

HOME REPAIR AND IMPROVEMENT

TIME
LIFE
BOOKS

Outdoor Structures



Basic Surveying Techniques

Before building any outdoor structure near a neighbor's land, be sure you know exactly where your property lines lie. Start by studying the lot plat, or map, that was furnished with the title to the land. When mapping the land, the surveyors drove metal stakes into the ground at the corners of the plot to serve as property markers. If you can locate one of them, your property map and a little basic geometry will enable you to find the others. You can determine the boundaries by driving stakes next to the markers, then stretching string between the stakes.

Once the boundaries are established, a few simple surveying techniques and tools will enable you to map the location

and size of the structure you want to build. Distances can be measured fairly accurately with a mason's line, wooden stakes, and a carpenter's tape measure, but keep at least 12 inches from a property line when siting a structure to avoid accidentally straying onto a neighbor's land. To sight lines for pouring foundations, or to establish perfect parallels or right angles to property lines, use a transit level.



CAUTION Before positioning or excavating trenches, find the locations of underground obstacles such as dry wells, septic tanks, and cesspools, and electric, water, and sewer lines.



TOOLS
Tape measure
Maul
Shovel
Magnetic stud finder
Transit level

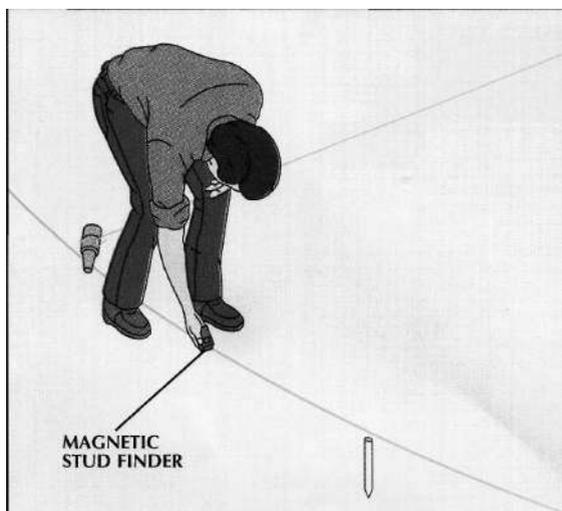
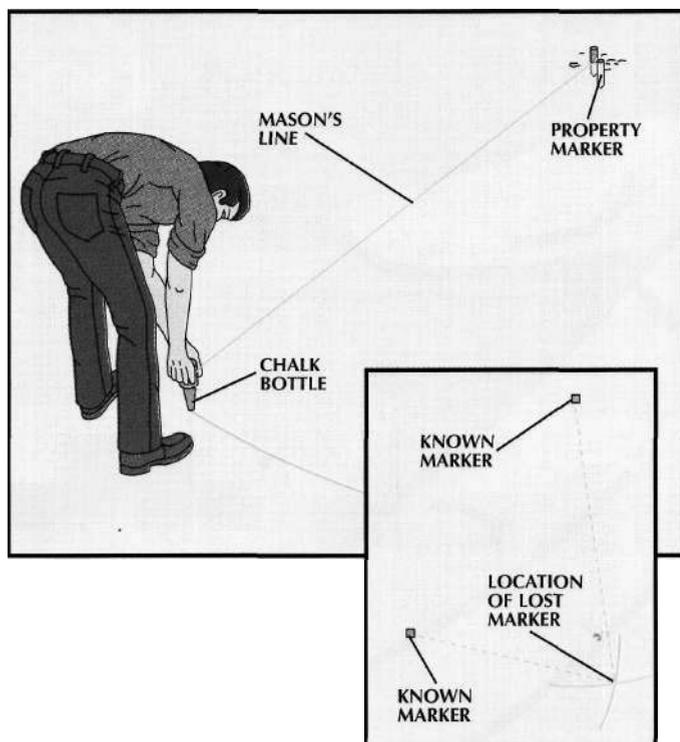


MATERIALS
Wooden stakes
Tall poles
Powdered chalk
Mason's line
Clear plastic hose

FINDING PROPERTY MARKERS

Working from two known markers.

- With a maul, drive a wooden stake next to a known marker. (Property markers may be lost in undergrowth or a few inches underground.)
- Attach a length of mason's line equal to the distance between the known marker and the lost marker, as indicated on your property map.
- Mark an arc on the ground near the lost marker with powdered chalk (*right*).
- Repeat the procedure at another known marker.
- Dig for the lost marker at the intersection of the arcs (*inset*).



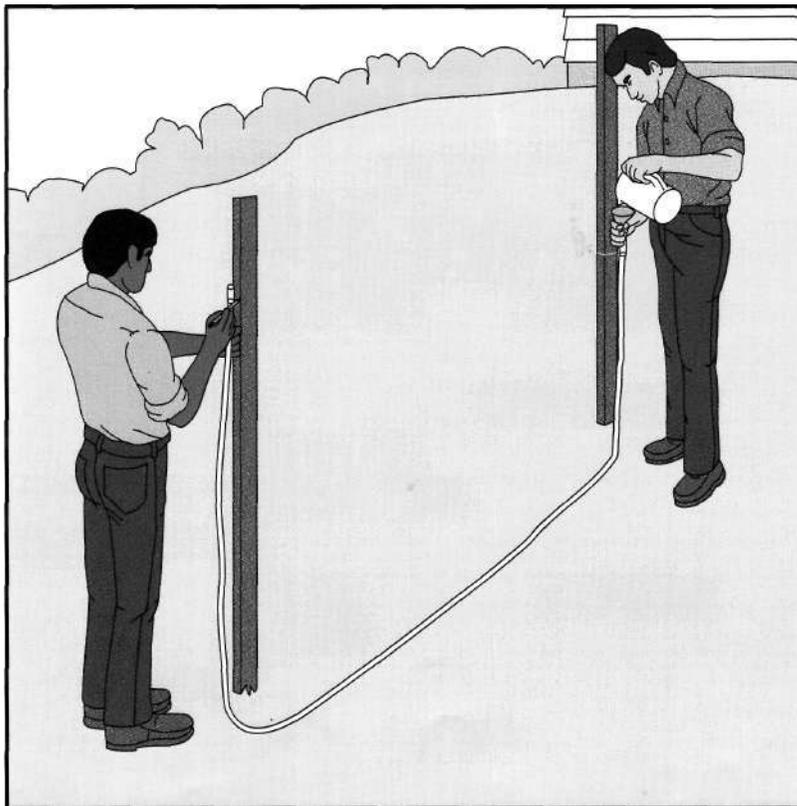
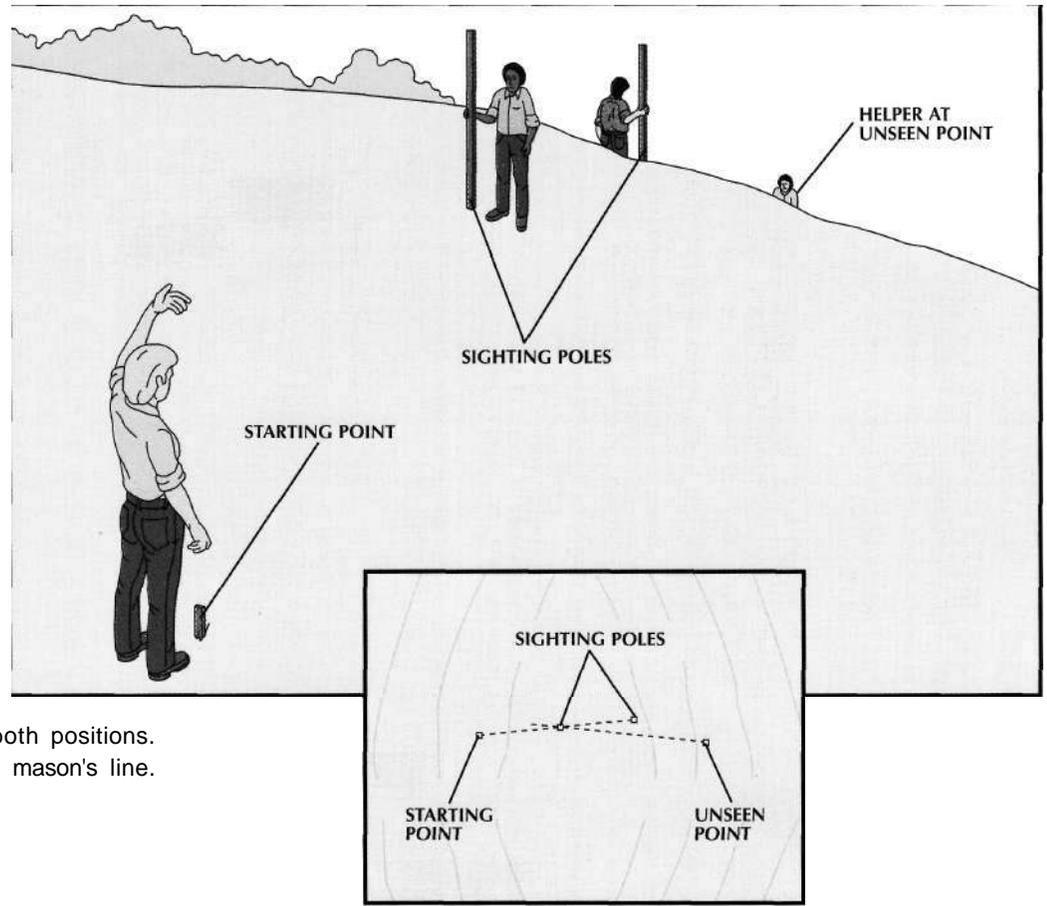
Working from a single marker.

- Mark an arc on the ground with chalk over the approximate location of the hidden marker (*above*).
- Brush a magnetic stud finder along the arc (*left*). When the stud finder's needle deflects, dig for the marker. If the stud finder does not work, try using a metal detector. The final recourse is to call in a professional surveyor to reestablish the property lines.

SIMPLE SIGHTING AND LEVELING TECHNIQUES

Sighting a straight line over a hill.

- Drive a stake at both the starting and unseen points.
- Stand at one stake, station a helper at the other, and have two more helpers hold tall poles in between at points where the tops of the poles can be seen from both stake positions (*right and inset*).
- Sighting from your stake, signal the pole holder nearest you to move until the two poles are in a straight line from your view.
- Have the helper at the unseen point repeat the procedure with the second pole person.
- Alternate sightings until the poles appear in line from both positions.
- Connect the four points with mason's line.

