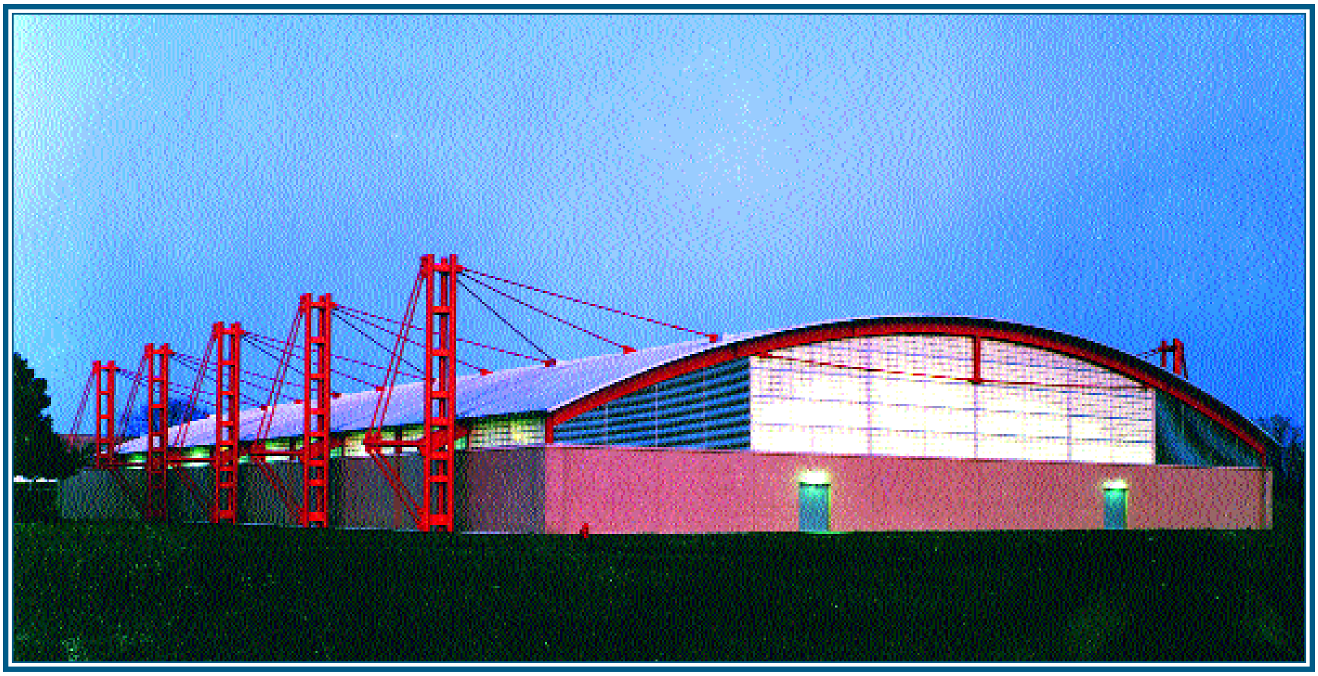
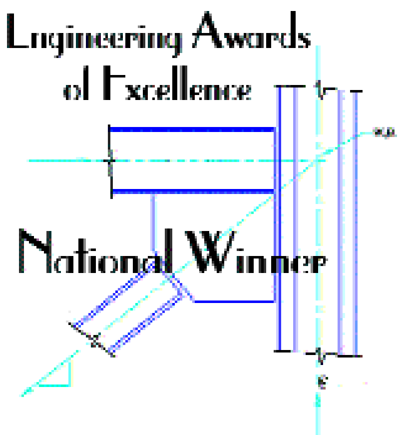
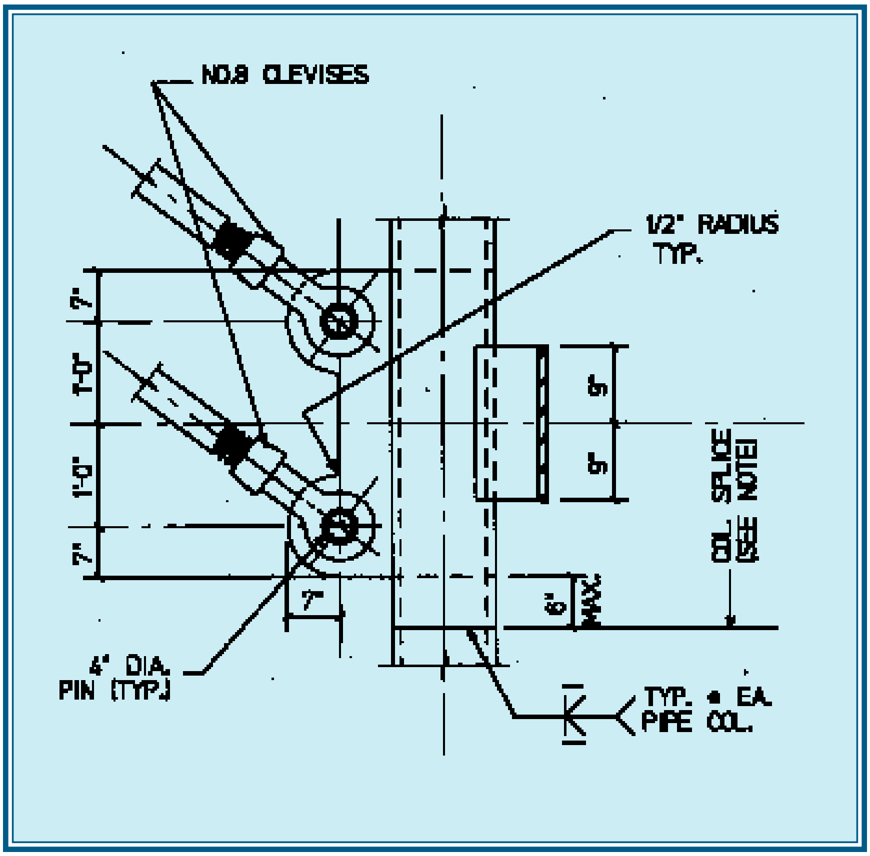

Niles West High School
Field House

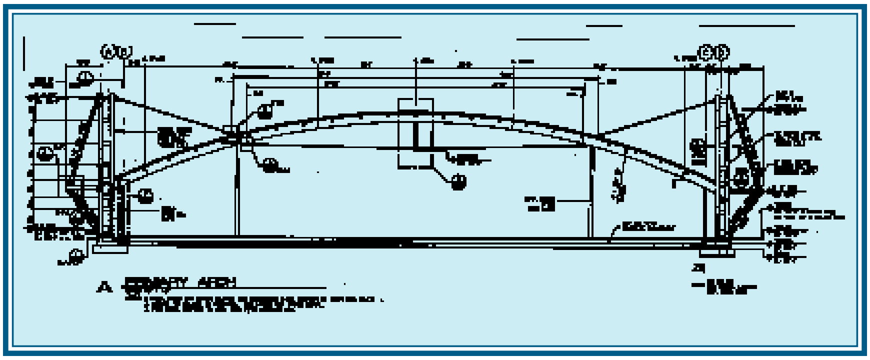


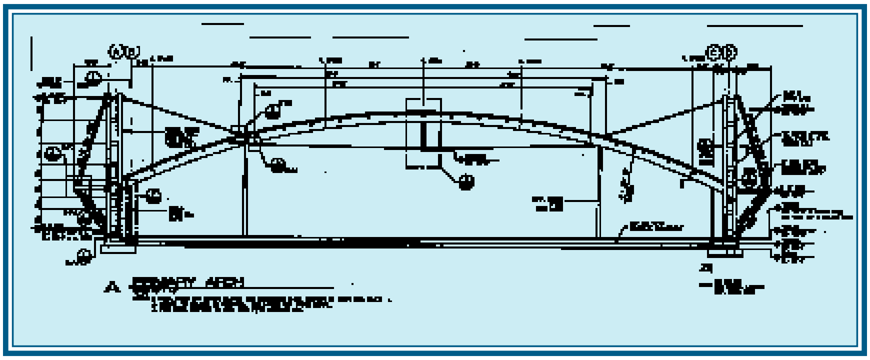


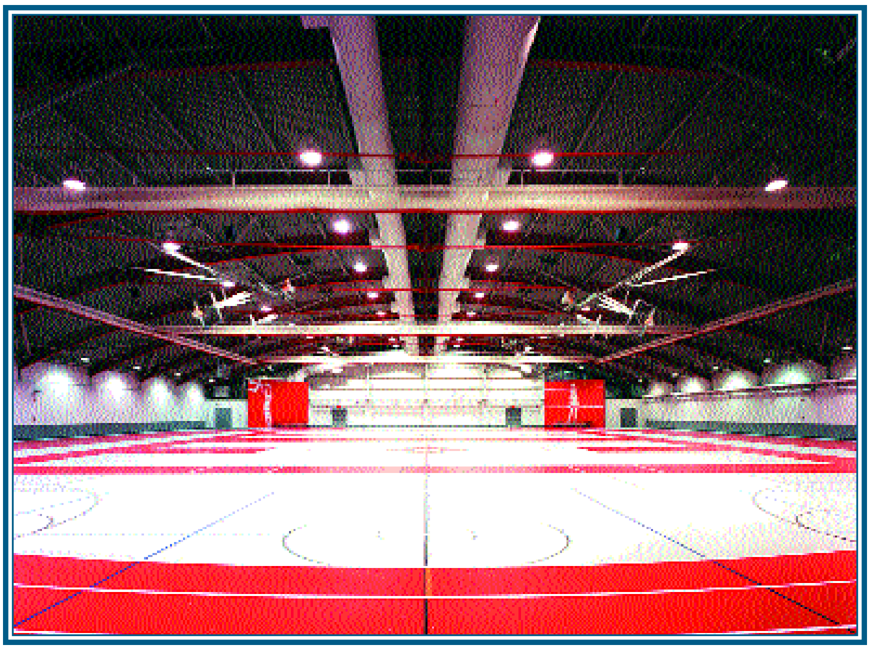


Designed to accommodate the physical education and athletic needs of a burgeoning student population, the 40,000-sq.-ft. Niles West High School Field House includes four teaching stations, a competitive 160-meter track and four full-size basketball courts, which allows several sporting events to take place simultaneously.

The design of the building was driven by programmatic and structural requirements. Perhaps the greatest challenge was to sat-







isfy the School Board's desire to minimize the volume and the new building and thereby reduce heating costs. The solution was a curved roof supported by exterior structural steel elements and clear-spanning 170' over the field

Judges Comments

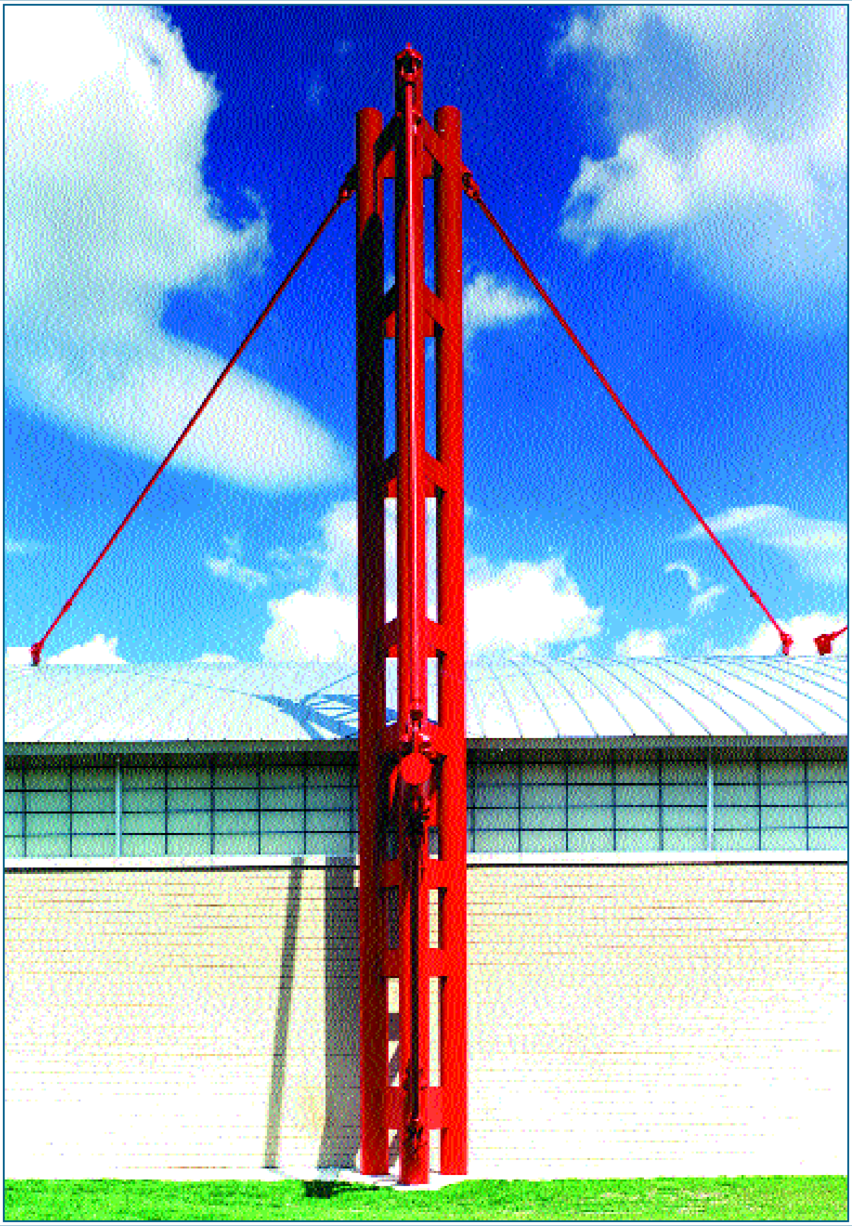
The combination of a steel arch, an unusual thrust tie system and the exterior columns yields a very elegant solution. A highly aesthetic yet cost effective response to the need for column free space.

house's open floor. Supporting the structure from above minimized interior obstructions while a curved long-span arch provided the required vertical clearance of a peak of 35' above the basketball and volleyball activities while providing a minimum height of 12' over the track. The curved structure eliminated approximately a quarter million cubic feet of unnecessary volume, which translates into an annual energy savings of about $27,800.

