When Block Foundations Go Bad

Steel bracing and improved drainage give new life to cracked and wet walls

by Donald V. Cohen

When people ask me what kind of house foundation I prefer—poured concrete or concrete block—I tell them to take a look at the Yellow Pages under "Waterproofing Contractors." Here in southeast Wisconsin, where I work as a building inspector and engineer, such a search will turn up more than 50 companies specializing in repairing cracks and stopping water seepage in concrete-block foundations.

This is not to say that concrete-block foundations are always a bad idea. They can perform well with proper drainage and appropriate reinforcement, but these conditions are not always present. Gradually, time and the elements can undermine the health of a block foundation, even a well-built one, a fact I am reminded of when doing inspections for prospective home buyers. I constantly see wet basements, or foundation walls that have cracked, buckled, tipped and sometimes even collapsed (photo above).

Soil pressure works against the foundation—Most problems associated with concrete-block foundations can be traced to two related factors: improper drainage and the seasonal expansion and contraction of soil, which puts pressure on foundation walls (drawing facing page).

Water seepage is the most common problem I see, but water-soaked soil around the foundation also imperils the structural integrity of the walls. When the ground freezes and thaws, pressure builds against the walls. Common failures are horizontal cracks along mortar joints where the wall has been forced in due to soil pressure. I usually find cracks like this between the third, fourth or fifth courses from the top in a typical ten or 11-course wall, which corresponds to the frost line. Often accompanying these cracks are other signs of failure: vertical shear cracks in the corners, step cracks following the mortar joints and walls pushed off the mortar joint between the first and second courses of block. Unrestrained walls sometimes slide under the joists in response to soil pressure, tipping the wall out of plumb (drawing facing page).

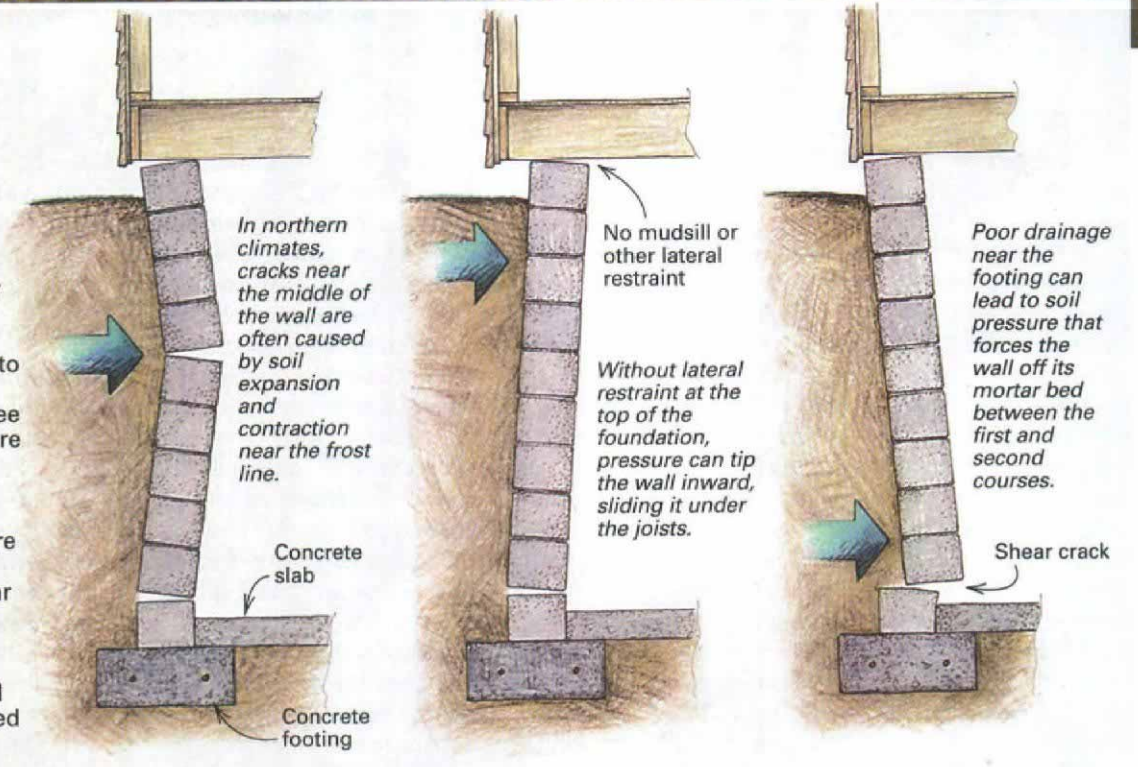
Water and soil cause other problems, too. Consolidation or settling of subsoil due to heavy rains, or a substantial loss of moisture in the soil, can undermine the foundation from below. This settlement may allow footings to drop, causing vertical and step cracks as well as tipped and cracked concrete floors. In some cases, this kind of settlement causes the walls to tip outward.

