

Building a House of Insulated Concrete Block

Dry-laid walls reinforced with steel and filled with concrete make a weathertight, bugproof house

BY FRED LEADBEATER



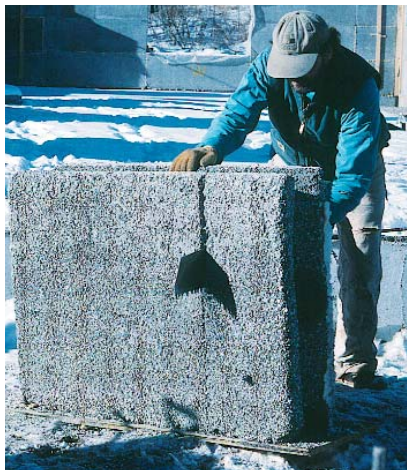
Solid as a rock. Insulated-block walls reinforced with concrete keep the weather extremes of southwestern Montana at bay while offering protection from insect damage, fire and earthquake.

Stick-frame construction is all but dead in Europe, and for good reason. Wood is too scarce and too expensive to use as a hidden structural element as it is in U.S. residential construction.

Instead, European builders use wood primarily for decorative details. Masonry construction is standard, as I learned in years of job-related travel that took me to Europe. When I moved to Montana a few years ago

and built a house (photo above), the technologies I had seen in Europe made more sense than standard wood-frame construction.

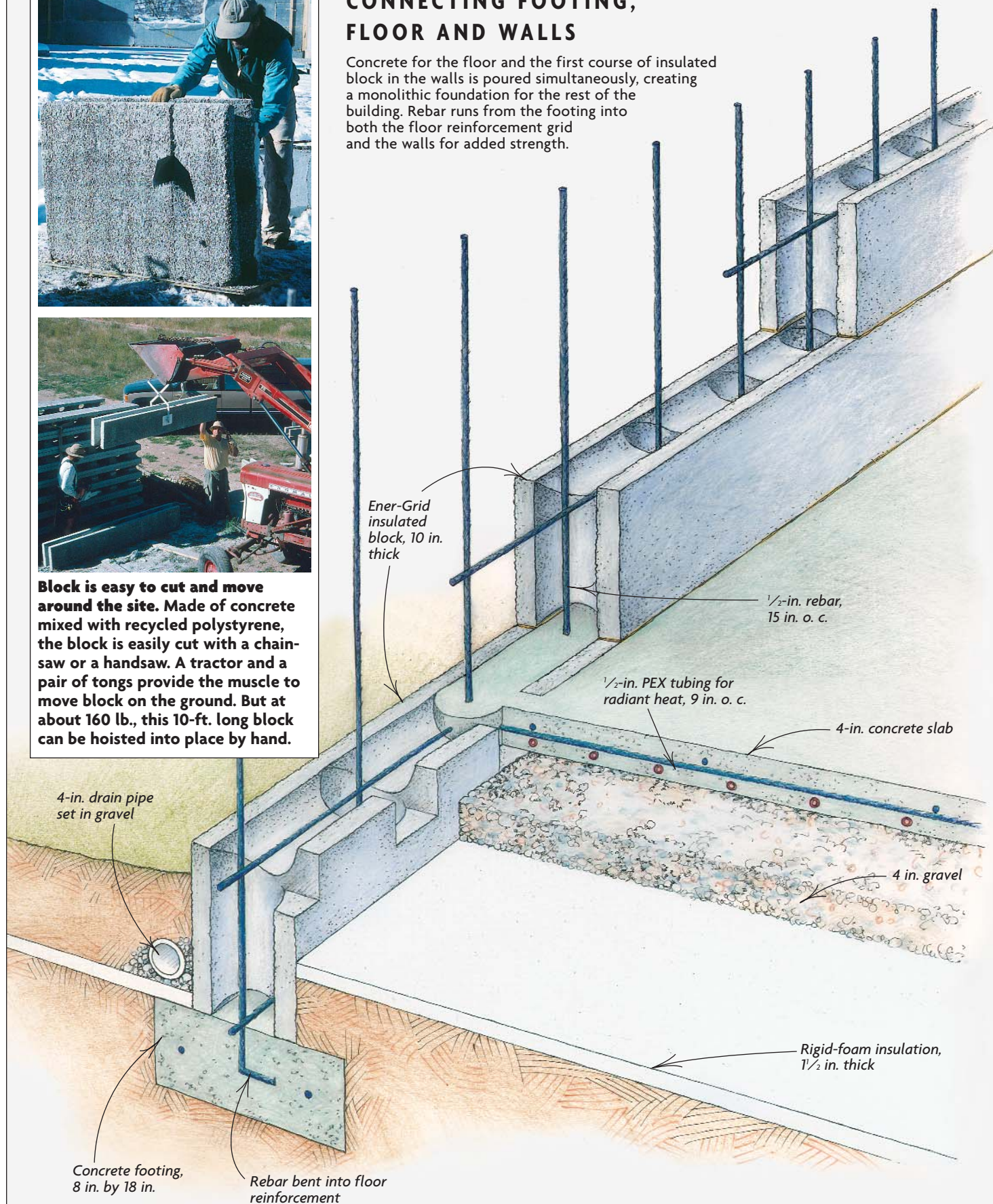
Weather conditions in the mountains of southwestern Montana are brutal: scouring



