Hopi Health Care Center – An All-Precast Concrete Hospital in the Desert

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Loadbearing and non-loadbearing precast wall panels were combined effectively into an all-precast/prestressed concrete structure to form the new $18 million Hopi Health Care Center in Polacca, Arizona. Key challenges in this project included meeting the federal grant requirements, fulfilling the Hopi tribe's desire for a culture-oriented facility, retaining the Indian Health Services' specification for a sterile hospital, and working in a harsh desert environment. Precast/prestressed concrete met these challenges with ingenuity and simplicity. The medical center features unique two-piece precast concrete wall panels and cylinder-shaped projections that emulate the "vigas," or wood joists, used as roof supports in traditional Hopi adobe structures. The long double tees provide a structural system with large bays of unobstructed space. The tees also span the crawl space beneath the building for access to mechanical and utility equipment. This article presents the design considerations and construction highlights of the project.

Precast/prestressed concrete played a prominent role in building the new multi-million dollar Hopi Health Care Center in Polacca, Arizona. The medical center is located more than 60 miles (100 km) from the nearest town (with a population of 5000 people) and more than 300 miles (480 km) from the producer that supplied the precast concrete.

This facility is a living tribute to the preservation of Native American culture. The Hopi Indian tribe had patiently

Fig. 1. Elements made of precast concrete, stone, and wood combine to blend the Hopi Health Care Center in Polacca, Arizona, into its environment.

endured 18 years to obtain a federal grant through the United States Indian Health Service to build a 110,000 sq ft (10200 m^2) medical center. The facility primarily offers outpatient services such as eye care, dental care, physical therapy, and speech/audiology. Also included are a birthing center, emergency-treatment areas, short-stay nursing rooms, imaging facilities, medical laboratories, a pharmacy, a dialysis facility, patient-education spaces, and a public health area (see Figs. 1 and 2).

Overcoming and mastering the major obstacles of this project became primary goals. From the outset, the time frame for the design process was lengthened because of the need for mutual understanding of each party's requirements. The architectural designers, federal grant representatives, Hopi Indian tribe, and the United States Indian Health Service met on numerous occasions to achieve a common vision and drum out mutual goals.

The federal grant representatives needed compliance with requirements for a specialized medical facility. The most encumbering aspect of the requirements was the mandate that the

Fig. 2. The medical center distinctly combines creative structural design and aesthetically pleasing architecture.

