VOLUME XXI NUMBER 2/SECOND QUARTER 1981

MODERN STEEL CONSTRUCTION

Builder with a New "Home"
The Anatomy of Design Flexibility
Three Days to Countdown!
A Consultant Looks at Steel Parking Decks
A New Leap into Tomorrow—with Steel

MODERN STEEL CONSTRUCTION

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1981 ARCHITECTURAL AWARDS OF EXCELLENCE BANQUET

A black-tie, AISC-hosted banquet honoring the winners of the 1981 Architectural Awards of Excellence competition will be held on Oct. 27, 1981 at the Continental Plaza Hotel in Chicago. Engraved steel-and-wood plaques will be presented to the successful architects at the banquet. Members of the construction industry are cordially invited to attend the $80-a-plate banquet (tables, 10 persons, $700). Tickets may be obtained from: AISC Member Services, 400 N. Michigan Ave., Chicago, 60611.

Winners will be featured in the October issue of Architectural Record magazine.

T.R. HIGGINS LECTURESHIP AWARD RECIPIENT

Theodore V. Galambos, Harold D. Jolley Professor of Civil Engineering at Washington University in St. Louis, has been chosen as the 1981 T.R. Higgins Lectureship Award Recipient.

The award, an engraved citation and $2,000, was presented to Galambos on May 1 at the 1981 AISC National Engineering Conference in Dallas.

As the award recipient, Galambos will present six lectures, the first of which he delivered at the Dallas conference.

The winning paper, "Load and Resistance Factor Design for Steel," which Galambos co-authored, was selected by the awards jury as the most significant paper on steel design published in the last five years.

1981 AISC FELLOWSHIP AWARD WINNERS ANNOUNCED

Six engineering students have been named winners of the 1981 AISC Fellowship Awards by the AISC Education Foundation. Selection for the $4,750 grant for graduate study was based on the relationship of the applicant's proposed course of study to the fabricated structural industry, academic performance, and university and engineering faculty recommendation.

The 1981 AISC Fellows are: Michael J. Ehredt, University of Washington; John P. Gladwell, University of Central Florida; Brian L. Grundmeier, Purdue University; Craig J. Hetue, University of Wisconsin - Milwaukee; Bruce E. Hopper, Clarkson College of Technology; Paul M. Thompson, University of Tennessee.

The six Fellows attended the AISC National Engineering Conference in April as guests of AISC.

Members of the AISC Fellowship Jury were: James M. Fisher of Computerized Structural Design, Inc.; James Holesapple of INRYCO, Inc.; Richard A. Parmelee of Northwestern University; William A. Milek, Charles Peshek, Jr., Robert O. Disque and Nestor R. Iwankiw, all of AISC. □

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Amenities such as handsome lobby/reception area and spiral staircase were built into Gilbane's tight-budget building.

Gilbane Company — Builder with a New "Home"

Much like the shoemaker whose children were always barefoot, Gilbane Building Company was a large builder without a real "home." Rated among the 26 largest builders in the country, its "home" was spread out between a five-times-remodeled warehouse and a conglomeration of construction trailers in its parking lot.

So, when the 108-year old Providence, RI firm decided it was time to build a new corporate headquarters, they faced some special challenges. Their fast-growing construction management firm had a strong commitment to New England, and especially to Providence. They had never even considered the option that other businesses had — that of leaving chilly Rhode Island for warmer, less costly areas.

Rather, Gilbane chose to meet the energy crisis head on. It is no secret the state is heavily dependent on oil and gas. Thus, the cost of energy is a major factor in any construction venture, and the demise of low-cost energy has burdened corporate expansion in the state since the first oil crisis.

But Gilbane, with its deep-rooted commitment to the area, acted positively to affect its economy. The direct result has been acclaimed as the state's most energy-efficient office building. In fact, the Gilbane building was cited during dedication ceremonies by the governor of the state and the mayor of Providence as a prototype of advanced energy-saving technology.

The new $4-million, 118,000-sq ft structure, located in a restored Cathedral Square area on historic Weybosset Hill, incorporates the best energy conservation features available. The 4-story structure, Rhode Island's first solar office building, uses an estimated 49,000 Btu's per sq ft, per year—far below the recently established minimum standard of 75,000 now required for new office buildings. Thomas F. Gilbane, the firm's chairman and chief executive, summed it this way, "It was important to show that, despite the problems posed by rapidly increasing energy prices, the new building could be energy efficient, and reasonably economical to operate."

The building is a practical demonstration of the range of energy-saving skills and construction techniques gleaned from more than a century of building, and of serving as construction manager for a broad range of clients—from the Smithsonian Institute's National Air and Space Museum to the recent Winter Olympic Games at Lake Placid.

Architectural Challenge

In choosing the architectural firm of Beckstoffer & Associates to design the building, Gilbane also threw out a challenge. Meet the demands of a fickle New England weather, from artic coolness to oppressive humidity. The designer used techniques tried on other buildings, but rarely in this combination, and particularly in Rhode Island. Here, the building and design

New corporate headquarters (above) houses firm, enjoys some rental income from outside tenants. Fourth floor skylight (below) outside executive offices saves considerable energy by virtually eliminating artificial lighting needs.

industry is only beginning to meet the needs created by the energy crisis.

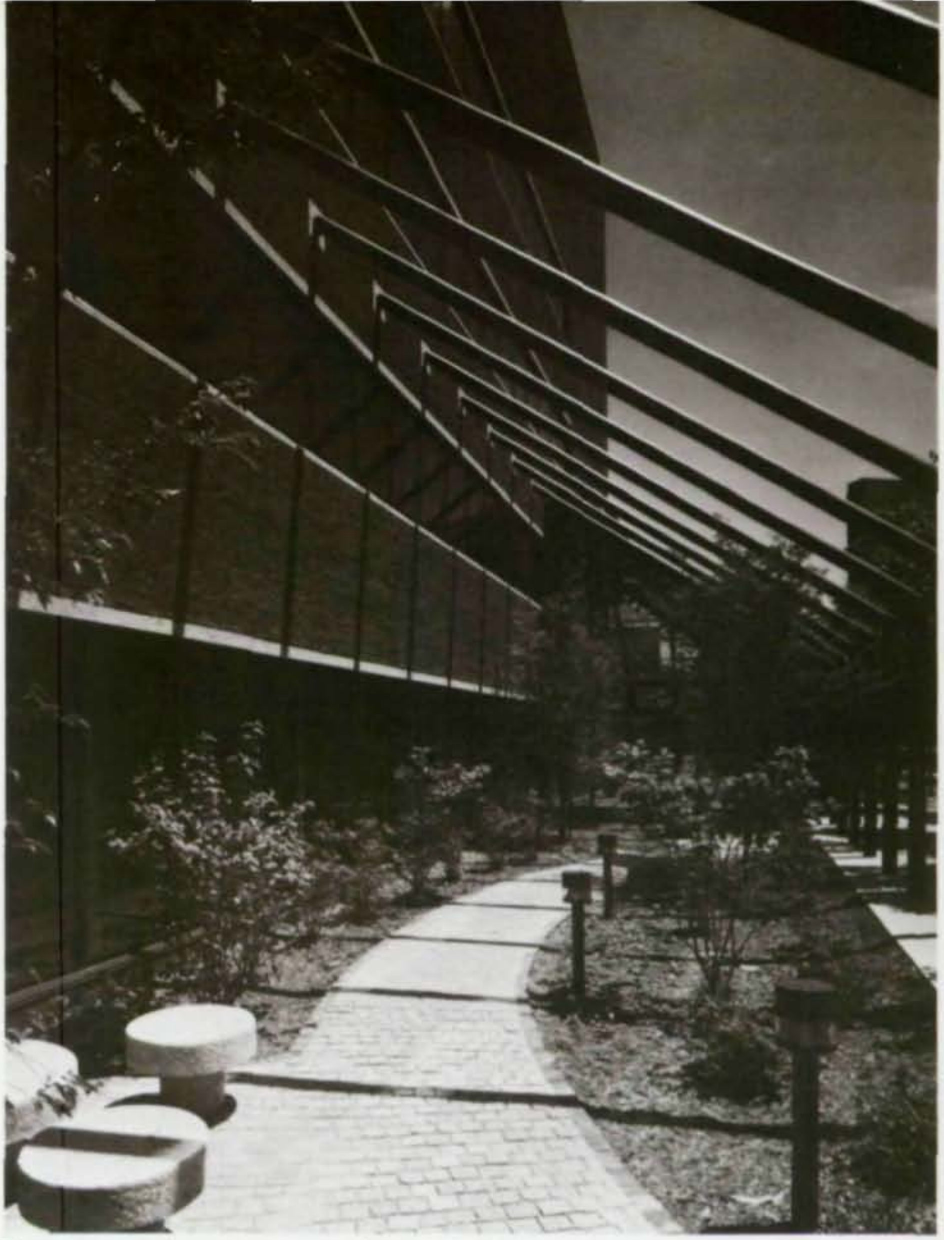
Specifically, the Gilbane Building design reduces drastically the energy needed to heat, cool and illuminate each square foot. During "cheap energy," it was not uncommon to find buildings that required 150,000 Btu's per sq ft for heating/cooling per year. Dramatically, the 49,000 Btu figure for this structure represents only about one-quarter of the average Btu's used by comparable commercial buildings in this climate. Engineers estimate this building will save enough energy to heat over 80 Rhode Island homes for a year.

