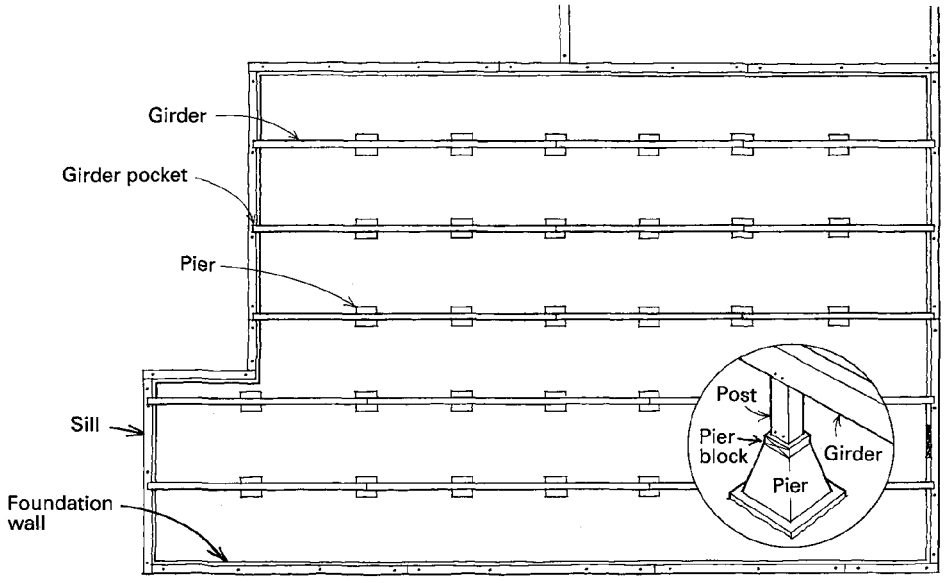
Framing a Crawl-Space Foundation

These timesaving tips make short work of setting sills, posts and girders

by Larry Haun

Foundation plan. *A crawl-space foundation is a system of wood posts and girders surrounded by poured-concrete or masonry-block walls. Concrete piers under each post provide intermediate support.*



There is no "best" foundation. Depending on what part of the country you live in, the preference might be slab, post and girder or full basement. In many areas, the crawl space is common. A crawl-space foundation consists simply of bearing walls surrounding a system of piers, posts and girders that support the floor (drawing above). Crawl-space foundations are readily adaptable to a variety of sites, and they're relatively inexpensive.

The bearing walls are usually built of masonry block or poured concrete set on a concrete footing, and construction follows conventional techniques (for more on foundations, see *FHB* #61, pp. 55-57). It's the carpentry side of the job—the sills, the posts and the girders—that I'll cover here.

Checking the foundation—The first task is to check the foundation for square and parallel. A good foundation contractor will leave the foundation square and level, but it never hurts to check before laying down the sill. If the foundation is rectilinear, check it by measuring diagonally from corner to corner; if it measures the same both ways, it is square.

If the foundation has offsets in it—for example, if it is shaped like an "L" or a "T"—there is still an easy way to check the comers for square. This is done using the Pythagorean theorem: $a^2 + b^2 = c^2$. On the job, this is usually called the 6-8-10 rule. Just measure 6 ft. from the comer along one side of the foundation, 8 ft. along the other side and then check the length of the diagonal. If it is 10 ft., this corner is square. It's that simple. It doesn't have to be perfect because you can do some correcting when you lay down the sills. You can use other multiples of 6-8-10, like 3-4-5 or 12-16-20. On a big building with long walls, use as large a multiple as possible to avoid error.

When you're convinced that the foundation corners are square, find out if the walls of the foundation are parallel. Measure across one end, then move to the other end of the foundation and measure again. If you come up with the same distance, the walls are parallel. Check this distance with the plans. Some error is permissible, depending on the size of the building. Walls that are out of parallel ½ in. over 10 ft. are worse than walls that are out of parallel ½ in. over 100 ft.

You need to check that the tops of the foundation walls are level. When I first get to the job site, I kneel down next to the foundation and sight across it. If the walls aren't parallel to each other, I know something's wrong, and that at least one wall isn't level. You can use a builder's level or a water level to determine what's wrong.

