BUILDING Poured-Concrete HOMES

Cast-in-place walls are fast and strong, and make the most of available labor

In 2000, I moved from Kentucky to Florida to manage Solid Wall Systems, a firm undertaking the construction of thousands of new residences for Mercedes Homes. Instead of conventional framing, these homes would be built using a cast-in-place wall system above a slab-on-grade foundation (see Figure 1, next page). I'd been running a successful foundation business back home, so making the transition to above-grade work was fairly simple.

Concrete-block walls began to replace wood framing in Florida's residential construction many years ago. Between fluctuating lumber prices, voracious tropical termites, and Hurricane Andrew in 1992, the shift was only logical. Concrete prices are historically stable, block is entirely termite proof, and concrete's mass provides superior wind resistance, as well as an ideal surface for a low-maintenance stucco finish.

The Case for Poured Walls

Even a skilled block mason is limited to a personal output of between 75 and 150 blocks per day, depending on the number of window and door openings and other details. A single 8x8x16-inch block is equal to about 9/10 square foot of wall area, so it typically takes a team of experienced masons several days to

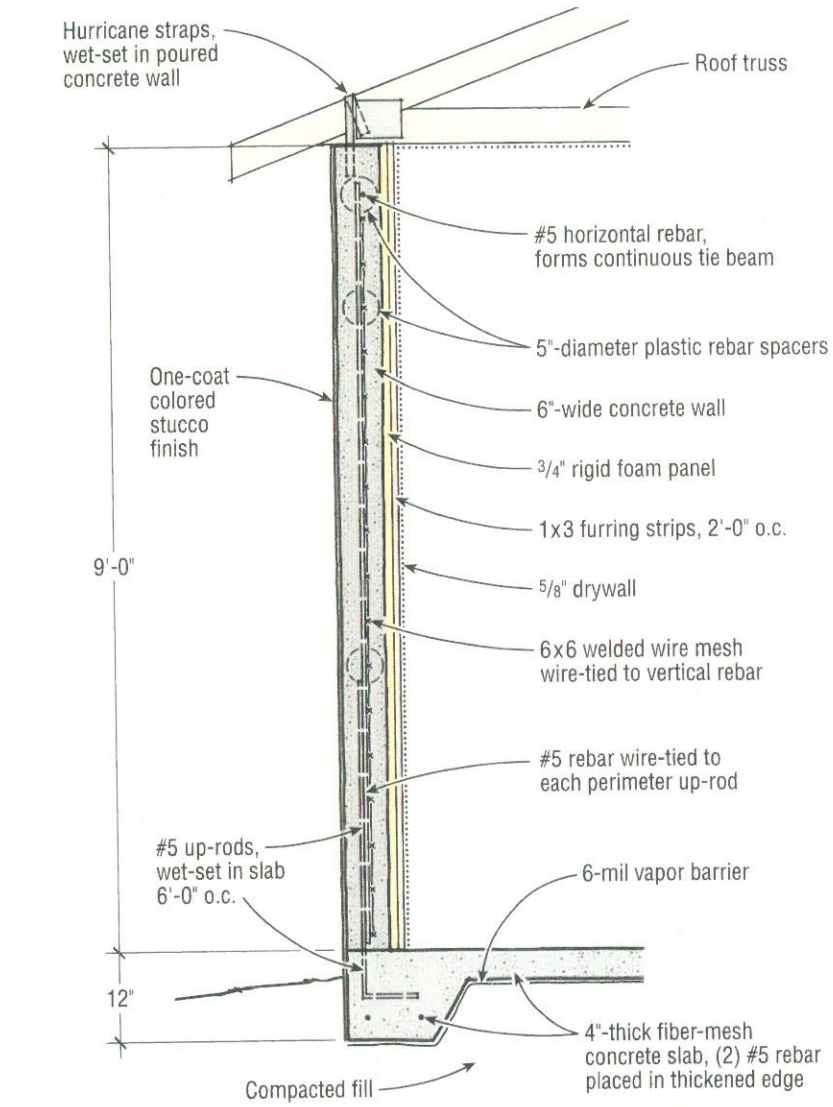


Figure 1. The author installs cast-in-place walls on the thickened edge of a slab-on-grade building platform. No. 5 rebar "up-rods" are wet-set into the slab and, once cured, wire-tied to the wall reinforcement.

complete an average, single-story house. But in Florida's expanding residential market, the available pool of skilled masonry workers is stretched to its limits.