Renewable Energy Systems

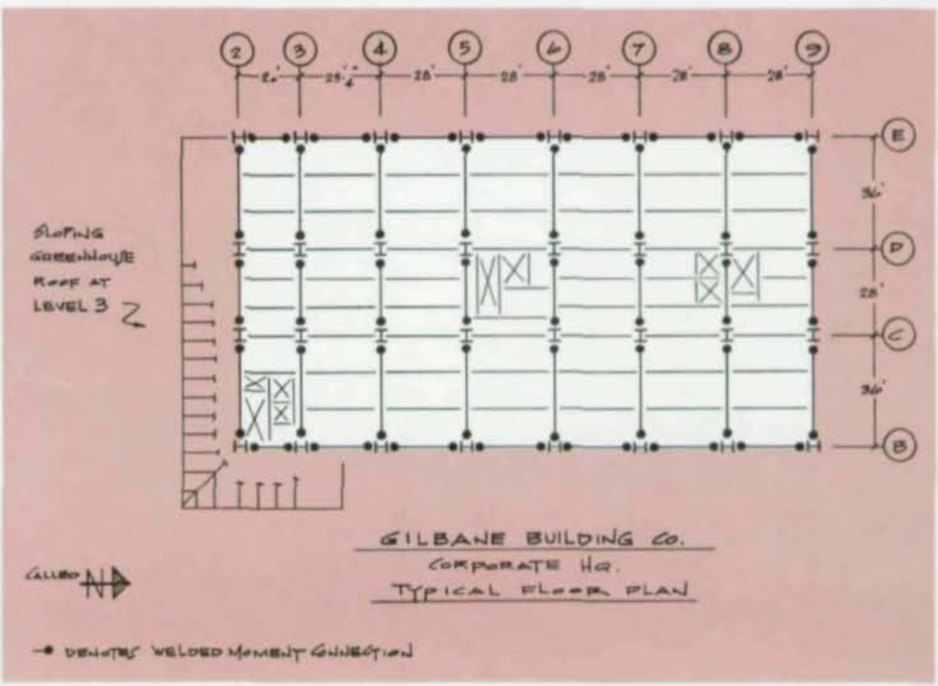
These dramatic energy savings were made possible by detailed attention to design and a commitment to full insulation on roof and exterior walls. Both exceed R-19 insulation requirements. The roof was especially designed to insure long life, and provide high insulation values. A conventional roof would usually be a metal deck, insulation and built-up roofing over it. The Gilbane Building roof incorporates a metal deck covered with 5½ in. of concrete, a sealer of polyurethane, 2 in. of rigid Styrofoam® and a layer of butyl rubber covered with stone ballast.

In addition to the amount of insulation, Gilbane made further commitments to alternative, renewable energy systems:

- The building's main entrance is a 2,000-sq ft greenhouse on a corner. The showpiece greenhouse uses a Trombe wall as a heat sink to absorb heat and capture it in ducts for redistribution, and for preheating outside air.
- Roof-top solar panels supply 80% of domestic hot water needs.
- Three 20,000-gal. tanks beneath the building store chilled water generated during evening hours to take advantage of off-peak energy rates. The water is used during daylight hours to reduce chiller loads.
- Ambient heat generated by lights, machinery and people is captured through ceiling plenums and recirculated to further reduce energy loads.
- Lighting, which often consumes more of an energy budget than heating/cooling, has been made significantly more efficient with parabolic fixtures which use only 1.65 watts per sq ft.



Showpiece greenhouse captures sun's heat to be redistributed through building. Typical floor plan (below) indicates welded moment connections.



• Glass has been kept to a minimum. The ratio of brick to glazing is 20%, as opposed to 25-30% in many new office buildings. Windows are bronze Thermopane, and recessed from the curtain line to prevent heat buildup in perimeter offices during afternoons.

Sophisticated Monitoring

Use of these energy-saving techniques and devices is regulated, for maximum efficiency, by sophisticated pneumatic controls which shut down specific systems when not in use. The mechanical system was designed to insure adequate heating and cooling 365 days a year—unique for the Providence area. A dual fuel system uses either electric or oil/gas (two boilers) to take advantage of price and availability. The electric boiler operates primarily in the evening, thus permitting off-peak rates to be enjoyed.

Gilbane officials estimated the total cost for the complete energy package at $850,000, about 20% more than with standard insulation procedures and conventional fossil fuel systems. With the rapid increases in costs of energy, Gilbane expects a payback, conservatively, within three years.

Handsome board room and fourth-floor corporate area (bottom) amenities add high style to Gilbane Building appointments.

Steel Structural Features

The building superstructure chosen was A36 structural steel framing supporting steel deck and 5½-in. floor slabs. The total slab thickness at the main roof level near the mechanical penthouse was increased to decrease vibration/noise transmission to offices below. The floor system at the first framed office level is 10-in. precast plank with a 3-in. concrete topping. The planks provide a finished ceiling in the parking area below, and satisfy fireproofing requirements.

Resistance to earthquake and windloads prescribed by the Rhode Island code was provided by welded rigid moment frames (see plan). Concrete was ruled out by designers as a structural material because of its higher cost, and a winter construction schedule.

The brick facade is supported on galvanized lintel angles welded to vertical light-gage structural steel studs supported at floor level. Diagonal "kicker" braces prevent rotation of wall panel units by transferring wind loads into the floor slabs.

The new Gilbane Building has created a stir in conservative Providence, where results are being watched carefully. According to Gilbane, "This builder's commitment is bound to raise the visibility of solar technology and energy conservation in a community that is still wedded to conventional fossil fuel systems." □

Architect
Beckstoffer and Associates
Boston, Massachusetts

Structural Engineer
LeMessurier Associates/SCI
Cambridge, Massachusetts

Fabricator
Roanoke Iron & Bridge Works, Inc.
Roanoke, Virginia

Owner/General Contractor
Gilbane Building Company
Providence, Rhode Island

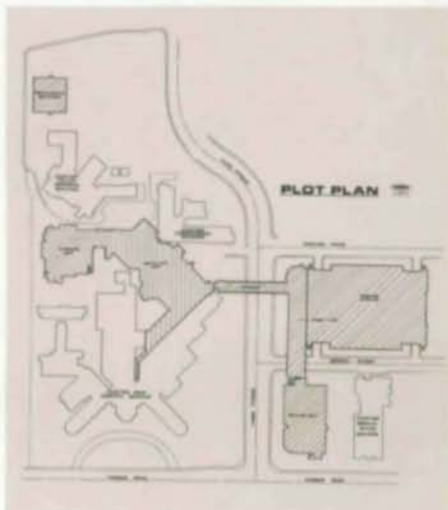
St. Joseph's Hospital spans major street in downtown Phoenix. Ancillary building (c.) and Nursing Tower (r.). See plot plan below.

