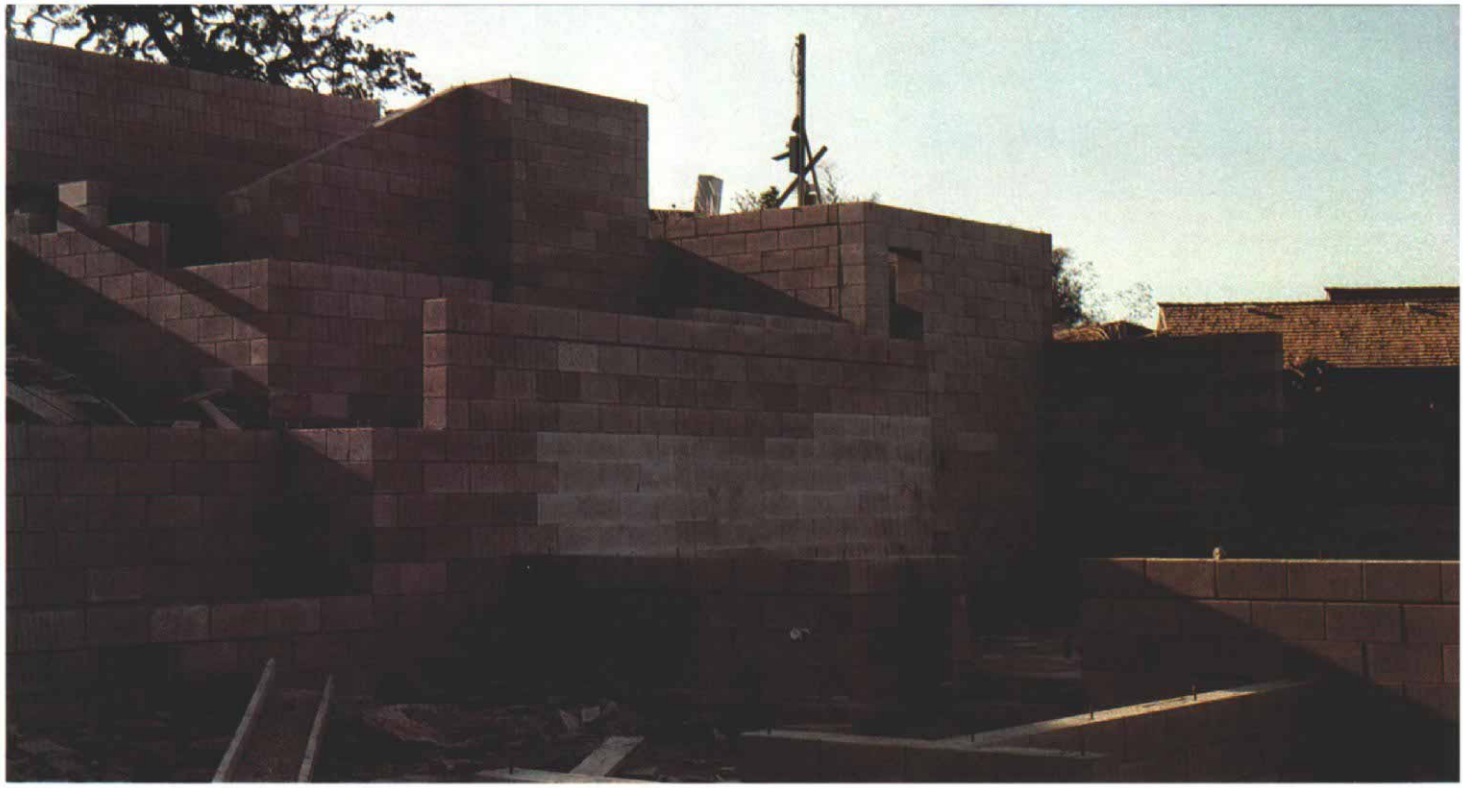


Dry-Stack Block

Precision-ground concrete blocks make it easy to build a wall

by Rob Thallon

Designers have been trying for years to develop a mortarless concrete-block system that could be used by unskilled builders. The concrete blocks in use today look quite uniform, but their dimensions actually vary so much that mortar is necessary not just to hold them together, but also to make up for their irregular sizes. Mixing and applying the mortar to the joints in a block wall require skill and time (see *FHB* #15, pp. 44-47), and the process accounts for 20% to 30% of the material and labor in a masonry project. Manufacturers have recently developed mortarless, interlocking block for industrial and commercial buildings. I use it in house construction. It's called dry-stack block, and it can be laid up as easily as the plastic toy blocks in a Lego set.

