VOLUME XIII / NUMBER 2 / SECOND QUARTER 1973

MODERN STEEL CONSTRUCTION

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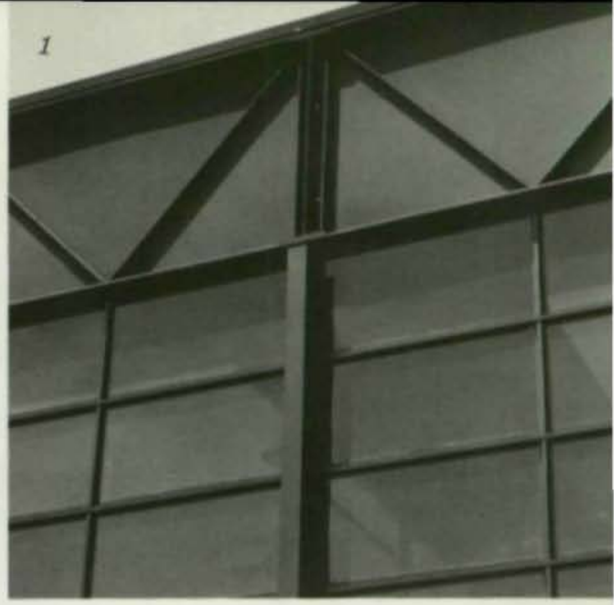

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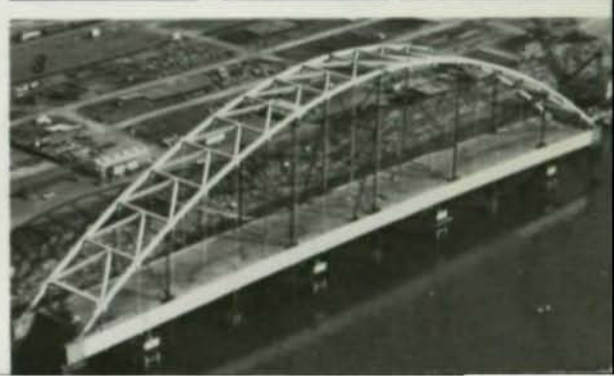

MODERN STEEL CONSTRUCTION

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COMPUTER PROGRAM FOR COLUMN DESIGN

To help meet the more sophisticated needs of today's engineering profession, a computer program based on the 1969 AISC Specification is available for the design of steel columns. This design aid offers a valuable means to utilize the computer to speed selection of the most efficient, economical column sections for a structure and to reduce design costs.

The program was developed by AISC in cooperation with the Committee of Structural Steel Producers and the Committee of Steel Plate Producers of American Iron and Steel Institute.

For further information, write to AISC 101 Park Avenue, New York, N.Y. 10017.

1973 ARCHITECTURAL AWARDS OF EXCELLENCE

All registered architects practicing professionally in the United States are invited to enter steel-framed buildings of their design constructed anywhere in the 50 states and completed after January 1, 1972 and prior to August 25, 1973. Each building must have been designed, detailed, and fabricated in the U.S., and all structural steel and plate must have been produced in the U.S.

The distinguished Jury of Awards includes:

Pietro Belluschi, FAIA *AIA 1972 Gold Medalist, Former Dean, School of Architecture & Planning, Massachusetts Institute of Technology, Cambridge, Massachusetts*

William W. Caudill, FAIA *Caudill Rowlett Scott, Houston, Texas*

Victor O. Gray, M.ASCE *Vice President, Consulting Engineering Council, Victor O. Gray & Company, Seattle, Washington*

Ambrose M. Richardson, FAIA *Chairman, Department of Architecture, University of Notre Dame, Indiana*

Archibald C. Rogers, FAIA *First Vice President AIA; Chairman, RTKL INC., Baltimore, Maryland*

Entries must be postmarked prior to August 25, 1973 and addressed to the Awards Committee, AISC, 101 Park Avenue, New York, N.Y. 10017.

Rendering of the Armstrong County Memorial Hospital in Kittanning, Pennsylvania.

A Modular Hospital for Flexibility and Economy

E. Alfred Picardi, Partner
The Perkins & Will Partnership
Washington, D.C.

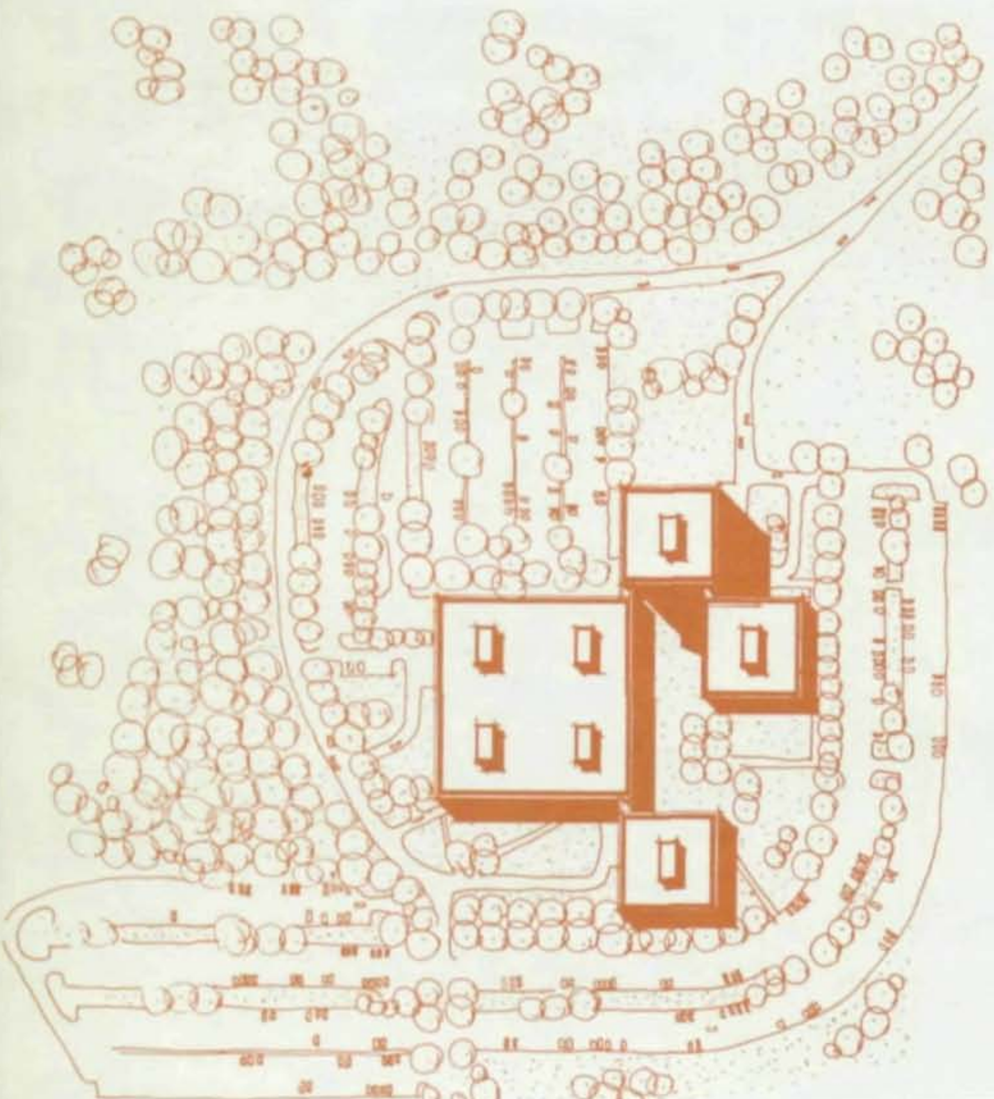
Although estimated at $10.1-million, the actual construction cost of the Armstrong County Memorial Hospital, in Kittanning, Pennsylvania, came in nearly $2-million lower, at $8,372,000. Further, construction time scheduled for 100 days took only 85. What kept the cost and time down was the modular system design. Using only three basic structural steel standardized components that could be utilized interchangeably speeded erection and produced the considerable savings.

The three-story, 220-bed hospital is the initial building of a projected medical complex. The modular system met the initial design objectives:

- Maximum flexibility of space to allow for changing needs and functions.
- Minimum interruption of services while space is undergoing alteration or expansion.
- Lowest feasible cost for construction and future expansion.

Above: Repetitive use of structural steel standardized components sped erection and cut construction costs.

Below: Plot plan indicates future modular buildings connecting to main hospital via bridges.



Design Features

The building comprises 48 modular units, each measuring 64 ft x 64 ft, connected and stacked on three floors of 16 units each. The size of the module evolved from an evaluation of optimal function layouts. The three basic structural steel standardized components used are columns, girders, and trusses. A checkerboard pattern of trusses in adjacent modules equalizes the girder and column loading, thereby allowing a standardized structural module. Columns are wide flange sections of A36 and A572 Grade 50 steels; welded plate girders are A36 steel; and Warren trusses with welded angle and tee members are A36 and A572 Grade 50 steels.

