



Make Mudsills

Careful measuring, precise layout adjustments, and repeated

Arriving on-site with a new foundation and a big pile of lumber is an exciting and important day in the life of a project. A good start here carries through to every part of the build that follows, from framing and sheathing to installing tile and trim. And the first part of a successful start is getting the mudsills square and level.

This house has a pair of details that affect mudsill placement. First, there's a stone plinth that sits on top of the concrete foundation. This meant that the mudsills needed to be set back $6\frac{1}{2}$ in. from the foundation's outside edge. The architect also specified a 1-in.-wide decorative chamfer on the top of the foundation's exterior.

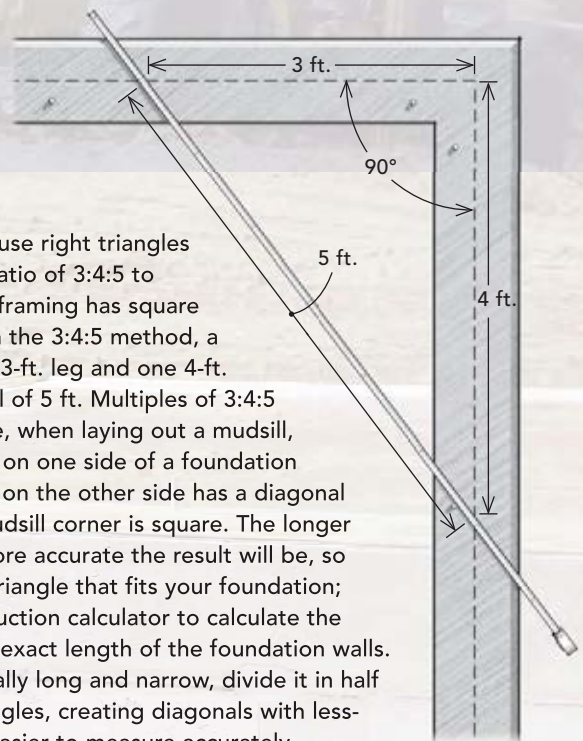
But even with the stone plinth and chamfer, the process for setting mudsills is the same on most of our projects. I highlight each of the critical steps here, and suggest how to deal with flaws in the foundation so your builds are framed square, level, and plumb.

In order to square mudsills—or most anything—I start by figuring out the diagonal dimensions of perpendicular walls with a 90° corner. This requires some grade-school geometry (see “Find square with a triangle” on the facing page). As we lay out the mudsill locations and fit the mudsill parts, we'll check diagonal and wall measurements and make adjustments to keep the corners square if required. One important step that's not shown in the photos is checking the



FIND SQUARE WITH A TRIANGLE

Carpenters commonly use right triangles with side lengths in a ratio of 3:4:5 to determine if a house's framing has square (90°) corners. Based on the 3:4:5 method, a right triangle with one 3-ft. leg and one 4-ft. leg will have a diagonal of 5 ft. Multiples of 3:4:5 also work. For example, when laying out a mudsill, a length of 21 ft. (3×7) on one side of a foundation corner and 28 ft. (4×7) on the other side has a diagonal of 35 ft. (5×7) if the mudsill corner is square. The longer the dimensions, the more accurate the result will be, so use the biggest 3:4:5 triangle that fits your foundation; even better is a construction calculator to calculate the diagonal based on the exact length of the foundation walls. If a rectangle is especially long and narrow, divide it in half into two shorter rectangles, creating diagonals with less-acute angles that are easier to measure accurately.



Square and Level

double-checks pay off with a faster, frustration-free build

BY JOHN SPIER

concrete formwork, which I do a day or more before the scheduled pour, even if I have to do it after working hours so I don't insult my trusted concrete subs. I do this even with concrete contractors I've worked with for years, because everyone has a bad day once in a while. A helper and I make sure that the walls are the right size, in the right place, and nearly perfectly square to each other, which eliminates a lot of problems later. If things aren't right, I'll have (and even help) the foundation contractor make changes before the concrete is placed.