The structure includes five primary arches and six secondary arches. All of the arches consist of curved W30x99 wide flange members.

The primary arches tie into columns consisting of three 12" diameter hollow structural sections in a triangular arrangement. The column design was chosen both for aesthetics and because the design provided the necessary stiffness. Heavy W12 members encased in concrete run under the building and tie the tower bases together, closing the forces full circle and eliminating the need to accommodate the large horizontal forces in the foundation system. The alternative, according to a soil consultant, would have been to use batter piles, but they would have been much more expensive.

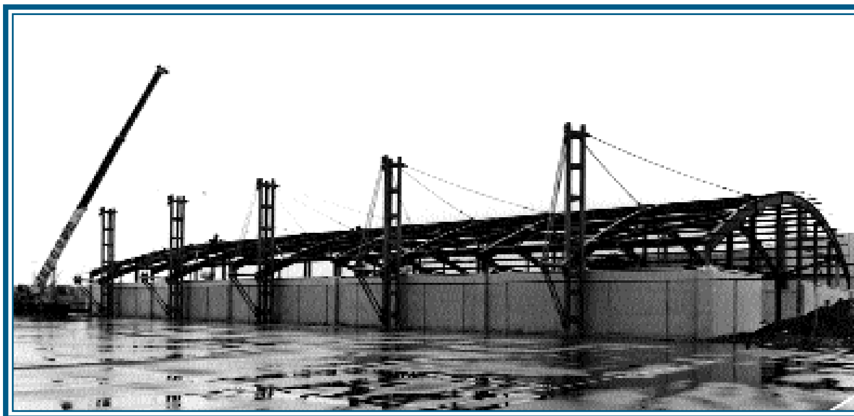
The thrust in the secondary arches is transferred to the tower columns through a truss, consisting of W12x40 members, in the "plane" of the roof. Transferring forces through the truss allowed the designer to cut the number of column towers in half and instead of having columns at each arch they could be at every other arch. Not only did this reduce costs, but it created a more open and attractive design, both light and dynamic in appearance.

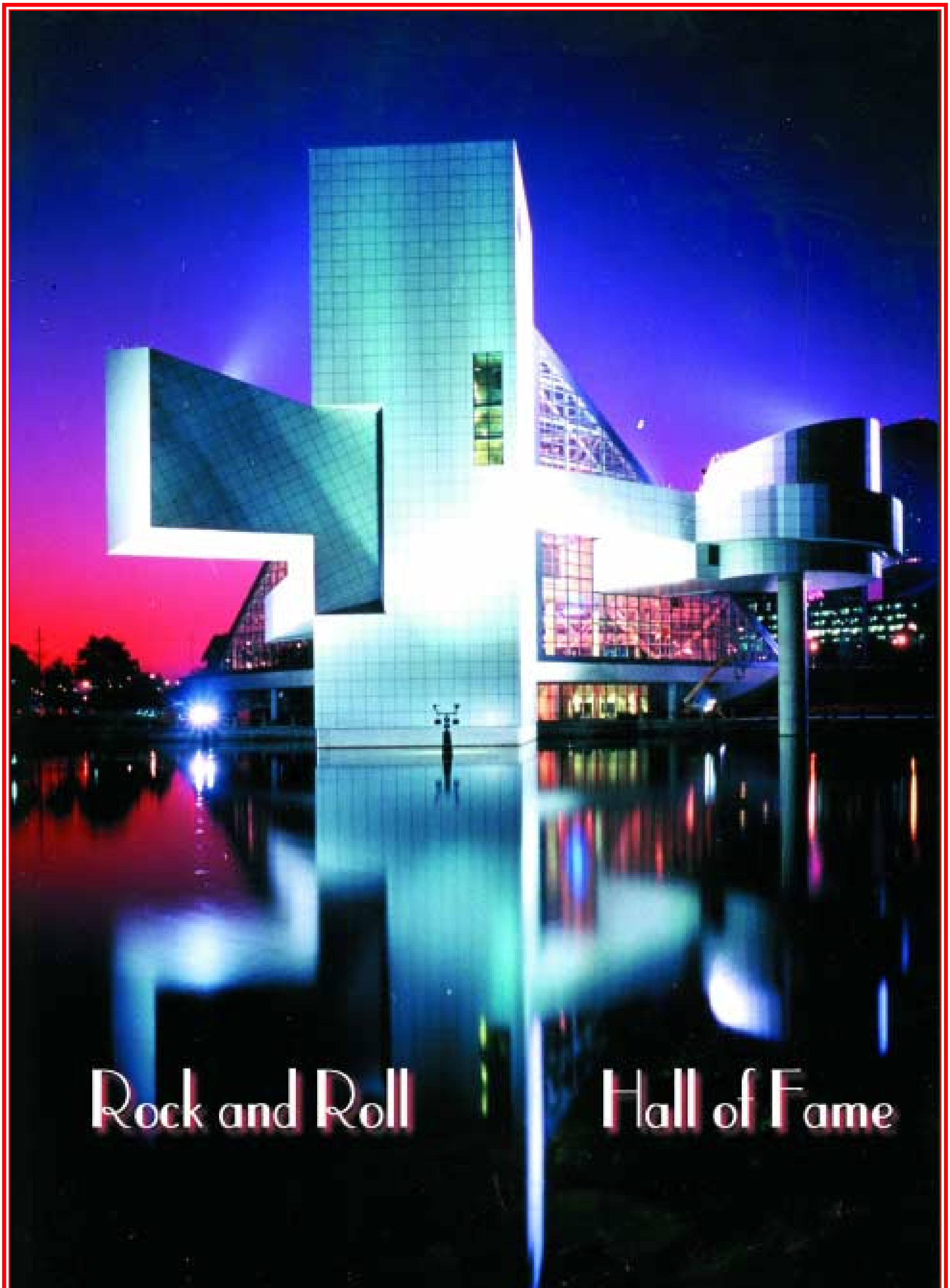


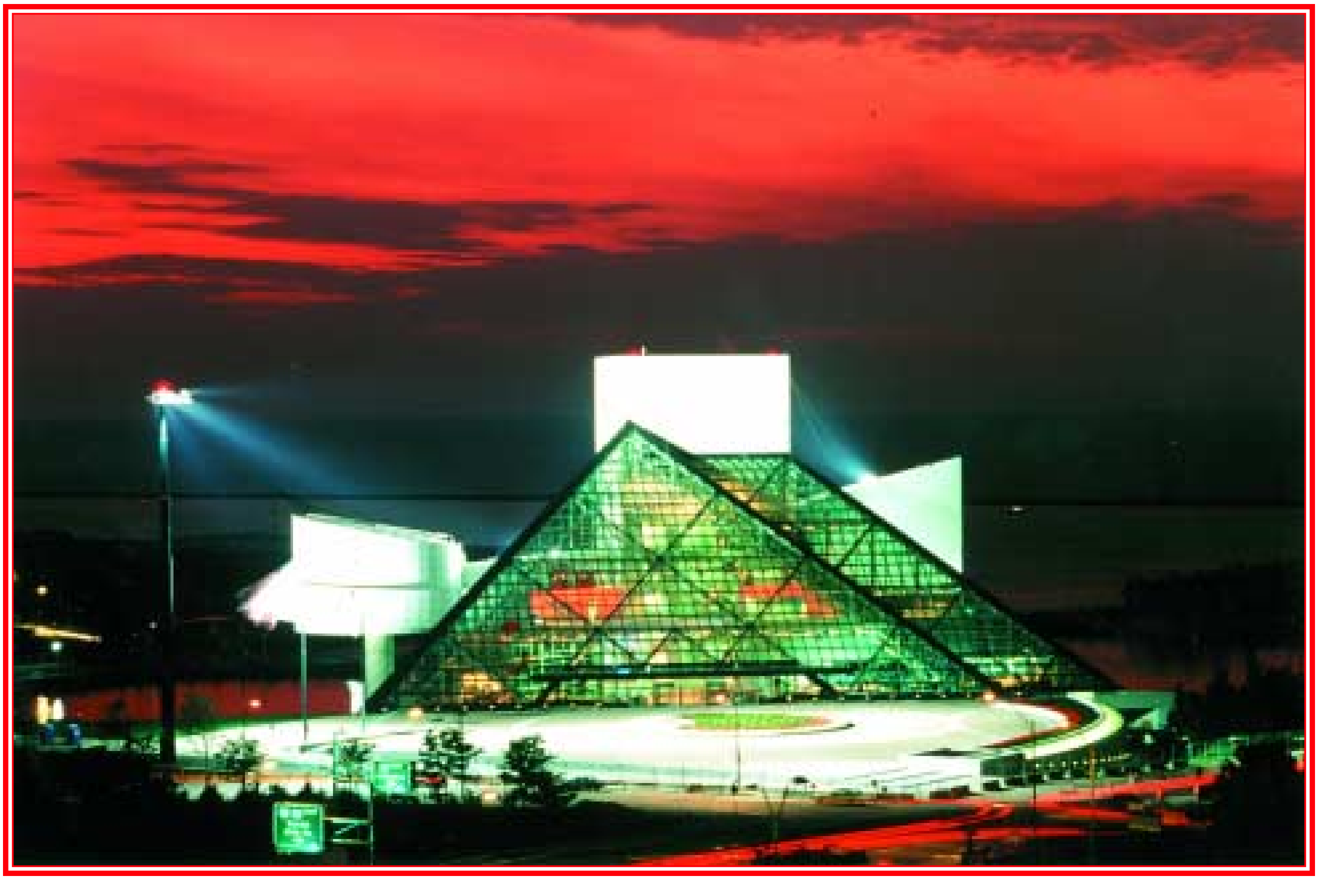
Project Team

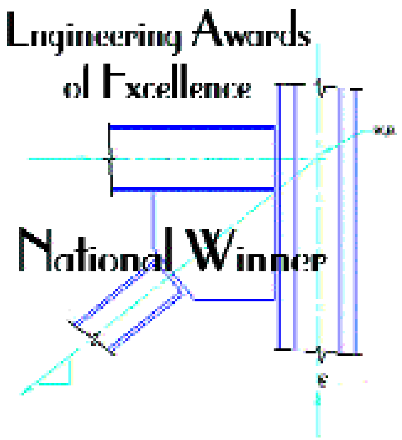
Architect/Engineer:
OWP&P Architects, Inc., Deerfield, IL

