VOLUME XXV NUMBER 3/THIRD QUARTER 1985

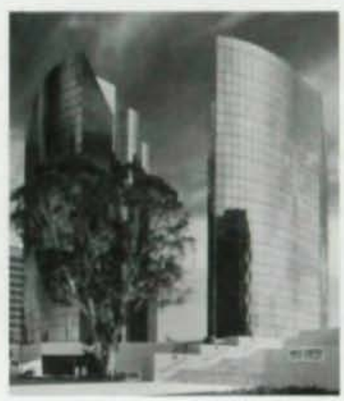
MODERN STEEL CONSTRUCTION

Special: California Issue!





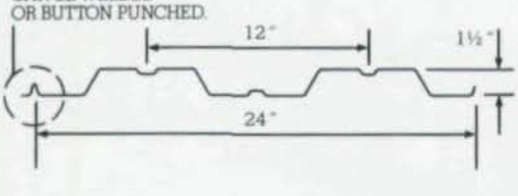




DECK DESIGN DATA SHEET

NO. 6

ALL ABOUT 1½" LOK FLOOR COMPOSITE DECK



w/h=3.85 (For stud design.)
Cv=0.0625
Concrete volume on undeflected deck in cubic ft. per square ft. is equal to the concrete thickness (inches) *Above* the flutes divided by 12 plus Cv.
V=t/12+Cv

SECTION PROPERTIES PER FOOT OF WIDTH

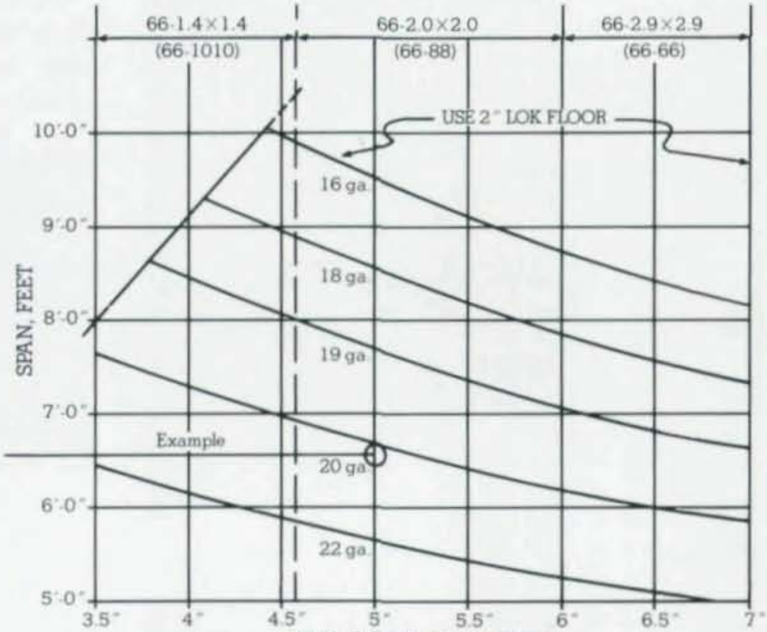
METAL THICKNESS		I	SP.	SN.	R. INT.	R. EXT.	WT.
GA.	INCHES	IN^4	IN^3	IN^3	LBS./FT.	LBS./FT.	PSF
22	0.0295	0.188	0.202	0.219	840	240	1.7
20	0.0358	0.236	0.260	0.281	1,140	380	2.0
19	0.0418	0.276	0.320	0.332	1,460	550	2.3
18	0.0474	0.316	0.381	0.381	1,820	750	2.6
16	0.0598	0.396	0.474	0.474	2,620	1,220	3.3

R int. is allowable interior reaction based on 5" of bearing. R ext. is allowable exterior reaction based on 2½" of bearing Properties and reactions based on American Iron and Steel Institute (AISI). *Specification For The Design Of Cold Formed Steel Structural Members;* 1980 edition. Steel conforms to ASTM A611. Grade C. or ASTM A446 Grade A (33 ksi Yield.)

RECOMMENDED GAGE CHART—NO SHORING

Chart based on Steel Deck Institute (SDI) Loading criteria for three (or more) span deck. Bending stress is limited to 20ksi and deflection (of deck) to L/180. 150 PCF concrete. Live load capacity of the deck/slab combinations covered by the chart is usually over 200 PSF.

Example: 6½' span with 5" slab. Intersection is in 20 Ga. area welded wire fabric is 66-2.0×2.0. No shoring req'd.



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Special: California Issue!

CALIFORNIA—THE GOLDEN STATE

by Alan R. Gianini

California is strong, and its economic future is filled with exciting opportunities. Personal income is up and jobless rolls are shrinking; 1985 promises to be another year of good growth and continued consumer confidence.

Businesses have demonstrated positive action by investing in California's future. In 1984, at least 420 companies located or expanded operations in California. These enterprises will generate $3 billion in new investment in the state. And in the first three months of 1985, 97 companies announced plans to locate or expand their California operations. This activity will create an additional 10,000 new jobs.

The strength of the economic expansion in 1984 was reflected more in construction than in any other sector. Declining interest rates for both business and individual borrowers, the low rate of inflation, improved balance sheets and widespread confidence in the future of the economy led to substantially higher levels of activity. Housing unit authorizations increased nearly 30%. Nonresidential valuation rose more than 20%. As a result, construction employment was up nearly 19%, with the addition of 70,800 jobs.

Additions and alterations to existing structures are often overlooked in the emphasis on new structures. However, such construction represents one-quarter of all new non-residential valuation and is an important indication of the strength of existing businesses. During the first two months of 1985, additions and alterations were up 24% from the same period in 1984.

The strong economy has resulted in the construction and expansion of commercial and industrial facilities, of hospitals, hotels and office buildings. Justifiable pride can be taken in the architecture and engineering of these structures, so it is appropriate that this issue of *Modern Steel Construction* be devoted exclusively to California. □

Alan Richard Gianini is the director of Office of Local Development, California Department of Commerce.

MODERN STEEL CONSTRUCTION

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FIFTH ANNUAL AWARDS BANQUET SET FOR OCTOBER 22

The prestigous 5th Annual Awards Banquet to honor this year's Architectural Awards of Excellence winners will be held October 22 in Chicago's Westin Hotel. A well known-panel of five jurors recently chose 11 of the most outstanding buildings from a field of 145 entries. The black-tie banquet, which has become an industry tradition, provides a forum for leading architects, structural engineers, bridge designers, contractors, fabricators and developers.

Tickets are now available from AISC Public Affairs, Chicago. 312/670-2400.

NOMINATIONS INVITED FOR T. R. HIGGINS LECTURESHIP AWARD

Applications will be accepted in early Fall for the 1986 Theodore R. Higgins Lectureship Award. The award recognizes the author of the most significant engineering paper related to steel in the period from January 1, 1980 to January 1, 1985.

The winner, who receives a cash award, also presents his paper on six occasions during 1986. A jury of six distinguished engineers from the fields of design, education and the fabricated structural steel industry selects the winning author. Nominations, which must be received by Nov. 15, should be directed to the Committee on Education, AISC, 400 N. Michigan Ave., Chicago, IL 60611.

Kilroy Airport Center:
A Distinctive Design Statement

by Paul K. Curran

Paul K. Curran, AIA, a partner in Charles Kober Associates, Los Angeles, California, was principal-in-charge of this project.

Someone once described El Segundo, Cal., as "the last Midwestern town in Los Angeles." Foreigners might have a problem with that one, but most Americans know greater Los Angeles as a sprawling aggregate of adjacent but distinct communities, each with something of its own flavor. One understands the comment when first encountering El Segundo's quiet, tree-lined main street, its modest one- and two-story storefronts and homely little churches. There is even a red-brick high school, right there on Main Street, set off by a wide, tree-shaded lawn.

In another sense, however, all this is quite deceptive. El Segundo (pop. 14,100) is home to several Fortune 500 Companies—such as Hughes Aircraft, Rockwell, Northrop and TRW—with particularly strong representation in the aerospace and defense-related fields. It is also home to Kilroy Industries, Inc., which long ago realized the value of property development in a community which abuts Los Angeles International Airport. When the company decided to expand its headquarters office facilities in late 1980, it presented its architect with many stimulating design challenges:

- The economics of the development dictated a program of approximately 700,000 sq ft of office space, with parking for 2,500 cars. This was to be accomplished on a site of 5½ acres, with mandated restrictions on the size of the building envelope.
- Since the site is adjacent to LAX, the northern property line being some 2,250 ft from the main east-west runway, FAA regulations called for a maximum building height of 178 ft.
- There was a clear need to be compatible with, and complementary to, the adjacent twin office towers and parking structure, built as Phase I of the Kilroy Complex in 1972.
- The California DOT appropriated a corner of the site in their design for an on-ramp to the new Century Freeway, soon to be built nearby.
- The client's intention, from the start, was to create a top-of-the-line corporate-type development. This called for not only high quality design standards for the building itself, but a clear recognition of the importance of street frontage, visibility and views.

Twin 12-story Kilroy Airport Center towers, El Segundo, Cal. Exteriors were conceived as window walls uninterrupted by exposed structural steel members.

All of these factors helped shape the end result, but the overriding design challenge, as with all important projects, was to give the complex an architectural character uniquely appropriate to the needs of the client, the program and the site. The solution was to capitalize on the corner location by creating twin towers paralleling the intersecting streets, linked at their intersection by a 5-story, clear-glass atrium oriented towards the centroid of the crossroads.

The twin 12-story towers contain the major portion of the office program—300,000 sq ft each. The remaining 100,000 sq ft is provided in a 2-story office building which "caps" the new 11-story parking structure. These 50,000-sq ft loft office floors are just about tailor-made for the specialized needs of the R & D and defense industry tenants, who form a large segment of the leasing market. The new parking structure was sited to act in tandem with the existing one. The internal access road separating the older structures from its office towers was extended to serve the new complex in the same manner, and further extended to provide site access at Douglas Street. Because of the perceived impact of the

Interior courtyard view of Kilroy Towers.

proposed freeway ramp, and, in line with the tone set in the existing development, very extensive landscaping was provided in the new complex. The carefully balanced blend of shrubs, trees, planters and ground cover, in conjunction with the extensive outdoor paved areas, provides a verdant and inviting setting for the new building, while serving as a buffer against traffic on the new on-ramp.

The office tower's exterior expression was early conceived as a window wall uninterrupted by exposed structural members. This blends with the character of the Stage 1 towers' glass curtain walls. Floor lines and structural bays in the new towers are expressed in the design of the fenestration. The choice of vision glass and glass spandrels involved on-site, full-size mockups of several window bays. To resolve the color of the glass, the owners and architects actually flew to the PPG factory in Pittsburgh for a final selection. The resulting window wall, with its dark grey twin solar glass and off-white metal components, is a refined, handsome blending of color and materials.

Steel Favored Structural System

A moment-resisting ductile steel frame was the favored structural system. The clear advantages offered by this choice in terms of the depth-to-span ratio, speed of erection and economic competitiveness, were well borne out in the final spread sheets. Non-composite construction was used to avoid excessive floor vibration, specifically for the long-span girders.

Focal point of the office design is the dramatic 5-story atrium linking the twin towers. The structure of the atrium, a series of welded tubular roof trusses supported by vertical steel trusses acting as columns, is completely exposed. Welds are ground, but all connections are revealed, and the entire assembly has a white fluorocarbon-painted finish. The resulting lacy network of tubular sections, framed in the soaring glass enclosure, gives a high-tech expression very much in tune with the character of the aerospace tenants who occupy much of the complex. Similarly, an exercise in exposed structure at the inside of the L formed by the towers was felt an appropriate expression of technology revealed. Here, the skin of the building is peeled back in a stepped fashion, to expose, on the exterior, the concrete-encased steel columns and girders adjacent to the atrium. This has the effect of dramatizing this courtyard-side building entrance, and provides an interesting visual punctuation to the views from the interior access road.

The developer, Kilroy Industries of El Segundo, a private, family owned concern, has recently moved their offices from one of the Phase I towers and now occupy the entire 12th floor of the Phase II Imperial Highway Tower. It is interesting that, in early 1984, during a slack period in the leasing market when many nearby buildings stood empty, the Kilroy company leased more than 500,000 sq ft in this recently completed project, despite the fact that construction of the complex started without a lead tenant. By fall 1984, leases had been negotiated for over 90% of the space.

Energy conservation was a prime consideration in the design of the facilities. In addition to the twin-pane solar glazing in the window walls, a major source of conservation was built-in to the site itself—the 500,000-gallon underground fire department reservoir. This becomes a giant thermal storage tank in the complex's cooling system. Use of electric power for cooling has been permanently shifted to off-peak hours by chilling the water at night for daytime cooling. The So. Cal. Edison Co. has rewarded the developer with a citation and cash bonus for this energy management and conservation program, which results in a savings of more than 10,000 kwh annually.

Great pains were taken, during the design stage, to see that the window walls would perform satisfactorily under various climatic stresses. In addition to normal wind and water penetration tests in a factory mockup, a sophisticated wind stress analysis was performed at the University of Texas. Architect and owners wanted to find out whether a venturi effect would be created by the sloped roof of the atrium in the comparatively narrow (25 ft) slot between the two 12-story towers. A scale model was tested in the laboratory's wind tunnel and the design came through with flying colors, even under the most rigorous stress simulations.

Design constraints imposed by the adjacent freeway ramp were turned to an advantage in the design of the parking structure envelope; its stepped profile, following the adjacent curving ramp structure, is a good example of visual serendipity. Attention to detail in the building design extended, as well, to the tower roof. Mechanical penthouses, roof surfaces and window washing equipment were all very carefully thought out in terms of contours, materials, finish and color.

When a building is looked over by just about every flight entering or leaving LAX, it has to look its best from every angle. These crisp, elegant office towers meet that challenge—and make a distinctive new design statement at the burgeoning gateway to southern California. □

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Los Angeles, California

General Contractor
Dinwiddie Construction Co.
Los Angeles, California

Owner
Kilroy Industries, Inc.
El Segundo, California

Exterior view of atrium (l.). Interior view (r.) highlights dramatic steel framing.

Junction of office towers and atrium.

ARCO Center:
Dramatic Corridor to a Harbor

by Richard C. Niblack and Albert A. Erkel

Richard C. Niblack, AIA, is partner in charge for the Luckman Partnership, Los Angeles, California.