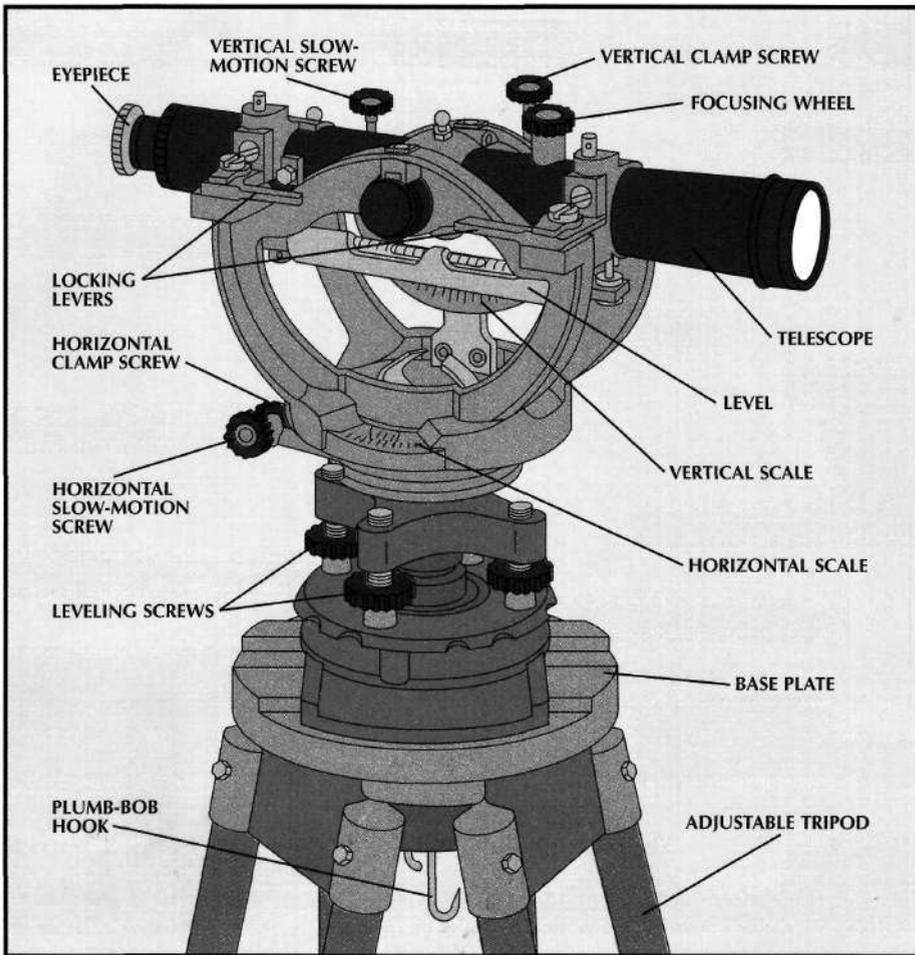


Finding level points on a slope.

You can find a point on a stake or post that is level with a mark on another by using a water level or a clear plastic hose partly filled with water.

- Make a mark at the desired or known height on the first post.
- Position the hose between the posts as shown. Hold one end a few inches above the mark you have made and have a helper hold the other end at about the same height.
- Fill the hose with water until the level reaches the mark.
- Make sure there are no air bubbles—if there are, block and lower one end to allow the bubble to rise to the surface.
- Finally, mark the second post at the water level in the hose (*left*).

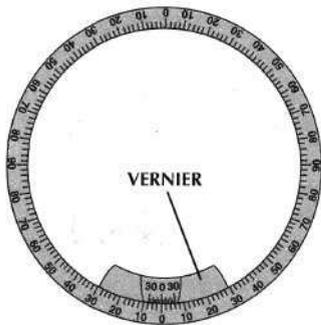
A TELESCOPE THAT MEASURES ANGLES



Anatomy of a transit level.

This professional surveying tool is essentially a tripod-mounted movable telescope with precise scales for reading vertical and horizontal angles. The 20-power telescope pivots at its center for vertical measurements and the entire mounting carriage rotates on the under-carriage for horizontal ones. A small spirit level mounted under the telescope assists in leveling and plumbing the instrument. A hook for a plumb bob hangs from the base plate; the under-carriage slides over the base plate to position the bob over a stake or marker, and four leveling screws are used to set the level. Angles are measured on vertical and horizontal scales; when only horizontal measurements are needed, as on the following pages, a pair of levers locks the telescope in the level position. Slow-motion screws allow you to zero in on the sighting stake by turning the telescope; clamp screws then lock the transit in position.

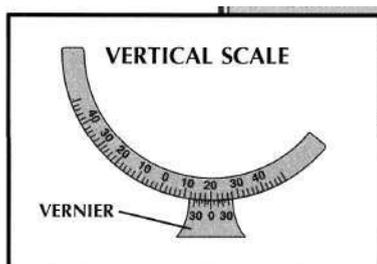
HORIZONTAL SCALE



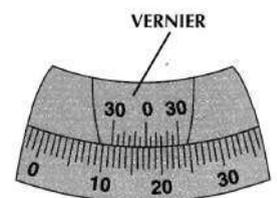
DIFFERENT SCALES FOR DIFFERENT ANGLES

In addition to setting straight lines or right angles (*pages 12-13*), a transit level can be used to measure a range of horizontal and vertical angles. Horizontal angles are read on a 360-degree circular scale divided into four 90-degree arcs (*top left*), vertical angles on a 90-degree arc (*bottom, left*). Small auxiliary scales called verniers serve as pointers for the main scales and give readings in sixtieths of a degree, or minutes.

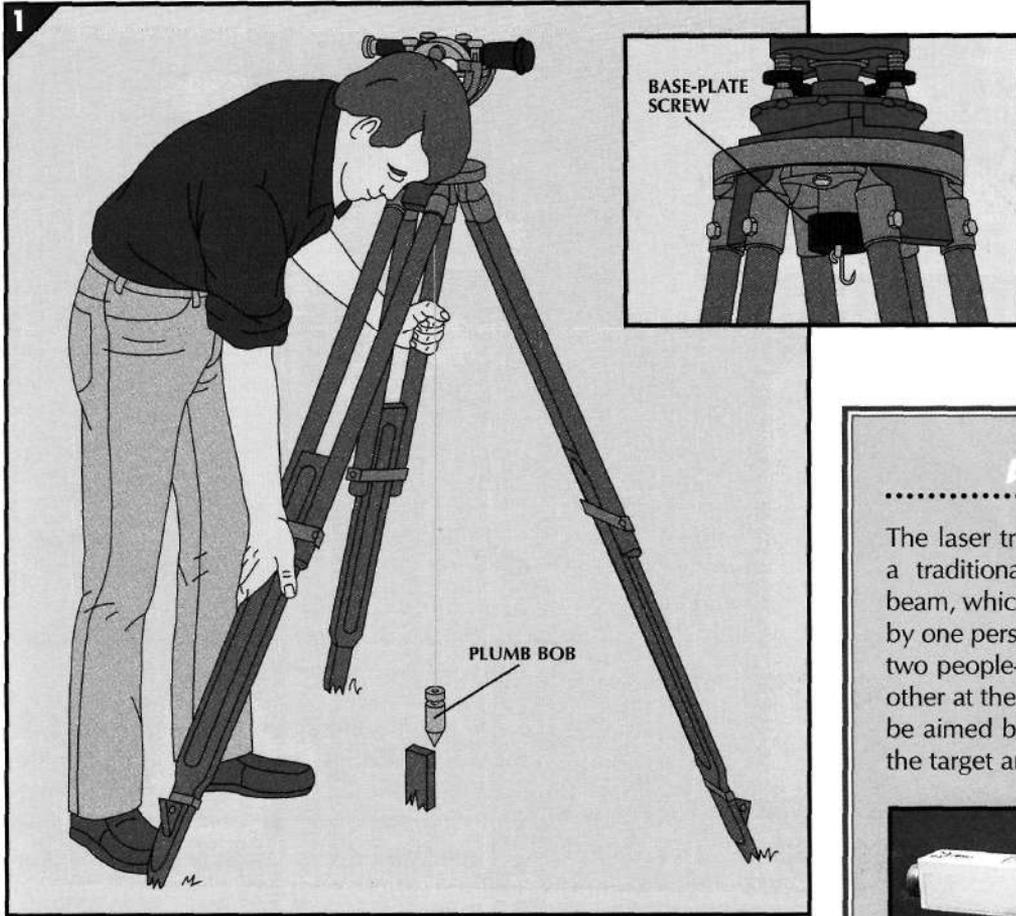
If the zero mark on the vernier falls between two degree marks on the main scale, read the lower mark and use the vernier to calculate the fraction in minutes. Reading upward from the degree mark, find the mark on the vernier that lines up perfectly with a mark on the main scale. Count the vernier spaces between the two main-scale marks. Each space stands for 5 minutes; multiply the number of spaces by five to get a reading in minutes. The sighting at right reads 17 degrees 15 minutes.



17 DEGREES 15 MINUTES

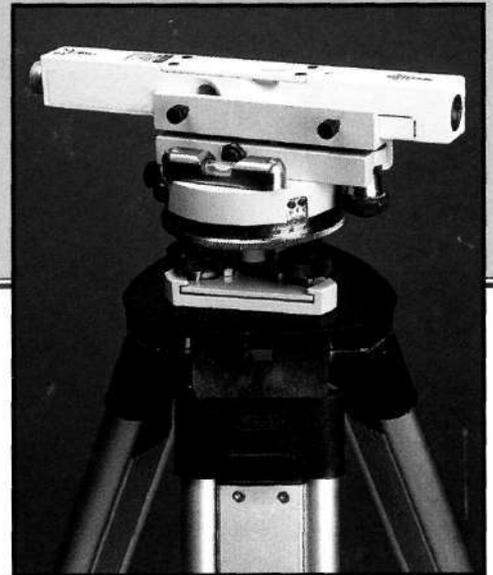


SETTING UP A TRANSIT LEVEL



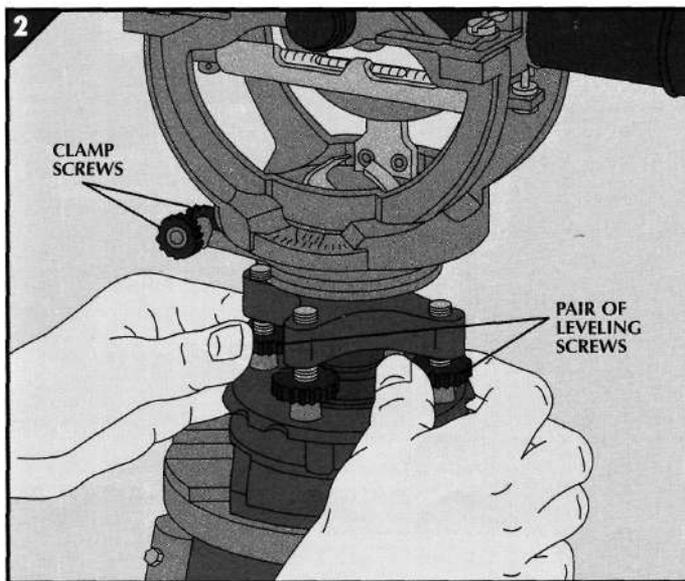
A LASER TRANSIT

The laser transit replaces the telescope of a traditional transit by emitting a laser beam, which enables the device to be used by one person. A traditional transit requires two people—one at the telescope and another at the target. But the laser transit can be aimed by the user who can then go to the target and observe the beam.



