VOLUME VI / NUMBER 1 / FIRST QUARTER 1966





# MODERN STEEL CONSTRUCTION



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## 1966 ARCHITECTURAL AWARDS OF EXCELLENCE COMPETITION

*The American Institute of Steel Construction has just announced the opening of its seventh annual Architectural Awards of Excellence Program to recognize and encourage aesthetic design and creative uses of structural steel.*

*Buildings of all classifications are eligible for awards, with equal emphasis given to all sizes and types in the judging. There is no limit to the number of entries that may be submitted by an individual or firm.*

*The competition will be judged by a panel of five distinguished architects and engineers. The members of the 1966 Jury of Awards are:*

**Lawrence B. Anderson, FAIA** *Anderson, Beckwith & Haible; Dean, School of Architecture & Planning, Massachusetts Institute of Technology, Cambridge, Massachusetts*

**Mario J. Ciampi, FAIA** *Mario J. Ciampi Architect & Associates, San Francisco, California*

**Charles M. Nes, Jr., FAIA** *President-elect, American Institute of Architects; Fisher, Nes, Campbell & Partners, Baltimore, Maryland*

**John C. Portman, Jr., AIA** *Edwards & Portman, Architects & Engineers, Atlanta, Georgia*

**Dr. Lev Zetlin, FASCE** *Lev Zetlin & Associates, Consulting Engineers, New York, New York*

*All registered architects practicing in the United States are invited to submit entries in the Competition. Any type of building completed after January 1, 1965 is eligible. All entries must be received by May 1, 1966.*

## A REMINDER

*Don't forget the 18th Annual AISC National Engineering Conference to be held in Boston on April 14th and 15th. Anyone who designs structures will find this Conference both stimulating and informative. If you have not already registered, contact AISC headquarters in New York.*

# MODERNIZATION
# Around 75 Year Old Steel Framing

*Renovation of the eleven-story Fair building, built in 1891, began in the Summer of 1964. The original steel frame was found to be in practically "mint" condition — was re-used without major reinforcing.*

**By John E. Starrett and Frank Klein**

Here's a case where steel saved us money in a rather unique way. Project goal was to transform a 75-year-old building into an attractive, modern structure. Our client, Montgomery Ward & Co., had purchased the old Fair store on State Street in Chicago in 1957, and wanted to make it into a showplace – its main store.

### Steel Frame Key to Savings

The key to savings was the fact that we could redesign without significantly changing the basic structure. And the key to this: steel was chosen for the structural framing by the original designer, William LeBaron Jenny. It's difficult now to imagine that fact as being unusual. But, as you may know, at the time, structural steel was an innovation – just beginning to roll from a handful of U.S. mills. (Steel for the Fair came from Carnegie Phipps & Co., Ltd.) To illustrate what a period of transition it was, the eleventh floor columns of the west half (the original building) were cast iron.

Perhaps it seems even more strange that we could re-use the old steel beams and columns without major reinforcing. Steel of that period was designed with a flexural working stress of 16,000 psi. However, when an independent testing laboratory told us that the old steel had characteristics similar to A7 steel*, we based the redesign on an allowable stress of 20,000 psi. Thus, except for major increases in load, most of the steel frame remained as we found it.

Of course, we did have to plan for a certain amount of supplementary work. Exterior beams on the lower stories had to be reinforced to carry solid masonry, for example. And so the question arose, will the old steel take a weld? Although the phosphorous and sulphur content in some samples was higher than the amount found in present-day steel, tests proved the original steel was quite weldable. We simply made sure the welders were careful, and specified low-hydrogen rods (A233 Class E-70).

### Old Steel in Excellent Condition

Another pleasant discovery was the fact that most of the original steel was practically in mint condition, with the shop coat of paint still quite bright. There were places around the roof coping, and at the sidewalk and alley, where water had leaked in and rust had done its damage. It is fair to say that where reasonable maintenance had been performed, and where the design had provided proper protection, rust was not a

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John E. Starrett, a registered structural engineer, is a partner of the Perkins & Will Partnership, Chicago, Illinois.

Frank Klein is a registered structural engineer and heads Frank Klein & Co., Chicago, Illinois.

*The analysis, by R. W. Hunt & Co. Testing Laboratory, Chicago, was as follows: % Carbon: .02 to .15; % Manganese: .001 to .74; % Phosphorous: .001 to .16; % Silicon: .05 to .12; % Sulphur: .04 to .075; Tensile Strength 68,200 psi.

*The Fair was one of the earliest steel-framed buildings. Designed by William LeBaron Jenny, it reflected heavy-handed masonry detailing in style at that time.*

problem. It was often possible to repair the damage. Where this was not practical, it was easy to replace the member.

Structural framing was modified to accommodate new conditions, such as new interior stair shafts, elevator shafts, duct shafts, or machinery rooms. We found it quite simple to reinforce beams and beam connections, by welding additional material on beam flanges, and by field welding the riveted connections.

## Features of Old Framing

The building was built in two sections (the west half in 1891, and the east half in 1896). Beam connections and column splices showed the development of knowledge and technique. Column splices were essentially in bearing and occurred at every story. The concept of columns resisting bending moment due to lateral forces had not yet been fully grasped. Yet the use of seat angles and top angles was a step in the right direction. The early work showed the lingering influence of wood and brick construction and of the early bridges. We found beams bearing on cast iron rockers, which in turn were supported on riveted angle brackets.

In general, because of welding, and the type of connections used by the designers, it was possible to reinforce the connections where necessary.

The original building contained two light wells, which were converted to floor space when more efficient interior lighting came on the market. Buildings of this period in Chicago were usually supported on spread footings located at the top of the desiccated clay layer which was at original grade. The footings were reinforced with a grillage of steel rails. On these footings immediately below the basement floor, the steel frame of I-beams and columns composed of Z-sections with a varying number and size of plates, carried a tile arch floor system. Wood flooring was laid on wood sleepers in cinder concrete fill over the tile arch system.

In 1923, the existing spread footings were removed and replaced with caissons to the hardpan, about 40 ft below. At the same time two additional subbasements were constructed with two large truck elevators. This remarkable feat involved considerable shoring, underpinning, tunneling, and revision of the lower framing. The inevitable movements caused a surprisingly small amount of damage to the flexible structure.

The basic structural element of the Fair store was revealed in the continuous piers and narrow spandrels of the street elevations, but this was rather obscured by heavy-handed details. Two courses at the top of the fifth and sixth stories, respectively, divided the elevation into a clumsy 5-1-5 ratio. Moreover, the rustication at the sixth floor and the huge

*Montgomery Ward store reflects lightness and vigor of its 75-year old steel frame.*

pier capitals at the fifth and eleventh stories detracted still further from the validity of the design.

The windows, as in all of Jenny's buildings, were relatively small. But total glass area was unusually large because the mullions were so thin.