Albert A. Erkel, P.E. & S.E., is a partner in the structural engineering firm of Erkel, Greenfield & Associates, Los Angeles, California.

ARCO Center, a twin tower office project developed as the theme piece of the City of Long Beach's Oceangate Redevelopment Project, was designed to achieve these objectives:

- Create an exciting architectural landmark to serve as the city's western gateway
- Provide 400,000 sq ft of premium office space in an energy-efficient environment
- Permit flexibility in interior space planning for both small and large users, with maximum window space per square foot to take advantage of harbor views
- Retain public view corridors to the harbor

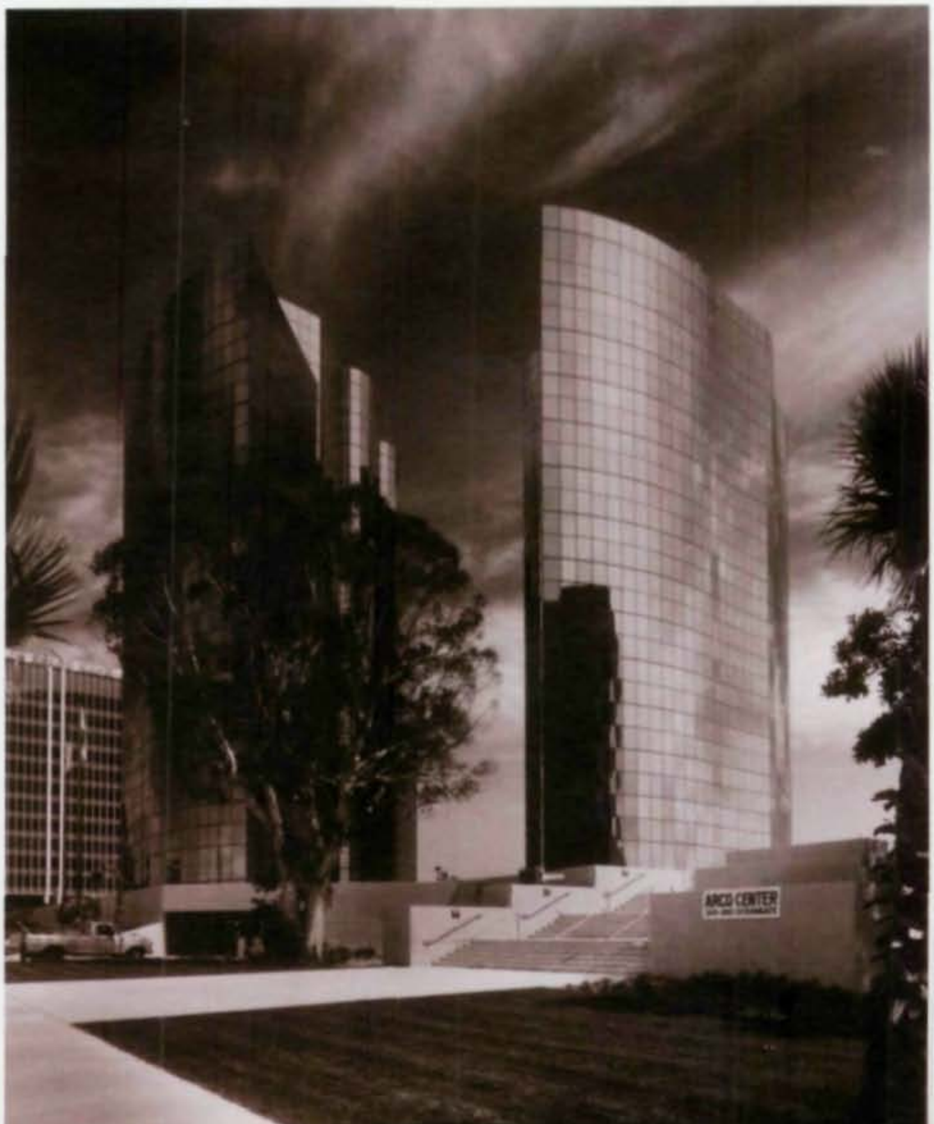
To accommodate these requirements, computer technology was used to develop a composite design reflecting the prismatic qualities of a sun path-oriented cylinder, sheared through diagonally to create two 14-story towers angled on the site. The unusual shape of the towers, their orientation and configuration were dictated by the sun, the site and the desired view corridors to the harbor. Exteriors of the towers are formed by a series of small cylinders joined together. Deep undulations provide sun protection where it is most needed. This creative idea not only cut mechanical equipment costs, but also reduces operating expenses. Because of the dynamic curvature of the exterior walls, many executive offices have windows on three sides—a major asset in a highly competitive office market.

The towers feature a four-side structural silicone glazing system which gives the sparkling visual appearance of a continuous glass skin. The everchanging facade and delicate faceting add human scale to the vertical surfaces, while the premium quality solar control glass blocks up to 65% of the sun's heat; 30% is vision glass to retain the ocean view, with the balance in spandrel glass to conserve energy.

A richly landscaped public plaza at street level complements the intent of the tower's position and form to retain the lovely harbor view. Subterranean parking is provided on three levels.

Steel Wins the Nod

The unique free-form shape of the towers posed unusual challenges for the structural engineers. A concrete system was considered initially because it lends itself to free form. The team rejected it only after many factors were methodically analyzed. Design and function were primary considerations. The larger, heavier concrete columns would have altered the aesthetic character of the towers. To preserve the integrity of the design, steel was the best



Semi-circular glass towers of Arco Center frames city's view of ocean. The $60-million complex is across bay from H.M.S. Queen Mary docked in Long Beach.

choice. Additionally, the steel system saved two or more months in construction time, an important economic consideration in the development of a speculative office complex.

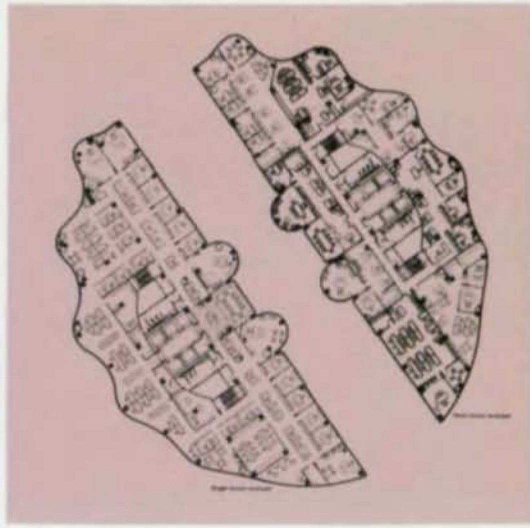
Cost considerations further dictated that rectilineal framing members rather than more expensive curved members be used to support the curved walls. To achieve this, the metal deck and slabs were cantilevered beyond the spandrel members. The floor framing system consists of 3¼-in. lightweight concrete slabs over 3-in. 18 ga. fluted metal deck supported by horizontal steel beams, approximately 12 ft o.c. In addition, seismic resisting frames are located at the perimeter of the building and at selected interior frames.

Long spans were used to create as much column-free interior space as possible. The payback in interior planning flexibility, and consequent enhancement of the leasing program, more than offset the added cost of the long spans.

The unusual shape and the separation between the two buildings generated concern for the impact of wind forces both at the pedestrian level between the structures and around the curved surfaces. It was especially important to determine the vacuum effect on the glass panels of high velocity winds whipping around the curvilinear structures. Accordingly, wind tunnel tests using 100-year wind characteristics were conducted at Colorado State University. Results provided the data required to be certain the glass panels were properly anchored to withstand historical wind loads. It was also possible by means of flow visualization methods to determine pressures and velocities in the pedestrian corridor between the two towers. Wind pressures and velocities were found to be within manageable levels without the use of permanent barriers.

In March 1933, an earthquake measuring 6.5 on the Richter Scale rocked the Long Beach area, leaving considerable destruction in its wake. As a result, the local building code recommends a static analysis be conducted as part of the structural engineering of high-rise office buildings. In designing ARCO Center, the engineers exceeded code requirements by conducting a two-tier dynamic computer analysis. As a result, these towers are designed to withstand earthquakes of a magnitude of Richter 6.5 on the Inglewood/Newport fault, in the immediate area, and up to Richter 8.5 on the San Andreas fault, about 40 miles away.

ARCO Center's ocean front location required site dewatering with well points during construction and a permanent sub-surface drainage system to keep the basement dry. The permanent drainage system consists of perforated pipes in sand bed around the perimeter of the building, and 50 ft o.c. in the interior, connected to a pump.

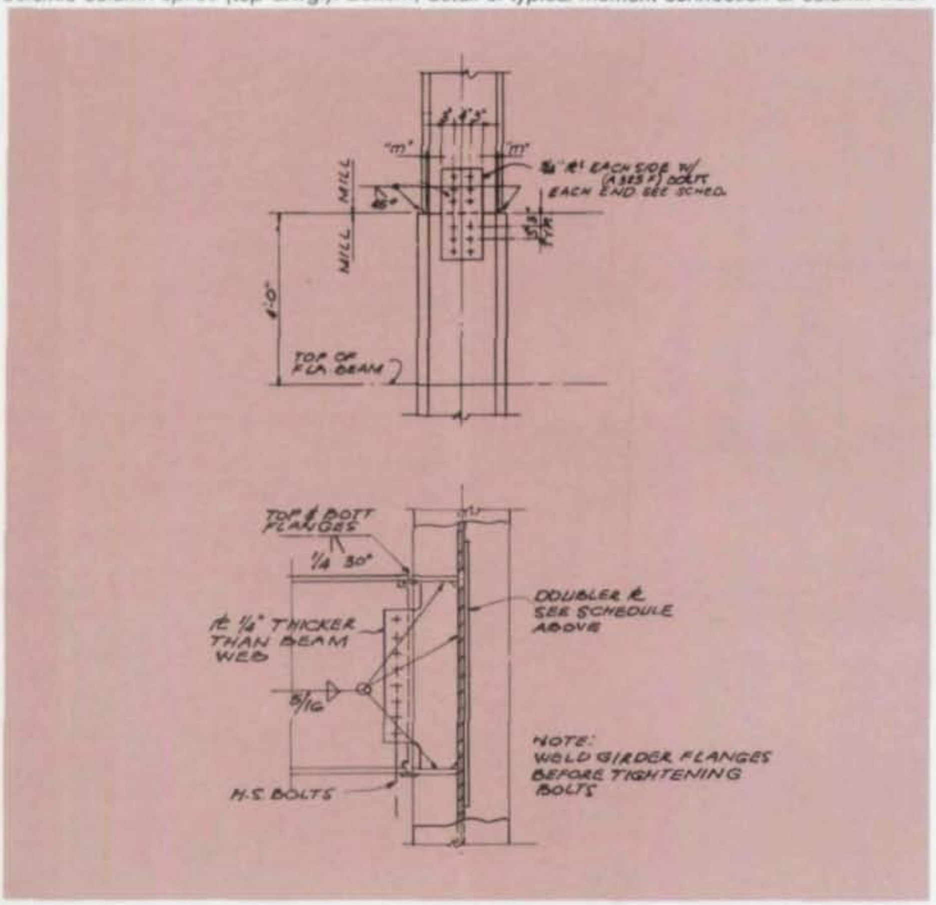


Site plan of twin Arco Towers.

The HVAC is a superior dual fan dual duct variable air volume system incorpo-

Unusual straight-up view of towers by photographer Wayne Thom.

Seismic column splice (top drwg.). Bottom, detail of typical moment connection at column web.



rating an economy cycle that permits use of outside air to cool the building without refrigeration. The system has multiple refrigeration compressors that can be operated individually so that only as many compressors as are actually needed are used to match the cooling load. The dual fan dual duct system, incorporating internal and perimeter duct loops, provides flexibility of operation and affords temperature control in any given zone without unnecessarily mixing hot and cold air. Additional energy consumption is saved as a result of each duct having its own fan to furnish the amount of air needed to do its job.

The city awarded the site to this project in competition with five design concepts entered by rival development teams. The award was made on the basis of the project's exciting and unique architectural form, sensitivity to the site, respect for public view access to the harbor, energy efficiency, subterranean parking, and its potential enriching influence on the future redevelopment of the city.

ARCO Center's shimmering semi-cylindrical towers framing dramatic view corridors to the harbor have earned the project landmark status as the city's prestigious western gateway. Open less than a year, ARCO Center already has become the symbol of the dynamic new Long Beach, a city that only recently has begun to emerge as an important commercial center. □

Architect
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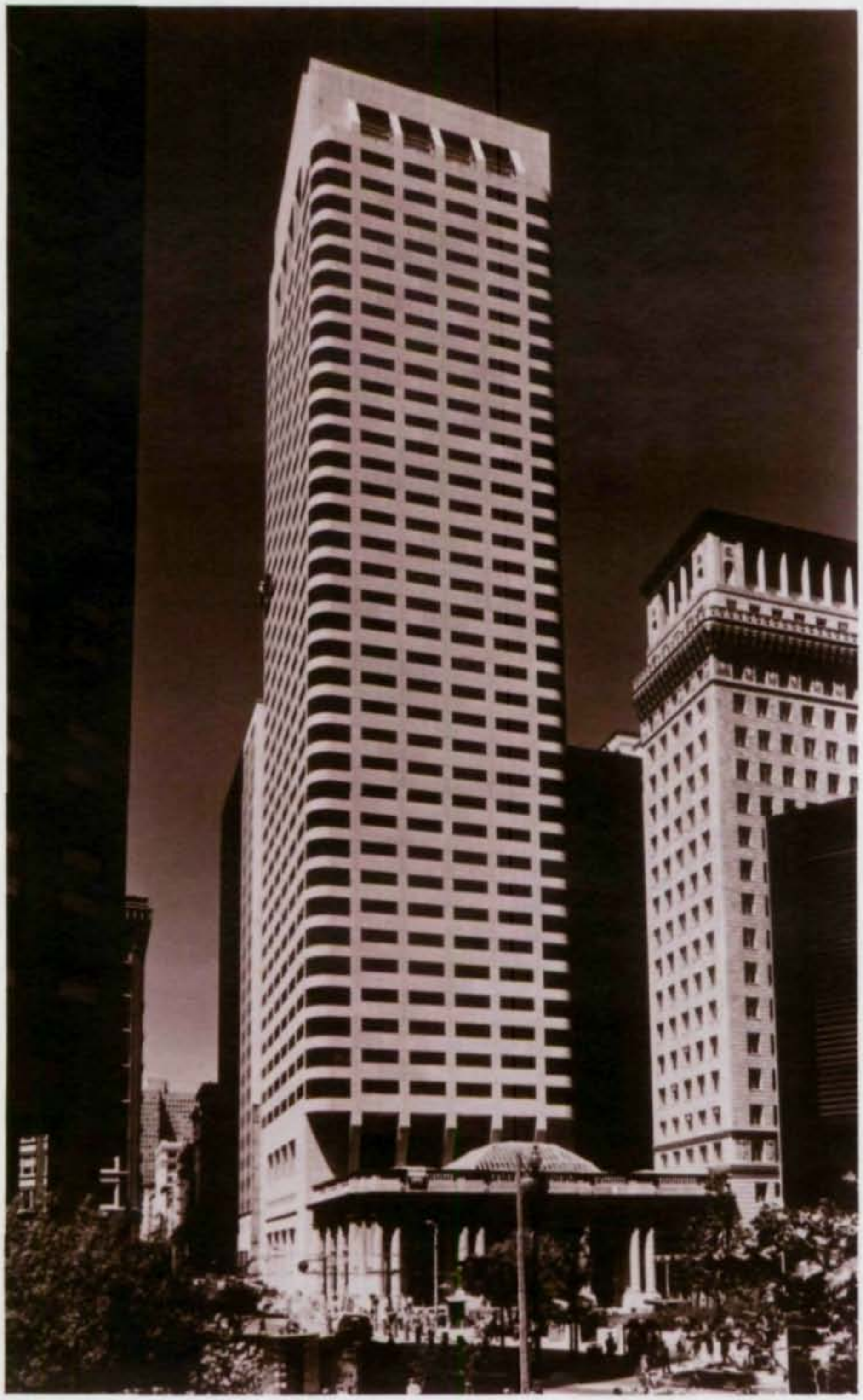
Owner
Norland Properties
San Francisco, California

Citicorp Center:
The Toughest Part was Restoration

by Dennis Oh



Citicorp Center, San Francisco, Cal. Original bank in foreground (with skylight roof) was restored as conservatory. Photo by Nan Park.

