns were slotted at their tops and the bottom flanges of the beams were notched at the bearing points, so that the beam webs could be dropped into the column slots, then welded to the columns. Lateral stability was provided by welding 4 in. steel tubing between the columns. This basic detail allowed doors, sliding doors, sliding windows, or fixed glass to be installed in any bay.

A steel girder at the interior wall of the drafting room divides the building into two spaces, front and rear, for framing the roof. This allows freedom of arrangement or rearrangement of interior non-bearing partitions. The roof beams were extended across the court for stability and continuity of design; this also makes possible a future roof over this area. The exterior front and side walls are of masonry.

The building is heated and cooled with a forced air system of ducts buried in the floor slab. Heat is supplied from a gas fired furnace. Refrigerant is furnished by a gas engine driven compressor condenser.

Interior finish consists of exposed steel framing, roof deck, and masonry front and side walls. All interior partitions are of wood stud and gypsum board or plywood paneling. Floors are cork tile, ceramic tile, slate and carpeting.

Architect-Engineer: Henry Sprott Long, AIA
Birmingham, Alabama
General Contractor: Bryce Building Co.
Birmingham, Alabama
Steel Fabricator: Tucker Steel Div.,
U. S. Industries, Inc.
Meridian, Mississippi



TAPERED BOX GIRDER CARRIES CHURCH ROOF

St. Raphael's Roman Catholic Church, under construction in Rockville, Md., will combine crisp lines of contemporary styling with natural-finish materials in a design which captures the rustic flavor of the Potomac hunt country. Exposed beams supporting wood roof decking, exposed brick walls and carpeted floors with slate flooring in the sanctuary will be attractively displayed in the interior of the low-profile, steel-framed structure.

Designed by the Rockville office of Johnson and Boutin, Architects, the church has a five-sided plan in the shape of a square with one corner clipped off. Seating capacity will be 800, with pews arranged like a fan around the altar, bringing the congregation in close to the center of worship, in accordance with the new liturgy of the Second Vatican Council.

The steel frame provided the most economical means of creating the desired architectural effect. It permitted large, open spaces with no interior columns to obstruct vision, while maintaining the thin-lined styling. Structural engineers for the project are Caffes & Jolles of Silver Spring, Md.

Donald S. Johnson Jr., supervising architect, commented, "With other materials, the beams would have been deep and bulky, detracting from the basic design." He added that leaving the steel beams and wood decking exposed eliminated the need for a hung ceiling, a major cost-saving feature.

Steel beams and purlins are wide-flange sections. These will be encased in metal lath and plaster to produce a box shape. Lighting fixtures will be attached to the beams, with wiring running along the webs, hidden by the plaster finish.

The structure is symmetrical on either side of a large steel box girder which rises above the main roof line to form the backbone of an A-frame containing a large, stained-glass window. The window, directly above the altar, will flood the sanctuary with natural light during the day and with illumination reflected from outdoor floodlights at night.

The large box girder is 72 ft long and 4 ft deep at its center, tapering to a dept of 24 in. at its lowest point and 18 in. at its peak. The lower end of the girder is anchored to a large concrete pier. It slopes upward to meet a supporting 12-in. wide-flange column, then cantilevers 48 ft, carrying the roof framework which radiates from it. Clear spans of 104 ft in two directions are made possible by the framing system.

The roof extends from an interior height of 8 ft at the periphery of the building to 22 ft at the center and 35 ft at the apex of the A-shaped window.

The seating area will be carpeted, with slate flagstone in the sanctuary and entrance. Walls are antique white, hand-made brick inside and out, with a decorative wood screen and carpeting on the interior wall at the narthex. The roof will be finished with wood shakes.

Included in the $468,000 project is a multipurpose building, measuring 60 ft x 98 ft wth no interior columns or bearing walls. Its hipped roof is supported by two welded-plate steel girders, 51 in. deep at the center, with ends tapering to a depth of 10 in. to match the roofline.

Offices and storage will be located at one end of this building; the remainder is a large hall which can be divided by means of folding partitions into as many as six rooms, three on either side of a central corridor.

Architect: Johnson and Boutin, Architects
Washington, D. C.