Cast-in-place walls resolve not only the labor issue, but also the key issues of speed, quality, and economy. The average pay on our jobs is $13 per hour, and it takes only a few weeks to train a new laborer in our methods. Furthermore, poured wall construction, at $4 per square foot (standard) to $6 per square foot (custom), compares favorably with block, which runs around $4 per square foot.

Our current crew of around 50 field personnel is on target to complete a thousand 2,000-square-foot concrete homes in 2003. Obviously, we have to have a rock-solid system to manage that kind of workload.

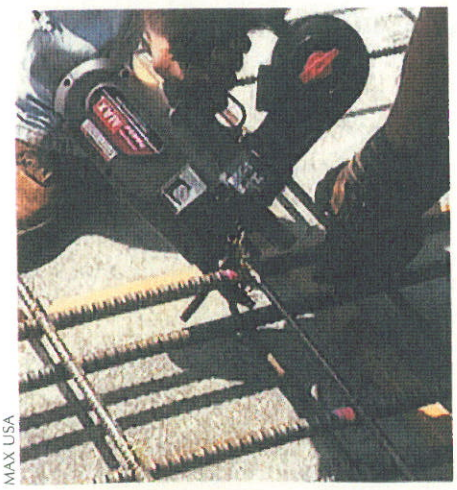
Blockheads. Although poured house walls are obviously nothing new — in the Caribbean and South America, cast-in-place house walls have been common for decades — the idea is just starting to catch on in the U.S. One likely deterrent is the start-up cost: Although a block mason can go into business with a few thousand dollars per crew for equipment, it costs at least $500,000 and up to $1,000,000 to get a cast-in-place company up and running at our current level. (When we started about a year ago, we were completing one job a day. Today, we've got eight crews and are completing four homes a day.) Another issue is unfamiliarity: Tract builders are concerned about losing sales with a different building method. An 8-foot ceiling height is standard in the residential development market, but we work with 9-foot forms. Many builders have trouble swallowing the added interior material costs introduced with 9-foot ceilings. But that extra foot offers some of the drama of a vaulted ceiling without adding framing, drywall, and finishing costs.

Slab Construction

We work hand in glove with local independent slab companies. The mild

mild climate, high water table, and flat land make deep footings unnecessary and impractical. The local soil is referred to as "sugar sand," a fine, smooth sand that resists compacting. The site is first prepared by placing a trucked-in layer of compacted soil over the sugar sand. The perimeter is then formed and deepened to provide a 12-inch-thick monolithic footing. Once the in-floor plumbing is roughed in and inspected, the slab crew lays a 6-mil vapor barrier over the compacted soil to prevent ground moisture from wicking through the slab. The slab is a 4-inch-thick 3,000-psi fiber-mesh concrete, pumped, spread, and finished inside the formwork. Fiber mesh replaces more costly 6-inch wire mesh and the 300 to 400 plastic chairs in the average 3,000-square-foot home. Pumping costs extra, about $500 to $600 per day, but that cost is more than made up for in labor savings.

To tie the walls to the slab, we use 4-foot-long #5 rebar "up-rods," bent at right angles and "wet-set" into the freshly poured concrete on 6-foot centers around the slab's perimeter. The rods are set about 3 inches in from the perimeter forms and stand 3 feet high. The slab is left to cure overnight, for a minimum of 8 to 12 hours.