Then make sure that the foundation anchor bolts are sitting straight up. If any of them have been bent or were put in crooked, straighten them with a 2-ft. length of ¾-in. pipe (bottom photo, facing page). Just slip the pipe over the bolt and bend it upright. Also, if the concrete contractor placed a bolt where one doesn't belong, break the bolt off with the pipe by bending it back and forth a few times. Or you can use a reciprocating saw with a metal-cutting blade.

If extra bolts are needed, an expansion bolt (also called a redhead or wedge anchor) can be inserted into the foundation after the concrete

Straightening bolts and scattering sills. **Bent anchor bolts can be straightened easily by levering them into plumb with a length of ¾-in. pipe (below). That done, it's time to set the sill stock roughly in place on the foundation prior to marking and cutting it (above).**

has hardened. These bolts are typically ½ in. by 6 in. and are fitted into a ½-in. hole drilled about 4 in. deep into the concrete with a heavy-duty drill or rotary hammer and masonry bit. Leave the nut on to protect the threads and drive the bolt into the hole. The bolt will expand as it hits the bottom, securing itself in the foundation.

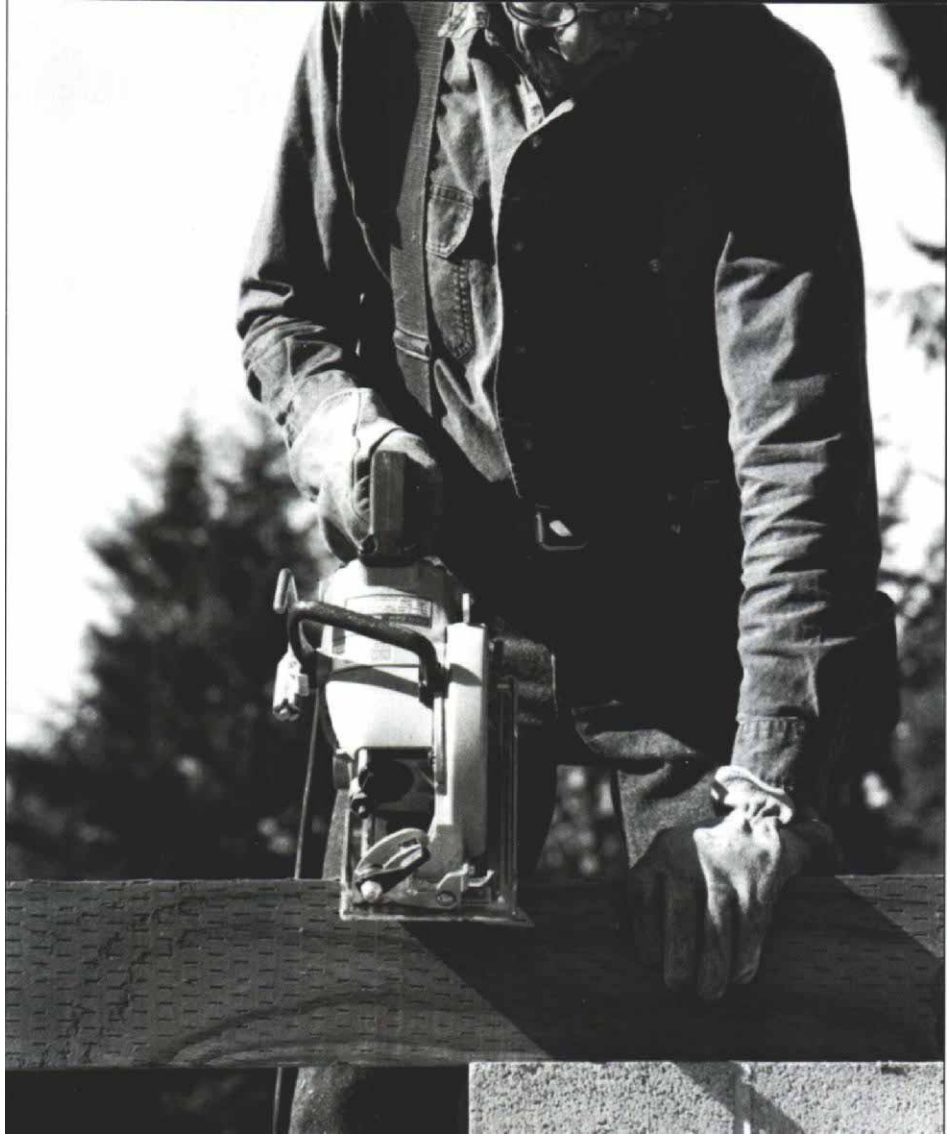
First wood: the sill—The first wooden member that is laid down is called a sill or mudsill. If it's installed straight, square and level, everything that follows will go faster and better. Good workmanship generally costs less in the long run, and it doesn't have to take more time.