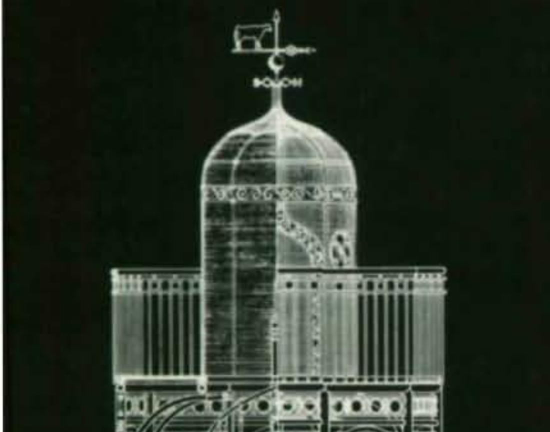
Structural Engineer: Caffes & Jolles
Silver Spring, Md.

General Contractor: Victor R. Beauchamp
and Associates, Inc.
Washington, D. C.

Steel Fabricator: Northern Virginia Steel
Corp., Springfield, Va.

A steel box girder is the backbone of the framing system. From its peak, tubular steel mullions extend downward to frame the A-shaped stained glass window above the sanctuary.

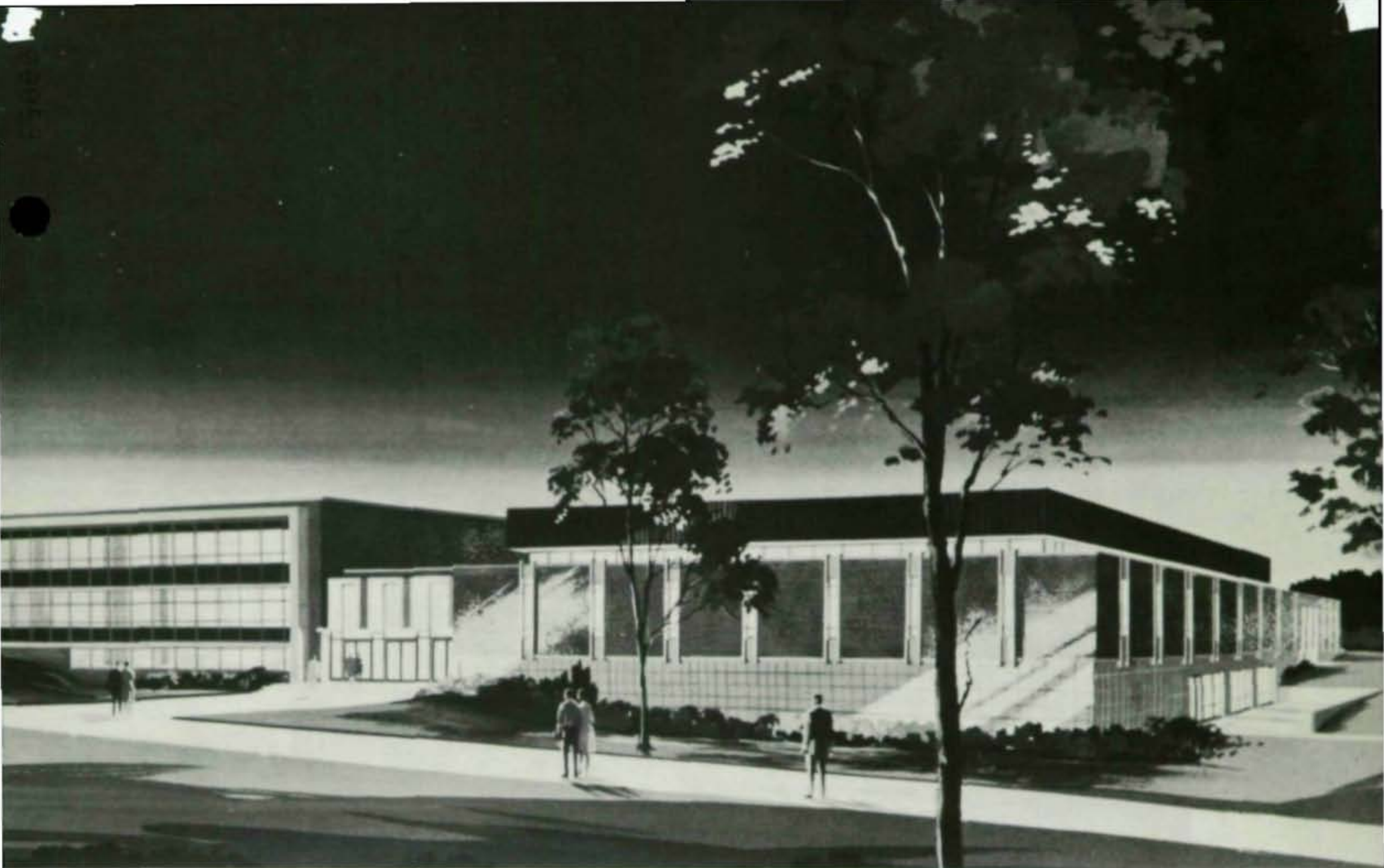
A GARDEN PAVILION



This charming pavilion is located in the garden of a summer home and orchard in the San Francisco Bay area. Over the years the owners had collected antiques and whimsical objects for their garden, including an antique spiral stair and a tall wire mesh aviary. Architects Chan/Rader and Associates, San Francisco, designed a platform for viewing the attractive surroundings, using these two objects in the composition.

The design incorporates the stair, the aviary and an antique weather vane into a single harmonious structure. Steel was selected as the basic structural and decorative material because it possessed both the necessary strength and the ability to be worked to achieve the lightness and grace required.

The platform is made up of triangular and rectangular panels of teak decking supported on steel angle frames which in turn are supported by a steel pipe structure. The primary members of the frame are 3-in. diameter, and the secondary members are 1½-in. diameter. Steel infill panels between the pipe columns are fabricated from bar stock and were designed to integrate the differences in scale between the new structure, the stair, and the aviary. All connections are welded.



TWO-WAY TRUSS ROOF— An Economical Solution

by Stanley D. Lindsey

Several unusual problems had to be solved in the design of the new Student Union Building at Tennessee A & I State University in Nashville. Careful studies of several structural framing systems showed that a steel two-way truss was the best solution to the challenges faced by the structural engineer.

The basic design requirement was a completely column-free interior for a square structure slightly less than 10,000 sq ft in area. Columns were to be provided only at the four corners of the building. Because windows were to be positioned beneath the framing, all around the building's perimeter, deflections had to be small for the large clear spans involved. The roof framing was to be kept to the minimum practical depth to avoid the "ponderous" appearance of trusses with usual span-depth ratios. All of this was to be achieved within a tight construction budget.