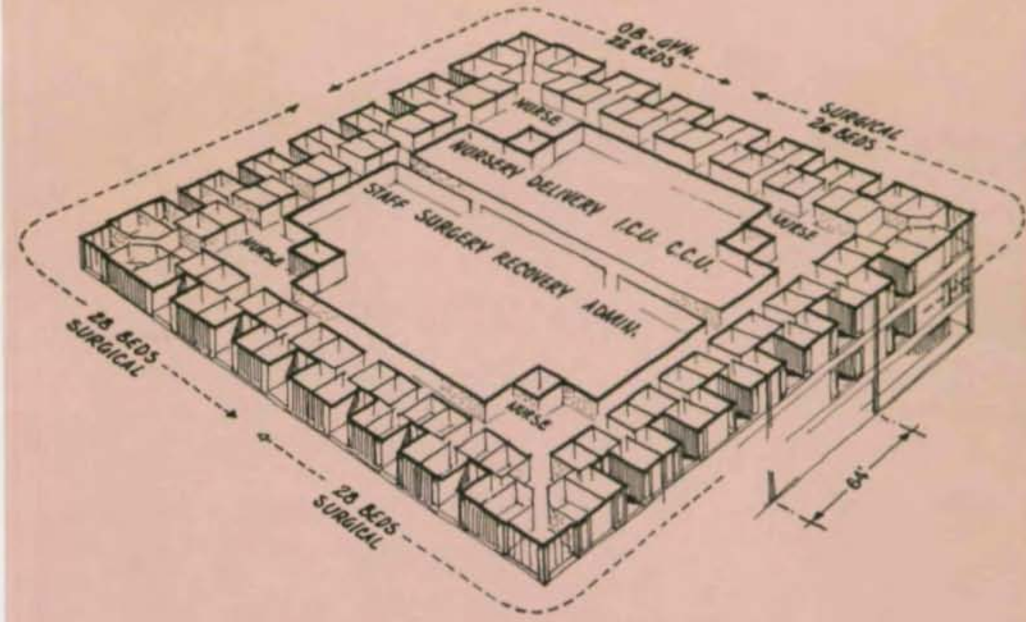
Mechanical and Electrical Services

The modular system optimized the mechanical and electrical installations. There is one vertical shaft located in a corner of each 64-ft square module. Four modules are grouped together in a 128 ft x 128 ft square to combine their utility shafts in the center and become a single service core, functionally independent and self-contained. With 16 modular units on each floor, there are thus only four utility cores. Vertically, each core serves 12 modular units in the three-story hospital. The distribution of services for each module is confined within that module and is done through the truss openings, offering a minimum of conflict between pipes, ducts, conduits, and structure.

Architect-Engineer:
E. Todd Wheeler and
The Perkins & Will Partnership
Washington, D. C.

General Contractor:
Martin and Nettrour Contracting Company
Pittsburgh, Pa.

Steel Fabricator:
P. B. I. Industries
Pittsburgh, Pa.



Third floor plan of hospital.

Plan Adaptability

The simple structural and electromechanical systems design provides maximum adaptability to changing needs as well as cutting the cost and construction time, both major concerns for health facilities.

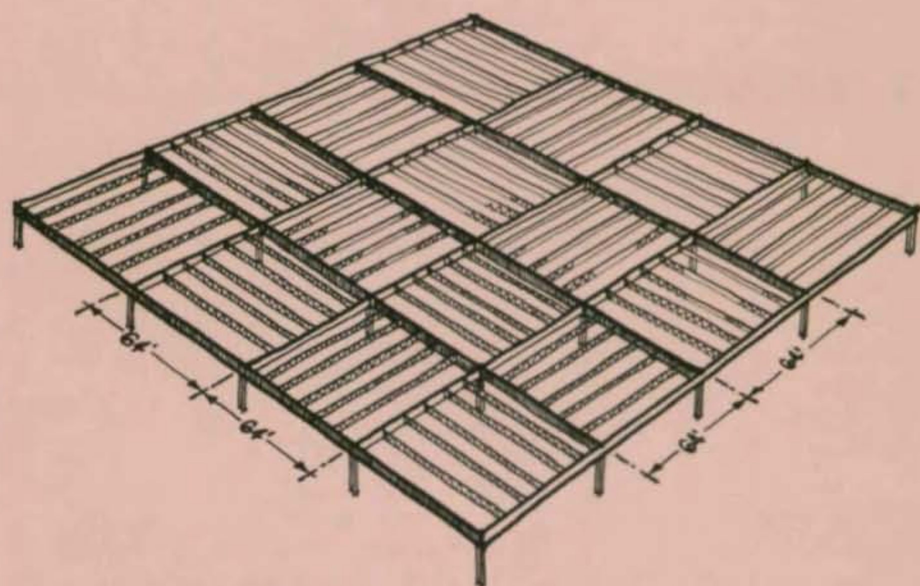
Except for the four utility cores and necessary stairs and elevator shafts, each floor can be a virtually uninterrupted space.

Growth Flexibility

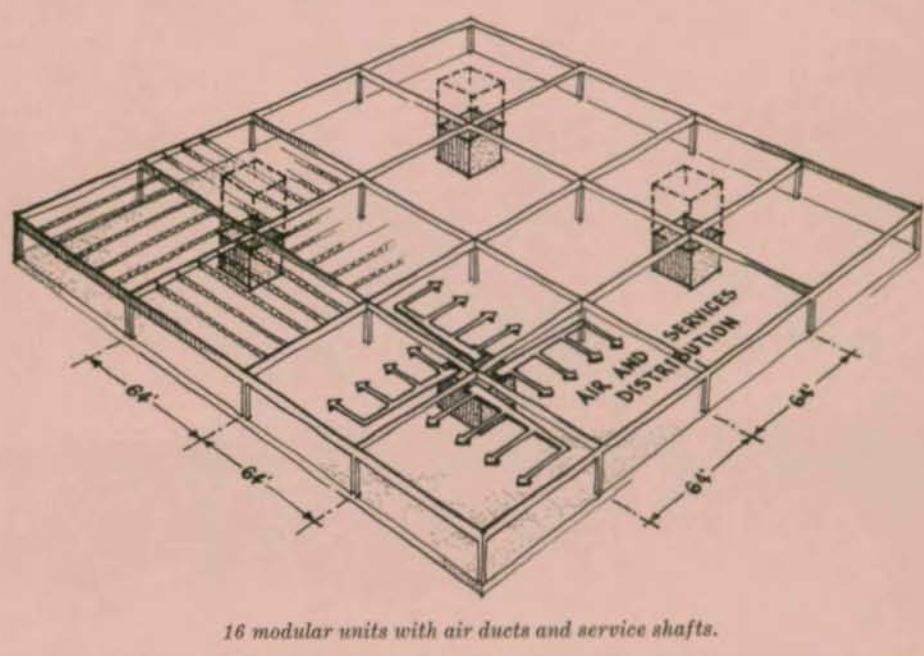
It is easier to plan for future growth with a systems hospital. For example, on the third floor of the Armstrong Hospital the surgical area contains four operating rooms, which can be expanded to double that number by relocating adjacent storage space and extending the recovery room.

The ground floor facilities of the Armstrong Hospital can be expanded separately and independently of the initial structure by adding the desired space at that level only. This potential recognizes the constant pressure to increase such ground-floor services as radiology, laboratories, and out-patient clinics.

