CONCRETE BLOCK FOUNDATIONS

by Carl Hagstrom

What makes for a better foundation: poured concrete or concrete block? I'm willing to bet that, of the nine out of ten builders who answer "poured concrete," few have had much experience with block walls. Concrete block foundations are strong, go up quickly, and in my area, they cost about 15% less than poured basements. As with anything else, of course, the success of a block wall foundation depends on proper design and detailing.

Get Off on the Right Footing

Given the wide range of soil characteristics you may encounter, it's impossible to describe a footer size that will work in all situations. The rule of thumb is to make the footer as deep as the wall is thick, and twice as wide, but you should check your local code for footer specs. If you don't like the looks of the soil, talk to somebody who is qualified to advise you.

Most masons assume the footers are square, so if a subcontractor other than the mason forms the footers, check the accuracy of the forms before the concrete is poured to make sure they're level, square, and correctly dimensioned. Do this before the blocks are set in the hole, otherwise the cubes — stacks of blocks about 4 feet on a side — get in the way of measuring diagonals. When I form and pour the footers myself, I usually stub up a piece of rebar or set a nail to mark all corners of the foundation.

If you encounter bedrock that interrupts the footing, you can step the forms up and over it. I usually form the steps in 8-inch-high intervals to match a full size block.

Mortar

Mortar is the "glue" that holds masonry units together. How the mortar is mixed and handled can affect the overall quality of the foundation more than any other factor.

Mortar has four basic components: portland cement, hydrated lime, mason's sand, and water. By blending these components in different ratios, you can vary the strength and working properties of the mortar. The five standard mixture types are listed in the table, "Standard Ratios," at the bottom of page 43. Check your code to see what type of mortar you should use.

Ingredients. Each ingredient in the recipe for mortar affects the mix in a particular way:

- **Water.** Generally speaking, the wetter the mortar, the easier it is to work with. But too much water will weaken the mix.
- **Sand.** Resist the temptation to cut back on the sand in the mix. Sand gives the mortar body and allows it to release properly from the trowel; mortar without sand has the consistency of caulk. Sand also controls shrinkage. Less sand makes the mortar more plastic and easier to work with, but the increased shrinkage may come back to haunt you.
- **Lime.** The amount of lime in the mix affects its plasticity, and makes it possible for the mortar to stick to the trowel and to the block. Lime weakens the mix, but it also makes for a more watertight joint by sealing cracks and voids more readily.
- **Cement.** In addition to improving the compressive strength of mortar, cement bonds the masonry units together and gives mortar its tensile strength.

Hot weather. You may need to take special precautions with mortar, depending on the weather. If it's hot and dry, moisture will evaporate rapidly from the mortar. This arrests curing (hardening), and compromises the wall's strength. In hot weather, mix the mud in small batches and keep it covered. If it starts to dry out from evaporation, you can bring it back to life (called retempering) by adding water. However, if drying is caused by hydration — the chemical process that hardens cement — you should discard the batch. Since it's difficult to tell the difference between hydration and evaporation, a good rule is to use a batch of mortar within two hours or else discard it.

As soon as joints are tooled, they should be kept moist, particularly if they're exposed to direct sun. If you can't spray the joints with water, keep them covered and out of the sunlight.

Cold weather. If wet blocks are allowed to freeze, you'll never get them to bond properly. In cold weather, be sure the blocks are delivered dry, and cover them upon arrival. Cover the finished wall with plastic to keep out light frost. If you expect the temperature to dip below freezing for an extended period, you may need to use insulating blankets.