The sill is commonly a pressure-treated 2x4 or 2x6, and it is usually attached directly to the foundation by anchor bolts. Most codes require that anchor bolts be at least ½ in. dia. by 10 in. long and be located 1 ft. from each corner of the foundation, 1 ft. from the ends of each sill and a maximum of 6 ft. o. c. throughout. *Every* length of sill, no matter how short, needs at least two bolts in it. The lumber used for sills often comes

in 16-ft. lengths, which require a minimum of four bolts in each sill. These requirements can vary regionally, so check your plans or local building code if you are unsure. Anchor bolts are important; they help the house to stay put during earthquakes and high winds.

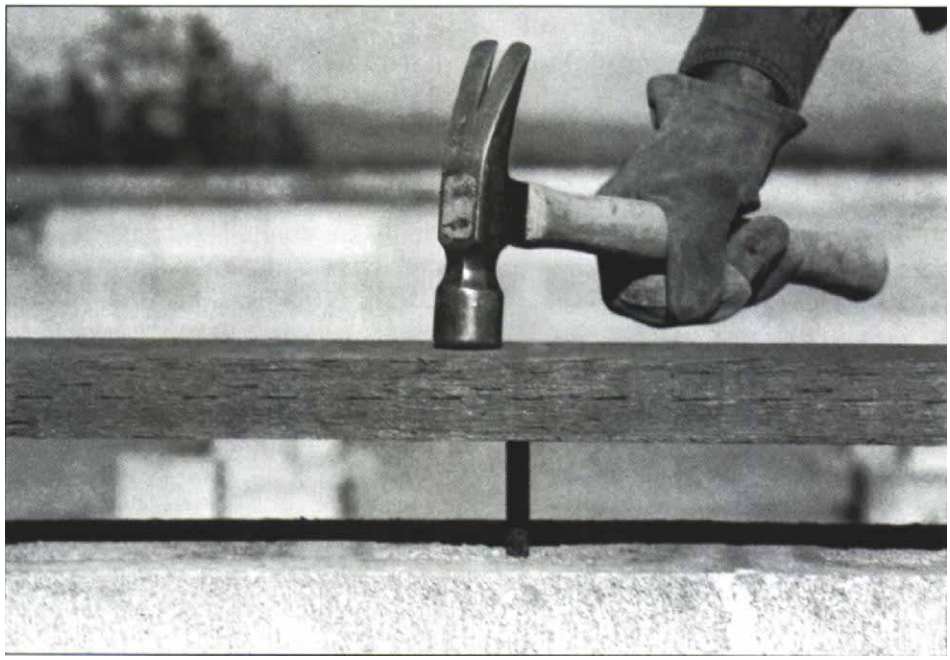
Scattering wood—An efficient framer doesn't carry, mark, cut, drill and attach one piece of wood at a time. Production framing means repetition: Do as much of one task as possible before going on to the next one. Scattering is one of those efficient procedures that production framers routinely employ. Before you do any measuring and cutting, carry and scatter all the sill stock; that is, place all the boards end to end around the foundation. Usually they can be laid roughly in position on the foundation near the bolts, which will make it easy to determine where they will need to be cut (photo above).

Cutting sills—Many carpenters spend a lot of time measuring and marking lumber before



Shortcut to straight cuts. **An efficient carpenter must learn how to cut lumber without measuring and marking the stock. When cutting sills, let the foundation edge be your guide for length. For a square cut, keep the front edge of the saw base parallel with the edge of the lumber.**

The 28-oz. pencil. **To mark the sill for drilling, set it on top of the bolts, flush with the outside of the foundation, and hit the sill with your hammer over each bolt. This will leave indentations on the underside of the plate showing you where to drill.**



cutting. This isn't necessary. If the sill stock is in position on the foundation, the building itself acts as a template, indicating where the cuts need to be made. With practice, you can cut sills square, or at least square enough, by simply eyeballing the front edge of the saw base on your circular saw with the edge of the wood (photo left). This squares the blade to the wood and allows you to cut accurately across any board, even a 2x12, without using a square.