I have been asked whether it's typical to use one mudsill plate or two. On my builds, I install two mudsill plates. When looking into

the topic, I couldn't find any regional norms, except that on the West Coast single 3x lumber plates are common because of the very tight spacing of nails for shear walls and to prevent anchor bolts from pulling through the sill in an earthquake. I like double plates because I think they make it much easier to establish a straight, square, and flat surface for the rest of the build. Proponents of a single mudsill say two is unnecessary and that the additional layer costs more in materials and labor. □

John Spier owns Spier Construction, a custom home builder on Block Island, R.I. Photos by Roe Osborn.

CHECK THE FOUNDATION

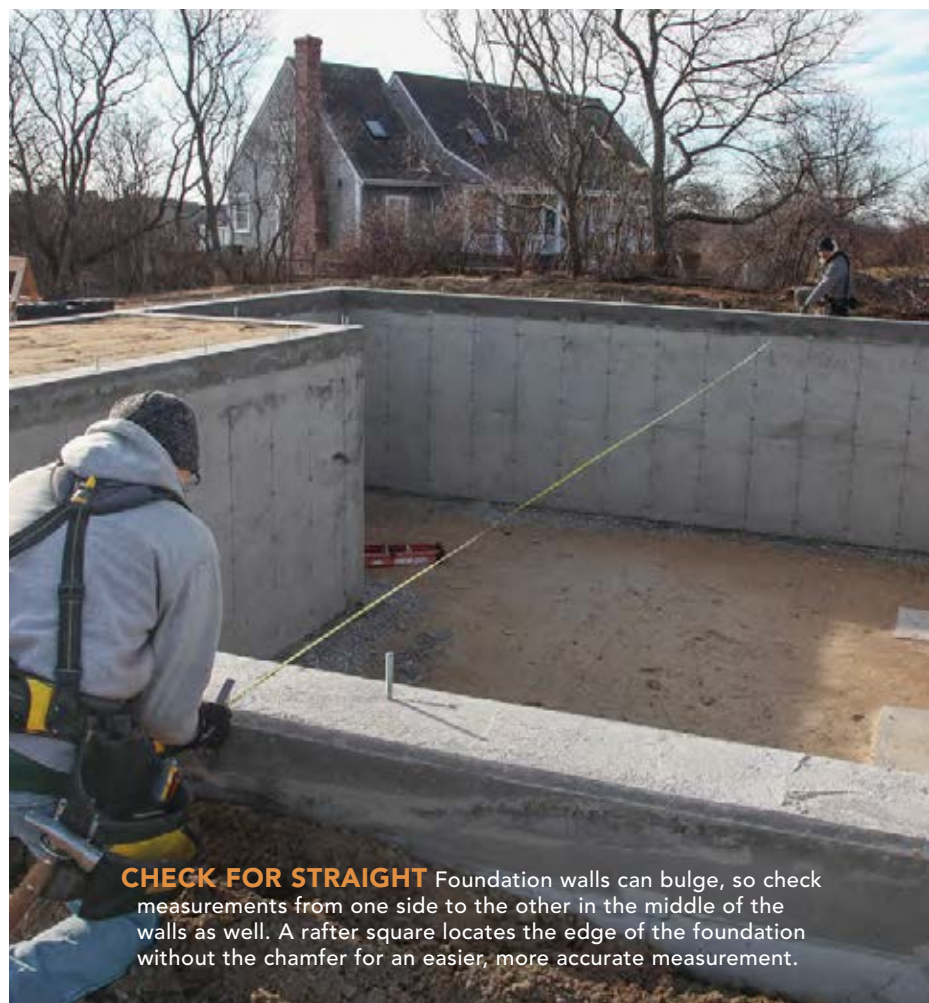
This house has a "T"-shaped gable roof with a pair of valleys. For the rafters to work out, the house has to be framed perfectly square. If the foundation contractor did a good job, all the final dimensions should be within 1/2 in. of those specified in the plan. If not, you or someone else will need to make corrections for a smooth build (see "Problem-foundation fixes" on the facing page).



CHECK FOR LEVEL Once the forms are stripped and the foundation is sufficiently cured, set up a laser level to check the tops of the foundation walls for level. With the exception of a high spot at one wall intersection and a few lumps from final screeding, this foundation was level within 1/8 in. to 1/4 in. of perfect.



CHECK THE LENGTHS Using a 50-ft. or 100-ft. steel tape, check the overall dimensions of the foundation wall to ensure they're within 1/2 in. of the foundation plan.