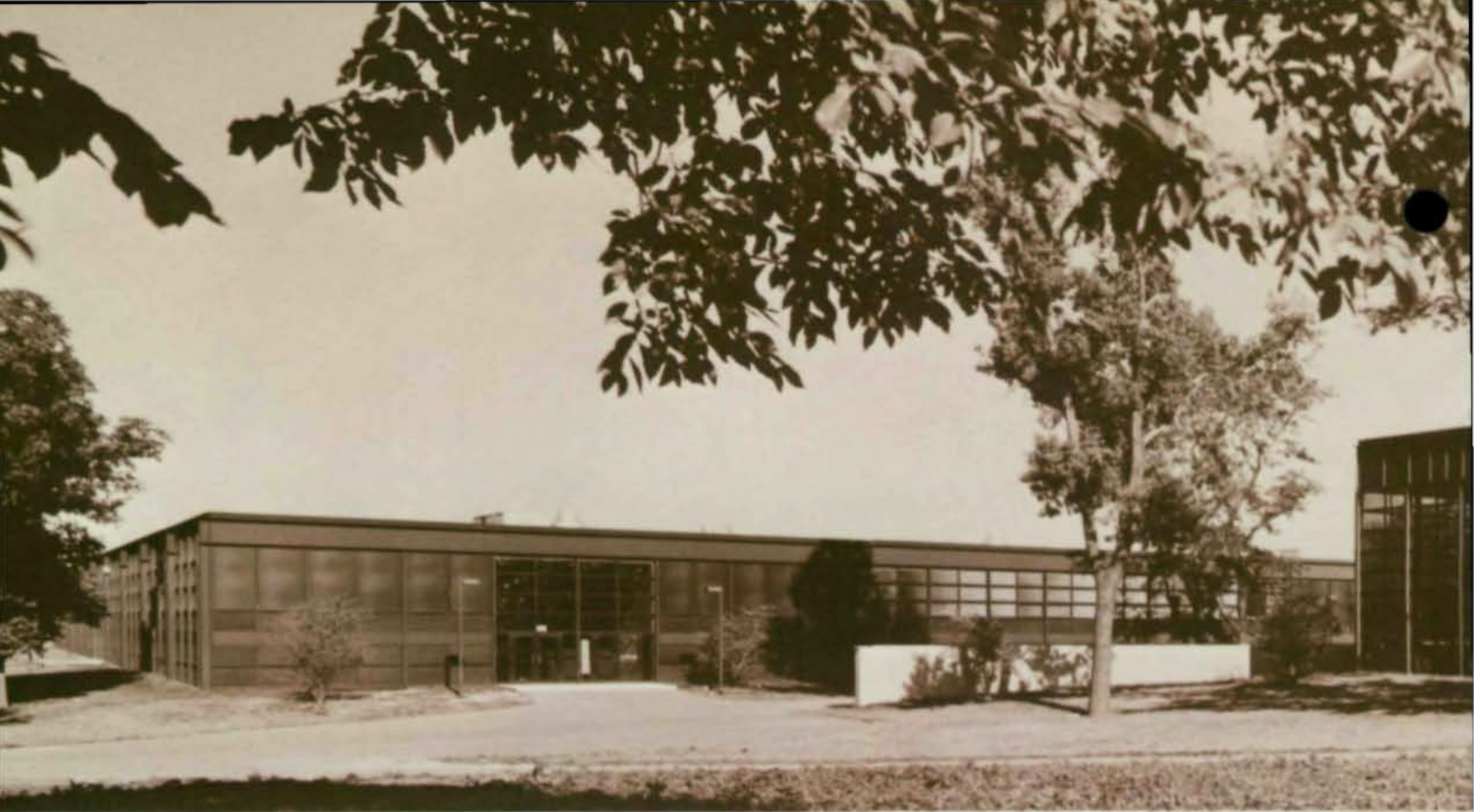
Planning for the hospital projects expansion to 500 beds, so allowance was made in the initial structure for floor space to house certain basic services needed for 500 beds. Thus, with many service spaces already provided, additional patient modules can be added, adjoining the existing structure at minimum expense.



One floor of modular units (16 modules) showing trusses.



16 modular units with air ducts and service shafts.



EXPOSED STEEL FRAMING FOR INNER

The design of the Walter H. Dyett Middle School, in Chicago, is based on an educational program to serve 1,500 inner city students in grades 6 through 8, and for community use of the facilities during non-school hours. Two basic concepts of the program were the subdivision of the student body into four "houses" of 375 students each to afford an identity with smaller groups during the transition from elementary to high school, and the use of team teaching. To do this, maximum flexibility of space was sought. Teaching areas are in the Academic Building. Physical education and community facilities are in a separate Recreation Building.

Academic Building

The 360 ft x 240 ft Academic Building, with two interior courts, has a main floor and an English basement. The main floor is used for teaching areas, laboratories, and administrative offices. Specialized classrooms, the library, student commons dining rooms, and teacher planning centers for each house are on the lower level. The interior courts, accessible from the lower level, provide outdoor spaces for activities such as nature classes, reading, and informal teaching.

The two level concept of the Academic Building minimizes circulation space, particularly stairs, allowing all areas to be within one-half story of entries. The main floor has column free bays 40 ft x 70 ft and 40 ft x 80 ft, affording space flexibility through the use of demountable or operable partitions. Teaching areas may be arranged from conventional classrooms to a series of open spaces of different sizes or shapes depending upon teaching methods desired.

Recreation Building

The Recreation Building, a 300 ft x 130 ft structure, has a 23-ft ceiling and houses a gymnasium, swimming pool, lockers, dressing rooms, and storage space.

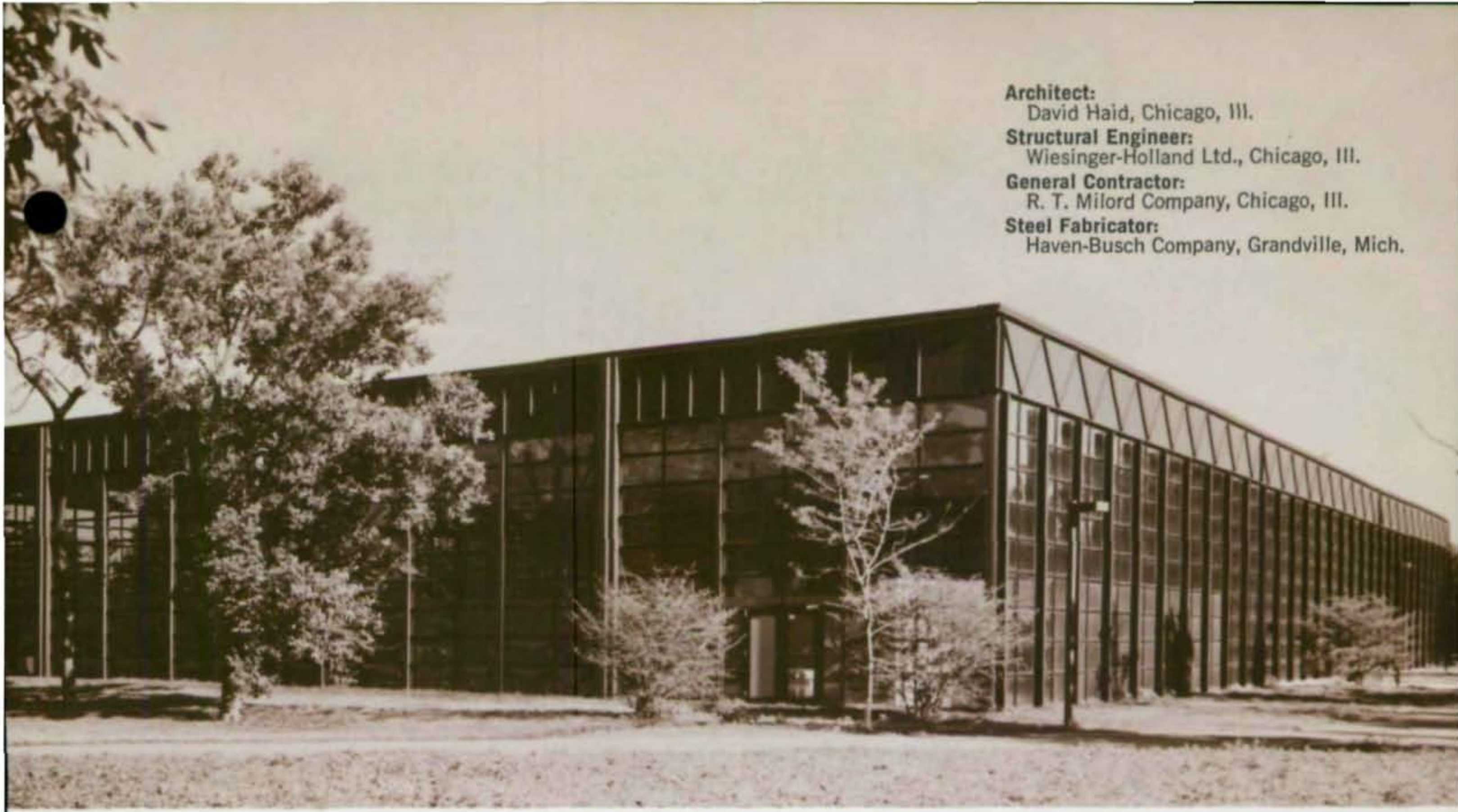
A multipurpose assembly room is the other major element in the building. An enclosed courtyard accessible from the pool area provides a private outdoor space adjacent to the pool. The roof structure is a cantilevered plate girder and truss system supported on eight cruciform columns forming three bays, each 100 ft x 130 ft..

Circulation between the buildings is at grade level on a landscaped plaza, or in inclement weather through a connection below this plaza from the lower level of the Academic Building to a basement lobby in the Recreation Building.

Exposed Structural Steel

Both buildings are welded, exposed steel structures, with wide flange mullions and fabricated plate, angle and bar fascias supporting aluminum

Architect:
David Haid, Chicago, Ill.
Structural Engineer:
Wiesinger-Holland Ltd., Chicago, Ill.
General Contractor:
R. T. Milord Company, Chicago, Ill.
Steel Fabricator:
Haven-Busch Company, Grandville, Mich.



Academic Building is to the left of the Recreation Building.

CITY SCHOOL

window frames glazed with grey tinted glass, polycarbonate, or metal panels. The Academic Building framing has W36 girders spanning the 70-ft and 80-ft bay dimensions, and W18 purlins spanning 40 ft, at 10 ft o.c. All connections are welded to form a continuous system. W12 columns are used throughout the building. The Recreation Building plate girders, 130 ft long x 6 ft deep, were shop fabricated and delivered for erection as complete units. The column-to-column spacing is 70 ft, with 30-ft cantilevers on each side of the mid-span. The 100-ft trusses, 5 ft deep, are 10 ft o.c. The eight cruciform columns carry all wind load in both axes of the building.

