

# Architectural Precast Concrete Beautifies Shriners Hospital for Children in Sacramento



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*The new multi-million dollar Shriners Hospital for Children at the University of California-Davis in Sacramento, California, serves as the gateway to a multi-functional redeveloping medical center. Situated in an old neighborhood replete with brick residences, the nine-story hospital and its adjacent three-level above grade and three-level below grade parking structure had to reflect the existing heritage while also projecting a contemporary image. To achieve this goal, the designers created a façade using architectural precast concrete featuring spandrel panels with two sandblast finishes incorporating a variety of reveals, a band of red granite and green terra cotta medallions that protrude attractively from the wall. The adjoining parking structure also is clad with architectural precast panels that reflect the style of the hospital façade. This was all accomplished while satisfying fire safety regulations and Seismic Zone 3 code requirements. This article presents the conceptual design, architectural features of the precast facade, and seismic considerations together with the production and erection highlights of the precast components.*

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**E**xecutives at the Shriners Hospitals for Children prefer to position their medical facilities in close proximity to teaching hospitals. That relationship benefits both organizations, but it also generates additional design challenges for producing a cohesive aesthetic exterior design. Not only must the hospital fit into the surrounding neighborhood and the physical site restraints, but it also must blend with the adjacent medical campus while projecting the strong image of the Shriners Hospitals fraternity.

Shriners Hospitals is a not-for-profit philanthropic corporation that provides quality medical care free of

charge to needy children in the specialties of orthopedic and burn treatment.

For the Shriners new nine-story Hospital for Children in Sacramento, California, that combination of elements was compounded by the need for compliance with fire safety and seismic code requirements. All of these challenges were resolved in part by designing an exterior building skin using architectural precast concrete (see Fig. 1). That same design was also used in the panels on the adjacent six-level parking structure (see Fig. 2).

In the spring of 1990, Shriners Hospitals formed an affiliation agreement



Fig. 1. Shriners Hospital for Children, Sacramento, California. This nine-story building features an exterior façade using architectural precast panels with a horizontal band of red granite, green terra cotta insets and two textures of finish.



Fig. 2. Adjoining parking structure also features architectural precast panels to complement hospital façade.

to co-venture the development of a pediatric facility with the University of California-Davis in Sacramento. The project, which served as the initial phase of a redevelopment plan for the university's medical center campus, was located at the major entrance to the university's campus, allowing it to form a gateway to the campus and serve as the dominant structure as visitors approach the newly developing medical campus.

Aesthetically, this high profile positioning meant the structure had to blend

into the context of the major medical center while also responding to the architectural design of the surrounding neighborhood. The area features many old brick homes, with a dominant Spanish Colonial style. Neighbors were concerned that the new facility would stand out too dramatically with its need for contemporary styling and large mass. The designers and owners worked closely with local citizen groups to reassure them and receive their input on any concerns. In all, six neighborhood associations reviewed

the final building plans and provided input on appearance issues.

The hospital's design also had to address changes in the health-care industry, such as shorter patient stays, increased focus on outpatient care and family-focused care. This meant adapting traditional designs to create more community-gathering areas, better access and flow of transportation for out-patient arrivals and departures and other elements affecting interior and exterior design driven by changing patient needs.



Fig. 3. Floor plan of Level 1 of hospital and parking structure.