CHECK FOR STRAIGHT Foundation walls can bulge, so check measurements from one side to the other in the middle of the walls as well. A rafter square locates the edge of the foundation without the chamfer for an easier, more accurate measurement.

CHECK FOR SQUARE Pull corner-to-corner diagonal measurements to check the foundation for square. Equal diagonal measurements mean the walls are square—but only if the opposing walls are of equal lengths, so make sure you’ve checked the wall lengths thoroughly.



MARK DISCREPANCIES

Whenever high spots or low spots are found about 1/4 in. or more, write the dimensions on the foundation as a reminder of where you’ll need to plane or shim to make the mudsill level.

PROBLEM-FOUNDATION FIXES

The foundation contractors I work with on Block Island are skilled and experienced, but like other home-building trade workers, concrete foundation contractors are scarce in many places and the work can reflect

the relative inexperience of folks who are learning on the job. Wall lengths and placement that are way off their marks are ultimately going to require adjustments to the floor plan. These are

a rarity, as multiple people involved in the build would have to neglect checking the wall locations.

I’ve heard of foundations that are as much as 3 in. out of level or square. I’d suggest contract

language that specifies that the foundation will be within 3/4 in. of square and within 1/2 in. of level. If your foundation is not as square or as level as this, you can use these strategies to get things on track.

OUT OF LEVEL

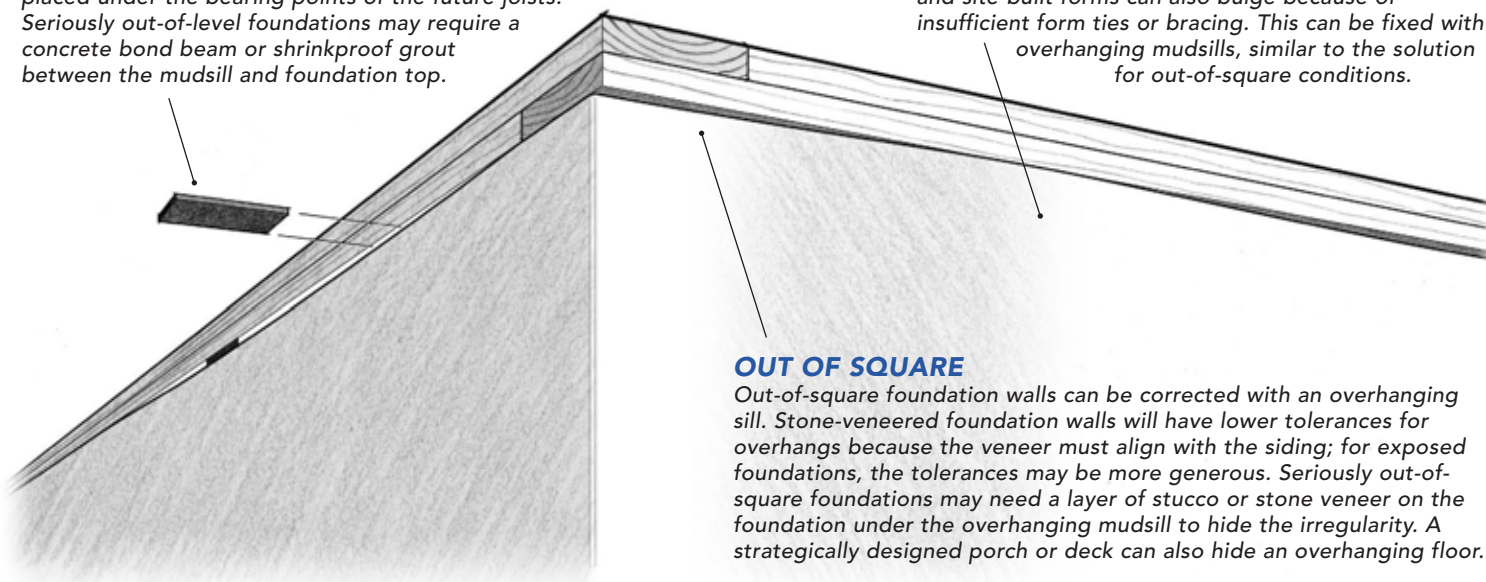
The mudsills on sloping or wavy foundation tops can be leveled with steel shims. The shims are placed under the bearing points of the future joists. Seriously out-of-level foundations may require a concrete bond beam or shrinkproof grout between the mudsill and foundation top.