Dry-stack blocks look very much like ordinary concrete blocks, but they are consistently a full 16 in. long and 8 in. high (regular blocks are an inexact ⅜ in. less in each direction to allow for the mortar joint). During the manufacturing process, the dry-stack blocks I use are sent through a machine that grinds the top and bottom surfaces to a tolerance of 0.005 in. These parallel, exact and smoothly ground surfaces are what allow the block to be laid up so regularly without mortar.

Most dry-stack blocks have interlocking tongues and grooves at their ends to help align and secure them during placement. Besides standard blocks, there are also bond blocks for bond beams (these have knockouts to accept horizontal rebar), and half blocks. Special corner blocks are manufactured without tongues for finished outside corners (drawing, facing page, center). Where the block remains exposed, its edges are usually chamfered to create a hand-tooled corner that's less likely to chip. It is also possible to have the face of the block ground and sealed to create a smooth, marble-like appearance.

There are three essential differences between the ordinary mortar-laid block and the dry-stack. First, the dry-stack method uses mortar only at the joint between the footing and the first course of block. This mortar joint at the base lets you set the first course absolutely level. Second, ordinary block is usually grouted (filled with concrete when the wall is complete) in only the cells containing reinforcing steel (rebar), while dry-stack blocks are usually grouted in every cell. This locks the blocks in place, and also fills the bond beams completely without having to pour them individually (drawing, facing page, top).

Third, you have to be careful with ordinary block walls to be sure that fallen mortar (as distinct from grout) doesn't hang up in the rebar or clog the bond-beam channels. This usually means that you have to build the wall in 4-ft. vertical increments so that the grout completely fills the appropriate cells. A dry-stack wall, however, can be grouted all at one time because there is no mortar to clog the steel or to plug up the cavities. Grouting tall dry-stack walls all at once can save a lot of time, especially if you use a concrete pumper.

When the dry-stack system was first introduced in the Eugene, Ore., area, about half the projects were questioned by the building department. The building official wanted to see calculations proving that the dry-stack system is as strong as a regular block-and-mortar wall. This is reasonably easy to demonstrate by showing that the compressive strength of the block is greater than that of mortar.

Residential applications—I had seen dry-stack block used successfully on several houses before I had the opportunity to try the system myself. I had designed a house for a steep site, with a complex foundation and several retaining walls. It looked as though using dry-stack blocks would allow a significant saving on labor. In addition, my client wanted a warm-colored block, and not having to use

Reaching as high as 12 ft., the finished blockwork is ready for the carpenters. A quarry-tile feature strip is visible just below the top course at locations where the walls will act as foundation for the house. The brownish-red blocks used above grade are special order.

mortar meant we wouldn't have to mix colored mortar to match the block.

Before ordering the block, I asked the supplier about various coloring agents, but everything they showed me gave the blocks a bland uniform color—they looked phony. As an alternative, the manufacturer (Willamette-Greystone Inc., P.O. Box 7816, Eugene, Ore. 97403) suggested using scoria, a brownish-red volcanic aggregate found in Oregon's Cascade Mountains. This seemed to be just what I wanted, so I ordered a special run of blocks.

