MY FIRST ICF Foundation

It looked easy enough: Stack a bunch of hollowed-out lightweight polystyrene blocks, fill the cavities with concrete, and presto! — an insulated foundation, ready for interior finishes. I was taken by the technology: With insulated concrete forms (ICFs), I would have a high-tech foundation. I quickly realized, however, that I had a lot to learn about working with ICFs.

by Lee McGinley

I had already built an ICF frost wall for a new entry porch on an old farmhouse. Although the concrete foundation didn't need to be insulated, the ICF blocks were easy to stack, and it was a simple matter to cut the blocks to fit around the existing rubble stone foundation. Once they were laid up, I backfilled on both sides and poured concrete into the voids. Slick.

Since this ICF job went smoothly, I was encouraged to attempt a full foundation. As it turned out, though, a full ICF foundation required greater attention to details than a simple porch job.

Fancy Footing Forms

The foundation configuration was straightforward: a 26x48 footprint with an offset to accommodate a small first-floor porch. I formed the footings with Form-A-Drain (see "Sources of Supply," page 7), a stay-in-place system that forms the footing, drains the foundation, and can be modified to evacuate radon gas (see Figure 1, next page). Form-A-Drain consists of hollow PVC sections, with one side slotted to capture groundwater, while the side facing the concrete is smooth. Accessories include couplings, right angles, outlet pieces, and connector pipes that join interior and exterior perimeters, facilitating underslab drainage.

The 12-foot-long vinyl sections cut easily with a handsaw. I set up batter boards,

Figure 1. Vinyl Form-A-Drain footing forms stay in place as permanent drain pipes after the concrete sets.

Figure 2. Lengths of 1x3 or 1x4 strapping are used to strengthen weak spots in the ICF forms. The strapping is screwed to the plastic tees embedded in the forms.

ran string lines 1 foot wider than the house footprint, and squared the lines. I then laid out the outside perimeter in line with the string, driving 5/8-inch rebar stakes through slots in the PVC to keep the forms from moving. The interior perimeter drain was placed 24 inches inside.

I leveled the outside forms with a transit, maintaining the elevation by screwing 1x3 stakes spaced 3 to 4 feet apart to the Form-A-Drain. I leveled across to the interior form and staked it in place. Then I poured the footing.

After the footing set up, I snapped lines defining the outside perimeter of the foundation. Using this line, I shot 1x4 rough-sawn lumber to the footing. (These cleats would be removed after the slab had been poured; I didn't want little critters making their home in decaying wood, and eventually nesting in the ICF blocks.) The first course of ICFs would be placed against this ledger. I had decided to pour the slab early; this would give me a flat, solid surface to work from, and something to secure the wall bracing to without fear of the foundation walls moving out of alignment. The 1x4 ledger on the footing would prevent the first course of ICFs from being pushed outward when the slab was poured.

I filled the area under the slab with about 8 inches of 3/4-inch crushed stone, level to the top of the footing, and shoveled a 24-inch band of stone around the outside perimeter.

Getting Set

Several manufacturers make insulated concrete forms, each company offering a variation on a couple of themes. The material of choice is expanded polystyrene, the same material used to make take-out coffee cups. Forms can be shaped like the three-hole blocks of their masonry cousins, or come in pre-cut sheets held apart with plastic tees. I chose Therm-O-Wall blocks, which are 48 inches long, 16 inches high, and either 8 or 10 inches wide. At each end, and spaced 16 inches on-center, embedded plastic tees provide furring for securing interior finishes. Another feature of

Therm-O-Wall blocks are their ready-made left and right corners; some systems require you to fashion corners from straight forms.

There are a few simple rules to keep in mind when laying and stacking the forms: Build the corners first, stagger the joints, and don't try to level each course, since it's impossible to stack the blocks perfectly. You'll need several canisters of low-expanding aerosol urethane foam, which is the glue used to bond the form blocks together. I used Pur-Fil foam and a Pur-Fil foam gun. You'll also need a supply of 1x4 strapping. The strapping acts like a band-aid to strengthen weak joints and bridge cracks in damaged blocks (Figure 2).

Simple tools. Tool requirements are minimal. ICFs cut easily with a handsaw, although a table saw helps if you need to rip a bunch of blocks to height. A cordless drill is invaluable; a cordless circular saw is handy, too. A heavy-duty rotary hammer drill makes light work of the dozens of holes that need to be drilled in the footing to accept the vertical rebar that gives the wall its strength. Snips to cut the tees and a rented rebar cutter/bender round out the tool list.