The Anatomy of Flexibility in Hospital Design

by Philip B. Waller

In April 1976, St. Joseph's Hospital in Phoenix, AZ announced a 60.5-million dollar expansion program consisting of a 450,000-sq ft parking garage as well as 560,000 sq ft of new hospital space. The extensive expansion was required to supply adequate space and flexibility to keep the hospital abreast of the latest medical technology. The expansion involved the design of seven separate buildings on two sides of a major traffic artery near the heart of downtown Phoenix.

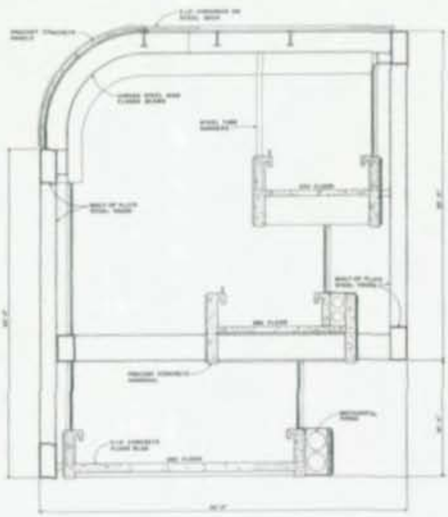
Due to space limitations on the existing site, the parking garage, outpatient clinic and the admitting building had to be built on the east side of 3rd Avenue. On the west side of 3rd Avenue, the existing hospital was supplemented with a new ancillary services building, a nursing tower and a new central plant. These facilities were joined by a three-level pedestrian bridge.



Alternate Systems

The key to any successful project is the ability to use the appropriate materials and framing systems for each

Philip B. Waller, P.E., is vice president and chief engineer of Robin E. Parke Associates, Phoenix, Arizona.



SECTION THRU BRIDGE

Pedestrian bridge was challenge. Fully enclosed, it joins three areas of hospital (above). Photo (l., below) indicates scale of 3-level bridge. Erectors (l.) hoist huge primary chord for pedestrian bridge.

individual part of the project. Among items to consider are economy, speed of construction, flexibility for future remodeling, vertical and horizontal expansion and fire rating. St. Joseph's Hospital provided a unique opportunity to apply this concept to its fullest extent.

The parking garage, although only 4½ stories, 450,000 sq ft, was built in this phase. But it was designed for nine stories, 900,000 sq ft. Furthermore, the garage had to be designed, built and occupied before the remainder of the project could start construction.

The nursing tower, designed as eight stories, plus a future basement and first floor, was a challenge both for gravity loads and lateral loads. It was designed for UBC seismic zone II, with an importance factor of 1.50, as were all other buildings on the site. In addition, the flexibility desired for future remodeling of the building precluded using shear walls either at the perimeter or in the core. With these items in mind, the system chosen was lightweight concrete over steel deck on composite steel beams for gravity loads, and moment-resisting steel frames for lateral loads.

Due to the complex functions occurring within the ancillary building, (primarily surgery and radiology), the hospital wanted to incorporate the interstitial framing concept. This permits modifications within the building with the least amount of interruption of ongoing services. Since the new structure had to match the existing building floor-to-floor heights, it was decided to make the interstitial floors a full story in height. To achieve this, full-story height steel trusses were used, which evolved into a 36-ft x 103-ft grid, allowing unlimited freedom for future remodeling.

Design of the other buildings on the site was approached in a similar manner. In each case, all aspects affecting both the building under consideration and the project in general were considered in selecting the appropriate framing system.

Interstitial System at the Ancillary Building

The system used to frame the floors above surgery and radiology areas of the ancillary building is full-story height steel trusses spanning 103 ft. The trusses vary in depth from 11'-6" to 13'-6" to match the existing floor-to-floor heights. Chords of the trusses are wide-flange shapes, with double angles used for the web members. All members for these trusses were A572 grade 50 steel. The top chords of the trusses support usable floors, and are framed with hardrock concrete over steel deck. In addition to being a usable floor, this part of the system supplies mass to help dampen vibrations that might be set up in the long-span trusses.

The bottom chords of the trusses support mechanical floors, and are framed with poured gypsum over trussed tee subpurlins. An important benefit of this system is that the gypsum floor may easily be penetrated without any special equipment. This permits revision of mechanical systems related to either surgery or radiology without any disruption of ongoing services.

Pedestrian Bridge a Challenge

The bridge across 3rd Avenue, the first such structure of its kind in Phoenix, is a fully enclosed, air-conditioned facility joining the out-patient, admitting and parking areas of the hospital with the existing building and the new ancillary and nursing facilities. The bridge spans the street and joins the two halves of the project at three separate levels to provide employees and visitors easy access from the parking garage to the hospital.

The bridge is two 29-ft deep trusses built up from steel-plate tubes. The trusses span 175 ft across 3rd Avenue between cast-in-place abutments. The trusses are staggered vertically and are joined rigidly together by curved steel beams and a rigid concrete diaphragm at the roof and a rigid Vierendeel-type truss at the bottom. The stagger of the trusses minimizes the southern exposure of the walkways to the intense summer sun. Walkways are precast beams and cast-in-place slabs supported from the steel structure.

The erection of the bridge trusses provided quite a challenge to the steel erector. Third Avenue is one of the major feeders for a nearby shopping area. It could not be closed for more than a few hours at a time. To resolve this problem, the fabricator completely fabricated the trusses in his yard, then cut them in thirds. The end thirds of the trusses were erected on cribs at the edge of the street, without impeding the flow of traffic. Center thirds were then brought out early on a Saturday morning and field-welded in place. Traffic was interrupted for only a few hours.

Other Buildings

The nursing tower, outpatient clinic, admitting building and central plant were all designed and built using lightweight concrete over steel deck and composite steel beams. The module for these buildings was 25 ft square. All deck was designed as unshored to allow maximum flexibility for the contractor to work on framed floors without the interference of shores. The lateral-resisting system chosen for all but the outpatient building was a moment-resisting frame. At the outpatient building, cast-in-place shear walls were used to resist lateral loads.

Fire Protection System

With the exception of the pedestrian bridge, the entire project was designed around Underwriters Laboratory assembly D916, which requires cementitious fireproofing of the steel beams, but not the steel deck. After consulting with local code agencies the designer also applied this system to the interstitial trusses at the ancillary building.

Since the architect chose to expose the steel trusses at the pedestrian bridge, a different solution to fireproofing had to be worked out here. After consulting with local code agencies and an independent fire protection expert, the architect agreed to install sprinklers beneath the bridge, above each steel truss on the roof and inside the bridge.

Summary

St. Joseph's Hospital has been a prime example of adaptation of materials and systems to fit the needs of a specific project. Due to the size of the project, only a few of the design considerations are presented here. As of this writing, half of the project is occupied, with the remainder scheduled for completion in September, 1981. □

Architect
Varney, Sexton, Sydnor Associates - Architects, Inc.
Phoenix, Arizona

Structural Engineer
Robin E. Parke Associates, Inc.
Phoenix, Arizona

Steel Erector
McNally Mountain States Steel Company
Provo, Utah

Construction Manager
McCarthy Brothers Construction Company
St. Louis, Missouri

Owner
St. Joseph's Hospital and Medical Center
Phoenix, Arizona

Congested conditions at hospital project required off-site staging of structural steel. Photo (bottom) shows interior of mechanical interstitial floor before equipment was placed.

ABC News broadcast facility for space shuttle launch.

Three Days to Countdown!

The ABC News division needed a broadcast facility for the space shuttle launch, originally scheduled for April 8. And blast-off was just 10 weeks away!

The location for the facility was a limited site at Kennedy Space Center in Cape Canaveral, Florida. The program called for a building about 25 ft x 40 ft to house a TV and radio studio, and accessory facilities.

To combine compactness with the best view of the launch site—three-and-a-half miles away—the designers raised the broadcast facilities into the air. The space under the studios had to be tall enough to accommodate mobile broadcast trailers containing technical equipment and personnel. Cables through the floor slab connected the units to the studio.

Launch Ten Weeks Away!

Just ten weeks before launch, design and construction drawings began almost concurrently. Since NASA would not permit foundations on the site, the structure would be of a temporary nature.