Contractor:
Boller Construction Co., Inc., Waukegan, IL




Rock and Roll
Hall of Fame



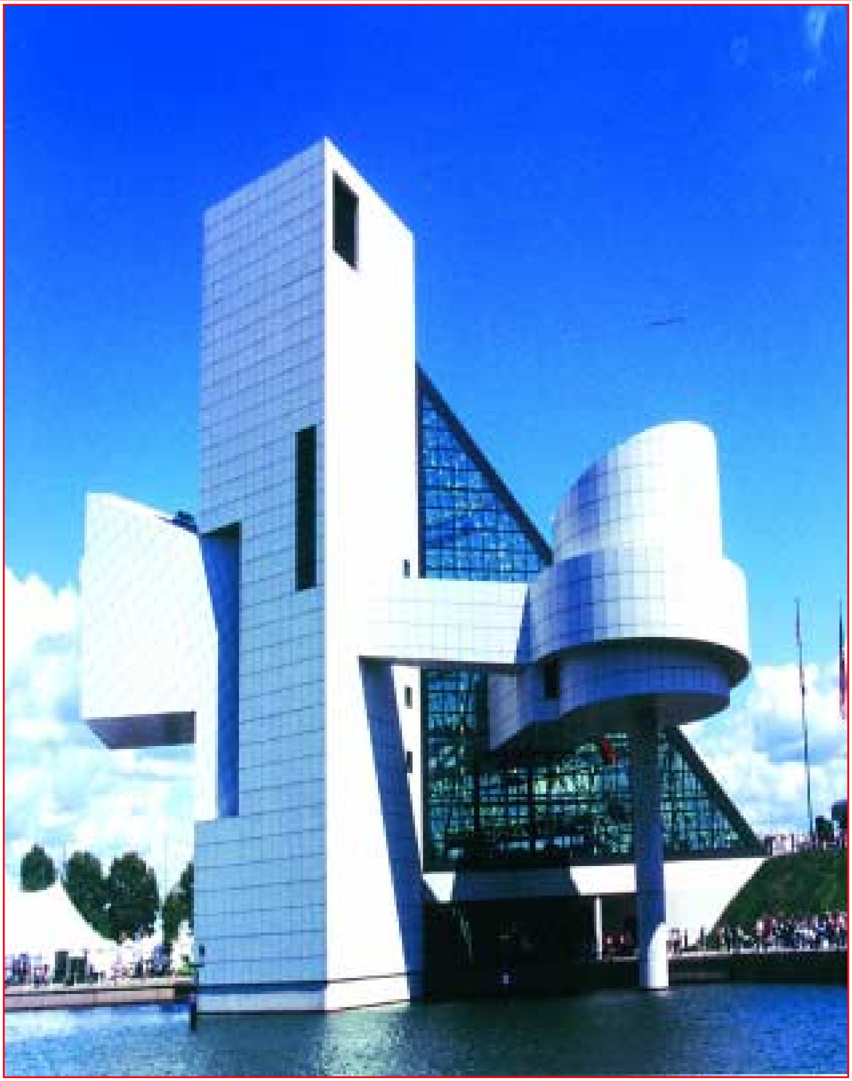


Rising boldly from the shores of Lake Erie—with part of the building actually extending out above the water—the new Rock and Roll Hall of Fame is a vital part of the new cultural and recreational area being developed along the Cleveland waterfront. In addition to the Hall of Fame, the 150,000-sq.-ft. project houses 50,000 sq. ft. of exhibition space for rock and roll memorabilia, a grand public atrium, theater, radio broadcasting studio and other support facilities.

Even before its opening, the building received national attention for its unusual architecture and exposed structural system, a design which, in the words of architect I.M. Pei, "echo(s) the energy of rock and roll." The design's energetic expression is readily apparent, with an unusual geometric configuration and portions of the building seemingly exploding outward from a central tower core. Needless to say, the complex geometry presented numerous structural challenges.

The desire for a signature structure resulted in a design that can be divided into five distinct parts: a sloping glass tent; central tower; cantilever theater wing; circular exhibit wing; and underground exhibit areas.

The glass-enclosed public space of the tent provides a dramatic entrance to the Hall of Fame from the plaza. The sloped surface of the tent literally leans against the tower beyond, with two vertical glass walls complet-



ing the enclosure. Structural steel pipes and tubes provided the architecturally expressed supporting structure, while the sloped surfaces are supported by an elegant system of gently tapering bowstring trusses. The interior of the tent is filled with light: balconies, stairs, bridges and escalators crisscross the space, bringing color and animation to the public spaces.

The sloped surface of the tent rises at a 45 degree angle to a height of 135' above the promenade level and is divided into two parts. The larger, triangular portion is in front of and 13.5' above the smaller parallelogram-shaped portion. Together, the sloped surfaces cover an area more than 270' wide. At the intersection of the two sloped surfaces, the tent is supported by a sloping pipe truss spanning 200' from one of the four corners of the tower down to the plaza. The top chord of this ridge truss is at the level of the triangular section of the tent; the bottom chord is at the level of the parallelogram.

The sloped glass surface is supported by a space frame grid of 16 bowstring pipe trusses varying in depth from close to zero at their ends up to a maximum of 6.5' at midspan. The bowstring trusses are oriented perpendicular to the sloped surface where they can most efficiently resist wind loads. The top chords form a planar surface, while the curve of the bottom chords was chosen by considering the deflected profile under a uniform load of a membrane having the shape of the sloped surface. The shape of the bowstring trusses produces an inherently efficient design because the greatest structural depth is provided where the most strength and stiffness are needed.

Judges Comments

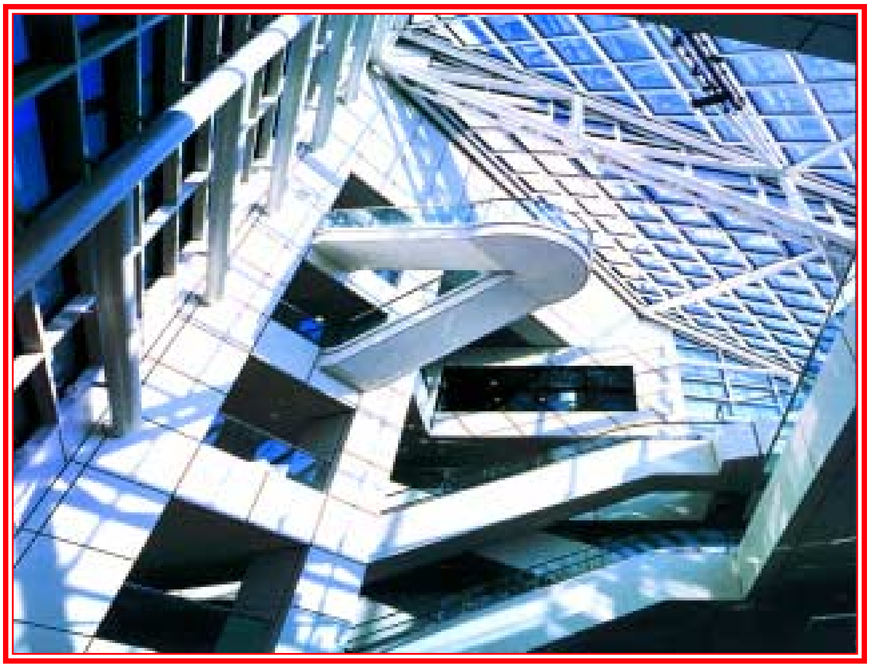
The complex geometry and variety of the architectural requirements provided the engineers with a unique opportunity to show the versatility of steel.

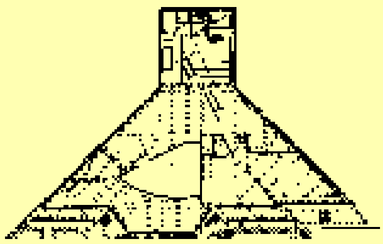
Design of the tent structure was largely governed by wind deflections. To control deflections of the ridge truss in the most efficient manner, its connections to the tower structure and to the plaza were detailed to achieve continuity. This resulted in approximately a fivefold reduction in deflections, and permitted the use of lighter steel sections that would be needed for the equivalent simply-supported truss.

The continuous connection at the base of the truss is interesting in that it provides moment continuity between the steel and the concrete structures. Continuity is provided by creating a couple between the back leg (compression) and the leading edge (tension) of the truss. The compression force in the truss chord is delivered to the reinforced concrete construction at the plaza level through a steel casting resting on a 9"-diameter spherical bearing. The tension force is resisted by a 3.75"-diameter steel bar anchored 16' into the wall below. These connection details are both economical and effective in providing a fixed-ended connection between a steel truss and reinforced concrete construction.

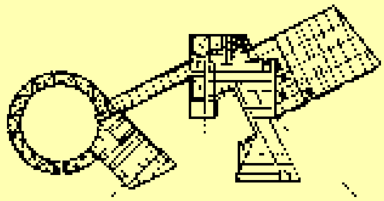
The tent structure also is unusual in that structural steel tubes were used for the mullions, rather than more conventional aluminum mullions. Tubes were used because the structural demands on the mullions are considerable: the system was designed to span across a triangular panel 38' high and 54' wide for 100-year wind loads. An added advantage of the steel tubing is that it gives a seamless architectural appearance to the underside of the tent structure.

With the huge expanse of sloped glazing rising from pedestrian level, even small out-of-tolerances would be clearly visible. Consequently, unusually stringent erection tolerances were specified. The curtain wall's slope complicated matters, however, since the structure tends to deflect out of position as the

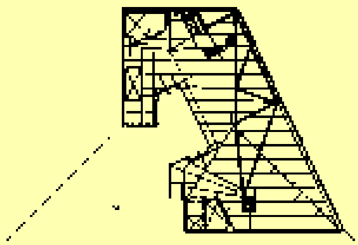




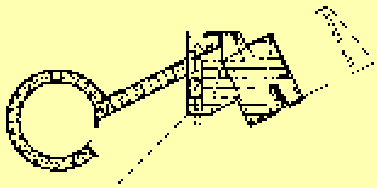
GROUND FLOOR



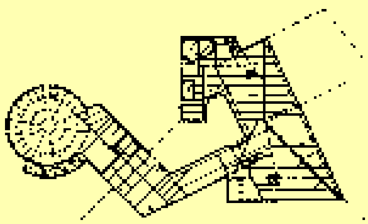
FOURTH FLOOR



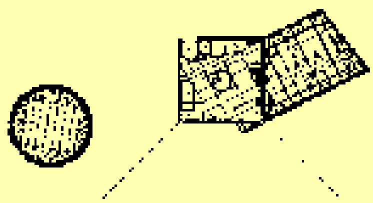
SECOND FLOOR



FIFTH FLOOR



THIRD FLOOR



SIXTH FLOOR AND HALL OF FAME

weight of the curtain wall is gradually applied. The requirement for strict tolerances led to an innovative system of cambering and pre-deflecting the trusses prior to installing the steel tube mullions and glass. The idea was to provide the curtain wall workers with a sloped surface that was essentially a true plane prior to the installation of the mullions and glass, and that would not deflect form this position as the weight of the curtain wall was gradually applied during installation.

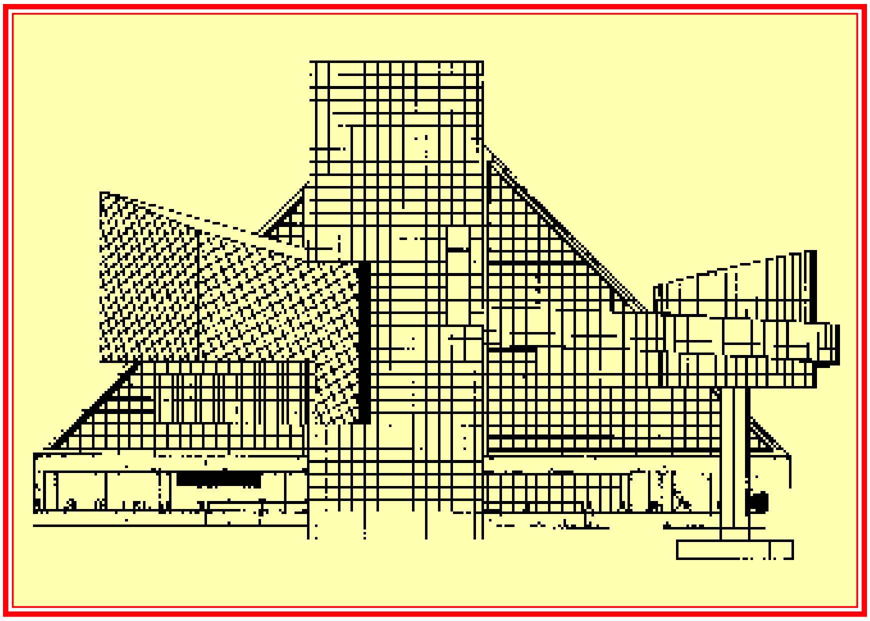
The bowstring trusses were fabricated with upward camber to compensate for the full dead load. The trusses were erected complete and then ballast was hung from predetermined locations on the truss with the weight of the ballast equal to the weight of the future mullions and glazing. The ballast was suspended slightly above the ground and the space between ground and ballast was shimmed just enough to close the gap without transferring any of the ballast weight to the ground. With the total load on the trusses equal to the full dead load, the cambered trusses deflected such that the top chords formed a nearly planar surface.

