

Total-Precast System Creates LEED-Certified School

Precast concrete insulated sandwich wall panels and double tees create new facility adjacent to existing one, boosting energy efficiency, lowering maintenance costs, and improving air quality

— By Craig A. Shutt

The usual demands of constructing a new high school building—including a tight budget and air-tight scheduling—weren't the only challenges that had to be met in designing the new Riverside High School in Greer, South Carolina. Once administrators decided to start from scratch and build a new facility, they wanted to incorporate as many sustainable-design concepts as possible. The result was one of the first LEED-certified high schools in the country, built with a total-precast concrete structural system and panels.

The process was complicated by two factors. As always, the transition from the existing school term to the

new one had to be completed seamlessly during the summer, so students could leave one school and enter the new one as the school year began without disruptions.

In addition, the project began as a massive renovation and addition to the existing school. But halfway into the design process, administrators realized that the cost to renovate and add to the existing building was approaching that of a new building. "They decided that it made better business sense to replace the high school with a completely new one and take advantage of more sustainable-design concepts in siting and design, which could offset some of the costs

long-term," explains Richard Powell, project manager at BPRH Architects-Engineers, Inc. in Atlanta.

That provided a more controlled approach, but a lot of time had been lost in the meantime and would require a second building to be placed on the site. That added more challenges, says Herb Marshall, project manager at M.B. Kahn Construction Co. in Greenville, South Carolina. "We basically had to shoehorn a full-blown, 4A high school for 1,500 students onto a site with an existing school already there while the school's day-to-day events and extracurricular activities continued unaffected by construction activity."



The new Riverside High School in Greer, S.C., was changed from a major renovation into a project built from scratch after design work showed remodeling costs were exceeding budget. The new school, featuring a total-precast concrete structural system and panels, was built adjacent to the existing school, where class remained underway.

Siting Challenges Arose

To segregate the old and new, designers sited the new 268,000-square-foot, two-story facility into space being used for parking. Even so, a new auxiliary gymnasium bumped against the existing school building. To accommodate construction, the new gym was left unbuilt until the rest of the new school was completed. Once the rest of the facility was ready for occupancy and the school year began, the original school was demolished. Once it was out of the way and grading was completed for parking and tennis courts, the new gym was built.

'The precast concrete helped make up a lot of time during construction that kept us on schedule.'

This phased approach was possible in part due to the structural design, which consisted of load-bearing precast concrete insulated sandwich wall panels and long double tees. Field-topped floor double tees and untopped roof double tees used the exterior walls and interior corridor walls for load-bearing support as well as for shear walls for lateral stability. Precast concrete stair and elevator shafts also were included, providing a complete precast concrete structural system. Tindall Corp. of Spartanburg, South Carolina provided the precast concrete components.

"The precast concrete design was optimal because so much time was lost during the initial renovation planning," explains Powell. "It helped us make up a lot of time during construction that kept us on schedule. It also helped reach a lot of the sustainable-design goals that allowed us to achieve LEED certification."

The precast concrete design also gave the building's exterior a connection to the original high school. The finish features a low-maintenance design of sandblasted concrete with accent blocks of inlaid thin bricks. The bricks were chosen to replicate the color and texture of those used on the original high school. "The new building's walls went up right beside the existing high school's façade, so



The classroom design was modified from a straight wall to a sawtooth design that ensured that each room featured fenestration that opened to the southwest or southeast.

we could see that we made the right choice with the new bricks," Powell notes.

The panels consist of 2 inches of insulation sandwiched between a 3-inch exterior layer of concrete and a 5.5-inch interior layer to provide structural support for the double tees. The insulation layer was increased beyond what might be typical, Powell adds, to provide a higher R-value to meet LEED standards. The panels feature plastic wythe connectors to ensure continuous insulating value without any thermal breaks due to conductive connections.

Construction time also was saved with the sandwich panels by giving the interior layer of concrete a smooth, finished surface. It was sim-

ply painted with a heavy-duty paint to hide imperfections, which saved time and material that otherwise would have been spent on furring out and drywalling the interiors. The concrete surface also provides added impact resistance that will lower maintenance and replacement costs often needed with drywall.