The design solution proposed was a tubular steel structure which would be virtually maintenance-free. The base, steel tube "feet" filled with concrete, rests on the ground. Critical wind loads required a very rigid frame to eliminate any movement that sensitive TV cameras might detect with their long-range lens. Earth shock at the time of launch was another critical consideration.

First choice for steel was of the weathering family, but time did not permit that luxury. An acrylic-epoxy paint was specified, a product to resist salt water corrosion and the constant battering of particulates carried by the winds.

Total fabrication, erection and interior treatments, including special acoustical requirements, took just three weeks.

ABC was ready—it was three days 'til countdown! □

Architect
Bloch, Hesse & Shalat, AIA
New York, New York

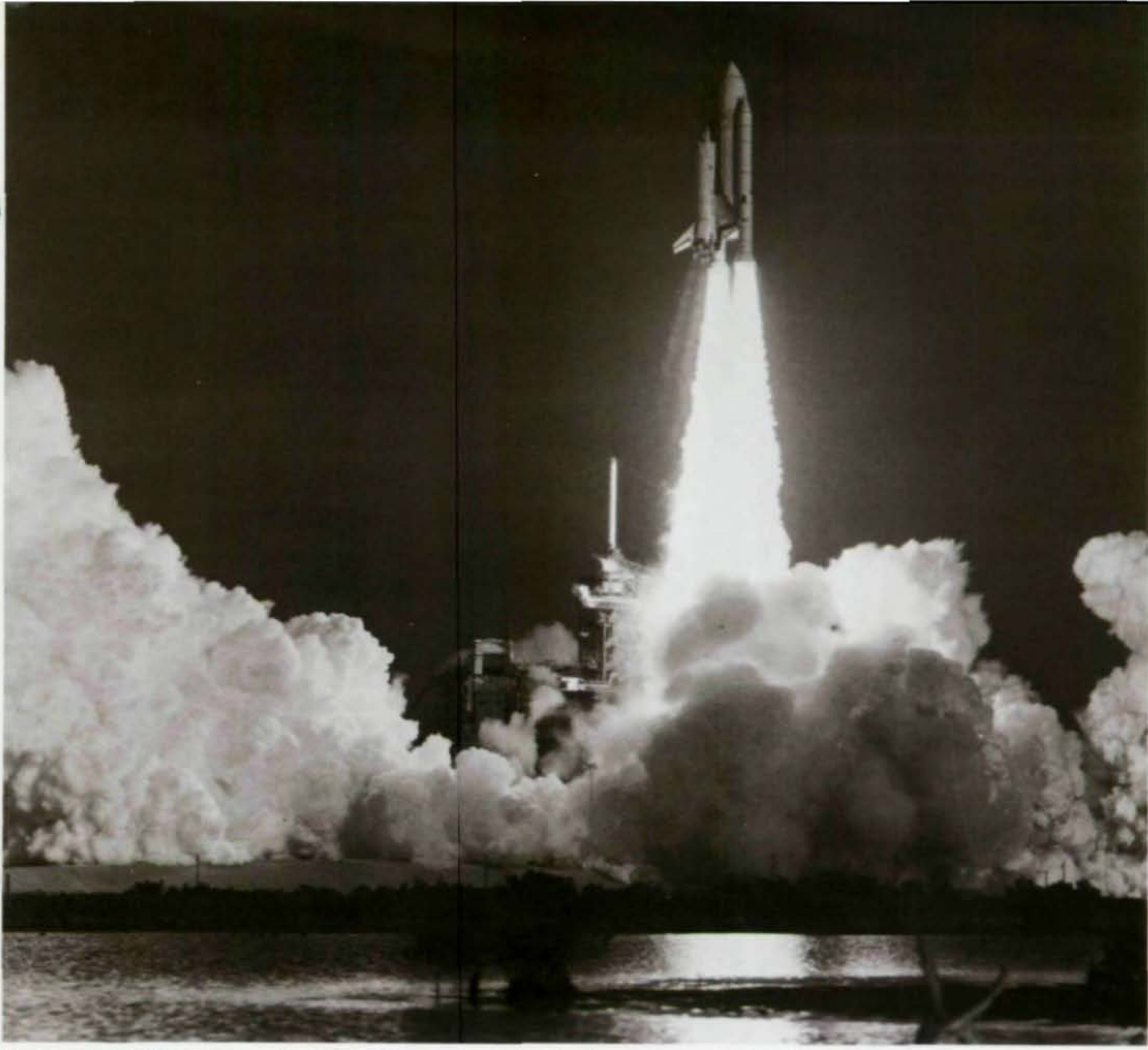
Structural Engineer
Martin Lovett Associates
New York, New York

General Contractor
Frank A. Kennedy Inc.
Cape Canaveral, Florida

Steel Fabricator
Florida Welding & Erection Service, Inc.
Orlando, Florida

Owner
American Broadcasting Company
New York, New York

Tubular steel frame and tube feet provided fast-track solution to building quickly needed facility.



Thunderous blast-off opens new vistas as Columbia roars skyward in latest leap into space on April 12.

