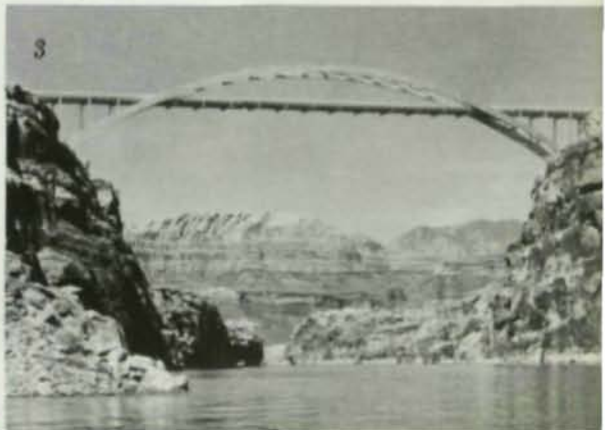
VOLUME VII / NUMBER 4 / FOURTH QUARTER 1967

MODERN STEEL CONSTRUCTION

1 *Notre Dame Athletic and Convocation Center . . . . page 6*

2 *Worship in a Steel-Framed Tent . . . . page 11*

3 *Prize Bridges of 1967 . . . page 17*



MODERN STEEL CONSTRUCTION

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CONTENTS

Bidwell Bar Suspension Bridge – A Historical Landmark 3
Notre Dame Athletic and Convocation Center 6
Worship In A Steel-Framed Tent 11
"Wrap Around" Technique Keeps Plant In Production 14
Bonus – An Independent Structural System 16
Prize Bridges of 1967 17

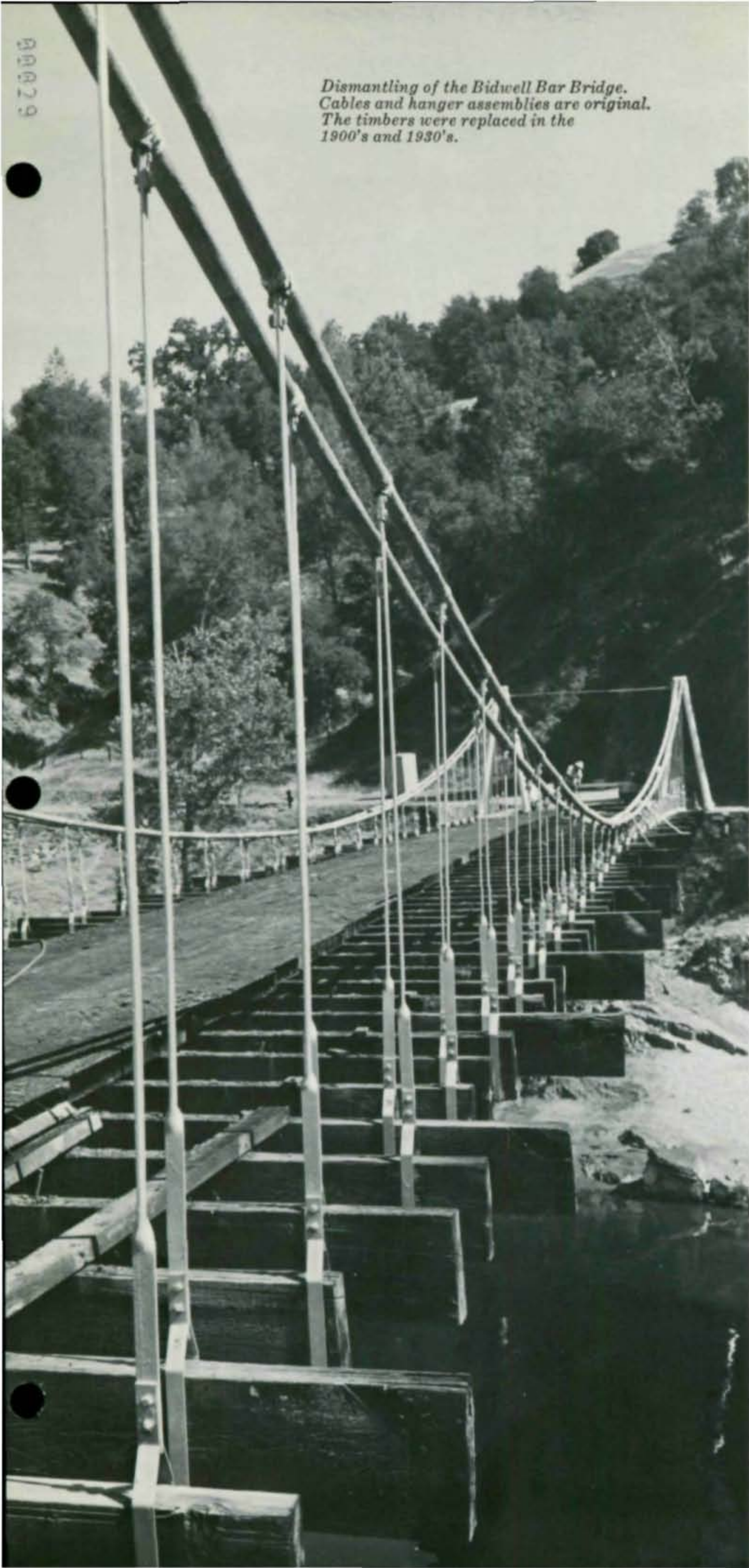
NATIONAL ENGINEERING CONFERENCE IN WASHINGTON, D. C.

The 20th annual AISC National Engineering Conference will be held on May 2 and 3, 1968 at the Sheraton-Park Hotel in Washington, D. C. Leading authorities in steel design, research, and construction will meet to exchange ideas and information about the latest developments in these fields. This conference is a "must" for anyone who designs structures.

For additional information about registration contact AISC, 101 Park Avenue, New York, N. Y. 10017.

SOUTH SAN FRANCISCO SCULPTURE

The story "Instead of a Billboard" in the last issue of MSC described Aristides Demetrios' 92-ft high steel sculpture for Cabot, Cabot & Forbes, but did not credit Structural Engineers T. Y. Lin, Kulka and Yang & Associates, San Francisco, and General Contractor Aberthaw Construction Co., South San Francisco, for their important contributions to the project. We regret the omission, and take this opportunity to salute all who were connected with this unusual and daring structure.



Dismantling of the Bidwell Bar Bridge. Cables and hanger assemblies are original. The timbers were replaced in the 1900's and 1930's.

Bidwell Bar Suspension Bridge — A Historic Landmark

by Ernest C. James

The Bidwell Bar Suspension Bridge near Oroville was one of several suspension bridges constructed in Northern California in the 1850's. One was constructed at Whiskey Bar, one at Rattlesnake Bar, one at Condemned Bar, and one at Comanche. There may have been other suspension bridges built in the gold rush areas in California during this period, but the Bidwell Bar Suspension Bridge is the only one remaining. All were significant in their contribution to the development of the northern part of the Sierras during the gold rush period.

The design and construction of relatively complex structures such as this provided a great step forward in the history of civil engineering. The names and backgrounds of the designers responsible for this work are not known today, but it is obvious that they had an engineering background.

The original Bidwell Bar Toll Bridge at this site was licensed by the Court of Sessions in May 1851. It was built, but was lost in a flood during April 1852. A second license was granted to Thomas A. Sherwood and Joseph E. V. Lewis in October of 1852 for construction of a toll bridge. In the meantime a ferry

Ernest C. James is Supervising Engineer, Dept. of Water Resources, State of California, Sacramento, California.

plied the river at the site. The bridge apparently was not built, as additional franchise applications were made during 1854. In December 1854 a license was granted to the Bidwell Bridge Company to build a suspension toll bridge. Advertisements for bids were entered in the Butte Record from January to March 1855. A contract was awarded in May 1855 for erection of the bridge. The successful bidders, Jones and Murry, contractors from Sacramento, completed the bridge in 1856.

Manufacturing processes for wire used in the Bidwell Bar Bridge were developed in the late 1830's. Records show that the manufacture of wire in any quantity did not take place until the middle 1840's. It is amazing that the pioneers during the gold rush period brought these technical advances to California, and had the capabilities of designing, ordering materials, and constructing structures of this magnitude under the extreme frontier conditions of the early 1850's.