1. Positioning the tripod.

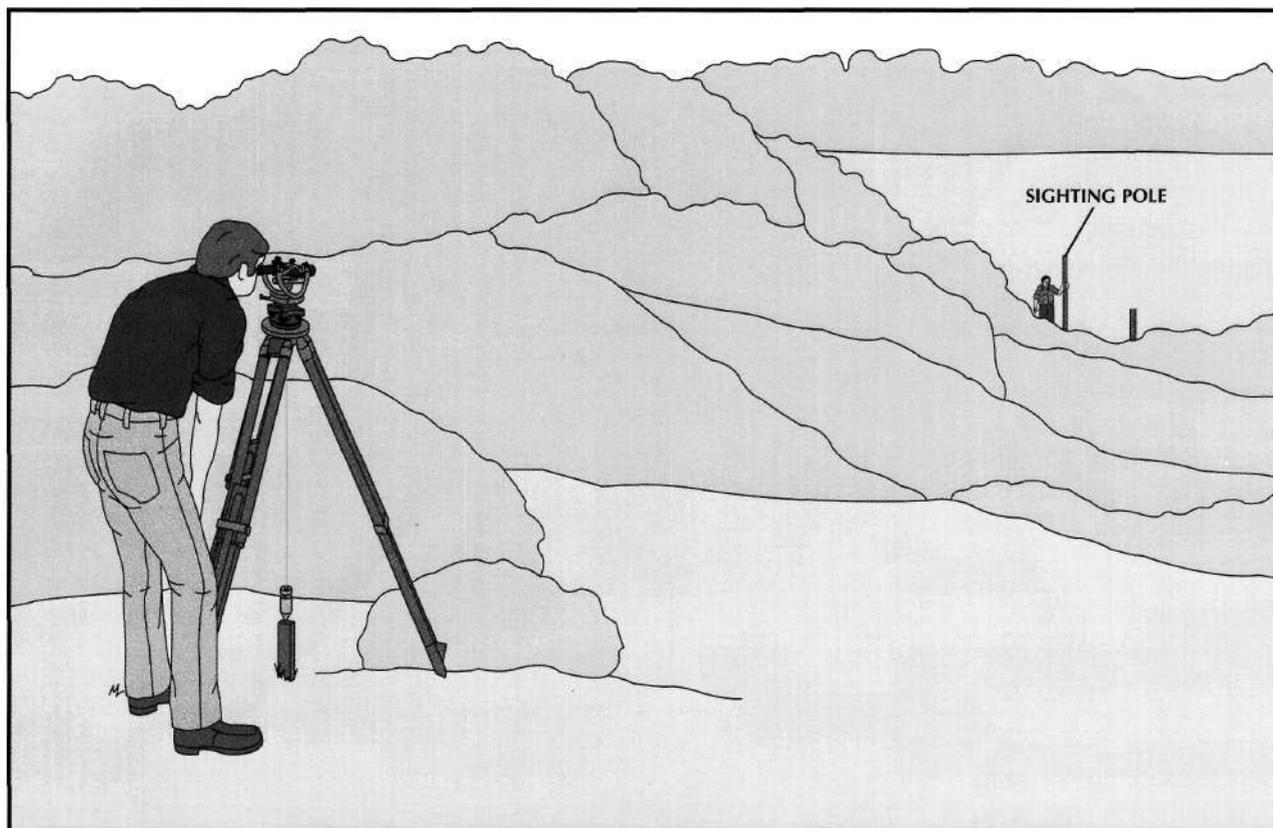
- Spread the tripod legs over a marker to be used as a starting point. Move the legs one at a time until the plumb bob hangs no more than 1/4 inch from the center of the marker.
- Loosen the screw under the base plate and shift the transit level so the plumb bob is directly over the center of the stake.
- Tighten the base-plate screw.



2. Leveling the transit.

- Set the vertical scale to zero.
- Loosen the horizontal clamp screws and turn the telescope until it aligns with one pair of leveling screws.
- Turn these screws until the bubble in the level is centered (*left*).
- Rotate the telescope 90 degrees to align it with the other pair of screws; adjust these screws the same way.
- Repeat as needed, making minor adjustments so the bubble in the level remains centered as the telescope swings full circle.

PRECISE LINES AND ANGLES



A line over a long distance.

- Drive stakes at the two points to be aligned and prepare an intermediate sighting pole for each of the major peaks and valleys between the stakes.

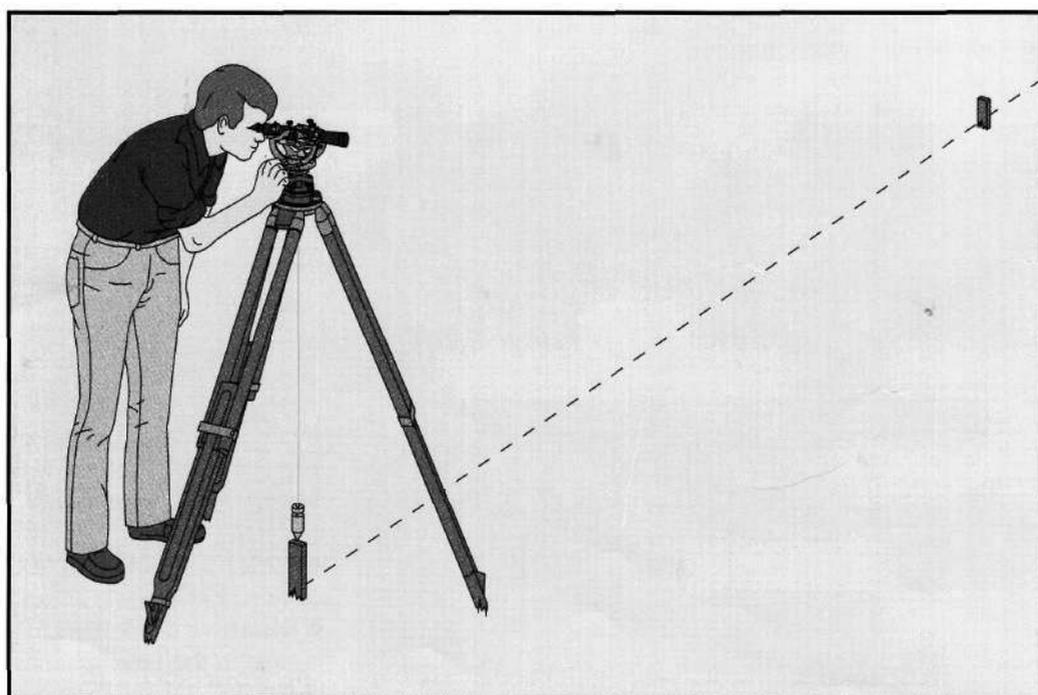
- Position and level the transit over the starting stake as shown on page 11.
- Focus on the far pole and tighten the horizontal clamp screw.
- Have a helper hold the furthest

intermediate stake at its approximate position (*above*), moving it until it is centered in your field of vision, then drive the stake into the ground.

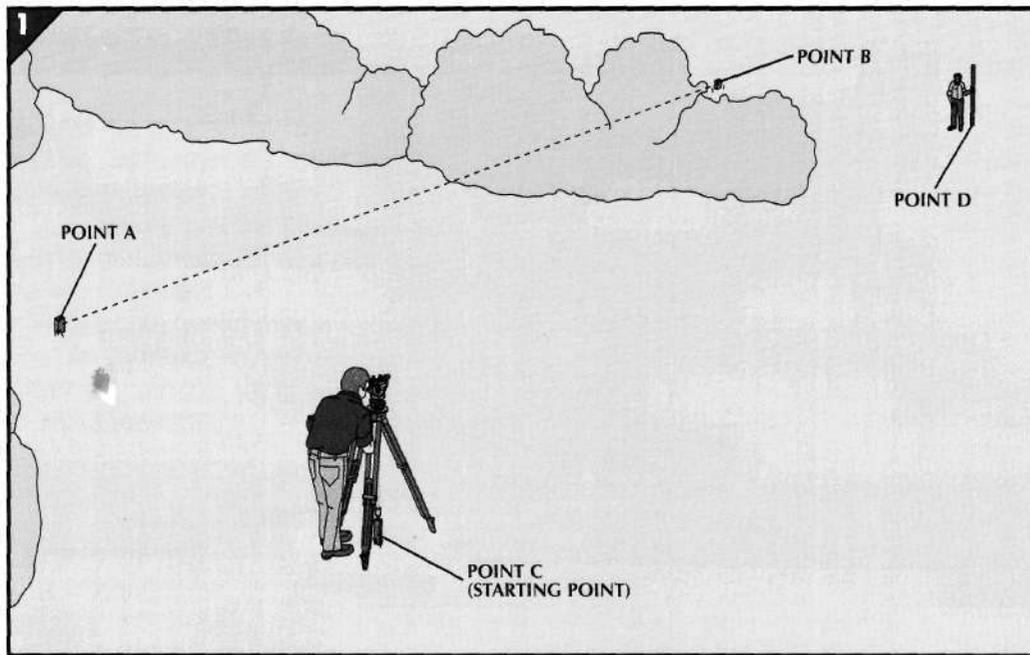
- Repeat the procedure for the other stakes.

Setting a right angle.

- Set a straight line to a stake, as shown above.
- Rotate the transit level exactly 90 degrees on the horizontal scale and tighten the horizontal clamp screw to lock it in position.
- Have a helper move another pole until you sight it in the cross hairs (*right*), then drive the pole in place.
- Check the angle by swinging the transit level back 90 degrees to the original pole and ensuring it is sighted in the cross hairs.



