

BUILDING ABOVE GRADE With ICFs

I am a general contractor — a carpenter by training — and have been building custom wood frame houses on North Carolina's Outer Banks since 1975. In April 1997, when a local

by Ralph Woodard

couple asked me to build a house for them using ICFs (insulated concrete forms), all I knew about this technique came from reading magazine ads. A year later, I've successfully built a single-story 1,800-square-foot house using an ICF system, and I plan to build more.

Strong, Energy-Efficient Shell

Because they were building on the beach, the clients wanted to be sure the house would stand up to high winds. They discovered Polysteel at a home show in Pennsylvania, and felt it addressed their concerns.

I figured it couldn't hurt to learn about a building system that's both strong and energy efficient. On the barrier islands where I build, we feel the effects of almost every hurricane and nor'easter that hits the East Coast. And because there's no natural gas service to the area, nearly all homeowners rely on electricity to heat and cool their homes. Insulated walls rated to withstand 200-mph winds and promising to cut electric bills in half might sell themselves.

I contacted Reid Pocock, an engineer, general contractor, and Polysteel distributor in nearby Virginia Beach. He invited me to come up and take a look at the product being installed on a job site. After this hands-on inspection, I took the manufacturer's user manual



Reinforced concrete provides excellent wind-resistance for coastal construction

home and watched a couple of videos the company provides to builders. The instructions were detailed yet not that complicated. It was clear that anyone with a reasonable amount of construction experience could do it. Reid helped me prepare a bid for the house and I got the job.

Educating the Subs

Since getting my general contractor's license in 1980, I've used many of the same subcontractors. Where some builders might find their subcontractors resisting a new way to build, I had worked with my subs long enough to know it wouldn't be a problem. I like a

“can do” attitude, and that’s what these guys give me. I didn’t have one sub say he didn’t want to work on the job — and when it was all done, each one of them said they’d be happy to do it again.

I realized that building with ICFs would affect my framers more than the other subs, so I took the framing crew to Virginia for another hands-on look at an ICF house in progress. I also gave them the instructional materials I got from Polysteel. I have to give credit to my framer, John Daley, because he read that manual and watched the videos and he was prepared to do the job.

Stacking the Blocks

Because of flood regulations, most houses in this area must be elevated, and this house was no exception. It was designed with a 3-foot crawlspace under the entire house, which meant that our ICF walls were 12 feet tall. We poured a concrete footing, 24 inches wide by 12 inches deep and stacked the ICFs directly on that.

Starting out level. The Polysteel literature recommends stacking the blocks the full height of the building, then shooting a level line around the top and sawing the top of the forms level. This seemed counterproductive to me, because if you start from a level footing, the blocks will stay level as you go. So we spent the time it took to get a perfectly

level footing, using rebar grade stakes every 3 feet in the trench.

The Polysteel blocks are 48 inches long by 16 inches high by 9¹/₄ inches wide, and have 6-inch-diameter vertical cores 12 inches on-center (Polysteel also makes an 8-inch core block). The foam is easy to cut with a handsaw, and we used a recip saw with a steel-cutting blade to cut through the expanded steel mesh and 1-inch steel furring strips that hold the forms together.

Rebar requirements. Before laying the first course, we had to install vertical rebar every 2 feet. We drilled 7/8-inch-diameter holes 6 inches deep into the footing and inserted 6-foot lengths of #6 Grade 60 rebar, securing them with Hilti epoxy. Our design also called for horizontal rebar every other course.

Working from the corners. We began stacking at corners, just as you would a CMU or brick wall, and cut the forms as needed to fill in the middle of runs or at openings. We used batter boards and stringlines to keep the walls straight. When we did this job, we had to miter the corner blocks. This is somewhat labor-intensive and also creates a potential spot for a blowout. Polysteel now makes prefab corner blocks, which we’ll use next time.

