Precast Concrete Delineates Biology Lab Inside and Out

Floyd D. Anderson, AIA
Project Principal
Lohan Associates
Chicago, Illinois

Jagdish Nijhawan, P.E.
Vice President
Wilson Concrete Co.
Omaha, Nebraska

Tom Kelley
Vice President, Precast/
Prestress Operations
Gage Brothers Concrete Products Inc.
Sioux Falls, South Dakota

The new Molecular Biology Research Building on the downtown Chicago campus of the University of Illinois took advantage of precast concrete's plasticity and aesthetic values to create a distinctive image inside and out. On the exterior, this was achieved in a number of ways, most obviously by differentiating the individual functions in the building — offices and laboratories — with different façade treatments. Other key elements included the addition of decorative precast medallions above the entry tower on each of two sides that allude to the building's biological mission and the creation of a large, glass-fronted atrium that shows off the interior staircase. That stairway was designed as a precast double helix, which alludes once again to the building's biological focus. The project, which cost $55 million, included two precasters working in harmony to create exterior panels, with the second also supplying materials for the staircase from shop drawings produced by the first precaster.

Close teamwork between designers and two precasters created the distinctive interior and exterior design treatment that graces the Molecular Biology Research Building located on the downtown Chicago campus of the University of Illinois (see Fig. 1). The building occupies a prominent location on the west campus, serving as the primary building seen when approaching the school from the nearby expressway.

The project also contributes to the enclosure of a landscaped quadrangle located at the terminus of a campus

Fig.1. The new Molecular Biology Research Building on the downtown Chicago campus of the University of Illinois took advantage of precast concrete's plasticity to express different building functions on the façade.

pedestrian pathway. Because of this strong visibility, university administrators wanted the new building to make a strong design statement that projected an impressive scientific and academic appearance while creating a unique and aesthetically pleasing appearance.

In recognition of the structure's visibility on the campus, the architects considered all four façades to be equally significant in their design plan. However, this created a key challenge in allowing the building to fit into its surroundings. The biology laboratory was the first major commissioned project on this part of the campus in a long time, and the other buildings in the vicinity featured a decidedly eclectic architectural style.

Most of these buildings date to the 1920s and 1930s and feature a variety of brick and precast concrete design motifs. There was no truly dominant image to play off in creating a program for the new building. Thus, the design goal focused on creating a style that would be compatible with this diverse group of buildings while also projecting the distinctive design statement the administrators wanted to project for visitors (see Fig. 2).

In plotting the initial design ideas, precast concrete architectural panels were a natural choice to serve as an exterior skin. Precast concrete could provide considerable flexibility in creating different looks due to its moldability, texturing and color options. The designers realized they could create design interest in the façade's articulation by combining different styles into one unified concept as well as adding detail pieces to create interest.

In addition, by selectively varying the colors and finishes used in the panels based on where they were lo-

Fig. 2. Artist's rendering for the design proposal showing the full length of the building and its siting within the university's campus.

cated, it was possible to pick up themes in nearby buildings without detracting from the structure's overall aesthetic look. The pieces fit together into a nice unified whole, with the result that each façade is compatible with its own distinctive surroundings while looking like it belongs as part of the new structure itself.

From a programmatic standpoint, precast concrete panels were a strong choice because of their durability. Maintenance programs for university buildings are not always as well followed as they should be, and the precast panels would reduce the maintenance requirements through the building's lifetime.