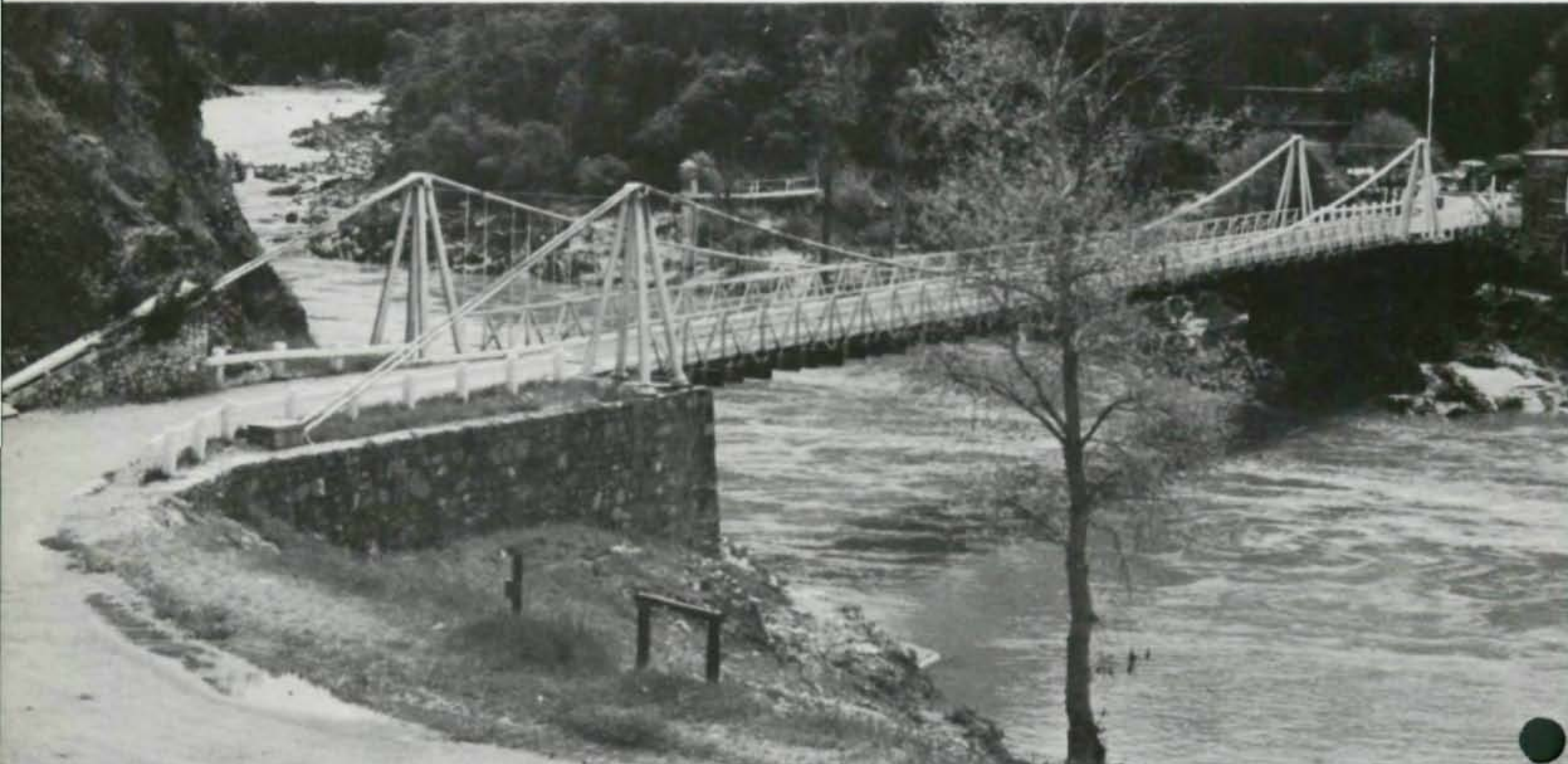
The original structural components of the Bidwell Bar Suspension Bridge were primarily of wrought iron or cast iron. The four 2-in. diameter cables were made up of about 300 No. 10 wires laid in parallel strands. Each cable was then spirally wrapped with a wrought iron wire of the same size and then heavily painted. Anchorages were bent wrought iron bars, buried deep in the foundations. The towers consisted of four cast iron posts tied together with a cross of cast iron plate at the base. Each assembly was capped with a specially fabricated cast iron cap, topped with a cast iron saddle on rollers which could move with the cables. The towers were made by the Starbuck Iron Works in Troy, New York. In 1964 all components of this bridge, including the anchor bars, were in excellent condition.

The Bidwell Suspension Bridge spanned the Feather River at Bidwell Bar approximately ten miles northeast of Oroville. In 1964 the bridge was dismantled because of the construction of the Oroville Dam and Reservoir. The State of California plans to construct the bridge in a historical park somewhere near its original location as part of the recreational facilities of Oroville Reservoir. Components are stored in the Oroville area, and are marked and classified for this reconstruction. Dismantling was done under the guidance of personnel from the State Office of Architecture and Construction, specializing in reconstruction of historical artifacts.

The California State Department of Water Resources is supervising construction of Oroville Dam and Reservoir, key facility of the $2.8 billion State Water Project, which will carry surplus Northern California water southward to areas of need. A new Bidwell Bar Bridge has been built as a part of the project.

This historic structure was named a National Historic Civil Engineering Landmark by the American Society of Civil Engineers in May 1967. Presentation of the bronze plaque will be made when the Bridge is reconstructed.

Bridge and toll house before dismantling.



Anchor assembly of wrought iron bars and pins. Little or no corrosion was noted even though these bars were buried for 110 years.

General appearance of cables throughout the bridge.

Cast iron cable saddle and roller assembly.

Cable covering deterioration near the anchorage. Exposed wires show little evidence of deterioration.

Notre Dame Athletic and Convocation Center

E. L. Gardner,
Chief Structural Engineer
Ellerbe Architects

The Athletic and Convocation Center is the 85th building to be erected for the University of Notre Dame since its modest beginning in an Indiana wilderness log cabin in 1882. Located adjacent to South Bend, Notre Dame is a self-sustained city of 1,000 acres with 1,800 full-time staff and over 7,700 students, of whom approximately 4,500 live on the campus and require eating, living, and recreational facilities.

From log cabins to $10,000,000 buildings in 125 years marks a great institution of higher learning with universal recognition for quality teaching facilities. Some of the more recent steel-framed buildings designed by Ellerbe Architects for the University are the North Dining Hall, Computing Center and Mathematics Building, $8,000,000 13-story Memorial Library, and, presently under construction, power plant extensions and a giant 308-ft diameter twin dome Athletic and Convocation Center.

Structural Details

The center is of two major structural materials – each used where it will do the best job comensurate with cost. Steel framing for the huge domes did a better job for less cost, saved money on foundations, and reduced construction time. There are 16 pounds of steel per square foot of dome surface or 584 tons per dome.

The domes have a 312′-7″ vertical radius with a 40-ft rise above support bearings. A higher rise would have required less steel, but the architects desired the short rise for aesthetic reasons. A 40 psf horizontal projection live load was used for the design with a full unsymmetrical live load located to produce maximum stresses in all framing members; 50 psf of roof surface dead load plus an additional 1,000 lbs concentrated load on each ring for each rib.

Each dome has a welded compression ring 15 ft in diameter at the crown, four intermediate rings, and a tension ring at the extremity. There are 36 ribs in each dome spanning from the compression ring at the crown to the tension ring at the base, which rests on graphic lubricated bronze bearings. The compression ring is fabricated in two sections and bolted together with high strength bolts in the field. The main ribs are fabricated in two pieces and are field spliced with high strength bolts. The section sizes vary; a 14WF61 section being used at the crown near the compression ring and increasing in size to a 14WF111 section used at the base near the tension ring. All connections to rings are made with high strength field bolts. The main ribs (spaced concentrically between the tension and compression ring) are 14WF78 at the top ring, and 14WF103 at the bottom ring. The tension ring is fabricated from a 14WF287 section. 36WF300 girders with 1¼-in. welded cover plates spanning 60 ft and framed into steel columns are used in the concourse floor to support concrete joists over the gymnasium below; 36WF230 girders are used for the concourse roof. Steel girders saved head room and building cubage which further added to cost savings.

The splices at the rib junctures are shop welded. Eighteen field welded splices are utilized along the circumference of the ring. Each field splice consumed one man-day of welding time. The webs were welded first, then the flanges. Field and shop splices were tested by ultrasonic techniques. All field connections are bolted except for the 18 field welds in the tension ring. A36 steel was used for all members.