Reinforcing Block Walls

Most residential foundations require 10-inch or 12-inch blocks. In my experience, either size is acceptable as long as you strengthen the portions of the wall subjected to high lateral loads. The code in your area will often specify what size you

A block foundation will perform as well as poured concrete if you use the right mortar and reinforcing, and provide for drainage

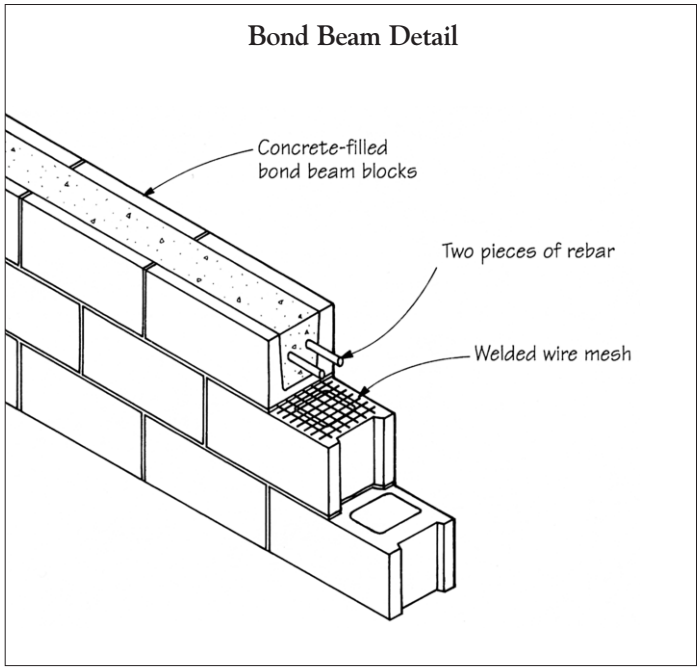

Figure 1. *To strengthen a block wall against lateral pressure, the author places a horizontal bond beam halfway up the wall. He also uses horizontal reinforcing mesh in every other course of blocks.*

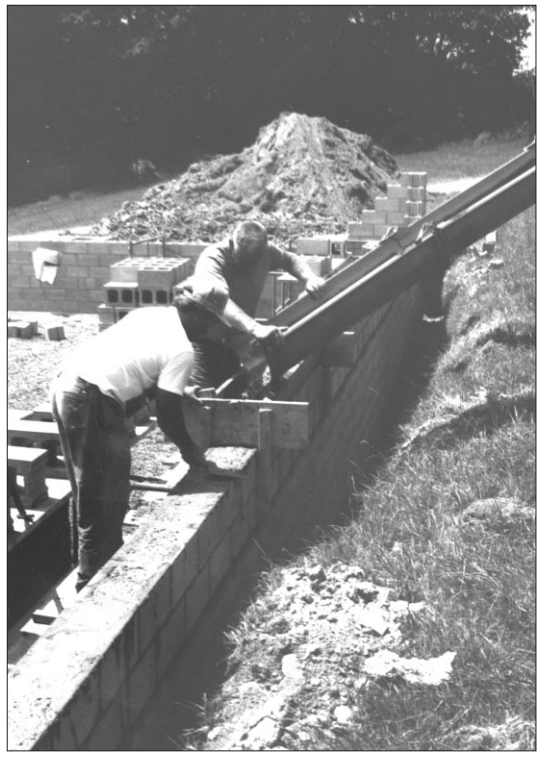

Figure 2. *Filling the block cores with reinforcing steel and concrete can strengthen a block wall. Here, masons use a movable wooden form to direct concrete from the chute into the block cores.*

should use.

The greatest force a residential foundation wall must resist is the inward push from the surrounding soil. This lateral pressure from the soil governs the wall design. Concrete blocks can easily handle compressive loads (the weight of the house), but they are notoriously weak against lateral loads. Under certain conditions, a concrete block wall can bow inward under lateral pressure from the surrounding fill.

If final grade around the foundation is 4 feet or less above the footer, you shouldn't need any reinforcement. But as the height of the grade increases, so do the stresses. Steel reinforcement adds the necessary tensile strength to resist the lateral load. I use several methods to increase the strength of the wall as the backfill height increases.

Joint reinforcement. Welded wire mesh, such as Durawall (601 No. Point Rd., Baltimore, MD 21237; 301/485-4120) will strengthen the wall, and is usually installed horizontally at every other course.