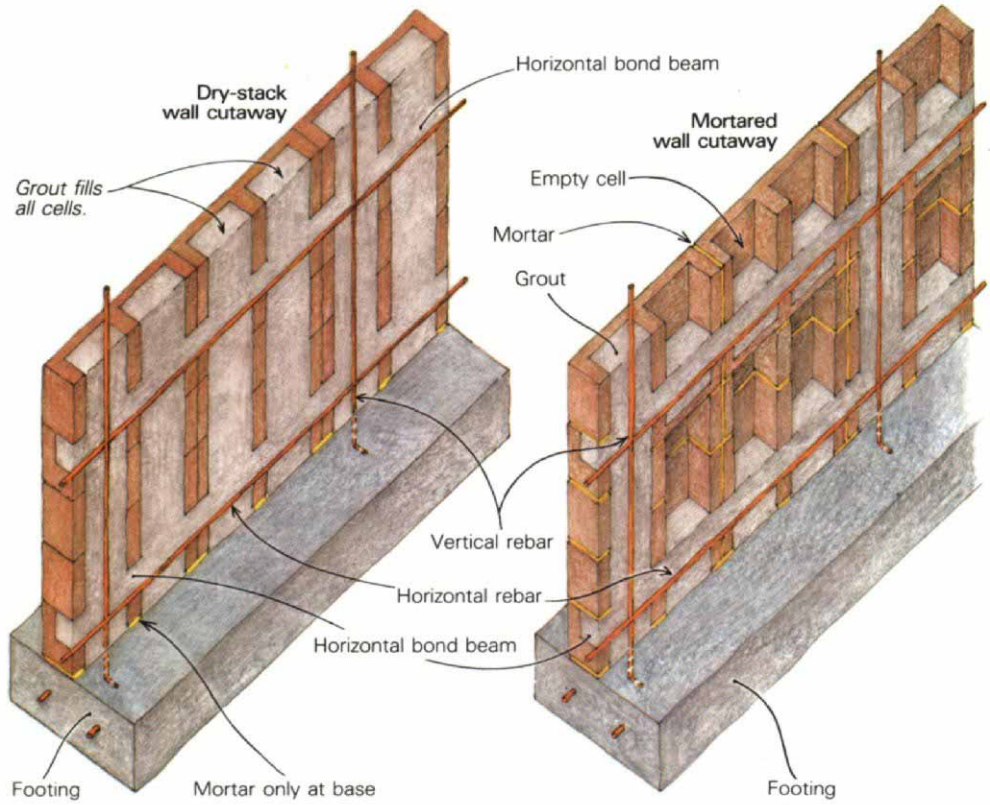
When the blocks finally arrived at the building site, I was surprised and disappointed. Instead of the rich, red-brown color I had expected, the blocks were pink. Evidently a slurry of scoria dust and cement had come to the surface as the blocks were extruded and vibrated during the manufacturing process. We eventually remedied the problem by sandblasting the finished wall.

With the footings poured and blocks on hand, we began building the walls. Our crew consisted of an experienced block mason and two laborers. I worked part time. The mason and I were anxious to see just how easily the dry-stack block could be laid up—he from a professional's point of view, and I from the perspective of a novice. On this job, we used almost 3,000 blocks and finished the foundation walls and three large retaining walls in about two weeks. The mason estimated that it would have taken four weeks using regular block and mortar.

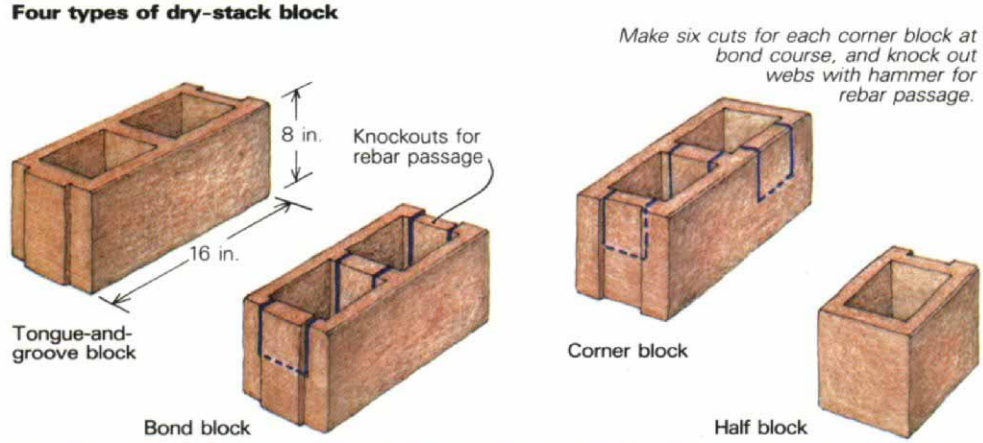
First course—Getting the first course level is the most important part of the whole process. If you don't get it right, you'll be fighting your mistakes for the rest of the job. So the first rule is to have good footings, flat and within ¼ in. of level.

Mark the corners of your building on the footing, just as you would for an ordinary block-and-mortar wall, and check for square. It's a good idea to lay out at least one wall on the footing without mortar to test the blocks for length. We found that our blocks varied enough in length to accumulate a ½-in. error in a 20-ft. run if we didn't pay attention. By laying out the blocks dry, we could see how big a gap we had to leave between blocks to make things come out even.