As the weight of the mullions and glass was added, the weight of the ballast gradually and automatically shifted from the trusses to the ground, without further deflection of the structure.

Another structural challenge was the 162'-tall, six-story central tower, which rises dramatically from the waters of Lake Erie. In addition to housing the HVAC and other operational systems, the steel-framed tower provides ground exhibit space, a radio broadcast studio and the museum's café on floors that extend out from the tower proper into the atrium. The actual Hall of Fame is housed in a cubic room near the top of the tower. From the east side of the tower, the 175-seat theater wing cantilevers 80' out over the water. The tower is founded on steel piles that extend 100' below to a single concrete pile cap.

To the west of the central tower, a drum-shaped circular exhibit hall perches on top of a single 10'-diameter concrete column rising from the water. Access to the circular exhibit space is via bridges from the tower and tent. Like the tower, the circular exhibit wing is founded on steel piles; however, the single pile cap is hidden completely underwater.

Much of the project's engineering challenge emerged from dealing with the buildings unusual shapes, which often required special connections not often encountered in more conventional steel projects. The circular exhibit wing is a prime example



of the difficult design requirements presented by this job. In addition to having to support the 75'-diameter steel-framed exhibit hall on top of a 10'-diameter concrete column is the problem of the unbalanced loading on the exhibit hall, which resulted in an overturning moment at the top of the column.

The solution was to wrap the concrete column with a 1½"-thick steel plate anchored into the concrete with Dywidag threadbars to resist the overturning moment. Steel plate girders are welded to this ring and cantilever radially outward from it. The remainder of the steel framing is supported by plate girders.

Another challenge was the design of the cantilevered theater wing. The wing cantilevers more than

Project Team

Structural Engineer: Leslie E. Robertson Associates, New York City

Architect: Pei, Cobb, Freed & Partners, New York City

Assoc. Arch: Robert P. Madison Intnl., Inc., Cleveland

Contractor: Turner Construction Co., Cleveland, in assoc. Colejon Corp., Choice Construction Co., Inc., & Bradley Construction Co., Inc.

80' from a tower only 60' in width. In addition, the wing is skewed in plan with respect to the tower and the top and bottom of the cantilever wing do not correspond to framed levels in the tower.

The solution included the use of full-depth cantilever trusses in the walls of the theater wing. Partial support is provided at the south wall of the cantilever wing by a story-high cross truss, which spans between the northeast corner of the tower and a column in the glass wall of the tent.

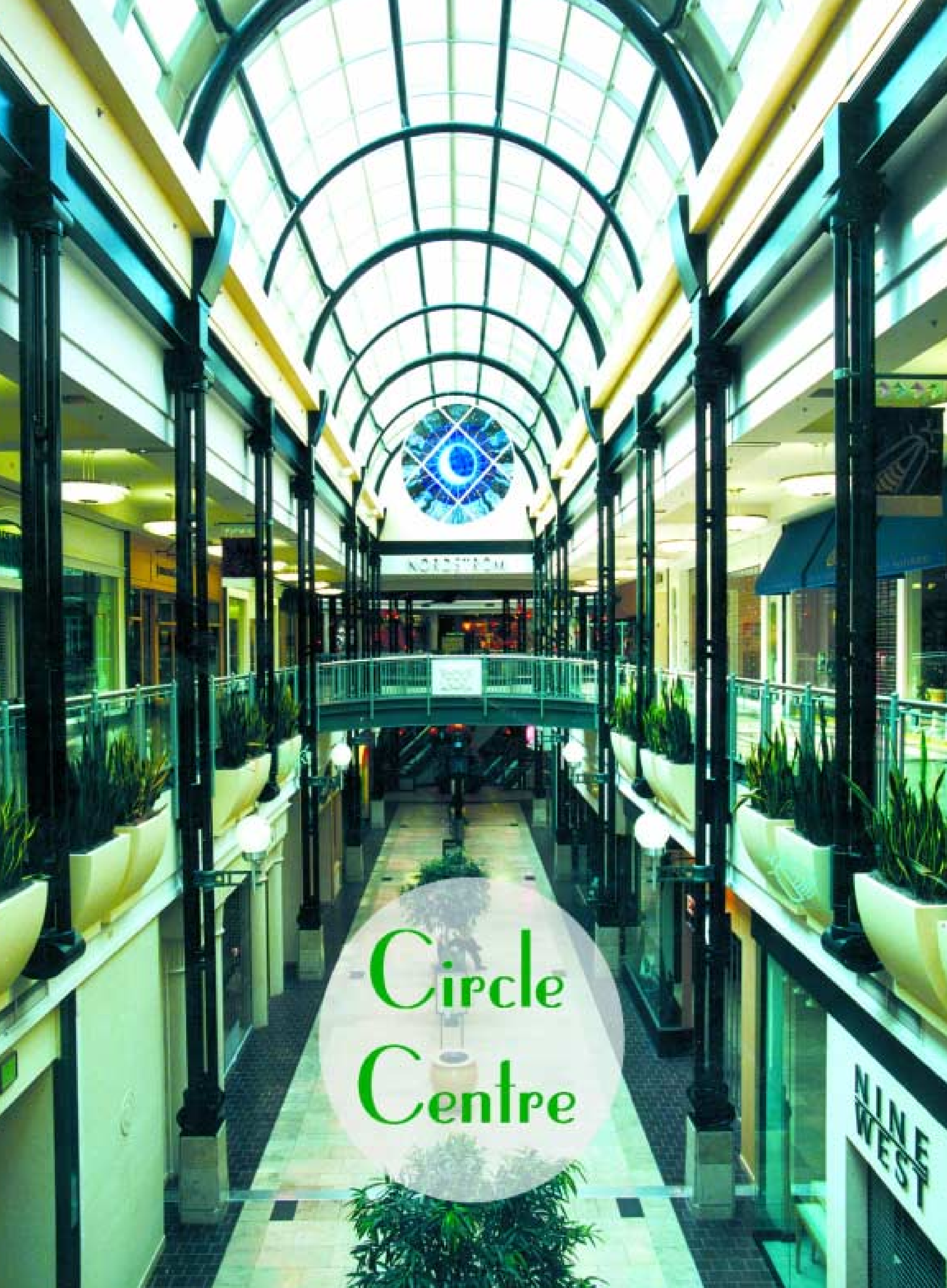
The tension and compression components of the overturning moment are resisted by the diaphragms of the sixth floor and second floor, respectively. At the sixth floor, the concrete slab is cast on a steel plate diaphragm. This diaphragm is used to distribute the cantilever truss reactions to braced frames located around the perimeter of the tower since a direct connection to the braced frames would have been difficult on account of the skew between the theater wing and the tower. In addition, the substantial eccentricity between the location of the cantilever work point and the elevation of the sixth floor diaphragm had to be resolved in the same connection detail.

At the second floor, there are large architectural openings in the floor where the compression load from the cantilever truss is delivered. To work around these architectural constraints, a horizontal truss was built into the floor framing to span past the openings. Similarly, numerous architectural openings through the south wall of the tower, in the area most critical to resisting the loads from the cantilever wing, meant that braced frames were not acceptable in this area. To work around this, a substantial moment frame system was provided around the openings to provide stiffness and strength requirements.

The cantilever wing was even more of a concern from a stiffness point of view rather than strength. Even under dead load, the overturning moment from the cantilever wing tends to induce significant horizontal side sway in the tower structure. With stringent architectural tolerances for the construction of the tent's structural and glazing systems—which are supported directly by the tower—it was desirable to erect the tower with minimal built-in side sway.

In the interests of structural efficiency, the engineers took full advantage of all available sources of stiffness. The significant stiffness of the tent structure was used to limit the side sway of the tower, and even the stiffness of the circular exhibit hall, which is connected by a bridge to the tower, was taken into account. Relying on other sources of stiffness to reduce construction-phase deflections of the tower meant specifying that steel erection and concrete pours at the cantilever wing be postponed until other portions of the structure had been completed. Additionally, the tower was horizontally cambered to the west to reduce some of the side sway effects.

The careful attention to detailing and coordination with the architectural systems paid off: despite the complexity of the project, erection proceeded smoothly and quickly and the building was completed on time and on budget.


Circle
Centre
NORDSTROM
NINE
WEST

Engineering Awards of Excellence

Regional Winner

Occupying 3½ city blocks in downtown Indianapolis, Circle Centre contains more than 970,000 sq. ft. of retail, parking and entertainment space, as well as a series of walkways connecting pedestrians to existing hotels and other facilities in the heart of the city. But what makes the project unique, both in its architecture and engineering, is its preservation of many exterior facades and surrounding structures: The new construction had to be "shoehorned" in, around and even over various existing historic structures and facades.

Fortunately, much of the project was fairly straightforward, with typical bays of 30'x30', though many cantilever conditions existed around the perimeter where the project butts against existing structures. The floor system consists of a composite metal deck and a concrete slab on composite structural steel beams. The most efficient lateral system consisted of bracing the building in one direction and using moment connections in the other. The columns, as designed for gravity loads, provide sufficient stiffness for moment frames as long as they are all oriented in the same direction. Load and Resistance Factor Design was used for the project, which resulted in substantial material savings. A total of 4,500 tons of structural steel was used on the project, approximately 10% less than would have been required from a comparable design based on allowable stresses.

Composite shear walls were used in the braced direction, since potential bracing locations were limited and uplift, due to overturning, became a prohibitive issue for normal X-bracing.

The main challenge from the very

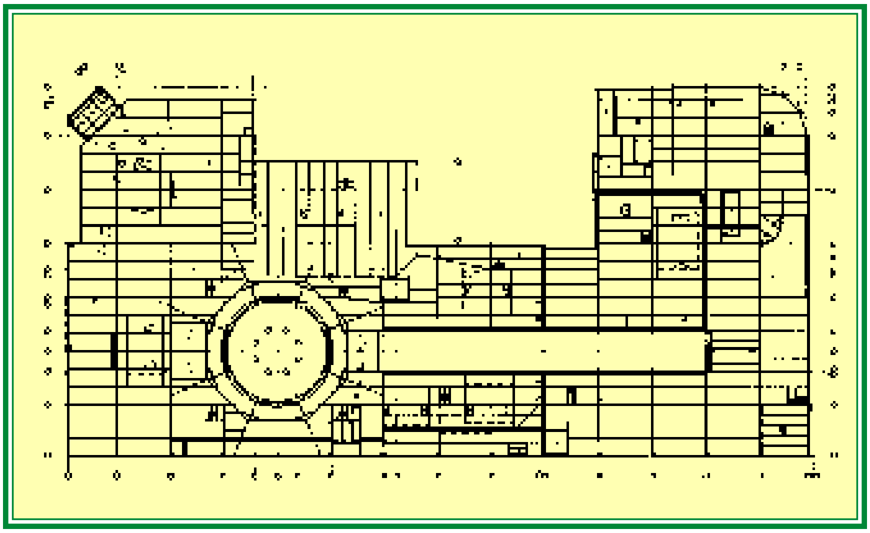
Judges Comments

The marriage of the architectural ornamentation with the structural elements leads to both an aesthetic and economical structure

beginning of the project was creating a framing system that could economically satisfy both the architectural and structural requirements of the project. Early on it was decided to leave much of the structural system exposed—a marriage of architecture and structure that produced tremendous cost savings to the owner. The architect came up with a triangular grouping of three 5" diameter pipes (8" in the main atrium) with vertical transitions for the main ornamental columns along the length of the concourse of the project. However, the configuration of the columns, along with varying properties along the height, dictated a special buckling analysis since no conventional means was readily available. Instead, the engineer created a spreadsheet program based on Newmark's finite difference method to calculate the varying moments of inertia in the many columns and to calculate the load-carrying capacity of the columns.