MAX USA

Figure 4. A mechanical rebar tie gun can make a secure connection in less than a second.

Figure 2. The typical concrete window header is 16 inches deep and is reinforced according to the particular design load.

Reinforcement

The morning after the slab has cured, the steel crew is on it. An 8-foot-10-inch-long #5 reinforcing bar is wire-tied to each perimeter up-rod. The up-rods are connected at the top of the wall to a continuous tie beam formed from single 20-foot lengths of horizontal #5 rebar to outline the exterior wall. Above all door and window openings, the crew ties a double layer of specially designed header reinforcement (Figure 2).

Next we stand and tie 8x10-foot sheets of 6-inch-square welded wire mesh against the up-rods. We start the panels at the building corners and work toward the middle, overlapping sheets by 1 foot. To avoid conflict with the 1-foot-on-center form ties, the worker sets the mesh by propping the sheet on the toe of his boot, lifting it about 2 inches off the slab. This offsets the wire sufficiently from the ties. Because the mesh is square and stiff, it forces the corner up-rods to stand plumb. The plumb corners prevent problems with centering the mesh between the forms. No

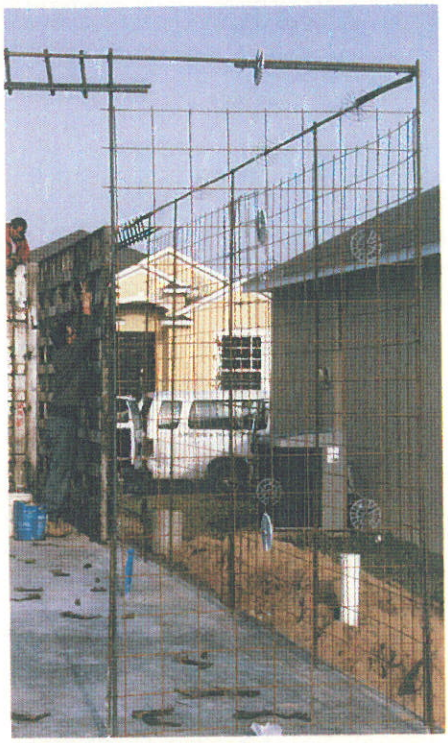
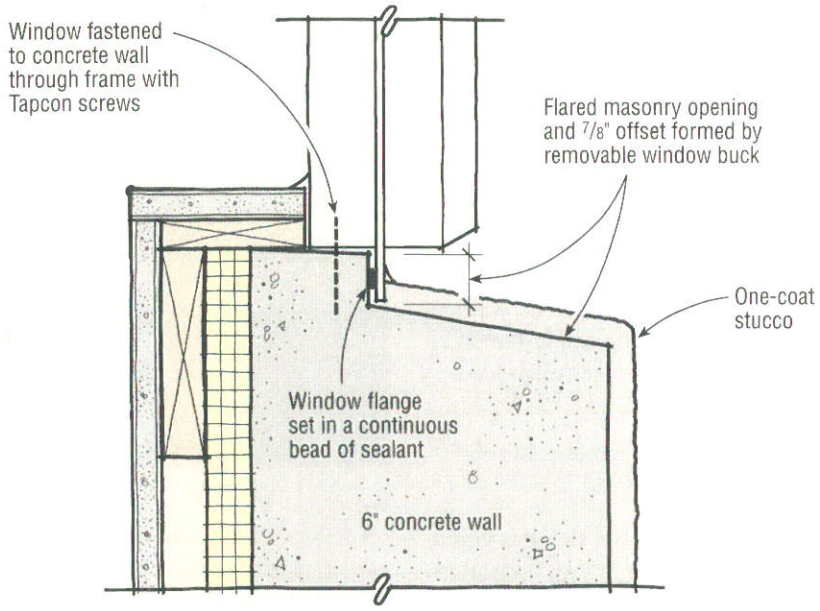


Figure 3. Six-inch-square welded wire mesh is centered between forms with the aid of plastic spacers placed on 4-foot centers. Mesh sheets are started at the building corners, and runs overlap 12 inches.