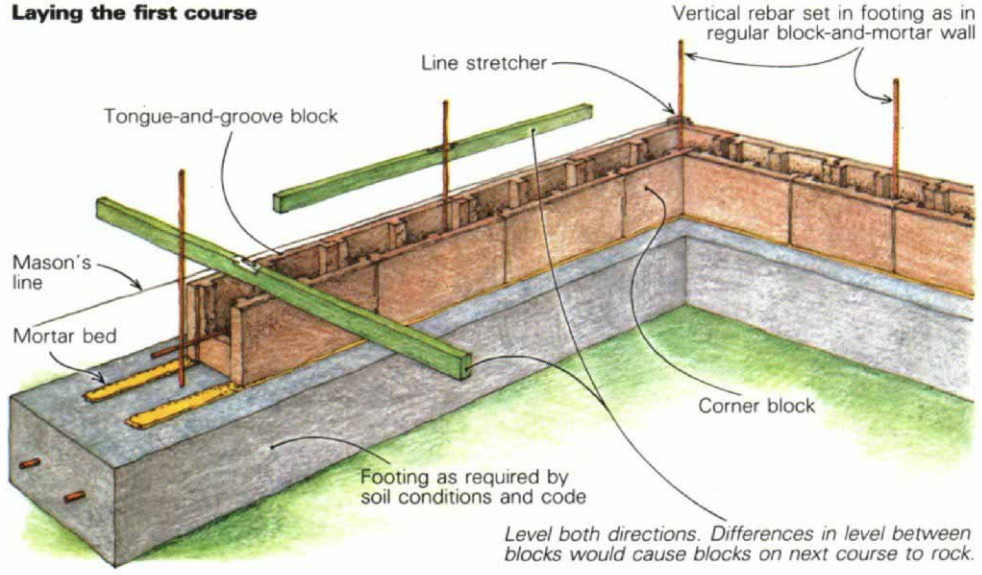
After setting the corner blocks in mortar, we stretched out the mason's line and got down to laying the first course. We found that the work proceeded more easily than we expected, because the vertical joints don't require any special attention. This is a boon for the inexperienced mason. All you need to do is to lay two tracks of mortar along the footing, set the block on the mortar and level in both directions (drawing, right). The smooth surface of the blocks makes leveling easy. As



