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PHONE: 312.786.0300
E-MAIL: INFO@PCI.ORG

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Architecture School Tests Boundaries Of Precast

By Craig A. Shutt

What better way to show off to architecture students what various building materials can accomplish than creating an extremely challenging and dynamic structure to house a school of architecture? That was the thinking behind the unique load-bearing precast concrete design for the new five-structure facility at Florida International University.

The design not only required state-of-the-art precast concrete casting methods, but it had to be accomplished on an extremely modest budget. To achieve these goals, the precast concrete detailers created wire-frame models of two complex structures to allow all the intricacies to be seen in three dimensions. The project’s concept and execution were so innovative that the project won the Harry H. Edwards innovation award in the 2004 PCI Design Awards competition.

Opened in 1972, FIU is one of the nation’s thirty-largest universities, with more than 34,000 students. The new 100,000-square-foot School of Architecture is located at a prominent site on the main campus. It was built to house several programs on a total budget of $13 million while projecting a dynamic image with an appearance as important as its function.

Designers at BEA International conceived the school as a

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Designer: BEA International/Bernard Tschumi Architects Joint Venture, Coral Gables, Fla.
Structural Engineer: BEA International Inc., Coral Gables, Fla.
Construction Manager: Biltmore Construction (BC), Tampa, Fla.
Precaster: Coreslab Structures (MIAMI) Inc., Medley, Fla.
Precast Concrete Specialty Engineer: Salmons P.C., Albuquerque, N.M.
Precast Concrete Detailing: Precast Inc., Burleson, Texas

"generator" of university culture, with the building intensifying the students' social and cultural interactions. In this way, the structure would activate as well as enclose activities. The resulting design featured two wings defining a space activated by the exuberance of three colorful "generators." The building wings were designed with precise yet user-friendly bright-white precast concrete panels. Two of the three "generators" feature precast concrete panels covered with variegated yellow, red and orange tiles.

The precast concrete system, which combined structural and architectural components, helped the buildings meet the budget of $125 per square foot. A system of load-bearing panels supporting a series of double-tee beams was used for all five buildings. In the lecture and gallery buildings, the two most complex structures, this allowed spans up to 70 feet plus inclined precast concrete walls, offering open spaces that could be controlled acoustically.

The ceramic tiles were applied to the panels in a recess using an 8- by 8-inch modular layout. The tile joints, as well as all control, expansion and panel joints, were organized into a precise matrix that merged skin, structure, thermal seal and color to form one cohesive system offering multiple levels of resolution.

The first three buildings to be constructed—the office, studio and model shop—were designed in typical fashion for the type and size of structures required. But the other two buildings created a variety of challenges for precasters and engineers, as the designers wanted to show what could be accomplished with precast concrete. They used a basic concept of supporting precast concrete double-tee spans on load-bearing panels, but the shapes and connecting points were unique.

"From a design standpoint, the buildings were irregular, with few square corners and walls that were intentionally out of plumb," explains Timothy R. Salmons, president of Salmons P.C. in Albuquerque, the specialty engineering firm. "Since it was a school of architecture, they wanted to show what could be accomplished with precast concrete and prove that you could do the most imaginative things with it. That created some real challenges for us."

Brian Irvin, project manager at Precast Inc. in Burleson, Texas, the precast concrete detailing firm, agrees with that assessment. "The first three buildings were standard designs, but the final two featured a number of things that you wouldn't normally do with precast."

To resolve those issues, Precast Inc. created wire-frame models of the two buildings so they could be envisioned in three dimensions. "We began doing the calculations by hand and plugging them into two-dimensional computer models," Irvin explains. "But it became too confusing and didn't give us what we needed. So we decided the most effective approach would be to create the wire-frame models." The engineers considered buying and installing new 3-D modeling software, he notes, but the short time frame didn't allow enough time for mastering the intricacies of a new program.