Dennis Oh, structural engineer, is vice president of the structural engineering firm of Chin & Hensolt Engineers, Inc., San Francisco, California.

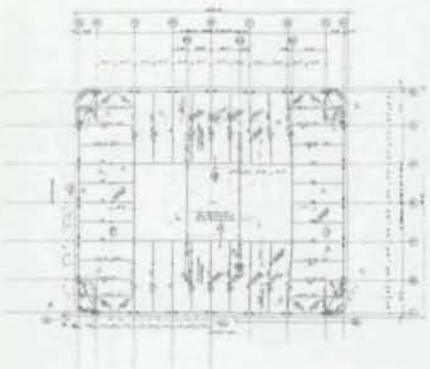
The Citicorp Center, at Sansome and Sutter streets in downtown San Francisco, is officially a 43-story building. But, with no second floor and no 13th floor, it really is a 41-story building. The building, 580-ft high, has a typical floor plan rectangular in shape with curved corners. Plan dimensions are 142 ft-6 in. x 118 ft, and typical story height is 12 ft-6 in. Columns on the east and west faces of the building slope outwards between the 43rd and 42nd floors and then continue vertically downward to the 6th floor. There, they slope inwards between the 6th and 5th floors, and then straighten out again to continue down into the foundations.

Design Criteria

The lateral load resisting system is a moment-resisting ductile steel frame on the building periphery. Because the exterior columns are 20 ft o.c., peripheral frames respond more like a tube structure. Codewise, the building was designed to meet the required seismic provisions of the 1979 UBC. Precast connections, however, were designed to meet the 1975 San Francisco Building Code, a lot more stringent than the 1979 UBC. That means a Cp factor of 2.0 for connections. In addition, a dynamic response spectrum analysis was performed for two levels of earthquake. Level 1 earthquake is a major E.Q., the equivalent of a magnitude 8.25 event with epicenter located on the San Andreas fault about 10-20 miles from the site. Peak bedrock acceleration is assumed at 0.5g. Level II earthquake is a moderate E.Q., the equivalent of a magnitude 6.2 event, with epicenter about 10 miles away and peak bedrock acceleration of 0.24g.

The design criteria for the moderate, Level 2 E.Q. is that the building should respond elastically, with very little or no structural damage. Under Level 2 E.Q., story drifts are in the neighborhood of ¾ in. Consequently, joints between precast panels allow for this movement. Under the very severe Level 1 E.Q., the building is definitely responding inelastically and story drifts are in the neighborhood of 1 to 1½ in. The building frame can be expected to suffer some structural damage, but it should be repairable. The frame members were proportioned so that plastic hinges will form in the girders first before forming in the columns. This is the classic strong column/weak girder concept most West Coast structural engineers prefer for earthquake-resistant design.

Design wind pressures and suction for the building cladding were obtained by wind tunnel testing at the University of Western Ontario, Canada. Test results indicate peak suctions of 40 psf at the NW corner of the building at about the 38th floor and also on the east face of the building at about the 12th floor. As far as peak positive wind pressures go, the maximum pressure of 24 psf occurred at the 42nd-43rd floor on the south face of the building. Another area of concern for design wind pressures is in the conservatory area at the east end of the project. The maximum suction or uplift pressure on the skylight occurs on the west side of the north skylight (23 psf); the maximum downward pressure occurs on the south side of the main skylight (18 psf).



Typical office floor plan shows column-free space created by structural steel framing.

Full-scale Tests of Panels

To verify the adequacy of the proposed cladding installation, a mockup of a typical curved corner plus a flat segment of the precast and window assembly were tested in San Leandro, Cal. The whole assembly was tested for the design cladding pressure of +40 psf and also a suction of -40 psf. Loads were imposed on the assembly for 10 seconds. Then the loadings were increased to +60 psf and -60 psf, which is at 1.5 times the design pressure, and again held for 10 seconds. The whole assembly passed the test without any damage. Then, to simulate story distortion under E.Q. loadings, the whole assembly was subjected to a racking test. The first series of racking tests subjected the top of the panels to ¾- in. movement in the plane of the flat panels for three complete cycles. There was no damage to the whole wall and window assembly.

Having successfully completed the mockup tests for the design wind loads and story deformation for the moderate, Level 2 E.Q., it was decided to test the assembly for the Level 1 story drift simulation, i.e., moving the top of the panel first 1½ in. to left, back to zero and then 1½ in. to the right. Under this simulation, anchors held and windows did not pop out, although some localized cracking of the precast panel did occur. It was very comforting to see the whole assembly hold together even under such extreme story distortions.

The floor framing system is 2½-in. rock concrete fill over 20 ga., 3-in. metal decking. The floor beams, 21-in. deep, span 37 ft-3 in. from central core to perimeter frames which are compositely designed to act with the metal deck floor. All main mechanical ducts run under the floor beams, with no penetrations for ducts except for the diagonal girders at the four corners of the building. The only penetrations are minor 8-in. dia. unreinforced holes to accommodate the main sprinkler loop.

Steel Framing System

The peripheral frame consists of rolled W36 columns in the upper and typical floors, with girders ranging from W30 to W36. In lower floors, because of 35-ft story heights and sloping columns, 40-in. x 22-in. built-up box sections were required. In addition, eight 26-in. x 26-in. box columns extend the full height of the building at the four curved corners. Plate thicknesses of

Top of steel framing with sloping columns at 42nd floor. Spandrel girders are recessed with torque box girders. Photo by Joe Perretti.

Start of steel erection. Sloping columns at 5th floor, and temporary bracing of existing bank's granite facade.

these built-up box sections range from 2½ in. to 4 in. for flanges and ⅝ in. to 1¼ in. for webs. All perimeter columns are oriented in the strong direction along the building face.

The flanges of all frame girders are field-welded to the column flanges with full penetration welds, and all girder webs are field-bolted. This method of structural steel erection is common on the West Coast and the norm for the industry. Economy for the building frame is achieved by using W36 rolled shapes for columns, ranging in weight from 135 lbs./ft to 527 lbs./ft. The special heavier sections over 300 lbs./ft are available through Belgian mills and are readily imported by Western steel fabricators. The deeper column sections, in lieu of standard W14 sections, result in considerable savings in the frame weight. The total structural steel weight is 9,000 tons or 25.5 psf. Of this total, about 3 psf is attributable to the sloping columns and the heavy horizontal diaphragm required at the 43rd and 42nd floors and also at the 6th and 5th floors.

All wide-flange column sections and plate material for built-up box colums meet ASTM A572 and/or ASTM A588, Gr. 50 standards. All beams and girders are ASTM A36. Structural steel erection began in mid January 1983 and the building was topped out in July 1983. Initial occupancy began in May 1984 and the grand opening was held Nov. 1, 1984.

Building Site Historical

In order to fit the Tower on the site, two of the original five arches of the historic One Sansome Building along Sutter Street had to be demolished and the building completely gutted. All of the Holbrook Building between the Equitable Life Building to the west and One Sansome to the east had to be demolished. One of its ornate arches at the top floor was saved for display in the Tower.

The most difficult and painstaking part of the project had to be the preservation and restoration of the One Sansome Building. The original bank building was built in two phases: the first phase, built in the early 1910's, had one arch along Sansome Street and five along Sutter. The next phase completed the whole facade along Sansome Street as it appears today. It was built in the early 1920's, and originally known as the London Paris National Bank, then the Anglo California National Bank which later merged into Crocker Bank. Today, of course, it is known as Citicorp Center.

The 15,000-sq ft space created by saving the One Sansome Building shell is undoubtedly one of the most expensive spaces ever developed. It cost over $6 million. Structurally, we had to put in a temporary and then a permanent bracing system for the building facade. Architecturally, the space was conceived as a conservatory on a grand scale. The floor and walls are sheathed in marble, requiring intricate detailing to match and blend with existing details. One unique feature of the conservatory is the 3-dimensional truss framing for the support of the skylight. The architect wanted a light, airy feeling to this space and opted to use pipe sections for the truss members. All vertical and diagonal truss members are 4-in. round standard pipe sections. All truss chord members are either 6-in. round standard sections or 6-in. round extra strong sections. These extra strong pipe sections function not only as truss chord members, but also serve as the water mains for the Conservatory sprinkler system. To our knowledge, this has never been done before in San Francisco. □

Architect
William L. Pereira Associates
Los Angeles, California

Structural Engineer
Chin & Hensolt Engineers, Inc.
San Francisco, California

General Contractor
Swinerton & Walberg Co.
San Francisco, California

Owner
One Sansome Street Associates

Anti-Submarine Training Center:
A Demand for Flexibility

The theme of this Operational Trainer Facility building is boldly expressed in the broad tri-color blue bands encircling it, each representing one of the many moods of the ocean: ultra marine for the arctic waters, true blue for the temperate zones and blue-green for the tropics. This four-story, 85,000-sq ft project is the first phase of an eventual 150,000-sq ft building.

The focus of the building is a central core which accommodates the various electronic trainers. Classrooms and offices encircle the centrally located trainers and open up to the outside with large expanses of glass, offering necessary human relief and contrast to the introverted highly technical core area.

Designing a building for operational trainers offered a particular challenge because of the almost unreasonable demands for flexibility. More often than not, the trainers themselves are being designed at the same time as the building. During the design process, many of the trainer space and utility requirements are not yet solidified. Yet when the trainers are designed, their needs are very precise and demanding. For these reasons, the architect is designing a building to very precisely accommodate something not yet fully defined.

Compounding the design challenge is the understanding that new technology is constantly being developed to meet new training needs, creating a future need for different spaces and utilities in the same building. Flexibility, then, is a very important aspect in the design of this building type. In designing this project, there were several additional concerns. The site, located on the edge of San Diego Bay, consists of bay deposits and hydraulic fill which suggested a relatively light and flexible structure supported by pile foundations. The project, the first of two phases, also required the anticipation of an addition which would almost double the size of the first phase.

In arriving at a solution, it was determined that placement of all of the trainers in a large central core would offer the greatest degree of spatial flexibility. Providing access to this core from the circling corridors would permit subdivision of the core into large and small rooms as trainer needs would dictate. In addition, a great degree of flexibility in room arrangement and rearrangement would be possible. This flexibility would be further facilitated by making the access flooring and integrated acoustic ceilings in the core continuous and uninterrupted throughout, with partitions extending only from floor to ceiling, permitting relocation without extensive rework.

Navy's new Operational Trainer Facility, San Diego, Cal. Typical floor plan demonstrates need for versatile floor planning.

Classrooms on the building perimeter, sharing common corridors with the trainer areas, would permit a ready movement from practical to academic environments as course needs would dictate. Staff offices would be located at the quieter ends of the building with study and conference areas adjacent. Vertical circulation would be primarily by way of stairs located at the corners and center of the building to minimize horizontal travel. Elevators would also be provided for movement of equipment and for handicapped access. The final plan reflects these determinations.

Steel's Flexibility Meets Flexible Demands

Steel was selected for the building frame because of its light weight, ease of erection and relative simplicity of connection to the future addition. Seismic bracing is provided with K frames located in the perimeter of the trainer core, leaving the building exterior free for continuous windows.

The exterior is finished with insulated enameled steel wall panels, selected for their light weight, inherent flexibility and esthetic possibilities. The horizontal panel application required a secondary adjusting frame attached to the structural grid with slotted connections to true up the final alignment.

The electronic equipment used in the trainer assemblies generates a high demand for cooling. Because of this, there is a particular emphasis in finding ways to minimize the overall consumption of energy. Locating the trainers in the center of the building eliminates solar gain from this air-conditioned area with additional insulation from the exterior environment offered by the surrounding offices and classrooms. Location of offices and classrooms on the building perimeter also affords natural light and ventilation, since offices and classrooms are not required to be air-conditioned in the mild climate of San Diego. Adequate ventilation is provided by operable windows, and heat is supplied from unit ventilators, with hot water generated by waste heat from the cooling system.

A more important flexibility has been designed into the mechanical and electrical services within the central trainer core. Conditioned air is supplied by zone to the entire core area, providing the required fresh air, humidity control and fundamental cooling for the basic heat gains such as lighting and people. As equipment is added, the required cooling is supplied by recirculating air units connected to a central chilled water loop. The air units draw air from the room and direct it below the computer floor, cooling the equipment by way of floor registers. The advantage of this system over a central multi-zone system is that, as training equipment needs change, the recirculating air units can also be readily changed. In addition to the chilled water loop, a deionized water loop is also provided for direct water cooling of select trainers.