To glue the blocks together, we used a low-expansion spray foam adhesive called Handi-Foam (Fomo Products Inc.,

P.O. Box 1078, Norton, OH 44203; 800/321-5585). It comes in aerosol cans with a spray attachment that mounts on top to dispense the foam.

We glued the first course directly to the footing, then shot 2x4s alongside it on both sides to prevent the bottom of the wall from moving. These 2x4 plates also came in handy later because they gave us a place to attach the bottoms of the vertical 2x4 braces. We used pressure-treated lumber for these bottom plates because I knew the sand would cover them up during the job and they would be left in place.

As the forms went up, additional lengths of vertical rebar had to be wired on with a 24-inch overlap. The horizontal rebar also had to be tied to the vertical and to the galvanized mesh that it rested on. We used precut wire ties and a pigtail to speed this job up.

There was one small gable on the house. It’s possible to form rake angles with ICFs, but we opted to stack them level and frame the one gable.

Openings and Penetrations

Openings for doors and windows had to be cut out and framed with pressure-treated 2x10s. We also had to cut a 5-inch-wide slot in the bottom of each buck to get the concrete into the blocks below. A framework of 2x4s on the outside kept the bucks square. On the larger



Vertical rebar, epoxied into place, extends from the footing (left) up through the Polysteel blocks. Horizontal rebar, laid in every other course, rests on the steel mesh that joins the sides of the blocks together, and is tied to the vertical rebar (right).



Spray foam dispensed from a can (left) glues the blocks together as they are stacked. Two-by-four bracing holds everything in place for the pour (right). Note also the squares of plywood holding the anchor bolts for the ledger in place.

openings we also installed vertical braces inside the bucks to keep the heads from sagging. Reid Pocock reviewed the plans to make sure the rebar in the lintels was adequate. For really large openings like garage doors or where heavy loads come down, special rebar design may be required at lintels. On this house, the standard rebar design was adequate.

Once all the blocks were stacked, the plumbing, electrical, and hvac subcontractors came to create mechanical penetrations. It was a simple matter of drilling a hole through the foam and inserting a PVC sleeve through the blocks at every point where they needed access.

Installing Anchor Bolts

The wood-frame floor hangs from a ledger attached to the ICF wall with bolts. Installing all those bolts — $\frac{3}{4}$ -inch J-bolts every 2 feet around the perimeter in most places — was easy though somewhat time consuming.

We first shot a level line around the inside for the top of the ledger. We then cut a 6-inch-square hole for every bolt location. To position the bolt before the pour, we cut a stack of 14-inch-square plywood pieces with a $\frac{3}{4}$ -inch hole drilled in the center. We fastened the bolt to the plywood, then attached the plywood over the bolt holes with dry-wall screws into the steel furring strips.

After the pour, this left the bolts pro-

truding from concrete pads that prevented the foam from crushing when we installed the ledger.

We also installed bolts for attaching interior walls to the ICF walls, as well as anchor bolts 4 feet on-center to secure the double top plate we used.

Polysteel instructions called for $\frac{5}{8}$ -inch bolts, but the distributor was offering the larger bolts for the same price, so that's what we used.

Bracing the Forms

Even though we used the spray foam in the assembly process, a lot of wood bracing is still required to keep the lightweight blocks lined up and in place during assembly and the concrete pour. I figure we spent up to 120 man-hours on the bracing alone. With careful planning, we were able to reuse almost all the wood in the interior framing.

On a visit to the site, Reid Pocock mentioned that I probably had more bracing than I needed, but for my first pour with ICFs I wanted to be safe rather than sorry.

We installed vertical 2x4s approximately every 4 feet on both sides of the wall. We held them snug to the wall with tie wires that ran through the forms and around the 2x4s. We also nailed them to the bottom plate and capped them with a top plate as well. This top plate — one on each side of the wall — turned out to be very useful dur-

ing the pour. Ordinarily we would have had to set up scaffolding to work from, but these 2x4 plates provided an ample walking platform for the man working the hose. Some pump trucks have flexible hoses that can be pinched off to stop the flow of the concrete. The hose on our truck was stiff and never stopped flowing, so the guy on the top of the wall had to be able to keep moving continuously to prevent too much concrete from going in at any one point.