A sizeable saving was achieved by designing all straight framing members for the dome roofs. The trapezoidal areas between the ribs and the concentric circles are flat surfaces. A curved appearance is obtained by straight lines in parabolic structures, and the same offset is obtained in circular buildings and dome roofs.

Erection

A temporary steel tower supported the crown compression ring while the ribs were placed in tandem across the dome with two cranes. Each rib was supported by steel jack posts at the half point between crown ring and bearings. The ribs were assembled on the ground in pairs, including purlins; then the pie-shaped sections were hoisted in place and field spliced at the center jack post.

All shop drawing steel dimensions were electronic computer checked by the design engineers. The 1/32-in. allowed by the fabricator on all steel members to compensate for "crawl" was insufficient. The closing space ring members were approximately 3 in. too long. Fifty-ton hydraulic jacks were used in the plane of the roof and parallel with the members to open the space, but they distorted the roof framing and moved the main ribs too far out of alignment on the bearings. Three pie-shaped sections were taken back to the fabricator's plant and trimmed for a drive fit. The deflection at the center compression ring was calculated to be 4 in. when the support tower was lowered. Actually the dome ring floated free when the closing members were installed and all rib members centered on the bearings. The diagonal bracing was installed loose, and tensioned after all main framing was in place. The high tensile bolts at the center ring were retorqued after the tower and jack posts were removed.

Roof Construction

1½-in. deep acoustical metal deck, welded to the steel purlins with the flat side up, is used on the roof of both domes. 2½-in. thick rigid insulation is asphaltic mopped to the flat surface. True white chlorinated polyethylene sheet laminated to flexible urethane foam tops the insulation for a finished roof surface.

General Features

The University needed a building that would house under one roof all the athletic activities plus flexibility-of-use features; this required a building 750 ft wide and 635 ft deep. The two domes are connected by a central core area containing concourse, athletic staff offices, auditorium with film viewing facilities, exhibit space, dining and banquet areas that can be used for alumni gatherings, dances, and civic meeting rooms. There are 460,000 sq ft of air-conditioned recreational facilities.

The arena dome seats 12,000 people for basketball games and can be reduced by folding the outer rings of seats in toward the center. This outer circle then becomes space separated from the arena and available for varied student activities. There are seven basketball courts; two of them are collegiate regulation size. Handball and squash courts are located in the periphery.

The fieldhouse dome is devoted to multiple use with track and field and ice skating. The track is 1/10th of a mile, six lanes wide, with a 60 yard straightaway. Space is also provided for three tennis courts and baseball. The regulation size ice skating rink is adjacent to the field and track area and is designed for hockey with a free skating area for student and public use. Flexibility is accomplished in the fieldhouse dome by using the ice skating area for ice shows or removing the ice and replacing with tennis courts. The area is large enough for a three-ring circus that will seat 1,200 people and an additional 1,200 in portable seats. Planned future expansions will add 2,000 more seats.

A peripheral ring of approximately ¼-span of the arena dome has acoustical fire rated plaster applied to metal lath framing on the underside of the framing and steel deck. The remainder of the deck is of sufficient height above the floors that fire protection is not required. Fire protection is not required in the fieldhouse dome.

Extensive studies and planning were made for sound control in the arena and it was determined that acoustical material in the roof decks, on walls, the seat backs that can be folded into the walls, and some fire rated acoustical plaster were sufficient for acceptable results.

Mechanical and Electrical Features

Climate control is achieved by a split system to meet the flexible requirements for warm air in the arena and at the same time maintaining a colder climate in the fieldhouse, especially the ice skating area. There are five changes of air per hour in the arena and fieldhouse, eight changes for the offices and four for the concourse; handball and squash courts in the arena periphery have three air changes per hour. The exhaust is removed in the circle at the top of both domes. The air conditioning load requires 1,200 tons of refrigeration; steam load is 30,000 pounds per hour. Air volume for the arena is 180,000 cfm.

Selective switching for metallic vapor and quartz floodlights in an elliptical ring lights the arena center activity floor while maintaining maximum spectator and performer comfort. Intensity exceeds 200 foot candles for basketball courts with switching that reduces levels to 50 foot candles. The elliptical light ring has provisions for a future 80-ft x 35-ft major theatrical stage with all lights and rigging. The fieldhouse is lighted by four, five, and six color true deluxe mercury vapor lamp clusters of high bay light, attached to the steel arch ribs. Selective intensity can be varied from 100 to 50 foot candles for general illumination. The hockey rink has 200 foot candles that can be reduced to 25 foot candles for civic skating. The 8,000 sq ft central concourse has 35 foot candles of soft quartz indirect lighting. Supplementary exhibit high-lighting is provided from concealed plug-in taps. Closed circuit and commercial T.V. and radio can be simultaneously or independently broadcast from either dome structure or concourse. A private automatic dial telephone system serving 100 stations, expandable to 200, augments the center's public communications. There is a two-way radio paging system for maintenance and operating personnel. Emergency power is furnished by a 100 KVA standby generator. There are two 4,160 volt service lines. Two 750 KVA transformers at each service location provide 277 and 480 volt power and lighting for the building. Unforeseen power and lighting demands can be supplied from portable panelboards and extension cables that plug into fixed power outlets located throughout the center.

Some of the unique features of the center are seats that can be elevated (permitting semi-trucks to enter the arena space), automobile size car elevators for moving exhibits to upper levels, television lighting for exhibit booths, and rooms for wire services.

Preliminary Studies

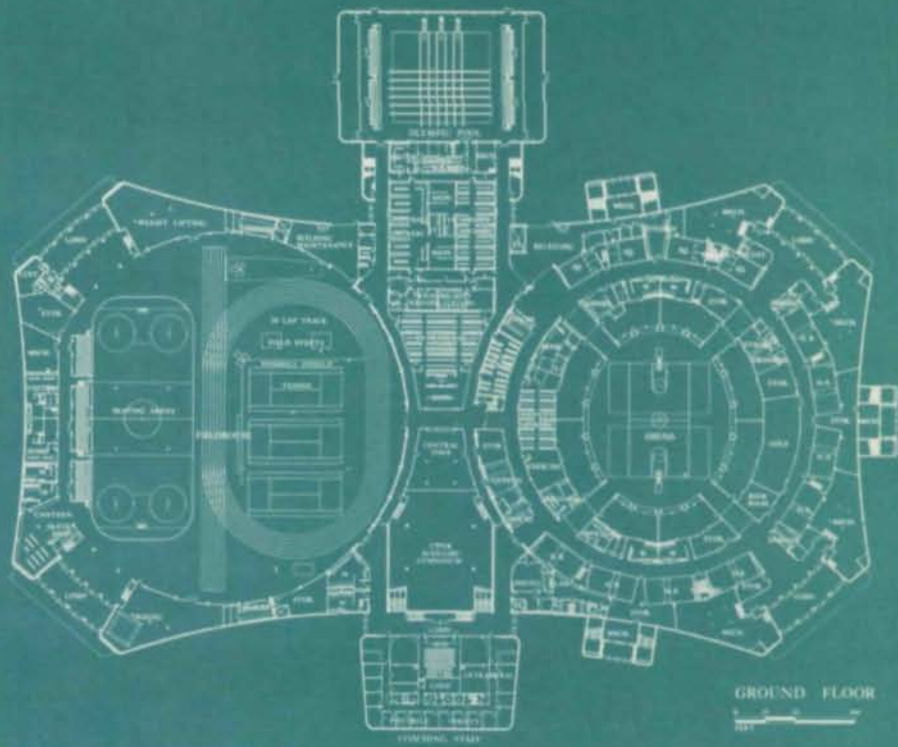
Preliminary planning began with an air trip to several universities and existing dome structures. Many people of Notre Dame contributed to the Athletic and Convocation Center concept. The flexibility of design achieved in the complex is the result of close coordination, through final design, between the contributors and architects.

Studies and cost estimates were made with several types of dome framing and roof materials, and steel led in all study results.