Bond beams. Another way to strengthen the wall is to cast a horizontal bond beam at the midpoint. Use special bond beam blocks with two runs of rebar embedded in concrete (Figure 1).

Filled cores. One alternative to a bond beam is to fill the block cores to grade level with concrete (Figure 2). I reinforce the wall horizontally with welded wire mesh, and vertically with a piece of rebar in every other core. Unlike a bond beam, this method allows you to pour the concrete after the masons have finished their work. It requires more concrete and steel than a bond beam, but it's more convenient and strong enough for most foundations.

Wing wall. Another way to resist lateral loads is to reduce the span of the main wall by building a wing wall at right angles to it. A wing wall is most effective as a buttress when placed on the interior, but it can be placed on the exterior of a wall as well. Wing walls can also be used in conjunction with bond beams.

Soil type, height of the water table, and other factors will determine which kind of reinforcement is best. If you're not sure which method to use, spend a few bucks on a structural engineer.

Running Up the Walls

A crew of four good masons can lay up a simple block foundation in two days, so it's important to straighten out all of the details ahead of time. First establish a specific area for mixing mortar and washing out tools and equipment. This is especially important on additions where the lot lines are tight or where the landscaping might be ruined. Also make sure your mason knows where anchor bolts should be placed and how far they should project from the top of the wall.

We usually parge the exterior of the foundation below grade with mortar to seal the pores in the block before applying a coat of asphalt. If the block work will be exposed above grade, determine the height of the parging so it won't be visible after final grading.

Let your mason know how accurate you expect the finished foundation to be. A good mason can easily build to a 1/4-inch tolerance or better over 60 feet of wall. The same is true of the tolerances for window and door openings. At basement hopper

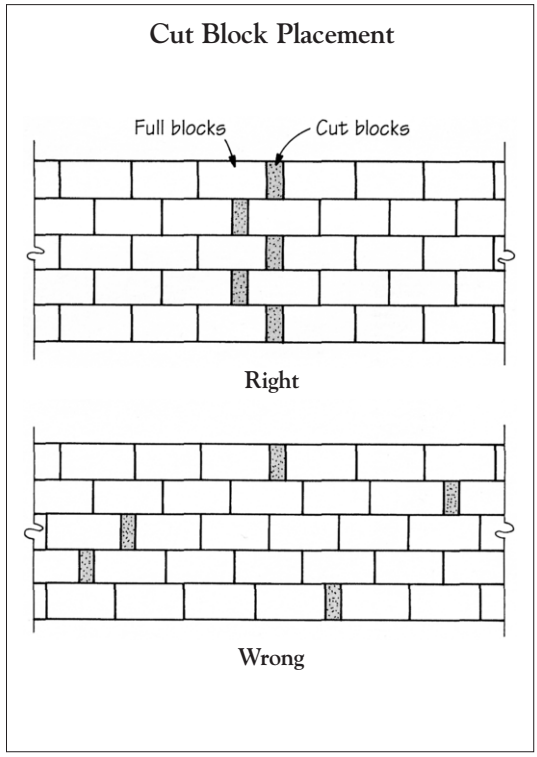

Figure 3. *If the length of a wall doesn't divide evenly into full blocks, align cut blocks in succeeding courses (top). This keeps the cores lined up and looks much better than random placement (bottom).*

Standard Ratios for Mixing Mortar

Type	Cement	Lime	Sand	Compressive Strength (psi)
M	1	1/4	3	2,500
S	1	1/2	4	1,800
N	1	1	6	750
O	1	2	9	350
K	1	3	12	75

Note: *The ratio of components in mortar has a dramatic effect on the strength of the mix. As a rule of thumb, tensile strength is 1/10 the compressive strength. Type S is usually specified for below-grade work; type N, for work above grade.*

windows, you can use a special sash block to frame the opening. It has a vertical groove 4 inches in from one side to accept the flange on steel or aluminum windows. At least one manufacturer (Interstate Window and Door Co., 322 Laurel Street, Pittston, PA 18640; 800/338-9997) makes a vinyl window with nailing fins made to fit sash block.