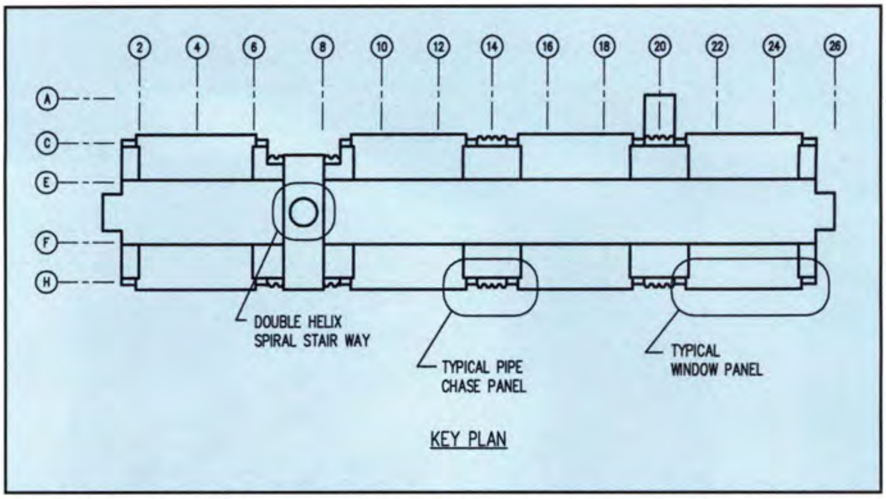

Fig. 3. Master floor plan shows how each level was laid out with key facilities along the perimeter and support services in the center.

Precast concrete, in general, offered stronger long-term cost benefits than other materials. For instance, a brick option also was considered, but it would have required many more joints and points of entry for water intrusion, especially after several years of wear. Designing with precast concrete eliminated most of those joint concerns and kept water-intrusion problems to a minimum.

Interior program needs also played a role in the planning for the façade treatment using precast panels. The building encompasses laboratory space, classrooms and teachers' offices, arranged in a linear pattern covering 240,000 sq ft (22320 m^2) divided equally among four floors. Offices and laboratories are organized along the building's perimeter, with support services in the central core (see Fig. 3).

This layout supplied an ideal catalyst for delineating each function with a different textural finish on the façade. The modularity of the design

Fig. 4. The laboratories' exhaust ducts were left exposed on the exterior, creating an additional design element and serving as a vertical break between façade sections.

Fig. 5. Distinctive precast concrete details were included both inside and out, including the "atomic clock" in the entry tower.

was picked up in the façade treatments through articulated precast panels divided by vertical exhaust ducts, which were left exposed (see Fig. 4). These elements serve to separate the building into four bays, reducing its mass and providing a distinctive and functional division.

Other visual elements were added to the exterior to showcase its academic image and tie it to its molecular biology focus. These included an asymmetrical entry tower that focuses attention on its height with medallions that top its structure on each facing side. On one side, the precast sculpture (which includes some fiberglass) replicates the university's logo, while on the parallel façade, the precast concrete frames a clock recalling an atomic structure (see Fig. 5).

DOUBLE-HELIX STAIRWAY

The project's most dramatic design element comes from its glass curtain wall exposing the central circular stairway that rises through the center of the building. This staircase was also fabricated from precast concrete propeller-shaped treads that create a double-helix spiral. The helix shape further recalls the scientific function of the building, as it replicates the form for DNA, the building block of life. The staircase is also illuminated at night, resulting in a dramatic precast concrete element that attracts attention throughout the day (see Fig. 6).

The building's structural frame features a hybrid system with steel columns, steel beams and cast-in-place concrete decks. The non-load-bearing architectural precast panels were initially designed and detailed by LEAP Associates International, Inc., with final shop drawings prepared by the winning precast bidder, Wilson Concrete Co., Omaha, Nebraska.

However, due to schedule restraints, the precaster decided to enter into a joint venture on the project with Gage Brothers Inc. of Sioux Falls, South Dakota, to keep the project on its required timetable. Gage was supplied with shop drawings and was responsible for casting the first-floor façade panels and the stair treads and components. This required close communica-

Fig. 6. Artist's rendering of the main entry showing how the designers intended to create drama with precast elements both outside, with the "atomic clock" in the tower, and inside, with a double-helix spiral stair, which is lit at night to provide a striking image.