To meet building code requirements, the columns were fireproofed with concrete and clad with ⅜-in. plate weathering steel surfaces in the shop. W8 and W6 clean, 10 ft o.c., are used on the Recreation and Academic buildings respectively.

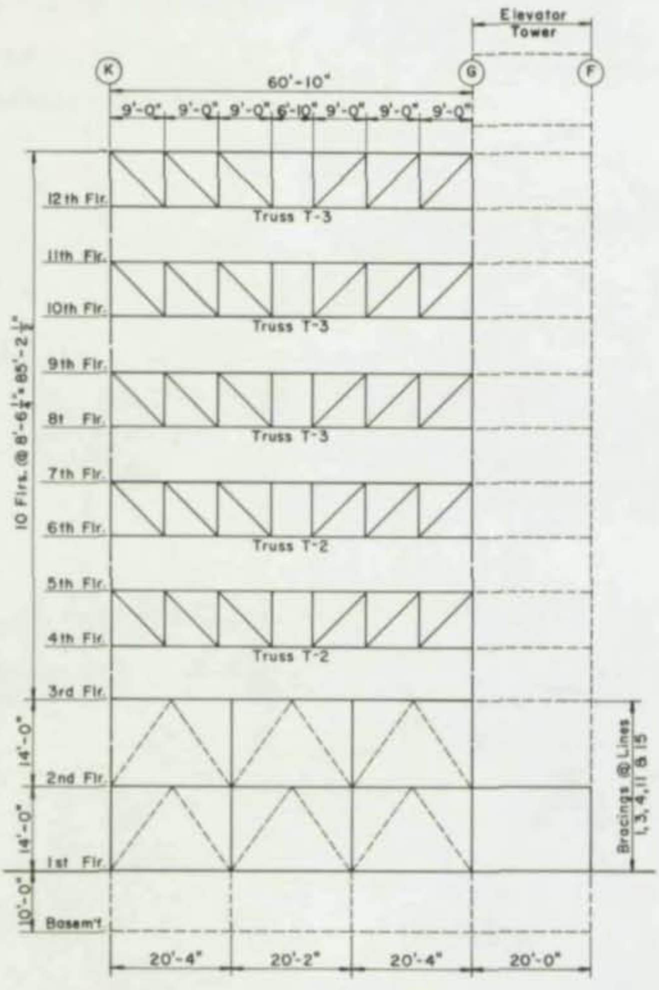
View of interior courtyard from library.

Seismic Design for a Staggered Truss Hotel

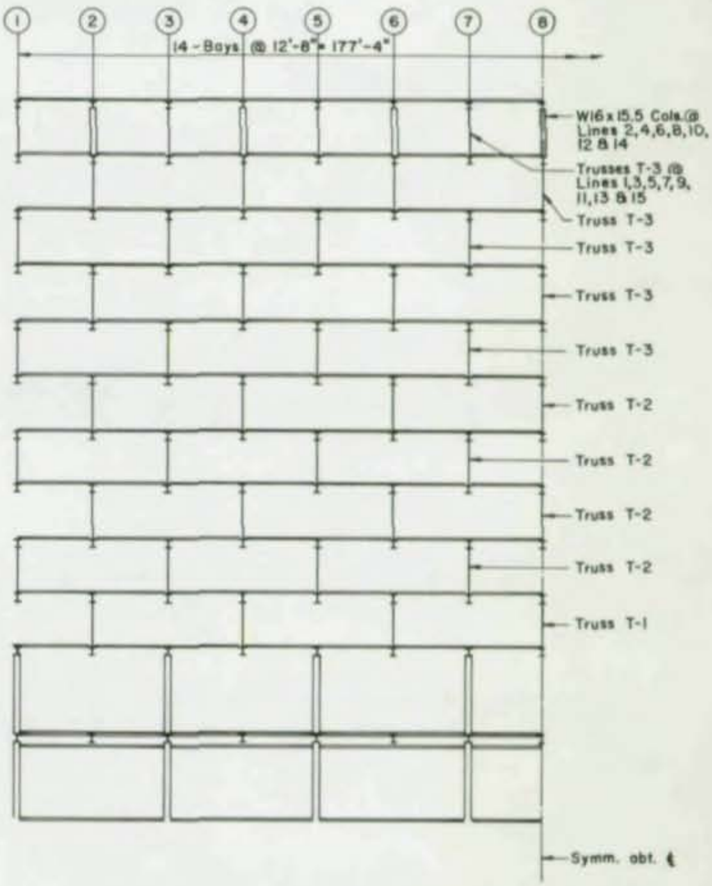
D. Kennett Forssen, Vice President
Kelly Pittelko Fritz and Forssen
Los Angeles, Calif.

The topping out of a 12-story, 266-room Ramada Inn in Los Angeles marks the first application of the staggered truss system in Southern California (Seismic Zone III). This new design approach effected sharply reduced construction costs through speed of erection and light framing weight.

Another staggered truss project, presently under design, will be built at Emeryville, California, in San Francisco Bay. Unlike the Ramada project, a dynamic analysis will be run on this complex — The Anchorage Marina Hotel — utilizing the results for review and evaluation of the static design.



TYPICAL SECTION AT LINES 1,3,5,7,9,11,13 & 15



HALF LONGITUDINAL SECTION
(Basement not shown)

Staggered Steel Truss History

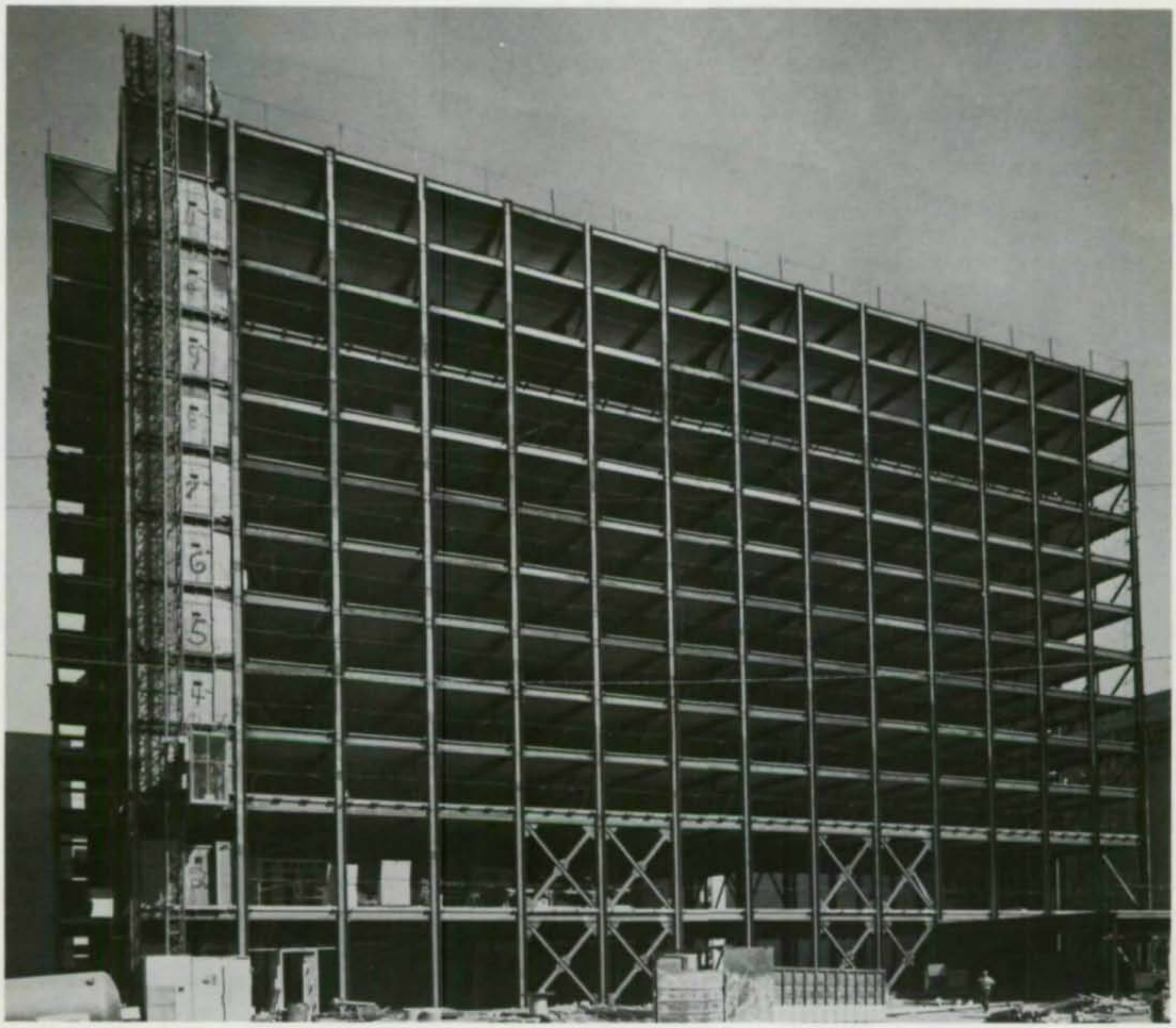
The concept of the staggered steel truss was developed by Massachusetts Institute of Technology with the co-operation of the United States Steel Corporation. Story-high trusses clear-span the width of the building at alternate wall lines, and are typically staggered at intermediate wall lines. Floors span from the top chord of a lower truss to the bottom chord of an adjacent truss in the story above. The system is highly compatible with hotel construction where a regularly staggered pattern is ideal, and where circulation is achieved by a central double-loaded corridor which penetrates the trusses at Vierendeel panels. Apartment construction can also beneficially use the system, with alternate spacing of trusses to allow wider rooms.