To score points with your plumber and electrician, have them give you the materials for the septic and service chases, and have your mason install them as the wall goes up. You'll have to plan their location in advance, but it will save drilling holes in the blocks (no fun when they're filled with concrete and steel), and you'll get a more watertight job than if they're patched in later.

Block Layout

Concrete blocks are designed to be laid in a running bond (sometimes called half-bond) pattern in which the vertical joint of two adjoining blocks falls over the center of the block below. The joint can be as close as 4 inches from a joint in the courses above and below and not affect the strength of the wall, but the appearance will suffer if the joints are off-center. Where a portion of the wall will have cores filled with concrete, keep the half bond dead accurate. If the cores don't line up, you'll have a devil of a time getting concrete and rebar where it belongs.

Corners. Masons usually start foundation walls at the corners. If the length of the wall doesn't divide evenly to full blocks, position cut blocks in the same general area in succeeding courses (Figure 3, previous page). This keeps the cores lined up, and looks much better than random placement. For the same reasons, avoid using cut blocks at an opening. I prefer to use an uncut sash block at an opening, and place the cut piece in the field of the wall.

Intersections. One of the most difficult spots to bond properly is a T intersection, such as where a wing wall meets the main wall. This is especially true when the intersecting wall is a different size from the foundation wall because it's harder to lay out the blocks so they interlock properly (Figure 4). It takes more planning, but the basic layout rules still apply: Joints should never fall directly over one another, and you should maintain at least 4 inches between them.

Concrete blocks are designed for a right-angled world, and walls that intersect at an angle other than 90 degrees are probably the trickiest to bond properly. If the intersection is subject to high lateral loads, get some solid advice on how to construct them.

Lintels. Most basement windows are 32 inches wide and positioned at the top of the wall, where you don't need to span the opening with block and the wood rim joist acts as a header over the opening. For larger openings, precast reinforced concrete lintels are readily available in lengths up to 12 feet. Lintel widths of either 4 inches or 6 inches can be used in combination to match many different block sizes. But lintels are difficult to work with because of their weight, and they are not designed to be structural. If you need to support more than the weight of one or two courses of block over a long span — a garage door opening, for example — you will probably need to use a steel beam.