### Open For Business During Alterations

In redesigning the structure, we emphasized the lightness and vigor of the steel framing. Much of this was achieved, of course, by simply removing the massive masonry work on the elevations. One of the interesting points about this job, incidentally, was that Montgomery Ward never closed its sales floors for a single day. It did mean considerable shifting around for sales departments as work progressed. But this was managed with a maximum of alacrity and a minimum of grumbling.

Here are some of the features of the revitalized building, completed in time for Christmas shopping last year. The first four floors and the basement provide retail sales space for Montgomery Ward. It amounts to 225,000 sq ft, and it the largest of the company's 507 retail department stores. The top seven floors have been converted for office occupancy. All floors feature improved air conditioning, as well as new recessed lighting fixtures, accent lighting, flooring and acoustical ceilings.

The store front and entrance-ways were installed with set-back shopper arcades on the State Street and Dearborn Street sides. During cold weather, the arcade is heated by overhead infra-red units.

The Perkins & Will Partnership, of Chicago, handled the design in cooperation with Frank Klein & Co., who handled all structural engineering work. General Contractor was Ragnar Benson; Chicago Heights Steel Co. was the steel fabricator.

*Detail of original beam and column framing. Note seats, simplicity of framing in both directions, and absence of wind moment connections.*

# AN ALL STEEL

When Hyman Dave, president of the Dave Steel Co., a fabricating concern in Asheville, North Carolina, decided to build a new home, he wondered if it could be done entirely in steel. To his knowledge, such a job had never been attempted in the Southeast.

Mr. Dave called on a local architect, Charles M. Sappenfield, whom he knew had used steel and other materials in very imaginative ways on other assignments. Mr. Dave explained the home would have to be economical, comfortable, reasonable on maintenance, and in keeping with the character of its Blue Ridge Mountains setting.

The result was an award-winning 48 x 70-ft home, situated 100 feet up a hill a few miles north of Asheville, with a superb southern exposure looking down a valley toward Mt. Pisgah.

Architect/Charles M. Sappenfield, AIA, Asheville
Structural Engineer/Charles Kahn, Raleigh
General Contractor/H. Southworth Company, Asheville
Steel Fabricator/Dave Steel Company, Asheville

"I told the architect I wanted a very livable residence utilizing as great a variety and quantity of steel as possible, which I felt would be good for business," Mr. Dave said. Thus, except for an interior stone wall and some cabinetwork, steel is seen throughout the building.

The house has 10 bays, each 14 x 24 ft, plus two bays of entranceway and carport. Off the living room there is a covered terrace, column-free so that the mountain view is unobstructed, and partially protected by an 8-ft cantilevered roof.

The framework consists of 16 tons of structural steel. There are 21 5-in. H columns and 15 14-in. deep WF beams (fabricated at Mr. Dave's plant, of course.) The steel framework was erected in only a day and a half without the need of any special equipment.

Acoustical ribbed steel roof deck is exposed on the underside, and is topped by 2-in. insulation board and a built-up roof. A steel channel fascia runs completely around the perimeter of the roof. The steel roof was field welded very rapidly. This meant that construction work could be done under cover, a big advantage during rough weather.

Two of the exterior walls are floor-to-ceiling glass units, set in steel frames. The other walls consist of 2-ft wide sheets of 20-gage ribbed steel siding. Interior walls are metal lath and plaster over 2½-in. steel studs.

Once the framework was completed, the steel siding was welded to the steel studs, and the steel doors, door frames, and window frame panels were welded to the columns. The steel window frames, produced in 14-ft units, had to fit within a fraction of an inch. Thermopane glass is set in all window frames and doors.

The entry court, covered by a roof that cantilevers four feet, is flanked on both sides by screens of expanded steel

# HOME IN THE CAROLINAS

mesh, painted white. The screens were welded in place to the vertical mullions and projecting WF-beams, with junior beams and channels above forming an aesthetic trellis.

An architectural feature of the home is the large, open living room (24 x 28 ft), entered through an enormous foyer (14 x 24 ft). "One of the reasons steel was so effective was its ability to span large areas and to use thinner members to support greater loads than other materials," Mr. Sappenfield said.

Six sections of ⅛ x ¾-in. steel grating, painted white, were welded vertically to form screens which divide the cross-corridor in the house from the living and dining room areas.

The dining room features an unusual 10-ft table. It rests on a single tubular steel leg embedded in the concrete foundation and cantilevered from the floor.

Throughout the three-bedroom, two-bath house, all walls are painted white

and all exposed beams and structural columns grey beige. Exterior steel is also a beige color, with one shop and two finished coats of paint.

**A Warm Interior**

The surprise which greets most visitors is the real "warmth" of the house. The native stone fireplace wall, the lighting, furniture and carpet fabrics and textures, the coloring of the steel frame – all are combined to overcome the general attitude that steel is "cold." The acoustical deck provides a very textured – and very quiet – ceiling. Light patterns on the ceiling and through the steel grating used as screens create additional visual excitement.

Asked what it is like to live in the all-steel house, Mr. Dave replied it is pleasant even when mountain storms howl outside. "Temperature changes have not affected the steel in the ways that our weather in Asheville affects wood and plaster construction," he said. The steel siding came with pre-caulked lap joints and no warpage trouble is expected, even at the many door areas.