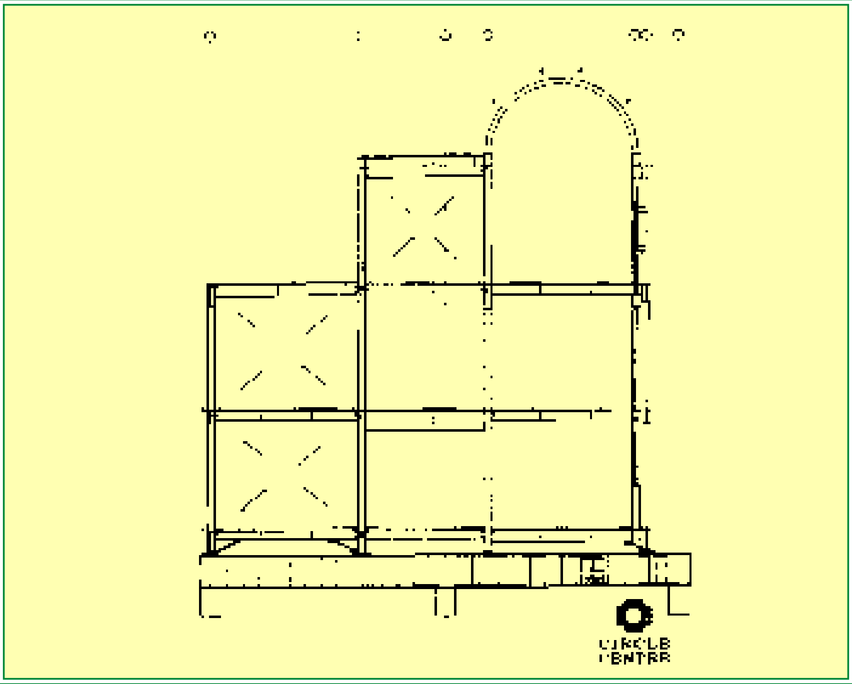
The central concourse splits the building into two halves. Stretching above the concourse is an arched skylight. Structurally, the skylight framing was insufficient to tie the two portions of the building together in a seismic event. Therefore, the pedestrian bridges stretching across the second level of the concourse were designed to serve this purpose. The bridges consist of two curved W18x60 members with shear connections designed for the axial loads necessary to connect the bridges with the building.

Another challenging "overpass" occurs above what one of the main entrances to the center. The owner desired a "transparent" look for the overpass without any visual obstructions in the center portion from diagonal truss members. As a result, conventional truss design methods were discarded and a hybrid truss/suspension bridge was created with two main diagonal tension members in the two outer panels, but none in the middle bay—similar to the concepts used for suspension bridge design. The design provides the desired openness, which was further emphasized by the exclusion of large gusset plates for the connections of the diagonals. Instead, the members were welded directly together.



One of the keys to the success of the project was the combination of the old streetscape with new retail space. In one section of the project, the historic St. Elmo/Ryder Building complex, the entire first floor of the existing buildings were left intact. However, rear portions of the second and third stories were removed while the front portions were left alone—thereby preserving the street scene. In addition, after foundation work was complete, a partial fourth floor was added. The new construction is supported on a truss over the first level. One end of the truss is supported on the existing foundations, while the other end is supported on a new foundation added to an adjacent alley.

Sensitivity in renovation also was important in the creation of a new atrium in the existing L.S.



Ayres building. The tenant required a new atrium space through the lower four levels. The size of the atrium necessitated the removal of four existing columns up to the fourth floor, with the columns remaining intact for the stories above. Four columns were removed and loads were transferred to adjacent columns via a W36 member cantilevering into the space. The system had the added benefit of not requiring temporary shoring.

The project has proved to be an overwhelming success, with more than 12 million visitors in the first year and sales in 1996 averaging $400/sq. ft., compared to an industry-wide average of $230.

Project Team

Engineer and Architect:
Fink Roberts & Petrie, Indianapolis

Construction Manager:
Geupel-DeMars, Indianapolis

Fabricator:
PKM Steel Service, Inc., Salina, KS

Cockrell Butterfly Center

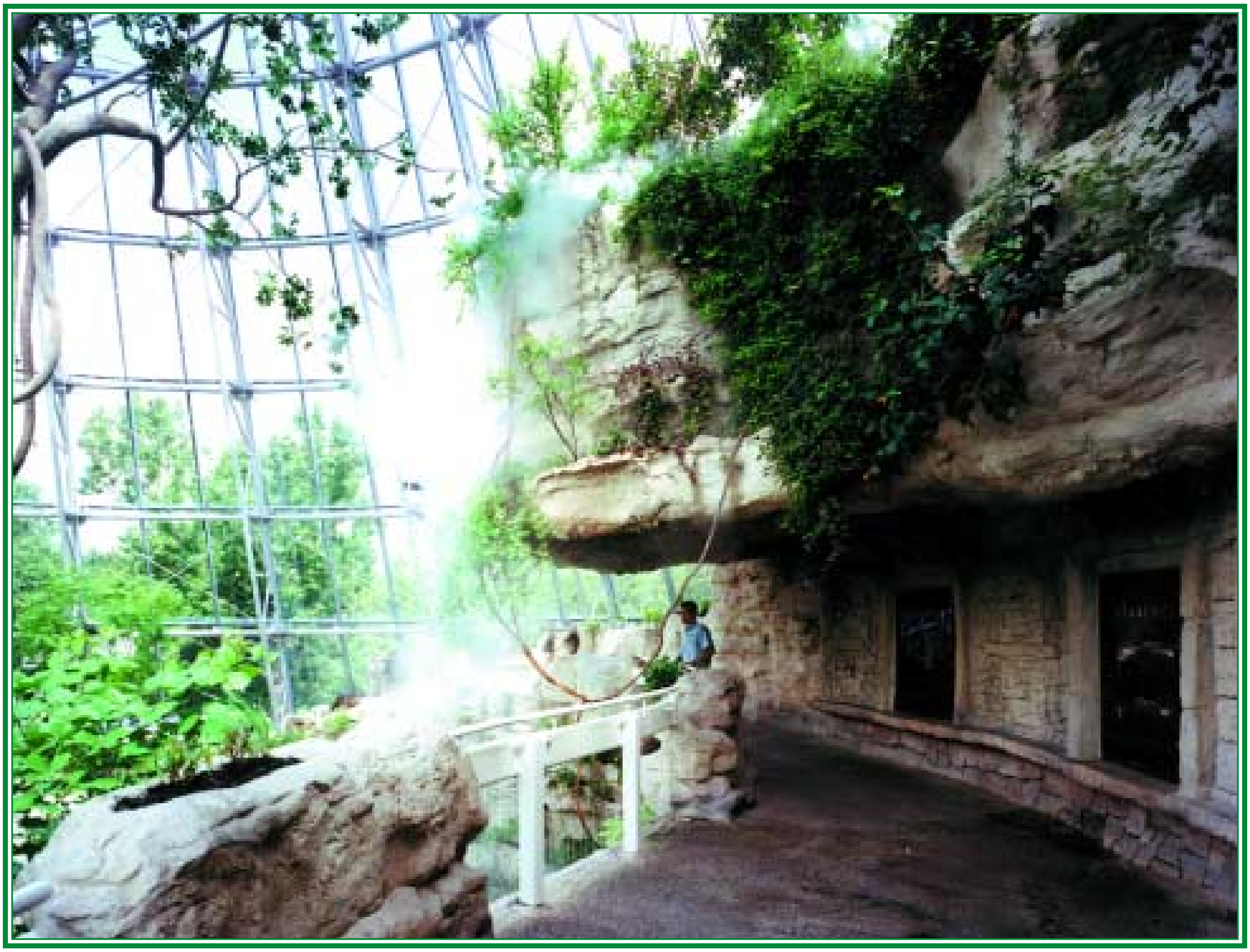
Houston Museum of Natural Science

Engineering Awards of Excellence

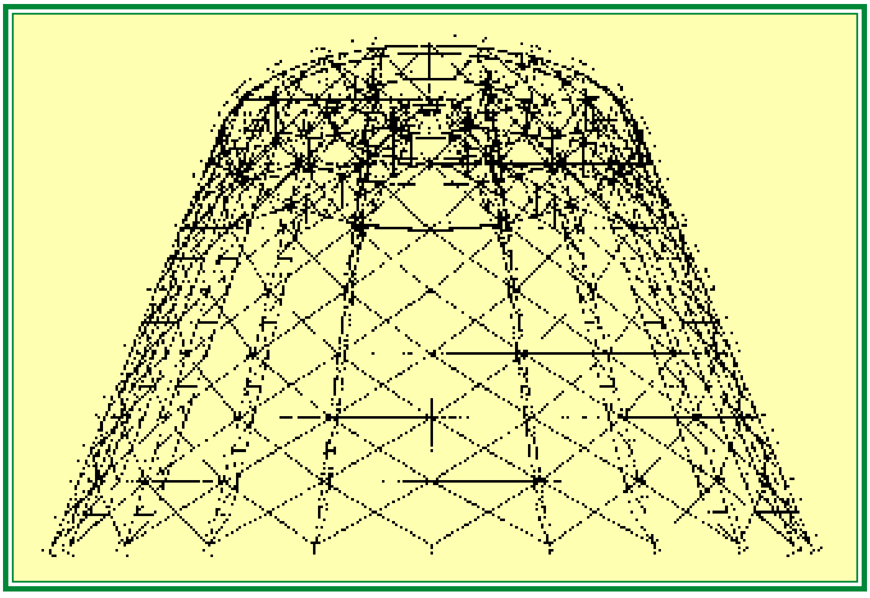
Regional Winner

Few creatures evoke more wonder and delight than the butterfly. Beautiful in their incredible variety of vivid colors and shapes, yet fragile as tissue, these amazing insects have an average life span of only two weeks—even under ideal conditions of tropical temperatures, high humidity and brilliant sunlight.

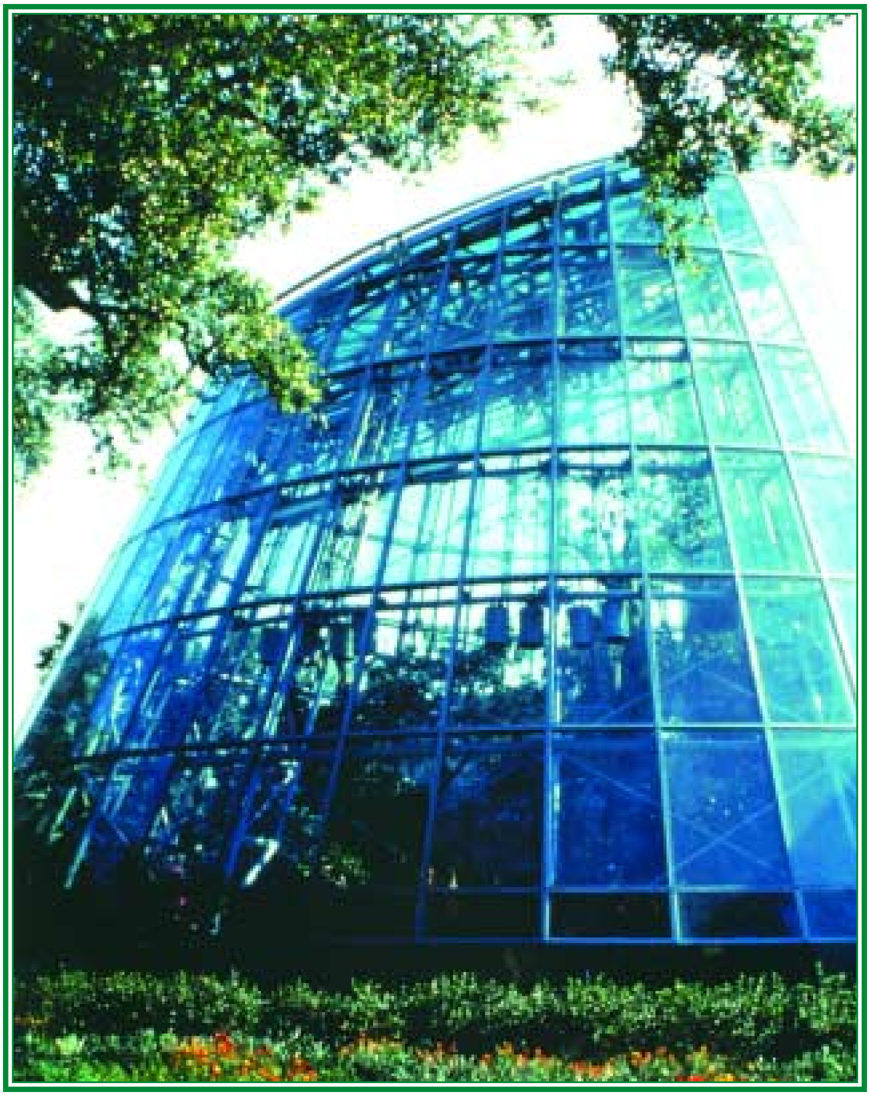
When the Houston Museum of Natural Science enlarged their facilities with a $19 million expansion program called "Face of the Future: Phase II," the centerpiece was a giant butterfly exhibit. As design began on the Cockrell Butterfly Center, it was clear that in addition to meeting the demands of the client, it was crucial that the center meet the needs of the butterflies. Each butterfly is purchased as a chrysalis at an average cost of $6 and raised by the Museum. The butterfly is a delicate species, surviving best in a lush tropical environment with an abundance of flowering plants, minimum temperatures of 80 degrees F and relative humidity of at least 70%. Because both butterfly flight activity and plant growth are



directly proportional to sunlight, careful selection of materials and shapes were crucial: An abundance of glass was necessary and projecting elements and sharp edges had to be avoided.