On this first job, framing the exterior walls took about two weeks longer than building with wood. On the next job with the same crew, we'll come closer to matching a stick-built schedule.

The Big Pour

Four weeks after breaking ground on the job, we pumped 30 cubic yards of concrete from a pump truck into the ICFs.

The concrete has to flow from the top of the wall all the way down to the foundation, through built-in steel mesh and around rebar and bolts. You need a mix that flows well, but not one that is watery — too much water increases the likelihood of blowouts.

Reid Pocock called in the concrete design to the ready-mix plant. He used a 3,500-psi mix with extra cement to improve flow. Generally, a 4.5 to 5.5 slump is good for ICF construction.

According to Reid, most ready-mix companies are accustomed to ICF requirements.

The pour was labor-intensive. I had one guy manning the hose and another helping him, three carpenters prepared to deal with leaks and blowouts, and two guys walking around tapping the forms to help the concrete settle. The form makes a completely different sound when it's full, so this gave us our best indication that we were getting the concrete into the forms. At one point we tried using a vibrator, but it caused the concrete to liquefy and caused a blowout.

Otherwise, the pour went well, with only about 10 minor bulges that we had to fix. When the foam began to bulge, a carpenter would take a good size scrap of plywood and place it against the forms, then use a 2x4 brace, staked at the ground, to press it back into place — just as you would when plumbing a frame wall. The trick was to get the guy with the hose to move along quickly before more damage was done. We had some lengths of threaded rod on hand just in case we had a major blowout and had to pull both sides of a form back together; fortunately, we didn't need them.

It took less than five hours to fill the 12-foot walls of the 50x36-foot house. After the concrete set, we cleaned up any small leaks and dribbles with a large

sanding trowel provided by Reid Pocock. It was about 8 inches wide and 16 inches long, and used the coarsest sandpaper I've ever seen. We also used it to flatten the walls anywhere there were bulges.

The original design for the house showed 12 concrete block pier supports under the floor framing. During the planning stage, I realized we could save time and money by using short, 24-inch-diameter cardboard tubes instead, and pouring these at the same time we filled the ICF walls. Once the floor ledger was bolted to the ICFs, floor framing proceeded in the usual manner.

Fine-tuning. When I build my next ICF house, I intend to do the concrete pour in two stages. I'll lay as many courses of block as it would take to get up to the floor level, fill them and the pier forms with concrete, then build the floor. This will allow my framers to work on the upper courses of block from step ladders and eliminate the need for scaffolding. The time saved stacking and bracing the blocks would more than cover the extra \$500 for a second pump truck visit.

Roof Framing

Because my clients picked reinforced ICF construction for its strength and wind resistance, I needed to pay extra attention to the roof design. A roof

built to code here is rated for winds up to 110 mph. I wanted to get the roof more in line with the 200-mph wind rating on the Polysteel walls. Before we began building, the homeowners agreed to change their gable-end roof to a stronger hip roof design, which we framed with 2x10s. We also used a heavier grade shingle for better wind resistance.

With most Polysteel houses, the builder adds a single top plate to the ICF wall and builds the roof. Because I'm building on the coast, I use Simpson H-10 hurricane clips on every rafter to meet state building code. Because the lower part of the clip would hang below a single top plate (and would normally be nailed to a wall stud), I doubled the top plate so that clips could be completely nailed into solid framing. The 10-inch anchor bolts were plenty long to pass through both plates.