The system is ideal for wind loads in that it is a braced "box" system for loading parallel to the trusses. Lateral loads are resisted in the other direction by braced frames or moment resisting frames at the exterior column line.

Seismic Design

The seismic design requirements for such a building posed new challenges, and close collaboration was maintained with both the City of Los Angeles Department of Building and Safety and the International Conference of Building Officials staffs during design to ensure not just minimum code satisfaction, but a design based on good engineering judgment and providing maximum safety and minimal economic loss in the event of a strong earthquake.

Conventional static design was employed with the factor of $K = 1.33$ utilized in the seismic formula in each direction. The trusses and floors act together as a bent diaphragm in the transverse direction, with shear due to inertial earthquake loading accumulat-



ing from the roof down. The major difference from a conventional bearing wall structure in which story shears are not accumulated and transferred requires special handling of the slab to chord connection in lower stories, and limits the height of buildings utilizing this system in Seismic Zone III.

In the Ramada project, horizontal shear in upper stories is transferred by welding the steel deck to the chords, and a transfer slab with welded studs was used at the third floor. Studs were required in addition to welding of the steel deck at the fourth and fifth floors. From the third floor down, K-braces are provided in both directions.

Dynamic Analysis

The staggered truss hotel in Emeryville comprises two five-story wings at 90° to each other. One truss drops off at each story, from bottom to top, creating a stepped end. A three-story structure, housing shops and restaurants, will surround the hotel.

Initial geologic information indicates that at the mud line the site period of vibration varies between 0.6 seconds and three seconds with a peak at one second, and at 16 ft below mud the values range from 0.3 seconds to 1.5 seconds, with a peak at 0.5 seconds. Peak acceleration is about one-g (acceleration due to gravity) in each case based on Taft earthquake criteria, 30%g and 5% damping.

The structure will be designed to respond with the longest possible period consistent with economy and drift requirements, and will be non-synchronous with the predicted site period. A three-dimensional, dynamic analysis of this non-symmetrical and complex structure will be run in order to identify weak links and discontinuities requiring special consideration. All final design absolute values will be set by conventional static design techniques as modified by dynamic design analysis results.

Statistics — Ramada Inn

The gross area of the $3.9-million project is 140,418 sq ft. The tower measures 60'-10" x 177'-4", with a 20'-0" x 19'-8" elevator tower located outside the building line. Trusses are spaced at 12'-8" apart and frame into W14 steel columns. The staggered truss arrangement thus produces a spacing in excess of 25 ft on each floor. Since each column is braced by a top or bottom chord at each story, and each truss is a bracing element, no moment is induced into the columns due to imposed lateral loads. The deep trusses are composed of very light shapes, and the short floor span allows 3-in. steel deck with 3½-in. lightweight concrete fill to be used without shoring. Each framing element, therefore, is very efficient in relation to span vs. depth, producing a very light framing weight.

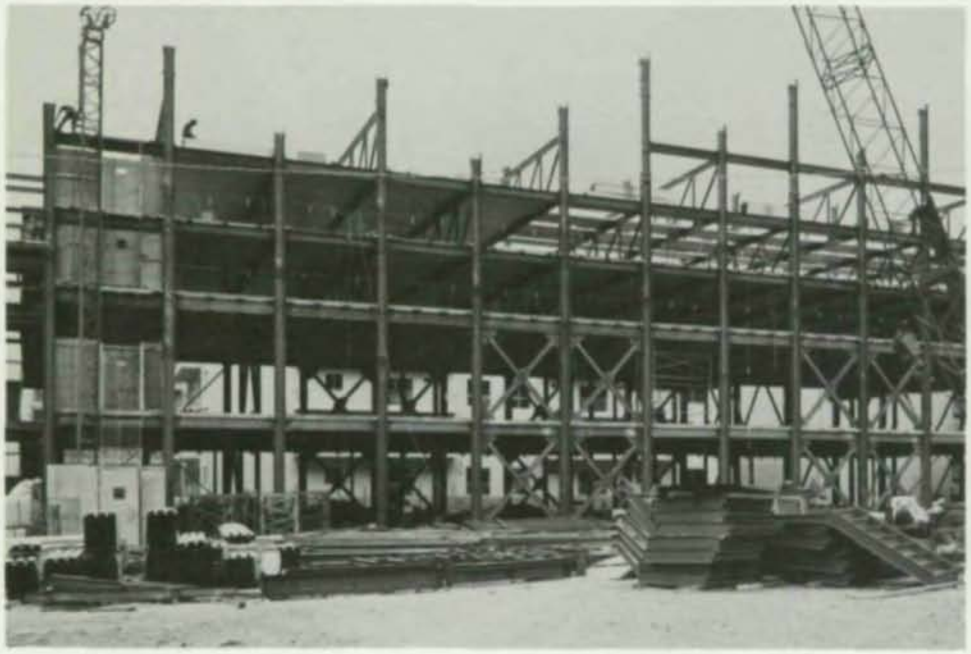
About 537 tons of steel were used (two-thirds being A572 Gr. 50 in columns and truss chords; and one-third being A36 at truss webs and spandrels, largely to control drift). The final framing weight will figure out to 6.9 psf, as compared with a conventional rigid frame which could be expected to weigh 12 psf or more.

Erection, at the peak of construction, hit two stories per week, using temporary diagonal struts at midspan to brace top chords. As decking was welded to chords, braces were moved up. Some shimming was required at milled column surfaces and at end plate type spandrel joints.

Trusses frame the upper 10 stories of the structure, which has a story height of 8'-6¼" and a nominal ceiling height of 8'-0". The ceiling was sprayed onto wire mesh attached directly to the underside of the metal deck. These stories contain no internal columns. Heating and cooling is achieved by wall units mounted on each floor.

The lower two floors utilize 14-ft high braced frames to provide large open spaces uninterrupted by trusses. Interior columns are very light since they carry only two-story vertical loads. K-bracing at end and certain intermediate walls provide lateral load restraint in the short direction, while moment resisting frames at the exterior longitudinal wall comprise the lateral restraint in the long direction.

The Ramada Inn, Los Angeles, under construction.



RAMADA INN

Architect:
J. Stewart Stein, AIA, Phoenix, Ariz.

Structural Engineer:
Kelly Pittelko Fritz and Forssen
Los Angeles, Calif.

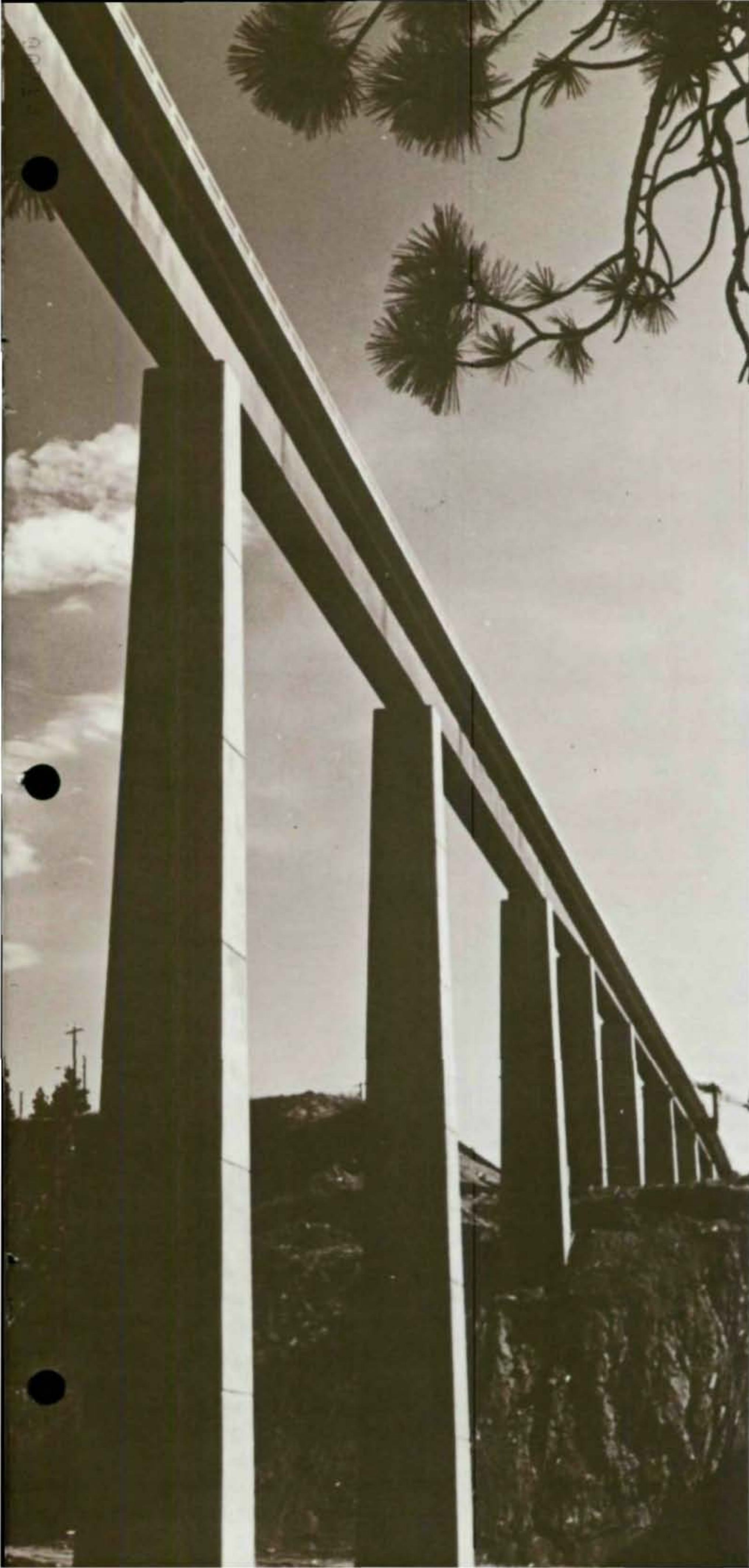
General Contractor:
Ramada Development Company
Phoenix, Ariz.