Carpenters need to train their eyes and leam to trust their judgments, which will improve with practice. Having to pull out a tape or a square for every little measurement and cut is time-consuming and often unnecessary.

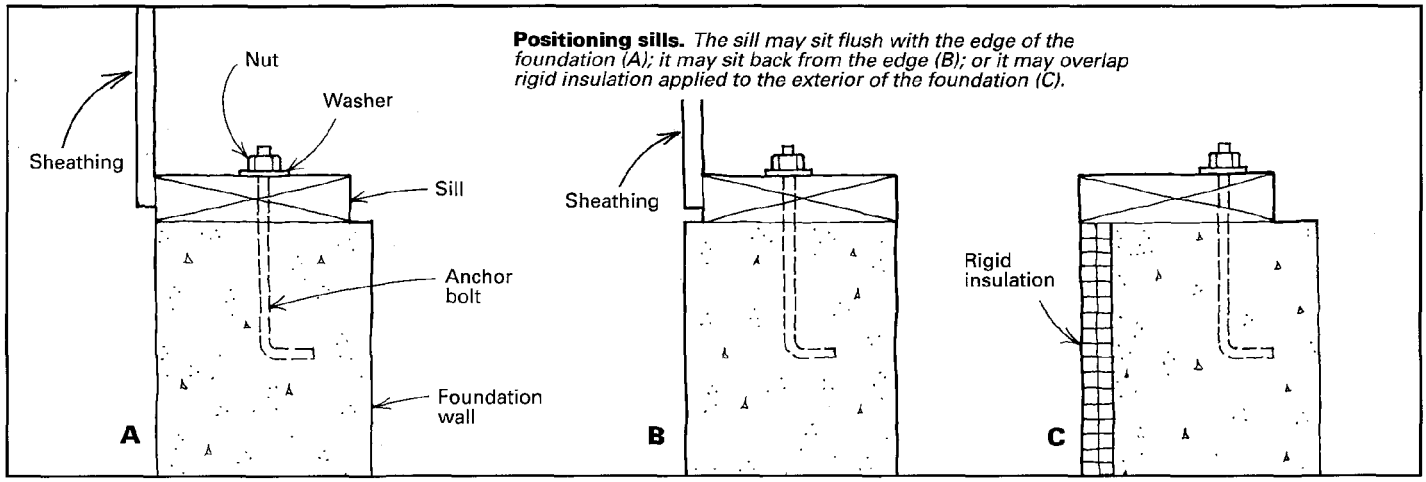
Marking bolt holes in the sills—The next step is to mark on the sill where the holes will be drilled. This is a time to think ahead and check the plans to see what will be covering the exterior walls. The sill may be installed flush with the outside of the foundation; it may be set in from the edge of the foundation to allow room for sheathing or insulation board on the walls; or it may overhang the foundation to cover foundation insulation (top drawing, facing page). A plan detail should give you this information.

As long as the outside walls of the foundation are straight and parallel, marking bolt holes on the sill is easy. If the sill sits flush with the outside wall, set it on top of the bolts, sight down the outside of the foundation and hit the sill with a hammer on top of every bolt (bottom photo, left). This leaves a mark on the wood indicating the drilling location. If the sill sets back on the foundation wall or if the wall isn't straight, first snap a chalkline on top of the foundation and align the sill with it, then mark the bolt locations. Doing this accurately takes a bit of practice but will save you time once you get the hang of it.