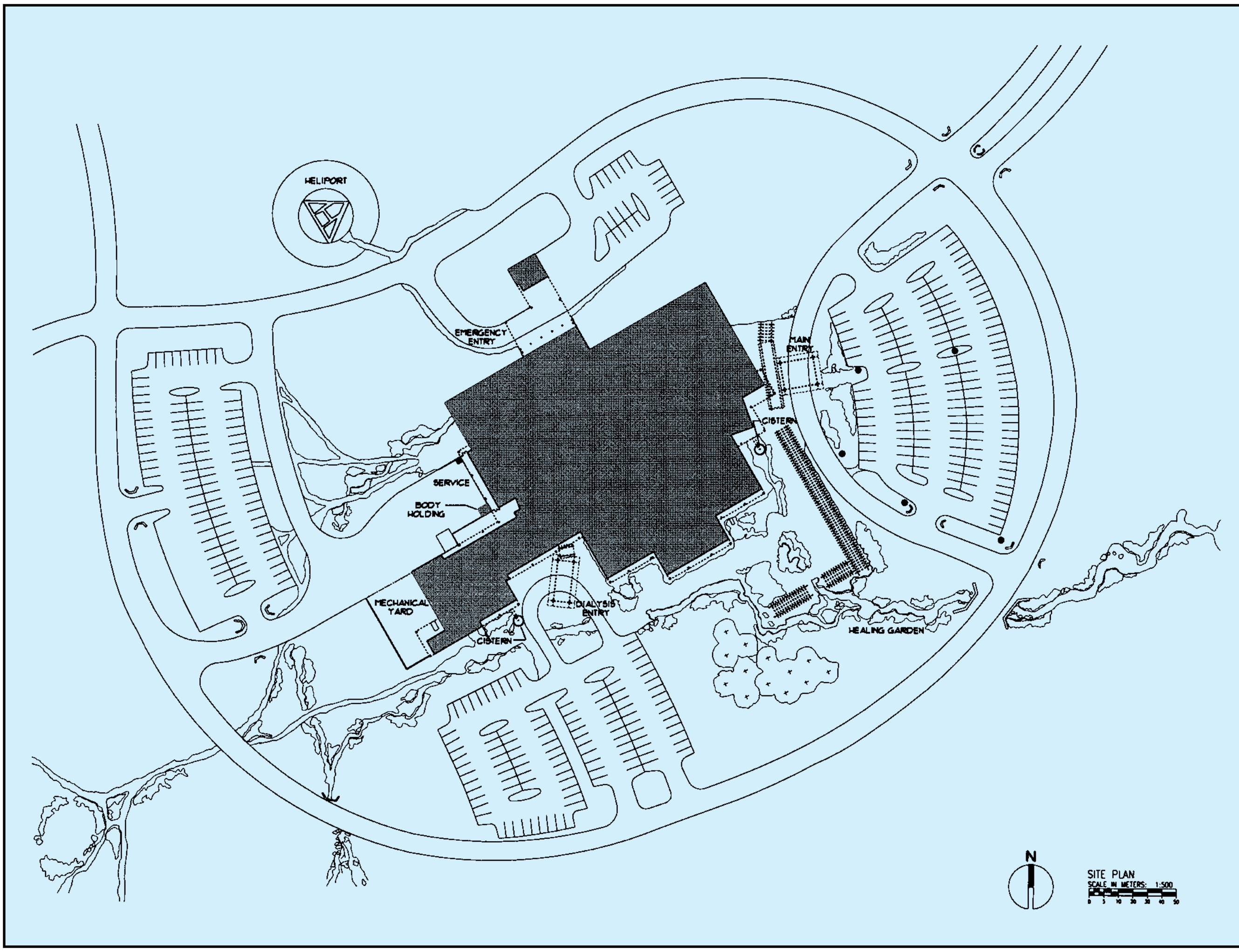

Fig. 3. Site plan of the medical center.


Fig. 4. The precast concrete panels use 5000 psi (35 MPa) strength concrete with an architectural concrete mix that includes imported Rosestone aggregate and dye.

building be designed and detailed completely in hard metric units. This meant that all dimensions had to be detailed in even metric units, not simply by using a soft metric conversion.

Yet, finding products scaled to these dimensions in the United States can be difficult. For example, a 900 mm wide door does not equate to a 3 ft (914 mm) wide door; thus, planning and adjusting building dimensions after product delivery were critical ingredients in this project. The adaptation to metric measurements added to the difficulties of building the facility in a remote desert area.

Another grant requirement was that the contractor hire local, Native American labor wherever possible. Fortunately, this allowed the project designers to take full advantage of the skilled, semi-skilled, and unskilled labor immediately available.

While the federal grant requirements set the tone for the first round of obstacles, the Indian Health Services insisted that the building retain a sterile environment and a hospital-like layout. This conflicted with the Hopi tribe's desire to have a center that fit in with their own culture and lifestyle.

The site, located on the Hopi Indian reservation, is surrounded by the Navajo Indian reservation (see Fig. 3). Most of the homes and commercial buildings on the reservations are Native American adobe structures, some more than 900 years old and still being used.

The traditional adobe-style architecture features stucco with a mixture of straw and sun-dried mud. Roofs are framed with logs for joists, called "vigas," usually 6 to 10 in. (152 to 254 mm) in diameter, and typically spaced at 2 to 5 ft (0.6 to 1.5 m) on center.

The decking consists of saplings, 2 or 3 in. (50 or 80 mm) in diameter, which are laid perpendicular to the vigas. These "latillas" are then covered with a mixture of straw and sun-dried mud. Vertical support is provided by a combination of loadbearing walls and columns consisting of large vigas standing on end. The façades have been tempered by weather and desert winds; i.e., the sand has softened the corners and dulled the smooth adobe finish.

PRECAST CONCRETE EXTERIOR WALL PANELS

After considering many options for achieving the blend of high-tech interior needs and native ambience for the exterior, precast concrete panels were specified to clad the building. A tan color was selected, with a light sandblast finish in order to blend the structure into the desert landscape. Both tilt-up and precast concrete panels were considered, but precast concrete ultimately won out because tilt-up panels could not be guaranteed to attain a consistent high quality on-site under the harsh climatic conditions.