Figure 5. Attached captive pins are affixed to the face of each aluminum form on 12-inch centers. The pins pass through flat steel snap-ties before engaging the next form in line. Adjustable guide-ties enable proprietary window bucks to hang on the pins, automatically leveling the bucks in the forms.

Window Installation



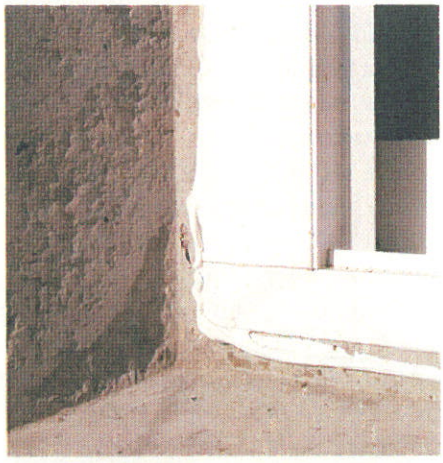


Figure 6. Windows are installed from the outside of the wall and are pressed into a continuous bead of silicone sealant against a 7/8-inch offset lip cast in the opening. The installation tolerance is tight, typically only about 1/4 inch over the unit dimension, to minimize air infiltration around the window.

leveling is needed as long as the same worker positions the mesh (and doesn't change his boots). Rebar spacers — 5-inch-diameter spoked plastic disks — clip onto the wire mesh in a 4-foot-square pattern to keep it evenly spaced between forms (Figure 3, previous page).

The crew can tie two to three houses a day by using mechanical rebar tie guns (Max USA, 800/223-4293, www.maxusacorp.com), which take less than a second to throw on a tie. Even at $2,500 per gun, the tool quickly pays for itself; we've got seven of them (Figure 4, previous page).

The Florida building boom keeps local building officials too busy to schedule inspections, so we allocate a full day for steel reinforcement inspection.

Forming Walls

Wall form erection actually begins in the front office with a CAD-generated plan that details the size and placement of every form panel in the wall system. The crew snaps offset wall lines and carefully checks the spans and diagonals for square and parallel. The slabs are generally poured quite level and reasonably square. If we do run into a dimensional discrepancy, we can make adjustments of up to 2 inches without serious problems. But because the roof trusses rest directly on our walls, the layout must be as square, parallel, and accurate as possible.

Most forming systems are based on a 2-foot module; we use a 3-foot modular aluminum form system (Precise Forms, 800/537-0706, www.preciseforms.com), which effectively reduces erection time by about 33%. Using this system, we can start setting panels for a full house at 7:00 a.m. and be ready to pour by 10:00 a.m.

The panels are held together by a series of captive pins that also engage the wall ties. The ties are flat 10-inch-long steel straps with a hole at each end. The pins pass through the tie holes and connect to the next form in line (Figure 5, previous page).

The panels are spaced for a 6-inch-thick wall. The outside forms rest on

the slab sub's dimensional lumber forms, and the interior forms are set parallel to the offset lines.

At the bottom of the form, a plastic clip gets anchored to the slab with a hand-driven masonry nail to prevent movement during the pour. The clip removes easily during form stripping.

Window bucks. The aluminum bucks we use to block out the window openings are made to fit a variety of typical windows, aluminum or vinyl clad. The bucks have adjustable tie guides that hang on the captive pins and hold the buck level inside the forms. The guides are set to allow for a standard 16-inch-deep concrete header. The buck forms a flared exterior opening and a 7/8-inch stop, recessed about 2 inches in from the interior face. This allows the windows to be installed from the outside, bedded in caulk against the stop (Figure 6, page 76).