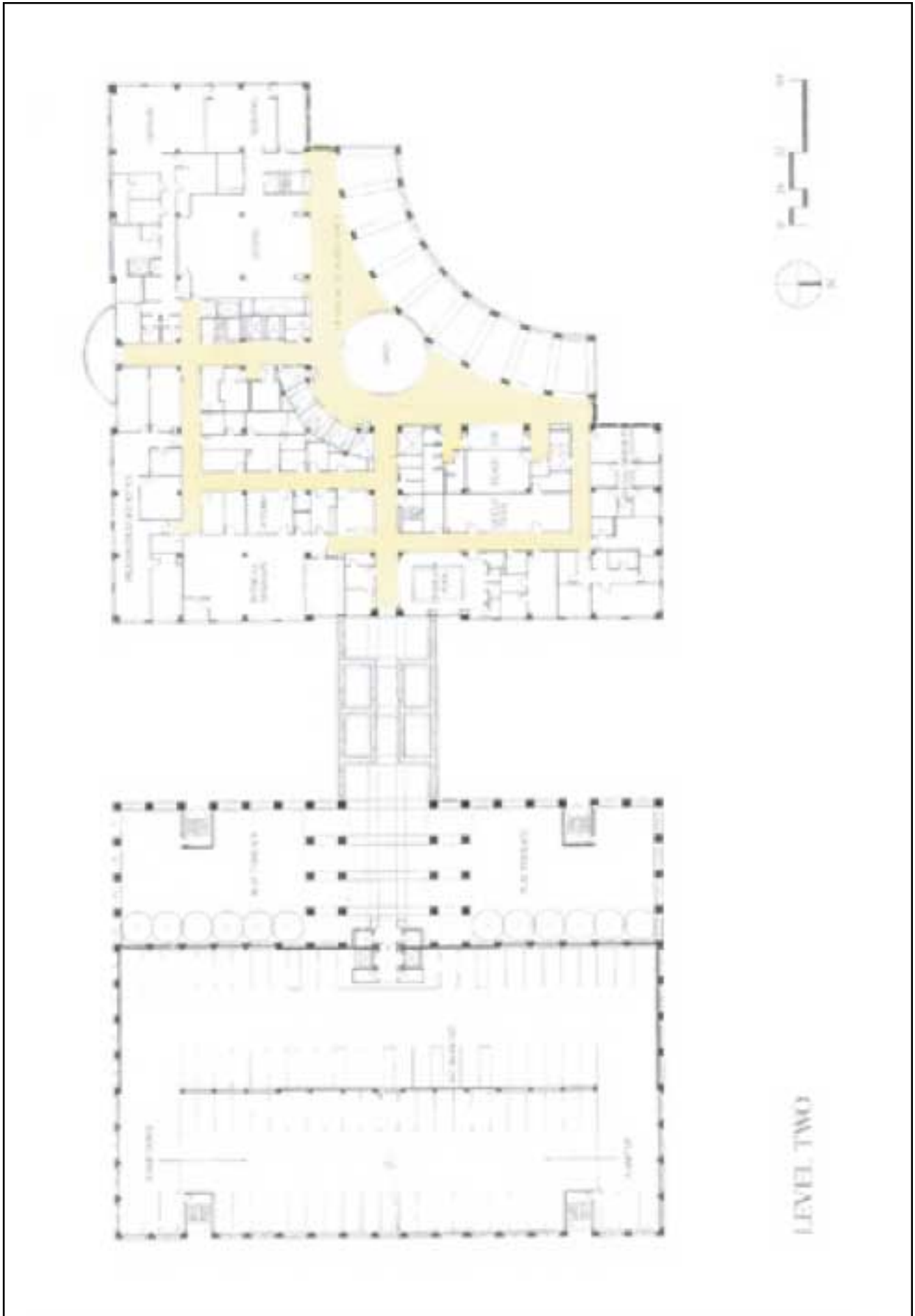


Fig. 4. Floor plan of Level 2 of hospital and parking structure.



Fig. 5. Model of hospital facility and environs. The facility's basic shape represents a square with a quarter-circle carved out of one corner, which provides its angled entry façade.

Figs. 3 and 4 show the floor plans of Levels 1 and 2 of the hospital and adjoining parking structure. Fig. 5 is a model of the hospital facility and environs.

As a result, the hospital was designed to center around a circular, sun-filled atrium that continues through all of the above-grade floors. A central activity space located at the base of the atrium serves as the main therapeutic space for the patients. In addition, several outside activity areas were incorporated into the facility, including a children's play terrace atop the adjacent parking garage and a family waiting space above the three-story colonnade at the front of the facility. The 300,000 sq ft (28000 m<sup>2</sup>) building features 80 beds and nine separate apartment suites for families and their children, allowing each family to resume daily activities while their child is still in the hospital's care.