Precast concrete also made sense because the architectural design included coloring, sandblasting, form liners, and intricate detail to evoke the environmental elements. The plant-cast panels have a 5000 psi (35 MPa)

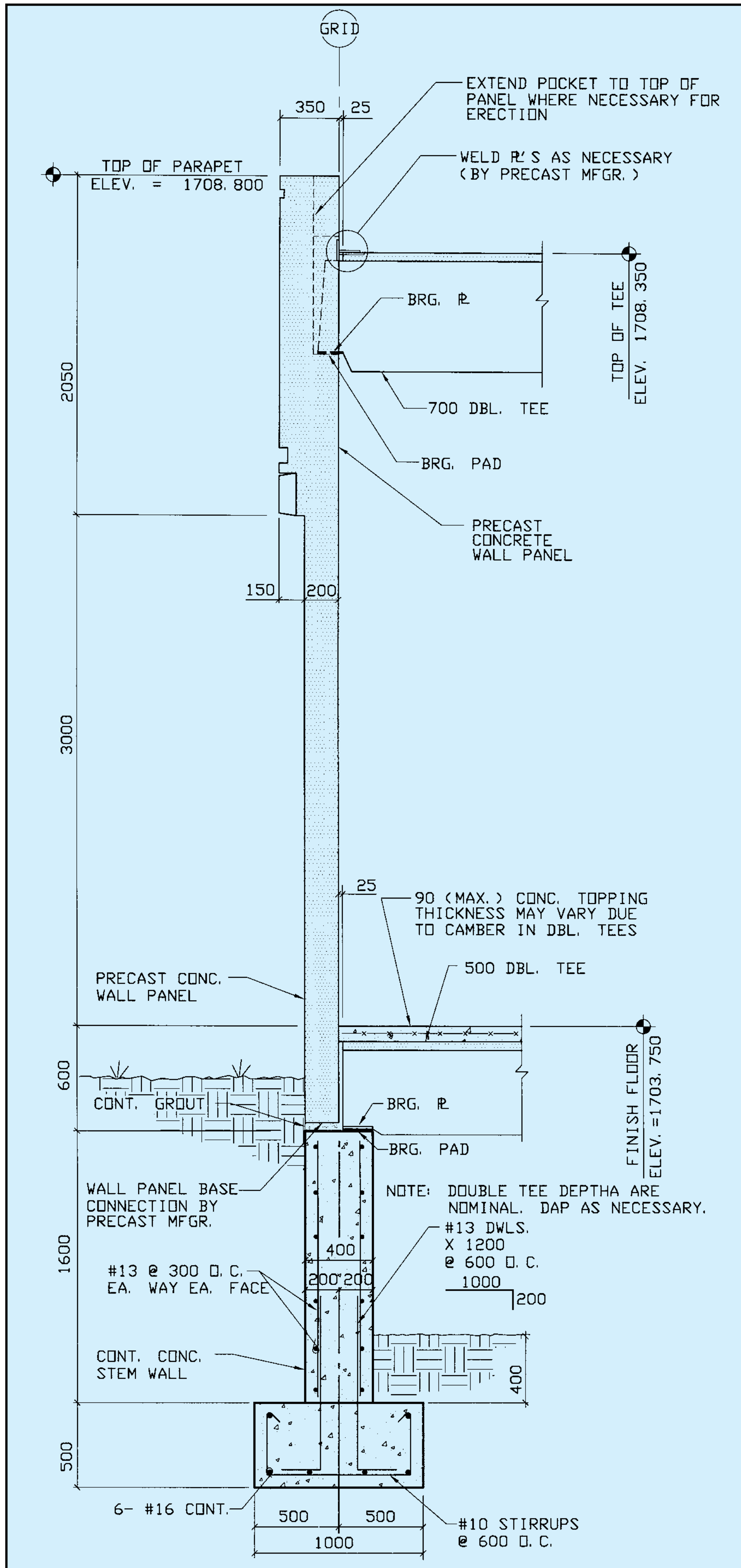

Fig. 5. Section of a loadbearing wall panel.