The steel two-way truss system best met all these structural, architectural, and economic requirements. It created a well-proportioned and functional expression of the purpose of the structure, minimized deflection and span-depth ratios, and fit the tight construction budget. Careful attention to details affecting fabrication and erection helped reduce the cost of the system.

The Two-Way Truss System

The two-way truss for this project is a square grid system. The grid is 98'-4" x 98'-4", with four supporting columns placed at the corners. The corner columns are 90'-0" on centers, and there is a 4'-2" overhang on all four sides of the building. Each 90'-0" span is divided into four equal spaces of 22'-6", since

---

Stanley D. Lindsey is principal of the firm of Stanley D. Lindsey & Associates, Ltd., Nashville, Tennessee, who were roof design consultants on this project.

The two-way truss frame was assembled on the floor, then lifted into place as a single unit. Four cranes, one at each corner, easily handled the 34½-ton assembly. Bar joists between the trusses and outriggers to frame the roof overhang were installed later.

that spacing allows optimum balance of economy between bar joist design and truss design. Steel bar joists span the 22'-6" spaces between trusses.

The span of the joists is reversed in adjacent bays to achieve a symmetrical two-way loading on the system, since all joists in the same direction would result in loading not conducive to two-way action. Metal roof deck tops the joists.

The 4'-2" overhang around the building was accomplished by extending the ends of the bar joists or by providing outriggers where the joists ran parallel to the overhang.

Total depth of framing is 6'-6". Computed maximum deflection of the framing is 2 in.

The entire two-way truss system was assembled on the floor, then erected as a unit. Assembly took about one week. Using a mobile crane at each corner, the roof framing was lifted into place in four hours, which included moving in, rigging, etc. The weight of the framing during lifting was approximately 8½ pounds per square foot. Well over 50 pounds per square foot would have been necessary to reach yield point in any of the trusses. With such a light and rigid system, erection proved easy.

With grid erection completed, deflections were checked and compared to those used in design. In all cases, the actual deflections were found to be smaller. The difference, which was slight, can be explained by extra rigidity of systems not accounted for in the computations.