A New Leap into Tomorrow—with Space-Age Steel

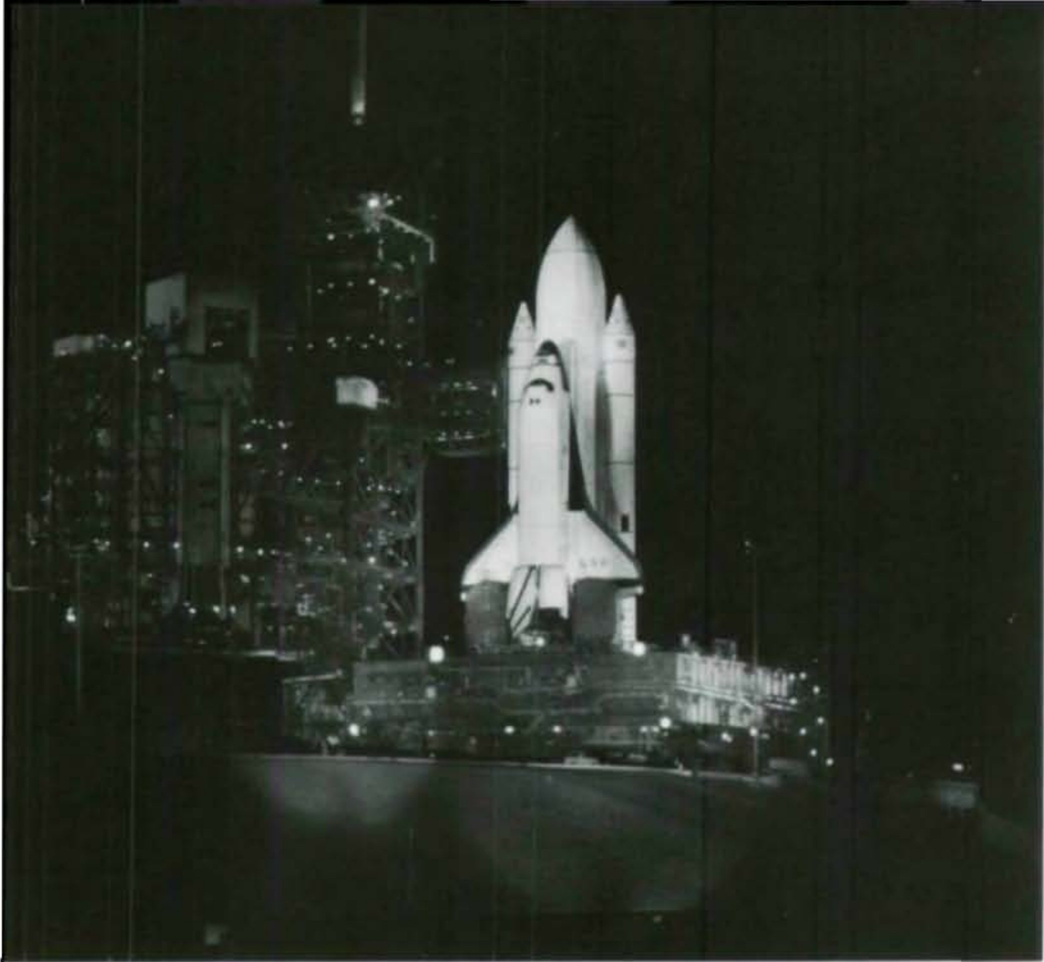
by Russell E. Stauffer

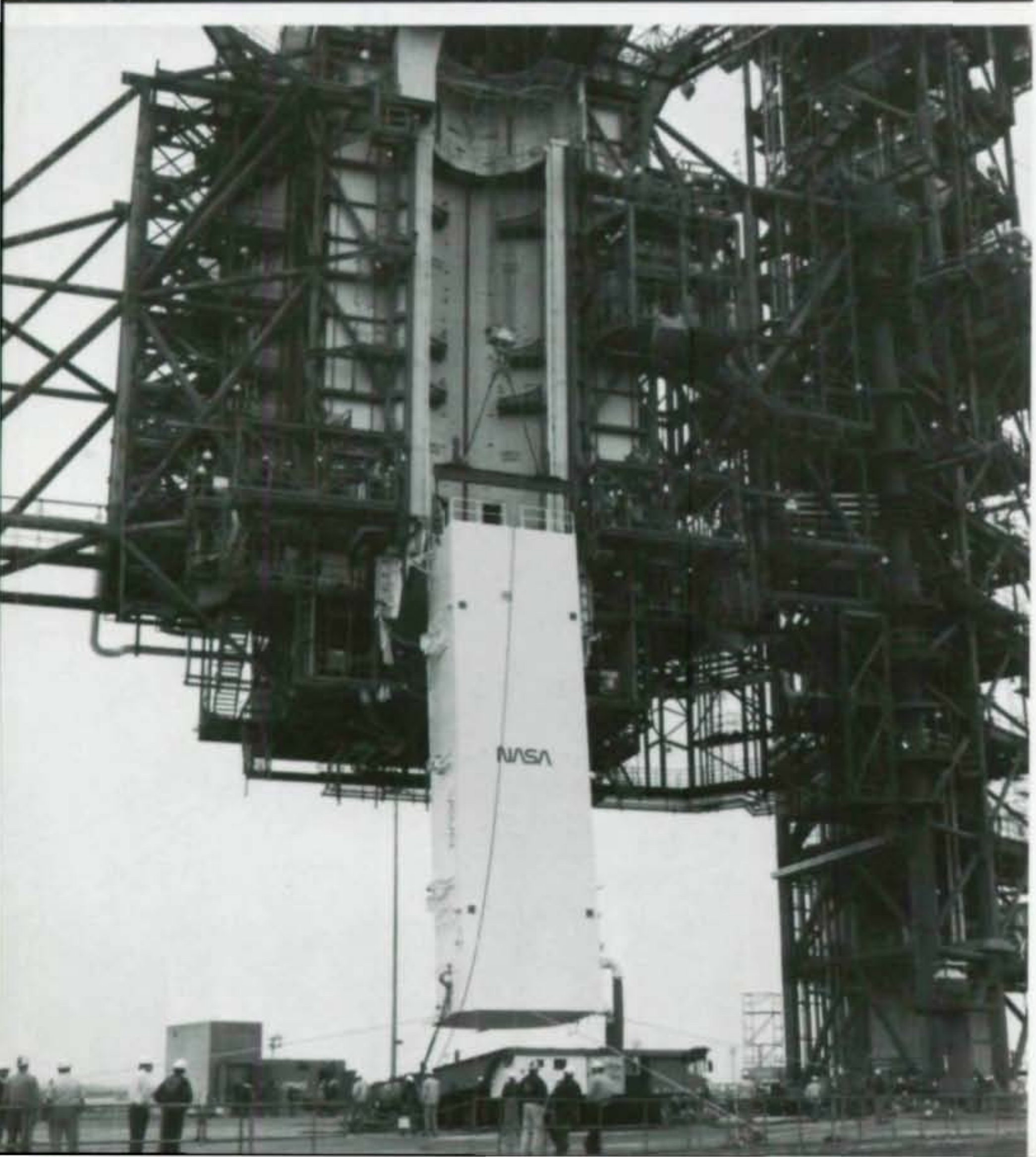
The Kennedy Space Center, on the east coast of Florida, is currently the scene of mankind's latest leap toward space exploration. This new milestone is the launching of the space shuttle—the world's first "reusable" space craft. To pursue these space-age aspirations, certain down-to-earth restraints had to be overcome. The use of structural steel on two of the many unique structures involved in the project helped achieve these goals.

The National Aeronautics and Space Administration (NASA) had to select an appropriate site for ground support and service the shuttle. Based on many studies—economic, logistical, schedule, timetable, etc.—reusing and modifying the existing Saturn V/Apollo, Moon Rocket Launch Complex 39 facilities at the space center were chosen as the best way to go. However, that decision presented many challenges to design and construction forces.

Launching the space shuttle followed the successful completion of many pre-launch activities. Requirements of these activities created a

Russell E. Stauffer, P.E., is AISC regional engineer in the Tampa, Florida area.





need for structures that "fit" the shuttle, in allowing necessary access to perform these functions. Some of these activities included fueling the vehicle, the preparation and loading of the payload, and the inspections and testing of various systems.

Additionally, just before launch these structures had to be removed from the immediate vicinity of the vehicle so they would not interfere with lift-off. Obviously, the structures had to be designed to withstand the high temperatures of rocket engine exhaust blast and acoustic pressures which occur at launch.

And, since these structures would be required for many years, as permanent parts of the shuttle program, they also had to be designed to overcome, efficiently and economically, everyday design problems, such as: strength, durability, deflection and alignment, corrosion, serviceability, adaptability, etc.

NASA's decision was that the two existing launch pads—#39A, completed and to be used for the initial launches, and #39B, nearing completion—were to be modified. Each would have a service facility of two parts, one stationary and one movable. The stationary structure is called the Fixed Service Structure (FSS). The movable, pivoted structure—with the ability to be retracted from the shuttle—is known as the Rotating Service Structure (RSS).

The Fixed Service Structure (FSS)

These 40-ft square x 247-ft high, open-framework structures were erected with steel from disassembly of the 380-ft high towers of the Saturn V projects. The 20 to 40-ft high segments weighed 48 to 212 tons each. Tower structural steel weighed approximately 1,377 tons. The mechanical and electrical equipment added 475 tons, for a total tower weight of 1,852 tons. The existing towers were disassembled and transported on trailers to the appropriate launch pad.

Here, the erection technique was the reverse of disassembly. The FSS provides, among other features, the following support and access to the crew access swing arm for shuttle cabin entry/egress: support for the 25-ton capacity revolving hammerhead

Major milestone as first space shuttle vehicle is readied for launch at steel-framed Complex 39 (top). Vertically processed cargos will be transported to launch pad in payload canister for loading on orbiter.

crane, with a 5-ft diameter x 75-ft high fiberglass lightning mast atop it; support for the slidewire emergency egress system for crew escape from the shuttle to ground level; support access and space from various fueling, venting etc., operations of pre-launch activities. Most importantly, it also provides the support and access to the Rotating Service Structure.

The Rotating Service Structure (RSS)

The RSS, or pivoting bridge, was designed to service the space shuttle orbiter's (vehicle) cargo bay, with payloads up to 65,000 pounds. Maximum dimensions are 15-ft in diameter, 60-ft long.

The RSS, therefore, provides support for the payload changeout room (PCR), which provides a clean, air-conditioned environment for payload checkout, insertion into, or withdrawal from, the orbiter's bay. The RSS is a new structure, a space frame of welded steel structural tubes in sizes up to 36-in. diameter. It pivots on one end from a 42-in. diameter hinge column, which is stabilized by struts to the FSS. It is supported on the other end by two 8-wheeled, DC motor-driven trucks moving along a circular, twin-rail track installed flush with the pad surface.

The RSS weighs approximately 2,100 tons, and is 160-ft long in radius and is designed to swing 120 degrees from its servicing position to its clearance position in 15 minutes — a major engineering achievement in its own right.