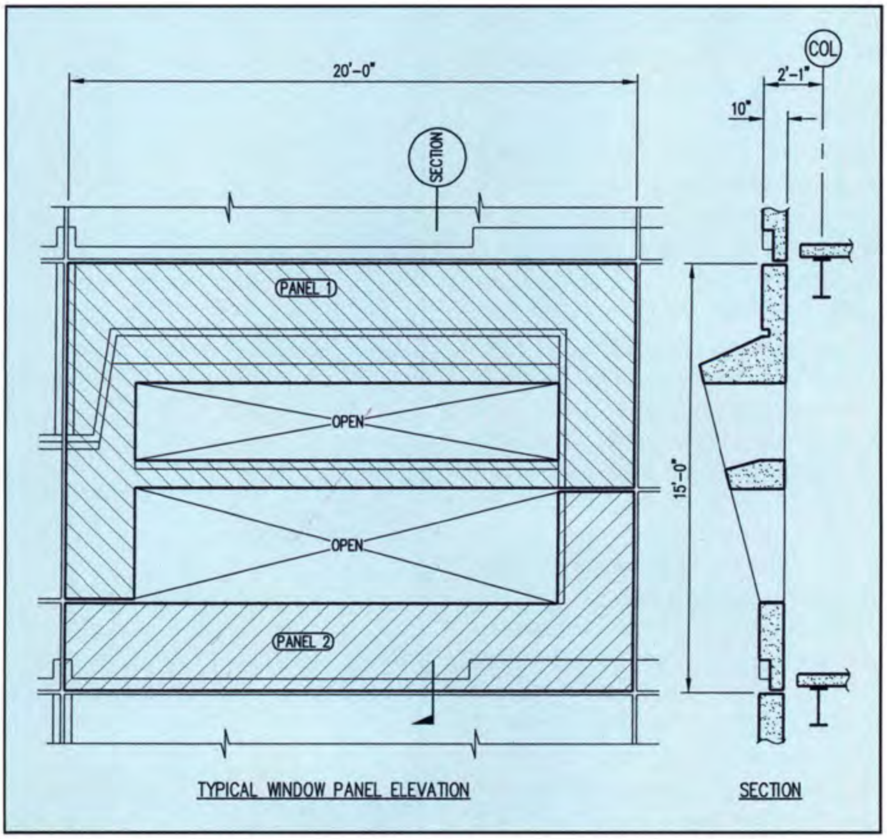

Fig. 7. Elevation of single panel used on the east and west façades showing how the two components making up each component were meshed to create the distinctive overhead eyebrow that shades each window.

tion and cooperation between the precasters to ensure that façade panels butting against each other vertically did not produce any discrepancies in color or texture due to their separate production sites.

ARCHITECTURAL PRECAST PANELS

The precast panels, though complex, showed versatility in architectural design while providing enough repetition to produce an overall economy. In all, nearly 15 different panel shapes were cast, with a variety of finishes included in that total. The east and west elevation window panels feature a pink acid etch finish and a concrete mix that comprises Nebraska limestone, Platt river sand and a combination of white and gray cement.

The north and south typical floor panels were designed with a red acid etch finish using red granite and a concrete mix that comprises red granite sand, silica sand and gray cement. The ground floor panels along these sides have a pink acid etch finish, to provide a strong base texture for the building.

Two different primary panel designs were required to complete the façade design: an eyebrow shaped element and a lower L-shaped component. Combining these two components into one panel made it vital that the panels be cast to tight dimensional tolerances.

In fact, the job specifications called for the tolerances to be half that allowed in PCI MNL-117, *Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products* (see Fig. 7). That made it necessary to use custom steel forms to ensure these tighter tolerances. Support panels for the university logo medallion and the atomic clock are located toward the top of these elevations. Amber-tinted windows reinforce this color scheme (see Fig. 8).

Connections were designed to ensure the panels fit together without any difficulty. The upper eyebrow panel transfers its weight and that of the typical L-shaped panel directly to the exterior steel column through two gravity connections, one at each end (see Fig. 9). The upper panel is stabilized by two tie-back connections located above and below these gravity

Fig. 8. The two-piece façade panels join with amber-tinted window glass to create striking designs for the fenestration in addition to offering energy-efficient shielding.