Design Economies

Several design decisions contributed substantially to economy. Duplication in truss material made fabrication much less expensive, with better load distribution to the trusses as a bonus. The more heavily stressed truss chords were carried through the truss intersections. Truss chords carrying lesser stress could afford reduced net sections at connections and were punched for field bolting to wing plates welded to the continuous chords. This connection detail, using high strength bolts, eliminated much field welding. Gusset plates were eliminated by permitting a small amount of eccentricity of the truss diagonals at some panel points and by welding these diagonals directly to the webs of the split-tee chords.

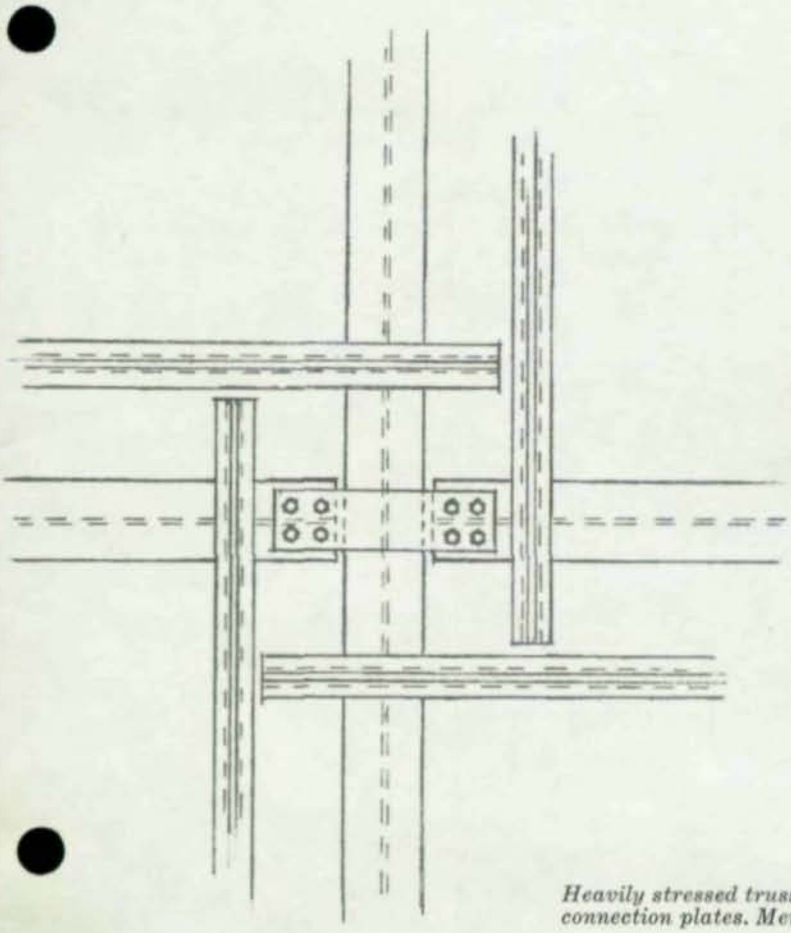
The unit cost of the entire two-way truss system, including trusses, joists, outriggers, and metal deck, amounted to only $2.13 per sq ft. The economy achieved can be attributed in part to the structural efficiency of the two-way system, but in part it was also achieved by carefully considering the requirements of both the material and the design problem. By duplicating fabrication, field bolting where practicable, and developing simple details, steel costs were reduced and economy was engineered into the job.

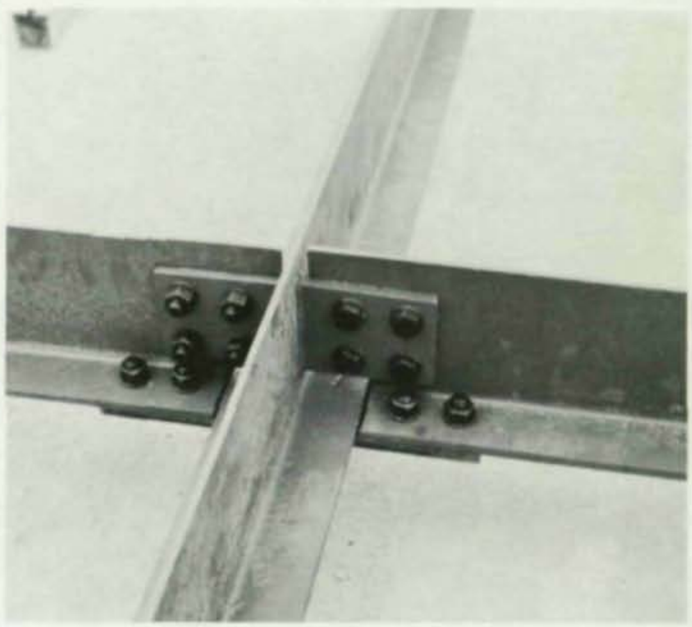
Architect: McKissack and McKissack
Nashville, Tennessee

