Curvature, Concrete, and Computers
Green Home Building
Precast for Homes
Precast concrete companies are increasing their revenues by developing new methods for building in the residential market.

Building Precast Concrete Homes

By Joe Naasik Although most of the precast concrete construction in the United States is dedicated to commercial projects, recently there has been increased interest in precasting panels for single and multifamily homes. To be competitive, these precast projects are usually located within 200 miles of the precast plant since transportation costs can significantly impact the cost of construction. To be considered, precast companies have to be cost competitive with other home building systems such as “stick built” housing—not that wood is comparable to concrete in terms of values and benefits.

A primary advantage of precast construction is that concrete panels can be constructed under controlled factory conditions and erected on a jobsite in all weather conditions in a very short time span. There are four systems used to build precast homes: solid concrete walls (with insulation on one side of the panel); sandwich panels that incorporate polystyrene foam insulation board placed in the center of a wall panel; and “double wall” panels composed of two concrete panels referred to as “wythes” joined by steel trusses, leaving an air void between them. The fourth method, Carbon Cast, uses concrete posts and beams cast into a concrete face; steel and carbon fiber reinforcement supply the tensile strength needed for this system.

Solid wall. Dan Kolb, vice president for product development for Prestress Engineering Corp. (PEC), Prairie Grove, Ill., calls this method of construction “generation I” and the double wall system “generation II” when he makes presentations on precast housing. Historically, PEC focused on precast transportation products within Illinois, but in 1997 decided to grow its business in the residential market. These efforts are beginning to pay off. Over the past eight years they’ve precasted numerous multifamily and single family residences—earning them two Prestressed Concrete Institute (PCI) awards. Their panels are usually 6 inches thick or 8 inches thick for panels with windows and doors. The largest panel they can fit
on a truck for shipment is 13 by 24 feet.

In the factory, workers form wall panels in special casting beds. Panels can be as large as the entire wall for a building or as small as a short wall section for a room. Inside the casting facility, panels are formed, reinforced, and cast with self-consolidating concrete (SCC). Steel weld plates are cast into panels where they adjoin one another on the jobsite. The panel is then trucked to the jobsite, erected, and braced. Workers weld the welded plates together to join the panels.

Kohl says they construct wood or steel stud walls against the inside of their panels to space for insulation, electrical, plumbing, and HVAC. But sometimes their concrete walls are left exposed on the inside for architectural effect. Their panels achieve four-hour fire ratings, and they often use formliners or thin bricks to provide exterior architectural treatments.

**Sandwich panels.** Scott Long, CEO of Precast Technologies of Las Vegas, says it makes sandwich panels using the Dow Chemical Companies’ Corning T-Mass system in its residential precast panels. Its wall panels are 4 inches of structural concrete on the inside face, 2 inches of rigid foam insulation in the center, and 2 inches of concrete on the exterior face of the panel. Rough electrical and chases for plumbing and HVAC are added to the panels during manufacturing. “We also install hollow core concrete floor panels for homes with basements, which are becoming increasingly popular in the Las Vegas area,” he says. As with PCC, the only interior concrete walls are those that separate the home from an attached garage.

**Generation II—“double wall” construction.** Richard Wherli, president of Dukane Precast, Naperville, Ill., researched double wall technology developed overseas and then designed a precast plant to produce concrete panels for residential construction. The plant is state-of-the-art, and there is nothing else comparable in the United States.

Double wall panels are light—approximately half the weight of a solid wall panel, greatly reducing the cost of transportation. The panels are built with two reinforced concrete wythes 3 1/2 inches thick held together by steel trusses. The panel surfaces are glass smooth and require painting only on the inside (no drywall is needed). Floor panels are constructed the same way except that the bottom wythe has prestressed steel reinforcement, making it possible to span up to 35 feet. Typical walls are 8 inches thick, and floors are 10 inches thick.

Workers at the precast plant install rough electrical in the interior or exterior wythes of wall panels before filling the space with a “green” foam insulation product made from bio-based materials such as soybeans. When homeowners request radiant floor heating, the tubing is also installed in the floor panels before being filled with foam insulation.

Brian Bock, Dukane’s vice president of sales and marketing, says that it takes 4 to 8 days to erect one of their homes, requiring 40 to 80 panels, depending on the size and complexity of a home design. Dukane typically installs concrete exterior panels, inside bearing wall panels, floors, and a deck over the top floor rooms. Roofs are constructed on the jobsite using either wood or steel stud framework.