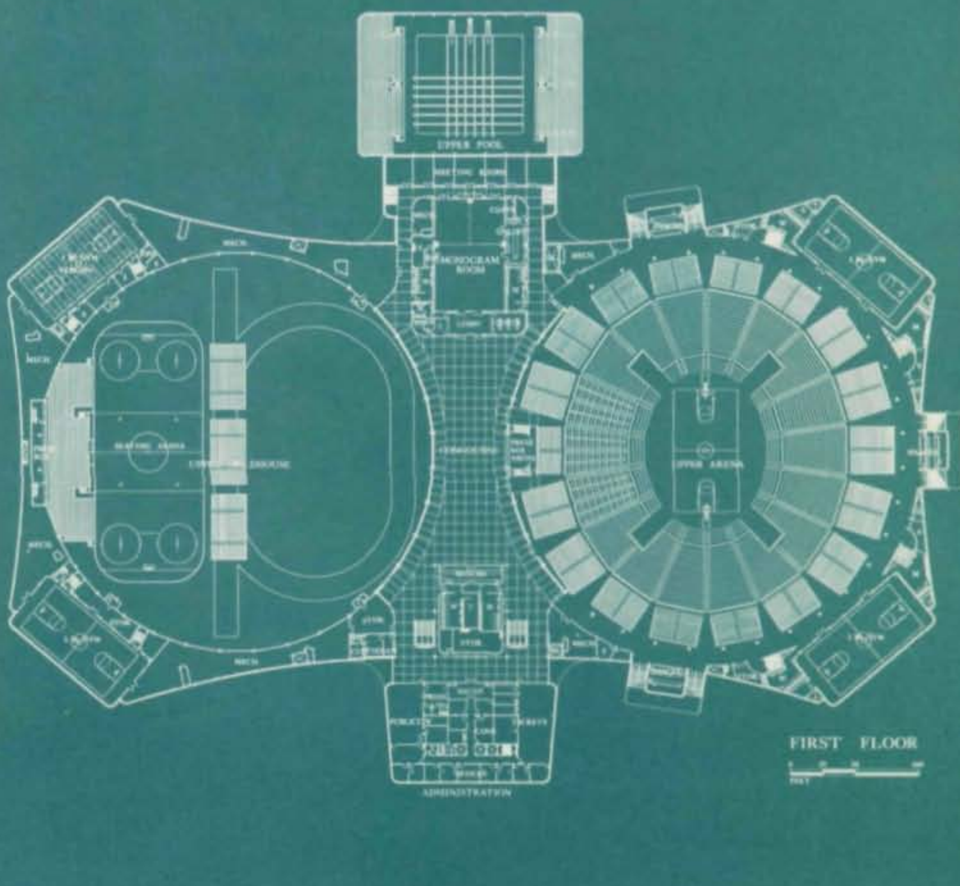
Architects-Engineers: Ellerbe Architects, St. Paul, Minnesota

General Contractor: Schumacher-Sons, Inc., Mishawaka, Indiana

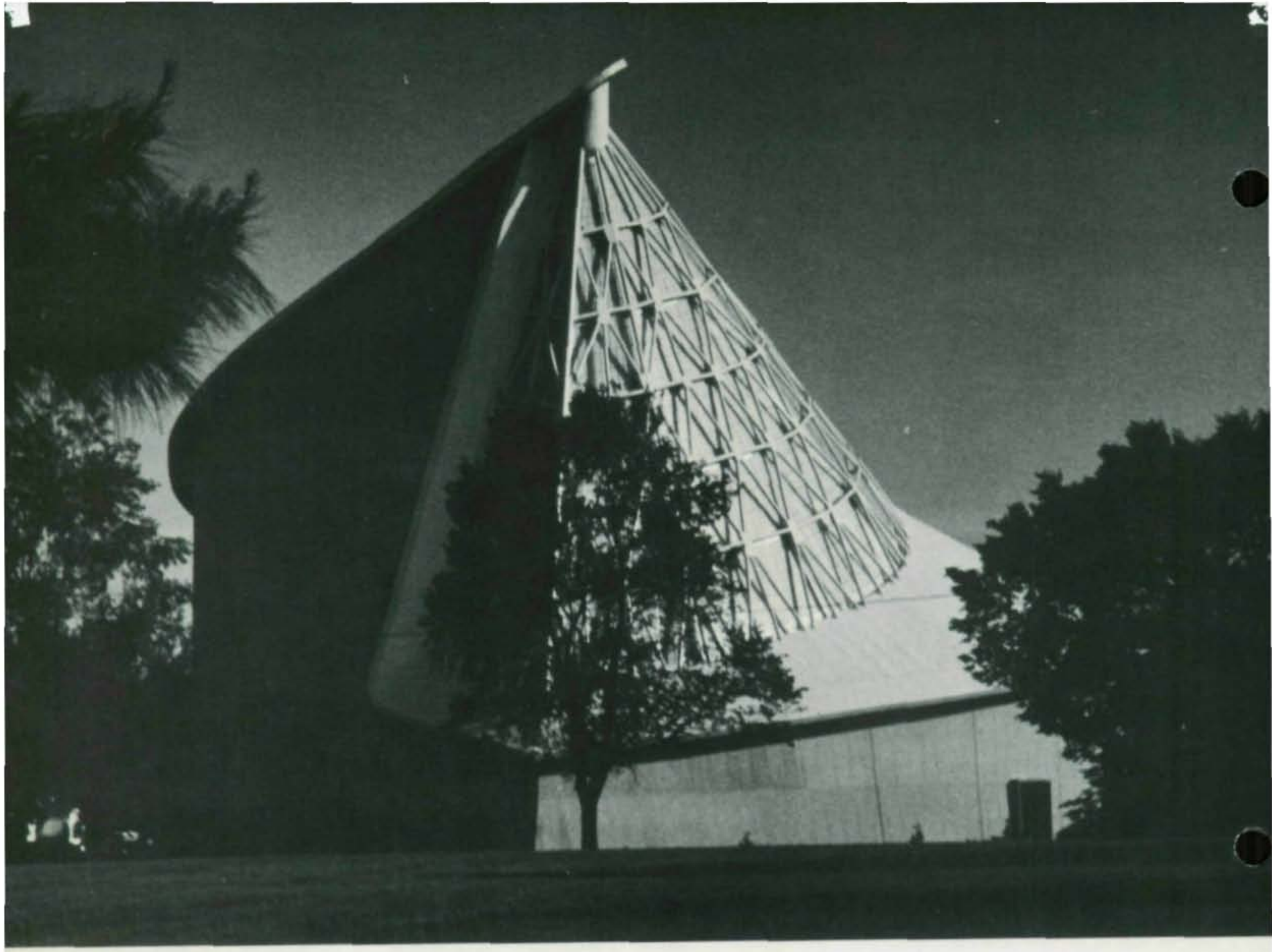
Steel Fabricator: Allied Structural Steel Co., Hammond, Indiana

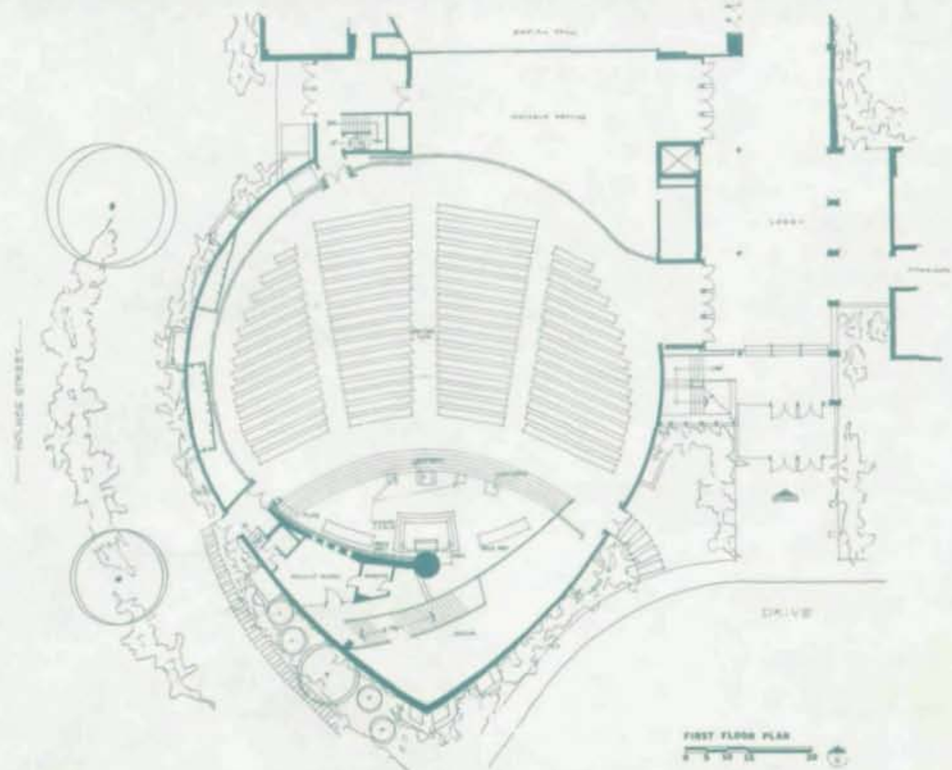


GROUND FLOOR



FIRST FLOOR





Architect: Kivett and Myers, Architects-Engineers, Kansas City, Missouri

Structural Engineer: Bob D. Campbell & Company, Structural Engineers, Kansas City, Missouri

