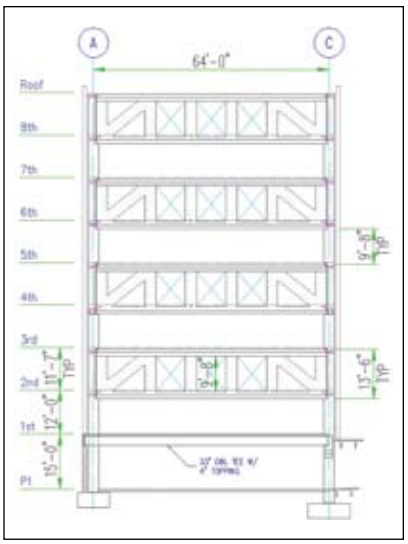
Innovative Housing Concepts Grow

— Craig A. Shutt

Precast concrete aids all types of housing to achieve sustainable, economical designs

Although the residential-housing market is not at its peak, housing projects of all types are still progressing. Many are in specialized markets such as university housing and assisted-living facilities. No matter the type of housing being created, precast concrete concepts can be applied to create sustainable, cost-effective, attractive designs.

"There aren't many condominium projects being built right now, because money is hard to come by," notes Gary Pooley, sales representative for Hanson Structural Precast Midwest Inc. in Maple Grove, Minn., which has worked on a number of such projects in recent years. "But those same designs are being used in apartment buildings, dormitories, assisted-living facilities, and other types of housing. They use similar types of designs and components, and those projects are definitely continuing."



This rendering of a 3-D schematic shows the column-free alternating floors provided by the precast concrete truss system. The system works well for housing, allowing a central corridor that remains open, similar to a double-loaded housing design.

Precast concrete offers a variety of benefits to housing projects, including:

- **Design freedom.** Precast concrete provides durability that stands up to transient residents as well as heavy equipment, including exercise machines. Hollow-core can minimize floor-to-floor heights to meet zoning restrictions while also saving material costs and labor. Hollow-core can span long distances, eliminating columns on lower floors while providing support for upper levels. And the concrete mass offers acoustical and vibration control to ensure good neighbors.
- **Sustainability.** Precast concrete's high thermal mass minimizes energy consumption naturally, aiding in the regulation of room temperature and shifting HVAC use to non-peak times. Insulated sandwich wall panels provide even higher energy efficiency. The material contributes to a variety of points in the Leadership in Energy & Environmental Design (LEED) program. And its inorganic composition and few joints ensure that moisture cannot penetrate to encourage mold growth. Wall panels also offer a durable interior concrete face, eliminating the cost of drywall, which can provide food for mold if residents allow moisture to linger.
- **Safety and security.** Precast concrete is inherently noncombustible, meeting fire codes with no additional treatment necessary, saving time and money. Its structural stability provides strong resistance to hurricane and tornado damage, and new design techniques can ensure that precast concrete buildings survive seismic events and can quickly be reoccupied.
- **Expedited schedules.** Precast concrete designs can be executed quickly, because there is less detail needed with precast's panelized system. Its ability to replicate components easily and economically speeds the construction process. The components also can be fabricated while site work begins, ensuring that components are ready to erect when the site is ready. And the panels can be erected all year round, even in harsh winter weather. Insulated sandwich wall panels provide a finished interior wall surface, eliminating the time and expense of furring strips and drywall.
- **Aesthetic options.** Precast concrete can replicate a variety of stone, granite, and brick appearances, either with embedded pieces or by casting the panels with formliners. It can adapt to any shape, curve, or geometric need, and it can be

The Cobalt Condominium project in Minneapolis, Minn., features an innovative precast concrete truss system that creates column-free space on every other floor.

Fact Sheet

Project: *Cobalt Condominiums*

Type: *Residential units, retail, parking*

Location: *Minneapolis, Minn.*

Designer: *Pope Associates Inc., St. Paul, Minn.*

Engineer: *Ericksen Roed & Associates, St. Paul*

Contractor: *McGough Construction Co., St. Paul*

Owner: *Exeter Realty Co., St. Paul*

Precaster: *Hanson Structural Precast Midwest Inc., Maple Grove, Minn.*

Size: *309,000 ft² (172,000 ft² of residential, 42,000 ft² of retail, and 95,000 ft² of parking)*

Precast concrete components: *Double-tees, open-space trusses, inverted-tee beams, truss columns, planks, solid slabs, architectural panels, spandrels, and insulated wall panels (Patent #7,010,890 and #7,275,348.)*

Project cost: *$44 million*

'The bay spacing provided by the exposed-truss system is very efficient for housing designs.'

provided in any color desired, including two tones in one panel. Designers completely control the finished appearance with the help of range samples and mock-up panels.