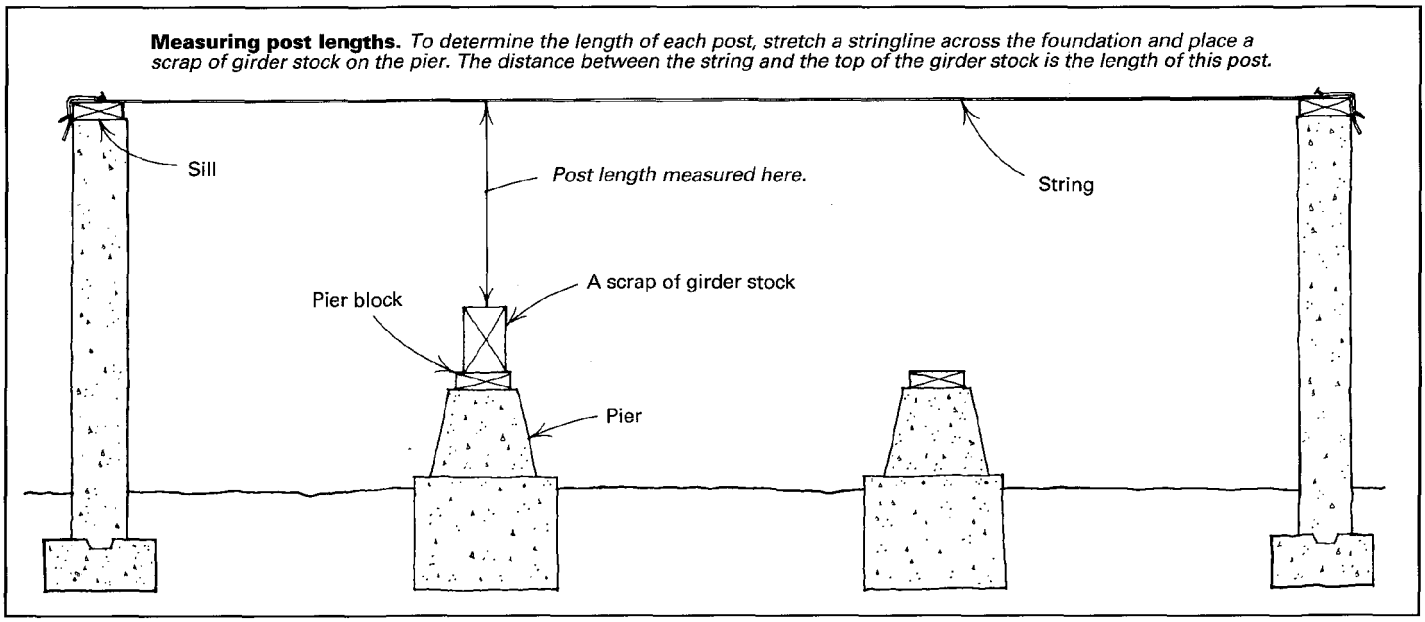
Even if the foundation walls are not straight and parallel, the sills can be. If the walls aren't parallel, snap chalklines that are parallel and use them as guides for placing the sills. Equalize any adjustments as much as possible. If the foundation is 1 in. out of parallel, for example, don't make all of the adjustment on one end. Instead, make ¼-in. adjustments on both sides at each end. Mark all sills before you drill the bolt holes.

Attaching the sills—Now prop the sills up on the foundation wall or across a scrap of wood and drill the holes using a ⅝-in. or $^{11}/_{16}$-in. bit. When all the holes are drilled, sweep any debris off the surface of the foundation and place the sills over the bolts; you may need your hammer to persuade a few boards to fit. Put the washers on, then the nuts, and tighten them down with an adjustable wrench, a socket wrench or, better yet, an impact wrench.

The sill should fit tightly to the foundation wall and provide a square and level surface upon which to support the floor system. If the tops of the foundation walls aren't level, shims can be placed under the sills to correct for this. The resulting gap under the sill, and any dips in the foundation, must be grouted or dry packed, which means that they should be filled with a fairly dry mixture of concrete. In many parts of



Positioning sills. *The sill may sit flush with the edge of the foundation (A); it may sit back from the edge (B); or it may overlap rigid insulation applied to the exterior of the foundation (C).*



Measuring post lengths. *To determine the length of each post, stretch a stringline across the foundation and place a scrap of girder stock on the pier. The distance between the string and the top of the girder stock is the length of this post.*

the country, a thin layer of insulation called sill sealer is often laid between the sill and the foundation. Sill sealer comes in a roll that makes installation a breeze. Some codes also require a sheet-metal termite shield to be placed between the sill and the foundation.

The post-and-girder system—After the plates are secure, it's time to install posts and girders. Girders are large horizontal beams that provide intermediate support for floor joists. Typically, they are supported on each end by girder pockets in the foundation. In between, the girders are supported by posts that are attached to pressure-treated 2x6 blocks, called pier blocks. These blocks are, in turn, attached to concrete piers that were poured simultaneously with the foundation. Girders and joists may also be supported by underpinning walls or full load-bearing walls in a basement.

By subdividing the length of a building, girders allow the use of smaller joists. The shorter the distance between bearing points, the smaller the joists can be. For example, if the span of a building or a room is about 20 ft., most codes allow the use of 2x12 joists, 16 in. o. c., to span the distance without intermediate support. If you tried to span 20 ft. with 2x6 joists, they would sag in the middle. However, 2x6s can be used as joists when they are supported by properly spaced girders or load-bearing walls.