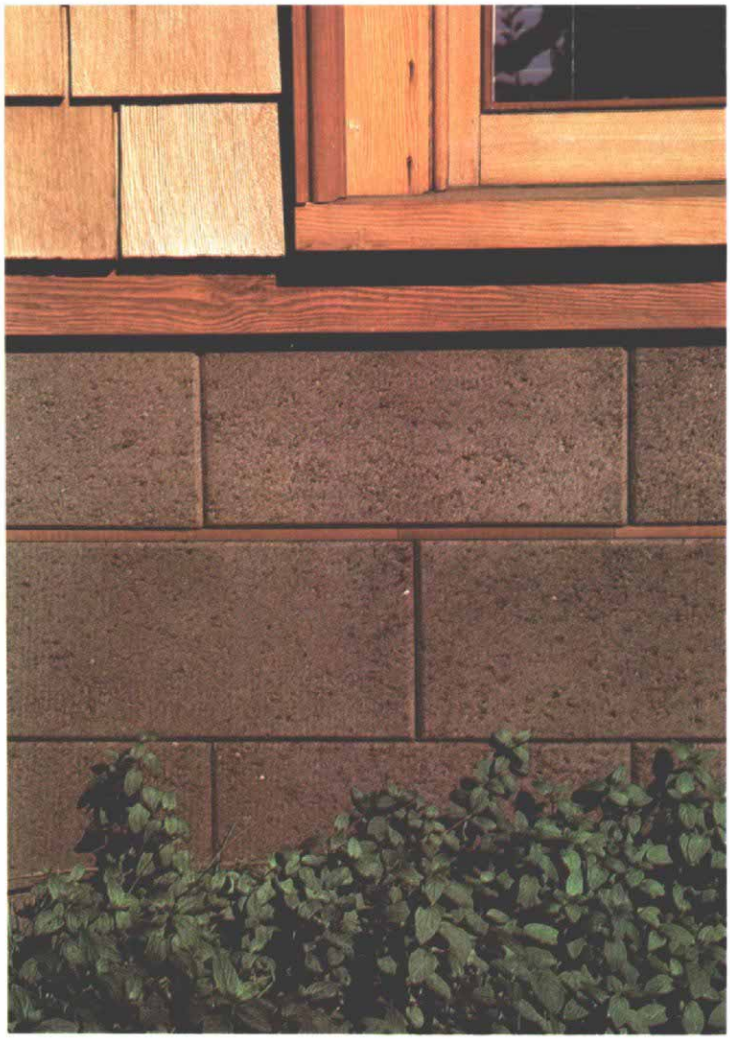
Four types of dry-stack block



Laying the first course



Photos: Rob Thallon; Illustrations: Christopher Clapp

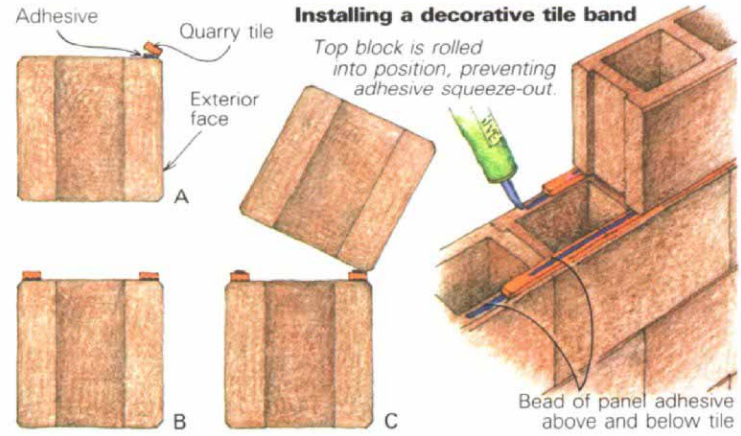


A quarry-tile inlay makes a thin red stripe around the house. The blocks have been sandblasted and sealed, revealing their volcanic aggregate.

Does it pay? **As the chart shows, the dry-stack method costs more for the block itself and needs 30% more grout, but it requires virtually no mortar and saves on labor for grout and laying block. In the project from which the figures were taken, about 10% more was spent for materials, but 24% was saved overall by using dry-stack blocks.**

	Dry-stack block walls (actual cost)	Standard block-and-mortar walls (estimated cost)
Materials		
Mortar	$ 30	$ 300
Block	2,847*	2,477
Grout	(32 yd.) 1,481	(20 yd.) 920
Steel (2500 ln. ft.)	461	461
Subtotal	$4,819	$ 4,158
Labor		
Laying block	$2,700	$ 5,400**
Grout-pump truck	165	(2 lifts) 330
Grout labor	200	300
Subtotal	$3,065	$ 6,030
Total	$7,884	$10,188

*2,414 8-in. regular, 345 8-in. half, 175 12-in. regular. **Based on the mason's estimate of cost-per-square foot at about $2, a conservative figure. The 1979 Western Edition Building Cost File quotes a figure of $3 per square foot.



we worked, we checked for length every 4 ft. or so and either tightened or loosened the joints slightly to come out even at the corner.

As block walls grow—Once the first course was laid, we built up the corners, carefully plumbed, as a guide for subsequent courses. The weight of the top blocks kept the lower blocks from moving and allowed us to stretch a mason's line tight from corner to corner as a guide. We kept the line about a string's width from the wall, so that accumulating error from successive blocks wouldn't force the string slightly out of line as they touched it. We found that we could set the blocks into place so rapidly that moving the string line became a significant part of the work.

In fact, the work sometimes went so fast that, in our enthusiasm, we made mistakes. The beauty of a mortarless system is the ease with which such mistakes can be corrected. At one point we dismantled a large portion of a 6-ft. tall fireplace footing and ash dump that had gone awry, and put it back together again in less than an hour.

We had some high walls on this project. One, which we built with 12-in. block, was more than 12 ft. tall, and we had several 8-in. block walls over 8 ft. tall. Walls this high can get pretty wobbly before they are grouted, so we spread a double bead of panel adhesive between every fourth course for stability.

Bond beams—The only major cutting we had to do was notching the corner blocks at bond courses to let in the rebar. We used a mason's saw for this, and for the other minor cutting chores required for vents, bolts and the like. On small jobs, a circular saw with a carborundum blade would work fine.

The rebar required for a dry-stack wall is the same as that required for a block wall with mortar. The minimum requirements are listed in local building codes. For retaining walls up to 4 ft. high or 12 ft. long, we used one #4 bar at 32 in. o.c. vertically and one #4 bar at 24 in. o.c. horizontally (every third course with 8-in. blocks). Beyond these limits we had the wall engineered. Masonry suppliers have brochures listing rebar requirements compiled by the National Concrete Masonry Association.