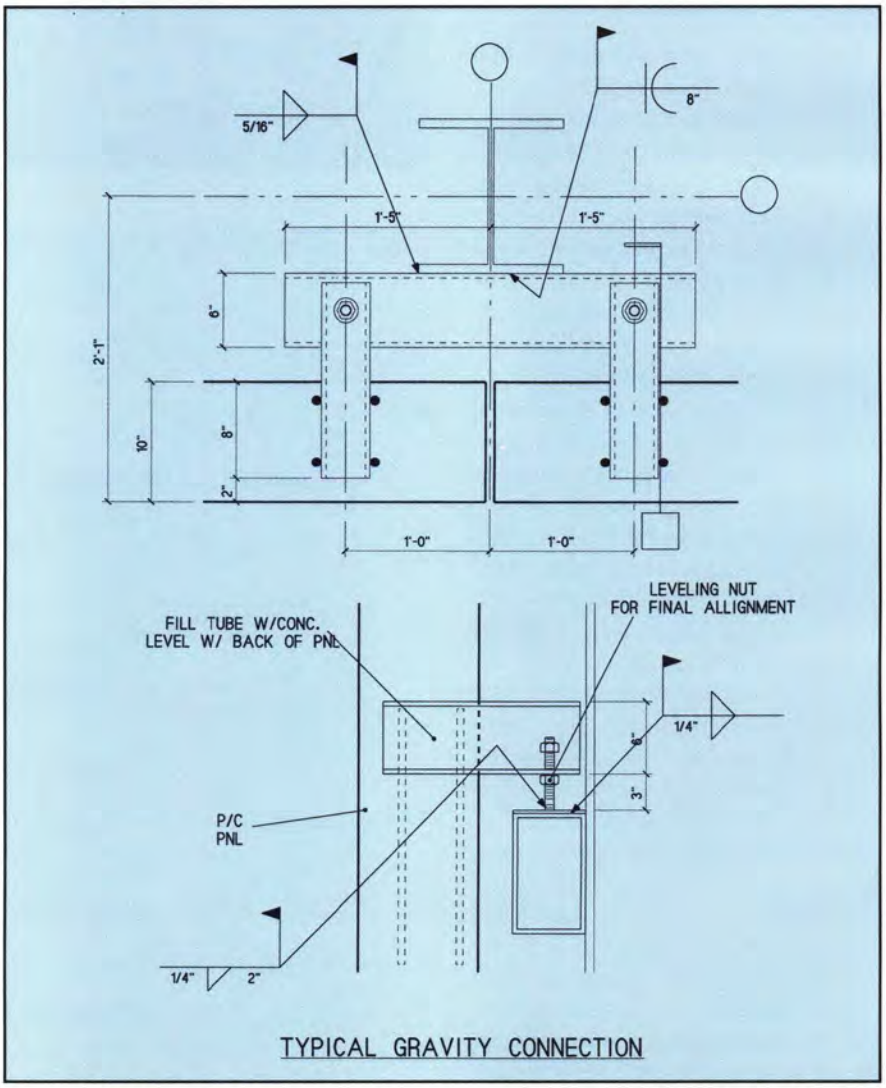

Fig. 9. The typical gravity connection was designed to support the upper eyebrow section of the window panels. Two connections were used for each panel.