OUT OF PLANE

Block and concrete foundation walls can be bulgy or wavy from bad workmanship. Both manufactured and site-built forms can also bulge because of insufficient form ties or bracing. This can be fixed with overhanging mudsills, similar to the solution for out-of-square conditions.

OUT OF SQUARE

Out-of-square foundation walls can be corrected with an overhanging sill. Stone-veneered foundation walls will have lower tolerances for overhangs because the veneer must align with the siding; for exposed foundations, the tolerances may be more generous. Seriously out-of-square foundations may need a layer of stucco or stone veneer on the foundation under the overhanging mudsill to hide the irregularity. A strategically designed porch or deck can also hide an overhanging floor.



LOCATE THE MUDSILLS

For this project, I chose the longest wall and its opposite as the starting point. When I'm locating mudsills, I don't accept anything less than perfect for the layout, because errors will accumulate as the house goes to the second and third levels. If the diagonal measurements are off at all, I adjust the layout by moving the plate location slightly and then rechecking the diagonals. I do this as many times as necessary to ensure the corner of the building is square.

START AT A CORNER Measure in from the outside edges of the foundation the width of the sill stock and any cladding on the foundation. In this case the distance from the outside edge of the mudsill to the outside of the foundation is 6½ in.



MARK THE OTHER END Pull a measurement from the first corner point and mark the length of the plate at the other end of the wall. Swing a line with a pencil against the tape. This provides a precise intersecting point for the perpendicular measurement. With the first wall laid out, measure over and mark the corners for the opposite wall, using the same setback for the stone veneer.



CHECK THE LAYOUT FOR SQUARE

With the corners of the first rectangle theoretically laid out, check that the diagonals are equal. Then use a construction app or calculator to determine the length of the diagonal based on the length of the two walls forming the corner. Adjust the plate locations until the diagonal measurement matches the calculation.

SNAP LAYOUT LINES

With the corner points located, we snap preliminary layout lines using nonpermanent blue chalk so that we can erase lines if tweaks need to be made. When we've snapped all four walls, I check that the opposing diagonals are the same, indicating that the equal-length walls are square to each other. Then, I turn my attention to laying out the sills for shorter walls for any jogs, wings, or bays. This project had jogs for two porches. If you find that small rectangular sections cannot be made square to the main rectangle, you can slightly rotate the main rectangle on the foundation to make the smaller sections fit better.



NAIL THE CORNERS

To make the line-snapping process more accurate, drive masonry nails at each of the corner points, leaving the nail heads about $\frac{1}{4}$ in. above the concrete.



3:4:5 IS AN EASY CHECK To verify the walls are perpendicular to each other, use a 3:4:5 triangle to check a corner. From the corner point, mark a multiple of three along one wall and a multiple of four along the adjacent wall. The diagonal between the marks should be the same multiple of five.



SNAP IN TWO

Hook the chalkline on the nail and stretch it to the opposite end. Then position a crew member in the middle of the line to hold the chalkline on the foundation and snap both sides.



RED MEANS IT'S READY

Once you have established that all layout lines are square and the elements fit properly on the foundation, mark the lines again with permanent red chalk.

SET THE SILL PLATES

THE BOTTOM PLATE

In our area, we install two mudsill plates, usually 2x6s, with the lower one made of pressure-treated lumber. These plates receive holes drilled to fit over the foundation's anchor bolts, and are then set on top of a foam sill seal. The sill seal prevents air leaks between the foundation wall and the

mudsill and acts as a capillary break between the foundation and mudsill. Before I start installing plates, I check the anchor bolts to make sure they are within an inch of the centerline of the plate layout, and placed high enough to fully thread a washer and nut over the plates. If one or more are significantly

off, we cut them off with a reciprocating saw and drill a hole into the top of the foundation with a rotary hammer a few inches away from the cut bolt. We then clean the hole with a brush and compressed air and install an 8-in. length of high-strength threaded rod with epoxy adhesive.



STRAIGHTEN UP

Straighten bolts that aren't vertical by striking them as low as possible with a hammer to keep from damaging the top threads. A safer option is to thread a nut onto the top of the bolt and hit the nut.