The center's exhibit space is a soaring, 75'-high truncated glass cone with a distinctive sloping glass roof. Chief among the structural challenges was to create a system that could withstand the Class 5 hurricane winds of the Texas gulf coast while not blocking sunlight or endangering butterfly flight patterns. The solution is an elegant system of vertical



trusses arranged radially around the perimeter of the glass enclosure. All truss chord and web elements were designed using shop-welded pipe members to improve reflectivity of sunlight, minimize maintenance requirements, and eliminate the sharp edges so dangerous to butterflies. The slender perimeter trusses, which are spaced on 16' centers at the exhibit base, utilize 4"-diameter pipes for the vertical chords and 2"-diameter pipes for the web members.

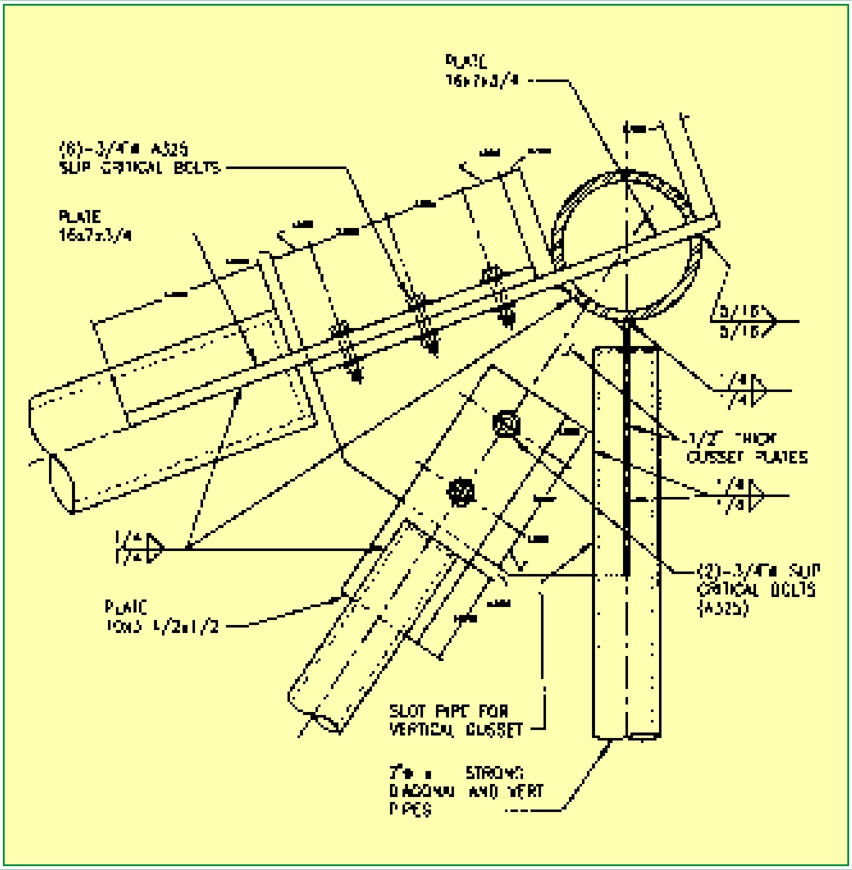
With the external chords connected just inside the glass with a graceful system of small tie rods, the truss system efficiently supports the weight of the exhibit and provides a stiff superstructure to resist hurricane winds.

An additional refinement makes the superstructure even more attractive and even safer for the butterflies. With the 3'-deep trusses arranged perpendicular to the glass enclosure, the inboard vertical chord members were unbraced. A more conventional engineering design would require supplemental intermittent bracing (in this case, at 9' centers vertically) to prevent lateral buckling of the chords, which are primarily compression members. However, such bracing, even if comprised of small diameter tie rods, would have created a dangerous maze of structure for the butterflies to negotiate in their natural flight paths.

Judges Comments

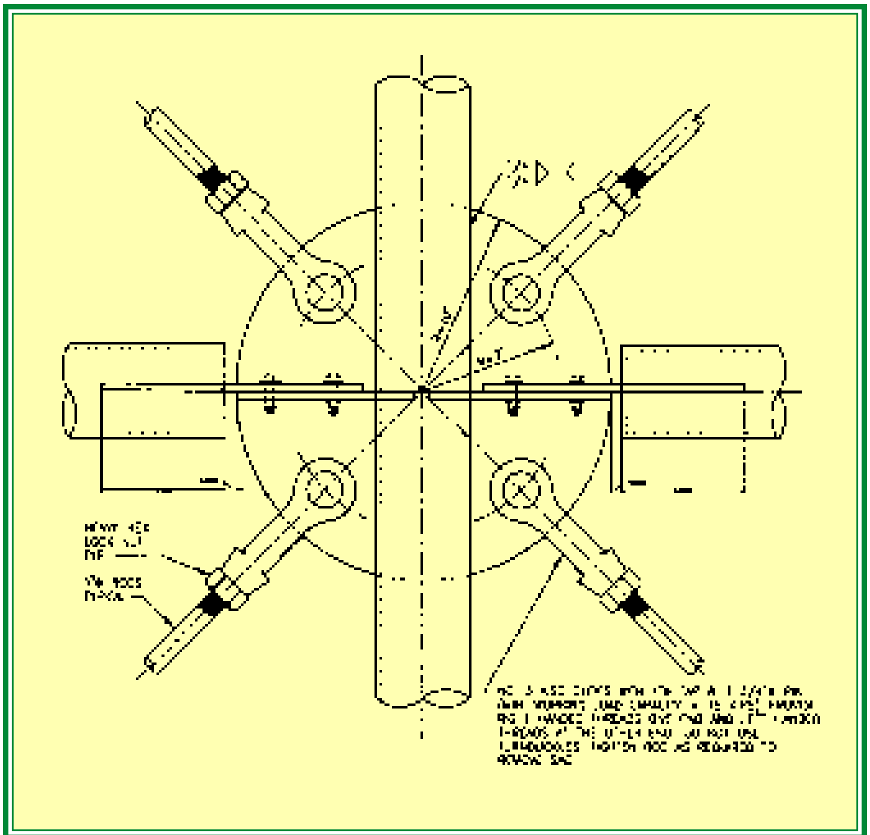
The building is an elegant and efficient design with a unique architectural shape and function. The exposed tension chord bracing not only is visually attractive, but also adds to the overall lightness of the framing. Also, despite the project's complexity, it came in under the original budget.

Instead, the structural engineer solved the problem by utilizing a structural bracing analysis technique more typically used in plate girder bridges. By stiffening the connections of the trusses along the perimeter glass, the designer created a tension chord bracing system that effectively braced the inboard truss chords. As a result, all supplemental lateral bracing of the inboard chord members was eliminated and the butterfly flight paths were kept uncluttered.



Because the structure supporting the slanted oval glass roof is integral with the overall exhibit superstructure, it also required engineering creativity. Sloping roof pipe trusses are arranged radially to connect with the perimeter wall truss system. To minimize the depth, weight and cost of the roof, a central 10'-diameter compression ring efficiently carries the roof loads and simultaneously provides an elegant roof pattern. The pipe sections used throughout the superstructure are highly efficient, resulting in an economical and graceful framework. In addition, their rounded edges are highly reflective and of minimal danger to flying butterflies.

All structural connections were carefully designed and detailed to satisfy all loads in an aesthetic way. The connections feature circular gusset plates, clevises, turnbuckles and high-strength bolts. Connections sizes were minimized to reduce shading.



The tropical humidity needed to extend butterfly life presented an additional structural design challenge. Because of the constantly muggy 80 degrees F air in the exhibit, long-term corrosion of the superstructure was a serious concern and special steel preparation and painting procedures were specified to extend the life of the structure and minimize maintenance. After fabrication, the structure was abrasive blasted, coated with inorganic zinc primer, and then painted with a coat of high-build epoxy paint and two coats of architectural finish paint. To speed erection and maintain the integrity of the shop finishes, the design call for all field connections to be bolted. As a final precaution against corrosion, all bolts, clevises, pins and turnbuckles were hot-dip galvanized prior to field painting.

The Center opened on schedule in July, 1994. Despite its complexity, it was completed for $5,847,710—more than 6% under the original budget. Since its opening, more than 350,000 visitors have toured the centers winding paths.

