Building for Affordability and Energy Efficiency

Walls of aerated concrete block, a passive-solar design and a truss roof all make it possible

BY KATHLEEN JARDINE AND JAMES CAMERON

When we met them, Martha and Kent Pearson were nearly resigned to building a conventional house on their beautiful 10-acre site outside Chapel Hill, North Carolina. A conventional house is just what they were hoping to avoid, but four other builders had just about convinced them an energy-efficient house with a low environmental impact would cost too much. It didn't.

We designed and built an 1,800-sq. ft. house (photo facing page), plus a screened porch, for $165,000, well below local costs for conventional custom homes in our area. Wherever possible, the house is constructed of environmentally sensitive materials, meaning they are nonpolluting or low in toxicity and may be recycled. Inexpensive to light, heat and cool, the house should last for well over 100 years with only minimal maintenance. The Pearsons got what they really wanted: a "green" house they could afford.

The story-and-a-half, three-bedroom cottage (floor plans p. 86) combines a number of innovative elements. It is a passive-solar structure. A radiant-heating system warms the concrete floor (photo below). We used an exterior-wall system made of autoclaved aerated concrete (AAC), a European product recently introduced in the United States (for more on using it, see the sidebar on p. 84). This material outperforms fiberglass insulation rated at R-30 in a wall that is 8 in. thick. All these features cost less or no more than their conventional counterparts, but they save a lot of money subsequently. Other features we used to bring down the Pearsons'

It's full of air. The 8-in. by 8-in. by 24-in. block used to build the first-floor walls is made from aerated autoclaved concrete, a lightweight material with high insulating values.

Concrete floor looks like slate. Tinted concrete poured over a bed of washed rock creates a thermal mass for the passive-solar design. When grooves scored in the surface are grouted, the floor looks as if it were made from large slabs of stone. Photo taken at B on floor plan.

Simple shape helps to keep costs low. A square footprint that simplified construction was part of the cost-saving strategy for this energy-efficient North Carolina house. Block made from aerated autoclaved concrete makes up first-story walls. Photo taken at A on floor plan.

Hebel block: a great wall system that masons love to hate

Masons are accustomed to speedy work with block, but working with aerated autoclaved concrete (AAC) can be slow going. You need special trowels and mortar, and AAC requires precise drilling for the threaded rod that connects the foundation with the top plate (drawing facing page).

Hebel makes its ACC blocks from a mix of cement, lime, sand, gypsum, water and an expanding agent. It's hardened in a mold and then steam-cured under pressure. One thing masons will like is the weight—far less than typical concrete blocks. Although the material is available in different densities and sizes, the block we used measures 8 in. by 8 in. by 24 in. and weighs 28 lb. It can be cut with a handsaw, but we rented a bandsaw from Hebel that made cutting the block easy (photo below left).

Although a masonry crew's first experience with the material can be discouraging, paying well helps. We pay $4.50 per block. This rate compares with $1.50 per standard concrete-masonry unit. Hebel block isn't cheap to buy, either. Blocks come to about $4.50 each with shipping. The Pearsons' AAC walls cost about $9,000. Although this amount is more than typical construction, finishing costs were lower. The exterior gets a single coat of stucco, and interior walls a single coat of a soft, high-gypsum-content plaster. These factors made AAC affordable for the first floor of the Pearson house. Costs are higher for scaffolding work, so we didn't use Hebel block in the gable ends.

HEBEL BLOCK STARTS JUST ABOVE GRADE

After pouring a concrete footing, we bring a standard concrete-block foundation up 10 in. to 12 in. above grade. Long ⅝-in. anchor bolts and couplers are set to the bottom of the first course of block, two or three per wall (photo below right). The block is then filled with concrete. The first course of Hebel block is set in S-type cement mortar, but subsequent courses are set with a special thinset mortar provided by Hebel. Blocks are laid with no visible joint, so it is crucial that mortar be applied carefully. Hebel sells special trowels designed for the job (photo below center).

As each course is set, blocks must be drilled precisely for threaded rod that eventually will run from the anchor bolts to the top plate. We drilled 2¼-in. holes to give ourselves plenty of wiggle room for the ½-in. rod (photo facing page). Each wall has two or three rods tying it to the foundation. At the top of the wall, we use a U-shaped Hebel block in which we pour a continuous concrete bond beam. Before the concrete bond beam is poured, we fill the holes for the rod with mortar.