**Cost is Competitive**

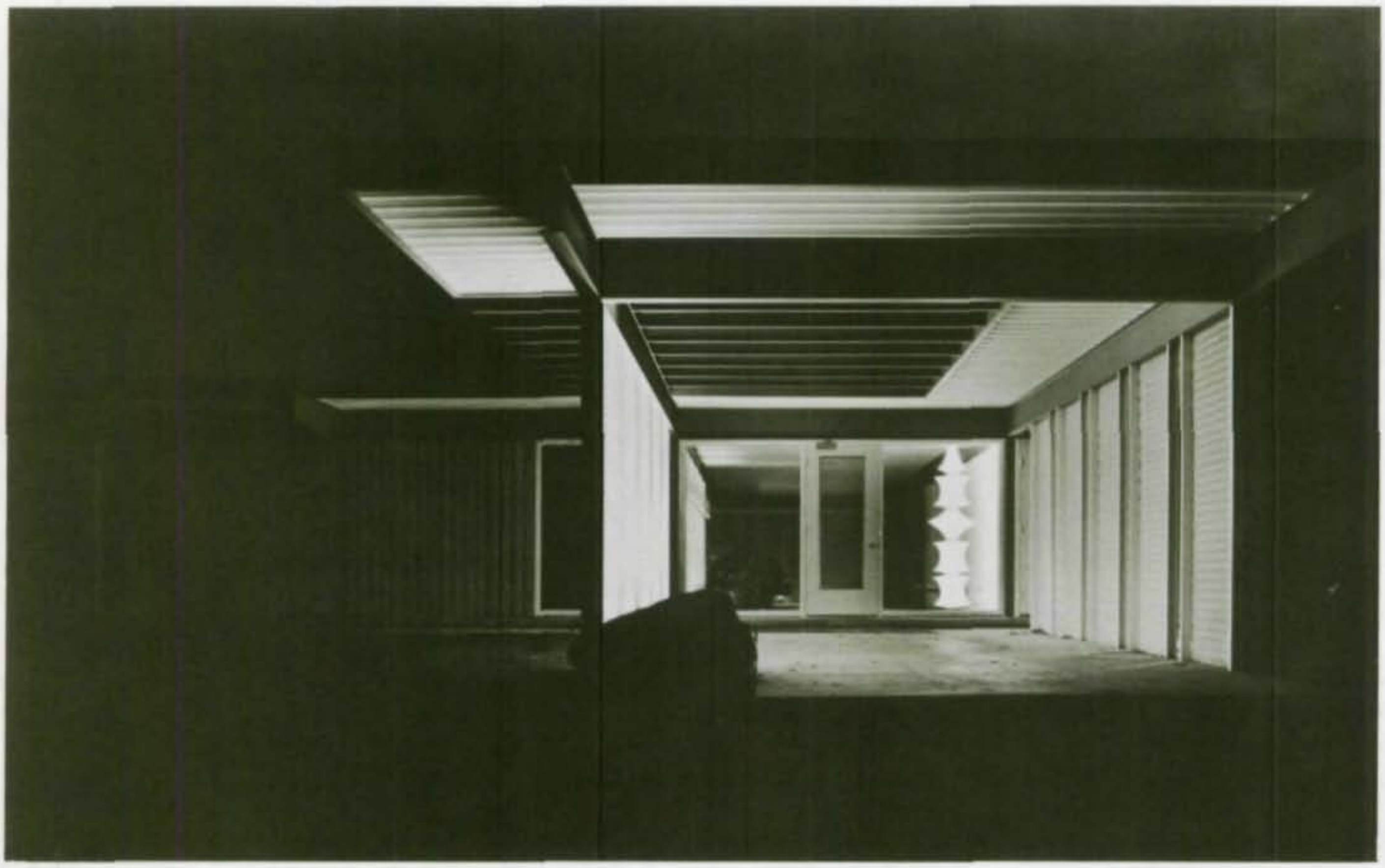
In terms of cost, Mr. Dave found his home competitive with other residences. It cost $18.40 per sq ft, which includes such extras as low voltage wiring, kitchen gadgets, built-in storage, air-conditioning, etc. The all-steel construction has led to two important savings in running expenses: only 2200 gallons of oil were needed to heat the home last year, and fire insurance is 20% less than for a comparable non-steel home, despite its location at some distance from a firehouse.

Mr. Sappenfield stressed that construction techniques for the residence were not unusual, having long been employed in commercial building. "The architect must remember to design for the labor that he has to work with," he said. "The tolerances are close when you work with steel so your craftsmen should be first rate."

Besides the great variety of applications of steel in the Dave residence, the aspects of the job that especially pleased the architect were the ease of erection, the flexibility of prefabricated components, and the warmth of the metal under imaginative treatment.

"We have begun the design of a second all-steel home – for a man who saw the practicality and warmth of the Dave house," Mr. Sappenfield said.

Mr. Sappenfield has won several awards from architectural and professional associations for his building designs, including the Dave project. He is also an assistant professor of architecture at Clemson University.



# HAWAII'S
## First Steel High Rise

To save money and construction time, architect Robert E. Wiese, AIA, chose structural steel framing in designing Hawaii's first high rise structure for the new $1.79 million, 100,000 sq ft Federal Aviation Agency office building. Although aesthetics were not a primary *consideration, the building is quite dis*tinctive with its curtain wall of terra cotta porcelain enamel steel panels and gray heat absorbing glass.

**Steel Problems in Hawaii**

Steel has not been widely used for high rise construction in Hawaii for several reasons. Local fabricating shops have limited facilities for handling large structural sections and framing members fabricated in mainland shops were penalized by high freight costs and shipping delays. Then, too, the scarcity of steel for wartime construction and the immediate post-war era led to the use of locally produced concrete, and the habit persisted.

**Advantages of Steel Frame**

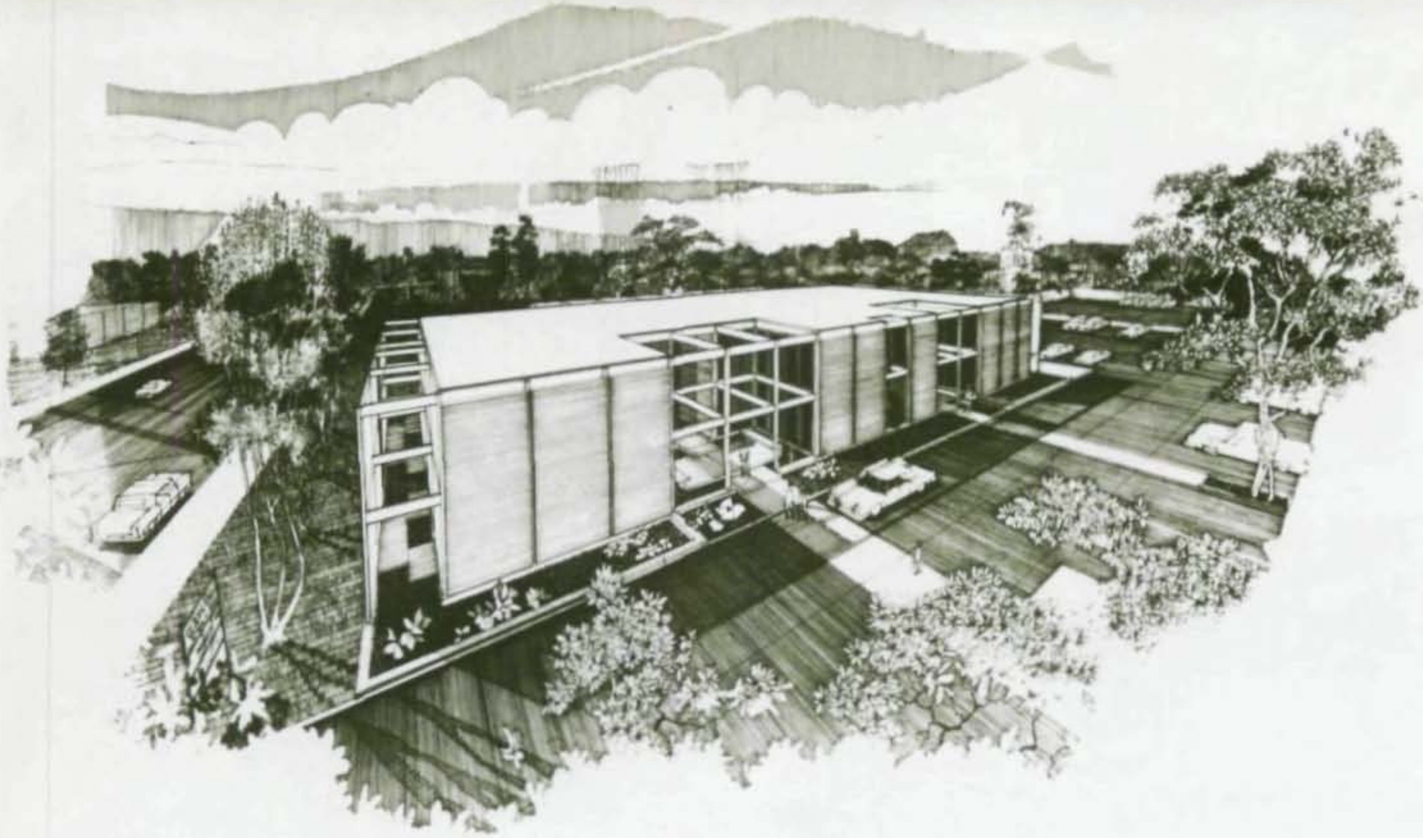
Architect Wiese was not immediately faced with an urgent time schedule. Moreover he knew from mainland experience that with a 10-story building, utilizing a modular system, structural costs would be reduced because of the very light dead loads of steel framing, and foundation requirements would be at a minimum. The entire structural framing system weighed 540 tons or 11 lbs/sq ft, including metal deck and concrete slabs.