SIGHTING A PARALLEL LINE AROUND AN OBSTRUCTION



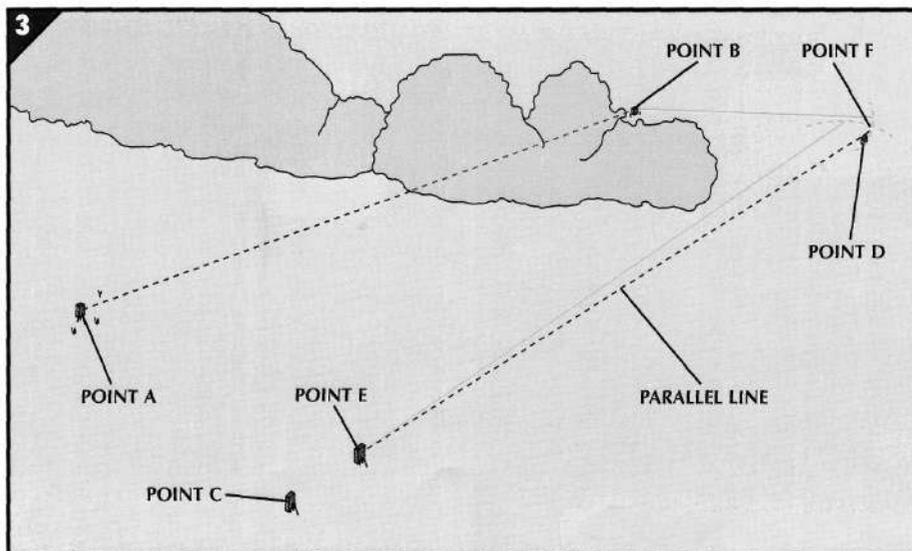
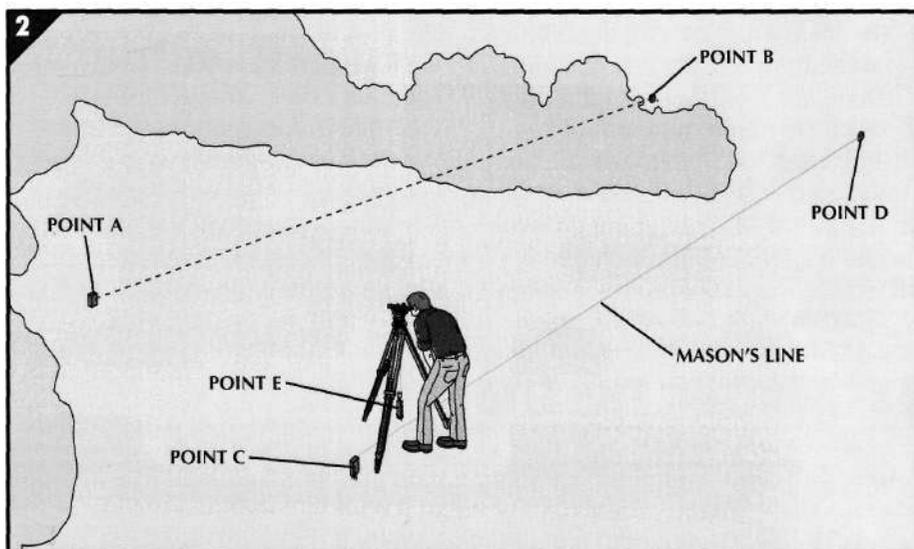
1. Plotting an approximate parallel.

You may need to set a line parallel to one that is obstructed, such as property line A-B in this example.

- Set up the transit over a starting stake where the view is unobstructed and sight a line roughly parallel to line A-B (*left*).
- On this line, drive a stake at point D so that lines A-B and C-D are equal in length.
- Stretch a mason's line between points C and D.

2. Locating the first stake.

- From point C, rotate the transit 90 degrees toward point A.
- Move the transit along the mason's line so that the cross hairs align with the stake at point A (*right*).
- Rotate the transit 90 degrees toward point D to line up the cross hairs with the stake; adjust the position of the transit as necessary, so that it rests at the apex of a 90-degree angle between points A and D.
- Drive a stake directly underneath the transit—at point E.



3. Locating the second stake.

- Measure the distance between points A and E, and cut a length of the mason's line equal to that distance.
- Attach the line to the stake at point B and swing it toward point D, making an arc.
- Loosen the line joining points C and D, fasten one end to the stake at point E, and swing the other end in an arc toward point D.
- Plant a stake where the two arcs intersect (point F). The line joining points E and F is now parallel to the property line between points A and B.

Creating Terraced Landings

The land surrounding your home may be hilly, making it difficult to find a level spot to erect a structure. Often the solution is to create a terrace by building a retaining wall.

Earth and water exert considerable pressure behind a retaining wall, so you must make your structure strong and provide adequate drainage. Begin by checking your local regulations on drainage (any change in the contour of your land will affect the flow of water) and any other restrictions.

Modular "Stone" Wall: Special concrete wall blocks (*opposite*) create the look of a stone wall in a fraction of the time and are just as strong. Depending on their design, they can be raised to a height of 24 to 48 inches without any anchoring. Each row of blocks is linked to the one above with matching grooves and ledges. The front face of the

blocks is usually wider than the back, making it easy to create circular and serpentine walls.

A Palisade of Posts: For a simple retaining wall up to 36 inches high, plant a row of vertical timbers in the ground and spike the timbers together with bars of reinforcing steel (*page 17*). "Found" materials such as old pier pilings or telephone poles make strong and economical choices for building supplies.

Limitations: The terraces created by these walls are suitable for light-duty demands such as supporting the structures found in Chapter 3. Walls supporting terraces for heavier loads, especially dynamic loads like vehicular traffic, need extra anchoring and should be referred to a structural engineer. Also, walls higher than 36 inches often require a building permit and are best left to a professional.

T TOOLS

Tape measure
Carpenter's level
Line level
Rake
Shovel
Square-edged spade

Pick
Posthole digger
Tamping bar
Rubber mallet
Maul
Mason's chisel
Caulking gun
Electric drill
3/8" ship-auger bit

M MATERIALS

Stakes
Posts
Reinforcing bar (3/8")
Coarse sand
3/4" drainage aggregate

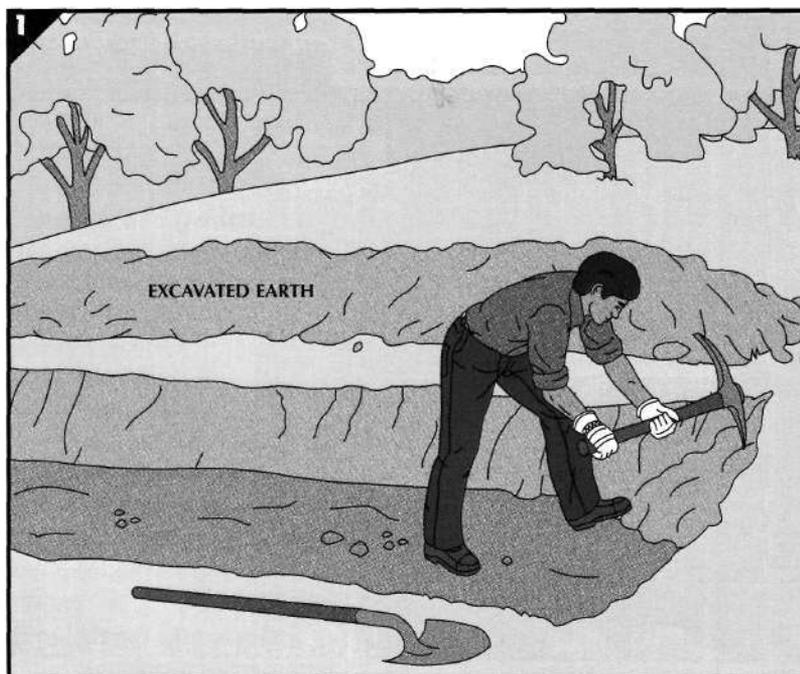
Gravel
Concrete retaining wall blocks
Concrete adhesive
Landscape filter fabric
Mason's line



SAFETY TIPS

Protect your eyes with goggles when drilling.