I decided to place the floor trusses in pockets in the foundation wall, eliminating air infiltration at the usual sill and rim joist connection. This boosted the overall foundation wall height to 9 ft. 6 in., allowing for 7 ft. 6 in. of headroom in the basement, and a 4-inch-thick slab. In order to end up with this final wall height, I ripped the first course of blocks 8 inches high.

Start at the Corners

With the help of an experienced ICF block layer, I set the corner blocks, cementing them in place with aerosol urethane foam. I then stretched strings corner to corner and laid the first course, keeping the tops in line with the string and butting them against the 1x4 ledger. Where there were dips in the footing, I filled the gaps with aerosol foam; wood shims work well for large gaps. I then nailed together 2x6 L-shaped corner bucks and plumbed and braced them at each outside corner (Figure 3).

Figure 3. Plumbed and braced 2x6 corner bucks will hold the foundation dimensions as the walls are stacked. The 1x4 cleat attached to the footing keeps the first course from kicking out during the slab pour.

Researching ICFs

A good place to start your search for information about ICFs is the Insulating Concrete Form Association (1807 Glenview Rd., Suite 203, Glenview, IL 60025; 847/657-9730; www.forms.org). They publish a list of member manufacturers, distributors, contractors by state, and design professionals, all of whom are linked to their website. The website also sells books, publishes a calendar of industry-related events, and promotes an annual convention.

While you're surfing, check out www.ICFweb.com, edited by Pieter VanderWerf, a well-regarded ICF expert. Here you'll find message boards, product reviews written by end users, and a search engine that will direct you to information on concrete admixtures, waterproofing techniques, and ICF contractors.

The Portland Cement Association also maintains a website with information on ICFs, at www.concretehomes.com/sys-icf.htm.

Some manufacturers will provide you with learn-before-you-buy construction manuals and videos, in addition to their product literature.

When evaluating these resources, questions to keep in mind include: How are the ICFs distributed? Is there a local supplier, or will freight charges be added to the order? Is there a list of contractors in your area who are familiar with ICFs? Is the manufacturer able to provide help with basic engineering calculations, such as the specifications for placement and size of rebar? What type of technical assistance is available? You will also need to find a local ready-mix company with a pumper operator who has had experience pumping ICF foundations.

Figure 4. The first course of block acts as a form for the basement slab. The finished slab provided a level work surface, since the foundation is built from the inside.

Figure 5. Aerosol urethane foam cements the tongue-and-groove connections between blocks. Note the plastic webs, which hold the sides of the blocks together and provide support for horizontal rebar.

With the first ICF course in place, we made preparations to pour the slab. I covered the crushed stone and the exposed interior portion of the footing with 1-inch-thick extruded polystyrene, topped with a 6-mil poly vapor barrier. We then poured a 4-inch slab with fibermesh in the mix (Figure 4).

Carpenters, Not Form Setters

Engineering tables provided by the manufacturer specced 5/8-inch (#5) vertical rebar every 16 inches, to provide the necessary lateral resistance. I chucked a 5/8-inch carbide-tipped bit into a rotary hammer, drilled a 2-inch-deep hole in the footing in the center of each core of block, and then enlarged the hole with an 11/16-inch drill bit chucked into a 1/2-inch drill. This gave us some wiggle room to set the rebar.

The manufacturer strongly suggested that I use carpenters rather than concrete workers to stack the blocks, because the skills required to place the blocks are more compatible with a carpenter's background than a concrete worker's. After working with the blocks, I agree with him. (While writing this article, I heard several stories about ICF walls built by concrete workers — walls so out-of-plumb that they had to be shimmed out before interior wall finishes could be applied.)

Therm-O-Wall blocks make tongue-and-groove connections with each other, so I squirted a 1/2-inch bead of aerosol urethane into each groove before pressing the next block into place (Figure 5). When a block had to be cut to length, we formed a tongue or groove as needed to join with the abutting block. Sometimes these fits were sloppy, so we shot in extra foam. Where we thought we might have a weak joint, we reinforced the area by screwing 1x4 strapping into the plastic tees.

Number 5 horizontal rebar was cradled in the first course of 16-inch-high block (Figure 6) and clipped into place with Snap-Lok rebar fasteners, 4 feet on-center. We inserted the horizontal rebar every four courses, as well as in the top course, overlapping the ends 24 inches.

For window openings, we scabbed

together pressure-treated 2-by material equal in width to the ICFs. The manufacturer insisted on 1/4x2x2 angle iron at each horizontal corner — four lengths per opening — to give the window bucks additional strength. But with small windows, this was overkill. Since we were essentially casting a lintel in place, I'm confident that two pieces of rebar spaced apart and placed above the buck would have been sufficient.