Steel Fabricator:
Techni-Builders
Division of Hogan Manufacturing Co.
Phoenix, Ariz.

ANCHORAGE MARINA HOTEL

Architect:
Bull Field Volkman Stockwell
San Francisco, Calif.

Structural Engineer:
Kelly Pittelko Fritz and Forssen
Los Angeles, Calif.



Steel box girder makes handsome bridge

Jack P. Shedd, F. ASCE
Office Engineer
Howard Needles Tammen & Bergendoff
Kansas City, Mo.

Responding to its own consolidation needs after the merger of four railroads and the City of Spokane's concern for aesthetics, Burlington Northern built a strikingly handsome bridge over the picturesque Latah Creek canyon in Spokane, Washington.

The 3,950 ft long structure, with piers reaching up 175 ft from the canyon floor, is part of a $13.5-million project that includes nine other new bridges and 6.4 miles of new trackage. Thanks to this construction, track distance between Spokane and Seattle is reduced 4.9 miles. The reduced distance plus reduced curvature provides better service to shippers.

Burlington Northern's project permits removal of the old Great Northern tracks through the city and will enable the city to convert Havermale Island into a recreational area in downtown Spokane. However, the new canyon bridge is 50 ft above and between two other bridges—the Interstate 90 highway bridge and a popular arch bridge more than 50 years old. Some local residents believed the new structure would detract from the natural beauty of the canyon.

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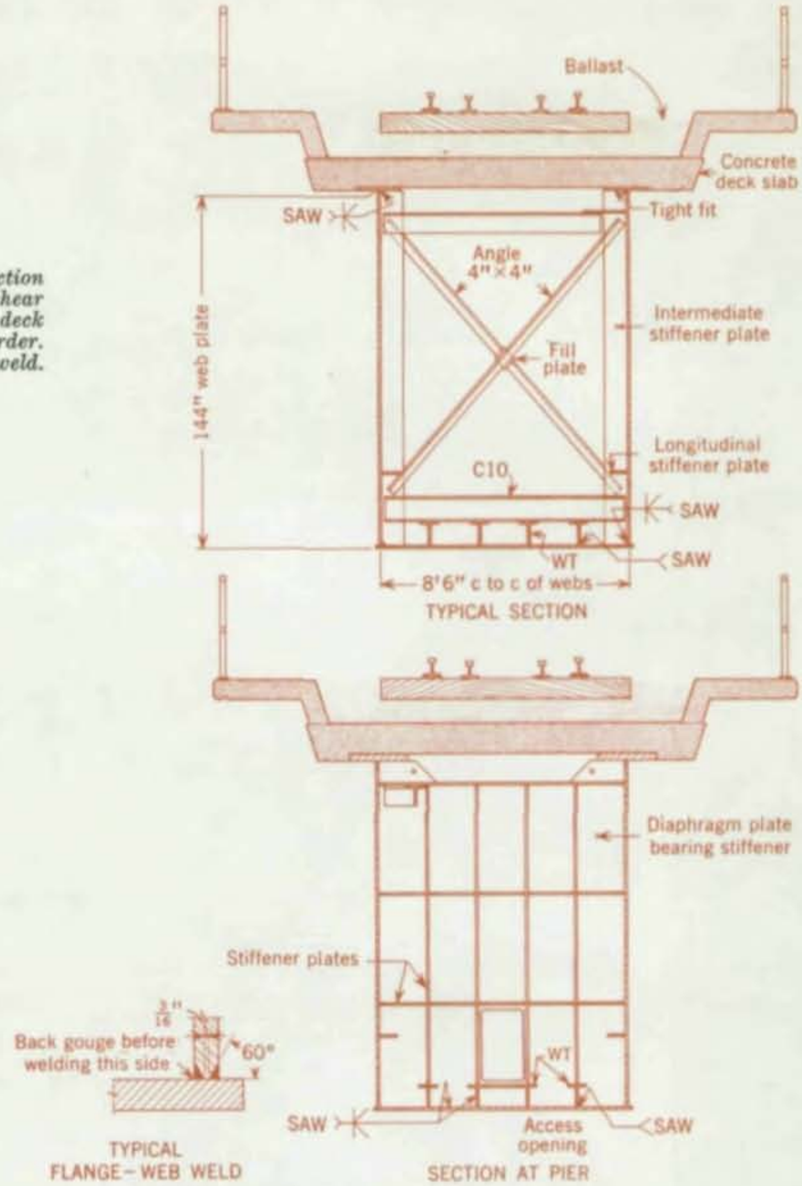


The box girder—typical section and section at pier. Welded shear connectors make concrete deck composite with steel box girder. "SAW" denotes submerged arc weld.

In response to these concerns of Spokane citizens, Burlington Northern arranged for the preparation of concept studies for a bridge that would be reasonable in cost and yet aesthetically pleasing. Several types of bridges were studied and compared in regard to aesthetics, cost and ease of erection. A structure of high-strength weathering steel box girders on concrete piers was selected by BN, and the selection promptly gained acceptance in the city.

The Latah Creek Bridge consists of six 160-ft spans that bridge the canyon itself and adjoining spans that vary from 80 to 100 ft. The structure was constructed for less than $6-million.

Included in the total length are two curved wye sections with a combined length of 1,660 ft. The north wye is the main line connection to Seattle and the south wye connects to the former SP&S line to Portland.

Optimum Span Length

During the concept studies, alternate span lengths for the canyon unit were compared. The physical features of the canyon were such that either 160 or 200-ft spans would fit. The 175-ft depth of the canyon indicated that longer spans might be economical. However, the piers could be founded on spread footings and because of their simple shape, the cost of each pier was comparatively small. Hence, for total economy, the 160-ft spans and the 200-ft spans were nearly equal. A study of the aesthetics of the alternate span lengths did not clearly indicate any preference for the longer spans. The 160-ft spans did provide for shorter pieces of completed box sections for transportation from the fabricating shop to the bridge site. Thus, the lengths of the canyon spans were established at 160 ft. Field splices were located 40 ft from each pier, with a maximum length of box section of 80 ft. The steel was fabricated by Kansas City Structural Steel in Kansas City, Kansas, and transported to the bridge site by rail.