Project Team

Engineer:
Walter P. Moore and Associates, Inc. Houston

Architect:
Hoover Architects, a 3D/I Company, Houston

Contractor:
SAE/Spaw-Glass Construction, Houston

Project Manager:
Century Development, Houston

Los Angeles Convention Center Addition

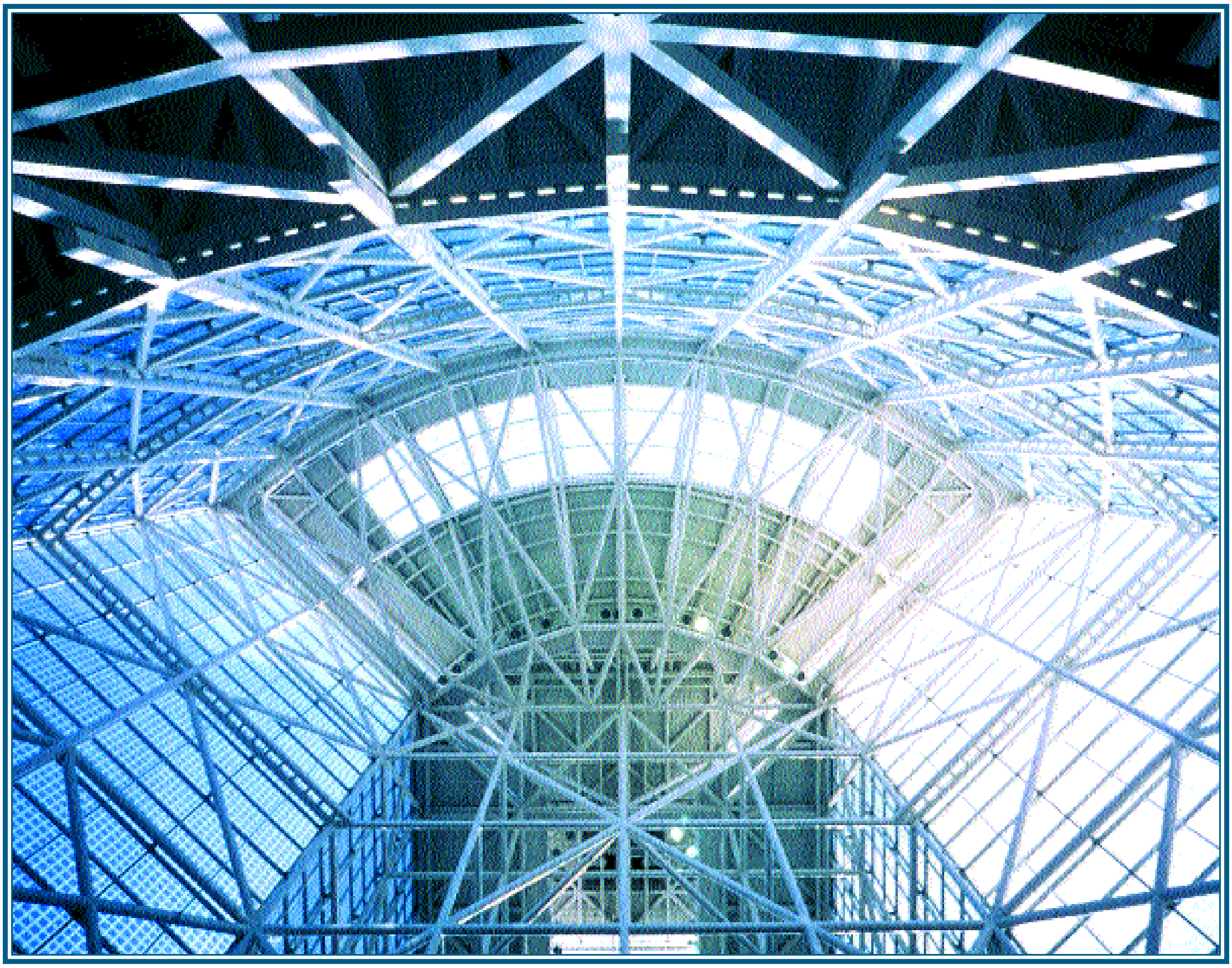
Engineering Awards of Excellence

Regional Winner

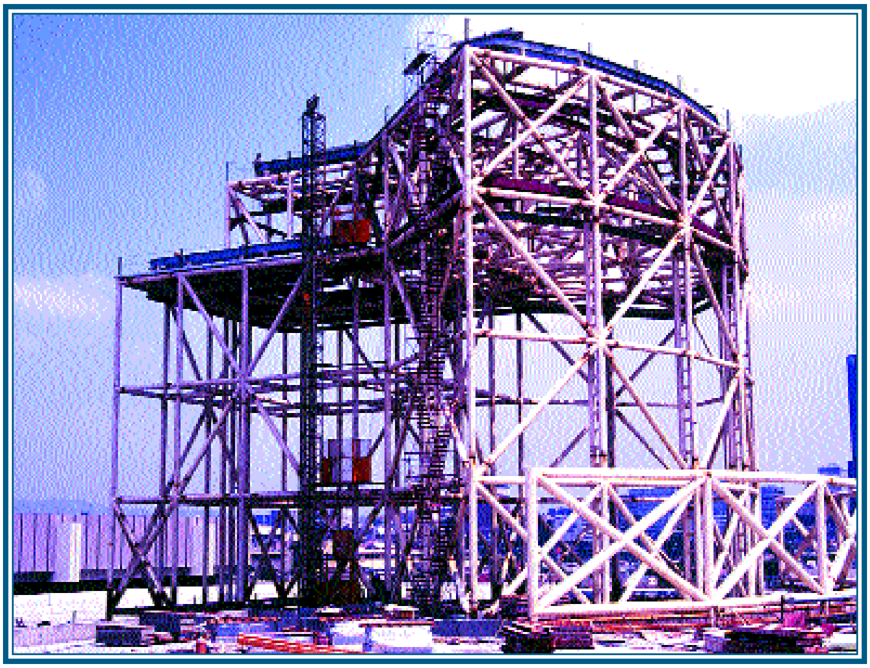
For the booming convention and meeting industry, bigger is almost always better. And adding 350,000 sq. ft. of exhibition space and 125,000 sq. ft. of meeting rooms to the Los Angeles Convention Center created the largest exhibit space on the west coast.

The expanded center serves as a striking visual entry to downtown Los Angeles with two soaring, skirted entry pavilions joined by a covered walkway, all glazed in teal-colored glass with white framing. Loading docks and exhibition space are concealed behind a curved teal wall, while the translucent entry pavilions welcome pedestrians on the opposite side. The city's skyscrapers, palms and mountains serve as pieces of urban art framed by the building's glass.

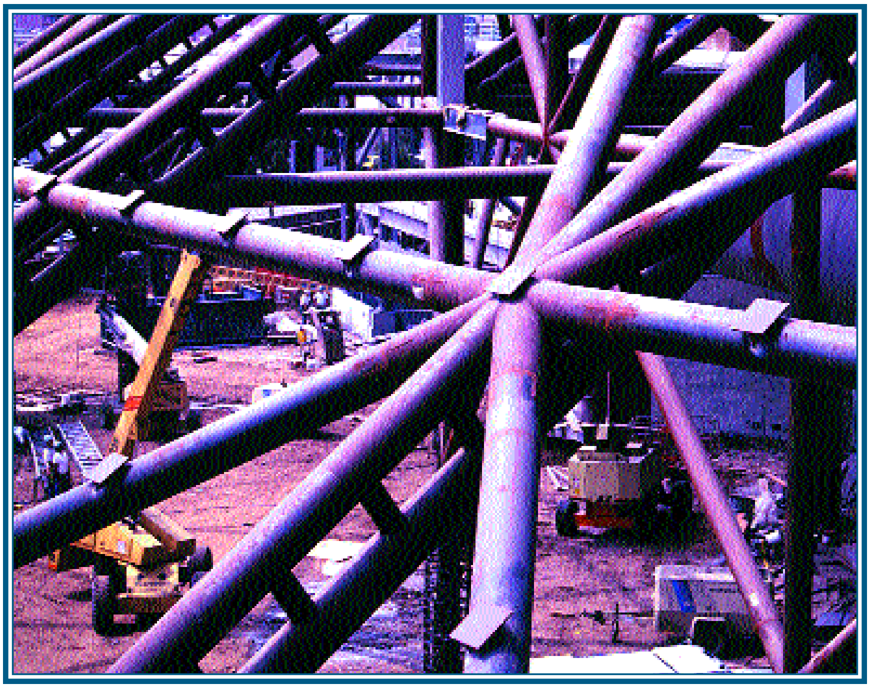
Glass was an integral architectural element in the building's design. Daylight streams through ceramic-fitted glass panels in the entry lobbies and through pyramidal skylights along the length of the concourse. The framing systems and walls were painted white to reflect the light into the building's interior, creating a "joyful" building.



While the architecture is striking, the engineering for the project is best described as complex. Because of the vast expanses of space required for a convention center—the South Exhibit Hall features a 230' x 960' x 40'-high column-free expanse—and Seismic Zone IV requirements, the seismic structural elements assist in the definition of the interior space.



In order to meet the column-free space requirements, structural steel members were chosen for the roof system. Steel provided the lightest possible structure to

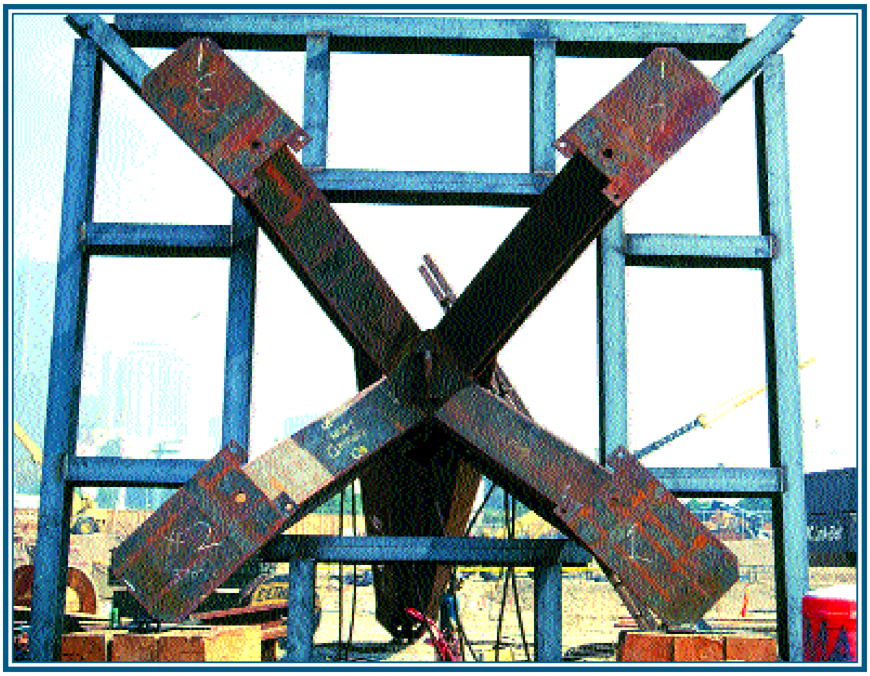


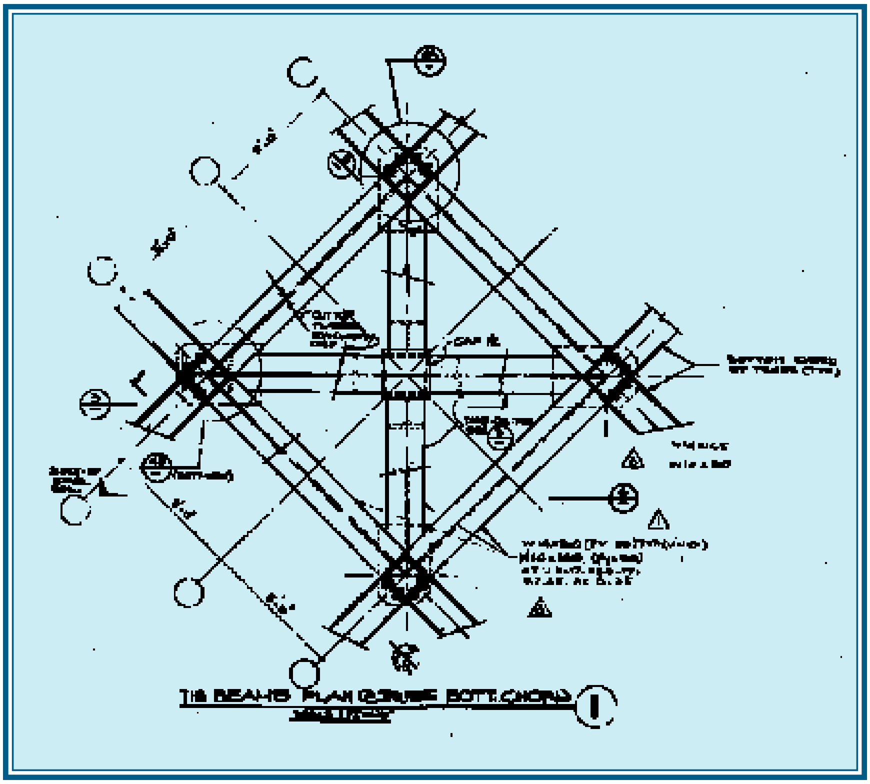
provide an efficient structural system to resist lateral loads.

The uninterrupted open space requirement dictated the use of "star" columns spaced at 240' on center. The columns consist of four 14" wide flange sections welded together around a 16" square central tube and encased in concrete. Each "star" column supports a pair of 20'-deep transverse primary trusses and a pair of 20'-deep longitudinal secondary trusses. The transverse trusses span 240' and the longitudinal trusses span either 60' or 120'. There also are 10'-deep longitudinal trusses at 30' on center spanning either 60' or 120' between the transverse primary trusses. Between these shallower secondary trusses are 14" wide flange purlins at 10' on center.

The Exhibit Hall's lateral system is a steel diagonally braced frame. The 60'-high frame is constructed of 20'-high segments. In 22 perimeter locations, each of the segments is braced for a total of 66 chevron frames. Bracing also is provided in some interior areas, such as between the exhibit space and the end of the hall.

Although the Exhibit Hall floor and the parking level below are cast-in-place concrete, the steel columns continue from the roof through the concrete levels to the foundation. This design was utilized to simplify the coordination between the concrete and steel structures, and to allow for the erection of the structural steel portions prior to the concrete construction.