Flexibility in electrical service is supplied from continuous bus ducts providing delta and wye service at full power to each trainer location. With these systems, each trainer has access to a large portion of the mechanical and electrical capabilities of the building.

The conflict between the needs for flexibility and structure in building is not a new one, as each project in some way presents this challenge, and the architect's creativity is often stimulated by this basic conflict. Design of the Operational Trainer Facility has been a particular challenge in this regard. Since only time will show the effectiveness of the solution, there is always a hopeful curiosity in waiting to see how it really works out. □

Architect
Macy, Henderson & Cole, AIA
San Diego, California

Structural Engineer
George R. Saunders Associates
San Diego, California

General Contractor
Santa Fe Engineers
Lancaster, California

Owner
United States Navy

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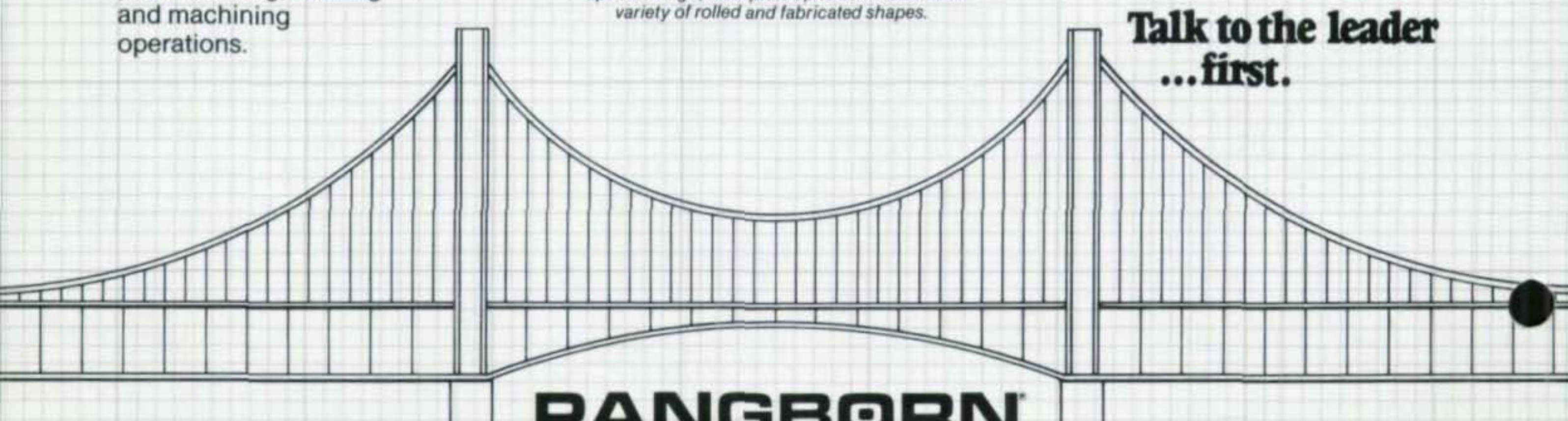

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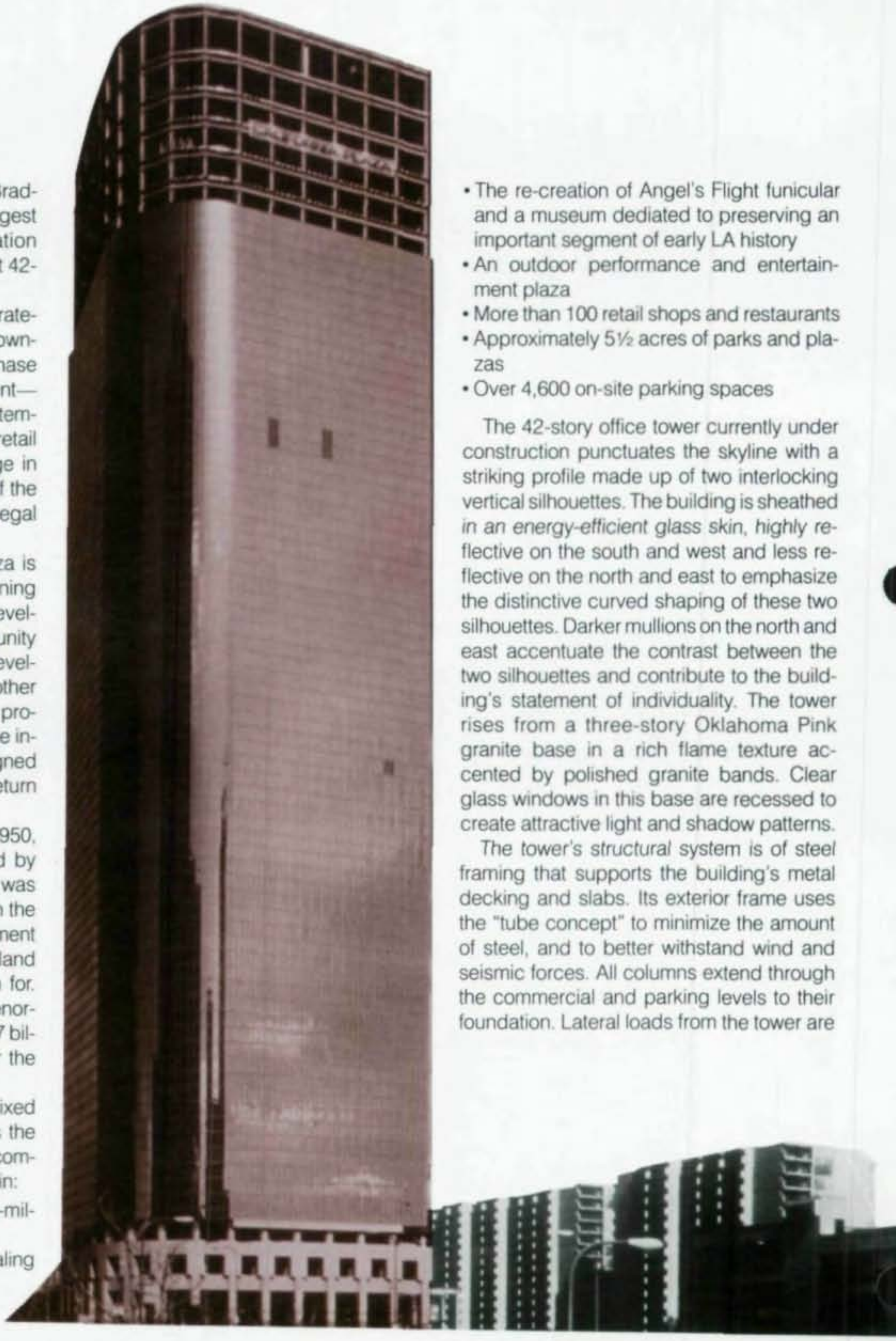


Hailed by Los Angeles Mayor Tom Bradley as "one of this continent's largest and most innovative urban revitalization projects," California Plaza opens its first 42-story office tower this fall.

The one-million sq ft office facility, strategically located on the highest point in downtown Los Angeles, is part of the first phase of the massive $1.2-billion development—which also includes the Museum of Contemporary Art, public plazas, restaurants, retail space and a 1,100-car parking garage in this initial phase. Twenty-five percent of the space has been committed to major legal and financial tenants.

What is unique about California Plaza is that its 11.2-acre site, the largest remaining parcel in the 133-acre Bunker Hill Redevelopment Area, was leased by the Community Redevelopment Agency (CRA) to the developers instead of being sold, as were other parcels in the ambitious downtown program. In effect, CRA gave up immediate income at the time the agreement was signed in 1981 for a much larger financial return over the 99-year lease.

Planning for Bunker Hill began in 1950, and the redevelopment plan prepared by the CRA for the severely blighted parcel was approved by the city council in 1959. In the late 1960's and early 1970's, development of the area accelerated. By 1982, all the land under control of the CRA was spoken for. The Bunker Hill program has been enormously successful, as shown by the $2.7 billion in private investment projected for the site.

Because of its prime location and mixed uses, California Plaza is envisioned as the focal point of downtown. Planned for completion in 1991, its 11.2 acres will contain:

- Three high-rise office towers with 3.5-million sq ft of office space
- Three high-rise residential towers totaling 750 units
- The Museum of Contemporary Art
- A premier hotel
- The Dance Gallery, the only theater in the nation devoted exclusively to dance
- The re-creation of Angel's Flight funicular and a museum dediated to preserving an important segment of early LA history
- An outdoor performance and entertainment plaza
- More than 100 retail shops and restaurants
- Approximately 5½ acres of parks and plazas
- Over 4,600 on-site parking spaces

The 42-story office tower currently under construction punctuates the skyline with a striking profile made up of two interlocking vertical silhouettes. The building is sheathed in an energy-efficient glass skin, highly reflective on the south and west and less reflective on the north and east to emphasize the distinctive curved shaping of these two silhouettes. Darker mullions on the north and east accentuate the contrast between the two silhouettes and contribute to the building's statement of individuality. The tower rises from a three-story Oklahoma Pink granite base in a rich flame texture accented by polished granite bands. Clear glass windows in this base are recessed to create attractive light and shadow patterns.

The tower's structural system is of steel framing that supports the building's metal decking and slabs. Its exterior frame uses the "tube concept" to minimize the amount of steel, and to better withstand wind and seismic forces. All columns extend through the commercial and parking levels to their foundation. Lateral loads from the tower are

Highest point in downtown Los Angeles is graced by California Plaza (l.), focal point of first phase of huge $1.2-billion project. Tube-concept steel frame (above) withstands wind and seismic forces.

transferred to the low-rise floors and resisted by concrete shear walls in the lower stories.

A handsomely appointed lobby, surfaced with granite on the floors and walls, creates a warm, elegant simplicity. And it features a banded pattern in the flame texture that follows the structural lines of the building and extends to the colonnade. The developers, noting the building provides a most efficient use of space, also designed it to provide tenants with a wide range of amenities. Offices on its radius offer panoramic views of the city's rapidly growing skyline. Two-foot six-inch window modules maximize the opportunities for window offices. And column-free expanses permit tenants to respond to organizational space requirements. □

Architects
Arthur Erickson Architects
Kamnitzer & Cotton
Gruen Associates
Los Angeles, California

Structural Engineer
John A. Martin & Associates
Los Angeles, California

General Contractor
HCB Contractors
Los Angeles, California

Owner
Bunker Hill Associates
Los Angeles, California

Navy's Advanced Helicopter Home: A Study in Flexibility

by Kennon W. Baldwin

Navy's new advanced helicopter home, North Island. Central concourse (r.) features north-facing light monitor, exposed roof decks and steel framing members. Administrative wing (l.) has exposed utility systems.

The West Coast home for the Navy's most advanced antisubmarine helicopter squadrons has been established at the Naval Air Station, North Island, San Diego. Introduction of these helicopters to their future flight crews was accomplished months before the actual aircraft arrived by providing this steel-framed training facility which houses flight simulators developed by IBM and Singer-Link. To ensure that trained personnel were ready to take to the sky in these highly advanced Sikorsky SH-60B Seahawks, the simulator facility was required to be complete almost a full year before the first production aircraft were delivered.

As the architect for this critical defense installation we had to develop a 52,000-sq ft training center flexible enough to house as many as five different state-of-the-art simulators, designed to replicate all of the possible aircraft systems, including flight crew and pilot training, tactics and navigation, weapons systems deployment and integrated functions. Beyond the technically intricate aspects of the project, the real key to success was to provide inherent flexibility in the simulator spaces. None of the simulators were actually designed at the outset of this project. How then to provide a series of spaces with all types of future electronic and hydraulic interconnections possible, for devices which were still only "paper trainers"?

Through careful examination of similar devices and extensive collaboration with IBM — the prime contractor for the overall weapons system — a process of "deductive design" allowed development of trainer bays configured to adapt to almost any type of simulator.

Key a Systems Approach

Key to this "systems approach" was to eliminate all but essential obstacles between a series of high and low bay spaces. Only a steel frame would allow the minimal number of bearing points and long-space framing members necessary for those spaces to be truly adaptable.

Kennon W. Baldwin, AIA, is project architect and senior associate in the architectural, planning and interior design firm of James McGraw Associates, San Diego, California.

Steel roof joists carry five-ton hoist as well as long-span roof loads.

To compound these design criteria, the project siting placed the facility, with its numerous classroom and briefing rooms in addition to the simulator and computer-support spaces, immediately adjacent to the runways where jet aircraft practiced "touch-and-go" takeoffs. The associated low-frequency noise directly impacted the project and required an extensive acoustical analysis. Several attenuation proposals were developed. The most cost-effective solution seemed to be increased structural mass in the building envelope. Thus, a mixture of the steel frame and solidly grouted masonry units was designed. The structural steel frame provided interior flexibility and supported gravity loads while the masonry envelope provided acoustic mass and an additional resistance to lateral loads.

This mixture of steel and concrete is carried throughout the building's roof and floor systems. Reinforced concrete roof and floor decks (providing additional acoustic mass) installed over steel form deck are carried by open web steel joists, which in turn bear on the steel frame.

Since the project completion date was critical, construction sequence was a major factor in selecting the structural systems. Basically, after the foundations were in place, the steel frame, joists and form deck were erected and temporarily braced. Next, masonry walls were constructed and remaining roof joists and form deck installed. Finally, the reinforced concrete floor and roof were cast, tying all lateral load resisting elements together.

Steel Frame Essential

The selection of the steel frame system was essential to successful project completion — no other structural system could compete with steel for speed and ease of erection.

The flight simulator high bays are each associated with an adjacent computer room, packed with IBM's latest hardware devices. These units generate the visual images, audio signals and actual motion systems that are then transmitted by elaborate cable networks to the simulators. Field evaluations revealed that the airstation's radar blanketed the site with levels of electromagnetic interference (EMI) high enough to seriously disrupt these computer functions. Thus complete EMI shielding of all computer and simulator bays was essential. Walls were shielded with copper foil beneath the studs, but it was also determined that the steel form deck served as an excellent EMI shield when tied into the overall envelope. Again, steel's properties saved time and money by its inherent shielding value.

