Surface-Bonded Block

A strong, fast and inexpensive alternative to poured-concrete or block-in-mortar walls

by Paul Hanke

Pouring concrete walls is a difficult and risky business, and I don't recommend it for the inexperienced. Even professionals sometimes have forms let go, creating various degrees of disaster and pandemonium on the site. Laying up block with mortar has drawbacks, too. It is time-consuming, it takes practice, and the result isn't especially strong.

Surface-bonded block, on the other hand, suits owner-builders to a tee, and can be a less expensive alternative for professionals. It is a method of laying concrete blocks without mortar, then troweling both wall surfaces with a portland-cement coating laced with chopped fiberglass for strength. Built on standard footings, surface-bonded block walls can be used below and above grade, for foundation walls and for finished living spaces. The method is fast and reliable. It requires no particular skill, and the finished wall is stronger than a block-in-mortar wall.

Surface bonding was originally developed as a low-cost construction technique for self-help housing. A USDA booklet on the subject (Information Bulletin No. 374, now out of print) shows a 12-year-old boy doing a successful job after 15 minutes of practice. Even professional masons are reported to be 70% more productive using this method than laying up block in the conventional way. The USDA estimates that stacking and bonding 100 blocks would take a person an average of 7.4 hours. Several years ago, two friends of mine, Chapin and Donna Kaynor, built an earth-sheltered house using this technique. It took their crew of four inexperienced people, some of whom worked only part time, less than five days to stack and bond about 1,200 blocks.

Strength and cost—Stacked blocks coated with bonding mix have an average tensile strength (ability to withstand longitudinal stress) of from 300 psi to 500 psi, according to lab tests conducted by the USDA and the University of Georgia. This is about equal to the

Paul Hanke is a designer and draftsman at Northern Owner Builder, in Plainfield, Vt.

strength of unreinforced concrete, and is six times stronger than block laid up with ordinary mortar joints. Mortar has very little adhesive power, and virtually no tensile strength. Its main purpose is to level blocks between courses. Because the weakest part of conventional block walls is the bond between block and mortar, these joints tend to crack, making water seepage a problem. A surface-bonded wall, with its seamless outer coating, is much more watertight (though the coating alone should not be relied upon below grade).

Having a block-in-mortar wall built costs about twice the price of the materials, plus footing and reinforcing. In our area, concrete foundation walls currently cost around $95 to $105 per cubic yard poured in place, including formwork and labor. A typical full basement accounts for about 5% of the cost of a house, or over $3,200 for the average $65,000 home. The builder using surface-bonded block can save as much as 35% to 40% of this figure.

Estimating materials—To build surface-bonded walls, you will need standard hollow-core concrete block, surface-bonding mix, galvanized corrugated brick-ties for shims (the Kaynors used about 250 for 1,200 blocks), threaded steel rod and connectors, a few sacks of mortar, and the rebar and concrete for footings. Order 8x8x16 block (about 65¢ each) for walls above grade or foundation walls that will extend less than 5 ft. below grade. Order 8x12x16 block (about $1.05 each) for a foundation wall deeper than 5 ft. Use the USDA table at right to estimate the number of blocks you need. Be sure to add extra block for reinforcing pilasters, the column-like buttresses used to strengthen the walls (discussed below), and half-length block, which you may need for the door and window openings. Order 5% to 10% extra to make up for waste and breakage. Have your block delivered to the center of your work area if at all possible, or deposited in strategic piles around the perimeter. To save time and effort, don't carry those heavy blocks any farther than you have to.

As the table shows, nominal 8x8x16 block is actually 7⅝ in. by 7⅝ in. by 15⅝ in. to allow for ⅜-in. mortar joints; so you can't figure in exact 16-in. modules when laying block dry. Having to calculate with fractional numbers would be a real headache, but estimating tables supplied by the USDA or surface-bonding mix manufacturers greatly simplify the task.

Bonding mix, which comes dry and includes the chopped fiberglass strands, is sold in bags of various sizes. A 50-lb. sack will cover about 50 sq. ft. of wall. Check the exact coverage when you order, and allow about 10% for waste from broken sacks, mixing and troweling. A 50-lb. sack of grey-colored mix currently costs about $14 in Vermont. White is about $17 per sack. You can also mix your own, as explained at right. In addition to the bonding mix, get enough sacks of mortar to lay the first course of block, plus a few extra sacks to use in spots where you need to shim more than ⅛ in.

I recommend using ⅜-in. threaded steel rod to connect the sill or top plate at the top of the wall to the footing below. It is available in 2-ft. and 3-ft. lengths at hardware stores. Threaded rod is expensive, but it makes a secure connection. You'll also need connectors to join the lengths of rod, and nuts and washers to secure the wood sill to the top of the wall. The rod isn't for concrete reinforcement, but to tie footing, foundation and framing together to resist uplift forces. The block cores that contain the rod don't require filling with concrete.