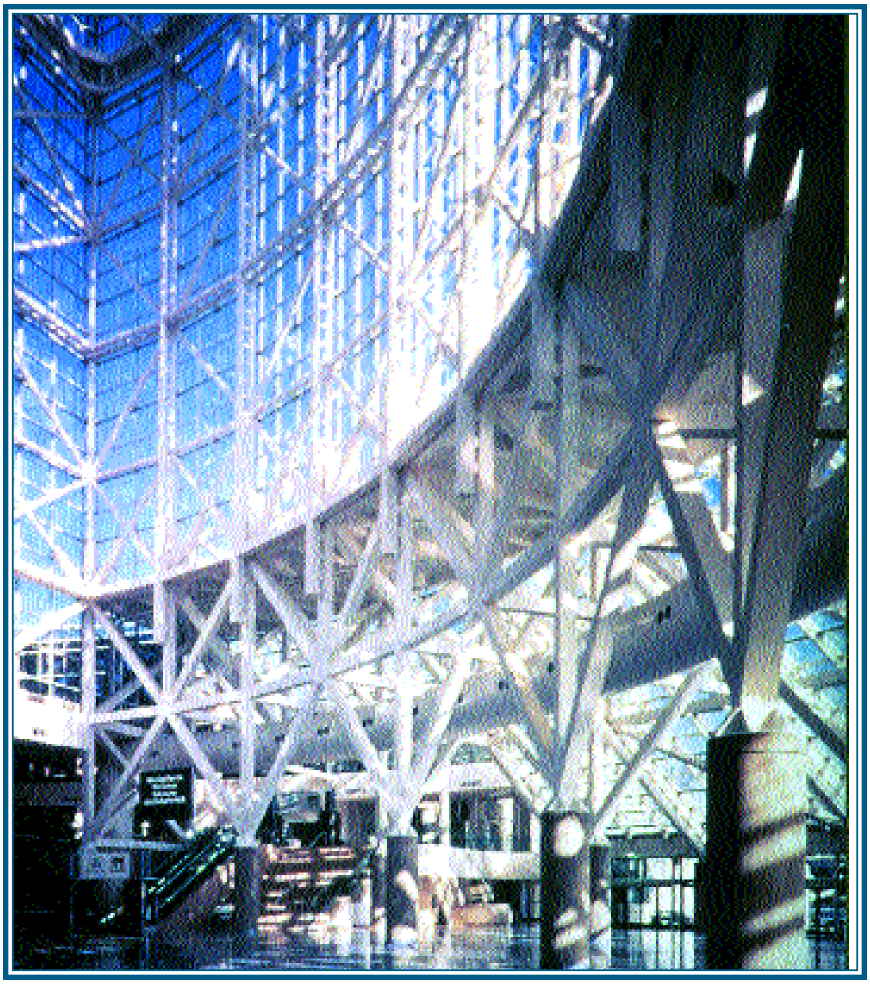


The Entry Pavilions feature exposed steel supporting large expanses of glass. The pavilion structures were constructed of welded steel pipe sections to form a three-dimensional space frame, which was designed for lateral forces caused by wind and seismic activity. The glass panels required strict lateral deflection criteria in the design of the pipe space frames. The Entry Pavilions feature a 160'-high clear space, the equivalent of a 10-story building. Further complicating the design is the unusual shape of the Pavilions: One side of each Pavilion is circular, while the other side connects to a rectangular shape. In addition, the base of the structure flares outwards, requiring sloping members.

Tracking down the gravity and lateral load paths of these complex three-dimensional truss frames required computer software not readily available off-the-

Judges Comments

Structural steel design at its ultimate. The designers put tremendous thought into the connections and joints to achieve the desired architectural requirements. Good work by the designers, detailers and erectors.



shelf. Instead, two R&D staff members from the structural engineer developed a proprietary software system exclusively for modeling, analysis, design and drafting of space frame structures. Initially named SPACE, the same software system was utilized for the structural analysis and design of the Biosphere II space frame in Arizona.

The steel pipe space frame sections consist of 12"-diameter pipe sections to create a completely uniform design—but with varying wall thickness from 7/8" to 3/" (x-x strong to standard pipe) because of varying load conditions. The pipe are connected with T, K and Y connections, which necessitated special welding requirements and details. Up to 14 pipes emanate from a single node and, in several locations where long spans were required, double tubes connected with perpendicular tubular spacers—similar to a truss—were designed.

The two Entry Pavilions are connected by the Meeting Room Bridge, which utilizes concrete shear walls with a steel-framed upper story. Because the vertical space was very limited and column-free space was required, portions of the Bridge were designed using single-story-high trusses with the bottom chord supporting the floor and the top chord supporting the roof.

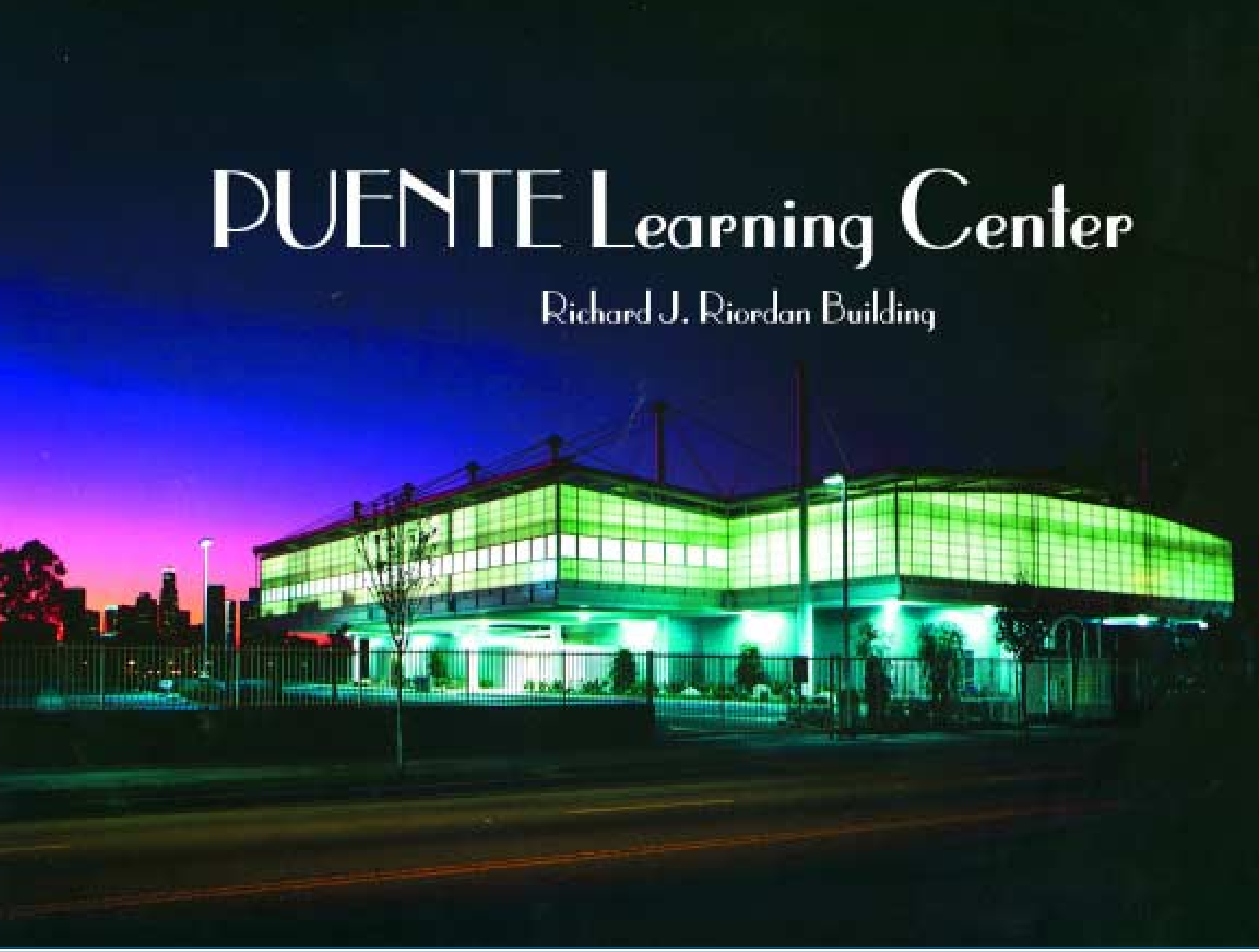
Project Team

Structural Engineer:
John A. Martin & Associates, Inc., Los Angeles

Architect:
Gruen Associates/Pei Cobb Freed & Partners

Associated Architects:
The Tanzmann Associates; Edward C. Barker Associates; Escudero; Fribourg Associations; Stuart Ahn & Associates

General Contractor:
George Hyman Construction Co./M.A. Mortinson Co.



PUENTE Learning Center

Richard J. Riordan Building

In the midst of a once riot-torn neighborhood, the PUENTE Learning Center is a beacon of hope for both teens and adults. The center, a nonprofit, nonsectarian education group run by People United to Enrich the Neighborhood through Education, now serves more than 1,600 students a day, providing basic education, job training, English as a second language, child preparedness and assistance to at-risk high school students.

In designing the center, the goal was to build a 40,000-sq.-ft. educational facility on two acres of land donated by Richard J. Riordan, then a business leader and philanthropist and now mayor of Los Angeles. Flexibility to accommodate changing hardware technology, low maintenance requirements and the need to provide adequate on-site parking were all important design considerations.

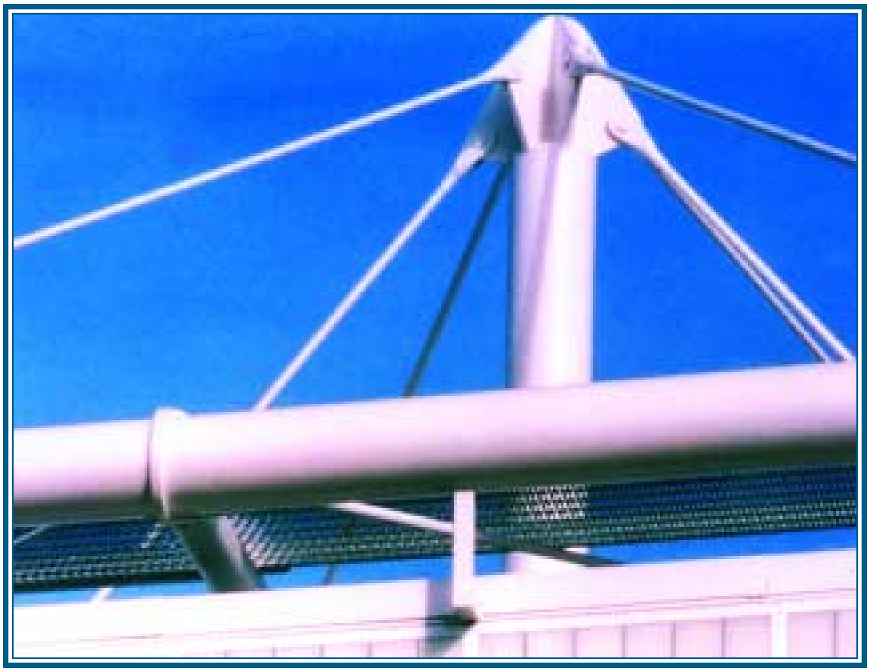
Schemes were developed around the theme of an internal courtyard space, but the severe need for parking and the decision not to build underground parking led to a more innovative proposal. The architect's solution was to place classrooms on the second floor, which was considerably larger than the first floor. The smaller first floor then left room below the overhang for parking. In the initial sketches, the second floor was clad with Kalwall, a translucent composite panel consisting of an aluminum grid between two layers of fiberglass-reinforced polymer, and the cantilevered second level was suspended on cables from three-story masts.

After extensive feasibility studies, it was determined that the 32' overhangs could indeed be hung from large masts. In the final design, the overhanging portions of the second floor and the entire roof are suspended from two rows of six 18"-diameter ASTM A500 Gr. B steel tube masts via tension rods and clevises in sizes varying with load. Hanger rods supporting the cantilevered portion of the second floor are attached to tendon points along the roof perimeter.

A crucial aspect of the design was the resolution of the forces in the sloping hangers. The roof structure acts as the compression chord of a truss, but unlike more conventional buildings where a roof diaphragm would provide horizontal rigidity, the Learning Center had a steel framework consisting of laterally unsupported elements floating above translucent panels.

Instead, the Kalwall roof is supported on hangers from the structural frame, which consists of tubes and wide flange shapes. The panels span 14' between continuous rows of headers that also support rain gutters. No supports penetrate the panels.

The project design is extraordinarily efficient. The use of steel in pure tension, rarely seen in build-



ings, allows full cross sections to be uniformly stressed, taking maximum advantage of the natural strength of the material. Members are smaller and the framework lighter than in conventional flexural/compression stress systems. More practically, the extensive use of architecturally exposed structural steel provided the desired high-tech appearance at no additional cost.

Another consideration was the building's location in a seismic region. Shear walls or braced frames were rejected since they would have constrained classroom flexibility. Instead, moment connections were utilized. However, the overhangs on the long sides of the building prevented the design of lateral force-resisting elements on the perimeter of the structure. This problem was solved by locating frames relatively close to the perimeter at the ends of the structure, providing additional strength needed to resist torsional effects during an earthquake.

A potential problem arose when no domestic supplier could be found to economically manufacture the relatively small number of high-strength fittings required for the project. Ultimately, two European manufacturers were found and McCalls Special Products of Sheffield, England (a division of AISC Associate Member British Steel) was chosen since their bid was slightly more economical and more compatible with the desired architectural aesthetic.

Project Team

Structural Engineer:
Drew A. Norman & Associates, Silver Lake, CA

Architect:
Stephen Woolley & Associates, Venice,CA

General Contractor:
Swinerton and Walberg Builder, San Francisco

Steel Fabricator:
Junior Steel Company, Industry, CA