The basic design of the hospital resembles a square with a quarter circle carved out of one corner. This helped reduce the visual mass of the building against the residential neighborhood it adjoins while providing a dramatic face to present to traffic as visitors approach the hospital. The center of that cutout then serves as the main plane around which the structure's regular symmetry from left to right was devised. At its midpoint is the full-height atrium. It combines with the colonnade and lobby that flank it to create a brightly lit and dramatic space that welcomes visitors and leads their eye up to the upper regions of the building.

## BUILDING FEATURES

The hospital's structure consists of a ductile moment-resisting frame of structural steel supported on a pre-stressed concrete pile foundation. The frame sits atop 800 —57 ft (17.4 m) long prestressed concrete piles that were driven into the ground to provide support due to the poor soil conditions in the area. The structural frame weighs 4600 tons (4170 t), with individual columns weighing more than 44,000 lbs (196 kN) at 875 lbs per linear ft (12.8 kN/m).

The frame system was designed especially to address the area's Seismic Zone 3 rating. For example, the two-

story columns were designed to allow the precast panels to rock slightly in the event of a seismic event. Seismic considerations affected not only the structural system but also the shape of the building and the size and thickness of the precast concrete panels.

Some 1400 architectural precast panels were used to clad the facility. These panels range in weight from 1700 to 32,000 lbs (7.56 to 142 kN) and feature considerable complexity in their shapes, owing especially to the curved form of the main facade. In addition, red granite insets were provided to create an intermittent horizontal dark band running the length of the building at every story. This reflects the surrounding brick architecture of the neighborhoods, giving them a touchpoint that ties the hospital to them without surrendering the facility's need for a contemporary, strong image.

Green terra cotta medallions that protrude attractively out from the wall also were interspersed among the granite bands at spandrel intersections to add further detail and interest. Two different finishes were provided through different levels of sandblasting to produce contrasting finish texture around the windows, with reveals added between and around the insets and bands (see Figs. 6 and 7).

### **CURVED PANELS ADDED CHALLENGE**

Creating the curved panels to clad the entire main facade provided a significant challenge. Precast concrete panels featuring nine different radii had to be worked out, with three materials integrated into most of these panels (see Fig. 8). As a result, more than 20 different panel geometries had to be devised, including curved architectural precast spandrel panels with integral soffits. Twenty-one different steel forms had to be constructed to mold the panels, with as many as 20 different forms cast on any given day to meet the specific shapes and number needed. These custom forms produced extremely tight tolerances on the panels, minimizing erection problems once they arrived on site.

The panels were cast 6 in. (152 mm) thick and ranged in size from 4 x 8 ft



Fig. 6. View from parking structure shows the attractive use of reveals flanking the granite bands and terra cotta medallions.



Fig. 7. Large expanses of glass integrated with spandrel panels create tranquil appearance together with greenery in foreground.



Fig. 8. The curving front façade features the Shriners' logo inset into the center panel, which reflects the logo used at the very top of the building. This circular shape and the pattern in the reveals is mimicked in the mullions in the windows, extending this design theme.

to 12 x 32 ft (1.22 x 2.44 m to 3.66 x 9.75 m), with the most typical size measuring 9 x 28 ft (2.74 x 8.53 m). This thickness was chosen because of seismic needs as well as the addition of the stone insets, which required more depth to provide sufficient connection strength. The panels were cast with 5000 psi (34 MPa) concrete to further ensure durability.

Table 1 provides details on the number, type, dimensions, and typical weights of the precast concrete components. The precast components were manufactured by Clark Pacific at their plant in West Sacramento in the winter of 1995-1996. The components were hauled by standard truck and 40 ft (12.2 m) long trailer the short 7 miles (10 km) to the project site. The hauling and erection were handled by the precaster.

Due to the seismic zone, the precaster used push-pull connections at the lower levels of the panels as well as cast-in-place bearing connections at the tops. The panels were designed to accommodate 2 in. (51 mm) of lateral drift on each floor, giving them sufficient ductility in the event of an earthquake. The precast panels required special connections, which the precaster typically uses on such designs in this seismic zone. These comprise closed-loop straps on the back of the embedded piece, through which the mild reinforcing steel is run. This added reinforcement ensures the embed and panel remain attached even under extreme seismic vibrations.

