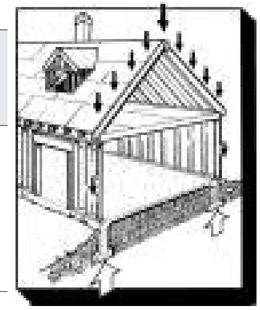

When a Block Foundation Cracks

by Christopher DeBlois, P.E.

For modestly priced homes in Georgia, where I work, basement walls are usually built with 8-inch concrete masonry units (CMUs) — otherwise known as concrete blocks. It's a relatively inexpensive way to build a sound wall that can be easily waterproofed. Unfortunately, these walls are too often built without any reinforcing steel, and that's when the trouble begins.

What the Code Says

The 1992 CABO (Council of American Building Officials) *One & Two Family Dwelling Code*, in Table R-304.3a, does allow the use of unreinforced block walls. For 8-inch CMU walls where the cores are not filled, the maximum acceptable depth of unbalanced fill is only 4 feet. ("Unbalanced" means there is no earth on the inside of the wall, as in a crawlspace or full basement.) And even with 12-inch blocks, you can't bury an unreinforced wall more than 6 feet below grade.

What's more, these limits only apply when the soil exerts a lateral pressure on the wall of 30 pounds per cubic foot (pcf) or less. Any more pressure than that and you must have your wall designed by an engineer. This last requirement applies more often than not. If your backfill is clean gravel, sand, or a mixture of the two, 30 pcf is realistic. Add clay, silt, or anything organic into the mix and the soil forces reach 40 pcf or more.

Since the CABO code doesn't allow unreinforced block walls for basements tall enough to stand in, and even then only if you have good soil, there are lots of unreinforced block basement walls that aren't structurally sound.

Reinforcing Guidelines for Block

If you are building a basement wall and want to use 8-inch CMUs, you should provide reinforcing steel. For a wall 8 feet tall, I recommend as a minimum that you reinforce every other cell with a No. 5 bar (5/8-inch diameter) placed 4 1/2 inches clear from the soil side of the wall. Of course, every reinforced cell should be grouted solid. This combination will handle about 42 pcf, adequate for most soils without much clay and that won't be fully saturated with water. Horizontal reinforcing, either ladder or truss type, should also be laid into the bed joints every other course. Just as CABO requires, though, you'd do even better to have an engineer look at each block basement wall you plan to build.

When Unreinforced Walls Crack

You may be wondering what becomes of all those unreinforced 8-inch CMU

Figure 1. *Horizontal cracks are common in unreinforced block foundation walls. Though they look threatening, such cracks move slowly and can often be repaired with simple measures.*