Steel also provided an aesthetic benefit throughout the building's interior spaces. Considered by Navy design criterion to be a non-combustible material, the steel frame could be exposed and expressed. Thus the frame is carefully detailed and highlighted by an accent color to clearly reveal its function. The steel form deck and steel joists were also exposed as frequently as possible, and painted white for light reflectivity.

One of the primary advantages of the openness allowed by the steel frame was the opportunity to integrate the mechanical and electrical systems into the structure in an exposed and readily accessible manner. As there is every chance the technologies associated with such advanced devices will evolve and require change, access to these systems is crucial. By exposing the ductwork, conduit, piping, etc., the highly sophisticated use of the facility is clearly expressed and left available for easy modification.

The facility now houses two primary simulators, with three more in the process of installation. The ease of introduction of these devices has clearly demonstrated the wisdom in selecting steel as the primary structural material. □

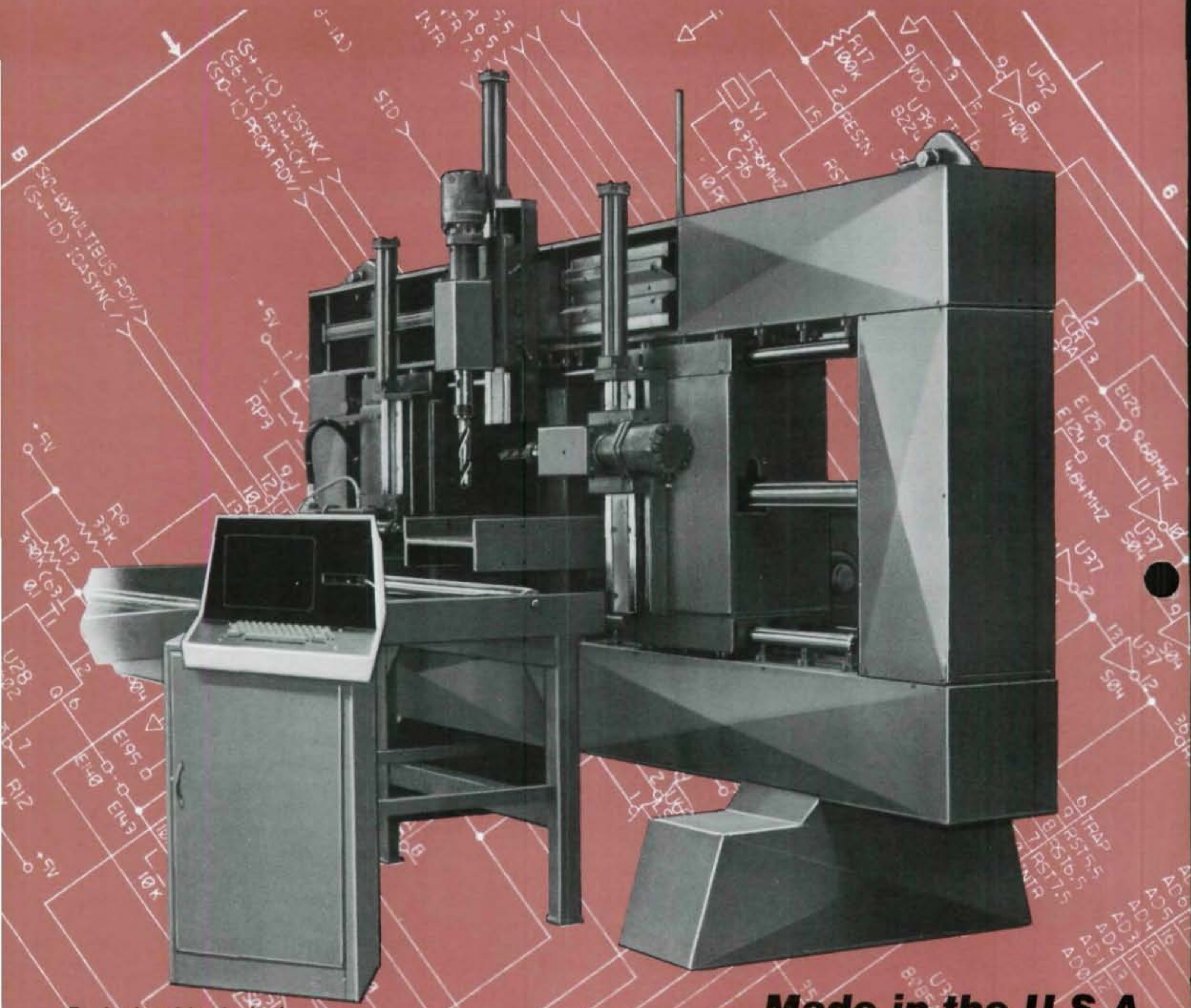
Architect
James McGraw Associates
San Diego, California

Structural Engineer
Coneer Engineering
San Diego, California

General Contractor
Trepte Construction Co.
San Diego, California

Owner
Naval Air Station, North Island
San Diego, California

HD-145 CNC DRILL



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University of California Parking Deck: A Neighborly Concern

Announce plans to build a multi-level parking structure in an undeveloped canyon rimmed with homes—and you are not likely to get much support from the neighbors. But, demonstrate the facility's need and involve the neighborhood in its planning. Then hold a competition to select the best design for the construction dollars and you are more likely to receive the support needed to get the project built.

The University of California, San Diego, took the second approach when deciding to develop a $7.5-million parking structure and lot. The facility serves the institution's medical center and hospital, located in a residential neighborhood.

Need for the facility was apparent. For several years, medical center employees parked on nearby residential streets because of inadequate on-site parking. This, in turn, created parking problems and traffic congestion for residents. The problem had become so serious that the medical center had begun running a shuttle service to satellite parking lots many miles away. This shuttle cost the university $1,200 a day. The university wanted to develop a parking structure and adjacent lot to accommodate a minimum of 1,100 vehicles. An access road and a pedestrian bridge from the structure to the medical facility also were proposed. The challenge came in developing a cost-efficient facility which would provide adequate parking, yet be unobtrusive to residents, and address environmental concerns unique to the site—four acres in an undeveloped canyon.

With help from neighborhood representatives, UCSD identified visual, acoustical and environmental concerns for the structure and its site. Among key concerns were:

- That the structure's size be visually reduced so as to preserve the open space quality;
- That landscaping or other screening lessen the visual impact of the building and its stored vehicles;
- That site and building lighting be shaded to eliminate spill light;
- That vehicular noise be minimized for the comfort of residents and hospital patients;
- That the structure's location and design take advantage of the natural slopes and prevailing winds to ease dissipation of carbon monoxide levels; and
- That landscaping provide wind breaks, shade, erosion control and a pleasing impression.

Giant "spokes" of structural steel form spiral-shaped ramps.

University of California hospital parking deck, San Diego, Cal. Concern for neighborhood translated into uniquely sited, cost-efficient structure.

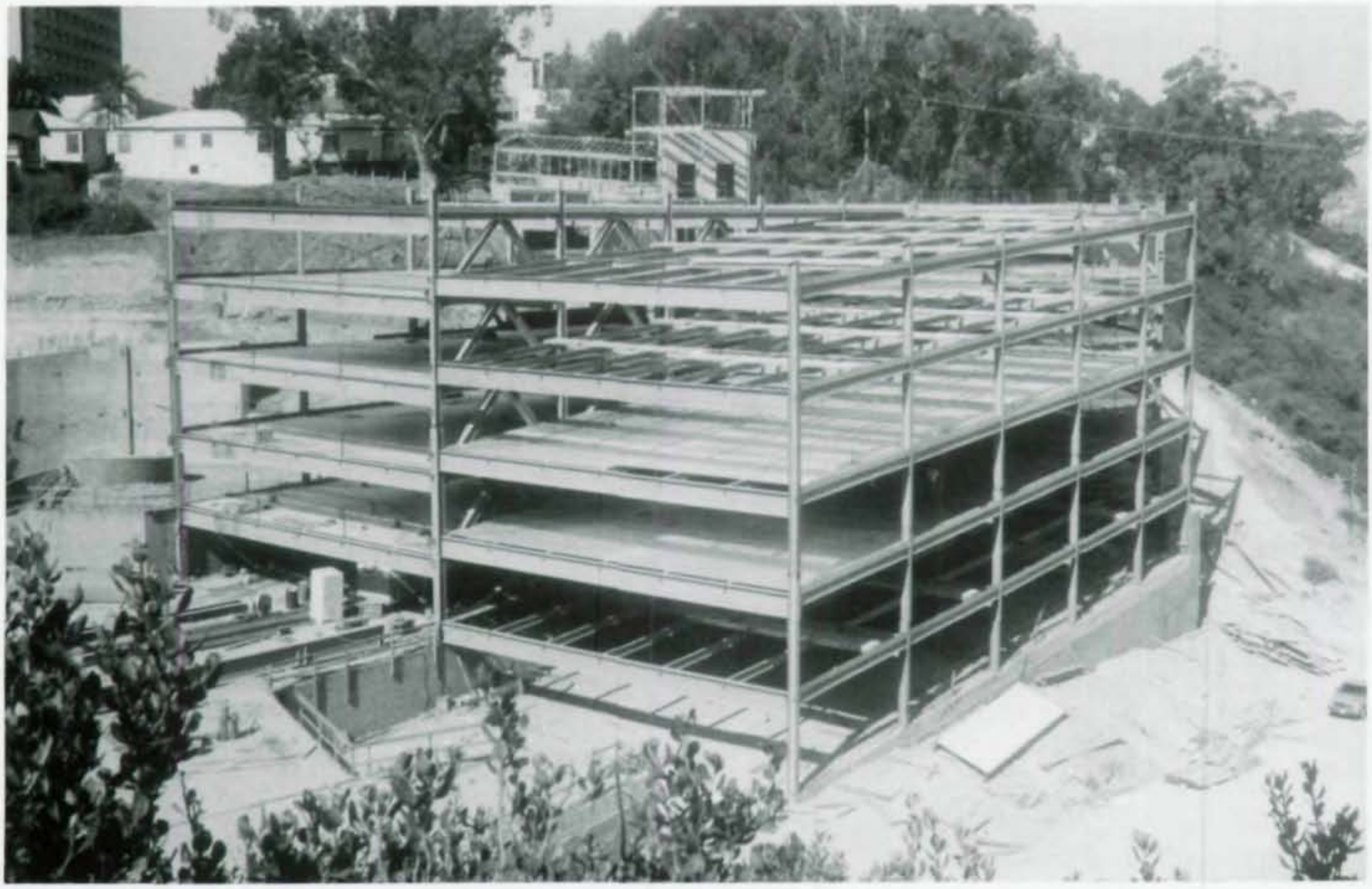
Competitive Approach

Then, rather than follow the traditional approach of retaining first an architect and then a contractor, the university used a type of turnkey contracting developed at the San Diego campus in 1974. Under this approach, the university selected an architect and contractor simultaneously through a competition which chose the winners on the basis of design quality and construction cost.

University architects first prepared bidding documents which described the project in terms of scope, design, objectives and minimum acceptable standards of construction. These documents then were released to bidders interested in competing for the contract. Each bidder was eligible to submit any number of plans, but each required both a technical design and a cost proposal. Each bidder also was required to use a licensed architect and/or engineer to prepare the design.

For about 12 weeks, the design part ot each bid team prepared a technical scheme. Those plans then were submitted anonymously to the university, which conducted a week-long, two-phased evaluation. First, university architects awarded each design quality points based on how closely each met or exceeded their design criteria in each of five categories.

For example, the parking facilities were to provide a minimum of 1,100 spaces.



Steel-framed parking deck made full use of ravine for both access and aesthetics.

Designs that provided additional spaces, up to a maximum of 100, were awarded bonus quality points for each space above the minimum—an incentive for designers to maximize parking. Then an evaluation board, comprised of university and neighborhood representatives, determined each design's final points. While those evaluations were taking place, the contracting part of each team prepared a bid on its design. Those bids were opened publicly after the evaluation was completed.

Through an identification process, university officials matched each bidder's total design points with his respective construction bid. Those total points were divided into the construction bids, with the result being a cost-per-quality-point for each bidder. The bidder with the lowest one was awarded the contract. Second place received $50,000, third place $35,000 and fourth place $20,000. Twelve bidders had submitted 19 different designs.

The winning design—submitted by SGPA Planning and Architecture and C. E. Wylie Construction Co.—provides a five and one-half level parking structure and adjacent lot for 1,159 vehicles. But the design deviates significantly from traditional, box-like structures. The architects designed a V-shaped structure, then tucked it into the canyon hillside to minimize its impact on the views of nearby residents. Existing alignment and contours of the canyon floor are followed closely to provide easy drainage and air circulation, reducing carbon monoxide levels.

Visual Impact Crucial

No openings on the structure's west wall and minimal openings on its southeast and northeast walls help to preserve the neighborhood's quiet atmosphere while substantially reducing nighttime spill light. In addition, those southeast and northeast walls were turned 45° to increase their distance from the residential neighborhood.

Landscaping played a major part in visually and acoustically reducing the structure's impact on the canyon and neighborhood. Continuous building planters filled with cascading landscape were designed along the structure's short eastern face to screen it from residents. The southeast and northeast walls also are heavily screened with landscaping. Existing eucalyptus groves in the canyon will be extended around the structure to harmonize with the canyon setting and screen parking surfaces from view.

Traffic circulation patterns to, from and within the structure were a key consideration. The structure consists of two integral halves. One half primarily serves traffic to and from one direction and the other half traffic to and from another direction. This concept provides for a continuous one-way circulation/search movement on either side, reducing traffic backup and waiting time. The two halves are not independent of one another, however. The design allows traffic to cross over and use the other half at every second level. Exiting is achieved by using a one-way, spiral-shaped ramp, accessible from all levels. The ramp is in the apex of the structure's V shape.

An 80-ft long pedestrian bridge links the parking structure to the medical center. It is of steel frame construction with precast concrete spandrel panels covering the lower part of each of two spans. Bronze tempered glass set in steel framing extends up from the concrete panels on one side, creating the upper part of that span and the bridge roof. The upper part of the other span is open for air circulation and security. A steel guardrail runs the length of that span to protect pedestrians as they cross the bridge.

Steel Also a Winner

Ed Wylie, president of the general contracting company, said cost studies were conducted on several different structural systems for the parking structure—precast concrete, poured-in-place concrete, and several combinations of steel and concrete slab configurations.

Steel was chosen for two reasons, cost and construction time. Wylie explained that at the time of the design and bidding, steel was the most economical material considered, based on estimates of the structure's size and the number of cars to be stored. He added that the actual construction time was faster using steel, another important factor, since the university was anxious to complete the project in a timely manner.