We set four courses and then erected 2x6 commercial-weight steel studs as wall braces, approximately 7 feet on-center. The studs were also screwed to the plastic tees. Next we hung Lite-Form scaffold brackets from the steel studs; this way, the wall braces doubled as staging for laying more courses as well as for pouring the concrete. At the top of each steel stud, we fastened a diagonal 2x4 kicker attached to a turnbuckle brace. Turnbuckle braces are available from masonry distributors and some ICF manufacturers. Each turnbuckle brace has a steel plate at the bottom, designed to be fastened to the slab with concrete screws. The turnbuckle attached to the kicker provides the necessary adjustment to plumb the walls and keep them aligned.

When it comes time to fill ICF blocks with concrete, the tops of the walls are more likely to want to tip out than in, since they are braced only on the interior. Because of this, the manufacturer recommended that we tip the tops of the walls slightly inward. Regardless of how hard we tried to plumb and line, as I sighted down a course of blocks, it was wavy; variations of as much as 1/2 to 3/4 inch were not uncommon (Figure 7).

We laid rough planks on the brackets and continued laying blocks. The plans called for a step down into the living room, so we cut the last course of blocks to height to accommodate the jog. The foam blocks stacked imperfectly, so the last course multiplied the foam's imperfections, leaving an up-and-down top edge. To correct this, we shot elevations, snapped lines, and trimmed the top course with a handsaw and Surform. The results were imperfect at best. Next, we dropped precut 5/8-inch

Figure 6. A preshaped wire wraps under the plastic web and over the rebar to keep the steel in place.

Figure 7. A vertical 2-by braced against the bank helps keep a wall intersection plumb. The wall braces, which can be seen behind the ICF wall, support staging brackets, which provide access for stacking the upper blocks and pumping the concrete.

rebar down each core into the drilled holes in the footing and wired them to the top horizontal rebar.

Finally, since the top of the floor trusses would be flush with the top of the sill plate, we created pockets in the foam to match the truss layout. To form the pockets, I cut slots in the foam blocks. I doubled up rough-sawn 2x6 blocks, scabbed them together, placed them in the slots, and held them in place with 1x3 strapping screwed into the plastic tees. After checking the diagonals at the top of the block walls, we were ready for the concrete pour.

Don't attempt to fill ICF forms without a concrete pumper (Figure 8). The concrete recipe for ICFs is a cement-rich 3,500-psi mix with extra sand. The proportion of large aggregate — in this case, the maximum size of the aggregate was 3/8 inch — was less than usual, and the slump was between 5 and 6 inches. This oozy mixture is perfect for the concrete pumper and doesn't get hung up on rebar and web ties. The end of the pumper hose was reduced from 4 inches to 3 inches, lessening the force of the concrete against the easily damaged blocks (Figure 9).

Figure 8. A pumper truck is essential for placing concrete in ICFs.

Figure 9. Moving the hose evenly around the forms ensures that the concrete is placed in shallow lifts. Note the steel wall braces against the rear wall, which support staging planks.

It's critical to fill the forms gradually and evenly, in several lifts. Our guy circled the foundation three times, allowing the concrete to set up somewhat before adding more. Around windows, he carefully built up concrete on each side. Triangular peep holes cut in the foam under each window buck, in the center of the opening, allowed us to detect voids. At corners, he switched from side to side to keep the pressure equal.

I held my breath during the pour. Although there were no blowouts, we were prepared for this possibility with 3/4-inch plywood patches that could be screwed to the plastic studs to cover a rupture. At the end of the pour, we inserted anchor bolts 4 feet on-center.

Sticky Stuff Won't Stick

Insulated concrete blocks are not waterproof, so they have to be protected from groundwater by attaching a waterproofing membrane to the exterior (see "Waterproofing ICF Foundations," 2/00). I chose Grace's Bituthene 3000, a peel-and-stick elastomeric membrane.

Applying the membrane is a two-person job. We installed it vertically, rough-cutting the membrane in sections long enough to cover the wall from the sill to the bottom of the footing. We nailed one end of the membrane to the pressure-treated sill with roofing nails. Then, while one of us peeled away the paper, the other smoothed the Bituthene and patted it against the blocks. We ran our hands across the membrane, ensuring even adhesion. Although the seven rolls of Bituthene came from the same lot, some of the material would not stick to the ICFs (even though we had hosed the surface dirt off the blocks). The manufacturer was unsuccessful in identifying the cause of the problem. The only cure they came up with was to buy additional Bituthene in the hope that it would stick. I did, and it did. (A year later, the basement remains leak-free.)