Steel Beam Reinforcement

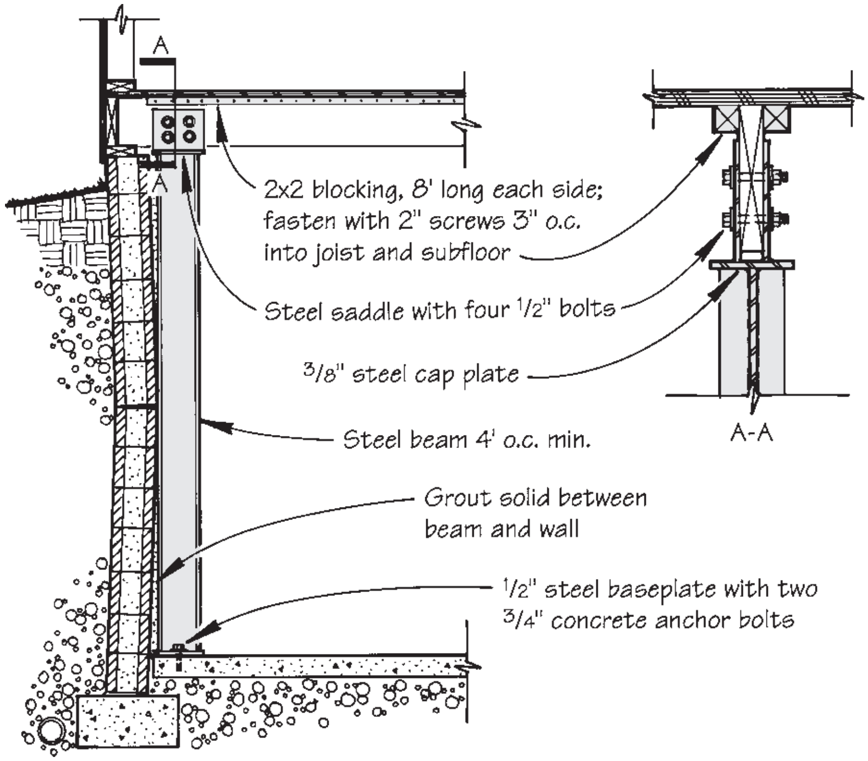

Figure 2. *Vertical steel beams 4 feet on-center can strengthen a cracked block wall. The beams must attach securely to the joists and slab. Where there is no slab, footings must be poured.*

Wood Stud Wall Reinforcement

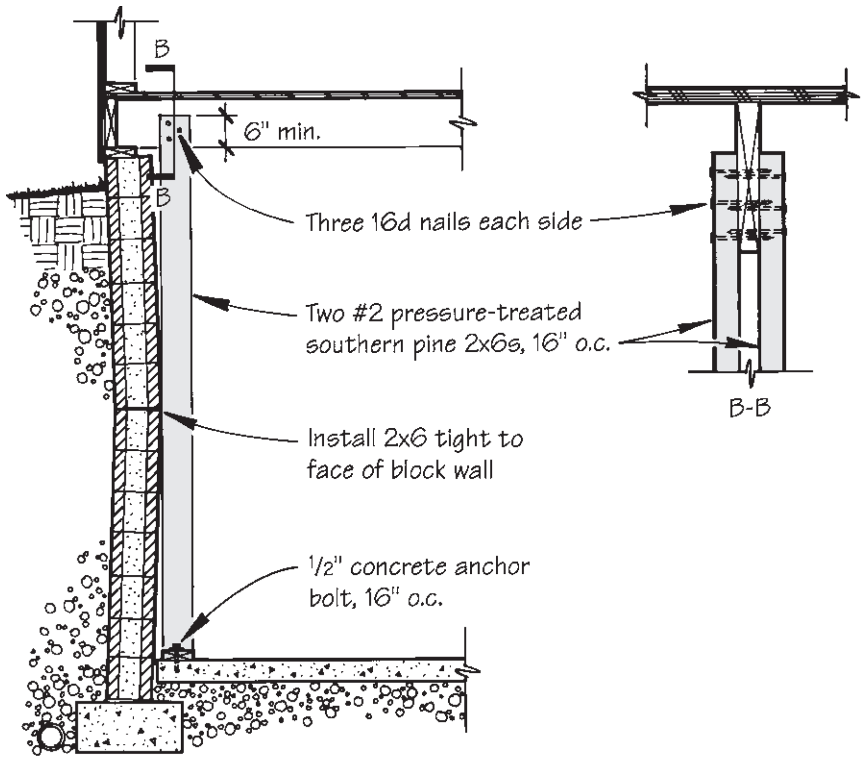

Figure 3. *For less demanding conditions, the author sometimes specifies double 2x6 studs, 16 inches on-center, to brace a cracked block foundation. The top of the studs are nailed to the joists, while the bottom plate bolts to the slab or footings.*

full-basement walls. Often, homeowners call me to help them repair their block foundation so they can sell the house. I usually find two classic signs of failure in progress. First, there is a more or less continuous horizontal crack between mortar and block about halfway up the wall and running the length of the wall. Second, the middle of the wall has bowed inward (along its vertical axis). As Harris Hyman described in this column (*Practical Engineering,* 11/94), concrete is lousy in tension. Concrete block and mortar are worse. When you are standing inside the basement, you are looking at the tension side of the wall, and that horizontal crack is how the wall responds to the tension force. Without any reinforcing, a CMU basement wall with a continuous horizontal crack has started a slow but relentless march into the basement.