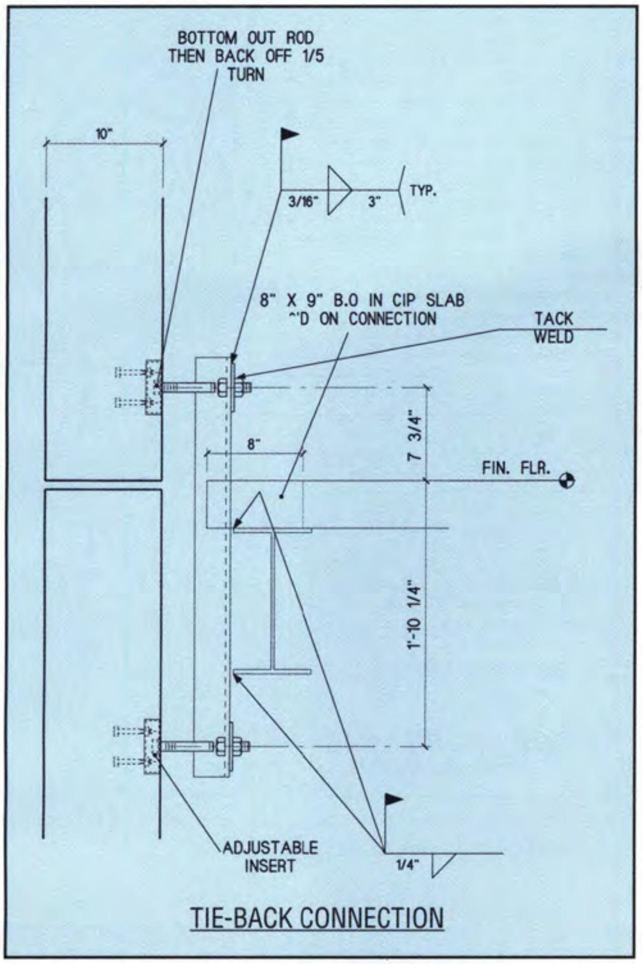

Fig. 10. The typical tie-back connection was used above and below the two gravity connections used for each panel.

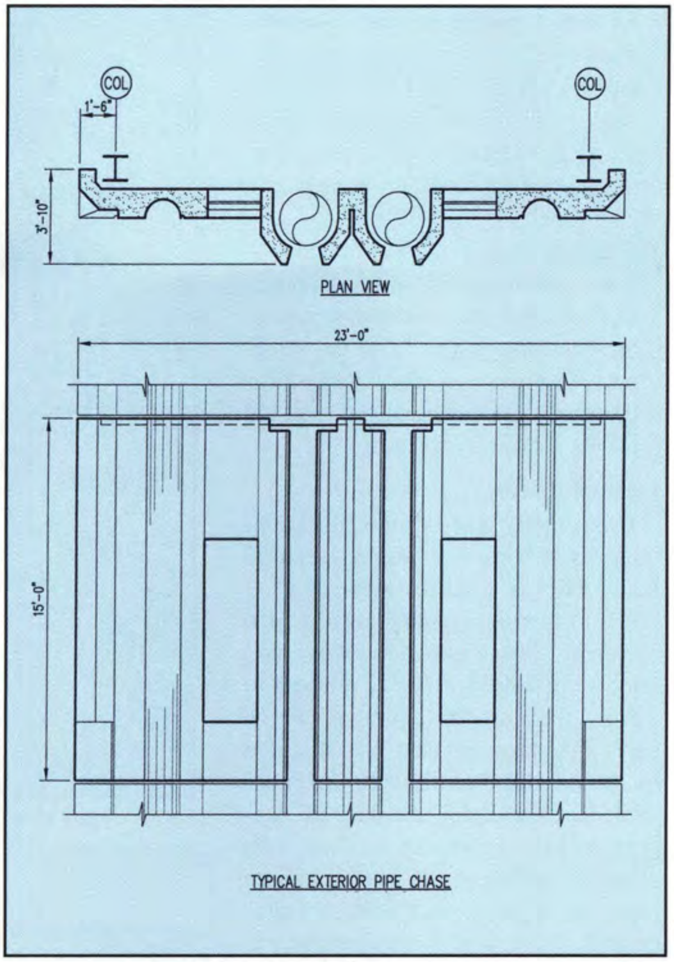

Fig. 11. Typical exterior precast pipe chases used to cover the exhaust vents running along the outside of the building.

connections (see Fig. 10). The lower L-shaped panel thus gains support from the lower eyebrow panel through confined shims, while the lateral stability is achieved through two tie-back connections at each end.

Connections

Careful thought was put into designing the precast connections. Some of the major features were as follows:

- **Spiral stair connection** — Connections had to be made and wiring installed progressively as each piece was erected. Cantilevered tread sections were analyzed using the finite element method to determine and control stresses and deflections.

Fig. 12. The precast "atomic clock" was created with five support panels for hauling and erection.