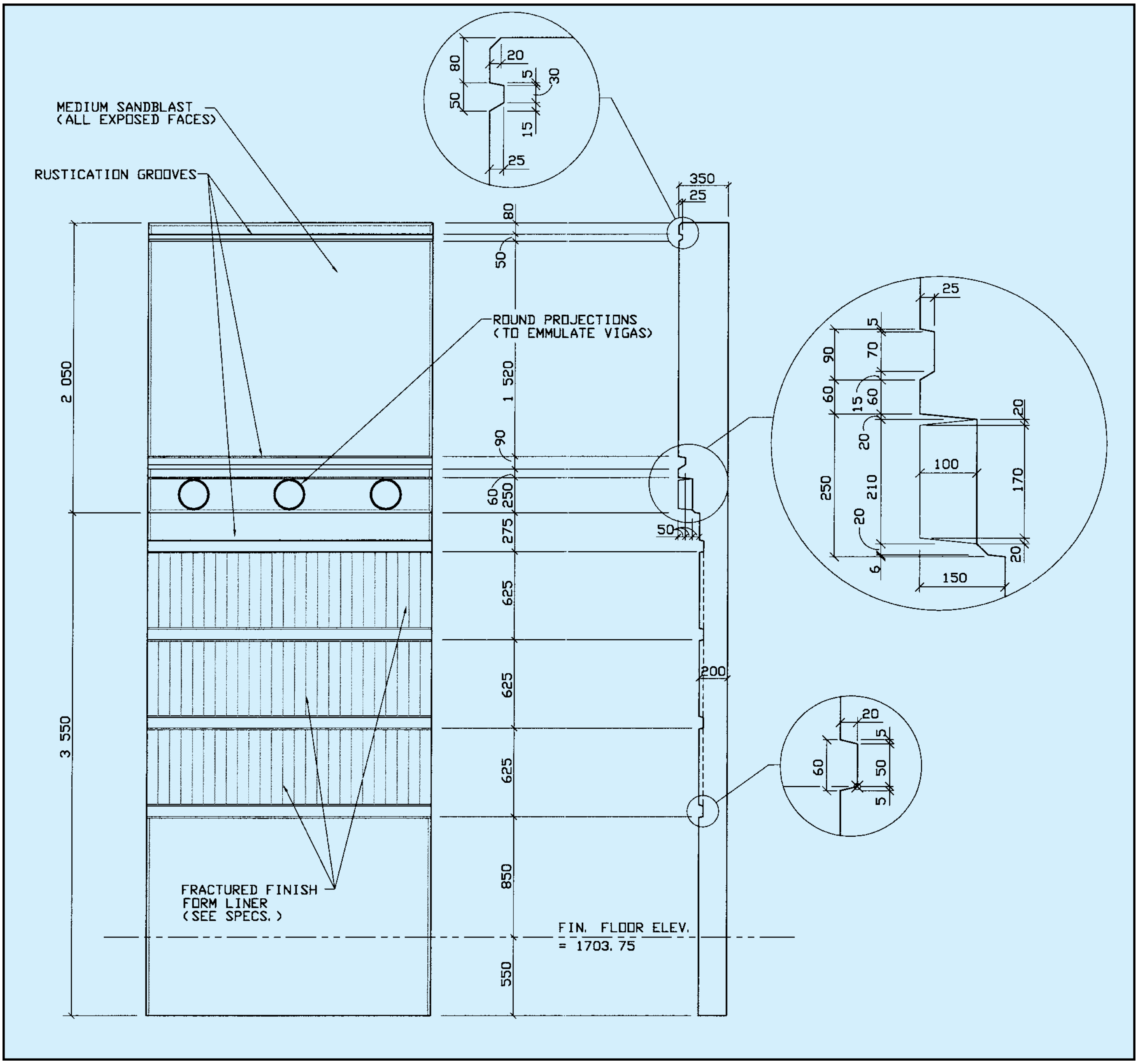

Fig. 6. Wall panel detail showing vigas and fascia that were created to add interest.

concrete strength with an architectural concrete mix that includes imported Rosestone aggregate and a dye (see Fig. 4).

Both loadbearing and non-loadbearing panels were used on opposite façades. The loadbearing panels rest on the foundation, which has a ledge on it to support the double-tee flooring (see Fig. 5). To meet the hard metric requirements, the typical loadbearing panels are 2000 mm wide x 6000 mm tall x 200 mm thick (6.6 x 19.7 ft x 8 in.).

A fascia effect was created by projecting the top 1.5 m (5 ft) of each panel 150 mm (6 in.) beyond the face of the lower portion. This required the precaster to build up the panel in the casting bed to achieve the appropriate cross section. Immediately beneath this fascia, cylindrical projections, approximately 200 mm (8 in.) in diameter, were spaced at 667 mm (2.2 ft) on center (see Fig. 6). These projections emulate the vigas that normally project through the walls of the adobe-style buildings and appear to support the fascia.