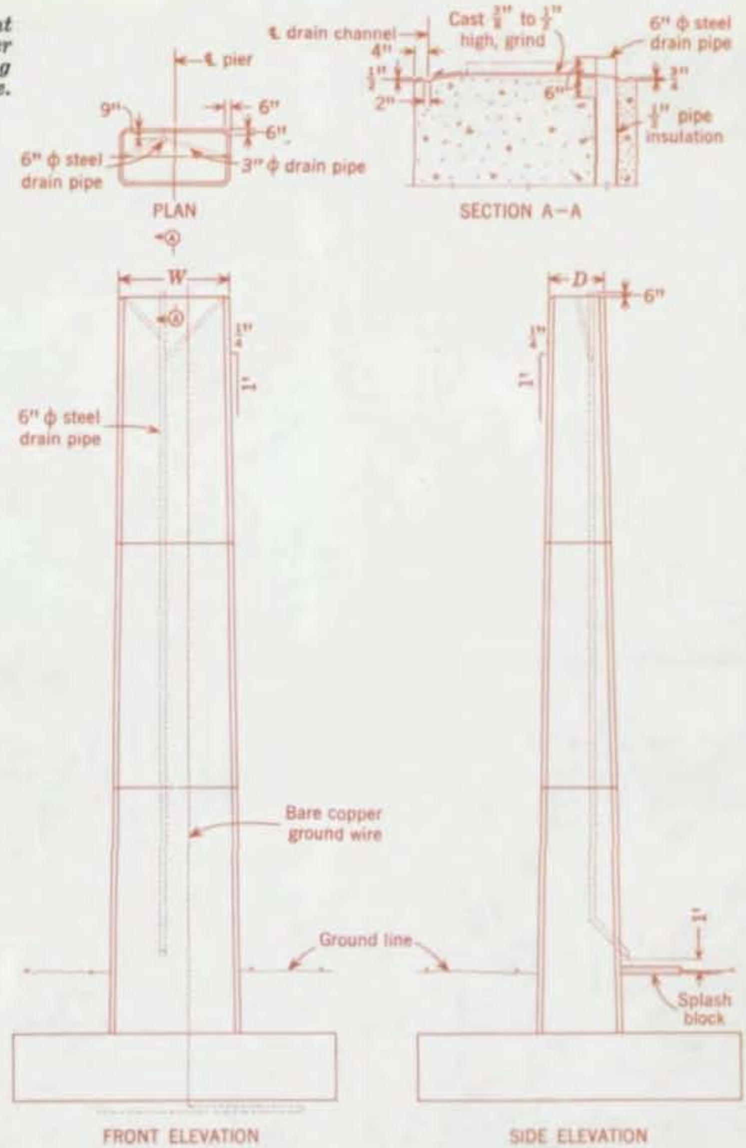
The superstructure consists of welded box girders of weathering high-strength steel with a ballasted concrete deck slab that supports the railroad track. Welded stud shear connectors make the concrete deck composite with the box girders. Computers aided the analysis of the four to six span continuous units. The curved, continuous composite design on the wye sections represent the first such use of the construction technique for a railroad bridge, although the method has been used before on highway bridges.

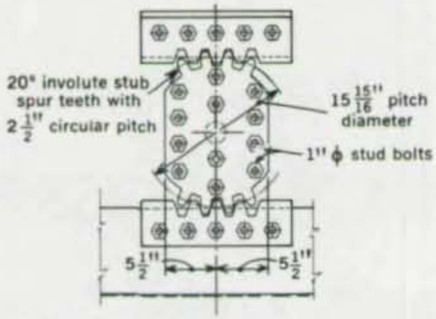
The angle braces were spaced at a maximum of 24-ft centers. At the piers a solid web diaphragm was utilized.

Teflon-coated Plate

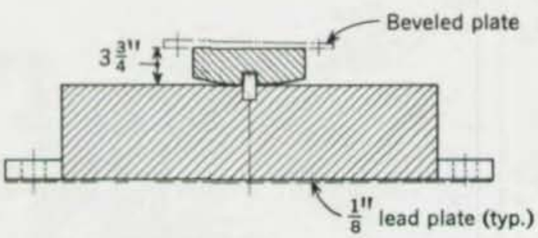
Bearings for the interior piers of the canyon unit were fixed. Provision was made, of course, for rotation due to

Pier details intended to prevent staining of pier concrete by rusty water running off from the weathering steel box-girder above.





Rack and pinion type bearing, designed to accept thermal expansion-contraction and rotation due to live load.



Rocker bearing, designed to permit live load rotation.

live load. At the end piers of the 960-ft canyon unit, a rack and pinion type bearing was designed. The fixed bearings for the shorter spans in the wye sections consisted of a rocker to permit live load rotation and a masonry plate. The expansion shoes in the wye section utilized a Teflon-coated sliding plate for expansion.

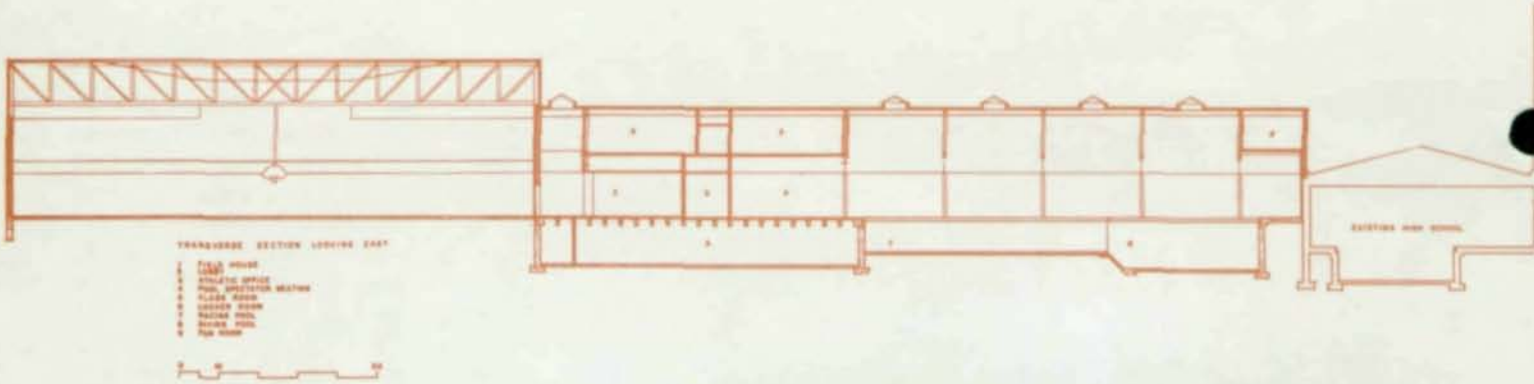
The erection technique by the contractor, Hensel Phelps, was similar to the erection technique on conventional girder bridges. Cranes worked from the bottom of the canyon floor, and the erection of the steel proceeded in a conventional manner.

The steel girders are supported on tapered reinforced concrete piers. Precautions were taken to prevent rust run-off and staining of the concrete piers during the period that the special steel will be weathering. Special drainage channels are installed on the bottom of the steel box to collect the water, and the tops of the piers are sloped so that water run-off is led to a 2-in. wide drain channel formed into the top of each pier. Run-off from the steel boxes drops onto the pier tops into the drain channels. There the water is collected and dispersed through a 3-in. insulated pipe to a 6-in. steel drain pipe cast in the pier. The 6-in. drain pipe also collects the water from the ballasted deck. The drain pipe exits at the bottom of the pier onto a splash block at ground level.

To provide maximum safety for Interstate 90 traffic during construction of the adjacent piers, drilled-in caissons were used. Other piers have spread footings into the dense compact gravel or basalt.