The alternative to running threaded rod all the way up through the wall is to fill the cores at the top of the wall with concrete two or three courses deep every 4 ft., and embed standard ½-in. J-bolts. Use screening to keep the grout from falling all the way to the footing, or stuff fiberglass insulation down the block core. This method works, but it will not provide a continuous connection from footing to sill, and will not resist uplift.

Footings—As a general rule, footings should be twice as wide as the wall above, and as deep as the wall will be thick. A standard 8-in. thick wall calls for a 16-in. wide footing. Pour 24-in. wide footings for either a 12-in. thick wall or a two-story house.

The bottom of the footings should be at least 12 in. below the frost line, and almost anyone can safely pour them. You can pour into shallow forms or directly into trenches of the proper size, provided that their sides and bottoms are of firm, undisturbed soil. Place two No. 4 (½-in. dia.) lengths of rebar near the bottom of a 16-in. wide footing. A 24-in. wide footing will require three lengths of rebar. Check codes for the rebar requirements in your area. Remember to widen the footings for pilasters.

Although you can mix your own concrete for footings, ready-mix concrete delivered to your site is best. Insert the lengths of threaded rod vertically into the concrete at the corners and pilaster locations, on both sides of all the door and window openings, and every 4 ft. to 6 ft. along the wall, as shown in the drawing on the bottom of the next page.

Stacking block—After your footings are poured and have been allowed to cure, you can begin on the walls. Using your batter boards and strings (see *FHB* #11, pp. 26-28), drop plumb lines to establish the outside corners. Use the table to determine exact wall lengths, and allow an extra ¼ in. per 10 ft. for irregularities in the blocks. Measure the diagonals to be sure that your corners are square, and adjust if you need to. Snap chalklines from corner to corner as guides, and then lay and level the first course of block in a bed of thick mortar. Check the top of the first course with a 4-ft. level as you go. If a block is too high, tap it down with the butt end of your trowel; if it's too low, remove the block, add more mortar and reset. Don't put mortar in the vertical joints between blocks; just butt them tightly against each other. Some skill is required here. Take your time and do a good job.

The rest of the wall is simply stacked dry in a standard running bond—each block overlapping half the block beneath. Begin by

Mixing your own

Here is the USDA formula for preparing 25 lb. of your own bonding mix. A friend who investigated this option concluded that it costs about 65% as much as a comparable commercial mix.

- **19½ lb. portland cement (78% by weight), white or type I grey, which is more common. This is the glue that holds things together. It conies in 94-lb. sacks.**
- **3¾ lb. hydrated lime (15%) for increased workability. It comes in 50-lb. sacks.**
- **1 lb. glass-fiber filament (4%), chopped into ½-in. lengths. Use type E fiber or, better yet alkali-resistant type K fiber, available from plastic and chemical-supply dealers, building-material dealers or boatyards.**
- **½ lb. calcium chloride flakes or crystals (2%), to speed setup time and harden the mix. It's available from agricultural-chemical supply houses. Calcium chloride is also used for salting roads.**
- **¼ lb. calcium stearate (1%), wettable technical grade, makes the mix more waterproof. You can obtain it from chemical distributors.**

Since the bonding mix sets rapidly after water and calcium chloride have been added, do not make more than a 25-lb. batch at one time (dry weight).

Begin by mixing the powdered ingredients, except for the calcium chloride. Add the glass fiber, and remix only enough to distribute the fibers well. Overmixing breaks the fibers into individual filaments, which makes application difficult. Be sure to wear a proper respirator. The chemicals are very corrosive, and you don't want to breathe fiberglass, either.

Mix the calcium chloride with 1 gal. of water, and slowly add this solution to the dry ingredients. Mix thoroughly. Add about ½ gal. more water, until the mix is the right consistency—creamy, yet thick enough for troweling. A mix that's too thick is hard to apply and may not bond properly. —*P.H.*

Wall and opening dimensions for surface bonding

Number of blocks	Length of wall or width of openings	Number of courses	Height of wall or openings
1	1 ft. 3⅝ in.	1	0 ft. 7⅝ in.
2	2 7¼	2	1 3¼
3	3 10⅞	3	1 10⅞
4	5 2½	4	2 6½
5	6 6⅛	5	3 2⅛
6	7 9¾	6	3 9¾
7	9 1⅜	7	4 5⅜
8	10 5	8	5 1
9	11 8⅝	9	5 8⅝
10	13 0¼	10	6 4¼
11	14 3⅞	11	6 11⅞
12	15 7½	12	7 7½
13	16 11⅛	13	8 3⅛
14	18 2¾	14	8 10¾
15	19 6⅜	15	9 6⅜

Blocks sold as 8x16 are actually 7⅝ in. by 15⅝ in. to allow for the size of mortar joints in standard block construction. Remember that cement blocks are not uniform. Add ¼ in. to every 10 ft. of wall length to take this into account, and before beginning to build, make a trial stack to measure the precise height your wall will be.