General Contractor: Sharp Brothers Contracting Company, Kansas City, Missouri

Worship In A Steel-Framed Tent

The Sanctuary of the Temple Congregation B'nai Jehudah, Kansas City, is a unique blending of ancient tradition, contemporary architectural philosophy and modern structural materials. Designed to house religious services for a Reformed Jewish Congregation, the Sanctuary seats 1,000 persons and can be expanded to a total of 2,000 by means of large movable sliding soundproof doors. The upper level of the building is a separate space to be used only for worship. The ground floor, below the Sanctuary, provides multi-purpose rooms, a rotunda for receptions, an area for choir practice, a lounge, and storage facilities. The building is an addition to an existing religious school.

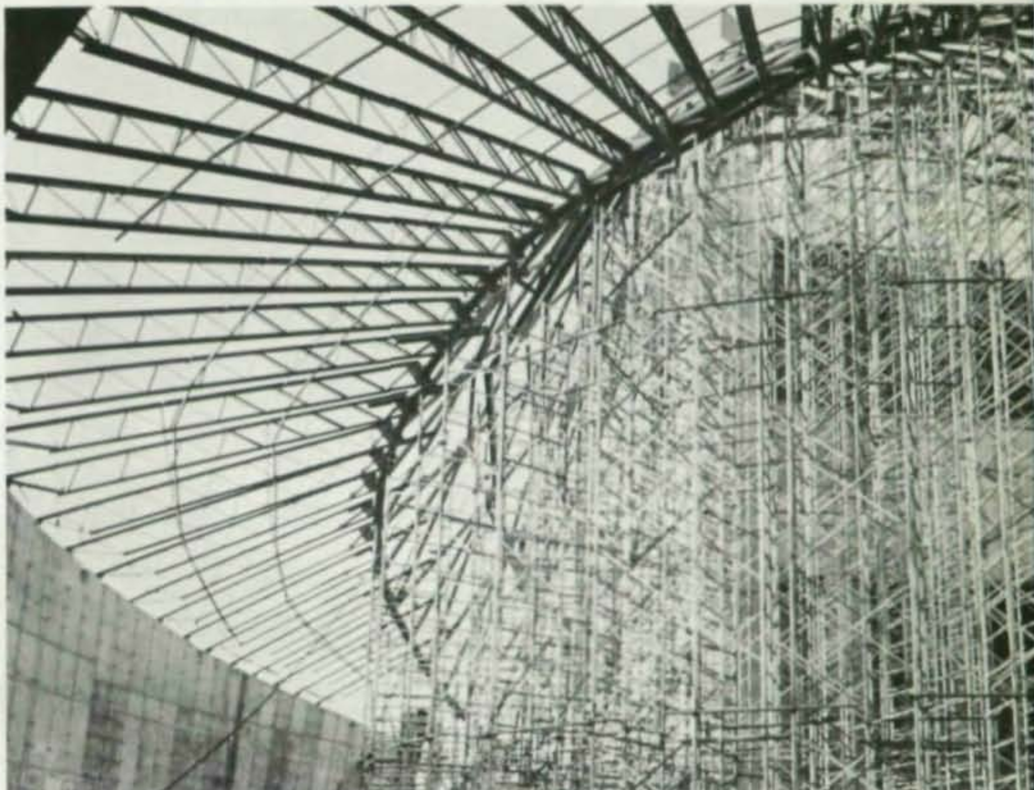
Clarence Kivett of Kivett and Myers, Architects-Engineers, describes the design philosophy of the structure in the following terms: "The form of the Sanctuary is a dynamic, physical and spiritual expression of the feeling and the character of the moral aspects of the religion and its religious aspirations for the advancement of mankind. The design total – the mass, weight, and inherent dynamics – is in deliberate contrast to the existing Religious Education Building, clearly emphasizing its single function as a House of Worship.

"This concept is a translation of ancient and revered forms into today's materials and construction techniques. The building has a timeless aspect – the basic idea of structure is the tent form, which is almost as old as man. Translating this tent form into a concept for today's buildings produced the spiral and helix. These shapes, common in nature in shells, plants, etc., are important considerations in linking forms of nature to the form and shape of a building. The materials are dealt with naturally and honestly, and are thus allowed to express their inherent characteristics as simply and organically as possible."

Physical Characteristics

In keeping with the tent concept, a towering center pole – a concrete column 6 ft in diameter and 83 ft tall – supports the major portion of the steel-framed roof area. The roof is designed as two elements. The smaller element is the upper cone, framed with exposed steel pipe, which supports a skylight of translucent deep-blue plastic panels. The lower area, a helix shape, is approximately 6 to 8 ft deep at its deepest part, with space within for air ducts and electrical and mechanical apparatus. The skylight allows only a minimum of deep blue light to penetrate, creating a sense of serene quiet and deep mystic haze up to the very heights of the Sanctuary.

The ark (an enclosure which houses scrolls of the five books of Moses commonly called the Torah) is attached to the center pole. The Bema platform (at the ark) is large enough for participants in the services, including adequate area for seating of confirmation classes. To the rear of the Bema, the choir is hidden, due to its location approximately halfway down from the Bema floor level. A small meditation area is also provided behind the platform, and this area also



includes the Rabbi's robing room, the organ loft and a family room where a bereaved family may easily watch a funeral service.