Block is easy to cut and move around the site. Made of concrete mixed with recycled polystyrene, the block is easily cut with a chain-saw or a handsaw. A tractor and a pair of tongs provide the muscle to move block on the ground. But at about 160 lb., this 10-ft. long block can be hoisted into place by hand.

CONNECTING FOOTING, FLOOR AND WALLS

Concrete for the floor and the first course of insulated block in the walls is poured simultaneously, creating a monolithic foundation for the rest of the building. Rebar runs from the footing into both the floor reinforcement grid and the walls for added strength.





One floor at a time. With first-floor block filled with concrete, a ledger to carry second-floor framing can be bolted into place. Bolts should be set before concrete is poured.



Snap ties reinforce block. Standard snap ties run through 2x4 blocking will help to keep block courses aligned when concrete is poured. These second-floor walls need only modest bracing.

winds, 90°F summers and -40°F winters. The climate seemed ideal for one of the best European products I had seen, an insulated concrete block called Rastra. Developed in Austria, the block is a type of insulated concrete form that is dry-stacked, reinforced with steel and then filled with concrete. Eighty-five percent of the material's volume is recycled polystyrene, which is shredded into beads and mixed in forms with cement to make the block. Once completed, walls resist fire, earthquake, wind, water and insects. Houses built this way are unbelievably comfortable summer and winter, and pleasing to the eye to boot (photo p. 92).

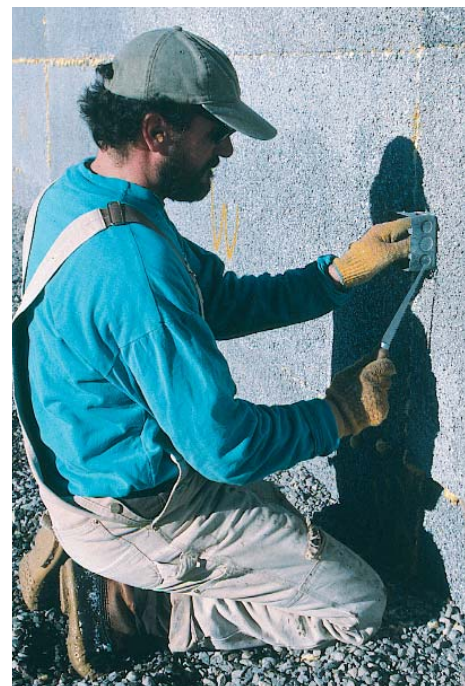
I am not a builder by trade. But my budget was tight, so I joined the construction crew that consisted of the architect-builder, Matthew Beardsley of the Baukunst Company in Bozeman, and one other person. We used block from a now-defunct company called Ener-Grid to build my house. It seems identical to the block manufactured by Rastra (888-727-8725; www.rastra.com). An-

other company is Cempo Forms Inc. (775-727-6565; www.cempo.com). Techniques we used to build my house should work with block from either of these companies.

Blocks are lightweight, and workable with common tools

Ener-Grid blocks were available in widths of 8 in., 10 in. and 12 in., and 15 in. or 30 in. high. Each block is 10 ft. long (sizes may vary, depending on which manufacturer you buy from). For all their bulk, however, blocks are relatively light. The 10-in. deep, 15-in. high blocks that we used weighed 160 lb. each. To move them, we used a rented farm tractor equipped with a simple clamp (bottom photo, p. 89). Once we were on the second floor, we also used a portable aluminum hoist.

The material is easily cut with a chainsaw or handsaw (top photo, p. 89). It can be routed, drilled, sanded, rasped, shaped and set into curves. That's the real beauty of the material: Its applications are limited only by your imagination. Running through the