"The wire-frame models were essential and worth every effort to those involved in the design and detailing," Irvin says. The result was a superior fit between the angled precast concrete components on the gallery building. Adds Salmons, "Creating the designs in three dimensions brought new details to light that weren't apparent early on. The gallery in particular had a lot of structural discontinuity that had to be addressed."

This included its load-bearing elevation walls, which had out-of-plane projections, so the double tees came in at a skewed angle. This required exact detailing to ensure the fit would be precise. "There was a lot of skewing, sloping and slanting, which was all unique," Salmons says.

The team produced the standard structures first, both to allow the precast concrete manufacturers to begin casting quickly and also to give the engineers more time to work out the details of the two unique structures, Salmons says.

"Structurally, all of the same concepts were used for all of the buildings, but with these final two, everywhere you turned, they were atypical. Every connection had its own unique design, and every panel and piece was unique, with no repetition possible."

Casting some of the panels also proved challenging, according to Bill Whitcher, executive vice president and regional manager at Coreslab Structures (MIAMI) Inc. in Medley, Fla. The original precast concrete panels for the lecture hall and gallery were too heavy for the plant's overhead cranes to handle. To reduce the crane loads, the panels were redesigned to include large foam cores, resulting in significantly reduced weights, which equaled the crane-load maximum ratings.

The triangular cantilever panels on the gallery building required a series of embedded tubes and receivers for grouted steel bars and bolts, creating challenges during casting. "While numerous other potential obstacles were overcome," Whitcher says, "the wall-panel production for the lecture hall and gallery building posed the greatest challenges by far, with the constantly changing miter angles, side rail tapers and irregularly shaped blockouts."

Due to state limitations on truck hauling, most of the panels were transported flat on triple-axle stretch trailers, with truck escorts used when panel widths exceeded 12 feet, he notes. To avoid these escorts as much as possible, many of the panels wider than 12 feet were transported on custom slant-frame trucks. Panels that had tile installed at the plant were hauled on edge, using modified A-frames to prevent any possible damage.

Project layout and erection required careful logistics because jobsite access and storage were limited, he notes. But the site was only about 10 miles from the plant, so the precast delivery trucks could be dispatched and turned around quickly. All panels were live-loaded and hoisted directly from incoming trucks.

The large, heavy precast concrete panels required a series of rolling blocks and spreaders to engage all of the lifting devices required to rotate the panels. The erection sequence was particularly critical on the lecture building, where the rakers and risers were erected concurrently with the walls, but prior to other precast members that were framed above.

After the precast concrete panels were rolled into vertical positions, a 175-ton-capacity truck crane hoisted them into place, guided by erection personnel on the ground. Anchorage hardware already embedded in the foundation was used to secure the panels to the foundation. A series of weld plates then fastened the panels to each other.

Erection of several precast concrete double tees was especially arduous where members spanned between exterior walls that were inclined into the structure. This angular arrangement necessitated shoring the walls until the double tees could be put into place. Then the walls were set in their final position at the needed inclination.

The result was a dramatic design that shows the versatility of precast concrete. “They really ran with the concepts and did them well,” says Salmons. “They showed the strengths and capabilities of the material. It’s truly a tribute to precast concrete. The designers had a real appreciation for the material and its possibilities, and they knew that it could do what they wanted it to do.”

In naming the project the winner of the Harry H. Edwards award for innovation in the 2004 PCI Design Awards competition, the judges said, “This project shows an innovative use of total-precast concrete technology by incorporating both architectural and structural precast, prestressed concrete components into the building complex. A variety of precast concrete components were used imaginatively, including double tees, rakers, load-bearing wall panels, stairways, risers, columns, spandrels and a pedestrian bridge walkway.

“Construction economy was a major factor in the selection of precast concrete. Future expansion also has been considered, which will nicely surround the palm-tree courtyard. The project gives the university a beautiful, durable, sustainable, fireproof facility that will be a signature building on campus. It also creates an outstanding living/learning teaching tool for young architectural students. What better way to market precast concrete to future designers than with this signature building?"