Girders over a crawl space usually span the length of the building and are often 4x6s or two 2x6s nailed together (see chart, p. 85). Typically, 4x6 girders spaced 6 ft. o. c. are supported by a post every 6 ft., but this spacing can vary with the type of wood used and the load the system will bear. The span is often greater over a basement than over a crawl space to provide larger rooms with fewer posts; in such cases the girders or the joists will have to be larger. Check the plans to get requirements for lumber.

Calculating post length—In areas where termites or moisture are serious problems, the posts in a crawl space should be made from pressure-treated wood (see sidebar, left). Codes generally require that girders in crawl spaces be at least 12 in. off the ground, and the posts are usually 1 ft. to 2 ft. long. Posts are usually cut from 4x4

Handling pressure-treated lumber

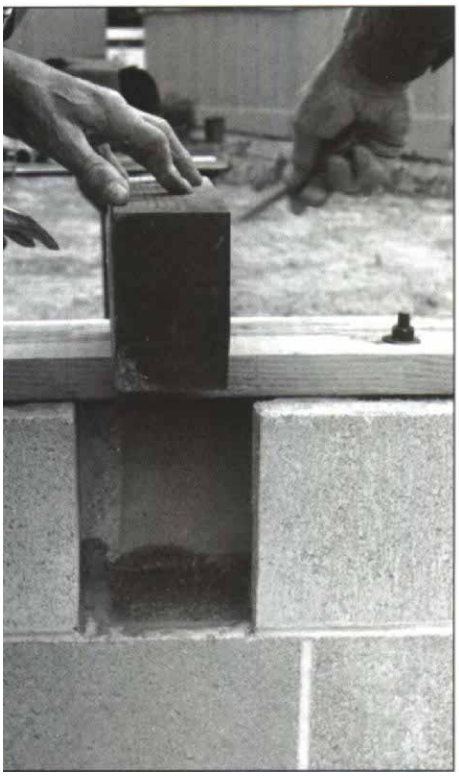
Pressure-treated lumber contains some hazardous chemicals that ensure its durability. Manufacturers claim that if it has been properly treated and dried, pressure-treated lumber is relatively harmless to humans, but take safety precautions when working with it.

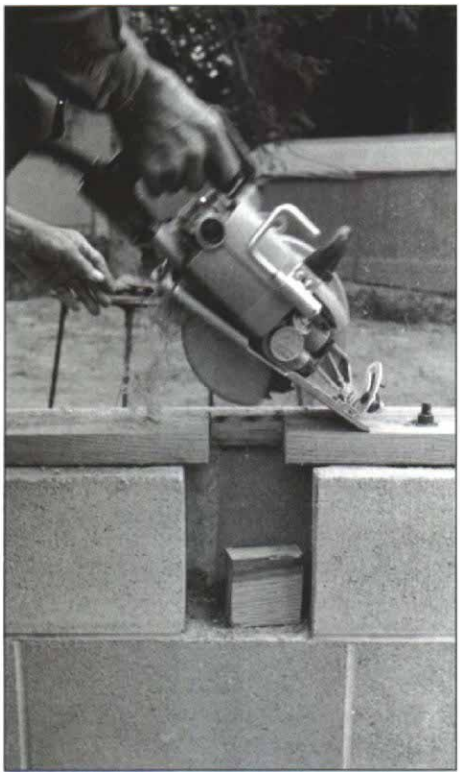
- **Wear gloves when carrying pressure-treated lumber.**
- **If you don't wear gloves, be sure to wash your hands before eating or drinking anything.**
- **Saw pressure-treated lumber outside, or wear a dust mask.**
- **Remove any slivers quickly (tweezers are an important tool in a carpenter's toolbox).**
- **Don't burn scraps in your woodstove or fireplace. Combustion releases the toxic substances that are bonded in the wood.** ***—L. H.***