The structural engineer, Peter Hsi, formulated his own equations, and programmed them into a computer, thus saving over 400 man-hours of calculations and producing the optimum in steel utilization. The total erection time was 56 days from the time the first column was in place. Full welded moment connections were used.

The floor system consisted of a concrete slab poured on a 3½-in. steel deck welded to the steel frame. The steel deck efficiently served three purposes: It (1) became a permanent form for the concrete slab, (2) created a horizontal diaphragm providing wind bracing, and (3) acted as a continuous cellular receptacle for the electrical conduit system.

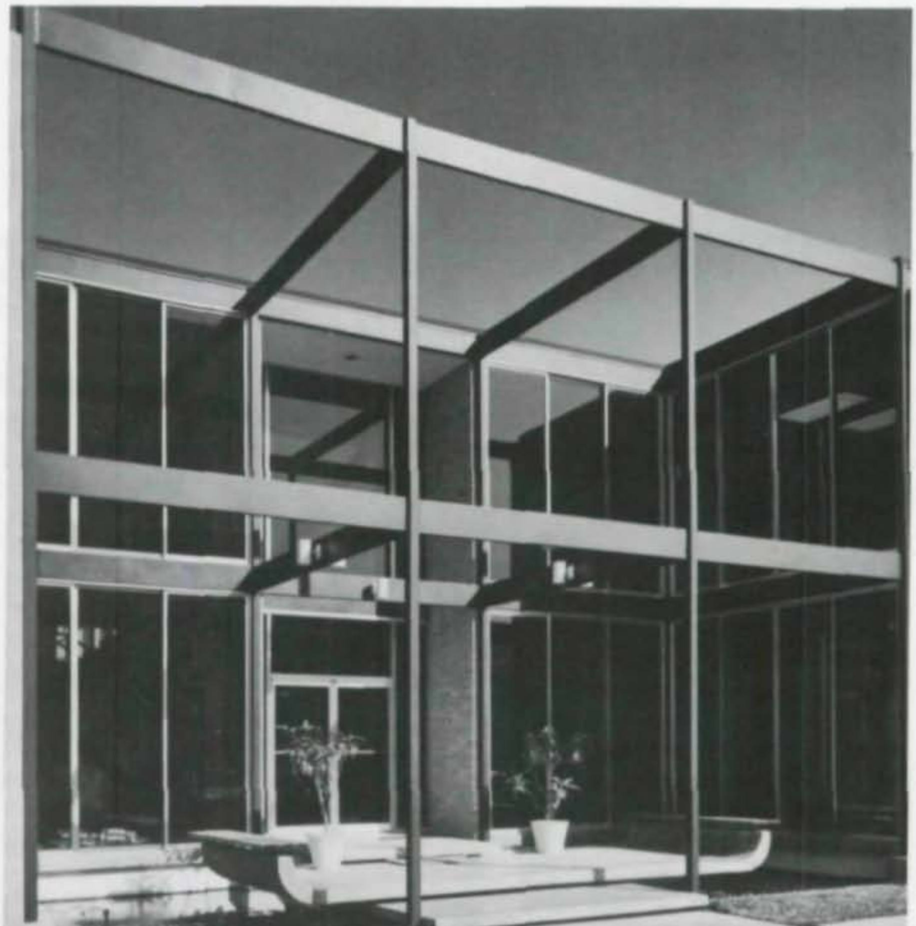
Building requirements included a 10 percent expansion space, which architect Wiese provided in an open ground floor, now utilized for parking and an arcade which can later be enclosed, but which gives a pleasing open, airy feeling to the entranceway. In order to bring out the Hawaiian-Island feeling of the building, a terra cotta porcelain enamel compatible with Hawaii's red clays in a basket weave pattern was chosen for the spandrel sections of this first true curtain wall high rise building.

This new contribution to Hawaii's rapidly expanding construction was built jointly by the contracting firms of Walker-Moody Construction Co., Ltd. and Dillingham Corporation. The steel was fabricated by Mutual Welding, Ltd.



# GOOD DESIGN is good business

**By T. M. Heersch,** Associate Architect
Jenkins Hoff Oberg Saxe, AIA
Houston, Texas



*The two-story entrance foyers have proved particularly successful. Entering and leaving the building is a two-stage experience, offering the visitor a gradual and engaging transition between inside and outside.*

Clean, strong steel lines in this Houston, Texas, office building go a long way toward producing a positive, rewarding image for its three major tenants — an advertising agency, a real estate organization and our firm. As an illustration, consider that we all moved in during the summer of 1964, and from that moment until the present, each of us has experienced a notable expansion in business volume. I'm sure that other factors have influenced this growth, but we all feel very strongly that the building's design has contributed the lion's share. In fact, if the image projected by the steel-framed structure were put into words, it might sound like: youth, vigor, strength, permanence, cleanliness and growth.

### Steel Tubing Chosen

Of all the vast array of stock steel shapes today, we agreed that square tubing best expressed the structural clarity and refinement of detail we sought. I might add that no special fabrication was necessary. The basic structural system consists of 4-in. square steel tube columns, 2 x 12-in. steel tube fascia and spandrel, and steel bar joists supporting the second floor and roof. The 2-in. square tube secondary members are used as stiffeners for sun control screens and as certain space defining elements.

