Building Concrete Homes

CHOOSE THE CONSTRUCTION TECHNIQUE THAT IS RIGHT FOR YOUR APPLICATION

By Joe Nasvik
Why would someone build a concrete home? That question is being answered by a growing number of people who are aware of the benefits of living in concrete buildings. "The three reasons most frequently offered for wanting to live in a concrete home are lower energy costs, increased comfort, and the current focus on green building," says Joe Lyman, executive director of the Insulating Concrete Forms Association (ICFA). Concrete homes reduce energy costs in three ways: by eliminating airflow through exterior walls, by using concrete surfaces as heat sinks that store energy (releasing it when temperatures between rooms and walls change), and by incorporating insulation materials with high R-values.

Building homes with concrete isn't a new idea. The first poured wall home construction in the United States dates back to 1844 in Milton, Wis. Today there are many systems, including removable form, polystyrene foam insulating concrete forms (ICF), cementitious ICF blocks, precast, masonry, and tilt-up. The method best for you depends on cost, speed of construction, and the available contractor expertise and labor skills in your area. Compared with traditional wood construction methods, all of these systems will provide you with significant energy savings, tornado and hurricane safety, fire resistance, durability, low maintenance, and excellent life-cycle costs. All methods can be used for exterior wall (envelope) construction, and some of them make it possible to build all walls—interior and exterior—and ceilings (referred to as decks).

Depending on the method, construction costs can be less than wood frame or as much as 30% more. It's also possible to save or add as many as 30 days to the construction time compared with wood construction.

Designers must make choices also. Some systems are better for custom-built applications, while others are especially well adapted for large developments and multifamily housing.

Here's a brief review of the different building systems currently available.

REMOVABLE FORM

This forming system for above-grade residential home construction uses precision-made, low-deflection "hand set" or "crane handled" panels. Most are made from aluminum. Workers typically form one entire floor level at a time. They place insulation either against the exterior form or within the wall—producing a concrete sandwich. Concrete can serve as the finished wall surfaces when the insulation is placed within the wall. Formliners can be used to add a wide range of patterns to exterior finishes. Interior walls usually require superficial patching and are then painted, eliminating the need for drywall. During the forming process, workers also add rough electrical and block-outs for plumbing and HVAC—shortening the time needed for those trades to complete their work.

Concrete mixes are designed to be very flowable. Concrete for entire floor levels, including exterior walls, interior walls, and decks is placed at once, usually as fast as it can be pumped. One builder, using one set of tunnel forms (a crane-handled system that forms walls and decks in a single operation), can complete a shell for a home ranging from 3000 to 4000 square feet in a single day.

Removable form construction is fast; low cost; provides the option to build all walls, floors, and ceilings with concrete; and enables high thermal efficiencies (as much as 60% over standard wood construction). Many contractors who specialize in foundation concrete work understand this method of construction. The initial capital investment in forms is seen as a disadvantage, but the forming cost per installed home goes down with each application. Another limiting factor is designing around panel sizes—especially when interior walls and decks are included—but some forming systems can now work with modules as low as 4 inches. Curved walls and walls coming together at angles less than 90 degrees also pose problems.

POLYSTYRENE FOAM ICFs

Lyman defines ICFs as any stay-in-place forms that have insulating value. Currently more than 70 different manufactured products, categorized as panels or blocks, are available. They are used for constructing exterior walls. In addition, two polystyrene foam systems are available for constructing floors.

Rory Ahern, the owner of Tara Contracting, Greenfield, N.J., says that he originally installed house foundations, but decided 10 years ago to build ICF homes, starting with construction of his own home. Coming from Ireland, where home construction is either concrete or brick, he found building with wood out of the question. After marketing the ICF concept for several years, he
is now very busy with 26 homes contracted at the beginning of his construction season.

Whichever manufactured product is used, there are some common steps and procedures:
1. Setting ICF units is much easier if care is taken to cast level footings.
2. Layout begins from the corners and proceeds to the center of a wall.
3. Forms are glued to the footing.
4. As forms are stacked, window and door bucks are added.
5. Braces should be placed every 5 linear feet to adequately support walls.
6. Adding ICF hangers, ledger boards, and beam pockets completes the forming process.
7. The ICFA recommends using a 3000-psi, 3/8-inch pea gravel concrete mix with a 5-inch to 6-inch slump to fill the forms in 4-foot lifts.
8. The day after concrete placement, braces can be removed and forming started on the next level.

ICF forming systems are easy to work with and require few tools. They are especially adaptable for custom home construction, curving walls, and non-rectangular rooms. A cost disadvantage is that there is no volume advantage—ICF units cost the same per house whether you are building one home or twenty. Costs typically run 5% to 10% more than wood, and they take longer to build than wood frame homes. Both interior and exterior wall surfaces must be covered with other finishes, such as EIFS or stucco or brick.