Pumping Walls

After the forms are set, braced, and leveled, they're ready for pumping. We use a 3,000-psi concrete mix with 3/8-inch aggregate — limestone in our neck of the woods. Pumping can empty a 10-cubic-yard truck in 15 minutes. The average house takes 30 yards of concrete, so we schedule the trucks to arrive at 15-minute intervals. Even so, we take about 1 1/2 to 2 hours to pump a typical house. We use a "Super-P" mix containing water reducers and plasticizers, which flows well around the bucks and eliminates the need for vibrating. The forms are filled to the top and allowed to mound for about 10 minutes before striking off. The forms are of precise, uniform height and leveled on the slab, making the top of the wall automatically level.

Figure 7. Truss anchors must be accurately placed in the wet concrete, within 1/8 inch of the truss location to perform as designed. The anchor is embedded 4 to 6 inches into the concrete and wrapped over the top of the truss, then nailed. The anchors are rated to resist 120 mph wind uplift.

Figure 8. Wall ties snap on impact; those out of easy hammer reach fall to a length of 2x4. The forming crew leaves the slab broom-clean for the framers.

With a block wall, the framers grout their own steel truss anchors, but we wet-set them. We generally use USP TA-22 (22-inch) wall-to-truss connectors (Figure 7). Truss anchors wrap over the top chord and are nailed in accordance with the manufacturer's recommended requirements. The anchors have to be accurately set to work with the 2-foot-on-center truss layout; we're allowed only an 1/8-inch tolerance. We set the anchors according to a layout plan created using MiTek 4.2 truss layout software (MiTek, 314/434-1200, www.mitekinc.com). The anchors are embedded 4 to 6 inches into the top of the wall. We have to replace any off-layout anchors with Tapcon-fastened ties, so we try hard to avoid layout errors.

We can safely strip forms the day after the pour, when the concrete has reached 50% of its design strength. (Concrete reaches full design strength in 28 to 45 days.) The stripping crew removes the pins, strips the forms, and stacks them in special vertical

Figure 9. Foil-faced 3/4-inch-thick polyisocyanurate foam board is nailed to the interior wall surface and strapped on 2-foot centers with vertical 1x3 furring strips to receive the drywall. The furring and electrical boxes are nailed to the wall with PAFs.

Figure 10. One-coat stucco and standardized decorative detailing provide a simple, attractive, and durable exterior finish.

transportation baskets. The wall tie protrusions snap off with a sideways hammer blow. If they're too high to reach, we use an 8-foot stud (Figure 8, previous page). The stripping crew polices the site and cleans excess concrete from the slab, leaving it ready for the framing crew. This ends our company's involvement in the house, and we move on to the next site.

Interior Framing

Over the next few days, the framers set the trusses, sheathe and shingle the roof, and stand the interior partitions. Foil-faced 3/4-inch-thick rigid foam paneling is applied to the inside face of the concrete walls and held in place with vertical 1x3 furring strips, 2 feet on-center, nailed to the concrete with powder-actuated fasteners (Figure 9). The electrician cuts the foam away to set 1 1/2-inch-deep outlet boxes directly against the concrete, using a powder-actuated tool (PAF).

Interior partitions are typically framed with light-gauge steel studs, continuing the termite-resistant construction. Occasionally, SPF 2x4s are used, stood on a bottom plate of pressure-treated pine.

Exterior Finishing

The exterior finish is a one-coat colored stucco skimmed over a bonding agent and textured (Figure 10). Because concrete continues to cure for several weeks, we wait 30 to 45 days before bringing in the stucco crew. This delay minimizes the telegraphing of any shrinkage cracks through the stucco finish. Though infrequent and typically only hairline, these cracks are normal. If a crack does appear through the stucco finish, it gets repaired with colorized caulk.

Vince Heuser is a field manager for Solid Wall Systems in Cocoa, Fla. Thanks to Robert Wiebel, a technical consultant to SWS, who helped with this article.