Structural Engineer: Jack Figilis
Nashville, Tennessee

Roof Design Consultant:
Stanley D. Lindsey
and Assoc., Ltd.
Nashville, Tennessee

General Contractor: Melson Contractors
Shelbyville, Tennessee



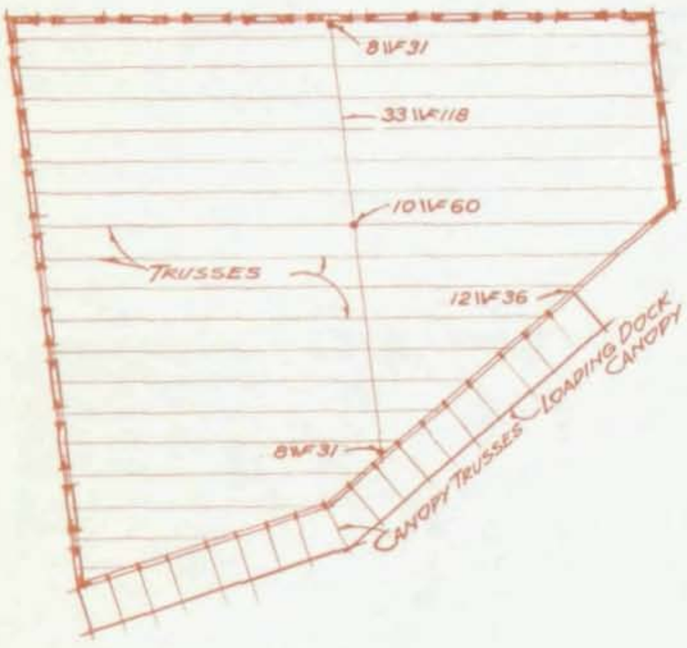


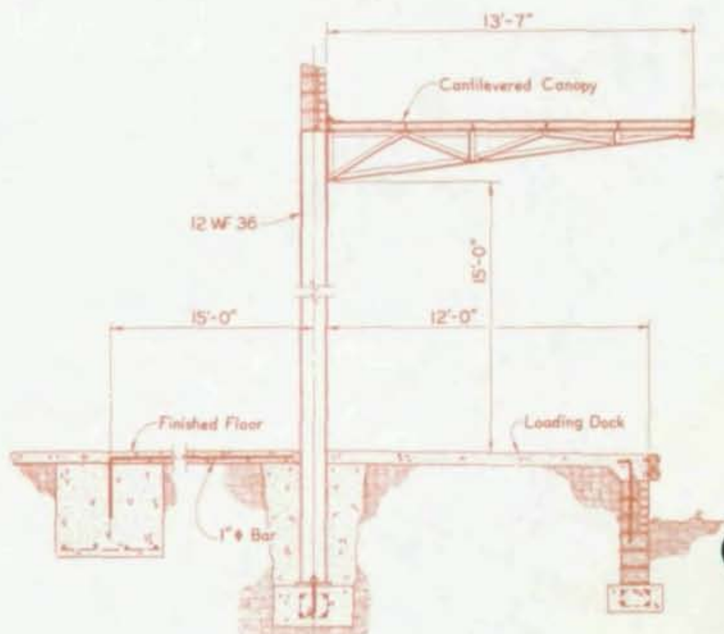
Heavily stressed truss chords are continuous through truss intersections, carry welded connection plates. Members subject to lesser stresses are field bolted to the plates.