The payload changeout room on the RSS measures approximately 50 ft wide x 45 ft deep x 130 ft high. It is constructed of steel framework and girts on the exterior—with galvanized, steel-jacketed, polyurethane insulated, smooth-faced panels on the interior walls. The PCR, in turn, supports the PCR main doors, which are used to seal the PCR in the orbiter's absence. These consist of two sets of two-panel, bi-fold, 20′-6″ x 62′-0″ steel-framed doors, each set weighing 35 tons. Additionally the PCR houses many of the more sophisticated systems required for servicing the payload.

In addition to the normal design conditions encountered in the everyday design of all structures—particularly severe wind loads due to the exposed coastal location—these service structures also had other unique features to be considered. According to George Walter, KSC's structural consultant, the "fast-track" approach, where the design of the facilities and vehicle proceed simultaneously, presented many occasions where in-design modifications to existing concepts had to be incorporated.

Additionally, it was pointed out the structures would be exposed to a relatively harsh, corrosive environment. Above all else, Walter pointed out, problems of alignment and tolerance are always critical considerations that have to be recognized. Bill Tolson, the FSS and RSS lead designer, added further that the structures had to be durable, and had to work!

Engineers, designers and technicians at NASA, and their supporting contractors and consultants, were able to overcome the myriad of potential problems associated with the design of these structures.

Reuse of existing Saturn V towers brought obvious economic and schedule advantages. However, not so obvious was the subtle recognition that, with the proper choice of protective painting systems and a reasonable maintenance program, exposed steel structures (which had already made their contributions years ago to the space program) were still structurally sound and capable of further extended usage.

Further application of the proper painting systems, an inorganic zinc system, on the newly designed structure (the RSS) further demonstrated confidence in the durability of the exposed steel structures.

The normal design considerations and the not-so-normal design considerations—for example, the ability of the RSS and other structures thereon to withstand 120-knot winds in its retracted hurricane tie-down position, and to self-propel through a swing arc of 120 degrees in a 40-knot wind—were solved by use of the proper engineering "tools," STRUDL & NASTRAN computer programs, and the application of proper engineering judgements based on many years of expertise.

Additionally, these steel structures allowed for a relatively easy way to deal with inevitable in-design modifications which had to be incorporated. The advantages of structural steel's adaptability and flexibility obviously paid tremendous economic and scheduling dividends.

Throughout the project, the proper application of quality-control restraints assured that extremely close tolerances and alignments required for successful completion of the structures would be maintained. This not only meant that shop-fabricated pieces, such as the joints for the RSS, sometimes consisting of 11 large diameter pipes whose center lines intersected at a common working point, but also that field erection and alignment tolerances were also under close scrutiny.

The large doors on the PCR, also of sensitive tolerances, on the order of 1/8 in., for their length, were another of the many examples of an extremely close fit that earmarks the project's quality, particularly on these structures—the FSS and RSS—quality that steel helps to provide! □

Service structure demonstrates huge amounts of steel used to withstand tremendous shock and heat of launch.

Security problems lessen when exterior open stairwells are designed into parking deck.

A Consultant Looks at Structural Steel and Parking Decks

by James M. Hunnicutt

The purpose of this article is to share some observations, gleaned from more than 30 years experience in working with 400 parking structures, on the practical aspects of structural steel in parking decks.

There are a number of major points to remember about this type of building which distinguishes it from other types of structures.

A Different Breed

First of all, a parking deck is out in the wind, rain, snow and other weather elements, which makes its structural system completely different from office buildings, apartments, houses or retail areas. It is not uncommon for a parking deck to undergo a 100° temperature change in one day. It also has rolling loads, vibration, and cars bringing in salt and dirt. Mixed with rainwater blowing in, these elements cause slab deterioration and premature aging of the building. Therefore, a parking deck project cannot be undertaken on the same basis as a commercial building.

Nor can a deck be approached the same as a highway bridge. With only a 50 psf live load in many cases, the deck is much lighter and more subject to vibration as the cars drive around it. The primary design criteria for a parking deck is that of automobiles, both parking and driving. Long spans of 60 to 65 ft must be used. But a parking structure must be designed for people also.

Another major difference in parking decks is maintenance. While steel must be painted on a regular basis, the repeat cycle is completely different from the shorter cycle required for a highway bridge. Interior beams, columns and girders may be some distance from blowing rain and wind, which causes uneven requirements for painting over the years. It is not uncommon to have to paint up and retouch only certain areas, rather than the entire structure.

We have found a number of positive points in favor of the use of structural steel in parking structures. These features provide the designer with a number of variables that can provide a well-functioning deck, a building that is easy to maintain and one with an attractive appearance.

Pointers for steel-framed parking decks:

1. *Ease of Construction*—Many of our buildings have sloped floors, compound slopes, warped sections, and more-than-average camber drainage. We experience difficulties in warping floors and getting the slopes we want in both post-tensioned poured-in-

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place and precast buildings. With both precast and poured-in-place, it is difficult to get anything other than flat floors—which limits the designer in solving specific problems.

In a recent project, we were required to tilt entire floors to get the required drainage, because of the limitations placed on post-tensioning and the inability to put a required camber in the floor system.

2. *More Headroom*—With proper design, and depending on column spacing, we have found that steel can actually give us additional headroom in the parking deck. As designers, we normally try to provide a minimum of 7'-6" under the beams throughout the building. This is necessary to provide headroom for recreational vehicles, vans and the occasional service vehicle or wrecker. Most often, during construction, there is a slight reduction in headroom. If we get a final clearance of 7'-3" within the building we consider ourselves lucky.

Keeping floor-to-floor height lower permits shorter ramps and driving aisles. It also allows us to have less slope on the ramps, which makes easier driving for users.

3. *Contract Familiarity*—Many parking decks are built for public agencies and therefore must be put out for competitive bidding. Often, contractors who may not be familiar with the methods get the job. As a result, they have difficulty in building precisely what is wanted. We have not had this problem with structural steel.

We know of several decks that have been very late in completion because the contractor had a difficult time figuring out how to perform certain construction techniques. The result is often less than satisfactory. And the owner can be left with a deck that is difficult to maintain because of marginal construction practices.

4. *Cleaner, Brighter Parking Structures*—The steel should be painted light, bright colors to provide more reflectivity for lighting. One of the major operating costs for a parking deck is lighting. With a well-designed electrical system, energy costs can be reduced substantially.

All concrete structures get darker as the years progress because concrete absorbs dirt and oily exhaust smoke. At the end of 10 years, the deck can be very dirty, and the original lighting system inadequate for good visibility and security.

I am familiar with two major parking decks that had to replace completely their lighting systems after about 10 years. Light meter readings indicated the light intensity on the floor had been reduced almost two-thirds by the darkening of floors, beams and columns. One owner steam-cleaned his deck and put in new lighting, which was very expensive.

Had structural steel been used, a new coat of bright paint would have eliminated this expense.

Caution: Analyses at Work

Often, when a designer considers steel as the main structural system, the owner asks him to make a life-cycle cost analysis to prove that steel will actually be less expensive over the life of the building. This is a reasonable request. But carrying it out is not as easy as it sounds. There are many variables in parking decks. We have seen some life-cycle analyses made by those not familiar with them. The results must be termed as just plain inaccurate. We saw one report not too long ago where the only comparison between a steel-framed deck and a concrete deck was the cost of painting the steel. The designer assumed the concrete deck would require no maintenance whatever. This is inaccurate!

It is not possible to give a precise method for preparing a life-cycle analysis of competing structural methods in parking decks. It varies widely from one part of the country to the other, and must be based on individual conditions. However, there are a number of things which should be considered, and which we look into prior to conducting such an analysis:

A. *Maintenance Practices*
Some owners are far more diligent in maintaining their parking decks than others. Many owners virtually abandon the deck, and never perform any maintenance whatever. The entire deck may be at the point of structural failure in as little as 15 years. Others look after it, keep it clean, make minor repairs as they come up—and the result is a deck that lasts much longer.

B. *Maintenance Costs*
Maintenance costs vary widely throughout the country. They are governed by the cost of labor, materials and similar supplies. Not only do maintenance costs vary, but also the operating personnel may know nothing about how to maintain a building. Very little has been written to train

Steel framing painted in light colors (l.) saves on electrical energy costs. Steel on parking deck (r.) never received final field coat. Shop coat paint still in good condition after 13 years.

owners on how to maintain their buildings, and maintenance personnel may know nothing about what to do to remedy problems when they occur.