EXCAVATING THE SITE

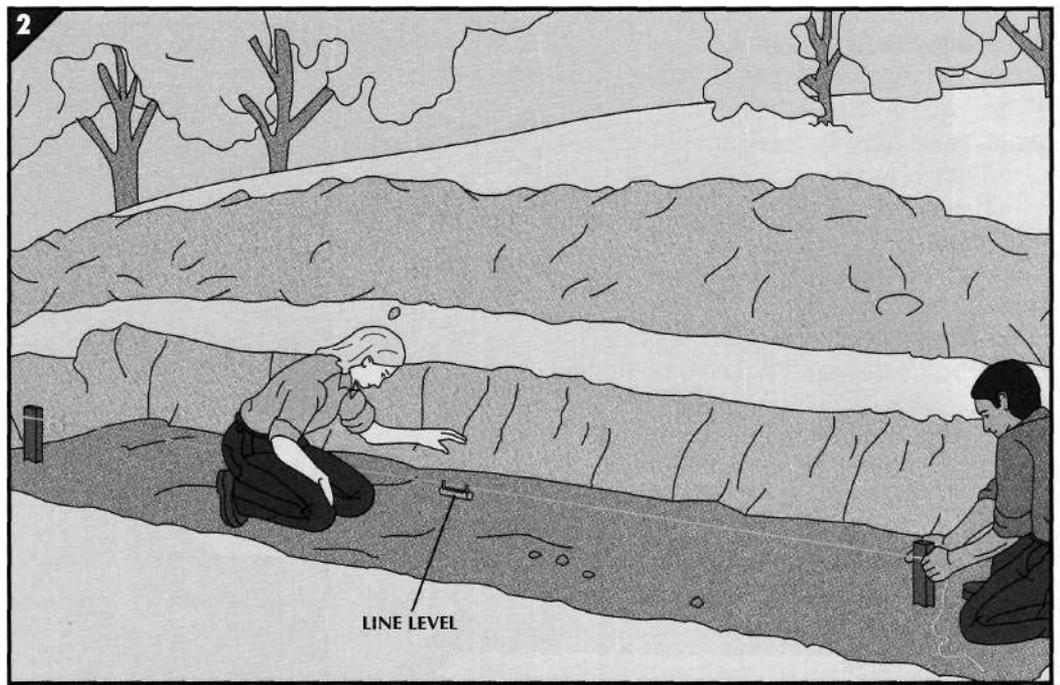


1. Cutting back the slope.

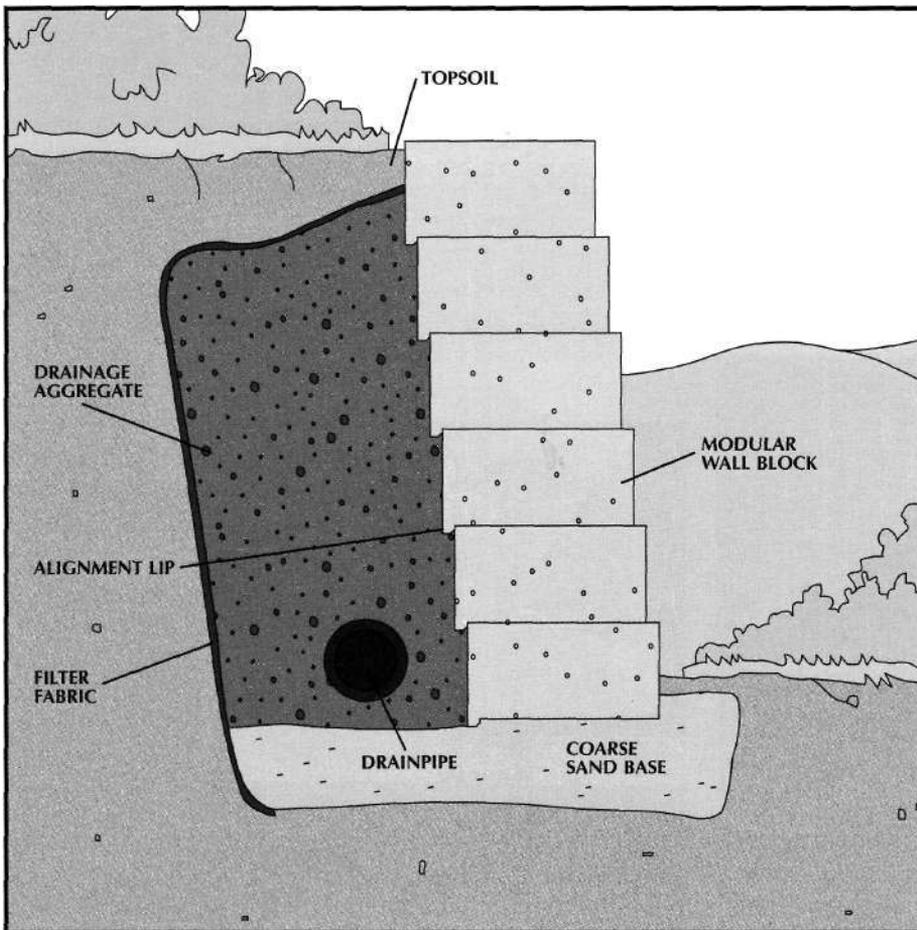
- Working upward from the base of the slope, cut away the earth along the path of the wall with a pick and shovel.
- Pitch the excavated soil behind the site of the wall to create a plateau, leaving a drop slightly less than the planned height of the wall.

2. Setting a level base.

- Drive stakes to mark the ends of the wall.
- Stretch a mason's line between the stakes and level the line with a line level.
- With a shovel and rake, level the soil to a uniform distance under the string all along its length.



A MODULAR BLOCK RETAINING WALL

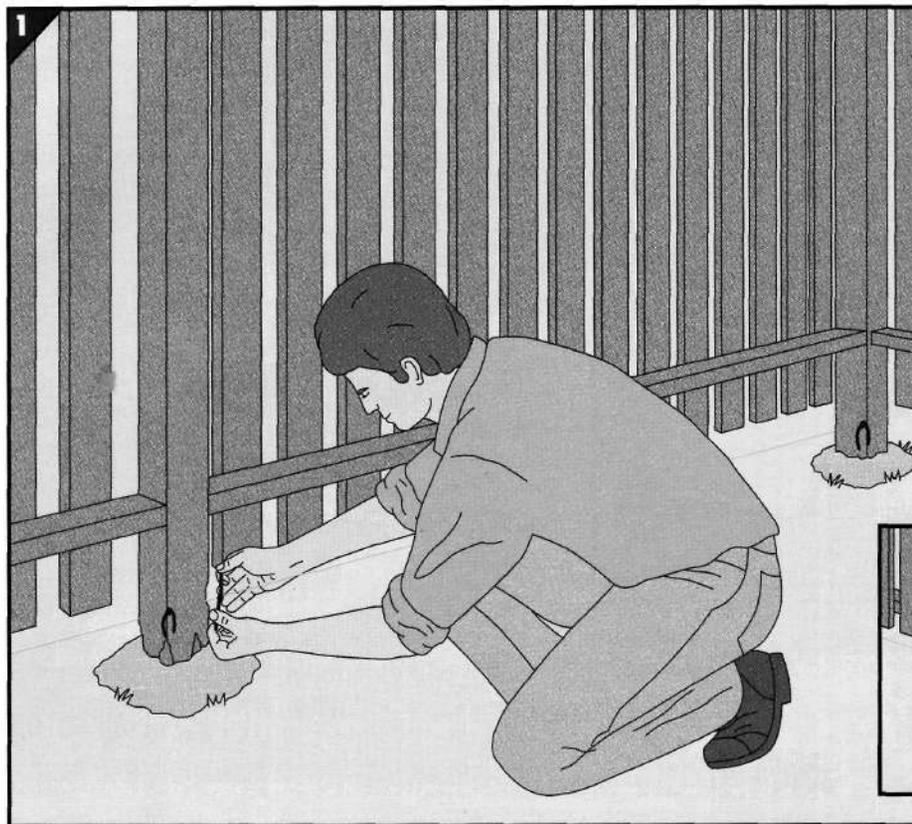


A look behind the wall.

Modular block construction eliminates the threat from frost heaves by preventing the buildup of water behind the wall. The mortarless joints allow water to weep through the wall face. The base of the wall consists of 4 inches of compacted and leveled coarse sand. In soils that drain poorly, a 4-inch perforated drain pipe is installed at the level of the first course. Each course is slightly offset from the one beneath it by alignment lips on the blocks. The wall is backfilled with 3/4 inch clean drainage aggregate and finished with 3 inches of topsoil. If the soil is very fine, a filter fabric (available at a landscaping supplier) is placed behind the aggregate to keep the backfill clean.

Modular block manufacturers recommend heights to which their walls can be built without reinforcement. Always refer to the manufacturer's height guidelines.

REPLACING A POST



1. Positioning a replacement post.

- To indicate the location of the old post before removing it, run a string tautly between the posts on either side of the damaged post.
- Tie a marker string to the line on each side of the post (*left*).

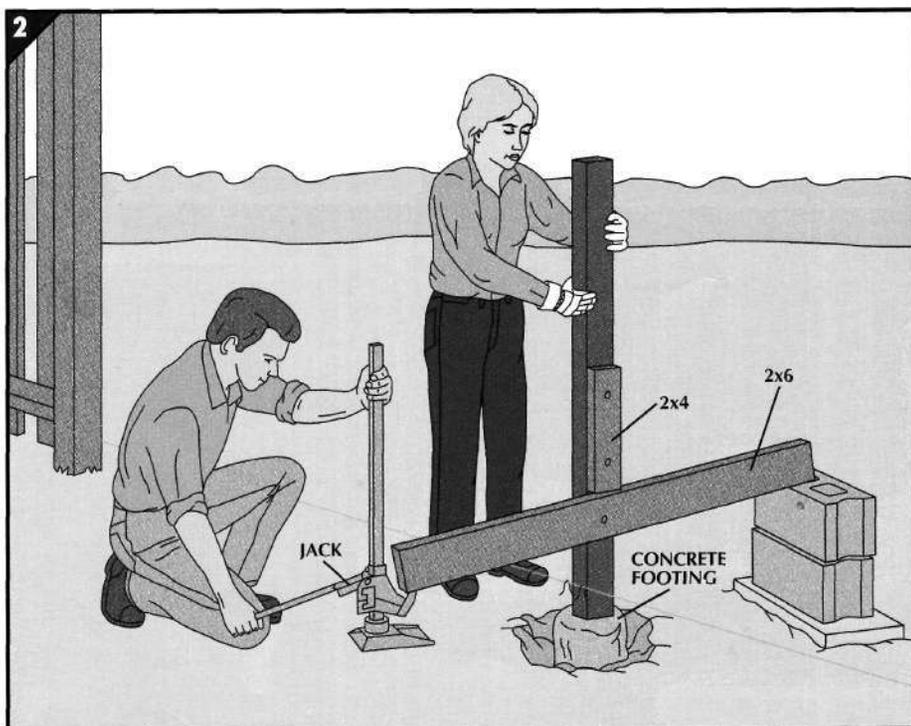
For a corner post, extend a line from both lengths of fence, past the corner post and secure each one to a stake (*inset*).

2. Removing the old post.

- Remove the rails and fencing on both sides of the post.
- Loosen the post and footing, if any, by removing the earth around the post with a shovel and a posthole digger, then rock the post back and forth.
- Install the replacement post as you would a new one (*page 26*), then reinstall the rails and fencing.

If the post is too heavy to be lifted out by one or two people—especially if it is set in concrete—enlist the help of a car jack.