BUILD BUCKS FOR DOORS AND WINDOWS

We build door bucks from pressure-treated stock. We use construction adhesive and 6-in. nails provided by Hebel to anchor the bucks to the block as the walls are built around them. This sequencing allows us to control the size, placement, plumbness and squareness of all the door and window openings. We try to size windows so that they fit on even courses of block without having to cut a lot of small infill pieces.

Although you can order ACC door and window lintels, we prefer to pour our own bond beams in place. We used the U-shaped Hebel block for the form, and we reinforced each lintel with steel. The premade lintels are dangerously heavy to

It's not wood but cuts like it. Hebel block can be cut with standard woodworking tools, such as a bandsaw. This saw was rented from Hebel.

Mortar joints must be exact. A special trowel helps to ensure precise mortar thickness for block walls. Joints are flush with the wall.

The tie that binds. Anchor bolts set in the concrete footing are attached to threaded rod running through the walls. Access is provided by a U-shaped cutout.

Photos this page, facing page: Kathleen Jardine and James Cameron

raise without the assistance of heavy equipment.

"SO HOW DO YOU WIRE THIS WONDERFUL STUFF?"

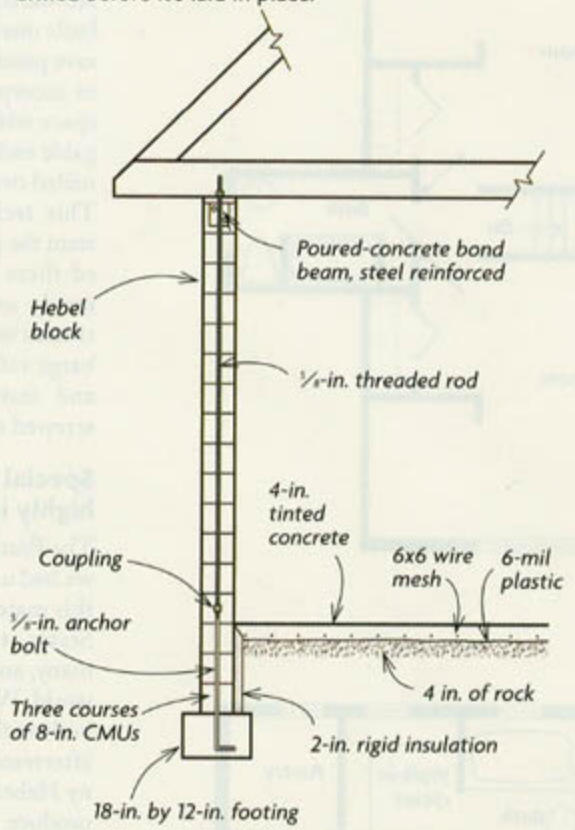
We're asked that question often. It's not that hard. Hebel will provide a router to cut channels in the walls for electrical conduit. But we think it's easier to use a circular saw to slice grooves in block, then chunk out the waste with an old chisel or a screwdriver. Buy an inexpensive saw because the dust from one job probably will ruin it. We use a diamond-matrix blade for the cuts.

Before finishing ACC walls, we patch any irregularities with Hebel-block patch and use a Hebel toothed rasp to smooth the wall surfaces. Stucco is floated on the exterior walls to make a decorative, one-coat finish that needs no vapor barrier. We also plaster interior walls. Wire lath isn't needed.

—K. J. and J. C.

STEEL-REINFORCED WALLS

Threaded rod ⅛ in. in dia. runs from couplings at the top of foundation anchor bolts all the way through the top of a poured bond beam at the top of the wall. To accommodate the rod, each course of block must be drilled before it's laid in place.



One reason Hebel block is slow. Each course of block must be drilled to accommodate ⅛-in. threaded rod that runs from the top plate to the foundation. Masons may not embrace the process immediately.

Drawings: Scott Bricher

initial building costs were a simple footprint and a truss roof. We also designed with homeowner labor in mind. The Pearsons eagerly went to work, saving themselves about $6,000 with their efforts.

Building in passive-solar technology with a traditional look

The Pearsons had done their homework before they arrived at our first design meeting. They knew what passive-solar houses were, but they were uninspired by the modernist style of the examples they had seen. They knew that passive-solar houses are sunny and warm in winter, and cool and shady in summer. They knew the design fundamentals: siting for solar gain; using large, south-facing windows with summer shading; and taking advantage of thermal mass, usually the floor, to moderate temperature extremes.