When a customer comes to Dukane with plans intended for wood construction, the first step involves converting them for concrete. Walls and floors must be adjusted to the thicknesses of concrete panels. Customers must decide...
Both walls and decks are included in precast home construction. Floor panels can span as much as 35 feet, and interior bearing walls are often concrete too.

whether to change outside or inside room dimensions in order to accommodate the change to concrete. They can also choose the R-value they want, especially in roof areas. And they can even make limited decisions about the fire rating they want their homes to have. Rock says it takes approximately a month to complete shop drawings and get approvals. Shop drawings are then completed for each individual panel, including the details for all other trade work. The whole process usually takes a couple months to complete—planning and organizing is the major time commitment in the building cycle. The actual casting and erection of panels to complete building shells takes only a couple of weeks.

With double wall construction, two wall panels and a floor panel often intersect at one location (see Fig. 1, p. 40). Dukane sets back the inside wythe for each wall panel and the top wythe for the floor to create an open space used to run electrical, plumbing, and radiant heat pipes. Afterwards, rein-
forcement is added, and the opening is filled with high-strength, non-shrink concrete to complete the connection.

Carbon Cast. Over the past five years the Alus Group, Lancaster, Penn., in partnership with Oldcastle Precast, Rehoboth, Mass., has developed a new method for building precast homes. Their new product, called Carbon Cast, is a panel system composed of steel reinforced concrete posts and beams cast integrally with 1/4-inch-thick external concrete facing panels. The facing panels incorporate a grid of epoxy coated carbon fibers, which are considered secondary reinforcement but have seven times the tensile strength of steel. Foam insulation behind the facing concrete results in panels with high R-values. The inside of the panel is left open so that electrical and other utilities can be installed onsite. Workers then cover the back with drywall. The panels are 66% lighter than comparable solid wall concrete panels, weighing just 28 pounds per square foot.

Harold Meseinger, a director for Alus, says they recently completed the construction of two homes for Habitat for Humanity in Yonkers, N.Y., and four more are underway. He adds that Carbon Cast homes can save about 40% of the energy cost of a comparable wood-frame home, partly as a result of a 35% reduction in the required size of the heating system.

The cost of construction goes down when both interior and exterior wall surfaces are concrete. Using formliners to provide a finished appearance is one way to accomplish this.
Erecting Precast Homes

Precast panels are almost always erected directly on the footings; it’s rare that a cast-in-place foundation wall would be constructed first. Workers embed weld plates in the footings then weld on angle brackets to hold the walls in position. Below-grade panels are waterproofed with what Kolb refers to as the “belt and suspenders” approach: sealing panel joints, placing a waterproof membrane on the walls, and adding drainage mats against the panel faces to allow water to flow down to a footing drain.

After panels are lifted and set into position, they are held upright with panel braces. Solid wall systems permanently secure panels with the weld plate system. The Altus group uses bolts with their carbon cast system. And Dukane depends on its grouted steel-reinforced connection.

Building Safer and More Energy Efficient

The fact that a home is built with concrete provides advantages over other building systems. They are naturally more resistant to weather forces, can save as much as 70% on energy over comparable wood-frame homes, are immune to destruction by termites, and aren’t a food source for mold and algae growths.

Programs to test the benefits continue. Dukane is completing a home built to the specifications of the “Fortified...for Safer Living” program developed by the Institute for Business and Home Safety, Washington, D.C. The intent of the program is to build homes that can resist strong weather forces and be safer. For example, there must be a specified connection between roof joists and footings, and windows must have tempered glass and be secured to the walls. Dukane will also be monitoring energy consumption for this home over the next year. And Precast Technologies of Las Vegas recently held a grand opening celebration for a single-family house that will be monitored for energy use for the next year by the University of Nevada Las Vegas (UNLV) and the Nevada Power Company.

When insulation is included in the center of a “sandwich” panel, it’s possible to provide finished surfaces on both sides—reducing costs. Formliner patterns are often used for the exterior face.

Cost

The cost of a precast home is usually more than a wood home, but they can still be shown to be competitive. If the home’s initial cost is more but it saves significant dollars on energy costs, owners may well end up saving money every month when they subtract the money saved on energy from the increased mortgage payment.