The structural system consists of a 4½-in. 4,000-psi composite concrete slab on 2-in. metal decking spanning 10 ft between steel beams. These beams span 26 ft to the principal girders spanning transversely across the double-loaded parking ramps. All beams and girders act compositely with the traffic slab.

The seismic resisting system uses braced frames of steel tube K-braces, supplemented by concrete shear walls. All structural steel is A36 with tubes being A500. Weight of steel for the structure, including braced frames, averaged 8.3 psf. The accepted design was the only steel-and-concrete structure of the 19 designs submitted. □

Architect
SGPA Planning and Architecture
San Diego, California

Structural Engineer
Hugh Brooks Associates, Inc.
Newport Beach, California

General Contractor
C.E. Wylie Construction Co.
San Diego, California

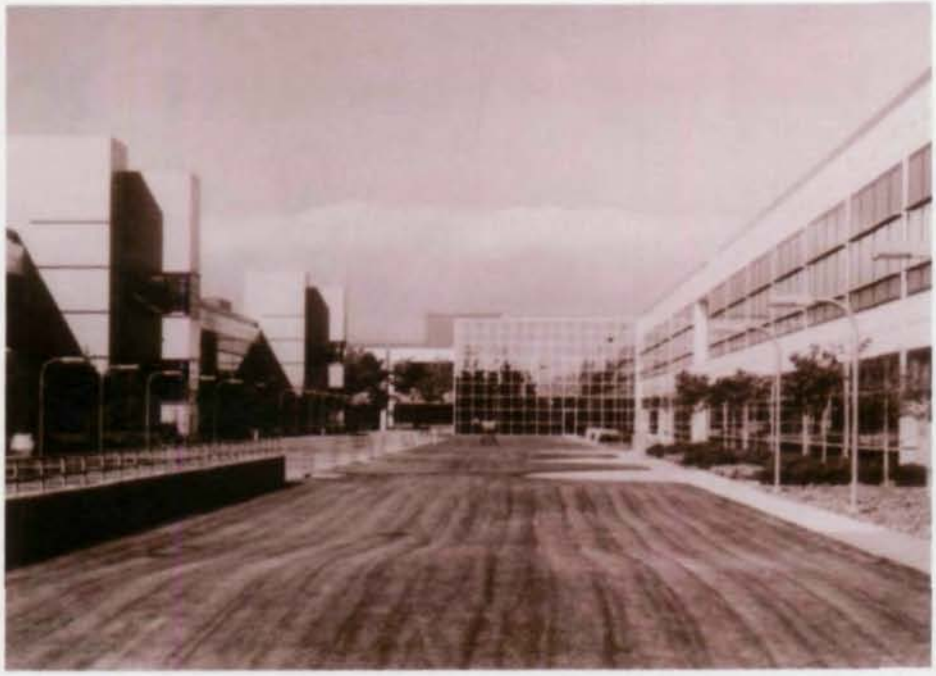
Steel Fabricator
W & W Steel Company
Oklahoma City, Oklahoma

Owner
University of California
La Jolla, California

An 80-ft pedestrian bridge provides easy access to medical center from parking deck.

Hughes Electro-Optical Group: Systems that Shape the Future

by Ernest C. Wilson, Jr.



Hughes Electro-Optical Group facility, El Segundo, Cal. Need to consolidate operations brought 35 units together in one structure. Two-story atrium/corridor (r., below) enjoys skylight illumination.

Ernest C. Wilson, Jr., AIA, a founding partner of Langdon Wilson Mumper Architects, directs the firm's Newport Beach, California office.

It is a high-tech community with a population of 8,000 housed on a 143-acre site. Yet, the design efforts coupled with the concern for the inhabitants and operations at Hughes Electro-Optical Data Systems Group's (EDSG) $306-million engineering and production facility involved more intricate planning than for many towns far larger.

Hughes EDSG in El Segundo, Cal. is a 2.34-million sq ft facility for the development and manufacture of highly complex electro-optical systems and equipment for space, strategic missile equipment, laser systems, fire control systems (airborne surface applications), and air space computers, processors and software systems.

Need to Condense Operations

In 1978, Hughes found itself in an unwieldy situation. Its EDSG division had grown to 4,000 employees who were working out of 35 different geographic locations, including 45,000 sq ft of mobile units. The management decided a major overhaul was needed to concentrate operations expected to double its personnel within two years. The architect who was designing a 12-story building for Hughes' Radar Systems group in El Segundo was chosen to design the complex facility.

The first task facing Hughes was to find the best location for the new facility, since employees were spread over a 40-mile arc from the San Fernando Valley to San Pedro. A 143-acre site within the city of El Segundo was purchased for its central location and suitability to requirements.

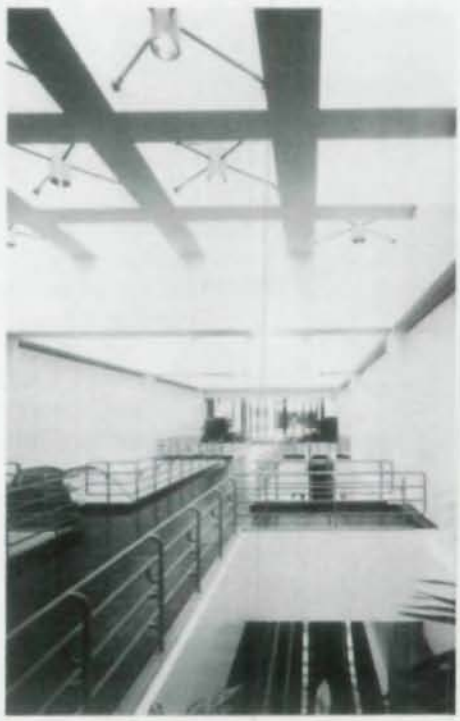
Although the architectural firm had designed numerous computer and technical manufacturing operations and more than 300 office buildings since their founding in 1950, the EDSG facility was the largest project ever undertaken. It presented a high-tech puzzle that involved facilitating communication among research and development, manufacturing and engineering functions while also providing an easy flow of people and buildings to blend into a total, unique environment.

The owner's criteria for the facility were extensive and extremely complex because of the scientific nature and variety of its operations. The design also must allow for future continuous alterations to accommodate change.

A Complicated Finished Product

The finished facility is a geometric interrelationship of an L-shaped engineering complex with a rectangular manufacturing facility connected by an underground access road used as a truck tunnel for circulation and security. Spaces vary from large bay areas with immense hydraulic lifts for manufacturing, to the specific, complicated areas for laboratories, environmental testing chambers, laser instrumentation and clean rooms. The project's seven two-story buildings also include extensive facilities for research and development, engineering, general and administrative offices, employees' services, large scale food preparation and dining for 900 persons at one seating.

The facility, which provides for all EDSG operations, consists of: a 1,091,730-sq ft engineering building; a 921,631-sq ft man-



ufacturing facility; a 158,501-sq ft core connection and entry building; a 58,513-sq ft service building; a 45,629-sq ft environmental test building; a 36,629-sq ft high-bay engineering facility; and a 29,237-sq ft central plant. A below-grade level and tunnel system connects the buildings and provides access for services and delivery by elevators up to each area. The entire facility is designed with Department of Defense security requirements in mind.

The L-shaped engineering building is designed with four atriums—roof-to-basement light wells allowing solar illumination at all levels. The atrium areas are connected to four vertical transportation pods containing stairways, elevators and electrical equipment. The unusual high-bay facility is a 35-ft high building containing 24 ft of usable vertical space dictated by the requirements of the building and the space necessary for an overhead bridge crane that spans 60 ft.

One of the most exotic processes in the high bay area is the holographic grating laboratory. Dealing with the projection of light images onto a multi-dimensional plane, a specially designed mirror is used to focus light rays in a narrow beam. To allow this to happen, the area provides a stable, vibration-free environment. Most of the building's interior is on Level 1, but there is also a 15-ton capacity mechanical lift. Its base rests in a pit one story underground, with the capability to raise optical devices above the rooftop for testing.

The laser rangefinder roofhouse provides a direct view of a 50-ft by 50-ft optical target, 2,000 ft away. By sighting on the target, employees are able to perform engineering evaluations of test devices. The building is also designed so that windows on the third level are removable to allow for off-site targeting and calibration of laser instruments.

Clean-room capability through the complex allows for testing and assembly in a dust-free environment. Equipped with airlocks, these rooms are certified to have no more than 100,000 particles per cu ft (a normal office environment has 600,000) and is the same standard used by hospital operating rooms for open-heart and brain surgery. The manufacturing area has one of the largest contiguous clean rooms in the world, equivalent in size to a football field. It also contains an automated batch manufacturing system, a computer-aided manufacturing system that produces machined parts of present products, as well as producing parts of future product lines solely by revision of software.

Aerial view of huge Hughes complex. Engineering building is in foreground, with manufacturing facilities behind.

Unique Architectural Features

Special architectural features of the facility include huge granite blocks set precisely level for stringent testing; heavy electrical labs containing various types and distributions of power, and an unique piping system requirement with 8-ft heights above ceilings for distributing liquid steam, coolants, industrial gas, de-ionized water and compressed air.

Steel was used as the primary material throughout the project, including the structure, decking and curtainwall. Given the owner's wish for a high-tech, aerospace design, the many varied structural requirements, the continuous future alterations anticipated by Hughes and the strict time schedule for design and construction (1979 to 1982), steel was chosen because it provided the flexibility for design creativity and would produce a high quality, functional product.

A total of 12,000 tons of structural steel was fabricated for the project. Exterior walls contain 170,000 sq ft of sandwich panel. Approximately 1.5-million sq ft of metal floor and roof decking were installed. The buildings were designed for lateral seismic forces higher than specified by code, and the general forces for design were 40% greater than required. Vertical design live loads were also higher than code minimums to conform with Hughes' requirements.

To accommodate the need for continuous change of the interior structure, none of the walls are structural and all of the weight is carried by the steel frames of the buildings. The demountable walls allow for maximum flexibility in making changes. The approximately seven and one-half acres of slab used on the manufacturing floors required more than 6,000 yds. of concrete and more than 60 mi. of steel reinforcing rod. The floors were designed for l00 psf live loads for placement of equipment at random.

Cafeteria accommodates 900 at a time.

In keeping with the security requirements of the facility, the exterior is clad in a continuous wall of silver metal with openings only at secured points of entry. From the outside, the wall permits only glimpses of the interior forms. Once beyond the plane of the wall, the true nature of the complex becomes clear and the different functions are expressed in form. The careful use of color, texture and material promotes a comfortable environment and a positive interaction between people and the building.

The Hughes EDSG facility is comprised of highly sophisticated structures that have many different components. The activities that go on inside these buildings are not just manufacturing or research as we think of them and it is precisely these functions that make these structures so unique. The size, ability to integrate these many functions into a whole unit and its distinction as the first electro-optical research facility of this magnitude makes the EDSG facility noteworthy among other facilities. □

Architect
Langdon Wilson Mumper Architects
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Structural Engineer
Brandow & Johnston Associates
Los Angeles, California

General Contractor
C. L. Peck Contractor, Inc.
Los Angeles, California

Steel Fabricator/Erector (mfg.,test lab,central plant, pods, ped bridge)
Riverside Steel Construction
Santa Fe Springs, California

Steel Fabricator (high bay,services bldgs.)
Palm Iron & Bridge Works
Sacramento, California

Horton Plaza, San Diego, Cal.

Horton Plaza:
A "Grand Experiment" in Renewal

In August, the first phase of one of the most ambitious experiments in urban mixed-use redevelopment in recent times will open its gates to the visitors and residents of San Diego. Horton Plaza is an important contribution to the evolving philosophy of downtown revitalization and, in particular, to the City of San Diego. The recent success of urban specialty centers such as Fanueil Hall in Boston and the Harbor Marketplace in the inner harbor of Baltimore, helped pave the way for Horton Plaza. But, Horton Plaza will take a giant step beyond these projects by injecting major national and regional retail, entertainment and recreational facilities, a performing arts theatre and a nationally significant museum for the contemporary arts into the formula for the successful urban marketplace of tomorrow.

Over the 10-year history of the development of this project, the chronology of events leading towards this year's completion of its primary components has encompassed significant variations and adjustments to its initial downtown shopping center theme, ranging from:

- An initial site of 15 city blocks to the final nine block configuration
- A typical two-level, straight-line, regional shopping mall, to a six-level urban marketplace and cultural center, bisected by a meandering pedestrian street
- From the initial consideration of an enclosed ice skating rink, to the ultimate incorporation of a 550-seat live performing arts theatre
- From three regional department stores to four of the finest department store retailers in the country.
- An original high-rise office tower component, to an intimately scaled garden office development beginning 80 ft in the air, atop the elevated parking structures
- A financial commitment on the part of the city and the private developers that has grown from $90 million to $235 million currently.

A Bit of History

Since 1974, when the principal project developer, Ernest W. Hahn, Inc. was selected by the City's Redevelopment Agency, Centre City Development Corporation, numerous business agreements and design concepts have been initiated, reworked, refined and sometimes abandoned for better alternatives. The volatile economic climate of the recent past had a significant impact on the project program and schedule. With the passing of the State Tax Reduction Initiative, Proposition 13, in early 1978, and the recession of 1980 and 1981, the site had to be reduced in size, the project program increased significantly by the addition of more retail area and speculative office lease space. It was a difficult period to confirm the department store commitments to the project. Today, only one of the original department stores still remains in the project.

Because of the numerous external and internal influences on the project's direction and future, the design concept was subjected to countless modifications and revisions until the Fall of 1982 when the schematic design of the current scheme was approved unanimously by the city.

Model and aerial view reveal complexity of giant steel-framed structure.

A Design Perspective

The inspiration for the primary design philosophy behind Horton Plaza is the multiple-level open air marketplaces found throughout southern European hill towns and cities. The project is to be perceived as a collection of buildings, structures, spaces and forms that normally would have required decades, even centuries, to synthesize into a distinctive, dynamic urban district.

The design reflects a sensitivity to San Diego's architectural heritage through the re-creation of symbolic ornamental towers, the use of articulated plaster and terra cotta and the application of harmonious and complementary pastel colors throughout. In specific locations, historic structures originally situated on the site are being re-created in every exterior detail and incorporated into the overall project design. Horton Plaza, because of its location, configuration, uses and public space, should be seen as the first truly urban mixed-use, retail, recreation, entertainment and cultural center in the country. It will not and should not be seen as purely a building, but rather a zone within the urban fabric of San Diego where everyone can enjoy the activities and events of the project from early morning until late in the evening.