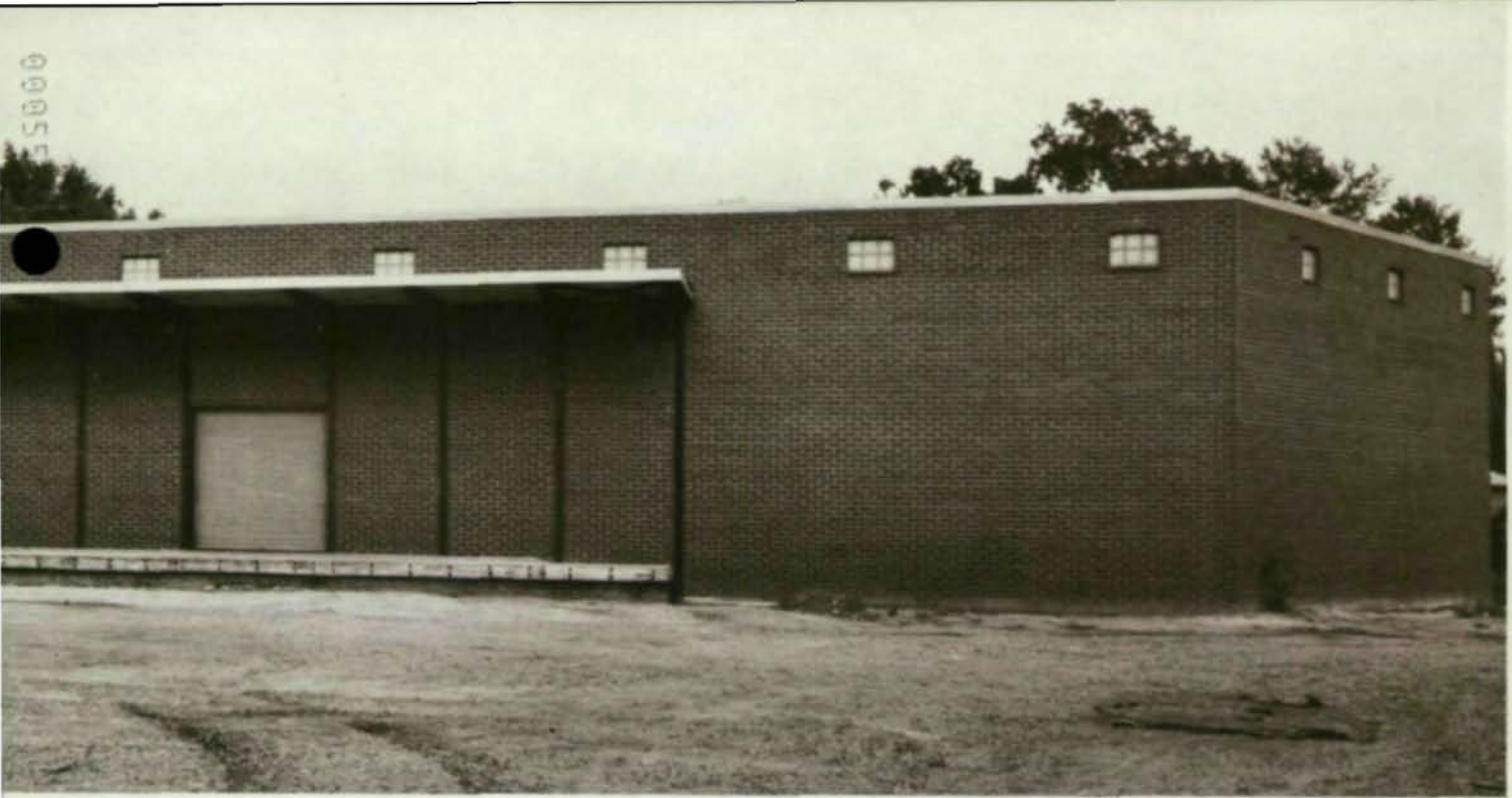
Simple Steel Frame for an "Open" Warehouse

Warehouses, like any other type of commercial building, must be designed and constructed in such a manner as to insure maximum usability of floor space if an owner is to realize the best possible return on his investment. This can best be accomplished by designing the building in accordance with the physical characteristics peculiar to the commodities it will be expected to house.