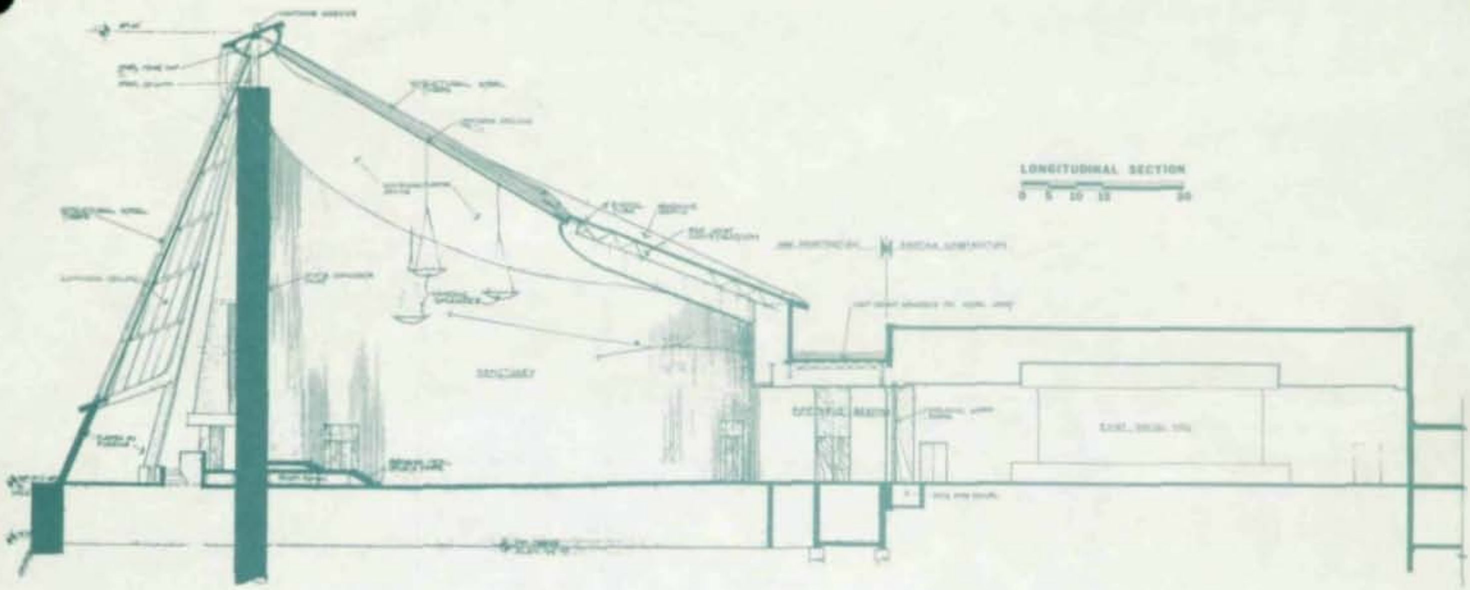
Structural Solution

The roof structure has two main conoidal elements. The larger area is helix-shaped and forms a singly curved shell roof which is supported by the walls around the exterior perimeter and by the other conical element at the inside edge. The helix is formed by straight segments (long span steel joists) and is a warped conical generation. The preliminary structural studies for the project were made with a helix of thin shell concrete. However, a half-scale model, which was load-tested, showed the shape to be sensitive to elastic buckling under certain loadings. Other studies indicated that long span steel joists could be used as leave-in-place forms which, when combined with the shell curvature, would provide good composite action for the final total load capacity. The steel-frame system was calculated to be less than half the cost of an equivalent rib-stiffened concrete helix.

The design of the inner cone, framed principally with 5-in. exposed steel pipe, was also an interesting problem. To provide free space for the interior, the concrete center pole was offset 44 ft to the south. To handle the resulting eccentricity, nine post-tensioned prestressing cables, attached to the terminals of the pipe framing at the basement level, were anchored to piers belled in shale under a 10-ft thick limestone ledge, slightly more than 50 ft below grade. The anchorage provides active instead of passive resistance to the loads on the pipe system.

For aesthetic reasons the pipe-framed cone is above and outside of the plastic skylight attached to it. The resulting thermal changes of the structural system added unusually severe complications to the analysis. Calculations indicate that in very cold weather 90% of the helix is supported on the inside cone. On the other hand, in very hot weather 75% of the helix load is carried on the outside walls. The intersection of the pipe cone and helix near the center of the building was calculated to move vertically 2¾ in. between temperature extremes, when considering the action of the dual support systems.

Several grades of steel were used to maintain relative sizes in the members. The 5-in. diameter framing varied from ⅛-in. tubing to double extra strong pipe of A53 steel. The column mast cap is A242 steel. Three of the nine tie-down units are A242 steel. The long span joists are LH type, and the short span joists are H type. All connections are welded, with many joints requiring full penetration butt welds.


LONGITUDINAL SECTION

"WRAP AROUND" TECHNIQUE KEEPS PLANT

Problem: How do you build a new manufacturing facility on the same site as an existing factory complex, without losing a single day of scheduled production?

Solution: Build the new plant over and around the old one, while production continues at a normal rate.

The old plant of Design & Manufacturing Corp., Connersville, Indiana, a manufacturer of small appliances, was a rambling series of old wood mill buildings constructed at various intervals since 1900. A new and larger plant was needed – both for space and efficiency. *Architects Fleck, Burkart & Shropshire* and structural engineers Fink, Roberts & Petrie designed a new steel-framed plant that could be built over the existing factory without halting production in any way – and at less cost than conventional plant replacement methods.

Careful studies indicated that a new 205,000 sq ft plant could be built over and around the old 150,000 sq ft facility at a cost of about $1,100,000 – almost half the cost of more conventional construction methods – and that production could be maintained without interruption throughout the construction.

Precise steel erection and close coordination and cooperation by the erector, the fabricator, the contractor, and the plant management were the keys to the success of the project. Interior columns had to be spotted to miss locations of heavy production machinery. This called for close tolerances, and at *times 12-in. columns, lowered through* 16-in. holes in the roof, passed within a foot of workers at their machines. Utility lines passing through locations of new columns had to be rerouted shortly ahead of erection.

Preplanning every step of the steel setting was a "must" in an operation as intricate as this one. The steel framing was divided into 12 erection sections of about 70 tons each. Shop fabrication was coordinated with installation, and deliveries were made to the site on the basis of a critical path method schedule. Much of the steel was erected directly from the delivery trucks. Setting was handled by crawler cranes with a 160-ft boom and a 50-ft jib.

Compounding the erection problems were lack of storage space on the site and a minimum of maneuvering space for the cranes. The erectors worked with templates and scale layouts to deter*mine crane positions in advance of each* steel lift. In many areas, because of the long crane reaches and tight quarters, radio-telephone instructions guided the crane operator. The time required to pick up and land a column averaged between five and ten minutes. All steel was set within seven weeks.

The new plant is approximately rectangular in shape, 768 ft long, 280 ft wide, and 38 ft high. One bay reaches a height of 45 ft. Column spacing varies from 40 to 55 ft, and intermediate beams are spaced 15 to 22 ft on center. Steel trusses roof an area over a former courtyard. The roof is 3-in. metal deck and fiberglass insulation board.

The old plant was almost as wide as the new building, but about 35 ft shorter. Average height was 26 ft, except for a section 34 ft high in the press area.

When steel erection was completed and the new building completely closed in, the old buildings were demolished from the inside. The entire operation required approximately eleven months from start to completion of construction.

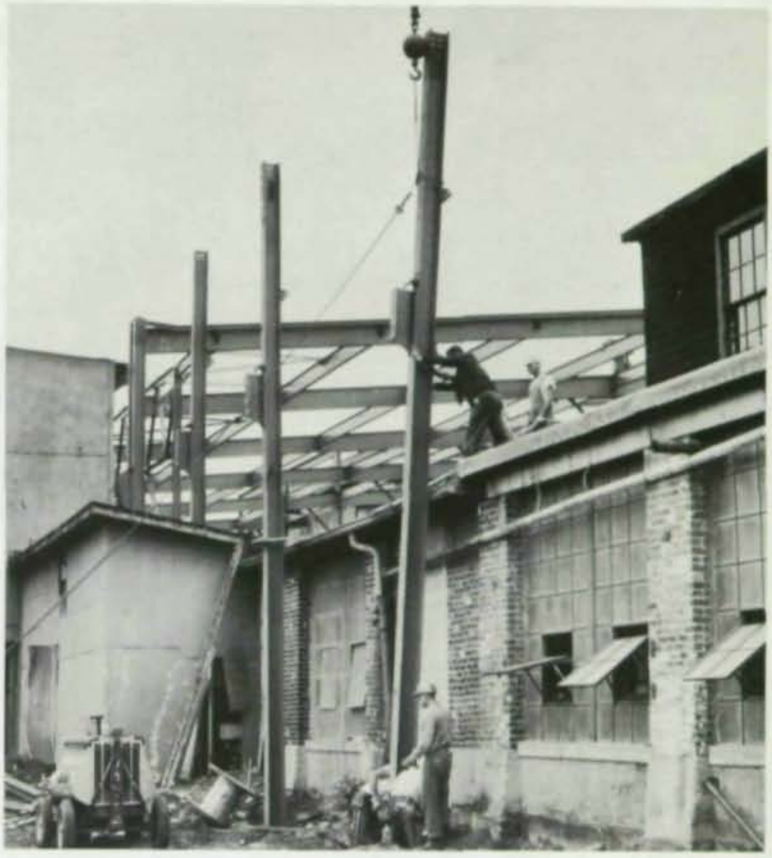
Architect: Fleck, Burkart & Shropshire, Architects & Engineers, Indianapolis, Ind.

Structural Engineer: Fink, Roberts & Petrie, Inc., Indianapolis, Ind.

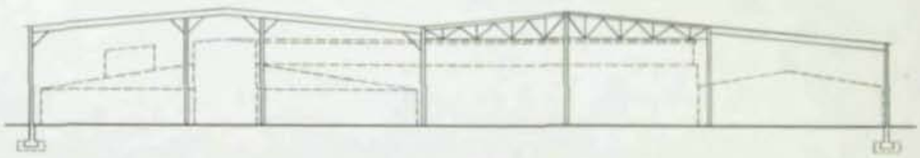
General Contractor: Glenroy Construction Company, Inc., Indianapolis, Ind.

Steel Fabricator: Hugh J. Baker & Company, Indianapolis, Ind.

Steel Erector: Erectors, Inc., Indianapolis, Ind.



