Top of the Class

—Randal G. Merrill, AIA

McGill Smith Punshon architect describes benefits of designing Cincinnati's first total-precast elementary school

By Randal G. Merrill, AIA, LEED – Vice President of Architecture McGill Smith Punshon Cincinnati, Ohio

Displacing incumbent building systems with sustainable technologies sometimes seems like an unnecessary risk in K-12 education. Politics and taxpayer demands can sideline projects or make cookie-cutter solutions preferable because they are familiar and easier. In Cincinnati, however, McGill Smith Punshon (MSP) was able to implement an innovative and thought-provoking all-precast design that outperforms traditional block, brick, and steel construction.

The design was made possible, in part, due to visionary thinking from the Ohio School Facilities Commission (OSFC) and Cincinnati Public Schools (CPS). The approach also received tremendous support and collaboration from Turner Construction, the construction manager, as well as local precasters.

Opened in Spring 2007, Roberts Paideia Academy is Cincinnati's first total-precast concrete elementary school. MSP worked with CPS's School Planning Team to create an architectural design, reminiscent of the International Style of Architecture, that takes advantage of the inherent flexibility of architectural precast to provide a unique, well proportioned blend of building massing, color, texture, and articulation.

A combination of acid-etched and sandblasted precast panels of red and beige were used to create distinctive façades. The precast design includes deep reveals that break up the mass and add appropriate scale to this magnet school, which draws students from around the district with its innovative "Paideia" curriculum. Not at all evident in the finished building is the value engineering that played a significant role in its final appearance.

Initial Design Changed

Budgeted before steel and masonry labor costs climbed in 2003, the original Roberts design presented a problem for CPS. The usual solution of block and brick

Fact Sheet

Project: *Roberts Paideia Academy*

Type: *K-8 school*

Location: *Cincinnati, Ohio*

Designer: *McGill Smith Punshon, Cincinnati, Ohio*

Engineer: *M-Engineering, Westerville, Ohio*

Construction Manager: *Turner Construction Co., Cincinnati, Ohio*

Contractor: *Monarch Construction Co., Elk Grove Village, Ill.*

Owner: *Cincinnati Public Schools, Cincinnati, Ohio*

Precaster (precast concrete management and architectural precast): *High Concrete Group LLC, Denver, Pa.*

Precaster (hollow-core): *Hollowcore Midwest LLC, Fairfield, Ohio*

PCI-Certified Erector: *Precast Services Inc., Twinsburg, Ohio*

Project Size: *94,450 sq ft*

Precast Components: *Load-bearing precast concrete insulated sandwich wall panels, hollow-core slabs*

Project Cost: *$16.4 million*

The original "brick and block" design for the Roberts Paideia Academy was value-engineered into a total-precast concrete system.

had been chosen for the schematic design, but market conditions made it difficult to complete the project on schedule and within budget with that design. Speed was of the essence, as the original 1962 school building on the site had been designated as swing space for students from other schools being constructed in the school district. Delays would hinder those school projects from moving forward.

MSP suggested interior structural precast components to minimize the use of masonry and steel, control costs, and maintain the schedule.

The short supply of qualified masonry labor further complicated the work. In block, brick, and steel designs, proper workmanship is critical to prevent the formation of mold, efflorescence, and vapor intrusion. Yet with the tremendous shortage of masonry contractors, only less qualified workers were available. The market was spiraling to the lowest possible quality while service skyrocketed to the highest possible price.

This deficiency, together with the tight schedule requirement, led Turner Construction to recommend architectural precast concrete as an alternative cladding. As project architect, MSP suggested the school district go one step further and use interior structural precast components to further minimize the masonry and steel, control costs, and help maintain the construction schedule.

The total-precast approach was a first for MSP and CPS. Local precasters were instrumental in helping the design team determine how to transform the previous "brick-and-block" design into an all-precast project. The final solution made use of architectural precast for the exterior walls, structural interior precast walls, hollow-core floor and roof slabs, double-tee roof components and precast stairs.

The façade features thermally efficient precast panels containing extruded polystyrene foam insulation that provided an insulating value of about R-18.

The school's initial brick-and-block design readily lent itself to conversion to precast concrete.

to demonstrate precast's thermal superiority, stressing energy savings and increased comfort for the kids. They also emphasized the cost and schedule savings plus reduced on-site problems. In the end, OSFC agreed to add the precast alternative to the manual. Even so, MSP had to file a variance request with the OSFC to use the precast components. Ultimately, the request was overwhelmingly approved (for details, see the sidebar).

Because this project was the first total-precast school in Ohio, it was extremely important to put together an experienced team that knew how to bring all of the trades toward a common understanding. Ohio Schools use the Five Prime bidding process, and bids were taken for the general construction, HVAC, plumbing, electrical, and fire protection.