We know of one parking deck where the manager spread large amounts of salt all over to keep ice and snow down. On the upper deck, where snow was pushed into one corner, large amounts of salt were thrown on top of the snow to melt it. After about eight years, a Volkswagen fell through the floor.

C. *Waterproofing*
Some decks are waterproofed initially, which can save large maintenance costs later. Parking authorities and other owners who have long experience know that a good positive waterproofing system (such as Firestone Rub-R-Road, and similar products) may add to the initial cost, but save money in later years.

The maintenance costs on a parking deck with a good waterproofing service look nothing like the maintenance costs of the previous structure mentioned, which not only received no waterproofing but also was poorly maintained.

D. *Good Design*
A parking deck designed by an experienced engineer or architect, with the advice of a design consultant, is more likely to be a better building than one that is not. The same designer, who takes a great deal of time with details and knows how to build-in maintenance-free features, will produce a deck that is easier and less expensive to maintain.

Obviously, the designer with less experience in parking decks is more likely to make inadvertent errors and cause the owner more than average maintenance costs. Statistics indicate the average designer has the opportunity to design only two parking structures in his entire professional career. Therefore, most are not likely to be very familiar with parking deck design details.

E. *Weather Conditions*
Decks in the snow belt, where salt intrusion and severe weather conditions are prevalent, are much more likely to be expensive buildings to maintain than those in hot, dry climates. For this reason it is difficult to call across the U.S. to get various maintenance costs, then crank them into a life-cycle cost analysis. Where heavy road salts are encountered, the costs of maintenance are considerably more than where they are not. Freeze/thaw cycles cause more maintenance problems than are prevalent in areas where very cold weather is not encountered.

F. *Maintenance Cost Data*
It is natural, in gathering maintenance cost information, to call parking deck owners and ask for information about how much it costs to maintain their buildings. This leads to strange answers, even from owners who have a number of facilities, such as a municipality or a parking authority.

In preparing this article, I called one parking manager and asked the cost of maintenance. I was surprised to find the cost was approximately $2 per car space, per year. On questioning the manager further, I was told that $900,000 spent on deck repairs two years before was not included as a maintenance cost, but had been budgeted as a capital improvement. Also, $700,000 in elevator repairs and similar electrical system changes were also included as capital costs, and, again, were not used to determine maintenance costs.

Another owner said their maintenance costs averaged approximately $100 to $120 per year, per space. But under questioning, this owner said that parking meter maintenance was included in this figure, as were some repairs on adjacent streets.

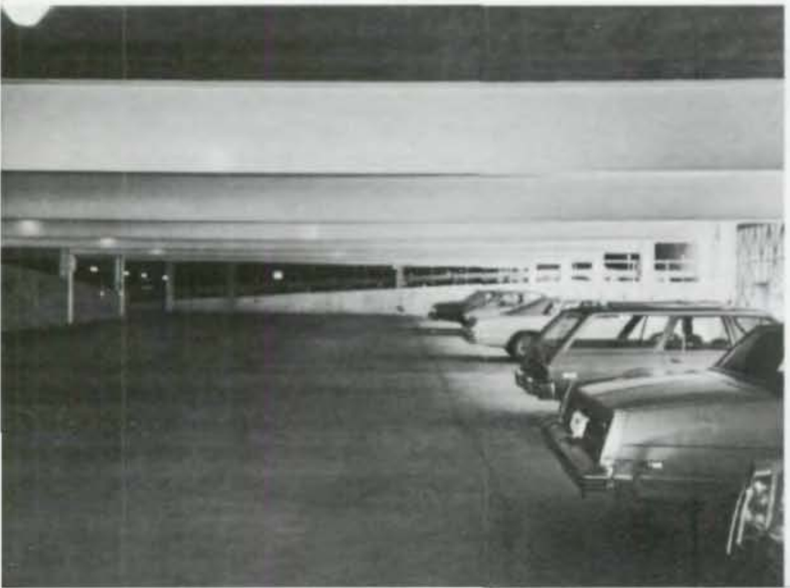
Therefore, I caution anyone who gathers life-cycle cost analysis information to be very careful in determining the exact details of the information being gathered, and *how* it is compared.

Generally, we have found the reduction in lighting costs resulting from sporadic repainting makes steel-framed buildings more than competitive with other types of structures. Another factor which must be considered: Due to uneven weathering of steel, the entire structural system does not have to be repainted at the same time. Only small areas may need to be scraped and painted. Here again, costs may vary from 56 to 82 cents psf for repainting.

A good life-cycle cost analysis must take in a myriad of different factors to be accurate. Other considerations, such as the attractiveness of a building that is a clean, bright and light-colored deck, create acceptance by the public who uses it. Colors that harmonize with surrounding areas, or are bright and decorative, remove a garage image from that of a dull, drab building. Bright surroundings also improve security, a difficult value to quantify.

In conclusion, we have found steel-framed parking decks are more than competitive on a life-cycle cost analysis, and, in general, easier to maintain than all-concrete buildings.□

Good floor maintenance on parking deck (l.) is essential, no matter what material is used. Also, steel framing properly painted adds clean, sharp look. Long-span construction (r.) with high-pressure sodium lighting that reduces costs, improves parking deck image.



Phase II expansion of Billings Deaconess Hospital required unusual steel framing to meet special needs.

Steel Permits Unrestricted Expansion

by Frank B. Moson and Gene Kolstad, AIA

Implementing the Phase II expansion of Billings Deaconess Hospital in Billings, MT provided a two-fold opportunity: to expand important departmental functions with services at a level commensurate with projected mid-1980 service loads; and to implement the initial phase of their long-range plan.

The existing facility occupied most of the block. Efforts to abandon surrounding streets, creating on-grade expansion, had failed. Due to tight site restrictions and the nature of the existing hospital, acquisition of additional adjacent land was necessary to fill immediate, as well as long-range needs. To solve the problem, and pave the way for efficient future expansions, the design team developed a scheme to bridge a major through-street. This created a functional connection to the adjacent block, allowing a new growth pattern and unrestricted expansion capability to develop. This particular solution provided the desired site continuity

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Over-the-street bridge ties buildings together, and provides needed space for several departments.

and maximum functional efficiency required for hospital operations.

The Phase II expansion provided for the redistribution of new facilities and permitted the hospital to replace outdated or undersized departments. Replaced departments include: emergency, radiology, radiation therapy, admitting and discharge, surgery, cardiopulmonary, critical care, progressive care and dietary. The long-range plan for Deaconess Hospital provides for a design capacity of 400 beds. The 146,000 sq ft Phase II expansion allows the hospital to accommodate efficiently 230 beds.

Surgery in Middle of Street

Specific problems of growth addressed during the Phase II planning stages involved bridging, physically, a major through-street to insure the functional continuity of all the buildings by tying them together. To efficiently use this space, the design team located several major hospital departments directly on the bridge above the street. Spanning the street was difficult because of the need to match existing building floor heights and maintain the proper clearance for vehicles using the street.

The Solution is Steel!

The design team employed long-span steel trusses, 5 ft deep at 15 ft on center, spanning 84 ft, located at the roof level. The floor structure is suspended from the truss system.

Because surgical procedures require precision instrumentation, the designer gave special attention to the location of surgery with regard to vibration characteristics of the structural frame. First, the deep-steel roof truss support systems help to reduce vibration. Second, the floor system over the suspended steel floor framing is a composite concrete-and-steel system to reduce vibration in the surgical area. Third, special isolation joints were designed to dampen foot traffic vibration from pedestrian corridors adjacent to surgical rooms.

This solution incorporates a double-beam system which isolates the structure of the surgical department from that of the north and south corridors. Sound dampening, also incorporated into the ceiling and the floor over the street, further isolates the surgery department.

Steel Plus Fast-Track Delivery = Savings

A construction management fast-track method of delivery, selected to allow earlier occupancy, saved the hospital inflation-related dollars. Structural working drawings followed closely on the heels of the design development phase. The award of the foundation and structural steel packages preceded the architectural working drawing packages by several months.