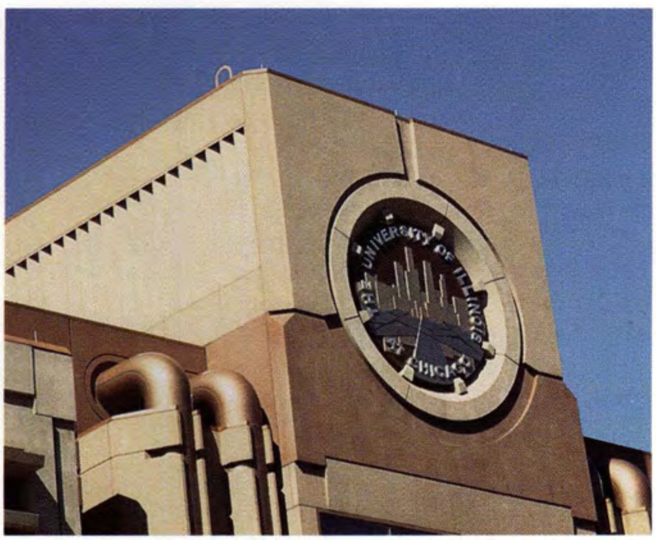

Fig. 13. The university logo at the top of the entry tower along the parallel facades.

- **Eyebrow panel gravity connections —** The connection detail provides a place to land the panel and moves gravity reactions away from the ends of panels while providing the ability to re-adjust panels at a later time.
- **Exhaust duct panel connection —** Panels were placed on one another, stacked from the foundation due to their distance away from the structure. Connections also allowed for unrestrained movement between the panels and main structure.

Exhaust Covers

Designing the exposed exhaust pipes as if they were an architectural feature of the exterior meant partial precast coverings had to be provided for them. This was achieved by casting a curved precast façade element to use as needed. The extent to which each pipe was exposed was dictated by the maintenance needs for the pipes while not sacrificing the desired exterior architectural expression. The clearness and openings between these pipes and the precast concrete was carefully designed by the architect in order to replace any pipe required without removing any of the precast elements.

Approximately 175,000 sq ft (16275 m^2) of precast panels were used on the façade, with some weighing as much as 30,000 lbs (13610 kg) and measuring 18 in. (457 mm) thick. Most of the panels measure 20 ft (6.10 m) wide to span between columns and stand up to 15 ft (4.57 m) tall. Precast concrete costs were about \$2.5 million out of a total construction budget of \$55 million.

The erection process for the precast components moved smoothly. The panels were erected at a rate of about 10 to 20 panels per day, with many delivered to the site one at a time due to their size. The design was completed by the end of March 1994, with precast concrete production beginning slightly earlier on February 14. Erection began on June 6, 1994, and was completed 3 months later on September 2, 1994.

The precast medallions capping the entry towers measure approximately 19 ft (5.79 m) in diameter and re-