The original design showed the viga ends flush with the fascia, as the initial intent was to cast them monolithically with the rest of the panel. Instead, the precaster elected to cast them separately in cylindrical molds, with a J-bolt projecting from the backside. The bolt was inserted through a hole cast in the wall panel and secured with a nut and washer on the interior face. The J-bolt, nut and washer were connected to the panel at the plant before shipment to the project site. Although this two-piece design might seem to add labor and other production costs, it instead sped up the overall fabrication procedure.

The wall beneath the fascia features vertical reveals that were created with a special rib form liner that provided depth and texture to this portion of the building façade (see Fig. 7).

The project had a number of set-

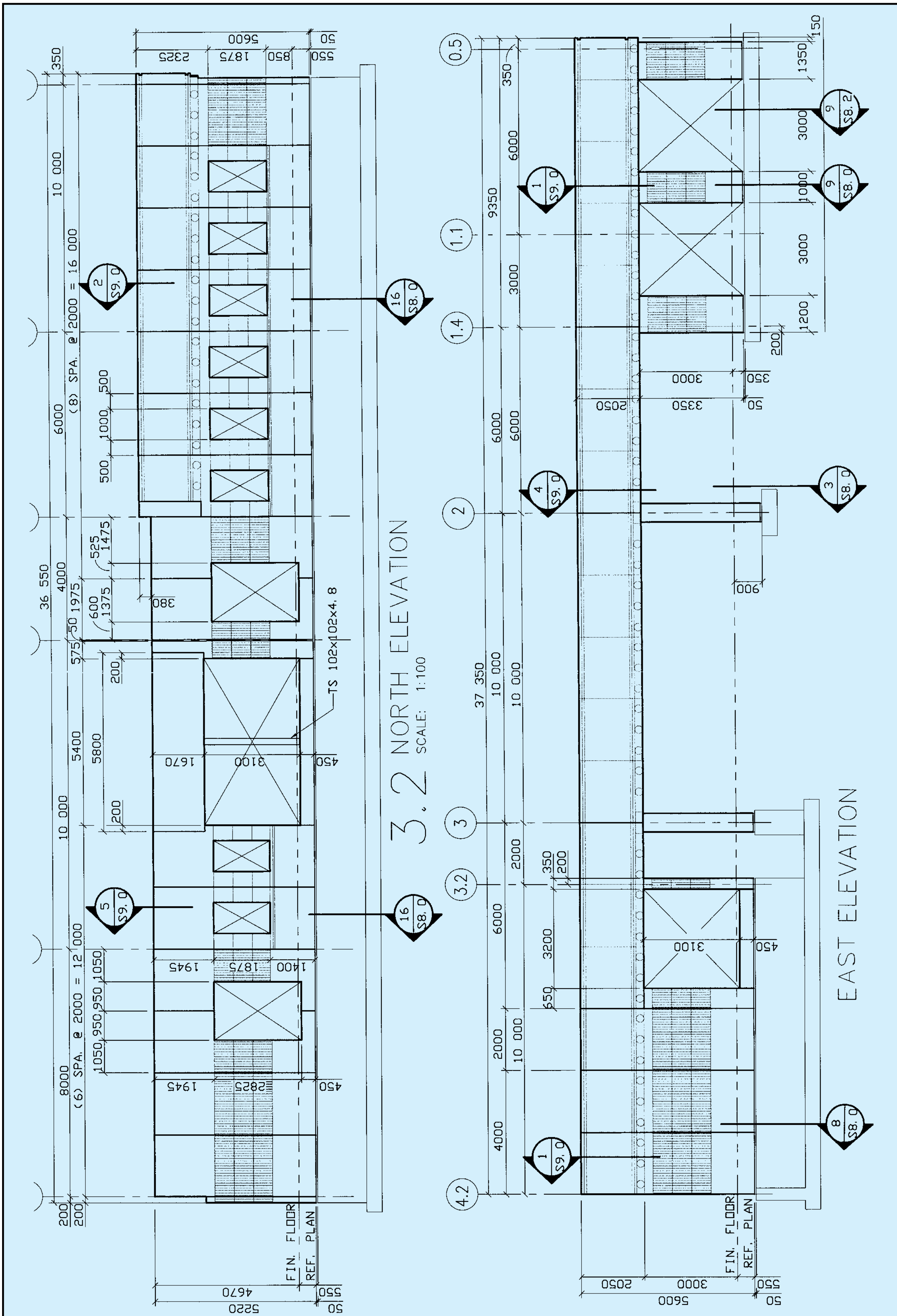

Fig. 7. Elevation of panel showing how various textures blended together.