Innovative Truss Eliminates Columns

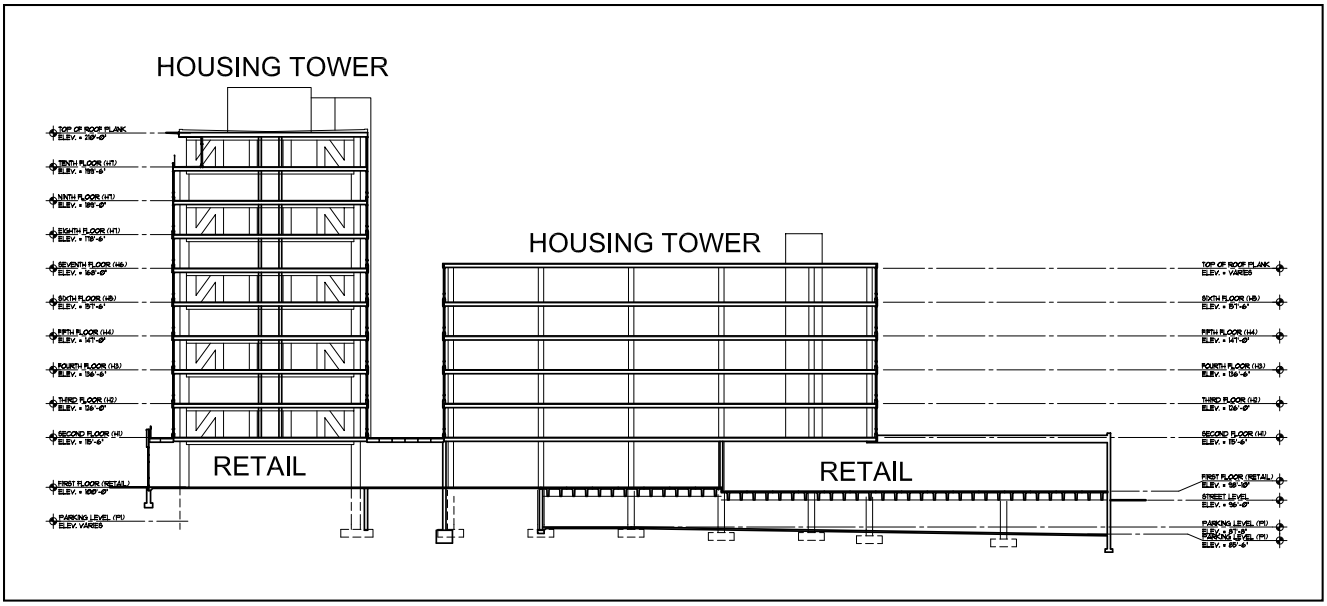
In addition to these benefits, precasters and engineers continue to find ways to refine and expand the material's capabilities, providing more diversity and flexibility for meeting designers' needs. A strong example of what can be achieved is found in the Cobalt Condominiums project in Minneapolis, Minn., which was completed in 2007. The project features an innovative precast concrete truss system that eliminated interior columns on every other floor of the complex, which consists of six- and ten-story towers plus a supermarket on the first floor.

"The bay spacing provided by the exposed-truss system is very efficient for housing designs," explains Steve Doughty, project manager for Pope Associates Inc. in St. Paul, Minn. It provides 64-ft-clear spans on alternate levels and maintains the shallow floor-to-floor height that was desired. "Even on the levels with the trusses, the design works well with housing."

The system, designed and patented by structural engineers Ericksen Roed & Associates of St. Paul, had been incorporated into several projects. These include a 9-story, 45-unit residential development in Minneapolis and a Courtyard by Marriott hotel in Rochester, Minn.; Turtle Creek Casino Hotel in Traverse City, Mich; 14- and 7-story apartment towers in Oak Park, Ill.; Staybridge Suites Hotel in Milwaukee, Wis.; and the Gateway Center student housing for Augsburg College in Minneapolis. The benefits, especially for mixed-use projects with retail on the first floor, are significant in terms of design flexibility, sustainability, and speed of construction.

The 309,000 ft² Cobalt Condominiums project features a variety of precast concrete components, including architectural panels, hollow-core, long-span truss beams supported by exterior columns, wall panels at stair/elevator shafts, and insulated panels at the foundation walls. A two-story, 95,000 ft² parking structure features double-tee decks, interior beams and columns, below-grade insulation foundation walls, and precast concrete grade beams.