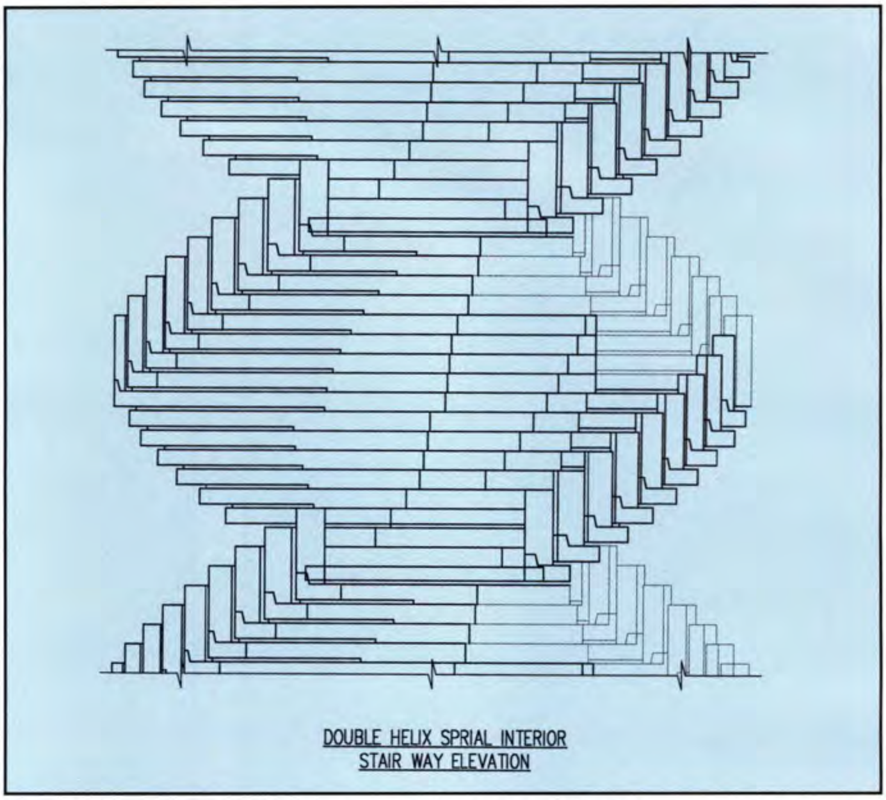

Fig. 14. The internal precast concrete double-helix spiral stair was a unique element that the precasters had never seen before, much less produced.

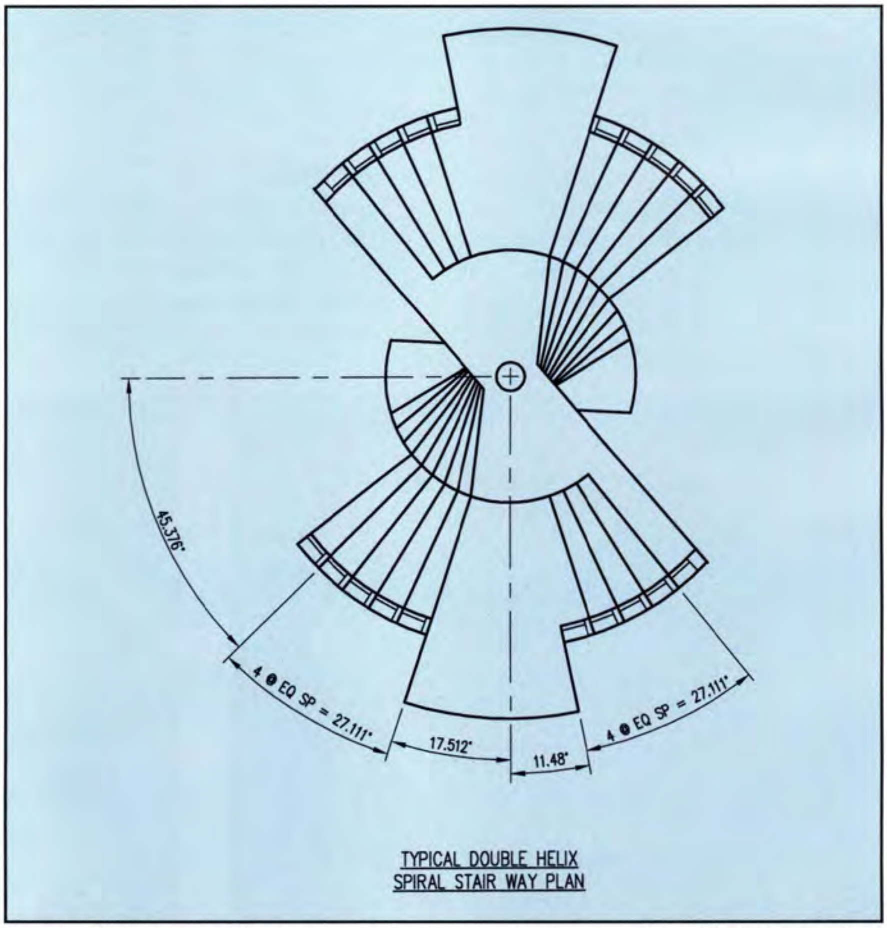

Fig. 15. Plan showing the shape and dimensions for the typical double-helix spiral stairway components created for the interior staircase.

Fig. 16. The dramatic spiral stairway features a bright-white finish that combines with its design to produce a powerful impact inside the building's entry.

Fig. 17. Landing components provided at each level are the only deviation from the typical dimensions cast for the propeller-shaped precast units.

quired special attention in their precast design (see Figs. 12 and 13). The support system consisted of five supporting panels to facilitate hauling and erection. The bottom panel was tied to the steel structure through gravity and tie-back connections.