Fig. 8. To blend the facility with the desert environment, a variety of setbacks and corners were created to avoid a monolithic wall design.

backs and changes in façade design, creating a large number of corners (see Fig. 8). Because of the variety in sizes for different wall panels, casting the pieces monolithically would have required a constant shifting of the viga's position on the panel facing, which would have called for more molds. To minimize the number of mold changes, each panel was simply cast with a pipe sleeve at the appropriate spacing for the viga projection to be bolted to it. This allowed the precaster to move only the sleeves when panel sizes changed, thus facilitating forming.

The vigas were cast with the same architectural concrete mix as the panels. Each day, between 24 and 30 vigas were produced. While the two-step process increased labor for connecting the vigas after they were cast, it significantly reduced the potential for chips and spalls.

This creative idea added aesthetically to the finished product because the projections were increased in length to more accurately reflect the look of the vigas and produce a longer shadow on the face of the panels (see Fig. 9).

PRECAST/PRESTRESSED STRUCTURAL FRAME

In planning this project, the designers studied and weighed the advantages and disadvantages of several structural alternatives. Three structural options were considered, namely, a structural steel frame with open-web steel joists, a structural steel frame with steel beams and composite floors, and the precast/prestressed concrete system that was ultimately chosen. The first steel choice would have yielded smaller bay sizes and limited design flexibility. Both steel options

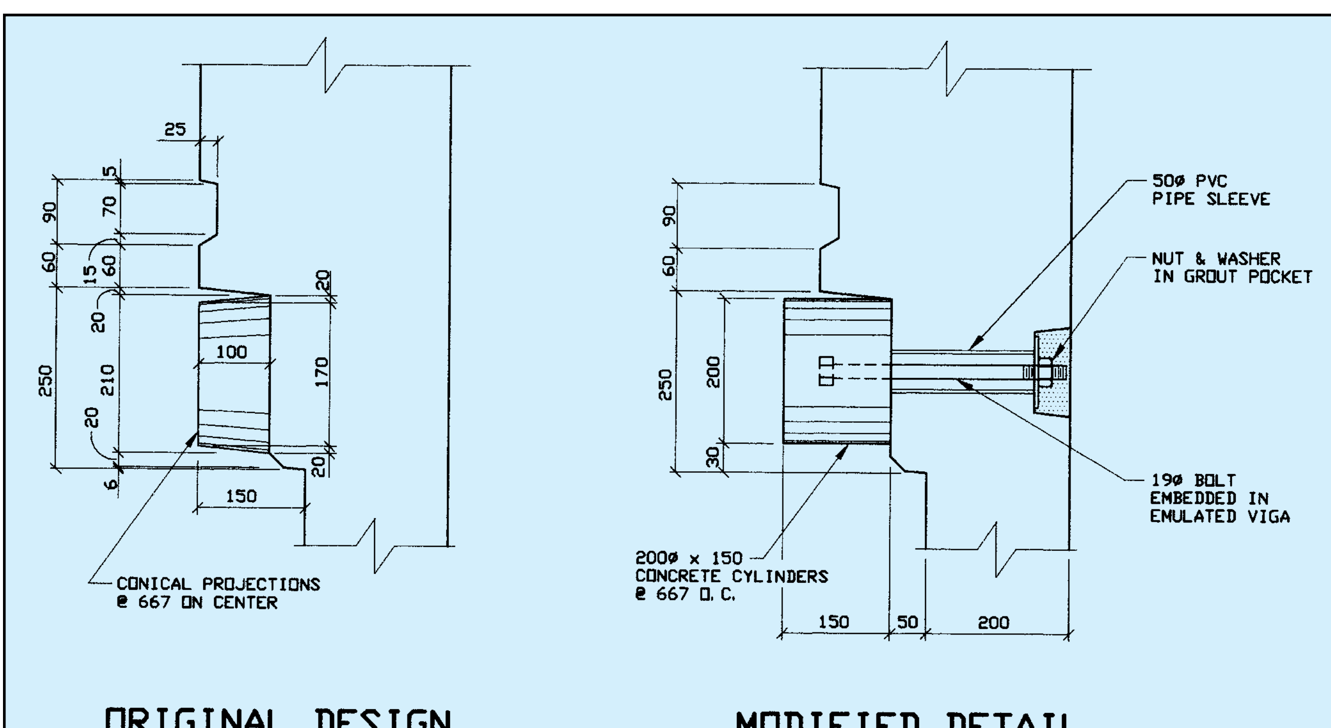

Fig. 9. By casting the vigas separately and attaching them at the plant, the precaster could change the shape of the pieces and make them longer and more realistic.

would have required more time to construct as well as the added expense of fireproofing.