The school's design consists of activity and mechanical rooms on one end of the structure, a central welcoming/administrative center, and classrooms on the other end. A courtyard runs through the center of the classroom wing, bringing daylight into the classrooms along the interior corridor. Rooms along the classroom wing's exterior wall were enhanced by a design change late in the program,

PROJECT SPOTLIGHT

Riverside High School

Location: Greer, S.C.

Project Type: High school

Size: 268,000 square feet

Cost: \$36 million

Designer: BRPH Architects-Engineers Inc., Atlanta, Ga.

Owner: Greenville County School System, Greenville, S.C.

Contractor: M.B Kahn Construction Co. Inc., Columbia, S.C.

Structural Engineer: Professional Engineering Associates Inc., Greenville, S.C.

PCI-Certified Precaster: Tindall Corp, Spartanburg, S.C.

Precast Components: Sandwich insulated wall panels, field-topped floor double tees, untopped roof double tees, stairs and elevator shafts



Thin brick embedded into the architectural panels used both for interior and exterior facings replicated the color and texture of those used on the original high school.

as the architectural team realized an alteration could have a big impact on the building's sustainable design.

Classroom Wing Revamped

The flat, straight exterior wall of the classroom wing was revamped into a stepped design with windows added

on each step. The windows face either southwest or southeast, adding daylight. "Every classroom has daylight streaming in from the south with this change," Powell explains. "We believe very strongly that daylight is a motivating factor in learning for students, and we wanted to provide as

much as possible."

Daylighting is controlled in some spaces, especially larger public areas, with monitors that track lighting levels. Spaces feature arrays of lights that can be cut back or turned on as needed. The system ensures lighting remains sufficient while taking full advantage of daylight as the first source for lighting. Fabric banners and clerestory windows help control daylighting to ensure heat levels don't build up. Occupancy sensors also are used to turn off lights when students leave.

Putting the Green in Greenville Schools

Riverside High School is part of an ambitious \$700 million green initiative in the Greenville School district to encourage the construction of green schools to both provide more sustainable design and also to serve as a teaching tool. In all, the program is aimed to replace or upgrade 70 school buildings.

The program is financed and directed by Institutional Resources (InRe), which provides protocols for the schools to follow to maximize efficiency and qualify for LEED certification.

The costs to include the various sustainable elements used in the high school are being offset in part by grants that could not have been earned otherwise, according to Andy Crowley, Riverside principal. "There are a lot of environmental-study grants out there that, in the past, we couldn't touch because the existing school didn't come close to meeting minimum efficiency requirements," he said when the school opened. "The grants we expect to get with LEED certification will definitely help offset the cost of attaining the certification. The results of LEED will far outweigh the costs in every aspect."

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The public areas were aided by the precast concrete system, which provided clear, open spaces thanks to the double tees' long-spanning capabilities. "We created some very exciting public spaces by using the precast system to open them up,"

Powell says. "They allow us to take full advantage of daylighting and create welcoming rooms. The cafeteria and media rooms in particular are very popular meeting places and are very conducive to fulfilling their functions." In addition, the long-span double tees make it easy to adapt the spaces in the future as needs change and new equipment is brought in.

Sustainability Concepts Used

A variety of efforts were made to meet LEED standards, incorporating a wide range of energy-efficient techniques and other sustainable-design concepts. Most dramatic were solar panels installed on the roof and a 5,000-square-foot green roof that was located on top of a first-floor room adjacent to the gymnasium's mezzanine.

The solar panels provide 550 gallons of pre-heated water storage for use in the kitchen and athletic locker rooms' hot-water system. Radiant-heat barriers also were added on the roof to reflect sunlight and reduce the heat load. Additional efficiency was created by using a series of five smaller boilers to provide heated water throughout the school, rather than one or two larger ones that would need to heat larger amounts of water with every hot-water need. This system reduces energy needs and provides hot water as needed in an efficient way.

The 5,000-square-foot green roof



The use of long-span precast concrete double tees allowed for the creation of large open spaces for key gathering spaces, such as the auditorium and science lab.

features a variety of plantings native to South Carolina as well as a bog pond to encourage plantings from nearby swamp areas. The space, which also includes a weather station, is used by the school as a teaching element for its agricultural classes.