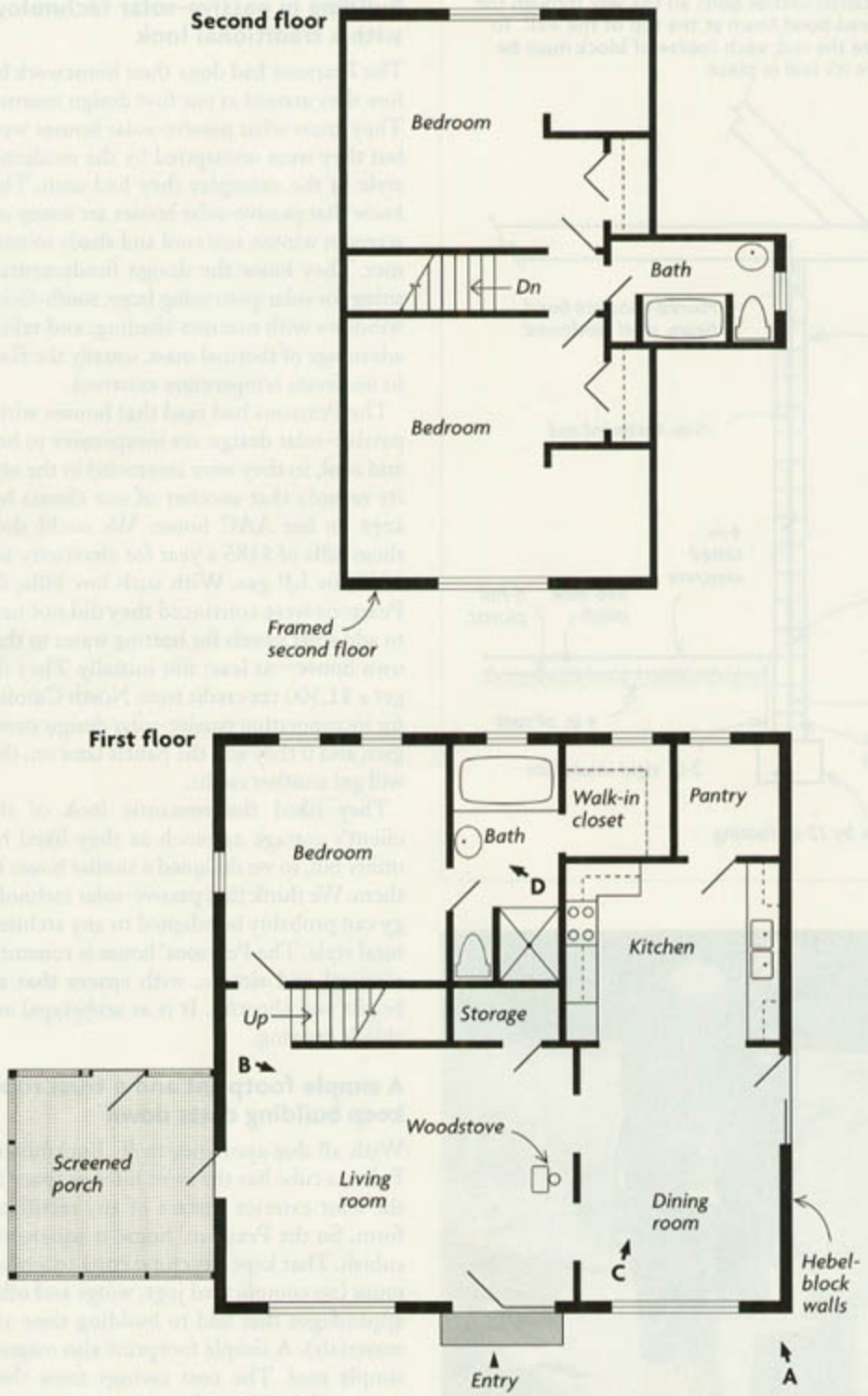
The Pearsons had read that houses with a passive-solar design are inexpensive to heat and cool, so they were interested in the utility records that another of our clients had kept on her AAC house. We could show them bills of $185 a year for electricity and $360 for LP gas. With such low bills, the Pearsons were convinced they did not need to add solar panels for heating water to their own house—at least not initially. They did get a $1,500 tax credit from North Carolina for incorporating passive-solar design strategies, and if they add the panels later on, they will get another credit.