To form an opening for a window or door, we supported a 2x8 formboard at the appropriate level with temporary posts, then laid up a steel-reinforced and grouted bond beam to serve as a lintel.

A tile feature strip—Just before the last course of block was laid, we installed a narrow tile feature strip. I wanted a thin band of color built into the wall itself to complement the horizontal water-table band at the top of the wall (photo above) so I had a local tile shop split 4x8 red quarry tiles into four lengthwise sections. I sandwiched these between two courses of block. The two pieces with finished edges were used on the exposed side of the wall, and the other two pieces on the hidden side.

We dusted off the top surface of the block and then laid a bead of panel adhesive about 10 ft. long near the inside edge of the tile. I aligned the tiles carefully along the chamfered edge of the block (drawing, above) and rolled them back onto the adhesive, forcing the excess toward the center of the block. This process was then repeated less carefully on the inside of the block and finally on top of the tiles with the final block.

The panel adhesive turned out to be an indispensable part of building the walls. It held all the tiles in position, bonded the top two courses together, and made the wall very rigid. This added rigidity was especially important during the grout pour.

Dry-stack block suppliers

If you're ready to build with dry-stack blocks, you need a local supplier because the blocks are just too heavy to ship economically more than about 150 miles. But finding a local supplier can be frustrating. We called all the block companies listed by the National Concrete Masonry Association as sources for interlocking block and ground-surface block, and asked each company if it could supply the mortarless units. It seems that relatively few builders ask for dry-stacks, so there aren't many made. As a result, the blocks can be hard to find.

The blocks we did find vary in price, design and dimensional tolerances. As a general rule, the closer the tolerances, the more expensive the block. In addition to the basic 8-in. high by 16-in. long by 7⅝-in. wide wall block, each supplier had a full line of sash, corner and bond blocks.

The McIBS Co. is the most active force in the mortarlcss-block industry. This company has perfected a special liner that can be used in conventional block-molding machines. The blocks made with these liners are double tongue-and-groove on their ends, tops and bottoms, and they maintain dimensions within 0.003 in. This close tolerance, coupled with the tongue-and-groove arrangement on all the hidden surfaces of the block, allows a wall made with them to be sealed with products designed for conventional block walls.

Of the mortarless blocks we found, McIBS are the most widely available, and the most expensive—from 30% to 80% more than conventional blocks. They are currently available in California, Colorado, Illinois, Indiana, Missouri, Nevada, Texas and Wisconsin, with several more states soon to join the list. Write to McIBS Inc., 130 S. Bemiston, St. Louis, Mo. 63105 for more information. For $1, they'll send you a brochure detailing their products and how they are used.

In Texas, builders can find interlocking blocks with tolerances held to ⅛ in. at two places: Valley Builder's Supply, Inc., P.O. Drawer Z, Pharr, Tex. 78577; and the Barrett Co., Rt. 3, Box 211 Bl, San Antonio, Tex. 78218. Both suppliers make blocks with tongue-and-groove joints cast into their ends. They cost only about 3% more than conventional blocks. Both companies recommend surface-bonding the finished wall (see *FHB* #12, pp. 34-37). Similar blocks are available in Minnesota at the Charles Friedheim Co., 3601 Park Center Blvd., Minneapolis, Minn. 55416, and in Iowa at the Marquart Block Co. 110 Dunham Place, Waterloo, Iowa 50704.

Oklahoma builders can find dry-stack blocks at the Barter Concrete Products Co., 1628 W. Main St., Oklahoma City, Okla. 73106. Harter grinds its blocks to ⅓₂-in. tolerance, and then cuts a ¾-in. deep slot in the top and bottom of each block to accept a plastic spline. The splines help to align the blocks vertically. The cost is currently about $1.30 per unit for the basic block, and surface-bonding the finished wall is also recommended.

Yet another type of dry-stack block is made by the Buehner Block Co., 2800 S.W. Temple, Salt Lake City, Utah 84115. The block is 8 in. by 16 in., but only 5⅝ in. wide. The blocks hold to ⅛-in. tolerance, and use an interlocking system of plastic rings for alignment during placement.