Table 1. Number, type, dimensions and weights of precast concrete components.

<b>Hospital</b>
Number of precast components: 1464
Surface area: 173,500 sq ft (16135 m <sup>2</sup> )
Square column covers: 690
Flat spandrels: 305
Wall panels: 130
Beam covers: 160
Planter spandrels: 31
Range of panel sizes: 8 x 4 ft to 12 x 32 ft (2.44 x 1.22 m to 3.66 x 9.75 m)
Typical panel sizes: 9 x 28 ft (2.74 x 8.53 m)
Range of component weights: 1700 to 32,000 lbs (7.56 x 142 kN)
Typical component weight: 17,100 lbs (76.1 kN)
<b>Parking structure</b>
Number of precast components: 517
Surface area: 71,000 sq ft (6600 m <sup>2</sup> )
Square columns: 132
Flat spandrels: 74
Wall panels: 147
Full beam wraps: 82
Planter spandrels: 41
Planter sills: 41
Range of panel sizes:
- 4 x 4 ft (1.22 x 1.22 m) square column caps
- 8 x 34 ft (2.44 x 10.36 m) bridge spandrels
Typical spandrel sizes: 8 x 14 ft (2.44 x 4.27 m)
Range of component weights:
- Cap pieces: 1600 lbs (7.12 kN)
- Bridge spandrels: 28,000 lbs (125 kN)
Typical spandrel weight: 10,000 lbs (44.5 kN)

## ERECTION TOOK SPECIAL CARE

Erecting the panels was tougher than it might appear. This was especially true across the front facade, where all panels were curved with no segmented sections. In addition, at the first-floor driveway, panels measuring 14 ft 8 in. x 14 ft (4.47 x 4.27 m) and weighing 10,500 lbs (46.7 kN) had to be set 36 ft (11 m) back under the second floor overhang (see Fig. 9). This required a special panel cart that could carry these pieces under the overhead portion. In some areas, a special crane boom tip had to be designed to set the panels in their proper positions.

Another challenge arose in creating the window sills and surrounding spandrels. Across the first floor, for instance, the sill panels are entirely granite, with precast backup. On each level, the tops of the spandrel panels are sloped to match the punched window system, tying the two systems together. The curved window sections also posed a difficulty, especially where the projected sill and returns come off the precast concrete panel and match with the segmented window.

The windows were designed specifically with seismic connections in mind. The fenestration is set behind the precast concrete panel, which allows the panel to move independently of the window jamb without taking all of the story drift. The two-story column covers also were designed in this manner, allowing them to move independently of the windows as well. This keeps each element separate in case of an earthquake and minimizes the chances for failure.

A variety of balconies were added at each level, including both curved and rectangular sections. The curved balconies project off two sides of the structure, while a complete garden terrace was designed at the roofline along the entry facade. This includes 4 ft (1.22 m) wide precast concrete planters that serve as a guard rail as well as a green space separating the terrace from the side of the building (see Fig. 10).

These balconies required considerable ingenuity to erect because of their inclusion of full-wrap column and beam covers. The erection had to be accomplished in an efficient manner while still allowing the precast components to be welded to the structure prior to the next panel being erected. It also required that all connections be hidden from view.

Another challenge arose with the two-story framework across the entry's roof (see Fig. 11). These structures combine two panels, one convex and one concave, which then are capped by another precast concrete piece that had to match both inside and outside curves exactly. Thus, while there are no compound curves in any of the panels, the cap pieces had to match two panels with different radii (see Fig. 12).



Fig. 9. A special panel cart was used to deliver precast panels to this area, where panels had to be set 36 ft (11 m) back under the second floor overhang.



Fig. 10. A variety of balconies, including both rectilinear forms and half-circles, provide a number of quiet spaces for patients and their families.

In addition, panels along the stairwell areas at the corners of the building presented a special erection challenge, as they had to be lowered through six floors of structural steel to their final resting place. In some instances, these panels were cast with a

thinner profile because of the reduced need for structural support as well as to aid maneuverability. Even so, some of these were enormous panels, weighing upwards of 20,000 lbs (89 kN), and they had to be handled carefully in tight enclosures.



