

STABILIZING BASEMENT WALLS WITH **Steel I-Beams**

Floor-to-floor bracing is
simple, fast, and permanent

I work in and around Kansas City, Mo., where the land is river bottom and the soil is all clay — one of our counties is even called Clay

by Dave Cunningham

County. Most of the houses built on this heavy, unstable soil are candidates for foundation work — drainage and waterproofing, foundation jacking, or wall repair.

Many of the homes in the post-World War II developments have block basements, often laid with no grout or rebar in the cores. I've rebuilt a lot of those basements, but there's plenty of work ahead of me. Other homes have stone foundations, which are also vulnerable to buckling inward from soil pressure. Even many of the poured concrete walls have tipped inward. That's why I've been able to make basement work a big part of my remodeling business.

Some walls (especially the stone and block ones) have to be torn out and rebuilt. But if they haven't moved too far, it's often effective to reinforce them in place, which is the subject of this article.



I-Beam Repair

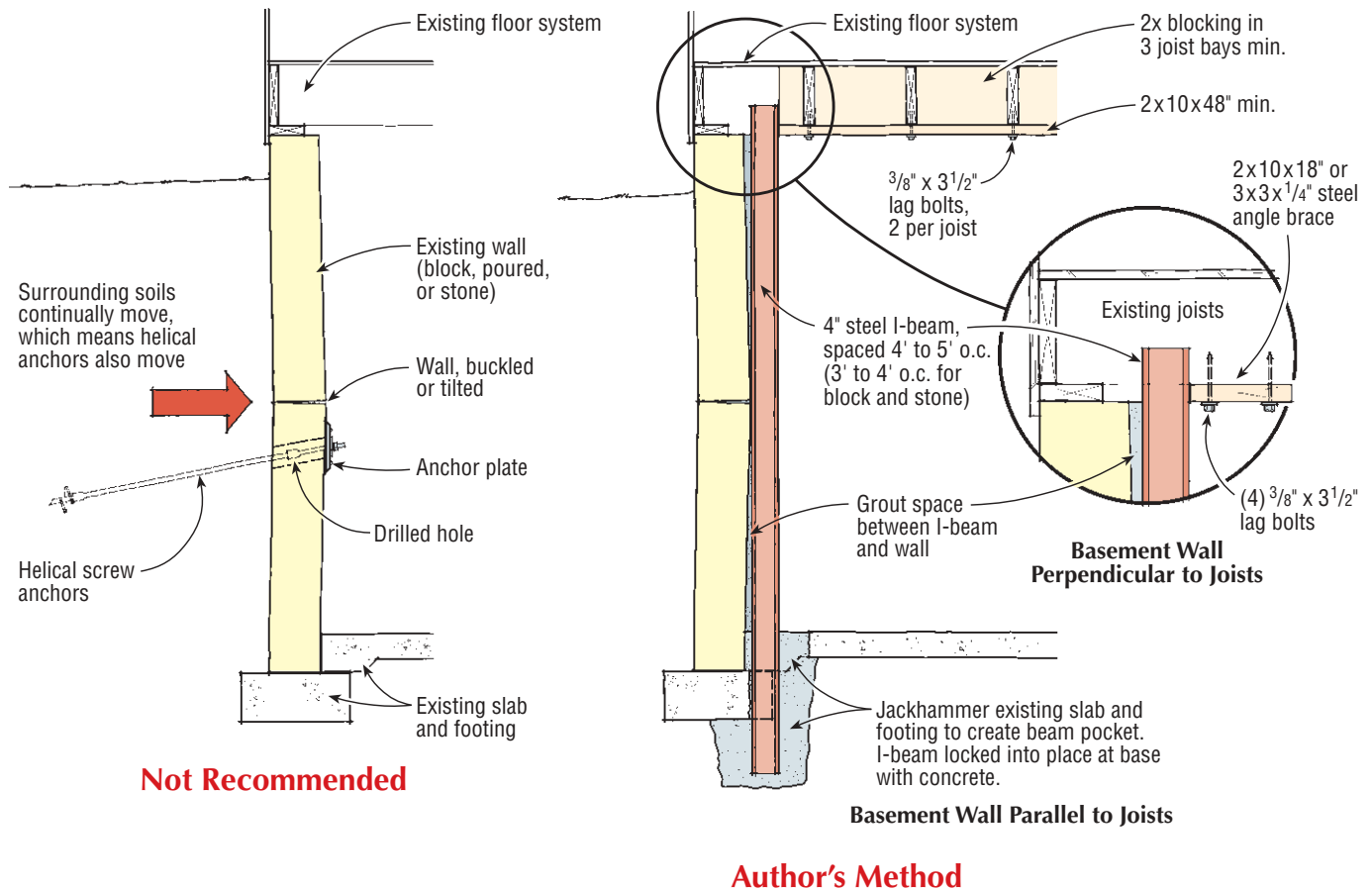


Figure 1. Helical screw anchors (left) rely on surrounding soils to stabilize walls and may need routine retightening. The author prefers an I-beam solution (right) commonly recommended by engineers in his area. The base of each I-beam is braced by soil and the basement slab, while the top is braced by a firm attachment to the first-floor frame. The author has had good results with I-beams spaced 3 to 6 feet on-center.