BOLT LAYOUT IN TEAMS

One crew member at the foundation calls out dimensions for the hole locations and the overall lengths of the sill section, while another marks and drills the holes for the bolts, and cuts each piece to length.



DRILL OVERSIZED HOLES

Drill $\frac{3}{4}$ -in. holes for $\frac{5}{8}$ -in. bolts and $\frac{5}{8}$ -in. holes for $\frac{1}{2}$ -in. bolts. Keep the holes minimally oversized so you can use the bolts as a fulcrum to straighten warped mudsill stock.



TWO REMEDIES FOR HIGH SPOTS IN THE FOUNDATION

Almost no foundation is perfectly flat. There are always places where the concrete settles a little or the forms shift, or the finishers miss their height marks by just a little. How I level the mudsills depends on how bad the imperfections are. If there are just a couple of high spots, I plane the plate or grind the raised spots. If there are low spots, I fill them in with nonshrink grout, which slows the work while we wait for it to set. Don't level the mudsills with cedar shims, which compress, causing future problems, especially where there are point loads.



SHAVE THE SILL Plane the bottom of the mudsill to remove stock where the foundation is slightly high. A power planer makes the process fast and easy.

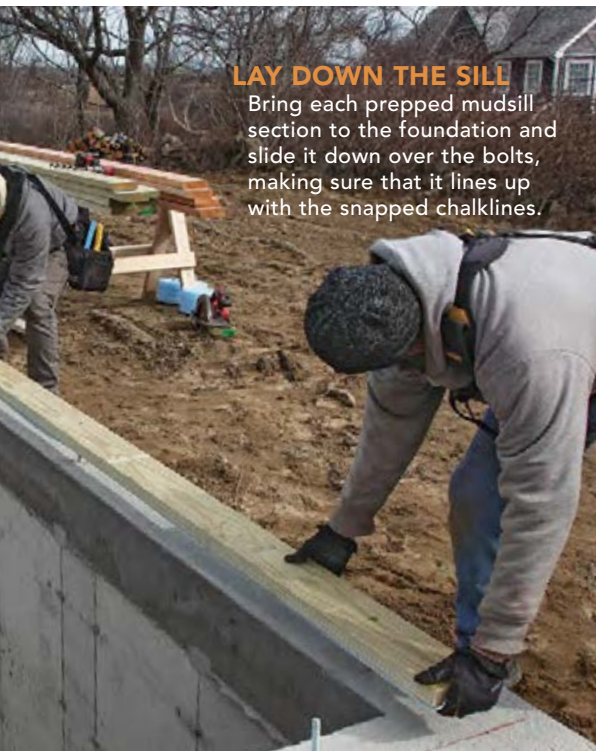


FIT THE ADJUSTED BOARD After planing the board, put it in place over the anchor bolts and then double-check the height adjustment with a level.



FLIP AND SEAL

When the cutting and drilling is done, flip the mudsill section over and roll out the sill seal, stapling it to the bottom side.



LAY DOWN THE SILL

Bring each prepped mudsill section to the foundation and slide it down over the bolts, making sure that it lines up with the snapped chalklines.

THE TOP PLATE

The pressure treated mudsill bottom plate is usually wider than the other plate stock, and most sills are laid out from the inside dimensions. Allow for the PT's extra thickness, or you'll end up with a flare at the bottom of your wall sheathing.



SECOND SILL FOLLOWS SUIT For the second mudsill layer we follow the same process as the first, with one crew member measuring the bolt locations and another drilling holes and cutting the sill pieces to length.



ALIGN AND NAIL

After setting each piece on top of the treated layer, drive a few nails to help align and hold the lined-up layers together.



TIGHTEN THE NUTS

Snug the nuts on the anchor bolts just enough to keep the mudsill layers level and flat. Use a 6-ft. level to check for flatness as you tighten, and do not overtighten the nuts, which can distort the sills downward and complicate subsequent framing.



GRIND SMALL LUMPS AND RIDGES

For bumps and lumps in the foundation surface, use a grinder with a diamond cup wheel to remove them.



FINAL CHECK After the nuts are all snugged down, check the foundation for level once more with the laser. To make the process go more quickly, set the detector/receiver on the rod about 1/8 in. low. At each location, the 1/8-in. gap between the rod and sill is easy to gauge.