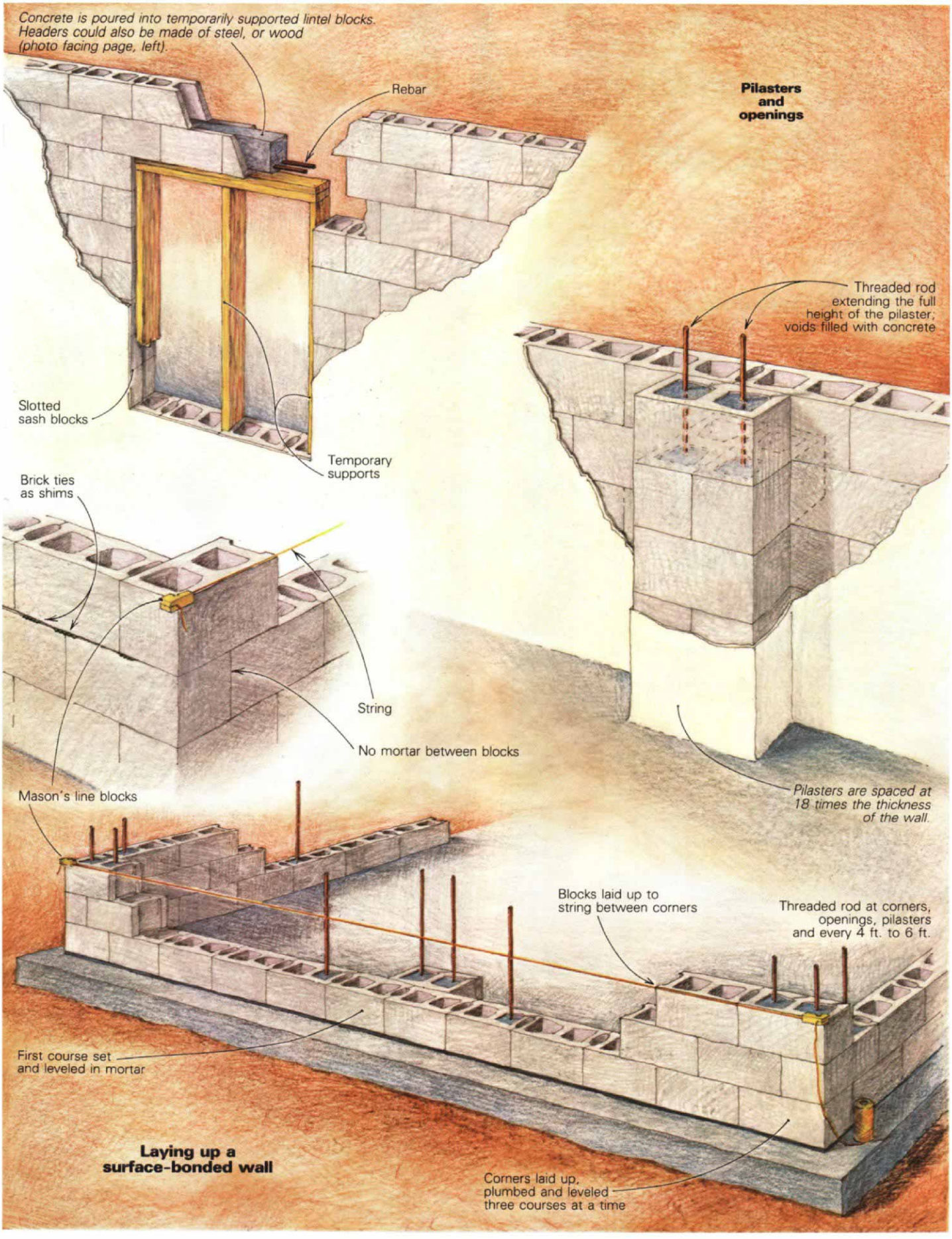

Illustration: Christopher Clapp; Photos: Chapin and Donna Kaynor

The first course of block is laid and leveled in mortar, as at right. The corners are built up three courses, then a level line is strung between corners. Dry block fills in up to it. Shims are used where necessary to keep blocks aligned. A mason's corner block, which holds a level line that is also the correct plane for the face of the blocks, is visible on the second course. Once the walls have been built up around openings, headers must be installed. These can be steel, concrete or wood, as above.

building up the corners three courses high. Check them for plumb with the 4-ft. level held vertically, and for level with a water tube. Then stretch a taut string between the top outside edges of each course of the built-up corners. Use mason's line blocks (available where you buy concrete blocks) to secure the line at each end. Fill in the length of the wall up to the string, and repeat the process every three courses, inserting metal shims as necessary to keep the wall level and plumb. If more than ⅛ in. of shimming is required, use mortar instead. Check the wall for plumb at least every three courses. Connect new segments of threaded rod as you go.