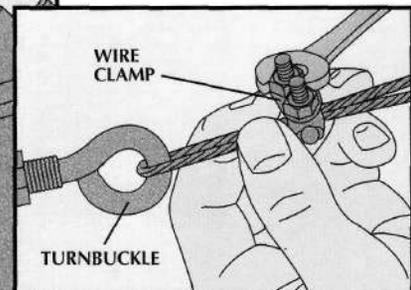
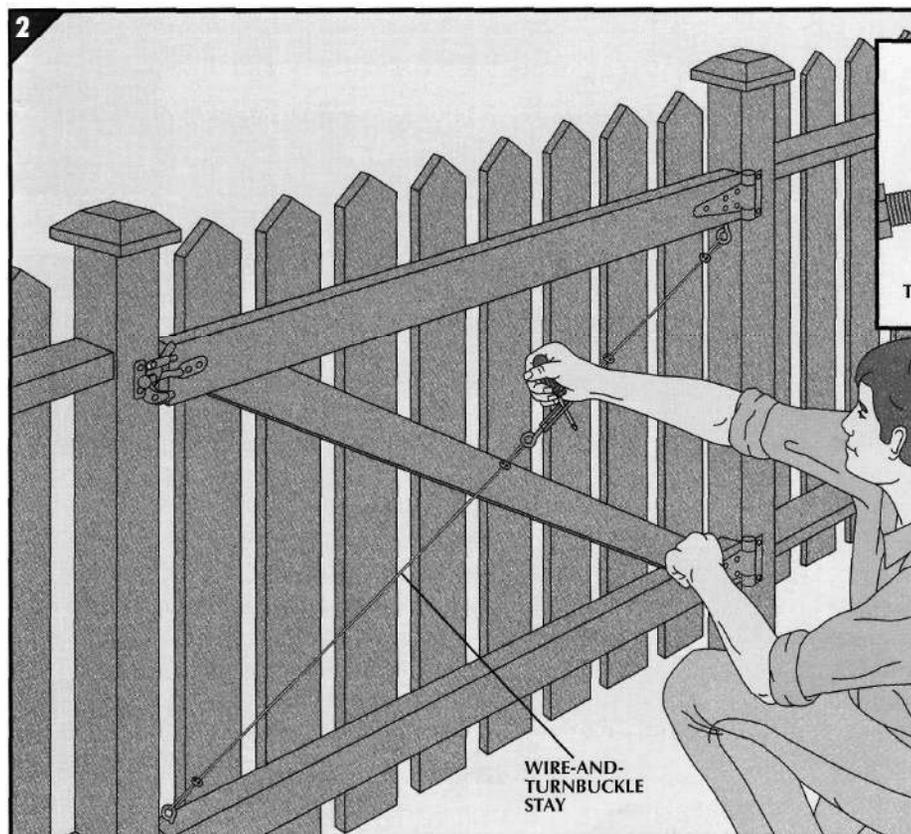
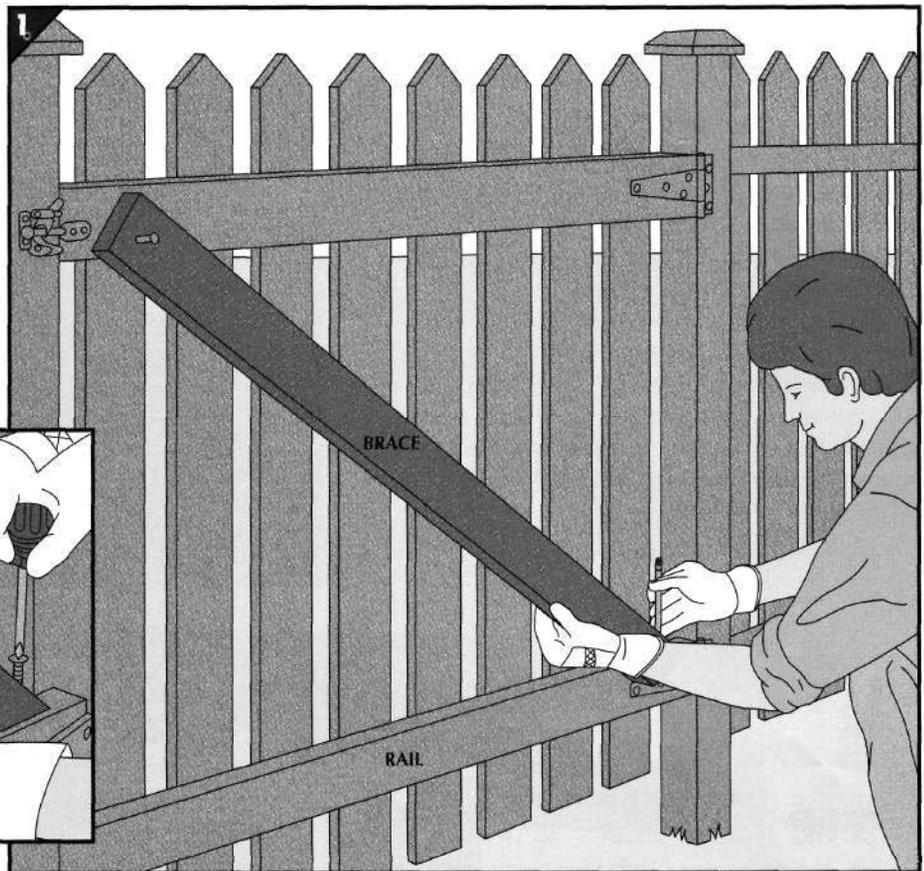
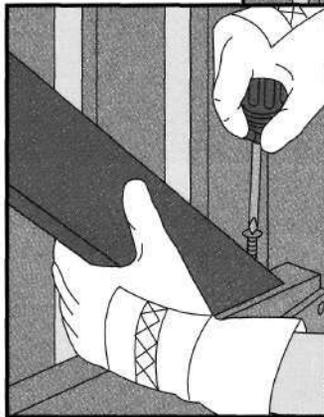
- Nail a 12-inch 2-by-4 to the post and nail a 2-by-6 under it, resting one end on the car jack and the other on a pair of concrete blocks (*right*).
- Support the car jack, and with a helper guiding the post, raise it with the jack.



REPAIRING SAGGING GATES

1. Bracing with wood.

- Prop a block under the latch side of the gate to hold it in its correct closed position.
- Tack a brace the same dimensions as the rails diagonally across the top and bottom rails, and mark cut lines on its back along the rails (*right*).
- Cut the brace at the marks.
- Position the brace between the rails, bore clearance and pilot holes (*page 20*) 1 inch from each end (*inset*), and drive 1 1/2-inch No. 8 galvanized wood screws into the rail.
- Also drive a 1-inch screw into every other picket.
- If the gate still sags, try correcting it with a wire and turnbuckle stay (*below*).



2. Bracing with a wire-and-turnbuckle stay.

- Open a 3-inch turnbuckle to its full extension and attach a length of cable to each end with a wire clamp (*inset*). The cable length will vary with the size of the gate.
- Fasten a 1/2-inch screw eye to the corner of the top rail on the hinge side and the opposite corner of the bottom rail as shown, then attach the ends of the turnbuckle wires. Trim any excess wire with pliers.
- Tighten the turnbuckle to pull the gate back into square (*left*).

Setting Fence Posts

The key to an attractive, long-lasting fence is a row of sturdy fence posts, securely anchored and properly aligned and spaced. Posts are the working members of a fence, serving to bear and brace the gates and railings.

There is a wide range of fence post materials, as shown in the box below. Before setting any posts, check your property line and local zoning or building codes, which may determine fence height or setback from the street.

To help protect the top of a fence from rain, cut the post at a 30- to 45-degree angle before setting it, or cover it with a plastic or metal post cap, available at home centers to fit standard post sizes.

Setting Posts Straight and Secure:

As a general rule, one-third of the post should be below ground. In relatively stable soil, tamped earth or gravel will hold the post securely. Gateposts and the end and corner posts, which are subjected to greater stress, should be set in concrete wherever possible. If you prefer not to go to the trouble and expense of using concrete, use longer lengths of lumber for these key posts and sink them deeper into the ground.

Avoid leaving holes unattended; set a post in its hole as soon as possible or at least mark the hazard by inserting the post or a tall stake.

Overcoming Frost Heaves: As freezing water expands under and

around posts, it tends to force them up. One solution is to sink the post below the frost line, which varies from region to region. It is generally impractical to sink posts deeper than 3 to 3 1/2 feet. In this case, set the post in concrete; nails partly driven into the post help to hold it to the concrete. For added stability first widen the hole at the base into a bell shape so the surrounding earth holds the concrete in place.

Whether or not you use concrete, always set the base of the post in 6 inches of gravel. The improved drainage reduces the risks of frost heaves and prevents the post bottom from resting in groundwater and rotting. Four ways to set a post are shown on page 30.



TOOLS

Carpenter's level	Hammer	Shovel
Line level	Maul	Garden spade
Plumb bob	Handsaw	Posthole digger
1x2 gauge pole	Mason's trowel	Tamping bar



MATERIALS

1x2	Gravel
Wooden stake	Pre-mixed concrete
Common nail;	Mason's line



SAFETY TIPS

Wear gloves when handling pressure-treated lumber; add a dust mask when cutting it.

MORTISED CEDAR POST

PLAIN CEDAR POST

PVC POST

TREATED 6x6

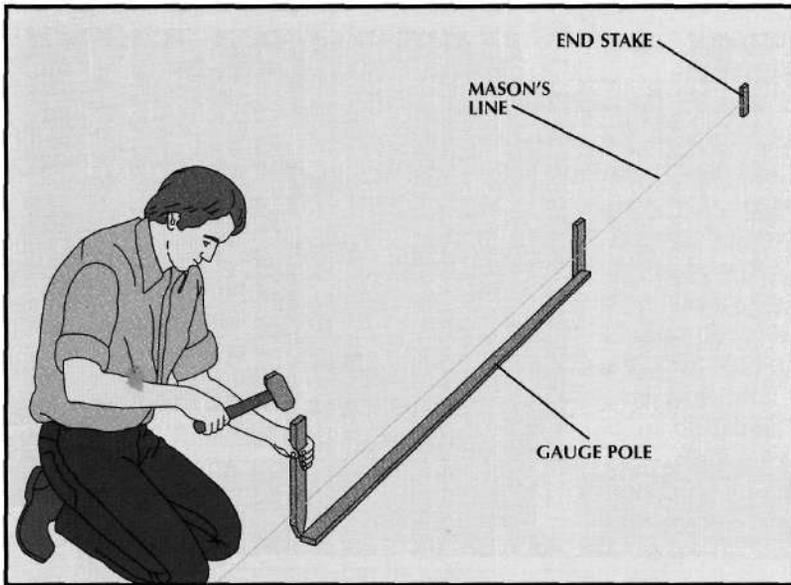
TREATED 4x4

AN ARRAY OF POST MATERIALS

Pressure-treated lumber is one of the most popular choices for fence posts, and with good reason: They are strong, widely available, and last at least 20 years. But there are other sound options. Naturally resistant woods like redwood, red and white cedar, and locust are all good choices if they are available for a good price in your area. They are commonly used for rustic-style fences. PVC posts, although more costly than wood, are attractive and typically guaranteed to last a lifetime.

Most wood fences are best supported by posts no smaller than 4-by-4s, but low picket fences can be anchored with 2-by-4 posts. All corner and gateposts should be 4-by-4s or larger.

LAYING OUT THE POSTS



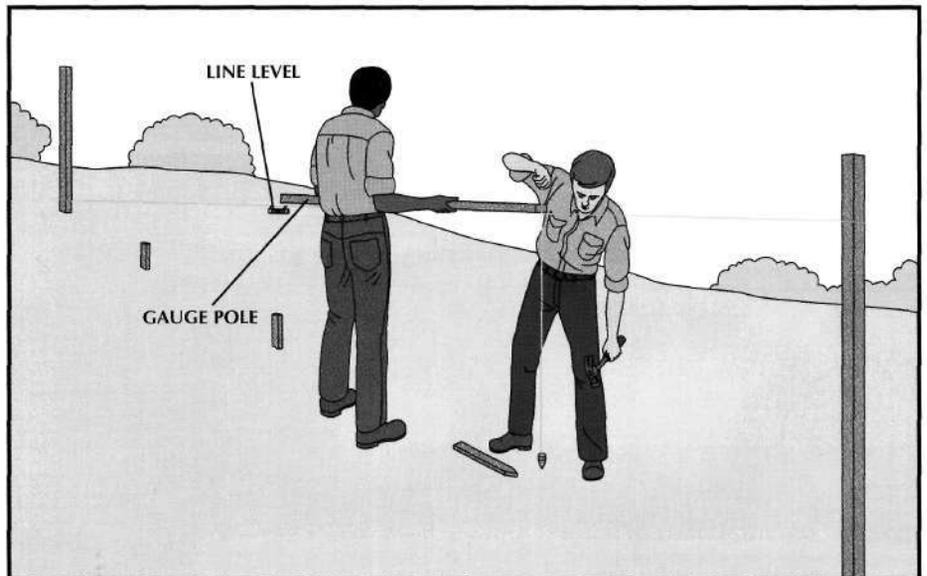
Locating posts on flat ground.