### Speed and Economy

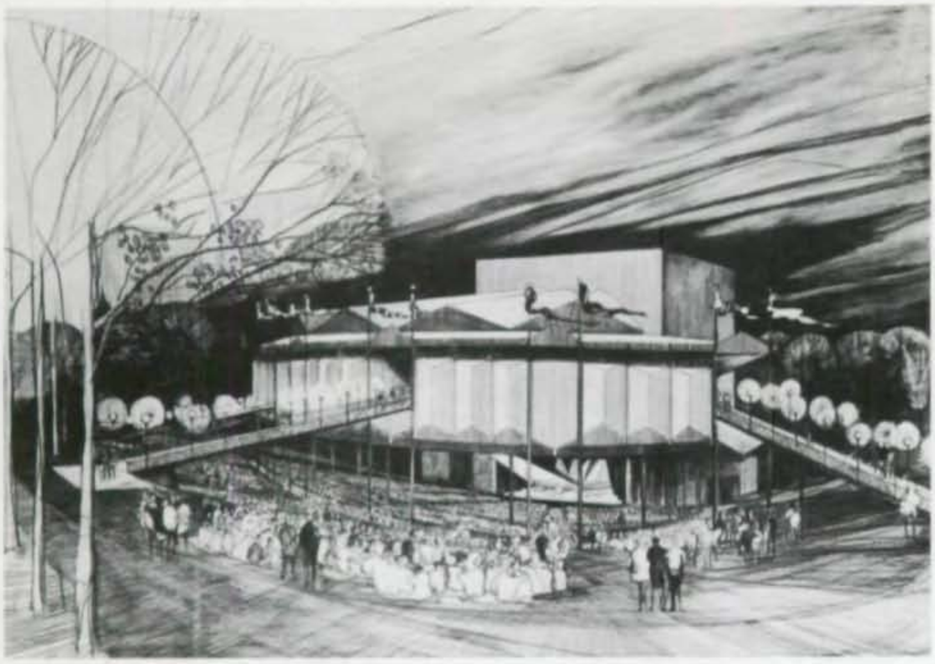
Although designing a building that genuinely said something was the initial and most influential reason for selecting steel, there were other, more practical reasons. For example, had we used concrete, we estimate that erection time would have been 15 per cent longer, and about 15 per cent more costly. (Wood was never considered, principally because of problems relating to maintenance, weathering, fire susceptibility and code restrictions.) We also found that steel provided the maximum in net lease space while still giving us the flexibility and light we wanted.

No real problems occurred during design or supervision. We attribute this to the fact that the design is basically simple and direct, and that we used stock steel items.

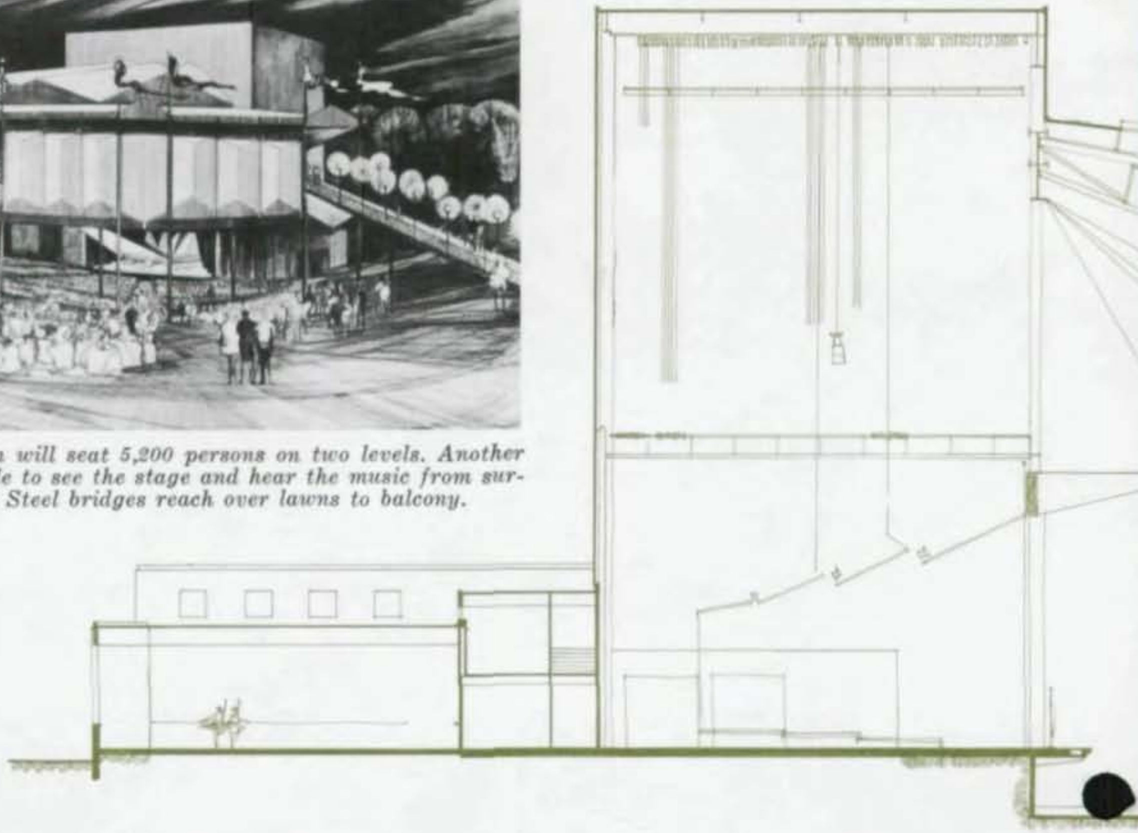
Our sun screens are more than a solar device. They also serve as a visual screen, defining the exterior limit of the building. All the occupants have appreciated the intimacy and "visual protection" the pierced exterior plane affords.

Named the Aylin Office Building, the structure was designed by us. Structural engineer was Sidney Loudermilk and the General Contractor was Kinly Corporation, both of Houston.

*Dark steel-tube framing clearly demonstrates the structural stability of the Aylin Building — gives visitors the same notion about its tenants.*



*Covered pavilion will seat 5,200 persons on two levels. Another 7,000 will be able to see the stage and hear the music from surrounding lawns. Steel bridges reach over lawns to balcony.*



# Steel Shapes a Summertime Center

We are pleased with the progress and development of our design for the Saratoga Performing Arts Center. For several reasons.

First, the construction costs for the Center, located in Saratoga Springs, New York, are within the original budget estimate. This is always gratifying, but considering the limitations of the budget, we are especially pleased. The total construction budget is $2,000,000 or about $400 per seat. Funds for site development were provided by New York State, since the Center is on state-owned property, but the building funds came exclusively from private contributions. These were raised by the Saratoga Performing Arts Center, Inc., under the direction of its chairman, Dr. Harold G. Wilm, former Commissioner of Conservation for New York State. The Center will present summertime performances by the New York City Ballet and the Philadelphia Orchestra, led by Eugene Ormandy.

Secondly, construction is right on schedule, and will be completed before the official opening July 9, 1966. On June 1, 1964, we got the green light for the project, based on our feasibility studies. We were also told that the Center had to be ready for ballet rehearsals on June 1, 1966. For a project of this size – the covered pavilion will seat 5,200 people–two years isn't overly generous.

To keep the tight schedule, early in the design stage we settled on a steel structural system. Any other structural systems – and we considered others – would have probably meant at least another full year on the job. Moreover, steel framing gave us maximum flexibility in developing our designs.