The three-story school essentially was built from a precast concrete "kit of parts" comprising thermally-efficient R-13 load-bearing wall panels, double tees to span the gym and administrative office roofs, 8-, 10-, and 12-in. hollow-core floors and roofs, and 6-in.-thick interior walls.

In all, 1,117 pieces and 161,221 sq ft of precast were used in this adventurous project.

Changing School Designs

The OSFC provides the guidelines and funding to renovate or rebuild the state's deteriorating, overcrowded, and inefficient schools. Until a precast-concrete alternative was added in 2004, the design using block, brick, and steel was the only building system listed in the Commission's Design Manual for Schools. In fact, it had been the only system used in Ohio for generations.

Numerous presentations were made by determined manufacturers

Upfront Research Pays Off

Cincinnati Public Schools manages 7 million sq ft of space, and it tends to be conservative in its approach to construction. However, CPS officials accepted the precast solution due to the thorough research presented by MSP, M-Engineering (the structural engineer), and Turner Construction. The steps leading to this acceptance included:

- A full lateral load analysis to validate the structural parameters.
- Analysis of potential building area reductions as a result of thinner wall profiles using both architectural precast at the exterior walls and structural precast interior walls.
- Analysis of reductions in the floor-to-floor heights due to lower floor assembly profiles using hollow core slabs.
- Cost evaluations and comparative analysis with masonry construction.
- Samples of concrete panels that allowed district personnel to see a representation of the finished product.

The precast concrete exterior walls are only 11 in. thick, saving about 4 in. over the original CMU proposal. Interior structural precast wall were 2 in. thinner as well. These savings allowed designers to add another classroom to the plan.

The school's initial brick-and-block design readily lent itself to conversion to precast concrete. Using both horizontally and vertically cast panels allowed the project to be erected effectively. Replication of panels helped limit fabrication costs.

The project's centerpiece is the façade made of thermally-efficient insulated precast panels. The panels feature a "sandwich" of concrete and insulating extruded polystyrene (XPS) foam. The walls control thermal transfer with a material R-value of approximately R-13 and, with thermal-mass contribution, totals about R-18.

The initial precast design called for about 30% of the façade to receive thin brick embedded in the precast panels to replicate the look of full-depth brick. This was the first element removed to meet the extremely tight budget requirements. The team relied on precast color, texture, and articulation to achieve the intended design statement.

Thinner Walls Save Space

Because the architectural precast exterior wall was only 11 in. thick rather than the 15 in. of the originally proposed CMU walls, the precast façade saved approximately 1,000 sq ft of space. In addition, the interior structural precast walls were only 6 in. thick instead of the typical 8-in.-thick masonry wall, saving an additional 500 sq ft. This reduction allowed MSP to create an additional classroom while maintaining the overall allowable area with a reduced gross square footage of 94,450 (approximately 1,000 sq ft lower than the program of requirements).

The overall construction factor was 6%, which is 40% lower than typical brick-and-blockschool buildings. This meant a savings of approximately 1,000 sq ft in roof area, and minimized corridors and wall areas. The team was also able to replace 24-in.-deep steel bar joists in many areas with 10-in. hollow-core slabs, which lowered floor-to-floor heights from 13'4" to 12 ft. This further reduced the exterior wall surface by 1,000 sq ft, which translated into an estimated $40,000 of additional savings.

An important measure of cost used by Turner Construction is the wall ratio, the external wall surface area divided by the floor area. Turner's previous experience in evaluating school projects has allowed them to determine that an appropriate wall ratio is between .45 and .50. Above that ratio, the project is deemed too expensive. When applied to the Roberts project, the wall ratio was .39, well below the standard. This wall ratio resulted from the use of hollow-core slabs for the floors and roof components as well as an efficiently designed floor plan.

Mechanicals, electrical, and plumbing were cast into the precast concrete walls. This approach forced MEP planning earlier in the process, but it also drastically reduced RFIs and potential change orders. It requires a change in paradigm for the MEP contractors, which must develop details up to three months earlier than normal. Good coordination drawings are essential.

By forcing the trade contractors to coordinate their work early in the construction process, having a well coordinated set of construction documents, and incorporating a system of open and effective communications, there were only approximately 160 RFIs submitted on the project. That's about half as many as Turner Construction has experienced on similarly sized, conventional school projects.

Construction Time Minimized

Erecting the academic wing horizontally, one floor at a time, allowed quicker erection on the difficult site topography, which essentially was the side of a steep hill. The total-precast structure and walls were erected in about $10^1/_2$ weeks, less than one third the time to construct most block, brick, and steel schools.

The speed of erection helped solve some problems, including poor soil conditions that required a deep foundation in the beginning of construction. Precast erection speed compensated for these problems and brought the project back in line with the original schedule.

The precast interior finish of Roberts Academy provides a tremendous improvement over the typical block finish. The interior finish of the precast walls in the classrooms, corridors, and other locations appears to be finished in drywall. You actually have to knock on the walls in order to tell the two types apart.