Dry-stack blocks end up in a wide variety of projects—from houses to roadside sound barriers, from racketball courts to Holiday Inns. They might even become the universal building component that Frank Lloyd Wright and his son Lloyd envisioned in the 1920s (see *FHB* #14, p. 71). The blocks are simple to use, and they offer the thermal storage capacity that is an essential element of passive-solar design. —*Charles Miller*

Grouting—Before we scheduled delivery, we calculated the amount of grout we needed with the following formulas:

for 6-in. block:
number of full blocks/110 = cu. yd. grout;

for 8-in. block:
number of full blocks /90 = cu. yd. grout;

for 12-in. block:
number of full blocks/50 = cu. yd. grout.

On our job, for example, the calculation was:
(2,414 + 345/2 [half blocks])/90 + 175/50
= 32.2 cu. yd. grout.

Because we needed so much grout (about 60 tons), we decided to hire a concrete pumper to get the grout from the trucks to the walls. We completed in about two hours a job that would have taken at least two days if we had done it by hand.

The only problem we encountered was on one of the tall walls. When we filled the cells, the weight of the mud blew out the side of one of the lower blocks, which was probably already cracked. Grout spurted out all over the place. We were able to repair the block and then refill the wall, a little at a time. If you have a wall 8 ft. high or taller, I recommend grouting it up to about 5 ft., filling the shorter walls, and then returning to top off the tall walls after the first pour has had time to set up a bit.

Cleaning—You will inevitably slop some grout over the sides of the block. It's easy to rough-clean the surface by scraping it within 24 hours after the grout is poured. If you have the chance, clean the walls immediately with a light water spray and a soft brush. This can save a lot of hard work later on. To remove the grout stains completely, use a masonry cleaner like muriatic acid.

On this particular job, we wanted to remove both the stains and the pink slurry that formed the surface of our dry-stack blocks. We decided to sandblast only after trying several chemical cleaners without success. The blasting produced the desired results and cost only $320 for the whole job.

Waterproofing—You waterproof dry-stack block the same way as regular block. Below grade, we used Thoroseal, a water-base sealer, which we brushed on in two coats. Some prefer to apply one coat with a trowel, but this requires more skill. I'm sure that any of the asphalt-base sealers recommended by masonry suppliers would also work.

We sprayed the exposed walls with a two-part application of clear acrylic sealer. First, we applied a coat of relatively inexpensive Stone Glamour, then we sprayed on a finish coat of Mex-Seal for the reflective surface we wanted. These sealers bring out the blocks' color much as an oil enhances wood, and protect the block from the deteriorating effects of water penetration. For longest life, an exposed block wall should be resealed every five years or so, depending on the severity of the thaw-and-freeze cycles in your climate.

We didn't do anything to seal the exposed cracks between the blocks, even though we worried about the problems they might cause. I was afraid that capillary action would pull water through the cracks and cause moisture problems inside the house, and that the moisture in the cracks might freeze and fracture the blocks.

We resolved the first problem by sealing the inside of the walls with Thoroseal wherever they enclosed living space. We decided to ignore the second potential problem because the climate here isn't very severe. In the three years since we finished the walls, there has been no cracking.

In a climate where the combination of moisture and freezing is liable to cause problems, I would seal the exposed joints with clear silicone caulk. The caulk could be spread between blocks as the wall is laid up, or applied to the grooves between the blocks' chamfered edges after the wall is assembled. Either one of these procedures would increase construction time and expense, but the job would still be quicker, cheaper and easier than laying up a wall with mortar.

Cost comparison—When we finished the project, all of us who had worked on it were impressed with the dry-stack block. The mason was sure we had cut our labor time significantly by using the dry-stacks (chart, facing page), and he thought that they would result in a 50% labor saving on an average project. The laborers liked it because they got to lay some block themselves, which broke the drudgery of their usual lot—lugging heavy objects around the site all day.

What's wrong with this system?—Availability, that's what. Dry-stack blocks are so heavy that long-distance shipping is prohibitively expensive. Consequently, the blocks have to be manufactured close to their point of use. Although makers of standard concrete block are liberally scattered around the country, relatively few have the grinding or molding equipment necessary for making dry-stacks (see the sidebar above). And unfortunately, there isn't a comprehensive list of manufacturers that make the blocks. So if you're interested in the dry-stack system, get out the Yellow Pages and do some dialing. □

Rob Thallon is a partner in the architectural firm of Thallon and Edrington in Eugene, Ore.