Buckled and tilted basements often get reinforced using helical anchors that bolt through the basement wall (see Figure 1). The contractor drills a hole in the wall and drives the anchor out into the yard at an angle, then installs a steel plate with a bolt on the inside. But, in my experience, that doesn't work around here. I often end up ripping those anchors out and starting over.

That's because the soils in our area continually move, which means the anchors move, too. So year after year you have to come in and torque down the nuts again so the wall won't move. Homeowners typically need someone

else to do that, so you're taking on a lot of service calls. Also, it means that if you want to finish off the basement, you have to leave access ports so you can get to the nuts.

The method I use is the one usually recommended by engineers in my area. It relies on the house structure for support. I stabilize basement walls with steel I-beams, placed vertically against the wall and spaced anywhere from 3 to 6 feet apart. I break open the concrete floor and footing, dig down at least 12 to 16 inches, place the I-beam in on end, pour a concrete pier around it, and then brace it off at the joists with 2x10s or 3x3 angle iron.

Then I grout between the beam and the wall using stiff concrete. I've done so many of these jobs I can't count them all. Over the years, I've gone back and checked a lot of them, and not one has moved a bit.

Sizing Up the Job

The first thing I do when I'm checking out a basement wall is to put my ear against it and sight down the wall to see what we're up against. Then I put my 6-foot level against the major bulges to see just how far out of plumb it is.

If the wall's less than 3 or 4 inches out of plumb, we can safely "I-beam" it as is (Figure 2, next page). If a poured



Figure 2. Block basement walls (above) tend to bulge in the center. Poured walls (right) are more likely to lean inward at the top due to failure of the sill connection. I-beams can stabilize both types of wall in place as long as the deflection is no greater than 3 inches. Block walls that are more than 3 inches out should probably be rebuilt. Poured walls that are more than 3 inches out can be pushed back to plumb and then stiffened with I-beams. For jobs requiring rebuilding or pushing back walls, exterior soils must be excavated, but for simple stabilization jobs, regrading may be sufficient.

concrete wall is 3 or more inches out of whack, I'll typically excavate the outside and push the wall back into plumb before I stabilize it. A block or stone wall that has bulged more than 3 inches should be replaced: The mortar joints are probably shot, and you can't expect to push that back out and have anything solid left. I tear those walls apart and rebuild with new block.

That 3-inch rule of thumb is consistent with engineering reports I've seen over the years, and it has always worked for me. In fact, generally I will not warrant an I-beam job on a wall that is more than 3 inches out of plumb, unless I've pushed the wall

back where it belongs.

The choice is really up to the homeowner, though. Some homeowners will insist that I push back a wall that's only an inch or two out of plumb, even after I assure them that stabilizing it in place is sufficient. Other homeowners may just want to stabilize a wall in place even if it's 5 inches in — which I don't mind doing as long as they understand that it's not guaranteed.

Dealing with drainage. After I assess the basement, I go outside to find out what's causing the problem. Reducing the pressures on the wall so the problem won't get worse later helps the I-beam repair.

As I mentioned, practically every house I see is sited in clay soil. But drainage and runoff are usually factors, too, when there's a problem wall. Houses with leaning basement walls are often just in a bad spot — at the bottom of a hill or the end of a cul-de-sac — or their yard and driveway slope toward the house. Even on flat sites, many of the problem homes have a negative grade funneling water toward the foundation, and a surprising percentage have no roof gutters. Bringing in dirt to create a positive grade and installing gutters with extended downspouts to carry water 4 or 6 feet away from the house make a world of difference.



Figure 3. After cutting back the insulating foam, a worker jackhammers through the floor slab and footing edge. A steel I-beam will be placed in each hole and set in concrete. The author prefers jackhammering to concrete sawing, because it creates less dust and provides a rough edge for good bonding between the existing concrete and the freshly placed pier footing.

Another common source of problems is a heavy concrete stoop in front of the house that is settling down and pushing the soft clay backfill against the basement. I often recommend replacing that concrete mass with a wood deck or porch.

I-Beam Placement

Steel yards carry beams in standard dimensions and weights. I use 4-inch-deep I-beams that weigh 9.5 pounds per foot. You can cut the steel on site with a cutting torch if need be, but generally I measure first to find out what length I need, then have the pieces cut for me at the steel yard.

For a concrete wall, I set the I-beams 4 to 5 feet apart. If the wall is block or stone, 3 to 4 feet apart is a safer bet. In any case, I position the beams so that they can extend up into a joist bay — steel or wood blocks spanning the joists will hold the I-beams tight to the wall. After laying out the I-beam locations, I break out a 1-foot-diameter hole for each I-beam using a jackhammer (Figure 3).

I prefer jackhammering to sawing concrete for a couple of reasons. A concrete saw throws off a lot of fine dust,

which is unsafe and makes a mess throughout the house. Besides that, sawing concrete leaves a smooth, shiny surface on the face you cut, and when you pour the patch, the new concrete doesn't bond to the old concrete — there will be a crack when the new concrete cures. Jackhammering, by contrast, leaves a rough cut edge that gives the new and old concrete surfaces a better chance of bonding.