"One of the driving forces behind using a system that created column-free space was the owner's need to maximize the number of parking stalls within the underground parking structure and create flexible retail layouts on the main floor," Doughty explains. Any columns penetrating the parking level to reduce the open-span length would have reduced the number of parking stalls,



The patented ER-POST system, visible at the top of the construction, provides maximum flexibility for layouts by opening every other floor, a critical benefit in the housing market.

which relates directly to the number of planned condominiums. "To optimize usable space in the project, the interior columns in the parking and retail levels needed to be minimized."

That goal was accomplished with the open-truss system, called the ER-POST system, which was value-engineered into the project after it was initially planned to use a post-tensioned, cast-in-place system. The ER-POST system features precast, prestressed concrete trusses that support two floors simultaneously. The trusses, which span between the exterior walls, are located at each column line, with bottom and top chords supporting floors. The trusses are located on every other floor, allowing odd-numbered levels to be free of interior structural supports, Doughty notes. Cobalt's ground level was designed to be as open as possible, with the exception of the extended perimeter columns and shafts from the condo tower above.

Truss Offers Benefits

In addition to its design flexibility, the ER-POST system provided some additional advantages, Doughty says. The large, modular structural members helped accelerate the construction schedule by minimizing the number of pieces to be erected, helping to enclose the building rapidly. It also allowed construction to take place on a restrictive building site, because there were minimal on-site manufacturing, laydown-area requirements, and piece erection. It could be erected in cold weather, eliminating weather-related delays and allowing work to progress quickly through the winter.

The truss system also allows exterior walls to be non-load-bearing, establishing greater flexibility in fenestration and cladding designs. It reduces the total material use for the precast concrete structure, minimizing costs and eliminating weight to make the pieces easier to handle and erect. The cross-bracing on the structural levels features supports along both sides of an open corridor, perfectly matching the typical housing design with a double-loaded corridor.

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The system minimized floor-to-floor heights, which was another key benefit for the owner, Doughty notes. The building code restricted the structure's height, making it critical to efficiently use the space available. "Our goal was to design as many units as possible, and the truss system provided the same benefit in that regard as the cast-in-place system."

The system added sustainable-design concepts, including enhanced thermal performance for the building, the use of recycled materials such as fly ash to replace cement, and the use of regional materials. By minimizing material use, it saved raw materials and costs as well. The elimination of interior columns also boosted daylighting, maximizing solar illumination and unobstructed views from the core of the building. The open floor plan available on every other floor, especially the first-level retail space, ensures ease of design for future tenants and less waste of materials.

"The openness was a wonderful benefit in terms of planning," Doughty says. Initially, the supermarket tenant rejected a layout that included cast-in-place columns 30 ft on-center throughout the space. The design with the ER-POST system required only eight columns in the entire space. "That's a very significant benefit," he says. It also provides a marketing benefit for future tenants, as the space can adapt to any needs that arise.

The ER-POST system did create some challenges owing to the size of the components, he notes. They required a larger crane to hoist them into place rather than tower cranes as originally planned, which created logistic concerns on the tight site. In addition, extra scheduling coordination was needed because interior crews could not work directly below where trusses were being erected on higher floors, to ensure safety. "It required more construction management to ensure the smooth construction and maintain the highest levels of safety," Doughty says.

'The precast wall panels reduced the mildew risk, because they inhibit water penetration and eliminate drywall.'

The cornice was topped with a white sandblast finish. The panels all feature $^1/_2$-in. reveals that impart surface relief to reduce the vast scale of the facade.

University Commons at Georgia State University in Atlanta, Ga., the country's largest privately funded student-housing complex, used insulated precast concrete sandwich wall panels for the shell of the four buildings in the project, which range from eight to fourteen stories and contain 2000 beds in all.

The sheer size of the University Commons project at Georgia State University magnified any design decisions, resulting in the project team selecting non-load-bearing precast concrete sandwich wall panels with 4 in. of expanded polystyrene insulation.

Inset brick was embedded in panels used at street-level height at University Commons, to provide the same look as other buildings in the neighborhood. Higher on the building, the panels feature a buff sandblast finish.

The system's fast erection played a key role in the project's success. "The speed of construction that the truss system provided was acknowledged early on, because it helped complete the project faster," he explains. "That cut loan costs and generated revenue more quickly." He estimates that the system saved $1 million for the $44 million project and cut approximately two months off the construction schedule.

"We'll be using it more, because it offers benefits," he says. In fact, some clients have approached the company about its use after seeing it utilized in the Cobalt project and others. "The speed with which the system can bring a project to market and its benefits for residential floor-to-floor needs make it a strong choice."