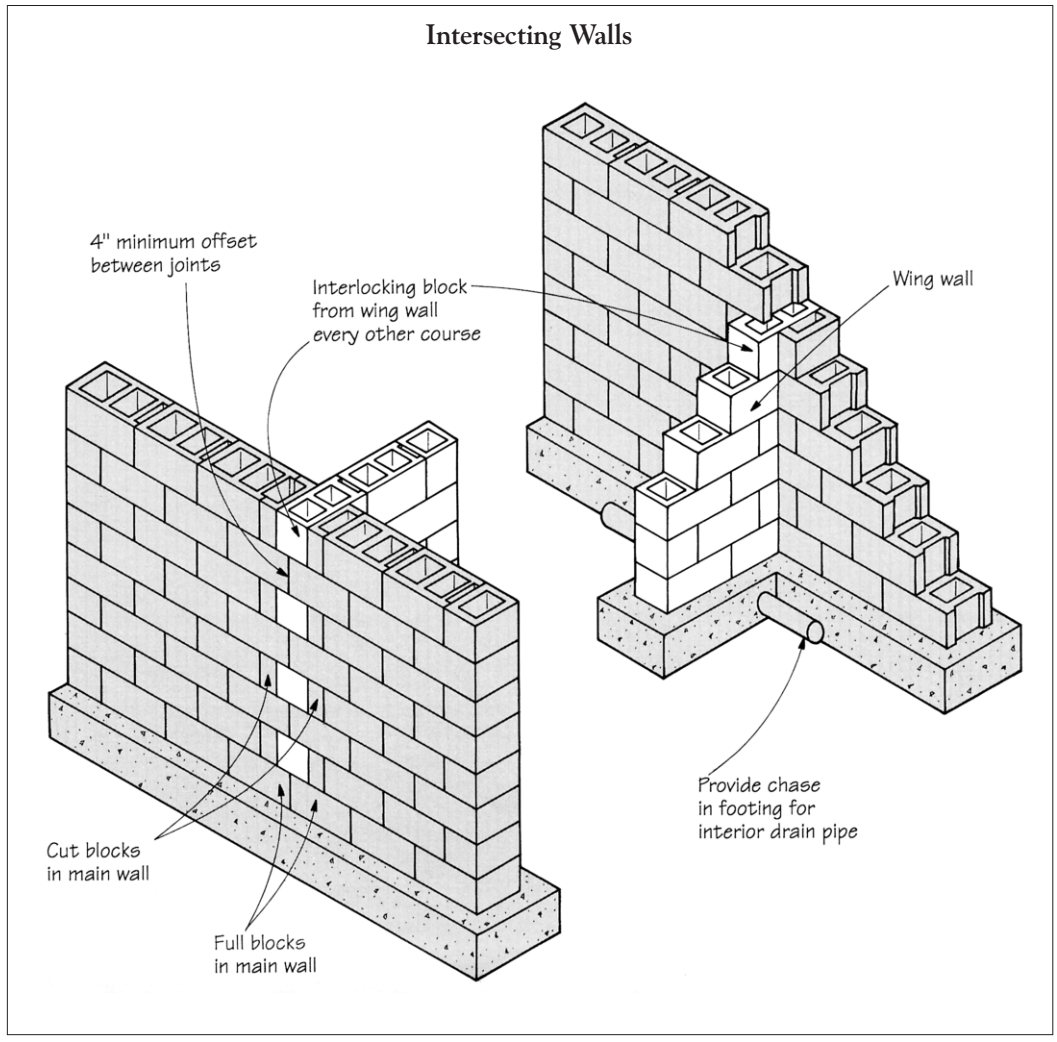

Figure 4. *Where walls intersect, the blocks must interlock. Layout is more difficult with walls of different widths, but all joints should still be offset by 4 inches or more.*

Keeping the Basement Dry

You can bet that the first concern of the customer is whether or not the basement will be dry and comfortable. It's not difficult to build a dry basement. I build in a region where the water table can rise to within one foot of grade in the springtime and footer drains run at a gallon a minute, yet I have no moisture problems with my foundations. Standard practice is to parge the foundation walls to seal the pores in the block before coating them with cold asphalt. But this will work only if the perimeter drainage system is flawless.

Good drainage begins at the footers. I always form my footers instead of trenching them because it allows me to lay the foundation drain pipe level with the bottom of the footer. With trenched footers, you have to lay the drain pipe on top of the footer. This puts the pipe level with the slab, inviting problems. I also lay a drain pipe on the interior side of the footer to keep water that migrates up through the ground from being trapped inside the foundation. The interior drain pipe exits through a chase in the footer.

I always fill the foundation interior with gravel, level with the top of the footer, to keep moisture from wicking up through the slab. If you spread the gravel before the blocks arrive, it will keep the bottom layer of blocks in a cube from getting muddy and also give you a dry, level work area.

Finally, I backfill to within a foot of grade with gravel, which effectively breaks the link between moisture and the foundation wall. Gravel backfill is arguably the best method to ensure that the foundation will perform to expectations. While it doesn't increase the strength of the wall, it serves the same purpose by reducing the stresses on the wall.

Before backfilling starts, the floor framing should be completed and sheathed to provide lateral support at the top of the walls. Even so, machine operators who "ram and jam" can do a lot of damage in a very short time. Your machine operator should ease the backfill material against the wall, keeping the machine as far away from the foundation as possible.

If you think this sounds expensive, you're right: All of these precautions can add $1,500 dollars to the cost of an average foundation. Is it worth it? Before you decide, see if you can find builders who had to go back and fix a moisture problem in a basement, and ask them how much it cost. A 3-inch rain can dump 3,000 gallons of water on the roof of a house. If your gutters aren't up, and you backfilled with dirt only, you can easily lose a foundation wall. ■

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