When my holes are ready, I set an I-beam in each. I place each I-beam tight against the wall, hold it plumb, and brace it in place with a 2x10 block or a piece of 3x3 1/4-inch angle iron, lag bolted into the joists above (Figure 4). The I-beam contacts the wall wherever the wall is farthest out (usually in the middle for block walls and at the top for poured walls).

The top brace connection varies depending on whether the joists run perpendicular to the wall or parallel. Perpendicular joists supply strong bracing — a single 2x10 or piece of angle iron spanning one joist bay is plenty. But a joist parallel to the wall is oriented sideways to the force of the wall pressure and can't handle the load by itself. In that case, I place solid



Figure 4. A worker braces the top of an I-beam tight against the top of the leaning wall (left). The 2x10 brace is fastened to the existing floor joists using 3/8-inch lag bolts sunk into predrilled holes (right). Three-inch by three-inch angle iron can be used instead of the 2x10 block. This step is easier with two people — one to hold the I-beam and block in place, and one to set the lag bolts.

blocking into the joist bays for three or four joists back from the wall, then lag a 2x10 into the joists under the blocking (Figure 5). This transfers the load of the I-beam into the whole floor system instead of dumping it all onto the side of one joist.

When my beams are pinned at the top, I plumb them up and brace them into the holes at the bottom. It's tricky to hold them still while you grout the bottom and the space between the I-beam and the wall. After years of struggling with that, I started bracing the foot of each beam into the hole with scraps of wood (Figure 6). It's quick and easy, and the wood gets buried in the concrete base of the pier.

Next I grout the space between the I-beam and the wall with stiff concrete (Figure 7, next page). I mix a batch of sack concrete in a wheelbarrow (dry enough to make a firm ball in my hands), put on some rubber gloves, and just pack it into the gap and whittle it smooth. That provides solid support for the wall from floor to sill.

Finally, I fill in the hole at the base of the I-beam, locking it into the earth and the existing slab (Figure 8, next page). That makes the whole assembly one continuous, solid structure. In the six years I've been doing it, I've never seen one of these I-beams budge a millimeter.

All I've described here is the wall stabilization. Many of these basements also need exterior waterproofing or an interior drain and sump system. As long as the water problems have been dealt with, the basement space can be finished any way the homeowner wants to once the I-beams are set (Figure 9, next page). There's no need to leave access to the I-beams — they can be simply painted, or boxed in and buried.

Costs and Scheduling

Jobs that require excavating call for careful estimating. There are dozens of factors to keep in mind — access, proximity to neighboring homes, attached steps or other structures, landscaping, and possible low overhangs that can



Figure 5. For bracing perpendicular to the floor joists, the author places solid blocking into at least three joist bays and lag bolts the brace to each of the joists directly under the blocking. The joist nearest the beam could not do the job on its own without this arrangement.



Figure 6. The author braces the base of each I-beam in place with small blocks of wood. The wood blocks will be encased in the concrete pier base when the hole is grouted.



Figure 7. A worker grouts the entire space between the I-beam and the wall with stiff concrete to provide full support for the wall. Excess grout is smoothed away for a clean finish (see photo on page 75).



Figure 8. The hole is filled with stiff concrete to embed the I-beam firmly into the slab and subbase. The surface is troweled level with the existing slab.

Figure 9. The completed I-beam installation (right) supplies reinforcing for the wall from footing to sill at 3 to 6 feet on-center. In the example below, the author then applied fiber-reinforced plastic panels to the basement walls. The basement is now ready for further finishing.



impede the excavator, to name a few.

But estimating a basic wall stabilization job is simple. Given a typical 30-foot wall to brace, I know I can break out the floor, dig the holes, and place the seven or eight beams that are needed in one day. I know it will take half of a second day to do all the grouting and clean up.

The only materials costs are for the beams, grout, lag bolts, and wood or angle iron for top bracing — which comes to about \$50 total in materials for each 8-foot I-beam I install. I price jobs to the homeowner for about \$200 to \$250 per beam, which covers labor, overhead, and profit.

For small jobs, I don't take a deposit. I just put the house on my schedule and call the owners a day or two before I start. Once I do start, I stay on the job until it's done; when I finish, they can pay me with a check or credit card. With this arrangement, I don't feel under pressure if I'm a day or two late getting started.

These small jobs often lead to larger jobs. Many of the people whose basements I've fixed will call me back later to finish out the space, or to do some kind of exterior grading or concrete work. And they often refer me to their friends as well — I get most of these jobs through word of mouth.

That's especially true of the homeowners who like to watch. Some homeowners don't want to know what we're doing, as long as we get it done. Others will pull out lawn chairs, pack a lunch, and sit and watch us for the whole time. Every few minutes, I find myself stopping to explain what we're doing and why. But that doesn't bother me a bit — the way I figure it, that makes them a little more educated. And it also means that when I'm done, they're that much more likely to refer me to someone else who needs my help. 

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