Electrical, Mechanical & Drywall

The electrician had to recess all the wires and boxes into the surface of the foam blocks. I provided a hot knife for this job and we played around with a spare block. It didn't take any time to get the knack of using it efficiently. Although most builders won't have to do this, our local building inspector required all wires to be run in PVC con-



After the pour, the ledger bolts extend from 6-inch-square pads of concrete flush with the surface of the foam (left). These concrete pads prevent the foam from crushing when the ledger is attached. The author poured 24-inch-diameter concrete piers to support the first-floor framing (right).

duit. This cost about \$1,000 extra for time and materials.

We designed the house so that no sinks or other plumbing fixtures came off exterior walls. This meant that except for running pipes through the Polysteel before the concrete pour, the plumber's work was no different than usual.

The hvac contractor didn't need to do things differently on site, but he spent several extra hours calculating the special pump requirements for the house. In our area, the hvac system is usually designed for heating efficiency. Because of the extra insulation value of the ICFs, he had to address cooling first. The heating load was 10,000 Btu/hr. less than for typical new wood-frame construction while cooling requirements were reduced by 3,000 Btu/hr.

While framing the interior of the house was no different from conventional stick construction, hanging gypsum board on the perimeter walls required a different technique. We glued the drywall to the steel furring strips, then secured it with screws into the strips.

Siding Installation

If any subcontractor was resistant to the idea of working with ICFs, it was probably the siding guy. We knew there would be more prep than usual to hang the siding, because the 1-inch width of the steel furring strips doesn't always give you secure attachment where you need it. The strips are also not continuous from course to course. To get around this, we used pieces of coil stock to bridge areas where we needed it. We screwed the coil stock to the strips with self-tapping oval head sheet metal screws. This process probably added about a day to the siding job.

The choice of siding also helped. We bid the job planning for vinyl siding, and thought we'd have to spend considerable time flattening the wall. During construction, the owners decided to use Nailite Handsplit Shakes, which come in 3½-foot-long panels two shingle courses high. The irregular texture and shape of the Nailite shingle pattern hid any irregularities in the foam substrate and made flattening the surface unnecessary.



Typically, the exterior surface of the foam blocks requires some flattening before installing siding. In this case, however, the finished structure was sided with panels of rough-textured wood shakes, which covered any slight inconsistencies in the foam's surface.

Secret of ICF Success

It didn't take long for me to figure out how to build an ICF house. Most of the house could be built just like any other house I build. The instructions were easy to follow, and there were no unfamiliar materials, tools, or techniques. I could use ordinary exterior siding, conventional doors and windows, and hang drywall without a lot of special preparation. If I had a question, the Polysteel distributor, who had himself built a dozen ICF homes, was close by for consultation.

I had an advantage, too, because my subcontractors and I had a long history of working together. If I had had to bid the job out to people I didn't know and who didn't know about working with ICFs, the price probably would have been 15% to 20% higher, and I might not have gotten the job.

Still living in a wood-frame world. I work in a resort area, where 90% of the homes are vacation and rental properties. With these houses, building cost is almost always the bottom line. My bid on this house was nearly 10% more than the same size wood-frame house would have been. Because my clients were motivated by their concern about hurricane damage, they accepted the extra cost. They will also keep their house

long enough to recoup that cost through energy savings. But so far, my other clients are still opting for wood-frame construction.

There are also some design limitations with ICFs. In this area, elevation is important. Not only do many homes need to be elevated 3 feet or more to meet flood insurance and zoning requirements, but most homeowners want reverse floor plans (living areas over bedrooms) to maximize water views. Two-story buildings with the first story 8 to 9 feet above the beach on pilings are typical. Engineers are presently working on a cost-effective way to build these typical beach houses with ICF construction.

It's probably only a matter of time before I build another ICF house. Whenever prospective clients come into the office to discuss building a house on grade or a year-round house, I pull out the Polysteel block and do a little show-and-tell for them. I don't push it, but I like to get them thinking about the possibility of building a stronger, more energy-efficient home. Now that I've finished one house, I think in time I'll see more interest.



Ralph Woodard is a custom home builder in Kitty Hawk, N.C.