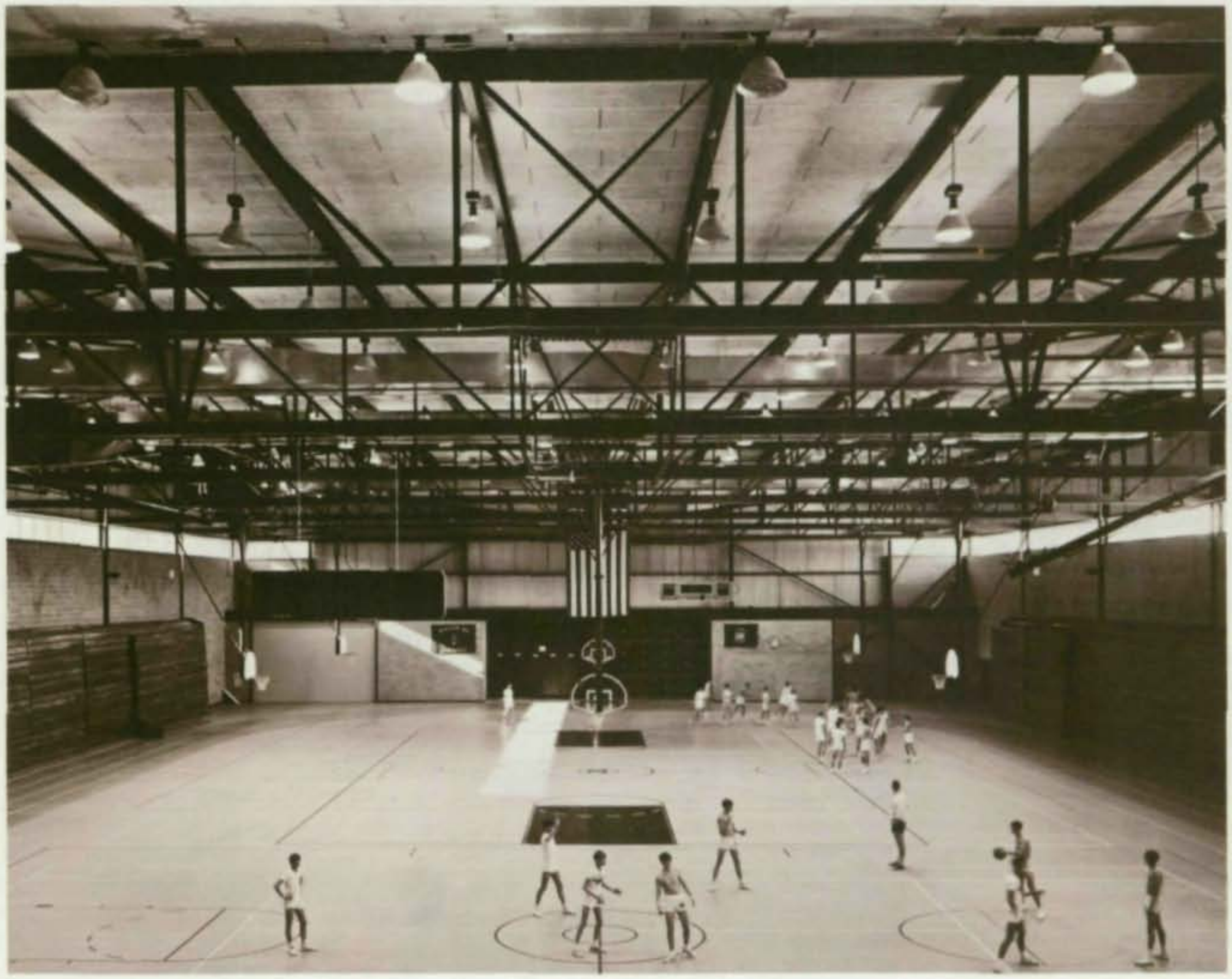
Three Months Early

Weathering steel was found to be less expensive than reinforced concrete, and BN will enjoy the savings in future painting maintenance. The brownish color of the steel will provide a rustic beauty to the canyon. Steel also offered a reduction in time for construction This reduction was realized during the project, and BN held dedication ceremonies three months ahead of the scheduled opening.



Long Span Steel Trusses Frame Fieldhouse and Pool

Robert Lorenz
AISC Regional Engineer
Milwaukee, Wisconsin



Additions to existing educational facilities have been a continual challenge to architects where growth space is limited or nonexistent.

The problem is often compounded by the need of modern facilities to keep up with fast developing educational demands.

The Office of Fitzhugh Scott Architects/Planners Inc., Milwaukee, Wisconsin, faced the problem of adding ten additional classrooms within the confines of a planned addition of new athletic and educational facilities for Wisconsin's Whitefish Bay High School on an extremely limited site.

The athletic facilities consist of a fieldhouse and pool with the usual ancillary facilities. To obtain the needed classroom area, the lobby between the fieldhouse and pool was situated to allow a second floor to partially project over it and the pool's bleacher area.

The long span requirements for open clear space in the fieldhouse and pool of 134 ft and 105 ft respectively, dictated the use of structural steel trusses for minimum material weight. In order to express the athletic vitality of the occupancy, the exposed structure is thematic throughout the project. The structural steel is A36 and A441.

Left: The 136 ft clear span fieldhouse provides ample room for bleacher or multi-use sport options.

Below: The pool area features welded tubular trusses protected against chlorine and water vapors.

The constant depth trusses provide a light open space offering needed clear height between members for ball sports and high diving and at the same time accommodate electrical and mechanical services within their depth. The fieldhouse trusses are of a conventional design with full bolted splices at midspan.

In the pool area, the trusses and columns are steel tubular members with all welds gas-tight for corrosion resistance. This exposed steel is then protected with a zinc-rich primer, followed by a chlorinated rubber paint selected to meet the architect's strict performance specification of chlorine and moisture resistance.

The roof deck of the pool is natural finished cedar on steel beams, which adds a warm atmosphere. Further, glare reducing glass walls with sliding doors allow summer access to an outdoor pool terrace.

This wood-steel theme is carried into the classroom and lobby area. The classrooms overlooking the lobby are enclosed with glass and metal panel which carry the open feeling of the design theme into these areas.

Exterior walls match the brick masonry of the existing building and light metal panels provide a deep fascia and economical lightweight wall above the strip windows.

Because of the intensive use of the facilities for both student and evening adult physical education and recreation programs, the facility has become an integral part of the life of many residents of Whitefish Bay.

Architect:
Office of
Fitzhugh-Scott-Architects/Planners, Inc.
Milwaukee, Wisc.

Structural Engineer:
Graef-Anhalt-Schloemer & Associates, Inc.
Milwaukee, Wisc.

General Contractor:
Joseph P. Jansen Company
Milwaukee, Wisc.

Steel Fabricator:
Lakeside Bridge & Steel Co.
Milwaukee, Wisc.

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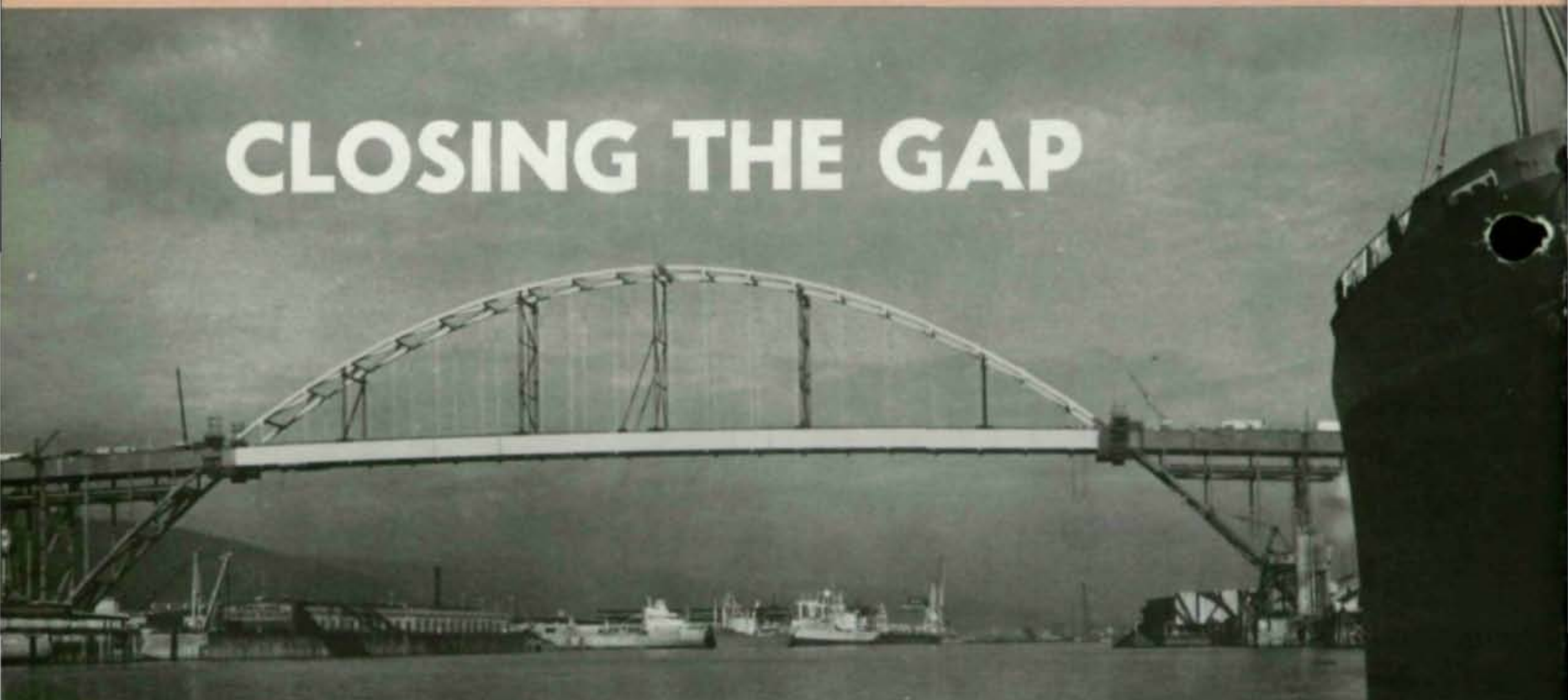
Permit No. 6662

CLOSING THE GAP



In one of the largest lifts ever, the 6,000-ton, 902-ft long Fremont Bridge center span was moved from its place of construction at Swan Island in Portland, Oregon, and lifted 170 ft into final position over the existing approaches high above the Willamette River.

Engineers and erectors from around the world witnessing the 40-hour operation considered it among the most remarkable events in the history of bridgebuilding.

A series of 32 jacks, eight at each corner, were used to lift the span in two-ft increments, or about four ft per hour.

The bridge design incorporates a stiffened tied arch structure with an orthotropic upper deck to carry four lanes of westbound traffic and a conventional concrete lower deck to carry four lanes of eastbound traffic. Its 16 traffic lane miles, equivalent to a two-lane bridge eight miles in length make the Fremont Bridge the largest structure on the Oregon highway system. When completed, the bridge will be among the world's three longest steel arch structures with its 1,255 ft main span.

Parsons, Brinckerhoff, Quade & Douglas of New York City designed the bridge for the Oregon State Highway Division. The prime contractor and steel fabricator is Murphy Pacific Corporation, Emeryville, California. The jacking system was designed and produced by the Wm. S. Pine Division of Templeton, Kenly & Co., Broadview, Illinois.