If the warehouse is to be divided *into separate storage areas, intermedi-*

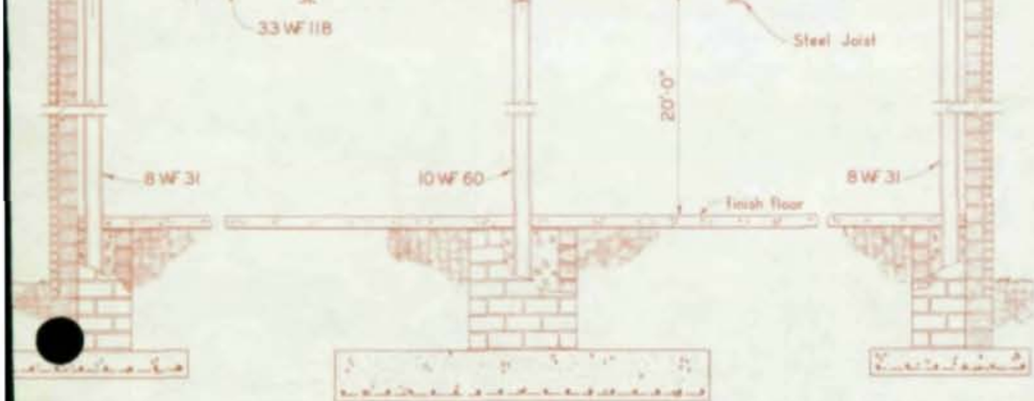






ate support columns can sometimes be used to advantage in the form of partitioning members. However, in the case of the warehouse designed and built recently in Augusta, Georgia, by Harry Peihl Vanderkhoff, the commodity to be housed was furniture, and a single, large area, free of obstructions, was desirable.

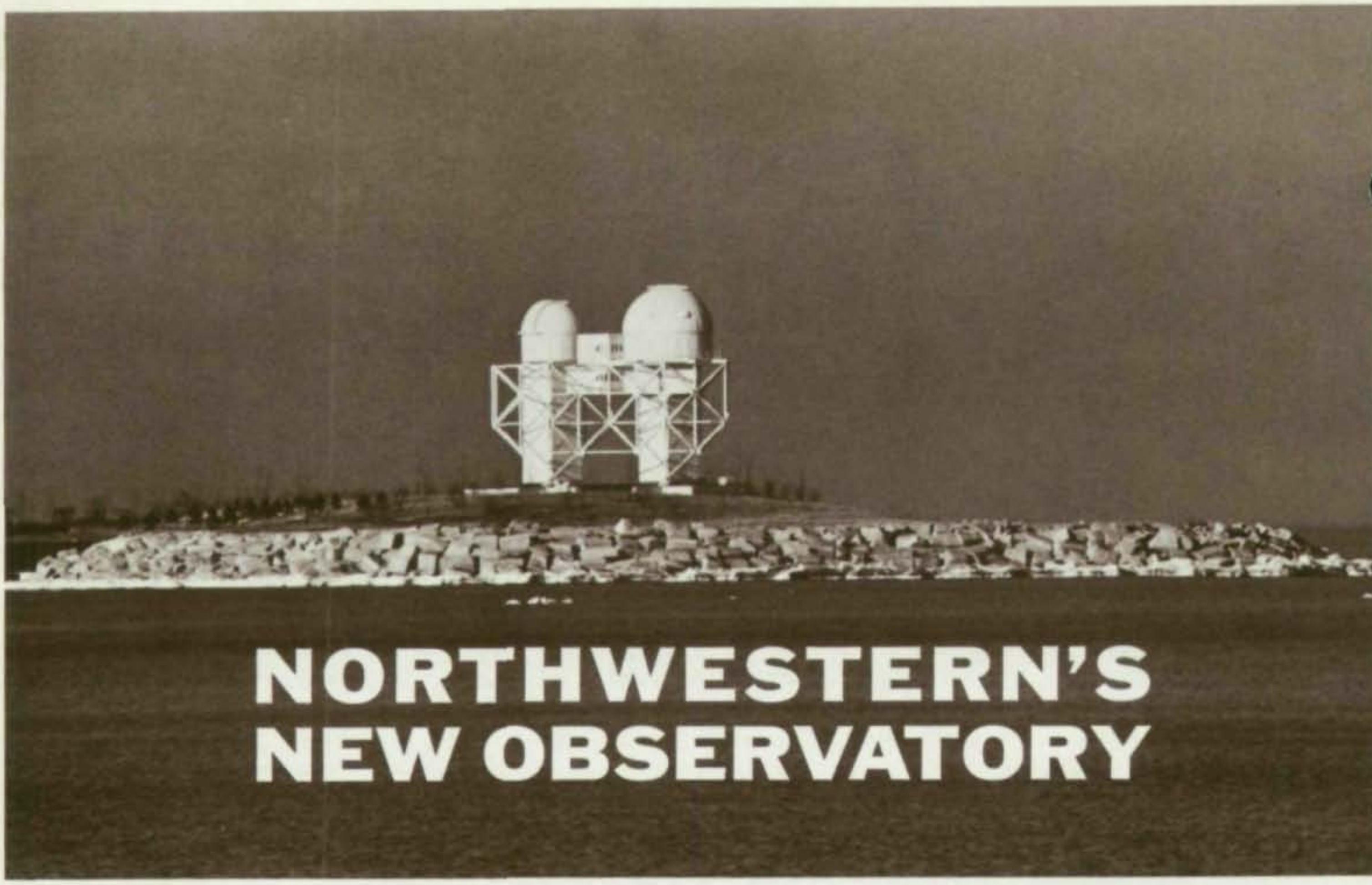
This requirement was met by using a 2-span variable section continuous beam of A36 steel approximately perpendicular to the rear of building, with A36 steel trusses 8 ft o.c. placed at right angles to the continuous beam. The section modulus of the continuous 33WF118 beam was increased over and adjacent to the intermediate column by welding four 3-in. diameter bars 20 ft long to the inside of the top and bottom flanges on both sides of the web. By this means the depth of the beam and the depth of the bearing portion of the trusses were kept constant throughout the building. The trusses were simply supported by the beam and the exterior masonry walls. This design required only one intermediate column, providing 17,000 square feet of floor space with optimum flexibility for storage arrangements.