Dorm Uses Insulated Panels

Precast concrete components also aided the country's largest privately funded student-housing complex, University Commons at Georgia State University in Atlanta, Ga. The project consists of four buildings ranging from eight to fourteen stories, containing 2000 beds in all. The 646 apartment-style units feature a full kitchen, dining room, and living room. The buildings encircle a large, landscaped courtyard and include 17,982 ft² of retail space.

"The sheer scope of the project magnified any design decisions, good and bad," says Dale McClain, senior project manager at Niles Bolton Associates, the architectural firm on

Fact Sheet

Project: *University Commons Student Housing at Georgia State University*

Type: *University housing*

Location: *Atlanta, Ga.*

Designer: *Niles Bolton Associates Inc., Atlanta*

Structural engineer: *Browder & LeGuizamon & Associates, Atlanta*

Contractor: *Hardin Construction Co. LLC, Atlanta*

Owner: *Board of Regents of the University System of Georgia, Atlanta*

Precaster: *Metromont Corp., Greenville, S.C.*

Size: *1.16 million ft²*

Precast concrete components: *Insulated sandwich wall panels with expanded polystyrene insulation and carbon-fiber wythe connectors*

Project cost: *$168 million*

the project. "The project team had to weigh every option for the building envelope and consider cost, performance, speed of completion, logistics, aesthetics, and many others."

After all factors were evaluated, the team specified insulated precast concrete sandwich wall panels with 4 in. of an interior expanded polystyrene insulation and carbon-fiber connectors connecting the 2- and 2.5-in.-thick concrete wythes. The connectors provide relatively low thermal conductivity, preventing hot or cold spots from forming. Metromont Corp.'s Hiram, Ga., plant provided the components.

"Initially, we planned to create a building with precast concrete panels at the base and conventional brick veneer on a metal-stud back-up above," explains McClain. "But steel availability was very tight, and the cost was high, as well as for drywall. We looked at other options, and the escalating construction costs and tight time frame led us to the precast concrete panels."

The general contractor, Hardin Construction Co. in Atlanta, previously had used the system for several low-rise projects and knew it would work just as well for this high-rise design, he says. In addition, the insulated panels provided an *R*-value of 13, compared with an *R*-value of 7.1 for the brick/metal studs/batt insulation approach.

Several Weeks Saved

Precast concrete panels were specified for several additional reasons. "Since the panels were finished on the exterior and ready to paint on the interior, it limited the cost and unpredictability of field labor as well as finishing materials," he says. "It knocked weeks, if not months, off the construction schedule."

Because the complex is located in a humid region, administrators were concerned that mildew could form in the building. "The precast wall panels reduced the mildew risk, because they inhibit water penetration and eliminate drywall from the exterior enclosure, a potential food source for mildew and mold," he says.

The wall system will provide an annual savings in fuel costs of about $54,000 when compared with the alternative system, according to a third-party MEP consultant. The panel system overcame challenges of a tight site, with space for staging and construction limited, McClain says. The panels were delivered for immediate erection, eliminating site congestion and material- and equipment-storage needs required for field-construction methods.

"Time is money," he notes. "The erection benefits of precast not only allowed the team to meet the deadline, but it reduced the anticipated and indirect costs of field labor that would have been more sensitive to price fluctuations." That was critical, he adds, because the project experienced some of the industry's highest levels of inflation in recent history during the project's programming and design phase. "We closely monitored the design to understand the impact of the project's evolution." Variance reports were provided with every estimate to keep costs in check.

Inset brick was embedded in panels used at street level to provide the same look as other buildings in the neighborhood. Higher on the building, the panels feature a buff sandblast finish. The cornice was topped with a white sandblast finish. The panels all feature $^1/_2$ in. reveals that impart sur-

Fact Sheet

Project: *Symphony House*

Type: *Condominium residences and theater*

Location: *Philadelphia, Pa.*

Designer: *BLT Architects, Philadelphia*

Engineer: *The Harman Group, King of Prussia, Pa.*

Construction management: *Intech Construction, Philadelphia, Pa., and L. F. Driscoll Co., Bala Cynwyd, Pa.*

Owner: *Dranoff Properties, Philadelphia, Pa.*

Precaster: *High Concrete Group LLC, Denver, Pa.*

Size: *507,000 ft², including 5000 ft² of retail and 400-seat theater*

Precast concrete components: *Insulated wall panels with expanded polystyrene insulation and carbon-fiber wythe connectors*

Project cost: *$125 million*

Three colors were used for the panels, with two integral with the casting and the third applied after the panels were created.