Once prefabricated steel members reached the jobsite, the speed of erection was phenomenal. Almost overnight, the orderly structural network of steel beams, columns and trusses appeared and the shape of the building unfolded.

Structural costs were well within the budgeted amounts, giving added credibility to the selection of steel as a major structural component. The

Two-story dining room, visual focal area of hospital, is central point of overall expansion program.

146,000 sq ft facility required 930 tons of A36 structural steel framing. Wind and seismic restraint was provided by a moment-resisting frame.

Several design/construction objectives were aided by the use of steel components:

- The desire for the most economical building system;
- The need for a system that could be erected in a timely manner;
- The need to construct a portion of the facility over the street, requiring long spans with minimal vibration characteristics;
- Compatibility with the selected exterior metal skin materials;
- Structural steel coupled with a lightweight concrete floor system poured over a metal deck, allowed for reduced dead loads, thus making seismic restraint a much easier task.

The column grid used in all areas, except the street, was 25-ft x 25-ft bays. The floor sub-system includes wide-flange purlins at 8′-3″ on center with a 1½″ metal deck supporting 4¾″ lightweight concrete.

Steel Allows Flexibility in Design

Another important concept in the design of Phase II was the incorporation of natural light, color and variety of spatial volumes. These were aided by the selection of a system which allowed a large degree of flexibility. All these aspects were incorporated into the design to contribute to the humanization of the health-care environment.

Introduction of natural light into the hospital interior occurs at two major points: along the staff and patient corridors that run the length of the new expansion; and directly adjacent to the two-story dining room space which bisects the structure on an east-west axis. The dining space is visually a point of focus for the hospital and serves as a central point of departure for the new spine when the Phase III expansion is implemented.

The quality of the dining area is further accentuated by the extensive use of color graphics throughout the two-story space. These bold, colorful wall accents, coupled with interior plantscaping, turn the dining space into a vibrant area. The two-story volume adds not only visual excitement when the viewer is within the space, but also provides contact with light and color from the various adjacent spaces on the second-floor loft. This penetration is apparent from the critical and progressive care waiting areas, where visual access to the two-story dining space, as well as the glassed-in corridor, adds significantly to the interplay of light, color and shadow.

With incorporation of elements such as those used in Billings Deaconess Hospital's Phase II Expansion, the physical design of a modern health-care facility can create an atmosphere which is non-institutional—incorporating natural light, color and variety in spatial volumes as a major design concept. □

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Steel Erector
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Minneapolis, Minnesota

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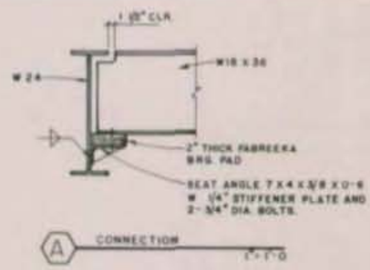
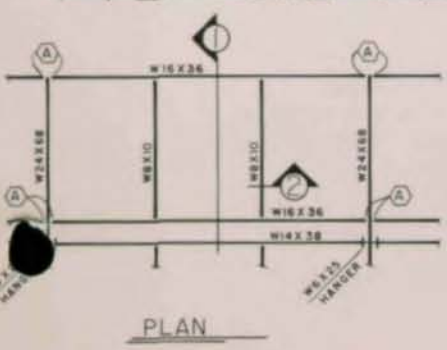
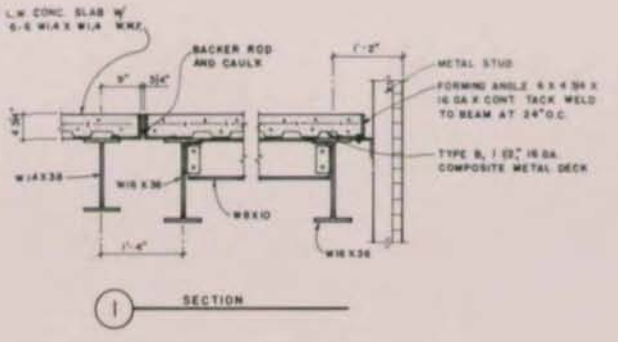
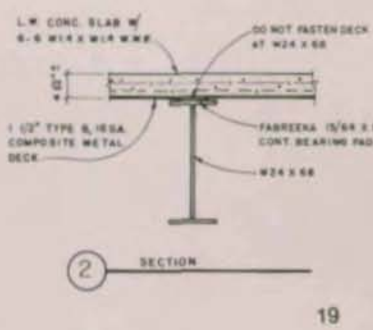


Plan shows special details—vibration isolation joint (Sec. 1) and vibration-dampening details (Sec. 2). Steel bridging (l.) solved major problems of continuity in design.







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30 Days—and the Steel was Up!

Two South Executive Park, Charlotte, NC went up in a hurry.

Close coordination between owner, architect and suppliers got this 100,000-sq ft multi-purpose office building out of the ground and ready for occupancy in whirlwind time.

Based on a fast-track schedule, prices quoted by suppliers and their commitments for delivery and the time frame related to weather impact, the architects chose steel for framing.

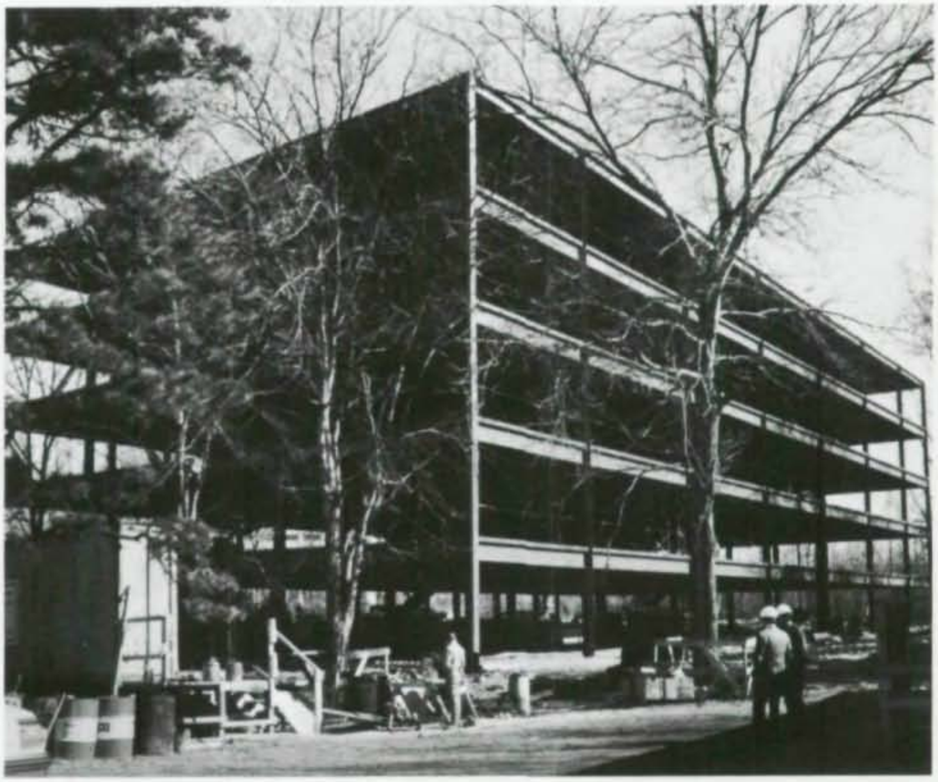
Just five weeks after the architect/engineer was chosen, the structural design was completed and contracts awarded. It was August, 1980.

By late September, site work had begun. October and November were devoted to other drawings and caisson foundations.

The steel frame started up in early December—and was completed in 30 working days!

Steel beams were designed composite with the floor slab, with interior girders raised three inches above the floor beams to gain added space for mechanicals.

The owner's directions that occupancy must begin June 1, 1981 were met. □



Two South Executive Park, Charlotte, NC

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Charlotte, North Carolina

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Metric Constructors, Inc.
Charlotte, North Carolina

Steel Fabricator
Southern Engineering Co.
Charlotte, North Carolina

Owner
Queens Properties, Inc.
Charlotte, North Carolina