Look for problems outside the foundation—The first approach to fixing a wet basement is to correct the grades around the foundation so that water flows away from the walls. Make sure downspout drains, sump-pump discharge pipes and storm sewers convey roof and surface water away from the house. Low spots around the foundation are likely to collect water, so any depressions should be filled. (For

HOW DID MY BASEMENT BECOME A SWIMMING POOL?

Soil pressure can push a block wall off its footings

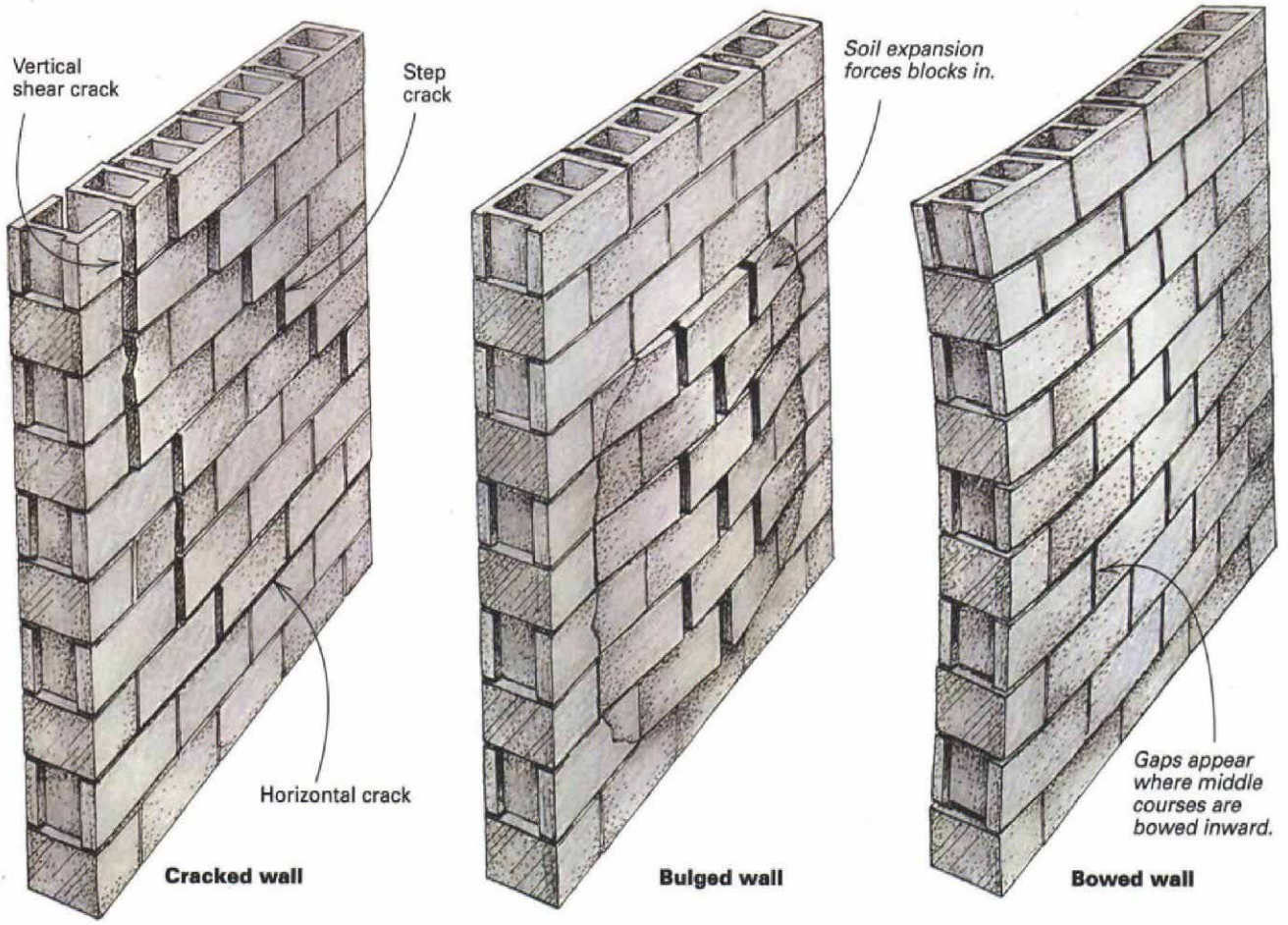
Without proper drainage, water gathers in the soil surrounding foundation walls, often finding its way into the basement. Sometimes disaster is unavoidable, as in the photo above, shot after a storm dumped 6 in. of rain in three hours. Other times, pressure builds slowly, particularly during freeze/thaw cycles. The drawing at right illustrates how soil pressure can tip foundation walls inward, cracking the mortar joints. Any wall displaced more than 1 in. from a plumb position must be excavated. Walls displaced less than 1 in. can be braced from inside.