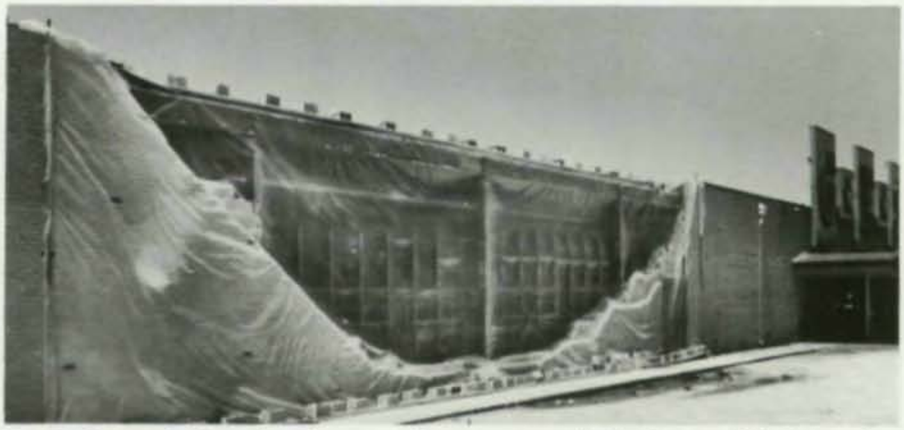
IN PRODUCTION



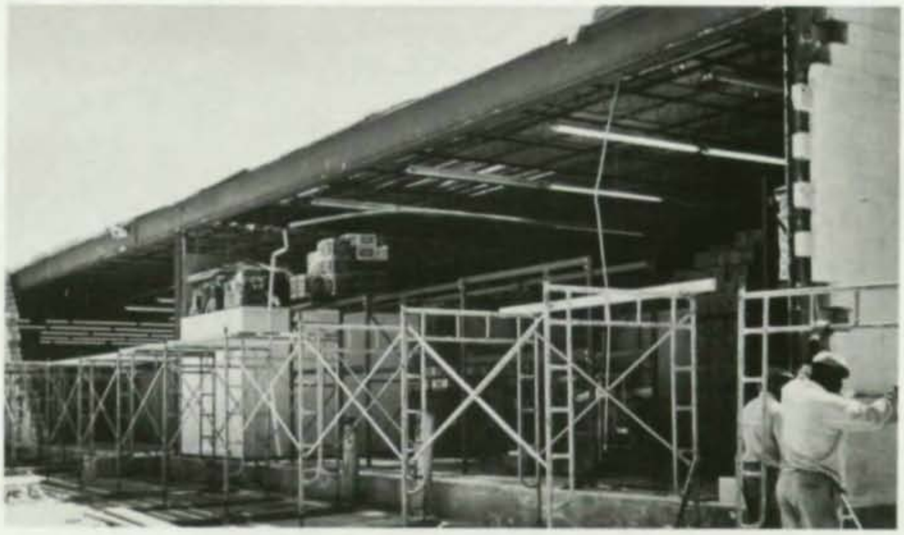
Bonus—An Independent Structural System

by Robert J. Schaffhausen, AISC Regional Engineer

Tornado "blew out" walls on three sides of GES Department Store in Birmingham, but steel frame was undamaged.



Repairs began the day after the storm. Store was open for business within the week.



It was a rather humid May 6th, a typical shopper's Saturday in Birmingham except for the growing early darkness caused by an increasing number of storm clouds. Our family had been in the GES Department Store shopping and had left about 4:00 p.m. to drive to a local drive-in for the evening snack. Increasing darkness and the forecast of impending thunderstorms caused us to cut our snack time short and we headed for the "over the mountain" suburban area south of Birmingham. We had hardly more than just reached home when the evening newscast announced the GES Department Store had been struck by a tornado.

The GES Store is a steel frame and bar joist structural system, one-story in height, with 12-in. concrete block-brick veneer combination non-load bearing walls. Neither was the roof unusual in that it consisted of poured gypsum on form board with bulb tees, which supported a conventional built up roof.

The store, though large, is not unusually so, relative to its shopping center class. It is 378 ft wide and 251 ft-8½ in. long. The tornado that struck, however, was unusual, catching both shoppers and store personnel by surprise.

A quick survey of the damage after power had been restored indicated that large portions of the walls on three sides had collapsed. The wall collapse was predominately outward, indicating a reduction of pressure on the exterior, caused by the tornado. The steel structural system remained in place. Steel columns, beams and bar joists were undamaged and no one had been injured. Mr. W. N. Rowell of Brice Building Company, Inc., the general contractor on the original building, had repair crews on the job the next day and the store was open for business within the week.

Tornadoes are unpredictable. We know they cause extreme air pressure differences and these, plus high velocity winds, are the source of their destructive power. Another might not affect the building in the same manner as this one did. The logical conclusion derived from this particular incident, however, indicates that the non-load bearing walls, being independent of the structural steel frame, acted as a safety valve. Their collapse returned a balance in pressure leaving frame and roof intact. This is why Mr. Julius Goldstein, Vice-President of GES, wrote Mr. F. O. McCollum of O'Neal Steel Company, the steel fabricator, saying in part, "The fact that the construction was a full steel frame (in lieu of wall bearing construction often used in this type building) in our opinion was the reason for our being able to resume operations in record time." Needless to say, architect Charles H. McCauley Assoc. and structural engineer Robert H. Wallace, Inc. were also pleased with the "bonus" provided by the independent structural system.

Dr. Newmark is Head, Department of Civil Engineering, University of Illinois. He is an Honorary Member, American Society of Civil Engineers.

PRIZE BRIDGES OF 1967

by Dr. N. M. Newmark

The function of a bridge is obvious. And its form, constrained by that function, involves other constraints as well — of topography, location of piers and abutments, required clearances, means of access, and the like. Hence, one would think that the aesthetic aspect of the design of a bridge, involving so little freedom of choice on the part of the designer, would be either unusually simple or remarkably difficult. If the designer pays careful attention to the function of the bridge, he can ordinarily achieve a passably attractive structure. But to obtain harmony with the surroundings, pleasing proportions, elegance of outline, the sense of strength and safety — in short, to achieve beauty — this can be exceedingly difficult because of the many elements beyond his control to change or alter.

As one of the members of the Jury for the selection of the AISC Prize Bridges of 1967, I was impressed with the high quality of the entries. Many of the designs presented were pleasing, some were attractive, and a few were indeed striking. In these, the designers had taken advantage of the strength of their material to develop an uncluttered form with graceful lines to express the essential function of the bridge, without interference with the landscape. One structure, the Colorado River Arch Bridge — the prize winner in the "Long Span Bridge" category — was so attractive that every member of the panel, independently, had marked it for special attention.

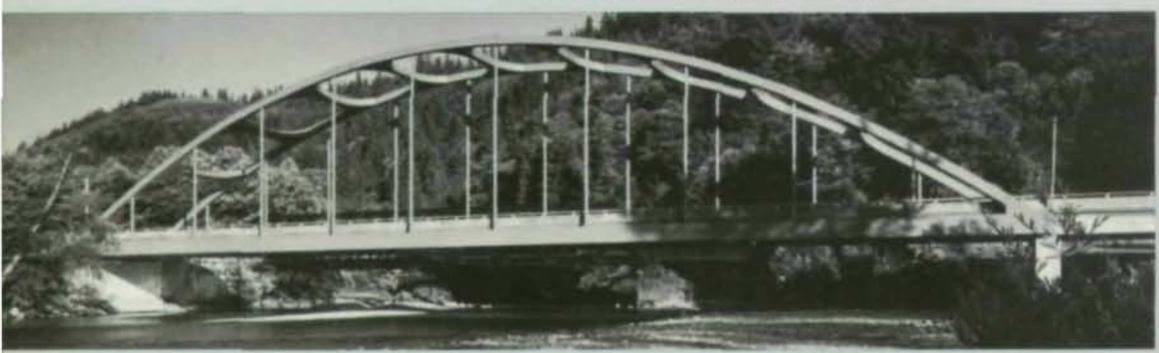
Although there were differences of opinion among the panel members on other categories, these were only slight; without being able to explain why, in detail, the panel members were remarkably consistent in their views as to the selections of the bridges for the awards. These selections appeared to have in common the qualities of simplicity, smoothness of line, lack of unnecessary ornamentation, and a sort of fitness of form to express the strength of the steel structure and the flow of traffic across the bridge. It is noteworthy that the prize winners had no haunches or other distractions to the eye of the observer and were in harmony with the piers and abutments, which also were graceful in proportion and simple in outline.