Concretoe Block Construction
Approximately 70% of all the homes built in Florida are constructed with concrete products. Harry Junk, market manager for residential construction for the National Concrete Masonry Association (NCMA), says that 85% to 90% of those homes are built with concrete block. And since the 1940s, concrete block home construction has been the primary building system in that state.

Depending on the region, ungrouted block cores may be left empty or filled with insulating materials. When the building is engineered to withstand hurricanes or seismic activity, masons add horizontal reinforcement to rows of special bond-beam blocks, place vertical reinforcement in the vertical cores, and fill them with grout.

Like other concrete home-building systems, masonry walls save energy—from 20% to 60% depending on the location and the type of construction. Junk says that experienced masons can build block homes in less time than wood frame construction, but they are 3% to 12% more expensive than wood.

There are many reasons to build with masonry. Maintenance is low, adding color and texture is easy and limitless, unit sizes can be changed to introduce patterns, and masonry walls are easy to use alongside glass, wood, or steel. Block walls can also be straight or curved. The largest disadvantage may be a shortage of skilled masons, though Junk says there is no accurate information to support this claim.

Cementitious ICFs
There are two types of cementitious ICFs currently marketed: one using small wood chip aggregates and the other using polystyrene aggregate. Durisol, made from cement-bonded wood fiber, has been available since the late 1940s. Units can be 8, 10, or 12 inches wide, 12 inches high, and 3 feet long. The 8-inch block weighs only 40 lbs.

The blocks are dry-stacked to construct a wall. Rebars are then set in the same way as with concrete block construction: horizontal steel rests in bond beams and vertical is placed in the cores. No bracing is required when the cores are filled in 4-foot lifts; for higher lifts, bracing is needed and can be screwed directly into the block.

Vipul Acharya, sales manager for Durisol Building Systems, Hamilton, Ontario, recommends 8-inch slump concrete for filling the cores.

“The high slump ensures good consolidation, and the free draining nature of the block results in excess water being immediately removed from the concrete mix and thereby not adversely affecting concrete strength,” he says. “You can see the water draining through the block immediately after placement.”

With rock-wool insulation inserted into the cores at the time of manufacture, blocks have an insulating value of R-22. Eiron Schofield, the business developer for Living Architecture, Ketchum, Idaho, says that when homes are designed to take advantage of passive solar, along with these block systems, heating bills are only 1/3 of comparable wood frame houses. Homes built with cementitious ICF, however, take about as long to build as a comparable wood frame structure and cost about 5% more.
and have reinforcement within the 2½-inch-thick concrete interior and exterior shells. Workers install rough electrical in the panel core then fill the center 3¾-inch cavity with a high R-value soybean-derivative foam insulation. Floor panels are similar, except that they are 10 inches thick. The lower shell in a floor panel has prestressed wire strand reinforcement and can span up to 30 feet. Radiant heating tubes are often installed in the upper concrete layer of the floor during production.

Brian Bock, marketing director for Dukane, Naperville, Ill., says that 4 days are needed to crane-lift the exterior and interior wall panels and the floor panels into place for an average home. The junction between wall and floor panels is filled with reinforced concrete to complete the installation. Bock adds that the time for construction is approximately the same as for wood-frame construction. Double-wall homes easily exceed U.S. Department of Energy “Energy Star” requirements—saving homeowners 60% in energy costs over standard wood-frame construction.

An advantage of this precast method is that drywall isn’t needed for interior surfaces—panel seams are taped and filled, and a finish coat of paint completes the job. Due to trucking costs, precast systems are typically cost-effective only within a 150-mile radius from each production facility.

TILT-UP
Tilt-up construction has become one of the least costly ways to construct commercial buildings. And lately, tilt-up contractors have branched out into residential construction. Floor slabs are cast first so that workers can form and cast wall panels on them, complete with window and door openings. The completed panels are lifted by crane into position. Insulated sandwich panels are easy to construct, too, making possible special finishes such as brick, stucco, and exposed aggregate.

One tilt-up contractor, Jerry Daugherty, and his wife decided to build their own two-level, 10,000-square-foot home in Henderson, Nev., with tilt-up panels. After careful planning they cast 70 wall panels and erected them with only 2 days of crane time. This included most of the interior walls and all the shear walls. The heavier panels (as much as 85,000 pounds) were the first to be cast and lifted, with the smaller ones following. Continuing with a concrete theme, they chemically stained the concrete on the ground floor, but built a wood truss floor on the second level.

Their company, JD Construction, is currently building other tilt-up residential homes, and other tilt-up contractors in the United States are beginning to get involved, too.

For more information about building concrete homes with any of the methods reviewed here, circle the corresponding number on the reader service card:
1. Removable Form, Circle 1
2. Polystyrene Foam ICFs, Circle 2
3. Concrete Block, Circle 3
4. Cementitious ICFs, Circle 4
5. Precast Double Wall, Circle 5
6. Tilt-up, Circle 6

Though building homes using the tilt-up method of construction is a newer idea, building commercial structures with tilt-up isn’t. It’s hard to beat the cost of building with this system.