The precast concrete design provided longer span lengths than the other systems. The double tees made it possible to eliminate half of the columns and create 10 x 20 m (33 x 66 ft) bays, doubling the area of the originally planned 10 x 10 m (33 x 33 ft) bays. This opened up the interior, making it easier to lay out service spaces and allowing people to move more efficiently around the building (see Fig. 10).

The precast concrete option also offered the fastest and most economical method for constructing the building. In keeping with the federal mandate, however, the width of the double tees was reduced from 3048 to 3000 mm (10.0 to 9.8 ft). As a result, the completed design specifications consisted of a roof level composed of double tees measuring 3000 mm wide x 711 mm deep (9.8 ft x 28 in.), spanning the long direction; and inverted tee beams measuring 300/600 x 900 mm (12/24 x 36 in.) in the short direction (see Fig. 11).

The concrete support columns were 600 mm (24 in.) square, and the floors were subdivided into 10 m (33 ft) square bays with additional 600 mm (24 in.) square columns. Expansion joints divided the building into quarters. The precast concrete components offered an inherent three-hour fire rating for columns and beams and a two-hour fire rating for double tees, requiring no additional fireproofing.

The resultant enclosed shell provided an ideal workplace for the local tribes people to complete the construction. Using precast concrete for both the cladding and structural frame focused more of the project into a single-source provider, reduced the need for on-site trades people, and facilitated coordination. It also placed more of the responsibility on one company, ensuring smooth construction.

The ambience of the large interior spaces is enhanced by the use of controlled natural lighting, especially in the public areas. Prominent exterior and interior light shelves allow light to be reflected against the wood ceilings (see Fig. 12). The central corridor and two-story atrium are illuminated by skylights on top of the 8.2 m (27 ft) tall space. This expands the common areas vertically and lights interior walls, inviting the desert environment indoors (see Fig. 13). Where feasible, skylights in other sections were also used to bring the outside into the clinical areas.

Fig. 10. Long double tees made it easy to lay out the interior medical spaces.

Precast/prestressed concrete became more desirable when it became apparent that a structural floor over a crawl space was needed to accommodate the health care center's mechanical and electrical systems. The crawl space was lowered in several places when trenches were excavated for a network of below-floor sidewalks that provided access to key points of the building.

The floors of the five mechanical equipment rooms were also lowered to this below-floor sidewalk level for greater ceiling heights as well as to provide direct access to the below-floor network. This interstitial space


Fig. 11. Designers chose an all-precast concrete structural frame after looking at several steel options.

Fig. 12. Light shelves are prominent inside the facility, with daylight reflecting against the wood ceilings.

Fig. 13. The main interior corridor and lobby features a two-story atrium with skylights, allowing sunlight to penetrate deep into the facility.

allows options for future changes. Double tees, 500 mm (20 in.) deep and 10 m (33 ft) long, were used to span the crawl space, with a 90 mm (3.5 in.) thick topping applied to the tees for the required fire ratings (see Fig. 14).

To intensify the desert motif for the structure and make the transition to the clinical interior, the two primary entrances were designed with features that included ramadas, porte-cocheres, and canopies built with wood vigas (see Fig. 15). Latilla decking was added to some of the ramadas and placed loosely to provide shade for outdoor rest areas. One of the ramadas was placed at the southeast side of the building in a "healing garden," a traditional Hopi place for quiet reflection and meditation.

The designers made the transition from outside to inside space with round precast concrete columns. The precast columns provide exterior support for roof overhangs and are used within the interior in select locations (see Figs. 16 and 17). The columns were cast in two half-round pieces to offer the same architectural finish as the exterior panels.

Fabricating the columns in one piece would have created aggregate stacking that would have altered their appearance from the precast concrete panels after the application of the sandblast finish. Instead, connecting halves were cast with a pin or socket, which were first grouted together with the joint, and then grouted again.