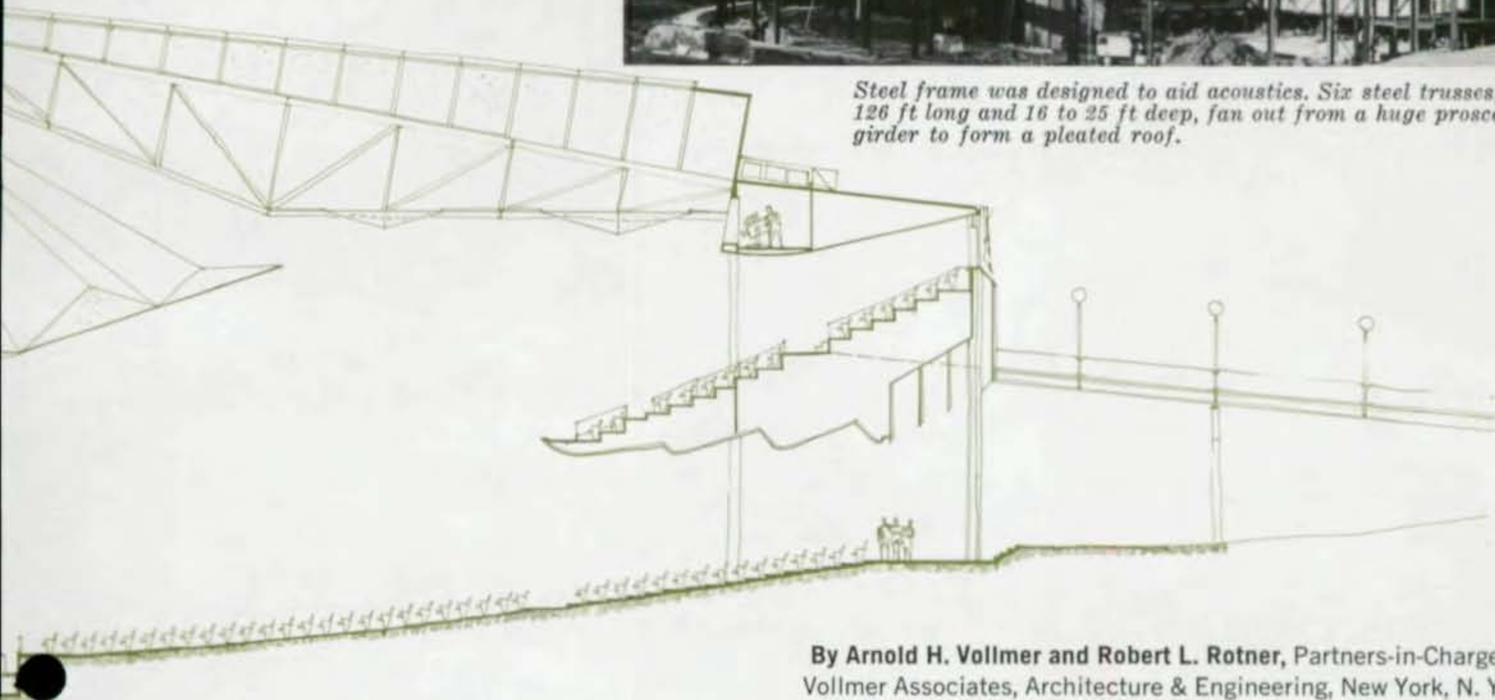
## Sophisticated Acoustical Design

This is the first time, to our knowledge, that a covered pavilion, open on three sides, has been designed for such sophisticated acoustics. Our intention is that everyone seated inside will hear the music directly without the aid of electrical amplification. As you might expect, the acoustical design for the pavilion has been extremely complex. Steel construction has made it possible to incorporate the development of our acoustical design in the most economical way.

The major acoustical element consists of a permanent canopy extending from the proscenium over the front portion of the orchestra seating. Almost 100 ft wide and about 50 ft deep, it is framed entirely of steel. Its undulating reflective surface is of wire lath and plaster, as is the balcony soffit, another major acoustical surface.

But perhaps our greatest satisfaction is knowing that the audience will be able to enjoy what they came for: music and

*Steel frame was designed to aid acoustics. Six steel trusses, each 126 ft long and 16 to 25 ft deep, fan out from a huge proscenium girder to form a pleated roof.*



**By Arnold H. Vollmer and Robert L. Rotner,** Partners-in-Charge,
Vollmer Associates, Architecture & Engineering, New York, N. Y.

# for Ballet and Music

ballet. For example, sight lines to the stage from every seat inside the pavilion are completely unobstructed. From the bowl-shaped lawn behind the pavilion, where there's room for another 7,000 people, only the thin steel columns mar an otherwise perfect view of the stage. It's an annoyance about as serious as watching a baseball game through the wire screen behind home plate. After the game starts, you don't even notice the screen.

### Unusual Steel Features

We also think everyone in the audience is going to find it surprisingly easy to get to his seat and leave when the concert is over. Four trim steel bridges reach over the lawn to the balcony. Going to their seats, balcony and box seat ticket-holders won't have to thread their way through the orchestra and lawn crowds. And since the pavilion is open, the ground level seats can be reached from any side. We hope that the steel will receive some aesthetic plaudits from the audience, too. Seated inside, a concert-goer will be able to see the 126-ft long inverted trusses supporting the pleated roof. The trusses range from 16 to 25 feet in depth, and are fabricated of high-strength steel (A441).

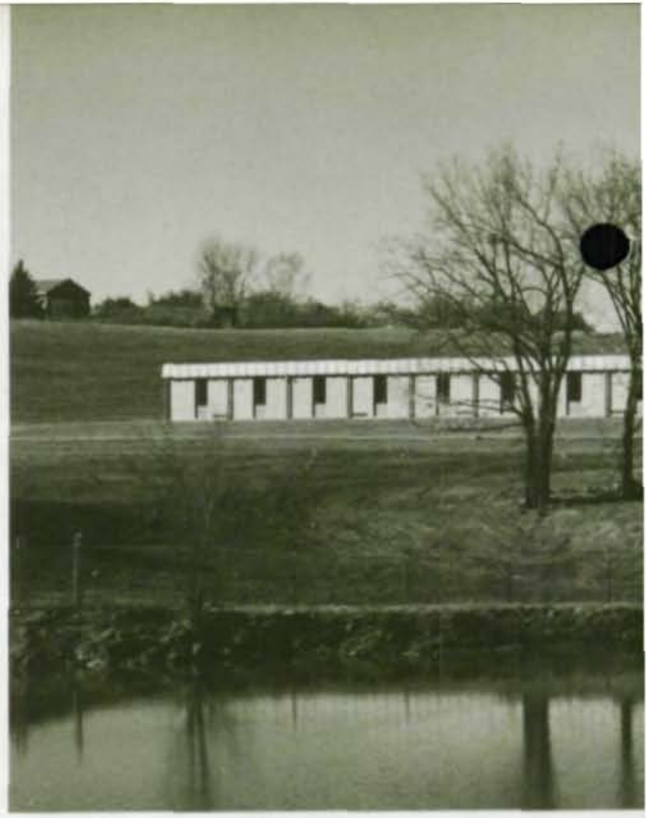
The steel framing went along smoothly from beginning to end. All field connections were made with high-strength bolts. We did go through some structural gyrations settling on the design of the proscenium girders, to which the trusses are attached. The problems of roof loads, of the auditorium loads, and of bracing were finally solved by an immense built-up girder. It's 82 ft long, 10 ft deep and checks in at an impressive 40 tons. Two 50-ton-capacity cranes were needed to erect the girder.