Pilasters—These are engaged columns that reinforce the wall against lateral forces and keep it from buckling under heavy loading. For basement walls, pilasters should be on the inside to resist the pressure of the surrounding earth. The Kaynors put theirs outside to get them out of the living area. They are tied in by rotating the blocks of every other course 90° so that they become a part of the wall itself (drawing, facing page). Threaded rod or rebar should extend through the block cores the full height of all pilasters. After the wall is laid up, fill the voids of the pilasters with concrete.

For above-grade construction, pilasters are usually spaced along the wall at a distance equal to 18 times the thickness of the wall (for example, every 18 ft. for a 12-in. wall, or every 12 ft. for an 8-in. wall), or on a shorter wall, at midspan. The pilasters on the house shown here are on 8-ft. centers for earth-bermed walls, which is probably a good precaution for any below-grade construction.

Weight-carrying beams should also be supported by pilasters at each end. Be sure that the beam pockets extend into the wall at least 3 in. to get good bearing surfaces. Once the beam is in place, you can continue dry-stacking blocks in the usual manner.

Openings—For doors and windows, just omit blocks in the proper locations. This is where half-blocks come in handy. With these, you don't need to cut standard block down to size. The blocks at each side should be slotted sash-blocks, which accept a metal or wood spline that attaches to specially made framing.

Headers are required above openings, as in any other type of construction, and they should be properly sized for their span and load. Consult standard tables, codes, or an engineer if necessary. Headers can be made of wood (photo above left), steel angles or U-shaped bond-beam blocks. You support the blocks temporarily over the opening you want to span, then fill their cores with rebar and concrete. Once the concrete has cured, remove the supports, and you have a solid beam.

Coating the wall—Once all the blocks are stacked and the pilasters are filled with concrete, the walls are coated with surface-bonding mix (see sources of supply, below). Commercial mix consists primarily of mortar and strands of fiberglass chopped into ½-in. lengths. Add water according to the instructions, and mix with either a garden cultivator or a mason's hoe (the kind with two large holes in the blade). The mix will cure in about an hour and a half, so don't whip up too much at one time. Hose down the block wall so that the mix won't dry out too quickly, then trowel on a 1/16-in. to ⅛-in. coat of the paste.

Both sides of the wall get surface-bonded. Use a hawk to hold a comfortable amount of the mix while you work, and press its edge against the wall to limit slop and spilling. Use a plasterer's trowel, a steel trowel about 12 in. long, and work from the top of the wall down so you can moisten the block as you go if it begins to dry out in hot weather.

The USDA breaks the procedure down into four steps. First, with a series of sweeps of the trowel, spread the mix 2 ft. or 3 ft. upward from the hawk over a section about 5 ft. wide. Then even out the surface by going over the area lightly with your trowel slightly angled. Repeat these two steps over the area just below the block you've just covered, and cover as much area as you can in 15 or 20 minutes. Lastly, clean the trowel in water and retrowel the plastered area with long, firm, arced strokes to achieve a final, smooth surface.

The glass fibers bridge the joints between blocks, and the tensile strength of the wall increases as the concoction cures. Because the fibers are so short, the system won't work if you lay the block in mortar before coating the walls with the bonding mix. The fibers would be spanning almost their entire length, and this would destroy their effectiveness. The interior surfaces of walls can be textured with a light pass with a stiff brush. Mortar pigment can be added during mixing to color the wall. Surface-bonded walls can also be stuccoed or furred out, if you prefer something other than the bonding mix as a finished surface. □

Manufacturers of surface-bonding mix

Fiberbond Surface Bonding Cement: Stone Mountain Mfg. Co., Box 7320, Norfolk, Va. 23509.
Q-Bond: Q-Bond Corp. of America, 3323 Moline St., Aurora, Colo. 80010.
Stack & Bond: Conproco. Box 368, Hooksett, N.H. 03106.
Surewall: W.R. Bonsai Co., Box 241148, Charlotte, N.C. 28224.
Quick Wall: Quikcrete, 1790 Century Circle, Atlanta, Ga. 30345.