The Mixed-Use Ingredients

Through the years of Horton Plaza's evolution, its components, and their respective programs have varied dramatically. But, it has been because of this evolving process that today the mixture of uses has become so dynamic and complementary. It appears to be the appropriate formula for its own success. But, more importantly, its ultimate goal of being the keystone to the successful renaissance of downtown San Diego is now not only possible but also probable. The current program for Horton Plaza integrates nearly 2.6-million sq ft of functional building area into its 12.5-acre site. The primary components are individually represented in the following summary.

Major department stores	
Robinson's (4 levels)	142,000 sq ft
Broadway (4 levels)	135,000 sq ft
Mervyn's (2 levels)	85,000 sq ft
Nordstrom (4 levels)	155,000 sq ft
Mall retail & common areas	497,000 sq ft
Restaurants	45,000 sq ft
Farmers produce market	20,000 sq ft
Multi-screen cinema complex	38,000 sq ft
Live performing arts auditorium	45,000 sq ft
Perimeter street retail	18,000 sq ft
Support facilities	175,000 sq ft
Parking facilities (3,000 cars)	1,240,000 sq ft
Total Program	2,595,000 sq ft

To further complement and enhance the project's mixed-use nature, additional facilities are scheduled for completion by the end of 1986. Py-Vavra Development will open a 17-story, 450-guest room Omni International Convention Hotel. The historic Balboa Theatre, located near the northeast corner of the project site, will be transformed into the San Diego Art Center, a world class museum of contemporary art with a special emphasis on architecture and design disciplines. Completing the entire effort will be the addition of 190,000 sq feet of three-and four-story leasable office space to be constructed atop the two eight-story, free-standing parking structures adjoining the retail center.

To illustrate the complexity and sophistication of the physical plant which will support Horton Plaza's festive environment, the following synopsis briefly outlines the major unique technological components and engineering features contributing to its initial cost effectiveness and long term operational and functional success.

Steel Structural Systems

1. A seismic moment-resisting structural steel frame using both standard and high-strength steel was selected for economy and spatial efficiency through controlling the sectional size and weight of all primary structural steel members.
2. The 30-ft by 30-ft typical structural framing bay was rotated 45° to the perimeter property lines to facilitate more effective retail spaces on the upper floors and efficient parking and service drive circulation within the lower levels.
3. The use of a newly developed seismic slip-joint connection detail at all seismic and thermal expansion joints eliminates the need for the traditional double-column detail at these conditions. This single detail substantially increased interior planning flexibility and saved significant money by eliminating redundant steel columns and concrete footings.

Service Systems

The electrical distribution system for the entire project includes five subterranean transformer vaults which distribute more than 41,000 amps of high voltage electrical service to specified zones. To further assist the energy-efficient lighting system, a computerized cost control management system for all electrical service throughout the project will be provided.

A centralized chilled water supply and return loop system was installed to service most of the project areas from an independent source six blocks away. The system will service the stores, the mall shops, the Arts Theatre and the commercial office development.

To effectively manage the circulation of fresh air in the subterranean service drive and parking levels, an automatically controlled carbon monoxide monitoring system cycles the ventilation systems.

A proprietary concern was that roof surfaces of the project be kept as free of mechanical equipment as possible because of sightlines from adjoining high-rise structures. All elevator equipment rooms normally located in penthouses at the top of each elevator shaft have been relocated to specially designed machine rooms at the base of each shaft.

All parts of the project have been provided with a fully automatic fire sprinkler protection system supplemented by intermediate standpipes throughout the facilities. Although city water pressure is adequate, additional protection has been provided by on-site water storage of 15,000 gallons.

A 40-ft wide and 900-ft long one-way subterranean service drive provides access to nine separate service dock locations along the drive which contain freight elevators for delivering or disposing of materials throughout the project.

The "grand experiment" Horton Plaza represents will be ongoing and, hopefully, self-perpetuating long after its opening date. Its successes and failures will be judged against an endless range of objectives and goals. For the sake of San Diego, it must be as successful socially and culturally as it should be financially. And likewise, its functionality must assist and enhance the grander effort.

By the time Horton Plaza is physically complete, literally thousands of individuals will have participated and contributed to its potential success. It is because of all the individual efforts that San Diego is now so close to realizing the "fruits of labors" and achieving the desired goal. □

Architects

The Jerde Partnership, Inc.
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Burbank, California

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Los Angeles, California

Taylor and Gaines
Pasadena, California

General Contractors

Nuhahn, Inc.
Harbor City, California

Robert E. Bailey Construction
Seattle, Washington

Steel Fabricators

Bannister Steel, Inc.
National City, California

Lee & Daniel
Azusa, California

Junior Steel Company
City of Industry, California

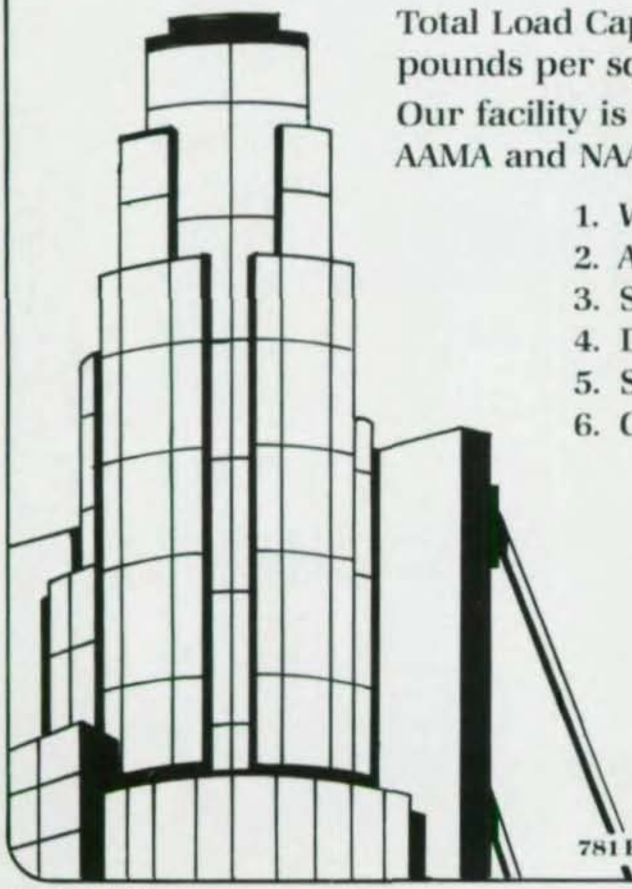
Owners

Ernest W. Hahn, Inc.

Robinson's Department Store

Mervyn's Department Store

Nordstrom Department Store

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Marine Corps Recruit Depot:
A Challenge in Scale

The Marine Corps program for a new Recruit Processing Center at San Diego required blending 113,000 sq ft of floor area (ranging from lecture rooms, offices and barracks) with the design vocabulary, scale and materials of the Mission/Spanish architecture characteristic of the base. The large scale of the two connected buildings, plus unusual site conditions and special interior requirements, presented many unique structural engineering challenges.

All structural materials currently in use, with the exception of wood, were used in this facility. The buildings are supported on concrete piles. A cast-in-place concrete structural slab and pile cap system form the first floors. Walls are 8-in. and 12-in. masonry. The second floor of the barracks building is metal deck and concrete fill on structural steel members. Structural steel columns support second floor and roof framing members. Precast, prestressed concrete double T's with cast-in-place concrete topping composed the ceiling of a fallout shelter protection area. The roof system is metal deck supported on structural steel purlins and beams. Fabricated long-span steel trusses are used in an 8,500-sq ft column-free classroom space.To keep the large Spanish tile roof expanses uncluttered, large mechanical plenums and equipment platforms are suspended from the roof and concealed above the ceiling level. Structural steel beams, purlins and metal deck with concrete fill are used for the concealed suspended mechanical walkway spaces and plenums. The majority of all interior columns are 10-in. wide-flange units varying in height up to 43 ft. A total of 432 tons of structural steel went into this facility.

The building is sited in an area of underlaying soft bay deposits in which the upper 20 ft of soil is susceptible to complete liquifaction during an earthquake.

New Marine Corps Recruit Center, San Diego. Its large scale posed many engineering challenges.

The concrete floor slabs were designed as flat plates supported on pile caps. Under a condition of liquifaction, the floor slab would function similarly to a pier deck over 20 ft of water. Lateral forces at the ground level are resisted by a battered pile frame system. Above ground, masonry walls act as shear walls (as well as an acoustical masking mass to shield the interior spaces from the adjacent airport noise) to transfer lateral forces from the metal deck roof and floor diaphragms. Inertial seismic forces generated from the suspended mechanical platforms are transferred by steel-braced frames into the roof diaphragms, which in turn transfer them to the masonry shear walls.

The structural module common to both the processing building and the two-story barracks building is a 28-ft square grid. The typical roof purlin span and spacing is 28 ft and 7 ft respectively. Typically, welded-tab and high-strength bolt connections were used throughout. The height of the buildings ranges up to 49 ft, with large hip roofs (covered with clay tile) having dramatic changes in elevation. Because of the hip roof requirements, as many as six beams are framed into one supporting column at the same location.

Perhaps the most dramatic structural feature of this project is the support of a hipped roof area over the 8,500-sq ft lecture hall. The four hips, formed by two steel trusses spanning 95 ft, form an "X" inside a square tension ring made up of steel trusses which span 67 ft-8 in. on each side of the square. This assembly is supported on four structural steel columns. Suspended from the center of the trusses at the peak of the ceiling of this large classroom area is an audio visual cupola housing four rear-screen projectors which project images on four sides for the new marine recruits. □

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San Diego, California

Structural Engineer
Atkinson, Johnson & Spurrier
San Diego, California

General Contractor
Riha Construction
La Mesa, California

Steel Fabricator
W&W Steel Company
Oklahoma City, Oklahoma

Owner
Western Div. Naval Facilities Engineering Command
San Bruno, California

Steel-framed roof structure meets not only need for long spans but also desire for Spanish architecture.

Hotel Inter-Continental: A Monument to Waterfront Development

Nine years ago, Architect Frank L. Hope, Jr. had the foresight to envision downtown waterfront property on San Diego Bay as an exciting commercial attraction. He later was to contribute something truly unique to that precious waterfront: a 25-story steel-framed structure that has become a San Diego landmark—the Hotel Inter-Continental.

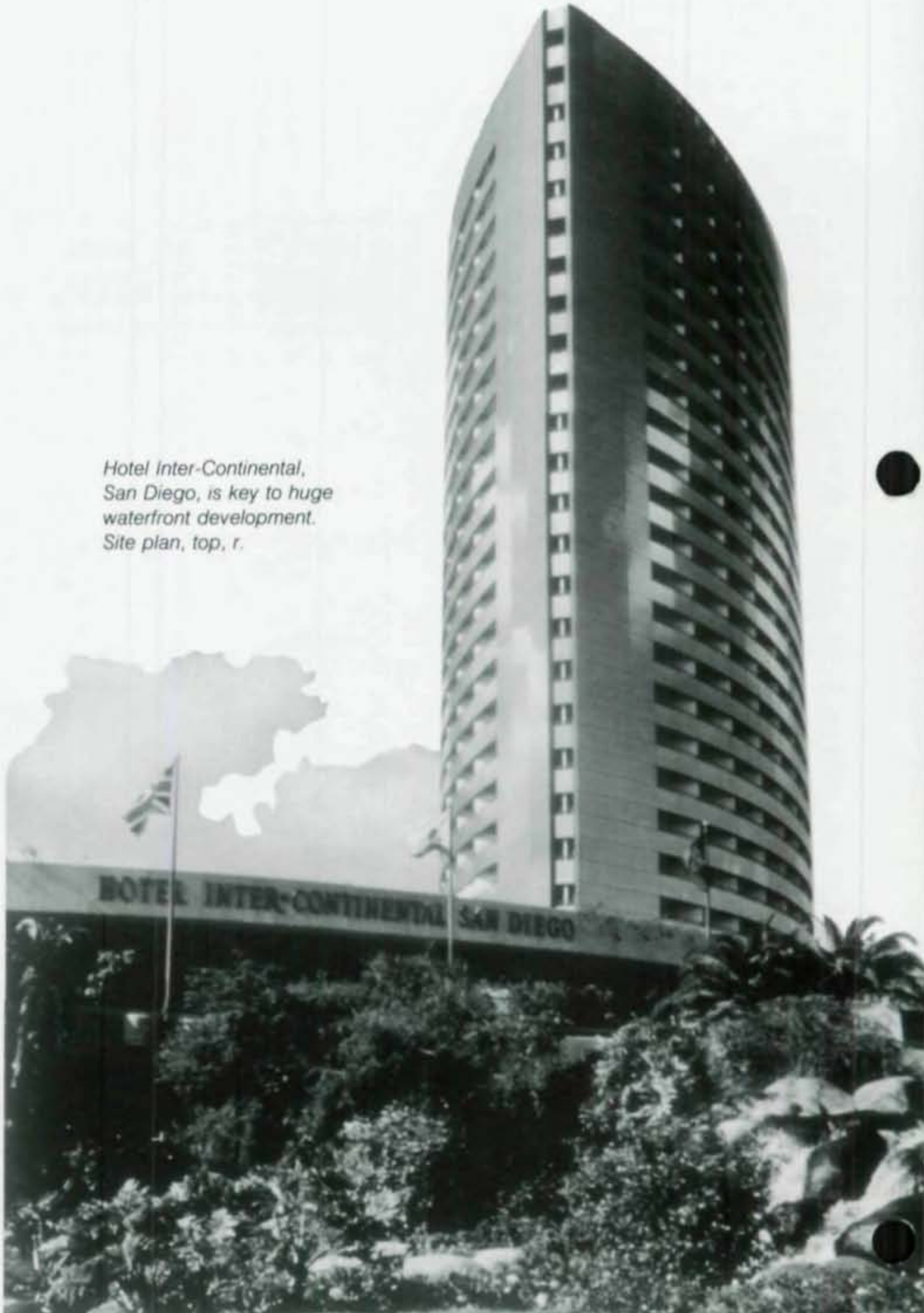
The steel-framed hotel was designed to ensure that every room has a view of San Diego Bay. The resulting elliptical shape, which appears as a ship sailing out to sea, seemed most appropriate for the waterfront.