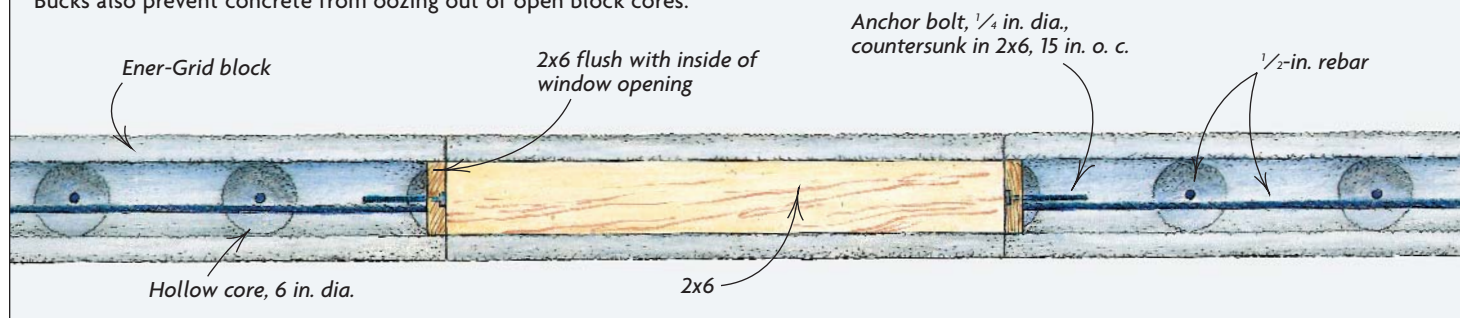
Wires and boxes are set into carved recesses. Because the block is relatively soft, many tools, including a keyhole saw, can be used to make electrical channels.



A pump truck saves a world of trouble. A soupy mix of concrete is placed efficiently with a 5-in. dia. line. Anchor bolts set in concrete at the top of the wall will be used to fasten a 2x top plate for conventional roof framing.

SETTING DOORS AND WINDOWS IN PLACE

Bucks, or frames, made from 2x6 material and anchored to walls before concrete is poured will provide a solid foundation for doors and windows. Bucks also prevent concrete from oozing out of open block cores.





Snug and comfortable. Dyed concrete floors that conceal a radiant-floor heating system and interior trim of vertical-grain Douglas fir help to give the house an earthy, low-tech appeal.

block, both horizontally and vertically, are 6-in. dia. cores 15 in. o. c. where steel-reinforcing bar and, ultimately, concrete are placed. Once filled, the blocks form a continuous, reinforced grid of incredible strength.

Before starting this project, Matthew had compared the cost of a well-insulated stick-frame house with Ener-Grid block and found that costs were comparable (my house cost roughly \$65 per sq. ft. to build). Performance of the block, however, is superior to conventional construction in almost every way.

Block walls are stacked, foamed in place and filled with concrete

There's nothing unusual in the way these walls start: Our first step was to pour a concrete footing 18 in. wide and 8 in. deep (we

used a frost-protected shallow foundation). Blocks are stacked directly on the footing. For a solid connection, we set lengths of #4 rebar into the concrete that would run up through the first few courses of block. When the blocks reached the level of the poured floor, Matthew used a chainsaw to cut notches on the inside face of the wall. Some of the rebar cast into the footing was bent 90° and tied to the steel reinforcement for the floor (drawing p. 89). When the floor was poured, walls and floor were connected in a monolithic structure. Radiant-floor heat is perfect with this technology.

Wall block is simply stacked up and temporarily glued in place with polyurethane foam. We used rebar both vertically and horizontally, running the steel into each hollow

core after the walls were stacked. One of the beauties of working with the material is that holes can be easily patched with foam. So we could run horizontal rebar right through the side of the block into the core, then patch the hole with foam.

Outside corners are formed with 30-in. high blocks mitered lengthwise at 45° and set into place on end. That created a neat, straight joint. The blocks were easy to cut with a circular saw set to a 45° angle. Matthew cut one face, flipped the block to cut the other face and finished the cut with a handsaw.

Windows, doors and floors require special planning

At window and door openings, we cut back the cores of the block to accommodate a 2x6

buck, or frame, whose faces were flush with the outer edge of the block (drawing p. 91). These bucks prevent concrete from spilling out of the block as walls are poured, and they make a nailable foundation for installing doors and windows later. Bolts inserted through the 2x6 bucks and into the hollow cores of the block make for a solid connection once the concrete has been poured.

We ran Ener-Grid block all the way up the gable-end walls, then snapped a line at the same angle as the roof pitch. Matthew cut to the line with a chainsaw, leaving core openings on an angle. We worried that the concrete would quickly drain out of these openings. But by making the concrete somewhat stiffer for those areas, we avoided a problem.

Floors can be hung at any height. Once block walls were erected but before they were poured, we pushed anchor bolts through the block wall and into open cores. Later, we drilled corresponding holes in the wood I-joists that were used as ledgers for the second-floor framing and bolted them firmly to the walls (photo left, p. 90). We used spacer blocks to fill spaces between chords and webs. Although we could have used solid 2x ledgers here, Matthew had already determined the floor framing would be I-joists, and keeping joists and ledgers the same made it much easier to hang drywall ceilings down the road. Anchor bolts also are set into the top course of blocks so that a plate can be attached at the top of the wall for the roof framing.