Fig. 11. Above the second floor, on the roof of the lobby area, a terraced garden was created with four-sided precast column covers on the exterior facing and precast planters in the gardens.



Fig. 12. The arched columns along the lobby's roof combine two panels, one convex and one concave, which are then capped by another precast piece that had to match both inside and outside curves exactly.

## INTERIOR AND EXTERIOR BLEND

The exterior precast panels also extend into the facility's interior by continuing from the outside walls around the edges and along the sides of the main lobby. This helps connect the interior and exterior designs, and this segue was aided by enclosing the lobby with floor-to-ceiling glass, providing visual continuity.

Similarly, the floor and ceiling surfaces in the lobby were sheathed in granite similar to that used on the exterior entry way, making the transition from outside to inside more gradual. This consistency was maintained on other levels of the building by adding precast concrete planter panels along all internal balconies. The central atrium, sheathed in gypsum board, was painted to resemble the exterior precast concrete design, including painting in the bands of dark red and green insets (see Fig. 13).

A final touch to the precast panels was supplied by creating recessed lettering and artwork, which was cast into the architectural precast panels. These included the Shriners' circular logo, which is featured in brass at the very top of the building as well as in a recessed image along the front of the facade at the entry.

Overall, many elements of this project made it resemble a three-dimensional jigsaw puzzle with each piece weighing 10,000 lbs (44.5 kN). It required considerable preplanning and discussion among the architect, general contractor and precaster to make it work properly. Through their mutual efforts, teamwork and ingenuity, the work progressed smoothly and quite rapidly.

The moldability and versatility of precast concrete to produce these panels with such varied shapes, textures and inset options were the primary reasons the architect specified the material. They overcame the real challenges of the design in ways that cast-in-place or some other material would not have been able to achieve. That confidence in the material paid off with a smooth erection, especially considering the large scope, unusual shapes and the need to be working as much as 150 ft (45.7 m) in the air.

The result is a distinctive facility that blends well with its environment and does not overwhelm the setting. Yet it also creates a distinctive centerpiece for the developing medical center. The precast concrete panels provide aesthetic appeal and visual interest that varies with the visitor's distance from the center. From afar, the center offers a cool mix of red-brick bands and green accents that are enhanced by the bold use of green fenestration. Up close, the red bands show their strong, polished-granite surface, while the precast concrete displays its mixture of rough and smooth finishes (see Fig. 14).

### PARKING STRUCTURE MATCHES DESIGN

An additional challenge came in designing the adjacent 650-car parking structure that connects to the hospital via a wide, second-level pedestrian walkway. This building is prominent along the main thoroughfare and combines with the hospital to form the campus's new gateway image. That meant it had to present a unified front with the main facility and avoid a parking garage type of image. The large scale of the structure and the need to blend it with the elegant architecture next door posed a distinct challenge in its design.

The most significant consideration came in the need to include a children's play area for the adjacent hospital on top of a portion of the parking structure's roof. This incorporates both hard and soft play surfaces, meaning both asphalt and grass, as well as an area planted with vines growing on top of trellises, providing both shade and natural stimulation for the rehabilitating patients. Adding this function to the parking structure required that it include a separate and higher fire rating than the rest of the building. Precast concrete easily met this requirement.

Overall, the parking structure features a rectangular footprint with four exterior stairwells set into the building's main body. These stairwells are composed of precast concrete wall panels with a cast-in-place center support wall and suspended landings at the mid-height of each story. Spe-



Fig. 13. The atrium inside the entry lobby features gypsum-board walls that were painted to resemble the precast concrete façade panels, including the granite insets and green terra cotta medallions.



Fig. 14. The variety of textures used in the project can be seen in this view from an upper level balcony. Reveals and two textures of sandblasted finish add visual interest and contrast to the polished granite insets.

cial coordination was the key to fitting the precast concrete side and back walls around the projecting reinforcing dowels required to connect the cast-in-place portion of the structure prior to pouring the stairs and support walls.