Initially, the green space was planned for the upper roof alongside the solar panels, but it was moved to a more prominent and accessible location during the design process, Powell says. "On the upper roof, it couldn't be seen, and it was more difficult for students to access it. In its new location, it's a prominent feature that can

be seen by fans in the bleachers during basketball games in the gym." The adjustment did not require any loading changes for the precast concrete double tees used to support it.

Construction Moved Smoothly

Erection of the precast concrete components moved smoothly despite the congested and active site, Powell says. "We had no problems during construction; it was a highly organized job site. We were very good neighbors to the existing school and its users."

The precast concrete structural

LEED Techniques

Riverside High School achieved LEED certification under the original system in which 26 points were required. The precast concrete structural system and insulated wall panels contributed to 23 of those points.

Among its contributions were energy efficiency, minimizing construction waste, use of recycled materials, use of local materials, local manufacture of products, meaningful recycling efforts during construction, and lessened impact on the environment during and after construction.

- Included in the sustainable-design features for the new school are:
- A waste-management system that recycles or salvages 50% of construction, demolition and land-clearing waste.
- Precast concrete insulated sandwich wall panels, which included 2 inches of insulation to provide an enhanced R-value.
- Solar panels to provide pre-heated water to the kitchen and athletic facilities.
- A green roof accessible to faculty and students.
- A reflective Energy Star roof that reduces heat emissions and provides R-30 insulation.
- Water systems designed to reduce water use by 20%.
- Light-well monitors that maximize daylight use for indoor lighting.
- Diffused-lighting system to prevent glare on neighboring properties, streets and the night sky.
- Use of low-VOC materials for adhesives, glues, paints, coatings and carpets.
- Use of 50% local and regional building materials within a 500-mile radius.
- Bicycle racks and a changing/shower room for bicyclists to encourage alternative-transportation methods.



Solar shields above windows help control daylight to ensure rooms stay bright but don't become too sunny or hot.

system played a significant role in that, he notes. The capability to cast components as foundation work progressed ensured that pieces were ready to be erected as soon as the site was ready. Trucks delivered each component to the site as needed along a segregated construction roadway away from the existing school, and the pieces were lifted from the truck and set in place.

The contractor shifted the precasting schedule, however, as the precast concrete was prebid and work was underway when the contractor was selected, Marshall notes. "They began casting the sawtooth classroom walls, but we needed them to first

create the 'back of the house' elements at the other end of the school," he explains. Those spaces needed to be enclosed first so all of the equipment for the mechanical and electrical rooms and kitchens could begin work. We had to change the thinking quickly to ensure everything came together in the end."

Once those components were fabricated, the precasters returned to the classroom wing. "We essentially erected the two ends to meet together in the center," Marshall explains. "Classrooms are typically easy to finish." That doesn't mean the classroom wing didn't present challenges, he adds. "The sawtooth design compli-

cated the erection. There weren't too many right angles anywhere in the school, and few parallel lines. It was more challenging than a typical school project usually is."

On-Time Opening

That effort paid off in a project that opened on-time with no disruptions to the school term. "Any time we can move load-bearing masonry away from the critical path of the project will likely improve the construction schedule," Marshall says. The schedule also was aided by the installation of precast concrete stairs and elevator shafts. The quick installation provided quick and easy access to upper levels, which also aided safety.

The precast helped the schedule further by being able to erect quickly through the winter to ensure the transition could take place over the summer. "Even in South Carolina, the cold and wet periods in the winter often aren't conducive to laying brick and block," says Marshall. "That's not a problem we have with the precast concrete panels. A big school project always moves faster with precast concrete."

The efforts also paid off in improved long-term energy efficiency. The school, possibly the first to achieve LEED certification when it was completed, has been returning impressive savings since. The combination of techniques, materials and products used to minimize energy use created a 30% to 40% savings in energy over a more traditional design, according to the LEED calculations done when the project was submitted, Powell says. "Everything factored into the savings, including the precast concrete structure."

School administrators are pleased with the decision to take this approach. "We're beside ourselves with the prospect of having a LEED-certified school that we know will benefit our environment, too," said Riverside principal Andy Crowley when the school opened. "As a country, we don't do enough of this." Adds Powell, "LEED construction is where the school industry is headed. This project exemplifies the potential in the school market and serves as an example for other designers to follow." ■

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