Then the two pieces above in the semi-circle configuration were connected together. These two pieces recessed to the logo and were temporarily braced. The top two precast panels then were connected to the steel structure, and the braces were removed for the final stability of the precast support system.

UNIQUE STAIRWAY

The other key design challenge came with the precast spiral stairway, which the precasters had never seen done before, let alone accomplished themselves (see Fig. 14). The double-helix design consists of two repeated elements, a dual tread and wider landing components (see Fig 15). The stairway was devised to transfer the entire load to the round steel column at its center, which in turn transfers the load to the foundation caisson. The caisson, with a 30 in. (762 mm) diameter shaft and a cap measuring 2 ft (0.61 m) thick and 8 ft (2.44 m) in diameter, was set 50 ft (15.2 m) below grade. The staircase connections were made by welding plates to the interior of this column.

The first section of the center steel tube was erected, and then the precast components were lowered into place through a hole that was opened in the roof of the completed shell structure. Each propeller-shaped precast component, measuring 19 ft long x 1.5 ft wide x 5 in. thick (5.79 m x 0.46 m x 127 mm), was then set in place.

About six such components were welded to the pipe at a time. Then, a new section of pipe was attached, six more treads were lowered, and were welded into place. Each was rotated approximately four degrees from the previous component, with landings provided at each level. Approximately 88 treads were needed to complete the spiral (see Figs. 16 and 17).

Tolerances Reduced

Because of the need for tight construction, tolerances were significantly reduced over the typical precast design. In fact, although this design was accomplished with no significant difficulties, it probably would be advisable to prestress each stair tread on similar projects in the future. The 5 in. (127 mm) thickness of the treads creates a little more "bounce" than may be desirable, and a couple of components experienced minor cracking.

Fig. 18. The casting process for the stair treads was complicated by the fact that all six sides were visible from some angle in the structure.

Fig. 19. Adding complexity to the calculations was the decorative precast guardrail on the end of each tread, which added more weight to each cantilevered segment.

Another challenge came in having to finish each component on all six sides due to their suspension on the framework (see Fig. 18). The selected finish blended white cement, #2 Wyoming white rock and a carefully selected mix of crystal white sand and limestone fines. This was lightly sandblasted, creating a bright-white finish. Guardrails also were provided in precast concrete with this same mix, and they too produced a challenge by adding significant weight at the end of the cantilevered structure (see Fig. 19).

CONCLUDING REMARKS

The result of this challenging design is a dramatic centerpiece structure for the campus that shines like a beacon day or night, projecting an aesthetically pleasing but institutional image. The project's design and erection solutions were so innovative that the building was awarded the 1997 Precast Concrete Design Award for Best Designed Educational Facility by the Precast/Prestressed Concrete Institute.

In recognizing this building for an award, the judging panel said:

> "Using precast concrete to build the interior double-helix staircase represented a bold design decision. In addition, the approach to breaking up the exterior façade with color and vertical breaks was dramatic and works well given the size of the building. This structure has a lot of visual interest. It really uses the plastic quality of concrete to achieve designs that could not have been accomplished with any other material. The shaping of the exterior elevations, especially by angling the windows and making use of the exhaust vents outside the laboratories, gives the building great depth."

In the 3 years since completion of the facility, the Molecular Biology Research Building has become a well-known campus landmark. Faculty, students and visitors enjoy and admire the new facility (Fig. 20).

Fig. 20. Finished view of award winning Molecular Biology Research Building on the Chicago campus of the University of Illinois.

CREDITS

Owner:
University of Illinois Office for Capital Programs, Chicago, Illinois

Architect:
Lohan Associates, Chicago, Illinois

Engineer:
Chris P. Stefanos Associates, Oak Lawn, Illinois

Consulting Engineer:
LEAP Associates International, Inc., Tampa, Florida

General Contractor:
Walsh/II in One, a joint venture, Chicago, Illinois

Precast Prestressed Concrete Manufacturer:
Wilson Concrete Co., Omaha, Nebraska (upper-level panels);
Gage Brothers Concrete Products Inc., Sioux Falls, South Dakota (first floor panels and spiral staircase)

Photographer:
Jon Miller © Hedrich-Blessing, Chicago, Illinois