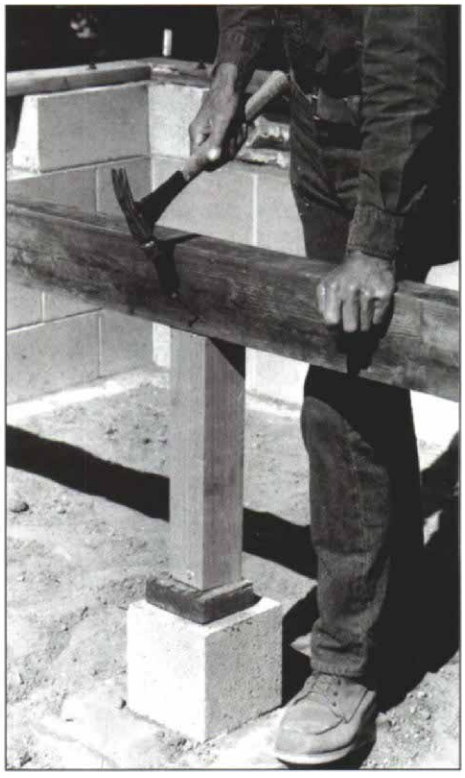
Drawings: Vinte Babak

Cutting and securing posts. **Post (and girder) stock can be cut accurately with a circular saw by keeping the front edge of the saw base parallel with the edge of the stock (above). Make the first cut and, keeping the saw square, turn the post toward the saw for the second cut. The kerf of the first cut will help guide the second cut. Each post is then nailed to a block atop each pier using three 16d nails or four 8d nails (right).**

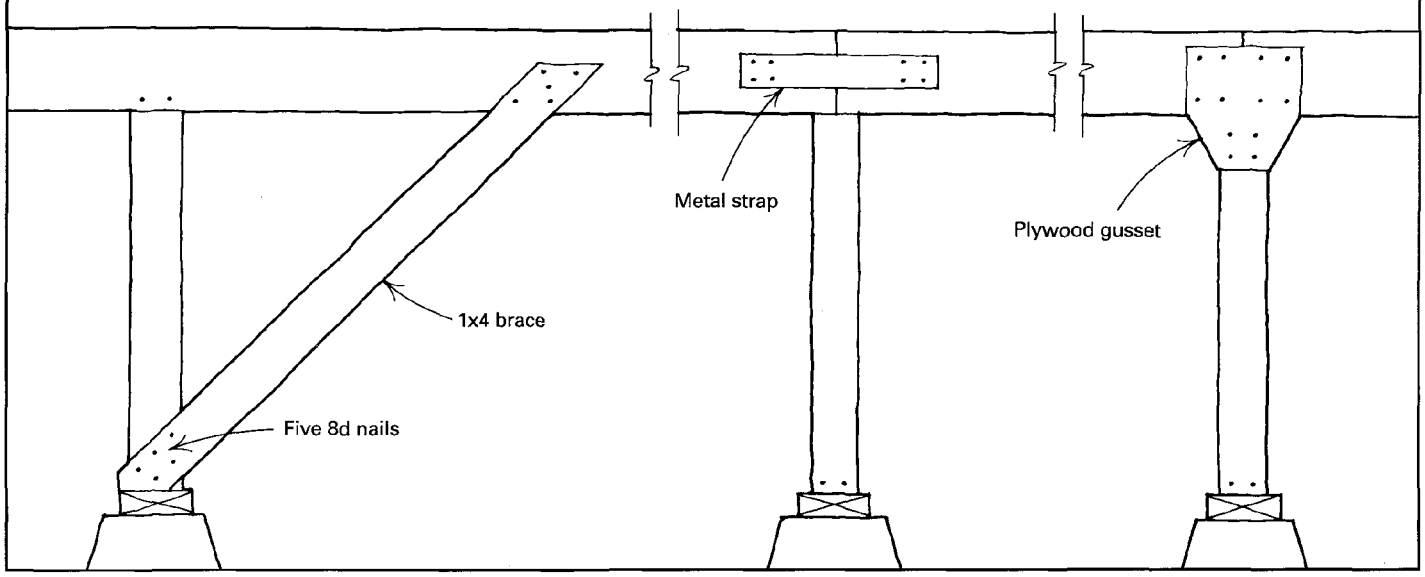
Installing girders. **A 3½-in. notch is marked on the sill at the girder pocket (photo below left). Make two side cuts and a plunge cut to make room for the girder (photo below center). The pocket itself is oversized to allow air circulation around the girder. Girders are nailed securely to each post with three 16d nails or four 8d nails (photo below right). Brace the girder with your leg to keep it in place as you nail it.**







Bracing and splicing the girders. *Joints between lengths of girder should fall over a post and be secured with straps or gussets. If the posts are more than 3 ft. tall, they should be braced to increase the stability of the system.*



stock. To determine the exact length of each post, first stretch a Stringline from sill to sill over the tops of a line of piers (bottom drawing, p. 83). Then place a scrap piece of girder stock on the pier (check the plans for girder size). The distance between the string and the top of the girder stock is the length of the post for that pier. Repeat this process for each pier. Write the length of the post on top of the pier block, and keep a cutting list of the lengths needed—I usually use a scrap of wood for this.