- Drive stakes at the locations of the end posts and stretch a mason's line between them.
- Measure the distance between the posts and determine the standard lengths of lumber or fencing that will make up the rails of the fence with a minimum of cutting. In general, posts are spaced a maximum of 8 feet apart; this way, a 16-foot length of lumber will span three posts.
- Make a gauge pole by cutting a straight 1-by-2 board to the length of the fence sections.
- Lay out the post positions with stakes as shown at left. Adjust the intervals for gateposts and to avoid ending the fence with a very short section.

Staking posts on uneven ground.

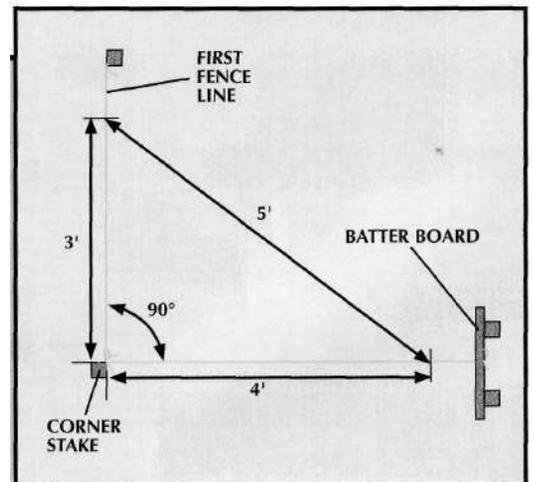
- For a fence with a level top, stretch a mason's line between two end stakes and level it with a line level.
- With a helper measuring along the line with a gauge pole, drop a plumb bob from the line to pinpoint each post location on the ground (*right*). Drive a stake at each one.

For a fence that follows the contours of the ground, drive stakes at the fence ends and at each high and low point in between. Join all the stakes with a mason's line and position the stakes for the remaining posts evenly along the line as shown above.



Marking a Square Corner

This simple method has been used to lay out right angles for centuries. Drive stakes to establish your first fence line, with one stake at the desired corner point. Attach a mason's line to these two stakes, then tie a marker string to the line at the 3-foot mark. Stretch another line from the corner stake, roughly perpendicular to the first line and secure it to a batter board—a horizontal board nailed to two stakes (*page 106*). Tie a marker string to this line at the 4-foot mark. Slide this line along the batter board so that the distance between the two marker strings is 5 feet (*right*). The angle between the two lines will be 90 degrees.

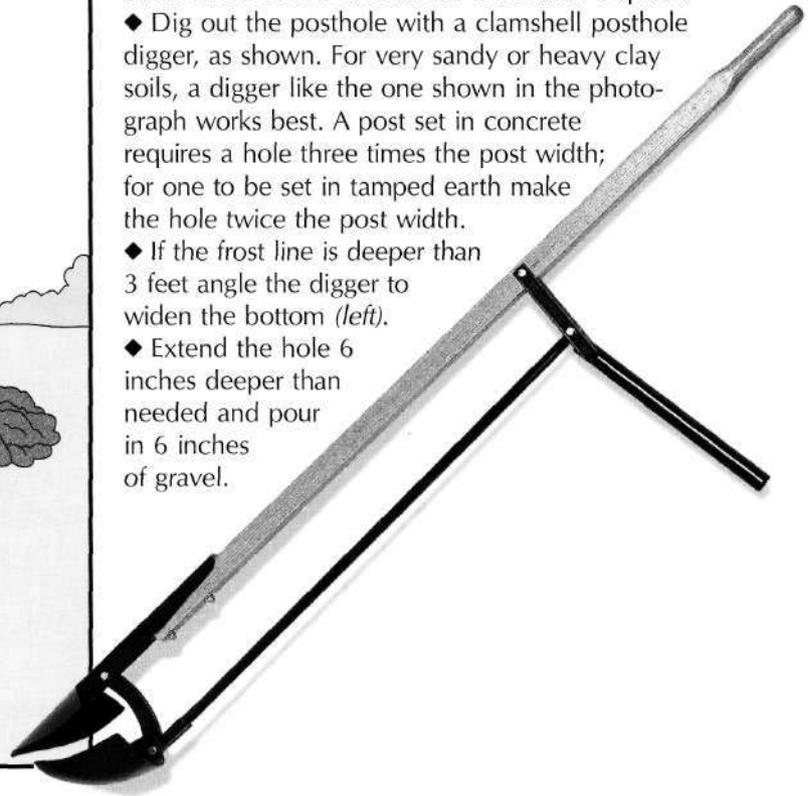


DIGGING POSTHOLES



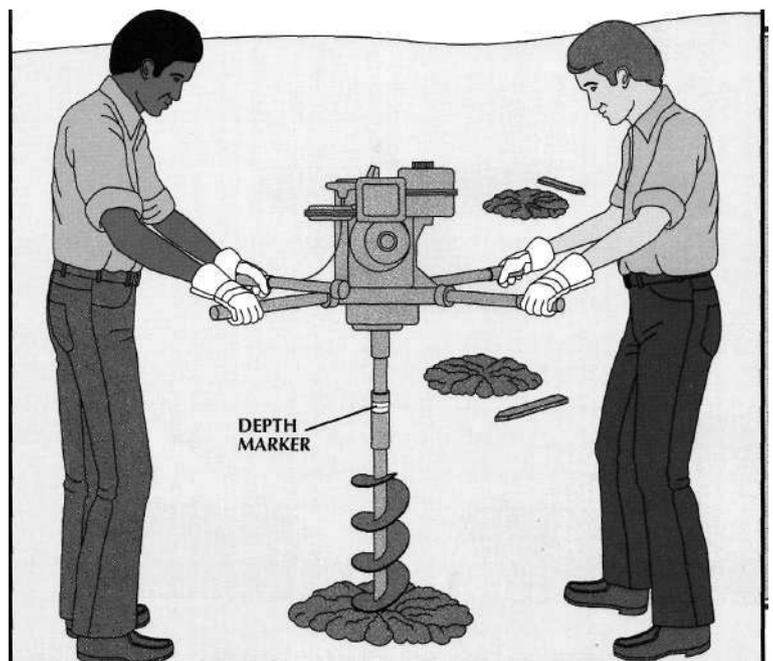
Burrowing a hole with a posthole digger.

- ◆ Untie the mason's line from the stakes, putting it aside for aligning the posts (*opposite*). Start the hole by cutting out a circle of sod around the stake with a spade.
- ◆ Dig out the posthole with a clamshell posthole digger, as shown. For very sandy or heavy clay soils, a digger like the one shown in the photograph works best. A post set in concrete requires a hole three times the post width; for one to be set in tamped earth make the hole twice the post width.
- ◆ If the frost line is deeper than 3 feet angle the digger to widen the bottom (*left*).
- ◆ Extend the hole 6 inches deeper than needed and pour in 6 inches of gravel.

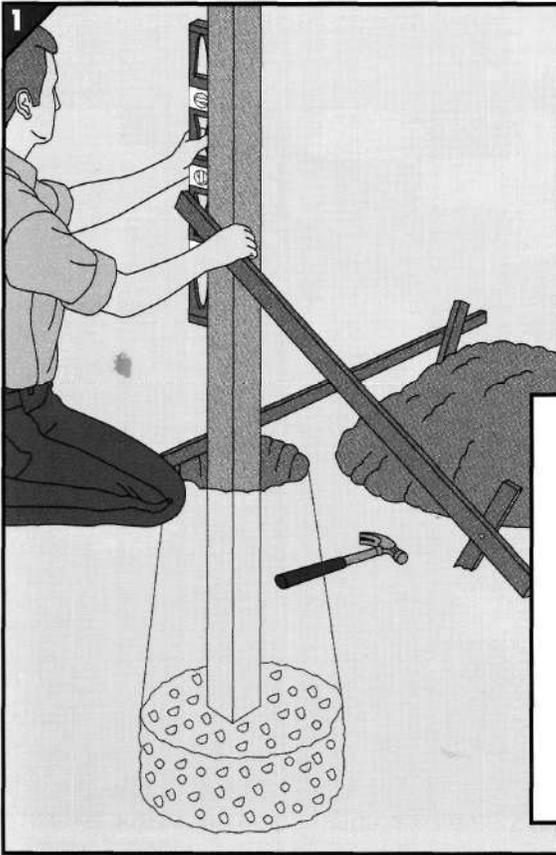


If you are setting 10 or more fence posts, consider renting a power auger. Unless you are working in very rocky or very heavy clay soils it saves both time and effort. The two-person auger at right is less likely to kick out of the hole when it hits a rock than the one-person version.

To use a power auger, mark the posthole depth on the bit with tape and set the machine over the marked position. Start the motor and adjust the speed with the handle-mounted throttle. Guide the machine as the bit pulls it into the ground. After digging 8 to 12 inches, raise the bit to clear the dirt from the hole. If you hit a rock, pry it loose with a digging bar or pick and shovel.

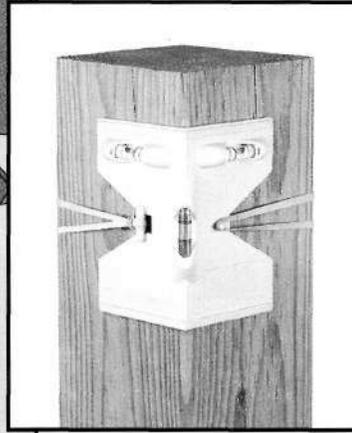


ALIGNING FENCE POSTS



1. Bracing an end or corner post.

- Drive two stakes on adjacent sides of the posthole.
- Fasten a 1-by-2-inch bracing board to each stake with a single 1 1/2-inch common nail.
- Center a post in the hole and use a carpenter's level to plumb one side of the post (*left*); alternatively, use a special post level (*photograph*), which will enable you to plumb both directions at once.
- Nail the first brace to the post, then check for plumb on the other side and secure the second brace.



2. Aligning intermediate posts.

- Attach two lines to the end posts, one near the top and the other close to ground level. For the upper line, make sure that it is attached at exactly the same distance from the top of the posts.
- Place an intermediate post in a hole. Add or remove gravel to set the post at the correct height according to the alignment line.
- Have a helper align one side of the intermediate post with the two lines, then plumb an adjacent side with a level.
- Sight along the top line to check both the post height and the alignment (*right*); alter alignment by shifting the post base.