Its design reflects that of the adjacent hospital, including a band of red granite and green terra cotta insets. The use of precast concrete also helped the designers minimize the scale of the parking structure. The exterior design of the first two above-



Fig. 15. The adjacent parking structure, which holds 650 cars, features a similar façade design using precast concrete panels on a reinforced concrete frame. The façade for the first two floors of the structure was treated as one unit, creating two-story-tall “bays” in order to reflect the two-story height of the hospital’s entry lobby.

ground floors were combined into one, reflecting the taller height of the hospital’s first floor. Two-story-tall bays were designed that help the structure avoid the look of a parking garage while still providing the needed levels (see Fig. 15).

The parking structure consists of a cast-in-place concrete frame on footings, which was designed to accommodate seismic movement that allows the frame to be ductile in the event of an earthquake. The interior of the structure incorporates shear walls, while

the architectural precast concrete panels and windows making up the exterior are designed to accommodate 2 in. (51 mm) of lateral drift on each floor. Similar to the hospital building, this allows the structure to absorb movement during an earthquake.



Fig. 16. The parking structure connects to the hospital at its second level via a pedestrian walkway. It was designed as a free-standing structure to aid its seismic resistance.

## CHILDREN’S PLAY AREA IS PRESTRESSED

The large post-tensioned beams supporting the play terrace’s deck had a unique stage-stressing requirement. All final dead loads that were to be supported by these beams had to be placed on the deck prior to final tensioning of strands. This included not only all of the soil fill that was being used in the planters and deck for the natural grass areas but also the precast concrete panels that close up the structure on the interior.

Due to limited access to beam strands, the sequence of panel erection was of major importance. The exterior three-story column covers encasing the strands had to be able to rock in the event of a seismic event and had to be attached to the structure prior to attaching the internal portion of the full-wrap column covers. This required all of the column covers and sill panels to be set temporarily and

braced out of position as close to final position as possible. Once completed, the lengthy tensioning process began. When finished, all of the panels had to be reset and welded into their final position.

The other key challenge came in producing the elevator entrance panel. This required casting five individual panels and then placing each member into the body of the main panel. Each of the six panels incorporated a red diamond-shaped pattern to reflect the banding in the hospital. Originally, this final, large panel was to be made of the same granite that was used for the accent bands on the other panels on this project.

Due to the dissimilar materials and the possibility of differential thermal expansion, the design was changed to an exposed aggregate concrete mix using crushed red granite. This provided the desired look but reduced the risk of later spalling due to hot weather. The hard work and thought put into designing these pieces paid off with a distinctive look that serves as the focal point for the structure (see Fig. 16).

The 30 ft (9.14 m) wide pedestrian bridge connecting the parking structure and the hospital also had to resist seismic forces. This was accomplished by building it as a free-standing steel frame sheathed in precast concrete panels, again with 2 in. (51 mm) spacing to accommodate lateral drift, similar to the hospital's design. The pedestrian bridge also includes 8 in. (203 mm) seismic gaps on each end to ensure movement could be accommodated (see Fig. 17).

The precast contract, including production, hauling and erection amounted to about \$7<sup>1</sup>/<sub>2</sub> million.

The end result is a magnificent structure which blends very well with the neighborhood, while adding a new dimension to children's medical care. Fig. 18 shows a dramatic view of the hospital at dusk.

## CLOSING COMMENTS

Begun in May 1994, the finished structure was dedicated June 1, 1997, which formally marked the beginning of what promises to be a positive and enduring relationship with the greater



Fig. 17. The elevator entrance panel required casting five individual panels, which then were cast into the main body of the panel. Each casting incorporated a red diamond-shaped pattern to reflect the banding in the hospital.



Fig. 18. Shriners Hospital at dusk is dramatized by illuminated precast façade.

metropolitan area of Sacramento and other regional communities. Indeed, the facility began welcoming many patients even before its dedication, gaining many compliments as families saw the advantages of the facility and used its services.

Through its pediatric programs and enduring commitment to health care, this medical facility has and will continue to heal and enrich the lives of many needy children, all of whom are treated at the Shriners Hospitals free of charge.

## CREDITS

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