Drawings: Christopher Clapp

Common failures in concrete-block foundations

Water accumulation and the seasonal expansion and contraction of the soil put lateral pressure on foundation walls. Without proper drainage, the pressure against a concrete-block foundation wall can create failures along mortar joints and cracks in the blocks themselves.



more information about foundation drainage, see *FHB* #111, pp. 98-103.)

A wet basement may have a deeper source: the absence or failure of a foundation drainage system. For older homes with chronic water problems and no drainage system, the only solution may be to excavate the walls and install a perimeter drain. Clues that might indicate the absence of a drainage system are wet walls, lack of a sump pump and no evidence of interior drainage or exterior discharge pipe.

Most foundations today, however, are required to have a drainage system that channels water away from foundation walls. (Residential foundation-drainage systems are generally required by code if seasonal groundwater levels are less than 6 ft. below the surface.) The drainage system—usually concrete tiles, perforated plastic pipe or tubing 3 in. to 4 in. in dia.—is placed along the perimeter footings and covered with crushed stone. The outlet of the drain system can be external (run to daylight somewhere on the lot) or internal (to a sump pump inside the basement). Many modern drainage systems use cross bleeders through the footings from exterior drainage pipes to interior perimeter drains underneath the concrete slab. The cross bleeders are usually spaced 8 ft. apart, starting 4 ft. in from a corner.

If you suspect a blockage in the drainage system (wet walls along the lower courses, for example), the repair can be as simple as breaking open the concrete floor in the comers and at the midpoints of each wall and flushing the drain tiles. If that doesn't work, you may have to cut open the floor around the perimeter of the basement and replace all the drain tiles and flush all the cross bleeders. If water appears to be trapped inside the concrete-block core, drill a 1-in. hole through the face of the block along the top of the footing to allow any trapped water to seep into the opened drain tile. After the repair, cover the exposed tile with a 1-in. deep layer of stone, and replace the concrete level with the floor.