Michael Burson, facilities director at CPS, said that one major concern was the appearance of the finished project, and that had turned out to be the best surprise of the entire project for him. CPS also hadn't considered the long-term durability of the building in its construction budgeting, he added. Given the experience with the Roberts project and others, CPS now can accept precast panels without question.

The total-precast design contributes in several ways to sustainable design.

In fact, shortly after the Roberts Academy construction began, CPS approved MPS' design for a second total-precast structure for the Academy of World Languages, another magnet school in which students can study Arabic, Chinese, Japanese, Russian, or English as a second language. The 85,000-sq-ft K-8 school was completed last fall. CPS also is considering total-precast structures for other school projects.

Precast Advantages Abound

By nature, precast concrete compresses construction schedules because the components are fabricated off-site while the site is prepared. Precast also can be erected quickly and in almost any weather, minimizing delays caused by cold, rain, and snow. This inherent scheduling advantage was a driving factor in CPS' decision to use an all-precast system.

Thermally efficient precast walls control the risk of mold and efflorescence because there is no air cavity. Air cavities can present huge issues in schools within just 12 to 36 months of their completion, requiring extensive tear-out and repairs. Precast concrete's high density renders it virtually vapor non-permeable. Door and window openings are always consistent in precast concrete panels, eliminating additional and costly fieldwork to correct gaps and inconsistencies.

Precast also adds advantages from a safety standpoint by eliminating scaffolding that can be a major source of job-site injuries. Fewer people overall are required on the job site, limiting the risk of accident or injury and lowering insurance rates.

The total-precast design contributes in several ways to sustainable design. It compares favorably to site-intensive systems because it provides clean construction operations. There is essentially no waste by-product on the site, as all precast delivered to the site is erected. Precast also contributes to indoor air quality because it allows the building to be dried-in faster, greatly reducing water that can cause mold growth in the new structure.

Lessons Learned

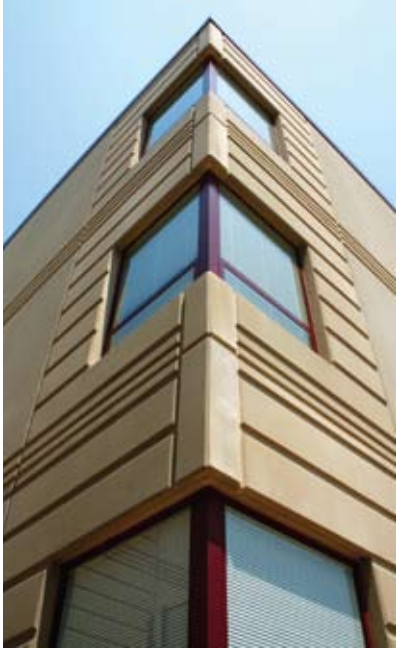
The methodology of precast planning and construction requires more communication early in the project. Front-loading requirements irons out problems early, before they become expensive. During the project life, the precaster frequently becomes an information conduit to ensure smooth operations at the job site.

Having gone through the precast learning curve on this project, MSP now handles things differently on our current precast projects. We learned that, unlike other formats, precast construction concentrates activities such as MEP planning at the front end of the project. Leveraging precast options to optimize value means getting off on the right foot, and that requires getting the precast technical representative involved early.

For example, one of the biggest precast advantages is schedule. The precast technical representative can offer advice on everything from panel sizes and erection sequences to site logistics and crane selection. There are numerous hidden factors that the precaster is familiar with. It is not only nice but necessary to have these insights for successful project execution.

It's also important to determine the precaster's casting schedule and align project expectations accordingly. It may seem obvious, but precast factories operate on schedules. Good precasters build flexibility into their schedules, but stalled decisions and other delays early on can push start dates back.

MSP suggests that the precast package be released early so that casting schedules can be properly coordinated and then assigned to the successful general contractor. The willingness and ability to release the precast bid package early can circumvent potential delays caused by factory casting schedules and solve precast delivery problems. One should work with precasters to understand their overall schedules, not just the project schedule.



After embedded thin brick didn't meet budget requirements, designers used color, texture and articulation to create an aesthetically pleasing façade.

Appearance also is a consideration. CPS officials were concerned when the thin brick had to be removed from the façade design to meet budget requirements. Our final design made up for that removal by using color, texture, and simple articulation. That replacement showed that the design flexibility of precast could achieve an excellent exterior aesthetic.

MSP is very pleased and excited about the final project, both inside and out. The architecture of the building meets the original design mission statement defined by the school planning team, and the school staff and students are thrilled about moving into their new home. The project's true success can be seen in their faces as their new school is unveiled and they begin to use the facility.

The almost unlimited appearance options available with precast concrete have not yet been fully appreciated in school construction. Knowledge of the possibilities and potential of precast will allow even more creative and economical solutions for school projects. Those who are informed can and should leverage this material for schools and many other project types that value durability, flexibility, cost. and schedule control as well as aesthetics. ■

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