Walls are reinforced with a combination of conventional snap ties and threaded rod bolted through 2x blocking (photo top right, p. 90). We added bracing where we thought it would be most needed—at doors and windows, for example, or where the block was cut. All in all, bracing was on roughly 8-ft. centers and was used to straighten walls prior to the pour as much as it was for strength.

A pump makes placing concrete faster and easier

With this kind of construction, the nail-biting comes when the concrete truck arrives. There are a lot of passages for concrete to fill, so we used grout with a slump of 8. That's roughly twice as fluid as standard ready-mix concrete. Matthew specified a seven-sack mix with 40% of the aggregate $\frac{3}{8}$ in. or less and the balance sand, which should yield concrete with a compressive strength of 4,200 lb. per sq. in. We also used a concrete pump truck, which simplified the pour (photo p. 91). We placed the concrete with a 5-in. dia. hose with an S-curve at the end. The curve is important because it slows down the concrete as it leaves the hose. A gate on the

S-curve allowed the person handling the hose to shut off the flow of concrete quickly.

Walls for the house were formed and poured in stages. We placed block for the first floor, poured concrete to that height and then added the second-floor deck. This process provided a solid platform for forming the remainder of the walls. Although Matthew has placed concrete in walls as tall as 17 ft. in one shot, a lower wall height reduces the risk of a blowout during the pour.

Any time wall height exceeds 8 ft., it's a good idea to place the concrete in two passes, or lifts. By the time you get back to the starting point, the concrete placed on the first pass will have stiffened somewhat. Because this concrete had such a high slump, we did not need to use any mechanical vibration to consolidate it. We used a total of 30 cu. yd. of concrete for my 3,000-sq. ft. house.

With a little planning, utilities are a breeze to install

Plumbing and wiring are not as difficult as they seem. It is important to plan utilities from the start so that conduit and water supply lines can be located correctly in the concrete floor. From there, electrical and plumbing lines are run mostly through interior partitions. You do need receptacles on outside walls, and this is where you will be thankful that the block is easy to work with.

A channel can simply be gouged out of the wall to create enough room for standard plastic-coated cable. Just about any tool—router, keyhole saw, chainsaw tip—will do the job. Boxes are set in their own cavities (bottom photo, p. 90) and then foamed into place. When the cable has been run, the wire and channel are simply plastered over. We didn't think metal conduit was necessary.

When it came time to apply interior and exterior finishes, we rasped the rough block joints smooth with a thick piece of expanded metal lath attached to a handle. The material can be shaped easily. You can plaster or tile directly to the insulated block. Hanging pictures or other light objects from block walls is easy with a plastic anchor and screw. Heavier objects require more support. The best way is to plan by inserting bolts into the hollow cores before the concrete is placed.

Almost any siding can be used on the block. We used stucco on exterior walls up to the gable ends. From there, we hung cedar siding from furring strips routed into the block and screwed into the concrete core. □

Fred Leadbeater is a former factory technician for Marker ski equipment and now lives in Bozeman, MT. Photos by the author, except where noted.

You will find little agreement on R-values for insulated-block walls

by Scott Gibson

You might have better luck mediating Mideast peace talks than winning agreement on the thermal performance of insulated-block walls such as those in Fred Leadbeater's house.

Rastra, a manufacturer of insulated-block wall systems, estimates the dynamic, or effective, R-value of a 10-in. wall ranges from 19.7 to 23.9, depending on where you live (the dynamic R-value takes the effect of thermal mass into account). The steady-state R-value of the same wall is 11, says Rastra.

Castleblock, distributor of Cempo Form block, is even more optimistic. It claims R-values of 3.5 per in., or R-35 for a 10-in. wall. The company says its numbers have been widely accepted by building officials. Besides, it adds, even if the numbers are high, 80% of a building's heat loss is through roof, doors and windows, not exterior walls.

Energy Design Update, a monthly newsletter dealing with building-energy issues, popped those balloons in its December 1999 issue. The publication disclosed that tests at Oak Ridge National Laboratory found a static R-value of 7.6 for a 10-in. Rastra wall. That's less than a conventional 2x4 wall filled with fiberglass batts. When "dynamic benefit multipliers" are plugged in, EDU said, R-values rise to between 13.6 and 16.5, depending on climate.

Oak Ridge isn't ready to release a report. Although the lab has conducted a number of tests for Rastra, the work has not been finished.

If you have Internet access, check out Oak Ridge's Web page (www.ornl.gov). It includes a wealth of information on the thermal performance of various building envelopes. At some point in the future, the lab hopes to add insulated concrete-block walls to the mix.

—Scott Gibson is a senior editor at Fine Homebuilding.