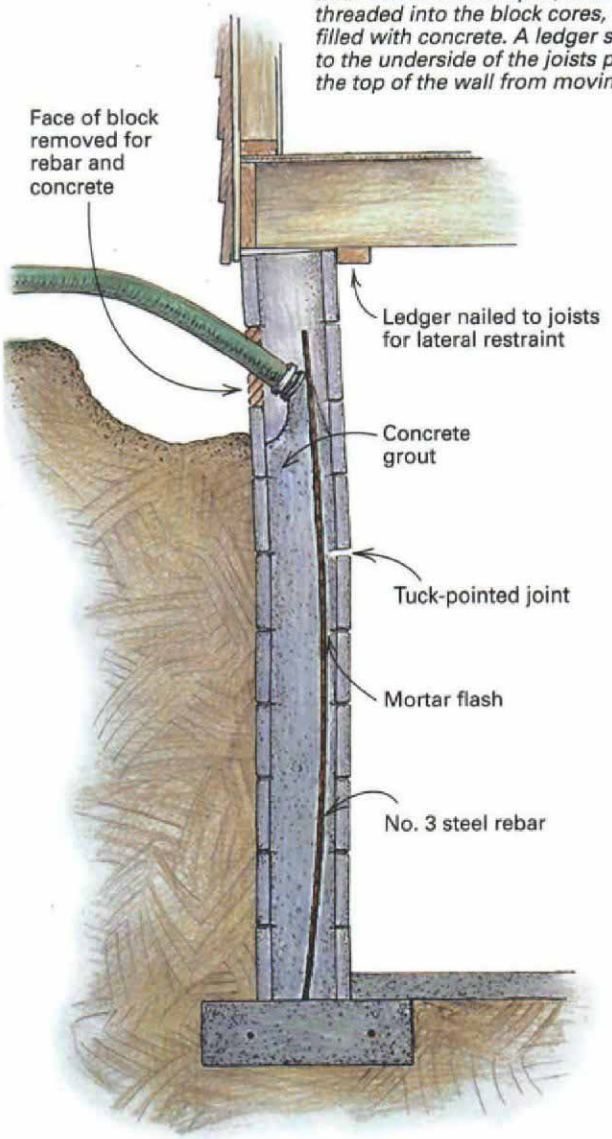
Bracing with concrete and rebar—In addition to leakage problems, concrete-block foundation walls often display cracks, the early signs of failure. If the walls are fairly dry and if they have not been displaced more than 1 in. from plumb, it is possible to brace the walls without having to excavate the foundation. (The bracing must be designed by a licensed engineer.)

There are two common bracing systems: filling the core of the block with rebar and concrete, and installing steel tubing vertically from the floor joists to the concrete slab. Both methods help the wall to resist soil pressure, sometimes (but not always) checking further movement.

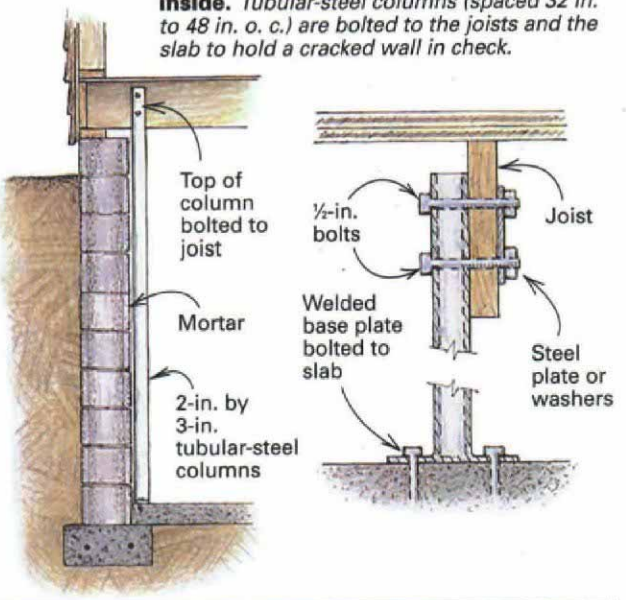
If you catch a problem early, you can brace walls without digging

Walls that are cracked but are displaced less than 1 in. can be braced against further movement. Two common bracing techniques are filling the cores with rebar and concrete, and fastening steel columns to the floor joists and slab.

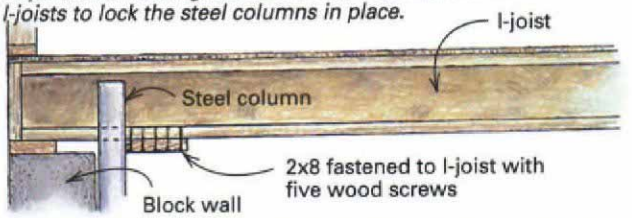
Reinforcing a wall with concrete and rebar. *In this repair, rebar is threaded into the block cores, which are filled with concrete. A ledger strip nailed to the underside of the joists prevents the top of the wall from moving.*