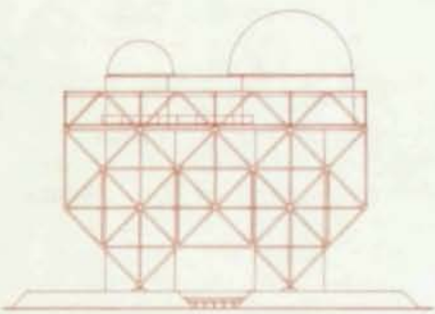
The intermediate column and the two end columns supporting the beam were concrete encased from the top of their respective footings up to a point just below the floor slab. This provided additional lateral stability for the building.

Continuing the theme of open, unobstructed space, the canopy trusses over the loading dock were cantilevered, eliminating the need for columns along the front of the loading dock. This innovation allows the trucks to load or unload at any point along the perimeter of the dock. The columns supporting the canopy were stabilized laterally by welding one end of a 1-in. diameter round steel bar to the column flange just below finished warehouse floor level and anchoring the opposite end of the bar into a concrete hold-back under the floor. The footing on which the wall and columns are supported is encased in earth of sufficient stability to prevent lateral movement of the bottom of the columns. In order to contribute further to the stability of the columns, the trenches around them were filled with 3,000 psi concrete.

Structural Engineer for the project was Harry Peihl Vanderkhoff and General Contractor was Peihl Corporation, both of Augusta, Georgia.



NORTHWESTERN'S NEW OBSERVATORY



Observatory structures are usually difficult to design and are often unusual in appearance, but few have the aesthetic appeal of the new telescope facility at the Lindheimer Astronomical Research Center at Northwestern University, Evanston, Illinois. Turning to light steel pipe framing as both a structural and architectural element, designers Skidmore, Owings & Merrill have created a facility that is not only functional, but is a dramatic landmark on the University campus.

The 7,700 sq ft observatory structure houses 40-in. and 16-in. reflecting telescopes. To distribute loads and minimize vibrations and thermal actions which could affect the rigid alignments of the telescopes, two completely independent structural systems were employed.

The lower level framing and the piers supporting the telescopes are reinforced concrete. The upper and observing levels, windscreens, and the domes are carried on an independent steel pipe tetrahedronal truss structure. The observing level is elevated about 60 ft above grade and comprises three spaces: a 36-ft diameter dome covered observing room for the 40-in. instrument, a control room, and a 24-ft diameter dome covered space for the 16-in. instrument. Immediately below the observing level, the upper level contains an instrument room, small dark room, and main code room. Stairs connect with the observing level and lower level, although major circulation to the lower level is by elevator.

The steel pipe structure and domes are painted with a special white titanium paint for reflectivity, as are the corrugated steel panel walls. Windows on the upper and observing levels are double-glazed operating sash.

Architect-Engineer:
Skidmore, Owings & Merrill
Chicago, Illinois

General Contractor:
Pepper Construction Company
Chicago, Illinois