They liked the romantic look of this client's cottage as much as they liked her utility bill, so we designed a similar house for them. We think that passive-solar technology can probably be adapted to any architectural style. The Pearsons' house is romantic, classical and simple, with spaces that are bright and cheerful. It is as archetypal as a child's drawing.

A simple footprint and a truss roof keep building costs down

With all due apologies to R. Buckminster Fuller, a cube has the most interior space for the least exterior surface of any rectilinear form. So the Pearsons' house is square and cubish. That kept structural costs to a minimum (no complicated jogs, wings and other appendages that add to building time and materials). A simple footprint also means a simple roof. The cost savings from these structural decisions allowed money to be diverted to otherwise unaffordable elements. These things included the colored galvanized-steel roof with its 100-year life expectancy, good-quality windows, No. 1 pine tongue-and-groove soffits and porch ceil-

Energy efficient and affordable. Radiant-floor heat and first-story walls of an aerated concrete block help to make this house energy efficient. A square footprint simplified construction and helped to reduce building costs.



Photos taken at lettered positions.

SPECS

Bedrooms: 3 **Bathrooms:** 2 **Size:** 1,800 sq. ft. **Cost:** $92 per sq. ft.
Completed: 1998 **Location:** Pittsboro, North Carolina
Designer/builder: Kathleen Jardine and James Cameron

ings, cedar fascias and lookouts, 9-ft. 6-in. ceilings, arched doorways, six-panel white-pine doors with porcelain knobs and a nice kitchen (top photo, facing page) and master bath. All of this made a great trade for a complex footprint and roof.

We like truss roofs for a lot of reasons, starting with their cost. Simple truss roofs are substantially less expensive than stick-built ones; they save framing time and can save painting time. The Pearsons' roof trusses incorporate an engineered second-floor space with 2x6 gable ends. We finished the gable ends on the ground with cedar battens nailed over ⅜-in. structural T-111 plywood. This technique allowed Kent Pearson to stain the gable ends before a boom truck lifted them and the rest of the trusses into a nearly instant roof and second floor. The trusses were skip-sheathed, and the soffits, barge rafters and lookouts were prestained and installed before the steel roof was screwed on.

Special cement block makes a highly insulated wall system

The Pearsons' house was the fourth in which we had used an AAC wall system. Although this material is relatively new to the United States, it has a 75-year track record in Germany, and it is also widely used around the world. We first heard of it from a friend who built with it on an Israeli kibbutz. Not long afterward, we read that the German company Hebel had opened a plant in Georgia to produce AAC block (800-994-3235). We immediately placed an order with them.

We had to learn to build with AAC ourselves because we could not find regular masons who would (the sidebar on p. 84 summarizes the process). We built our first AAC house with two days of help from a stonemason and his assistant, plus a Hebel technician. At the time, the company provided the technician's services for free. Hebel no longer offers that service, but the fee would be worth every penny. Don't bank on the instructions that come with the Hebel block—at the time we used it, at least, the technical manual was incomplete.

We have yet to find a masonry crew that really likes this material. The learning curve in working with any new product can be formidable, especially when one is faced with 30,000 lb. of it. But AAC's many wonderful qualities outweigh its unfamiliarity. It appears to be more or less fireproof, noiseproof, waterproof and hurricaneproof by comparison with conventional wood construction. It needs no chemical treatment for termites. It has a high insulation performance, and it is

long-lasting, low-maintenance and beautiful when stuccoed and plastered.

The masons' caution in working with an unfamiliar material is consistent with the larger building industry's. It's risky for both individuals in the trades and in the public to experiment with unknowns. Some bad ideas have swept the country as building trends and fads. But the pressure to develop energy-efficient and affordable houses is so powerful that designer/builders will keep trying new ideas. We thought the Pearson house had enough good ideas that we're finishing a smaller version of it for ourselves. □

Kathleen Jardine and James Cameron are a husband-and-wife team whose company, James Cameron Build/Design, is in Pittsboro, North Carolina. Photos by Scott Gibson, except where noted.

Simple and functional. A U-shaped kitchen opening to the dining area is a sunny, pleasant work area with easy access to a large pantry. Gracefully arched openings, such as those separating the dining room from the living room, are a detail the authors could afford to add by saving money elsewhere. Photo taken at C on floor plan.

Plaster has an unbeatable texture. On the interior, both partitions and block walls are finished with plaster. Surfaces have an appealing texture that standard drywall can't match. Photo taken at D on floor plan.