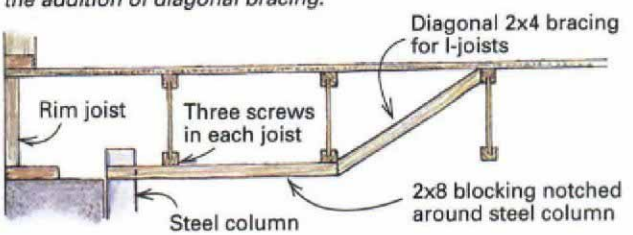
Steel columns provide bracing on the inside. *Tubular-steel columns (spaced 32 in. to 48 in. o. c.) are bolted to the joists and the slab to hold a cracked wall in check.*



I-joists take braces instead of bolts. *Wood I-joists require 2x8 blocking fastened to the underside of the I-joists to lock the steel columns in place.*



If the joists are parallel to the foundation wall, the blocking must be braced as shown below. I-joists require the addition of diagonal bracing.



The first method-filling the core with rebar and concrete—requires removing the exterior faces of concrete blocks near the grade line (not at the top), inserting #3 steel rebar into the block cores and pushing it down to the footing (drawing above). This can be done in every core or as much as 48 in. apart (I have seen it done both ways). The cores are then filled with a concrete slurry mix.

Keep in mind that this repair will not restrain the wall at the top and the bottom. The concrete slab—if it was poured without expansion felt-will provide support at the bottom. In new construction, a mudsill anchored to the wall (require by code) will provide lateral support at the top. But if there is no mudsill, as in many older homes, a ledger must be installed next to the wall and nailed into the underside of the joists (drawing above).

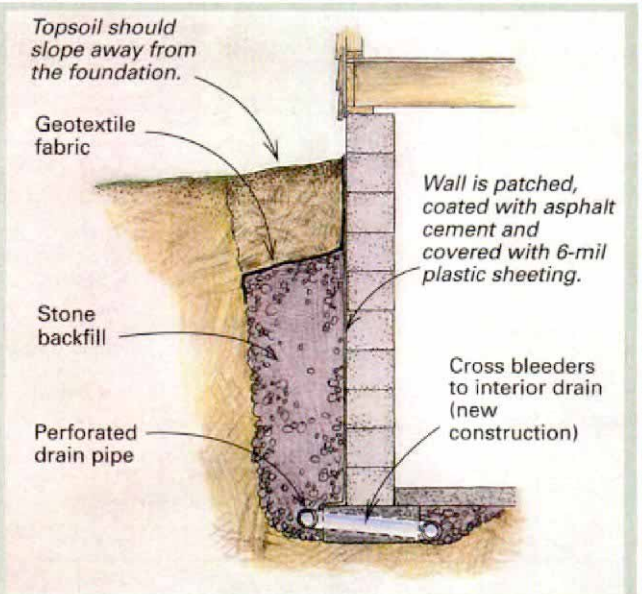
Filling a block wall with concrete and rebar is fairly simple, but it has some drawbacks. The concrete tends to hang up on mortar flash inside the block cores, leaving voids in the wall. Another problem is threading 6-ft. long rebar into the core through the open face of a block. I have seen workers cut the bar and drop the short pieces into the core as the concrete goes in, a method that compromises the strength of the repair.

Filling the core with concrete also causes problems if the wall fails again (if too few cores were filled, for example). A second failure may result in cracked or broken blocks, making it

SOMETIMES YOU HAVE TO DIG

Excavation is the last resort

It's expensive, but sometimes excavating the foundation is the only way to fix chronic water problems and severely damaged walls. After the walls are replumbed and braced, and before backfilling, the exterior of the wall should be coated with fibrated asphalt cement, then covered with 6-mil plastic sheeting. Drainage also should be added at the footing if none exists.



impossible to push the wall plumb. Sometimes, a repaired wall has to be excavated and rebuilt.

Steel columns reinforce walls from within—Another way to brace cracked walls is to install steel columns inside the basement that span the wall vertically between the footings and floor joists (drawing p. 101). This method is generally a cheaper alternative but does have one drawback: The columns will interrupt any smooth stretches of wall.