I normally recommend one of three approaches for cracking. The first is one the seller loves — do nothing. If the width of the crack is small — less than half the width of the mortar joint, for instance — it's possible that no repairs are necessary. The reason has to do with the movement of the soil. Soil engineers often identify two types of soil forces that act on walls — *at-rest* pressure and *active* pressure. At-rest pressure is always higher than active pressure and is used to design basement walls.

Active pressure applies only to soil that is on the move. As the soil moves, it develops an internal cohesion and has some ability to hold itself back. The difference is easy to understand if you compare soil and water. For water, the active and at-rest pressures are the same. Pour water from a bucket and it can't hold itself up at all — you get a big puddle. Dump soil from the bucket and you get a pile instead of a puddle. The more cohesion the soil has, the steeper the sides of the pile. So when a basement wall cracks, the soil behind it begins to move, and the force the soil exerts on the wall goes down. If the wall can handle the decreased force, equilibrium is reached and the wall has finished moving. Repairs are not necessary.

Repair Strategies

Unfortunately, this is rarely the case. First, cracking considerably reduces the strength of a block wall. Second, consolidation of the soil and movement of water through it may return the soil to an at-rest condition and the process starts all over. So, whenever I recommend the "do nothing" approach, I also recommend that the cracks be monitored. If the crack width doubles, it's time for repairs.

At this point, the homeowner usually asks, "Yes, but will it collapse while we're waiting to see if it's moving or not?" When the crack width is small, my answer is that — barring an earthquake or a flood — no. The soil and wall move quite slowly, and even very large cracks can take weeks to grow measurably larger (see Figure 1).

The two repairs that I prefer both supplement the existing strength of the wall. Basement walls act as vertical beams to hold back the soil. I add true vertical beams against the inside face to provide additional strength. Often I recommend a number of steel beams, typically I-beams or tubes (Figure 2). Sometimes, when the wall height, soil condition, or other factors allow, I recommend a wood wall instead (Figure 3). In either case, the existing wall pushes against the new vertical supports, and together they resist the pressure from the soil.

In designing and building these supports, two points are crucial. First is the bending strength of the steel beams or wood studs. The size and spacing of these members depends on the height of the existing wall, the force exerted by the soil, and the ability of the block to span horizontally between the new supports. For instance, a wall that has both vertical *and* horizontal cracks will need its supports spaced closer together than a wall that is intact except for the horizontal crack. And, of course, a 10-foot-high wall needs more and bigger supports than an otherwise identical 8-foot wall.

The second crucial point is the connection of the new supports at the top and bottom. The existing wall usually pushes against a concrete slab at the bottom and the first-floor framing at the top. Similar anchorage must be found for the new supports. Normally I recommend bolting the steel I-beams or the sill of the wood stud wall to the slab. When there is no slab, footings must be poured to anchor the base of the new supports.

At the top, the new supports must connect to the framing. Wood studs can usually be nailed directly to the floor joists (or to blocking if the joists run parallel to the wall). For steel beams, a steel saddle welded to the top of the beam straddles the joist or blocking and gets bolted to it. Because steel beams are usually spaced several feet apart, the force at the top of each one is much higher than at the top of a single wood stud. To make sure this concentrated force is fully transferred into the subfloor diaphragm, with steel beams I recommend that additional 2x2 blocks be screwed to the joist and the subfloor.

These two solutions are relatively straightforward, do not require extraordinary tolerances, and can be modified to handle a variety of conditions. If you are called in to repair an unreinforced CMU wall, make a sketch of the existing conditions. Include the height and thickness of the wall, and the location and size of the horizontal cracks. Also show the size, spacing, and direction of the floor framing, and the slab or other support at the bottom. For an hour's work or less, your engineer should be able to provide you with the type, size, and spacing of the new supports, and details for the connections at top and bottom. ■

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Curious about the forces that hold a building together — or cause it to fall apart? Address your questions to Practical Engineering, Journal of Light Construction, RR 2, Box 146, Richmond, VT 05477.