Essentially, the amphitheater contains three parts: the stagehouse, a series of backstage facilities surrounding the stagehouse, and the main pavilion. The stagehouse is 100 ft high, 102 ft wide and 60 ft deep, a size dictated by the need to hang an array of ballet sets above the stage. The stage allows ample space for not only the dancers, or the 100-piece orchestra, but is also big enough to put on an opera.

The amphitheater is on a 150,000 sq ft piece of land within the 1,500-acre Saratoga Springs reservation, a New York State Park. The state is preparing parking areas and building access roads from major arteries nearby.

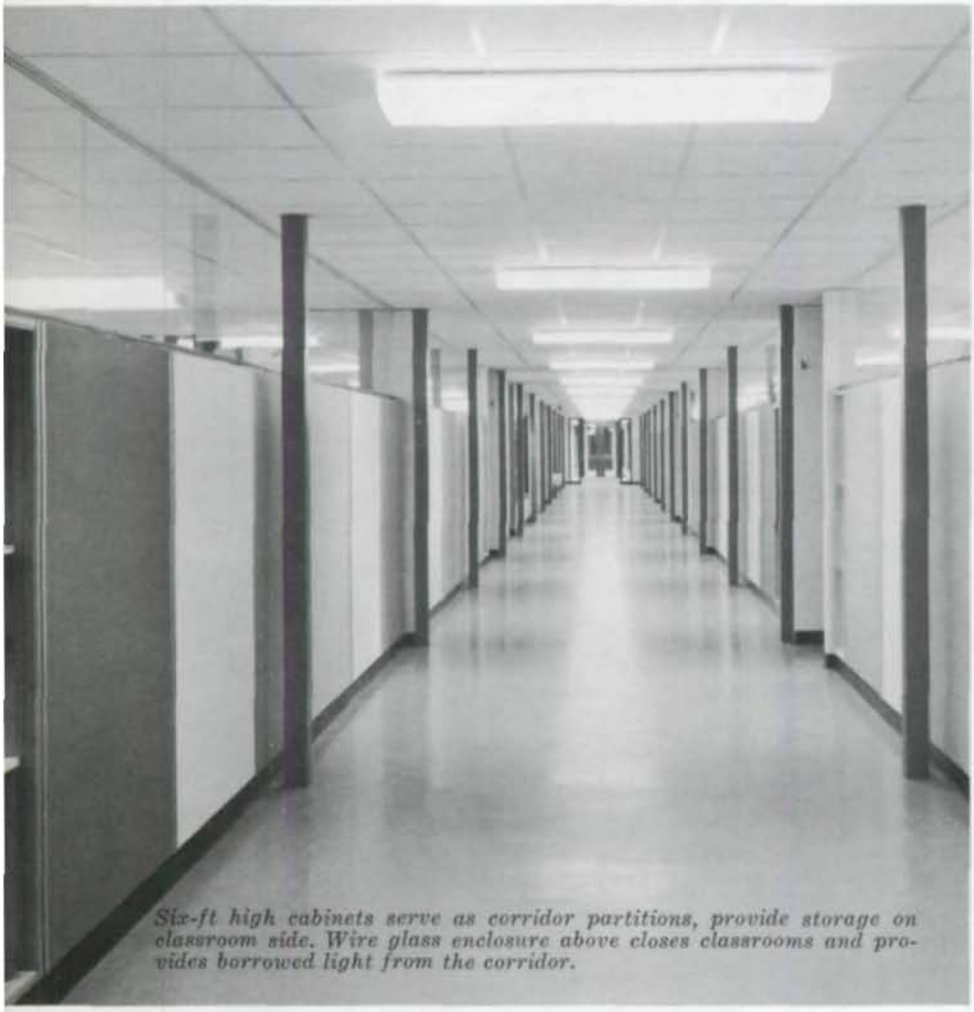
Our firm, Vollmer Associates, was responsible for the design. Structural steel was fabricated and erected by James McKinney & Son, Inc., of Albany, New York. General Contractor is L. A. Swyer Co., Inc., also of Albany. Acoustic consultant is Paul Veneklasen, Los Angeles.

# WAYZATA ELEMENTARY SCHOOLS



By **Donald M. Erickson,** Patch and Erickson, Inc., Architects

Architect: Patch & Erickson, Inc., Minneapolis
Structural Engineer: K. M. Clark Engineering Co., Minneapolis
General Contractor: Adolfson & Peterson, Inc., Minneapolis



*Six-ft high cabinets serve as corridor partitions, provide storage on classroom side. Wire glass enclosure above closes classrooms and provides borrowed light from the corridor.*

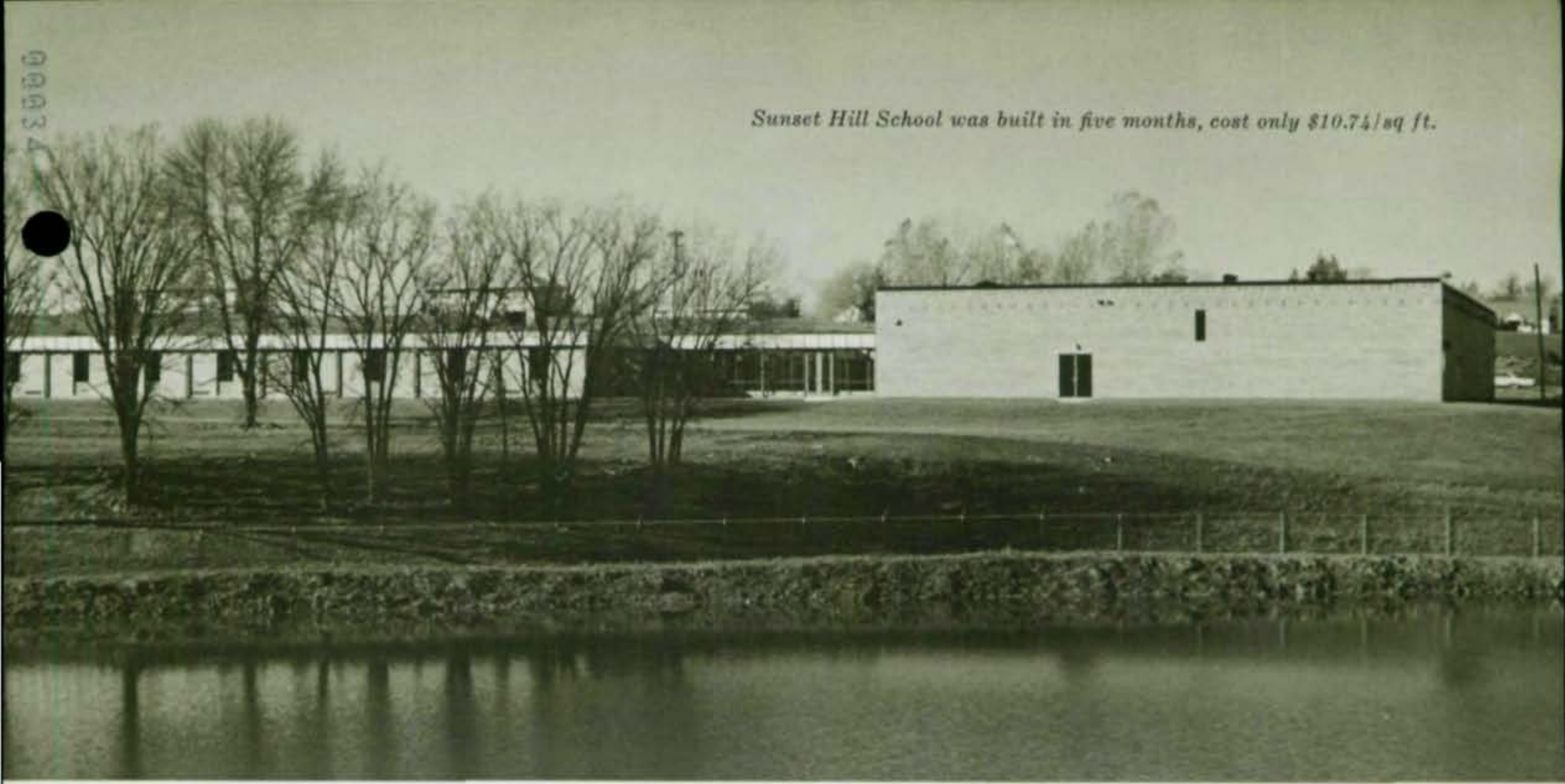
The new Wayzata Elementary Schools are planned with two dominant considerations. The first is the design of the buildings to meet the educational program and the second to design the schools to fulfill changing requirements as educational demands change.