The 32-story Symphony House luxury condominiums and theater in Philadelphia, Pa., features carbon-fiber-reinforced precast concrete architectural cladding to achieve a classical look with architectural details throughout the facade. The project was honored as the best high-rise building of 2008 in the recent GreenSite Project awards.

face relief to reduce the vast scale of the facade.

The building helped create a unified image for the university, which had housed students in former Olympic sites some distance away, requiring transportation to reach classrooms and fragmenting the campus. The new facility both houses students and expands the campus, unifying it. Administrators wanted to take advantage of that by providing the housing facility with a strong appearance. "They see this building as a way to centralize their students and create a better presence overall," he explains.

Additional buildings nearby have subsequently been purchased to serve as office buildings, solidifying the university's presence in the neighborhood. "Administrators were wary that we were delivering an unproven system that could be a future maintenance issue," he says. "We had to ensure them that this was a tried-and-true system, and when we showed them the reports and examples of other buildings, everyone became comfortable with it."

McClain expects to use the precast concrete panels more in the future, he notes. "We are open to using them on other applications, even beyond housing," he says. "There is a lot more potential for the panels going forward with other projects that we're involved with."

Adding Green Benefits

Some buildings seek sustainable design; others have it thrust upon them as an inherent part of their construction. The latter occurred with the 32-story Symphony House luxury condominiums and theater in Philadelphia, Pa. Upon the project's completion, it was singled out as winner of the High-Rise category in the GreenSite Project of the Year 2008 competition sponsored by two concrete magazines.

The owner did not set out to create a project focusing on sustainable-design concepts, says Michael Ytterberg, principal at the architectural firm BLT Architects in Philadelphia. "The owner didn't have a strong goal of going green, and we didn't go out of our way to build a green project," he says. "But once we decided to use precast concrete panels, they added a significant inherent sustainable aspect that paid off for the project."

'Once we decided to use precast concrete panels, they added a significant inherent sustainable aspect.'

The building features carbon-fiber-reinforced precast concrete architectural cladding produced by High Concrete Group in Denver, Pa. The lightweight material reduced superstructure and foundation requirements, while innovative slab-attachment procedures reduced the number of columns in the tower, permitting more open floors. Precast concrete components also were used on the seven-level parking structure.

Designers considered creating a brick facade, but that proved too expensive and too heavy for the structure, Ytterberg explains. "We looked at other thin-concrete-panel options than the carbon-fiber-reinforced, foam-insulated panels, but none provided the benefits, especially with the amount of three-dimensional articulation we could achieve with the foam-insulated panels." At the same time, the 7-in.-thick concrete flange provided better sealing of the building than is possible with other thin-concrete-panel systems.

That detailing was critical for the design, which features a lot of setbacks and expanses of glass framed by the 7-in.-thick panels, reminiscent of 1930s art deco designs. "Some of the pieces are quite extraordinary in their design," he notes. They include the entryway, which is one architectural piece 25 ft across, 10 ft tall, and 3 ft deep.

Three colors were used for the panels, with two integral with the casting and the third applied after the panels were created. "We specified dark colors, which sometimes require so much pigment that the concrete can be difficult to make flow into the forms properly," Ytterberg explains. "But we experienced no problems."

The carbon mesh and insulated core helped lighten the panels. That allowed them to be set on the edge of the post-tensioned slab without the need for a perimeter beam. This approach avoided the need to connect the panels column to column, allowing for the elimination of some columns while creating larger openings in the wall. It also sped up the erection process.

Speed a Critical Element

Speed turned out to be critical for the project's success, he notes. Four other high-rise condominiums were being built at the same time in 2007, creating a large supply of units just as demand was dropping. Symphony House was the first to market, beating the next-closest project by nearly one year, he says. The others have recently finished or are expected to finish construction later this year.

"In this market, that speed was critical," he says. "The owner was able to sell units before the condo boom went bust. And that allowed the owner to pay off loans faster." By the end of 2008, the project was 90% occupied—and the construction loans had been paid off for one year. The next project to finish still is struggling to find buyers, he says.

"We're proud of the fact that we could use 21st-century design techniques for the building's skin while using that skin to aspire to a historic form that reflects the neighborhood and provides a rich, attractive appearance. And we achieved that while providing savings and speed that helped make the project a success."

It also was a success with the GreenSite Awards, which honored Symphony House for such factors as innovative techniques, use of innovative materials, cost- and time-saving methods, innovative engineering, workmanship, and creativity.

"The owner didn't focus on those ideas originally, but he does now. All of his projects are green," Being able to market high-performance residences while providing attractive, cost-efficient, and quickly constructed designs creates a successful project in any market for any type of housing project. ■

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