With the membrane in place, we backfilled carefully, dumping a 2-foot perimeter band of sand against the foundation to avoid membrane punctures caused by sharp rocks, and then proceeding to

backfill with excavated material. To hide the Bituthene and protect the foam above grade, I cut 2-foot-wide strips of a fiber-cement panel siding, HardiPanel, and nailed the strips to the sill.

Do They Stack Up?

If you've been mentally building this foundation as I've been describing it, by now you realize that there are many steps, and many opportunities for procedures to go awry.

Although the ICFs I used are a good product, the documentation and instructions could have been stronger. As I puzzled together the best way to assemble the forms, many of my questions could be answered only by phoning the manufacturer.

What little guidance I received was strong on concrete technology but weak on a builder's perspective of how a house goes together. For example, the recommendation that I form pockets into which to drop floor trusses — rather than supporting the trusses on a ledger — added unnecessary expense, wasted time, and was unforgiving of layout errors. Details are available for attaching a ledger to ICFs (see "Step By Step With Foam Forms," 12/95). I wish I had had this information before I started.

And then there were the problems that arose as I went about building a house on top of the foundation. For example, to disperse a point load, I had to place 3/4-inch plate steel under a post holding up a corner of the second floor because there was more polystyrene than concrete at the point of contact. When I went to attach corrugated steel window wells around the basement windows, I had nothing to screw into but foam. And when I went to screw plywood to the interior walls to support the electrical panel box and mechanical system components, I discovered that the fastening strips didn't hold the screws that well. Attaching electrical boxes to the form was also challenging.

The summer I built this foundation was one of the wettest on record. Laying up ICFs is time-consuming, and after each rain, the cellar hole sides collapsed, forcing us to bring back the excavator to clean out the hole. I lost two weeks dealing with mudslides, and another two weeks with the Bituthene problem. Had I used conventional plywood forms, I could have snuck a foundation in between storms and mopped on asphalt dampproofing, all in a matter of three or four days.

I'm planning to build a deck, but since I can't attach it to the foundation, it will have to be a free-standing structure supported by additional concrete piers — an added expense. If I decide to add a family room, there will be similar problems, as I work out the best way to attach a poured concrete frost wall to an ICF wall with a waterproof connection.

Sometimes, Low Tech Beats High Tech

ICFs entered the market as an innovative solution challenging a time-tested, low-tech building system for foundations — plywood forms filled with concrete. While the insulating benefit of ICFs is hard to ignore (my ICF manufacturer claims an R-value of 22, while others boast values as high as 40), I wonder if this feature is worth the time and trouble of learning a new set of skills, dealing with new materials, the potential for blowouts, the extra cost of using skilled labor, the extended construction time, and the need for long-distance technical support.

Could some of my problems have been avoided? Sure. I take full responsibility for plunging in before fully investigating ICF building technology and not putting in the extra thought needed to plan out an ICF foundation. On the other hand, some problems and system limitations would not have gone away. These include the extended building time, waterproofing problems, the cost of skilled labor, and structural restrictions.

My suggestion: If you decide to use ICFs, pull together information from several manufacturers, watch their videos, and then choose an approach that fits your building style. Also, buddy up with someone who builds with ICFs before attempting one on your own.

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Sources of Supply

CertainTeed
P.O. Box 860
Valley Forge, PA 19482-0101
610/341-6950
www.certainteed.com
Form-A-Drain

Hawkeye Concrete Products Co.
Highway 61 South
Mediapolis, IA 52637
319/394-3197
www.hawkeye-pipe.com
Snap-Lok rebar fasteners

James Hardie Building Products
26300 Alameda St., Suite 250
Mission Viejo, CA 92691
800/942-7343
www.jameshardie.com
Hardipanel fiber-cement siding

Lite-Form International
1950 W. 29th St.
So. Sioux City, NE 68776
800/551-3313
www.liteform.com
Lite-Form scaffold brackets

Standard ICF/Therm-O-Wall
7 Preble's Way
Gray, ME 04039
888/584-3466
www.therm-o-wall.com
Insulated concrete forms

Todol Products
P.O. Box 398
Natick, MA 01760
508/651-3818
www.todol.com
Pur-Fil aerosol urethane foam

W. R. Grace
62 Whittemore Ave.
Cambridge, MA 02140
800/354-5414
www.gcp-grace.com
Bituthene 3000 waterproofing membrane