The steel columns should be at least 2 in. wide, 3 in. deep, with a 5⁄16-in. wall thickness and can be 32 in. or 48 in. apart for a standard 11-course basement. If joists run perpendicular to the foundation wall, the column is fastened to one side of the joist with ½-in. bolts through a steel plate or washers on the other side of the joist. (Wood I-joists require 2x8 blocking fastened to the underside of the I-joist to lock the column in place.)

If the joists run parallel to the foundation wall, the columns can be held in place with 2x8 blocking notched around the column and pressed firmly to the wall. The blocking should

span at least two joist bays to provide lateral restraint. Again, wood I-joists require additional bracing (drawing p. 101).

For lateral support at the bottom of the wall, each column should have a welded-steel plate, which is bolted into the concrete slab or footing. Any spaces between the wall and column can be filled with a mortar grout. If there are pipes or conduit on the walls, they can be accommodated by notching the face of the column to fit over the obstruction, although the notch should be limited to a depth of 1 in. Ductwork along the basement ceiling can be bypassed by welding a horizontal leg to the top of the column at the wall, and then a vertical piece to fit alongside the joist beyond the duct.

Walls displaced more than 1 in. must be excavated and replumbed—If water problems go unchecked, the accompanying seasonal expansion and contraction of soil can wreak havoc on foundation walls, sometimes causing severe displacement. Building-code officials here in Wisconsin require any foundation wall displaced 1 in. or more to be excavated and jacked back to plumb (photo facing page).

After the wall is excavated but before it is jacked or pushed back in place, cracked joints must be cleared of mortar to release the joint and to straighten the wall. With the wall replumbed, the joints must be filled with new mortar. It's important to remember that excavating a finished wall is not enough. Any wall that has been excavated and repaired must be braced or reinforced to prevent future failure. Once the excavated wall has been repaired and before it is backfilled, it's also a good idea to add a drainage system or to repair the existing one (drawings right, facing page).

Excavation can be an expensive repair. If there is a judgment call as to whether a wall needs to be excavated, as an engineer my decision depends on the extent of the cracking, the amount of moisture in the wall, the distribution of the building load and the character of the subsoil. Old brick-masonry walls 12 in. thick can bulge inward 2 in. and support a building. Concrete block, on the other hand, tends to fail under similar conditions.

In cases where the wall was constructed out of plumb, a displacement of more than 1 in. might be acceptable, as long as there are no stress cracks. If the same wall is wet, however, excavation might be necessary to repair a drainage problem that might cause a more serious failure in the future. □

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A reinforced-concrete grade beam braces walls after excavation

For severely displaced walls, a Milwaukee-area contractor has developed—and patented—an alternative to traditional concrete-block foundation repairs. The repair involves excavating the foundation, inserting steel rebar into the core of the wall and attaching the rebar to a horizontal, reinforced-concrete grade beam (drawing below). The grade beam is designed to brace a damaged wall to prevent failure in the future.

The process is straightforward: After the wall is excavated and pushed back to plumb, exterior faces in the fourth course from the top are removed at 4-ft. intervals along the length of the wall. The bottom block below the top opening is also opened, and steel rebar is worked up and down inside the core to clear mortar flash at the joints. Debris can be removed from the opening in the bottom block.

With the block cores cleared of obstructions, steel rebar is placed in the cores. The rebar projects out of the block at the top opening perpendicular to the wall, where it intersects a reinforced-concrete grade beam running parallel to the wall. The cores are then filled with concrete after which the foundation wall can be tuck-pointed and waterproofed, and new drain tile can be added.

Crushed stone is then added to within 6 in. of the projecting rebar. Then the 12-in. high concrete grade beam is formed on top of the stone fill, sloped away from the foundation wall. (The width of the beam can be determined by an engineer but is never less than 12 in.) Soil fill can be placed over the beam to restore the surface to its original condition.

Although this is an extreme measure, the cost of this repair is competitive with other bracing methods. The benefits of a concrete grade beam are its strength and the fact that it does not disrupt the walls inside the foundation.

For more information about this repair, contact Richard Fellows (1001 E. Mackinac Ave., Oak Creek, WI 53154; 414-764-0713).—*D. V. C.*

Patented grade-beam repair. *A displaced wall that has been excavated and repaired must be reinforced against future failure. One method is to excavate and install a concrete grade beam. The beam is connected to concrete and to rebar placed inside the block cores.*