Some of the piers may not be perfectly level on top. Check them with a level or by eye. A post placed on a pier that isn't level prevents the girder from resting with full bearing on each pier. When you run into this situation, cut the post to compensate for the angle of the pier. A quick way to do this is to measure the long distance and the short distance from the Stringline, transfer both measurements to the opposing sides of the post and cut the post at the proper angle. An experienced carpenter can measure to the short point and then make the cut by eye.

Posts can be cut to length with a circular saw (top left photo, facing page), a chopsaw or a radial-arm saw. Gather a supply of stock and your cutting list and cut all the posts at one time. Write the length on each post and scatter them to their appropriate piers.

Framers often leave the Stringline used to measure post length in place until the posts are nailed to the piers. It serves as a guide to ensure that posts are nailed to the piers in perfect alignment, giving the girder full bearing. Toenail three 16d nails or four 8d nails through the posts into the pier blocks (top right photo, facing page).

Installing the girders—With the posts all nailed in position, it is time to scatter the girder stock. Because piers are often 6 ft. apart, and any joints in girders must occur over posts, girder stock is often 12 ft. to 18 ft. long. Use straight stock for girders so that the floor joists will have a good level surface to rest on.

TYPICAL SPANS FOR FLOOR GIRDERS*

		Species: Douglas fir-larch Grade: #2 or better		Species: Hem-fir Grade: #2 or better	
Size of girder	Spacing of girder	Partition walls above	No partition walls above	Partition walls above	No partition walls above
4x4	6 ft. 8 ft.	4 ft. 3 ft.	4 ft. 3 ft.	4 ft. 3 ft.	4 ft. 3 ft.
4x6	6 ft. 8 ft.	6 ft. 5 ft.	7 ft. 6 ft.	5 ft. 4 ft.	6 ft. 5 ft.
4x8	6 ft. 8 ft.	8 ft. 6 ft.	9 ft. 7 ft.	6 ft. 5 ft.	7 ft. 6 ft.

*This chart based on Los Angeles code; other codes may vary.

For standard 4x6 girders, the support pockets in the concrete foundation are typically 4½ in. wide, 5½ in. deep and about 4 in. long. Girders rest on pressure-treated 2x stock in each pocket to keep untreated wood away from the concrete. A notch has to be cut into the sill to allow the girder to slip down into the pocket, leaving it flush with the top of the sill (bottom left and middle photos, facing page). If the pocket is too deep, place thicker pieces of wood in it for the girder to rest on. If the pocket isn't deep enough, use a thinner block or trim from the bottom of the girder. Don't trim too much, though; you'll compromise the strength of the girder.

The pocket must give the girder ½-in. clearance between it and the concrete on both sides. This allows for air circulation around the girder end and keeps the wood away from the concrete. Some building codes also require a metal termite shield to be wrapped around the girder end.

If the lumber was ordered carefully, the girders may fit exactly. If girders have to be spliced, cut them so that they break in the middle of the post, providing each piece of girder with equal bearing. Secure the girders into the top of the post with three 16d or four 8d toenails (bottom right photo, facing page). Check the plans to see if girder breaks should be spliced together with a metal strap or a plywood gusset.

If the posts in a crawl space are more than 3 ft. tall, most codes require them to be braced with pieces of 1x4 (drawing above). Run these braces from the bottom of the post at a 45° angle up to the girder. The code may require a brace running both ways. Nail the braces with five 8d nails on each end. In a basement, tall bearing posts are often part of an interior wall. These walls tie into the foundation and the girder-joist structure. They are often sheathed on one or two sides with plywood and add strength to the building. □

Larry Haun lives in Los Angeles, Calif., and is a member of Local 409. This article was adapted from his book The Very Efficient Carpenter *(The Taunton Press, Inc.) due out this fall. Photos by Roger Turk.*