Another interesting feature enhancing the native heritage is the two precast concrete scuppers designed to emulate the ones used on many local adobes (see Fig. 18). Scuppers funnel water from the roof down to cisterns where the water can be used for irrigation to aid conservation. The precast concrete scuppers required a separate precast concrete column for support because they were too heavy to cantilever from the building.

The channel sits in a notch cast in the top of the wall panel with a simple bearing connection attaching it to the column. The basin consists of cut-stone veneer facing on a cast-in-place wall around the cistern.

The precast/prestressed concrete

Table 1. Number and description of precast/prestressed components.

350	floor double tees [93,500 sq ft (8690 m^2)]
198	roof double tees [109,500 sq ft (10200 m^2)]
46	L-beams [1190 linear ft (363 m)]
130	inverted tee beams [3450 linear ft (1050 m)]
35	miscellaneous beams [682 linear ft (208 m)]
81	precast columns [1076 linear ft (328 m)]
98	architectural columns [1422 linear ft (433 m)]
440	architectural wall panels [43,200 sq ft (4010 m^2)]
1378	total pieces

Fig. 14. A crawl space was created to provide mechanical access, and this space was aided by using double tees for flooring.

Fig. 15. The medical center's entry features large wood posts along with beams acting as vigas to support an overhead canopy.

components were manufactured by Ferreri Concrete Structures, Inc., at their plant in Albuquerque, New Mexico. A breakdown of the individual products is given in Table 1.

The isolated, arid location of the project and the lack of available resources proved challenging. For example, delivering precast concrete components nearly 300 miles (480 km) across the desert on trucks and trailers from the precaster's plant did not pose difficulties. However, there was no water available at the site to wash off the dust and aftereffects of travel when the components arrived.

A water truck was rented and driven 10 miles (16 km) from the site to fill up, return, and wash off the panels upon delivery. The hot climate was another consideration in choosing precast concrete, as it would have been difficult to formulate and achieve a 5000 psi (35 MPa) concrete strength with the on-site batch plant.

The harsh climate did not unduly impact erection any more than might be expected in an area with extreme winter and summer temperatures. Construction crews dealt with cold rain and freezing conditions in the winter as well as high winds and blowing dust in the summer.

The erection itself progressed smoothly, even though delays did occur. For instance, the original architectural firm shifted its focus to building management and hired an associate design architectural firm to complete the project. The associate design firm's key designer subsequently left the firm. The new organization that the key designer joined was contracted to complete the design, while a separate coordinating architectural firm was brought in to supervise the construction.

The planning and design process for the Hopi Health Care Center began in 1995. A groundbreaking ceremony took place in the spring of 1998. Actual construction took almost two years to complete. The total precast concrete erection phase took approxi-

Fig. 16. Round precast concrete columns were used as exterior roof supports and also as interior supports, blending the two spaces.

Fig. 17. Precast concrete columns also were used both outside and inside to tie the two areas together.

mately 64 days, with the precast concrete components costing $3 million. The project was completed in May 2000 at a total cost of $18 million (see Fig. 19).

CONCLUDING REMARKS

This project is an excellent example of the combined use of precast/prestressed concrete framing with precast exterior wall panels to produce a functional, aesthetically pleasing and economical building which met many diverse requirements. This was made possible by the close coordination of all parties in the design-construction process.

The communication efforts resulted in a building with a superb blend of character and durability. The combination of native construction materials with precast concrete is unique. The contrast between the small scale of the stonework and wood textures against the massive, durable look of the precast concrete is striking.

The use of precast concrete pays homage to the adobe tradition of building with masonry but also presents a new way for these buildings to be created. The Hopi tribe's goal of having the building's design respect their heritage has been achieved with great success.

This project won an award for "Best All-Precast Structure for 2001" in the recent PCI Design Awards Program. The jury citation was as follows:

"This all-precast structure overcame several obstacles, including the economic challenge of building on an Indian reservation in the middle of a desert, matching the surroundings and the cultural needs of the Indian tribe, and designing to federally mandated metric measurements. All of these challenges were met by the design team, which created a very elegant structure that fits well with its surroundings, providing an innovative use of precast/prestressed concrete. The use of the plant-cast, precast exterior works well with the interior framing, creating an excellent all-precast design. Providing details that enhance some of the native type of construction also was a nice touch."

Fig. 18. Precast scuppers required a separate precast column for support because they were too heavy to cantilever from structure.

CREDITS

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Fig. 19. The variety of corners and overhangs, combined with the viga-like projections on the panels, create a distinctive look for the long, low facility throughout the day.