With modern materials and construction methods, it is not difficult to design and build bridges that are adequately strong and safe. The Prize Bridges of 1967 show that it is also quite possible to build bridges that are attractive, even beautiful. And this fact represents a major forward step in bridge engineering.

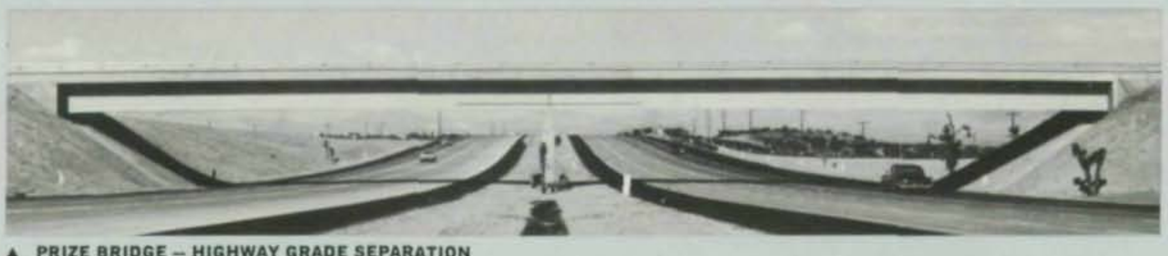
▲ PRIZE BRIDGE – LONG SPAN
Colorado River Arch Bridge
Utah Route 95, Garfield-San Juan County Line, Utah
Designer: Structures Division, Utah State Department of Highways
Owner: Utah State Road Commission
General Contractor: W. W. Clyde & Company
Steel Fabricator: Western Steel Company

◄ PRIZE BRIDGE – MEDIUM SPAN, HIGH CLEARANCE
Pioneer Memorial Bridge
Sacramento River Viaduct, Sacramento, California
Designer: State of California, Bridge Department
Owner: State of California
General Contractor: Kaiser Steel Corporation
Steel Fabricator: Kaiser Steel Corporation

▲ PRIZE BRIDGE – MEDIUM SPAN, LOW CLEARANCE
Merced River Bridge Bagby, California
Designer: State of California, Bridge Department
Owner: State of California
General Contractor: H. Earl Parker & Thomas Construction Company
Steel Fabricator: San Jose Steel Company, Inc.

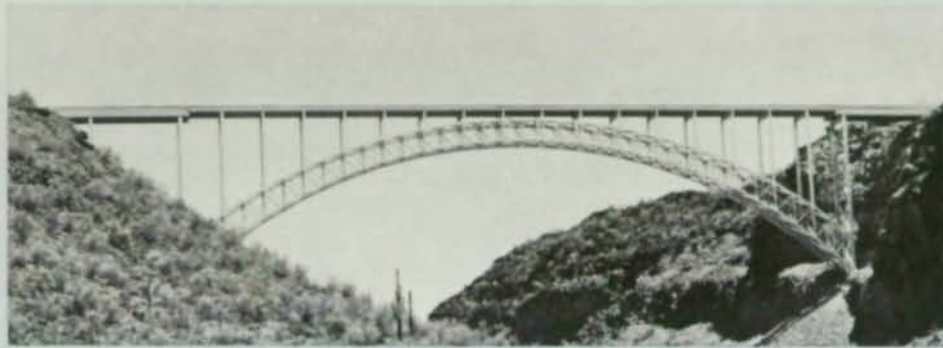


◄ PRIZE BRIDGE – SHORT SPAN
North Fork Stillaguamish River Bridge
Snohomish County, Washington
Designer: Bridge Division, Washington State Highway Commission
Owner: Department of Highways Washington State Highway Commission
General Contractor: Dale M. Madden Construction, Inc.
Steel Fabricator: North West Steel Fabricators, Inc.



▲ PRIZE BRIDGE – HIGHWAY GRADE SEPARATION
Oak Hill Road Overcrossing 14 miles South of Victorville, California
Designer: State of California
Owner: State of California
General Contractor: Kasler Corporation, Gordon H. Ball Enterprises, and E. L. Yeager Company
Steel Fabricator: Precision Fabricators, Inc.

PRIZE BRIDGE – MOVABLE SPAN ►
St. Paul Avenue Bridge Milwaukee, Wisconsin
Designer: Bureau of Bridges and Public Buildings, Department of Public Works, City of Milwaukee
Owner: City of Milwaukee
General Contractor: Edward Kraemer & Sons, Inc.
Steel Fabricator: Wisconsin Bridge & Iron Company



▲ **AWARD OF MERIT — LONG SPAN**
Burro Creek Bridge
Highway 93, Mohave County, Arizona
Designer: Bridge Division, Arizona Highway Department
Owner: Arizona Highway Department
General Contractor: American Bridge Division — U. S. Steel Corp.
Steel Fabricator: American Bridge Division — U. S. Steel Corp.

AWARD OF MERIT — LONG SPAN ▶
Klamath River Bridge
Orleans, California
Designer: State of California Bridge Department
Owner: State of California
General Contractor: Murphy Pacific Corp.
Steel Fabricator: Murphy Pacific Corp.

◀
AWARD OF MERIT — MEDIUM SPAN, HIGH CLEARANCE
Hansen Bridge Over Snake River
near Hansen, Jerome and Twin Falls Counties, Idaho
Designer: Idaho Department of Highways (Bridge Section)
Owner: Idaho Department of Highways
General Contractor: Peter Kiewit Sons Company
Steel Fabricator: Western Steel Company

▶
AWARD OF MERIT — MEDIUM SPAN, LOW CLEARANCE
Woodland Bridge Woodland, Washington
Designer: Bjorn A. Stiansen, Harry R. Powell & Associates
Owners: Cowlitz County and Clark County, Washington
General Contractor: Ralph Lockyear Construction Co.
Steel Fabricator: Fought & Company, Inc.

◀
AWARD OF MERIT — SHORT SPAN
Dry Creek Bridge
Ione, California
Designer: State of California Bridge Department
Owner: State of California
General Contractor: O. K. Mittry & Sons and A. L. Croft (Joint Venture)
Steel Fabricator: San Jose Steel Co., Inc.

AWARD OF MERIT – SHORT SPAN

Alligerville Road Bridge over Rondout Creek
Ulster County, New York

Designer: Office of the Deputy Chief Engineer (Design), State of New York Department of Transportation
Owner: Ulster County Highway Department
General Contractor: V. J. Constanzi, Inc.
Steel Fabricator: American Bridge Division – U. S. Steel Corp.

AWARD OF MERIT – HIGHWAY GRADE SEPARATION

Goddard Bridge Goddard Space Flight Center, Greenbelt, Maryland

Designer: Whitman, Requardt and Assoc.
Owner: National Aeronautics and Space Administration
General Contractor: Dewey Jordan, Inc.
Steel Fabricator: Cumberland Bridge Co.

AWARD OF MERIT – HIGHWAY GRADE SEPARATION

Spring Garden Street – West River Drive Bridges
Philadelphia, Pennsylvania

Designer: Department of Streets, Bridge Division, City of Philadelphia
Owners: Upper Bridge: Commonwealth of Pennsylvania, Highway Department
Lower Bridge: Department of Streets, City of Philadelphia
General Contractor: Conduit & Foundation Corporation
Steel Fabricator: Bethlehem Steel Corporation

AWARD OF MERIT – SPECIAL TYPE

Bell Aerosystems Personnel Bridge
Wheatfield, New York

Designer, General Contractor and Steel Fabricator: Guardian Engineering & Development Company
Owner: Textron's Bell Aerosystems Company

AWARD OF MERIT – SPECIAL TYPE

Cribbon Avenue Pedestrian Overcrossing
Cheyenne, Wyoming

Designer: Wyoming Highway Department
Owner: Wyoming Highway Department
General Contractor: Reiman-Wuerth Company
Steel Fabricator: Burkhardt Steel Company

AWARD OF MERIT – SPECIAL TYPE

51st Street Pedestrian Bridge over Lake Shore Drive
Chicago, Illinois

Designer: Westenhoff & Novick, Inc.
Owner: City of Chicago, Department of Public Works
General Contractor: J. M. Corbett Co.
Steel Fabricator: Bennett Industries, Inc.