Under Hope's direction, the port commission paved the way for a transformation of the downtown coastline properties that would allow the public to enjoy and use the area. Development began in early 1980 with Seaport Village, a 14-acre mixed-use recreational/commercial development of retail shops, restaurants and boutiques.

To further enhance this newly transformed area, eight acres of grassy parks, accented by walkways and bike paths and waterfront dining facilities have been developed. Tourists, downtowners and passing pedestrians can walk or picnic under trees on green belt areas and watch sailboats, fishing boats and naval ships cruise by.

Key to New Development

A key turning point in the waterfront development was the construction of the $125-million Hotel Inter-Continental which has been called a "destination resort" hotel by its operators, the Inter-Continental hotel chain.

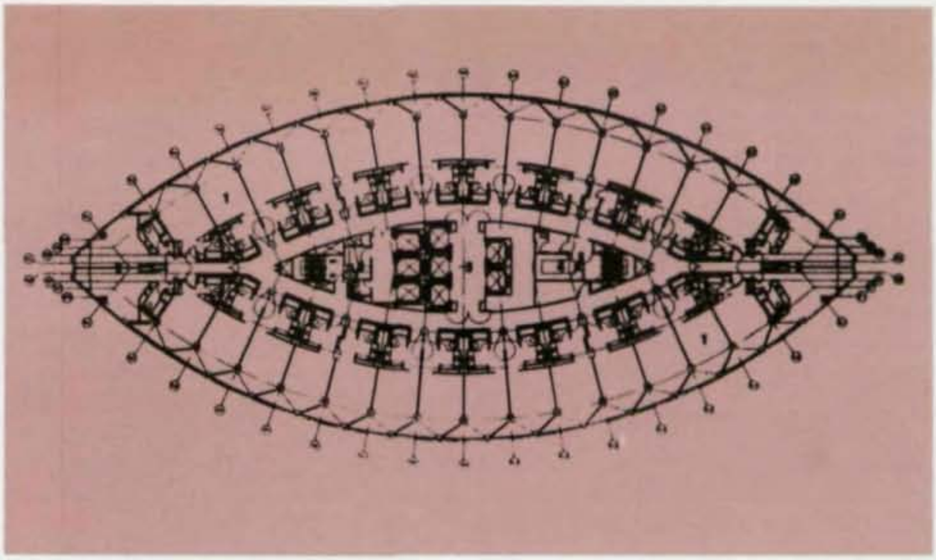


Hotel Inter-Continental, San Diego, is key to huge waterfront development. Site plan, top, r.

The hotel is situated next to popular Seaport Village on a site formerly known as Navy Field because of its use by the Navy as a recreational area. Graced with aquatic views from every room, easy accessibility to downtown, the airport and major freeways, the famous San Diego Zoo, Balboa Park and other major tourist attractions, this steel-framed and elliptically shaped structure has been described as a "beacon on San Diego Bay."

The hotel was designed to accommodate a twin tower of identical shape. In addition, San Diegans recently approved a measure calling for construction of a major convention center adjacent to the hotel. When completed, the hotel/convention center complex will draw thousands of locals and tourists to the downtown waterfront each year.

Hope's principal designer, C.W. Kim, said the decision to design an elliptically shaped structure was based on the developer's request to create something "truly unique;" a building that would reflect San Diego's symbolic character, create interest and demand for a destination hotel and enhance the waterfront site. Their design, submitted as part of a competition, was chosen over five others.



Design for Maximum Views

The winning view-oriented design called for a core structure, a feature of many luxury hotels, with the service elements—elevators, electrical equipment, utility rooms—located in the center of an efficiently designed structure. This design element lent itself uniquely to a curved or elliptical shape, according to Fred Livingstone, principal architect for the hotel. He said the curvature was accomplished by using three-dimensional computer frame analysis. The use of computer-aided design was a necessity in so intricate a configuration. Under normal circumstances, it would have been a painstaking task to figure and re-figure any design changes in the quest to obtain the exact curvature. The computer permitted designers to fine-tune the radius in relationship to the axis while accomplishing efficiency of the overall core design.

An example of use of the computer-aided design system is the "sun study" used to locate the swimming pool for optimum sun exposure. This was accomplished by feeding three-dimensional drawings of the building into the computer along with the altitude and azimuth of the sun at 10 a.m. and 2 p.m. for one day each month of the year. In a short time, the computer produced 12 drawings of the hotel and pool's shade under these conditions showing the design and location that would permit full sun exposure most of the time.

Livingston points out there are practically no right angle connections within the structure, thus creating a challenge unlike any he has experienced working with rectilinear forms.

Steel's the Choice for Unique Structure

Steel was selected for use in framing for several reasons, including speed of construction. "Steel also reduced the weight of the building in this high seismic area and provided the ductility needed for a building of this height," explained Attila Mocsary, the architect's vice president and director of structural engineering. "Steel proved to be the favorable choice in cost consideration as well," he added. "Using steel was a matter of necessity in constructing the first and second stories with heights of 17 and 27 ft respectively. These relatively high two stories required built-up box columns to provide stiffness for drift control. The design called for a ductile moment-resisting structural steel space frame as an aid in resisting lateral forces such as wind or earthquake," said Mocsary.

The unique shape of the tower required extensive analysis to determine the impact of wind forces on the building. Wind tunnel tests, performed by Prof. Cermak of Colorado State University, determined the wind load not only for the building but also for exterior glass walls.

Hotel Inter-Continental is unique structurally as well as visually. The floor was built of 2½-in. thick pre-stressed concrete panels which became permanent formwork and a 3½-in. thick composite topping was cast over the pre-cast elements. The topping contained the top reinforcement of the final 6-in. solid slab. The cost of concrete forming was saved and, since the underside of the pre-cast concrete panel is smooth, plastering was not required for room ceilings.

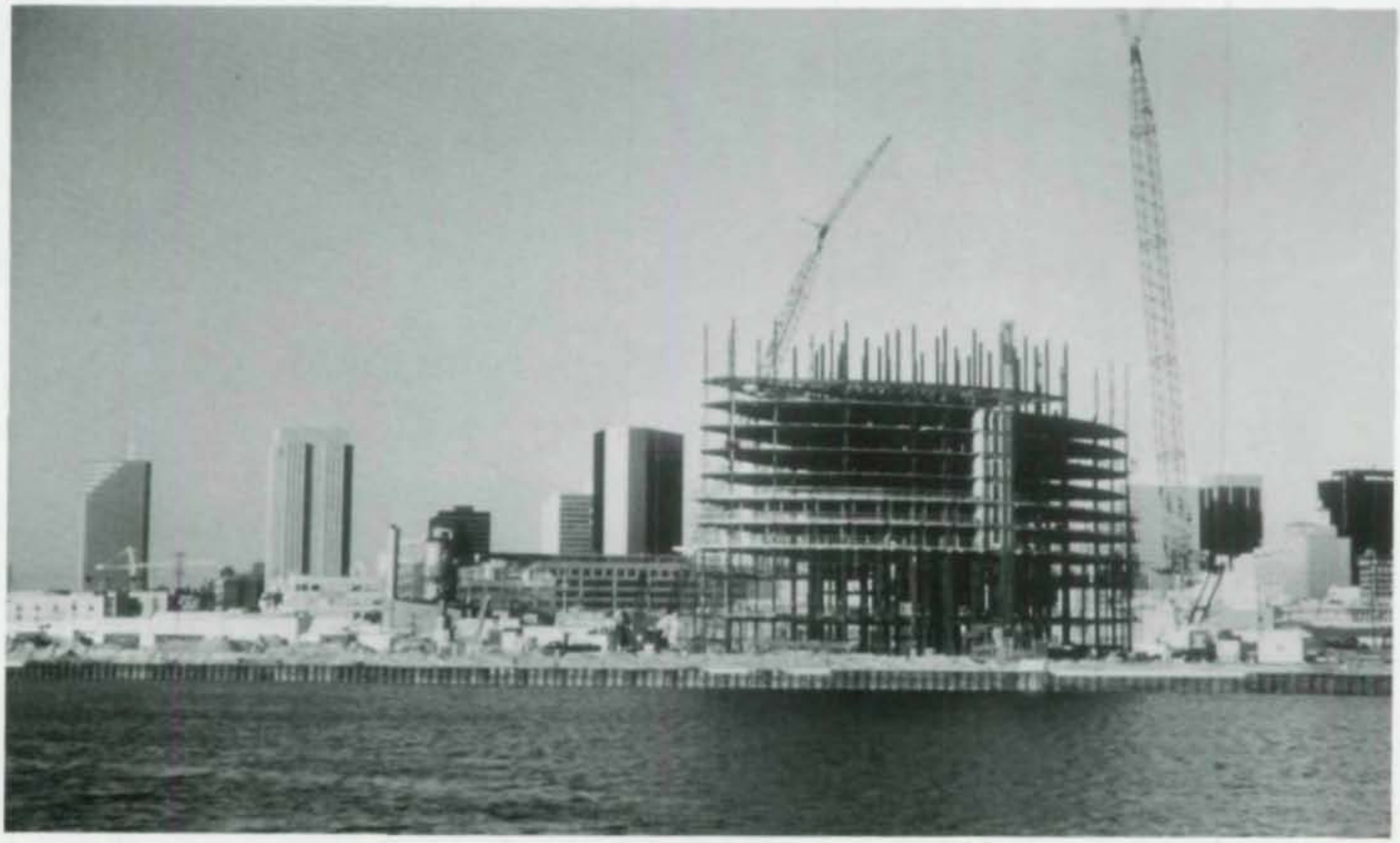
The coordination effort between the steel erection and placing of the pre-cast panels was an important part of the design concept. Pre-cast panels served as the planking, trailing two stories behind the rapid steel erection.

The unique shape of the Hotel Inter-Continental, which has already become a recognizable landmark, together with the success of the hotel as a destination resort are proof that the transformation of San Diego's vibrant waterfront is working to benefit the people and the city. □

Architect/Structural Engineer
Hope Consulting Group
San Diego, California

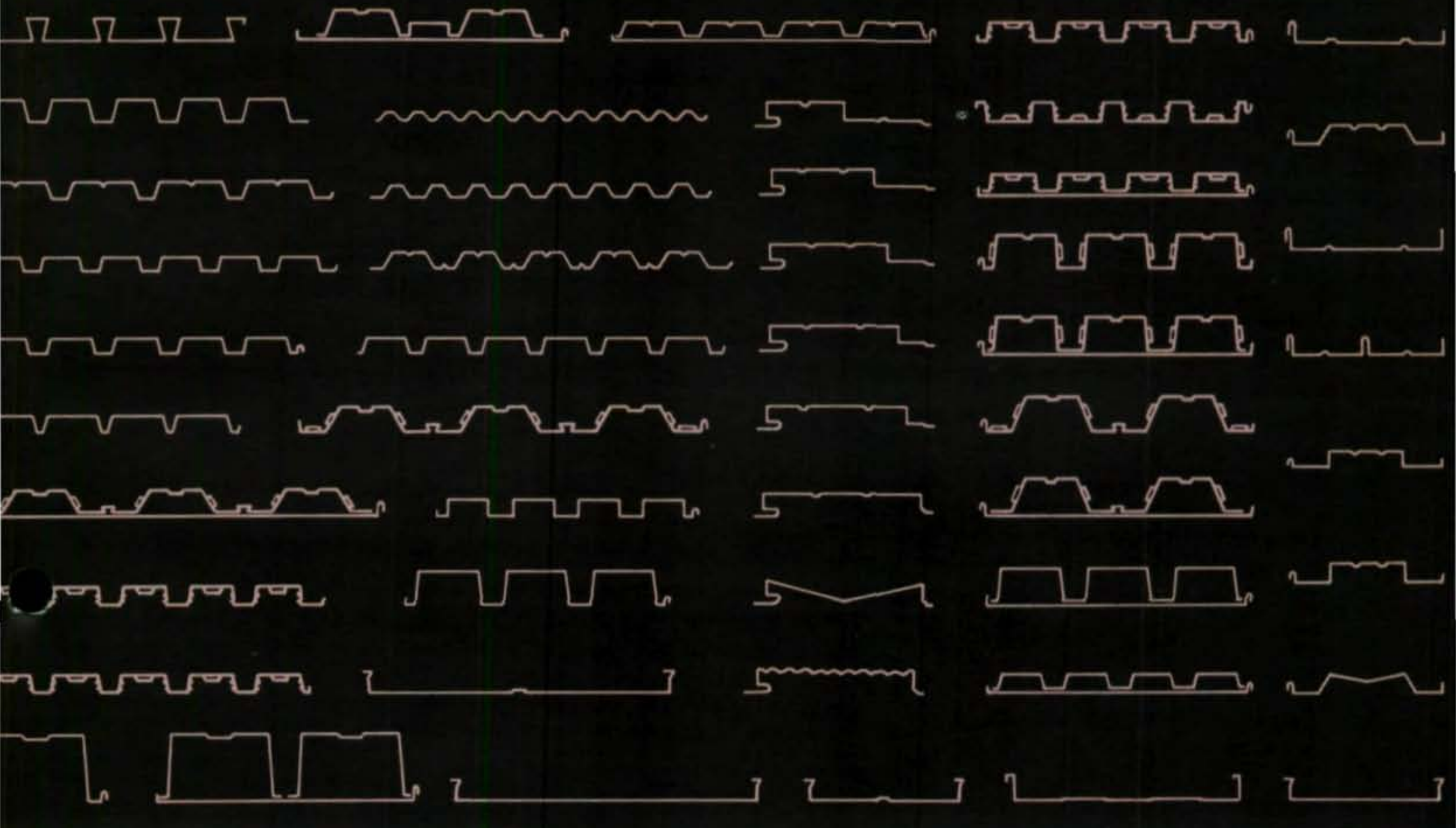
General Contractor
HUNTCOR, Inc.
Phoenix, Arizona

Owner
Pacific Landmark Hotel, Ltd.
La Jolla, California



Steel was choice for framing of $125-million resort hotel. Tower's unique shape required extensive analysis to determine wind forces, and sun studies to provide maximum room exposures.

STEEL FLOOR DECKS, ROOF DECKS, CELLULAR RACEWAY SYSTEM, SIDING AND WALL PANELS.



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