The academic building is designed on a 30 ft x 30 ft module overall, with the exception of two corridors on a 10-ft grid. This is based on a 900 sq ft classroom unit. All materials in the building relate to the basic module. The steel frame is used as a design feature with interior and exterior columns exposed and painted a light color.

The school administration and staff determined that a "closed" classroom would meet their immediate demands, but requested that this be highly adaptable to changes. The building was therefore designed on a complete steel frame, with none of the exterior or interior walls being loadbearing.

The basic concept of the building was to erect a roof over the academic area supported by thin column supports so, as educational needs change, the area can be rearranged under this roof to meet any demand. The entire mechanical and electrical design is coordinated for these changes whenever they may occur. The bar joist roof system provides excellent passage for electrical conduit

*Sunset Hill School was built in five months, cost only $10.74/sq ft.*



and piping. The exterior brick walls may be laid either before or after the steel is erected, subject to the schedule of the general contractor. The separation of the total frame from the masonry work allows the contractor far greater freedom of movement.

A metal ceiling grid "T" system for the acoustical tile was installed for the entire ceiling before an interior wall was placed. This lift-out acoustic ceiling allows complete access to the utilities, and, designed on the same module as the steel, provides a regulated placement for the classroom walls. All walls are brought up only to the metal grid, where a gasket is inserted to aid retention of sound. The schools have had no basic acoustic problems. The steel frame also allows for a complete installation of floor covering before placement of walls where an integral floor is specified.

A unique feature of the interior is the framing of the corridor classroom walls by means of storage cabinets approximately six ft high.These cabinets were moved into place as furniture after the interior work was nearly completed. On the corridor side an impervious, durable, flameproof plastic laminate was applied in various colors. These cabinets provide a scale and color environment which has proved pleasing to both children and adults. They are highly practical because of total storage on the classroom side and because they can be relocated in future years. A wire glass enclosure from the cabinet top to the ceiling encloses the classroom and gives borrowed light to the classroom, expanding the visual environment. Light control for visual aid is achieved by draperies. Exterior windows, two to a classroom, provide an exterior view but allow simple light control for the visual aid program.

The system of construction provided additional desirable features. The first school, Sunset Hill Elementary School, consisted of twenty-eight classrooms and was occupied in a five month building period. The building cost was extremely low, averaging $10.74 per sq ft. The parking lot, parking lot lighting, extensive sodding and planting, private well and sewage disposal system with holding pond brought the total expenditure to $11.58 per sq ft. The second school, Greenwood Elementary School, had thirty classrooms, and was bid for a slightly higher cost. Started in the spring, it was occupied by students in September.

*Success of Sunset Hill School led to similar architectural and structural treatment for new Greenwood School.*

# steelnotes

**World's Largest Suspended Roof**

Spanning 484,800 sq ft, a massive suspended steel roof will cover the $4 million Tulsa Exposition Center now under construction in Tulsa, Okla. When completed, this will be the largest suspended steel roof ever built. The structure measures 1200 ft by 404 ft and will provide 360,000 sq ft of column-free area to exhibitors, a feat made possible by an unusual combination of steel box-columns, built-up steel girders and pre-stretched steel cable. The horizontal framing for the structure spans 304 ft without column support. A series of cables and outside columns carry the suspended roof system load.

The building is scheduled to be completed this spring, in time for the 1966 International Petroleum Exposition. Structural Engineers are David R. Graham and Associates, Inc.; Architect is Bert E. Griffin; Steel Fabricator is Flint Steel Corporation.

**Tied-Arch Bridge for Milwaukee**

Scheduled for construction in 1969 is this proposed continuous steel through tied-arch bridge over the Milwaukee River Harbor entrance. Total length of the structure is expected to be 1080 ft, with a 600-ft center span and two 240-ft side spans. A width of 97 ft will provide for a six lane divided roadway and four emergency parking shoulders. A 115-ft vertical clearance will be maintained over the entire 470-ft width of the harbor channel.

Consulting engineers on the project are Howard, Needles, Tammen and Bergendoff.

**Bridge Design Competition**

A world-wide highway bridge design competition, open to both professional engineers and students in engineering colleges, has been announced by the United States Steel Corporation. In the professional engineer competition, first prize will be $15,000. Thirteen awards will be made in all. The first-place winner in the student competition will receive $5,000, and seven awards will be made in all. The deadline for entries is May 31, 1966.

The competition will require the design of an overpass structure in steel to carry a two-lane highway at right angles over an interstate highway. Factors in the judging will be originality of design, the degree to which steel is utilized, economy, and appearance. Rules and instructions may be obtained from Robert S. Holmes, General Manager, Highway Construction Marketing, U.S. Steel Corporation, 5 Gateway Center, Pittsburgh, Pa. 15230.

**Building a Big Image**

Reported to be the largest outdoor screen on the Florida west coast, this 100-ft x 78-ft curved screen was recently erected in Largo, Florida, in preparation for the opening of the Thunderbird Drive-In movie. The steel frame can withstand winds up to 200 mph.