ANCHORING POSTS IN THE GROUND

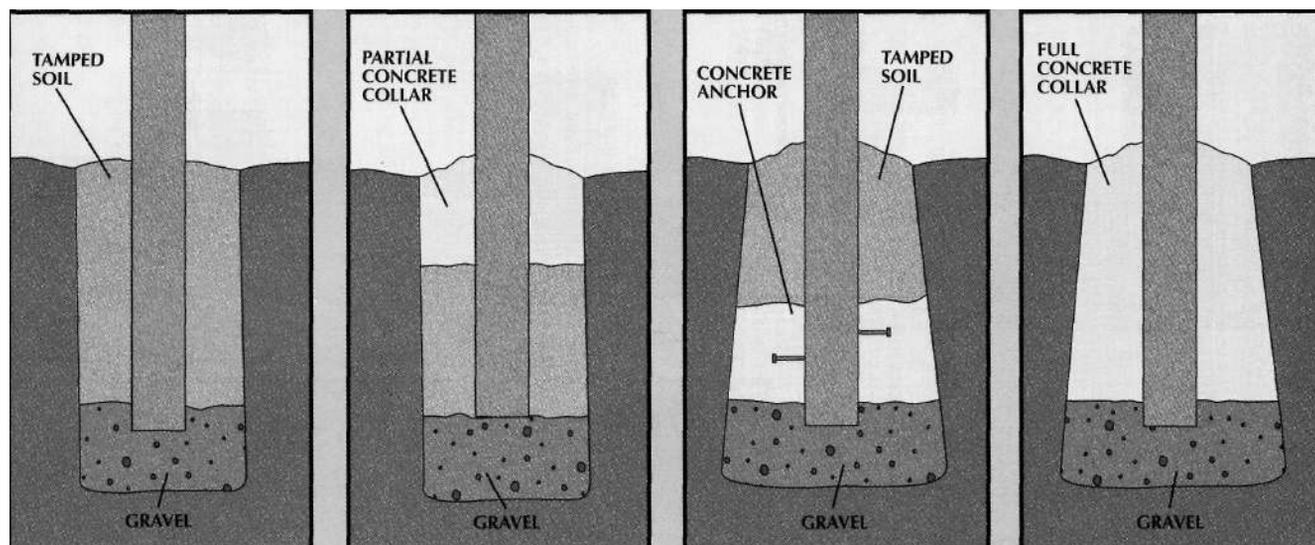
There is no one correct way to secure a fence post. Soil type, intended use, climate, and budget all influence the selection of fillers. The one ingredient common to all methods is a 6-inch base of gravel. This will help prevent water from pooling around the post bottom where it will be drawn into the end grain and hasten decay.

The simplest method is to replace and tamp the soil the: was removed to make the hole. This works well if the fence is less than 4 feet high and sitting in well-drained soil, which reduces the risk of frost heave.

There are two practical reasons to bolster a post with concrete: strength and protection from frost heave. If ad-

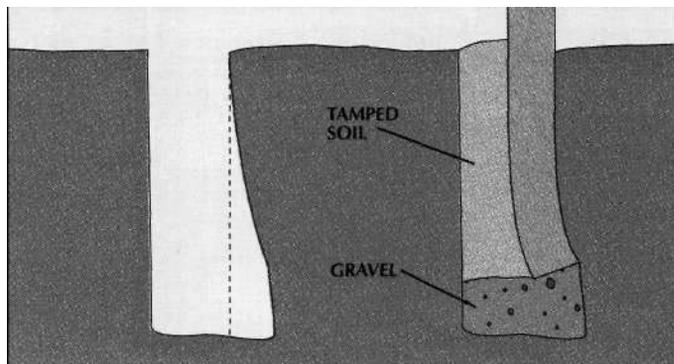
ditional strength is needed but frost heave is not a significant threat, then fill the hole halfway with tamped soil and top it with concrete, for a partial concrete collar. If the post only requires protection against frost heave, then pour enough concrete to fill the bottom 8 to 12 inches of the hole, driving nails partway into the post to anchor it to the concrete.

A full concrete collar, extending from the drainage gravel to just above the ground, is definitely the strongest method of setting a post. It protects against frost heave and will render a post strong enough to hang a gate or hold a tall fence.



Fitting a Hole for a Crooked Post

Unmilled round posts of cedar, locust, or redwood are often curved at their large end. To allow for this, dig the hole to the correct depth; then shape one side to match the curve on the post, allowing the above-ground part of the post to stand plumb. Finally, dig the hole 6 inches deeper, then add 6 inches of gravel for drainage. When the earth is tamped back in place the post will be directly braced against undisturbed soil, providing a secure support.





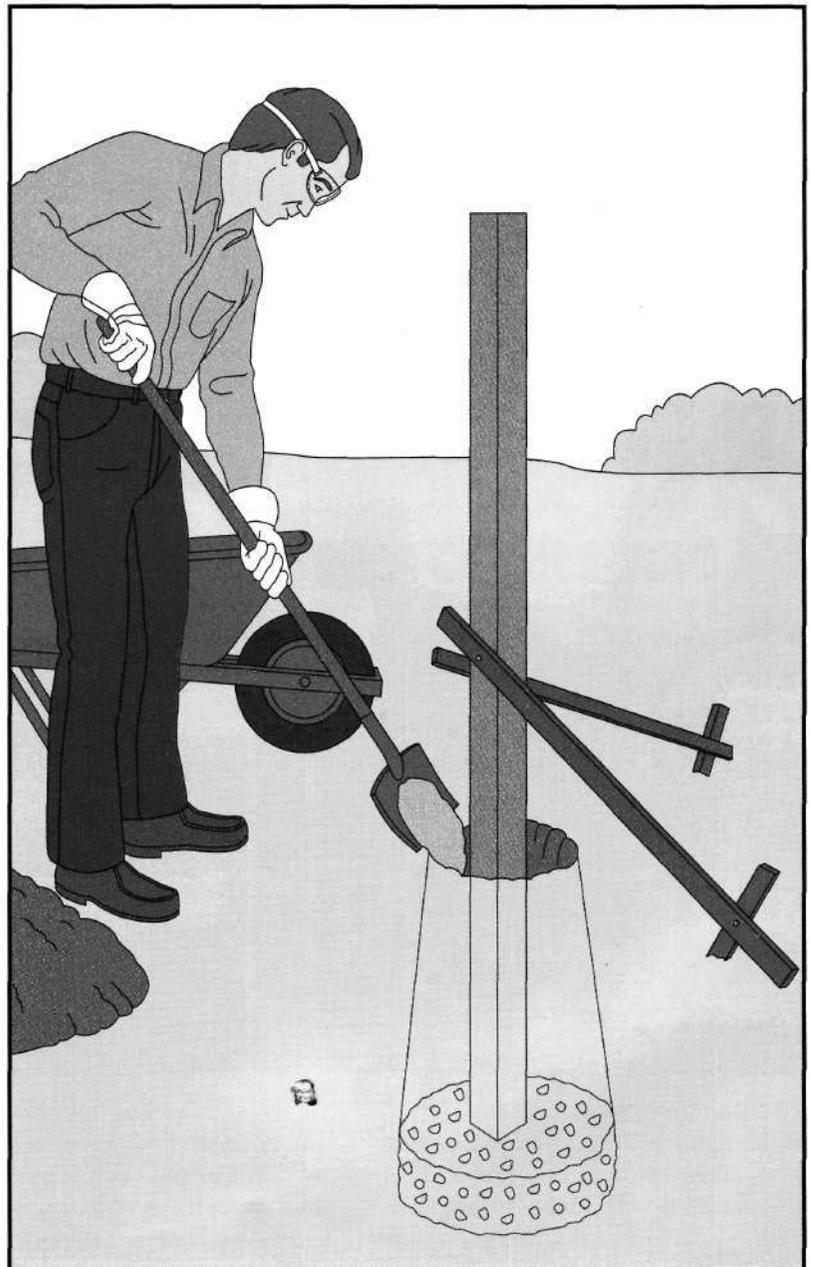
Securing a post in tamped earth.

- while a helper holds the post plumb and touching the alignment lines (*page 29*) fill the hole with earth in 3- to 4-inch layers, tamping as you go with the flat end of a tamping bar or a 2-by-4. Make sure you do not inadvertently shift the position of the post.
- If you are using only soil, overfill the hole and shape a slope of earth around the post to shed runoff. If you are topping the hole with concrete, simply fill the hole to the appropriate height with tamped earth, leaving room for the concrete (*opposite*).

Setting a post in concrete.

- Ensure that the post is aligned and plumb (*page 29*).
- Prepare a batch of premixed concrete with a square-edged spade according to the manufacturer's directions, then fill the hole.
- Agitate the concrete with the shovel to remove any air pockets, but be careful not to knock the post out of position.
- Overfill the hole slightly and use a mason's trowel to slope the concrete down from the post to improve runoff.
- Allow the concrete to set for 48 hours before removing the braces or attaching the fencing.

If you are only laying down a concrete anchor, pour in about 8 to 12 inches of concrete; usually this amounts to one bag of pre-mixed concrete for each post.



Wooden Fences

Almost every wooden fence is built on a framework of upright posts and connecting rails, or stringers. This simple skeleton can support a range of fences that will meet practically any need. A fence of nothing more than posts and rails makes a clear boundary marker, adapts well to rough or rolling terrain, and covers the most ground with the least lumber. Siding nailed to a post-and-stringer frame can take the shape of a low picket fence to decorate the border of a front yard or of a tall board fence (page 41) to ensure privacy or keep children and pets within bounds.

Building Materials; In all of these fence styles, your first concern is the quality of the building materials. Assemble the fence with pressure-treated lumber or naturally decay- and insect-resistant woods, such as

cedar or redwood. All are more expensive than construction-grade lumber, but they will last longer. Fasten the elements with hot-dipped galvanized, aluminum, or stainless-steel fasteners, which will not rust and stain the fence.

Post-and-Board Fences: The fence of this type shown on the following pages is made of 1-by lumber, face-nailed to 4-by-4 posts. For a three-rail fence, set the posts 36 to 42 inches high. For a four-rail fence, make the posts 48 to 54 inches high. To protect the top ends of posts from rot, top them with plastic or metal caps or with an angled cap rail.

Picket Fences: This type of fence is built in a wide range of styles. If you cannot find prefabricated pickets you will have to cut your own. A picket fence can be any height but

is usually 3 to 4 feet, with 1-by-4 pickets projecting about 6 inches above the top stringer.

The tops of picket fences can be cut into any number of original shapes. The best tool for a relatively short fence is a saber saw or, for mass production, a router equipped with a flush-trimming bit.

Post-and-Rail Fences: With tapered rail ends that fit into mortised posts, these fences are sturdier than post-and-board fences and almost as easy to install. With this fence style, the posts are not all set first—they are placed in their holes as the fence is assembled. Prefabricated mortised posts and tapered stringers are sold by lumber suppliers in a variety of styles. All are assembled like the split-rail fence illustrated on page 40.

TOOLS

Tape measure	Circular saw
Carpenter's level	Saber saw
Combination square	Electric drill
Carpenter's square	Screwdriver bit
Clamps	3/4" spade bit
Hammer	Drill guide
Maul	Drill-press stand
Tamping bar	Router and flush-trimming bit
Drawknife	
Handsaw	

MATERIALS

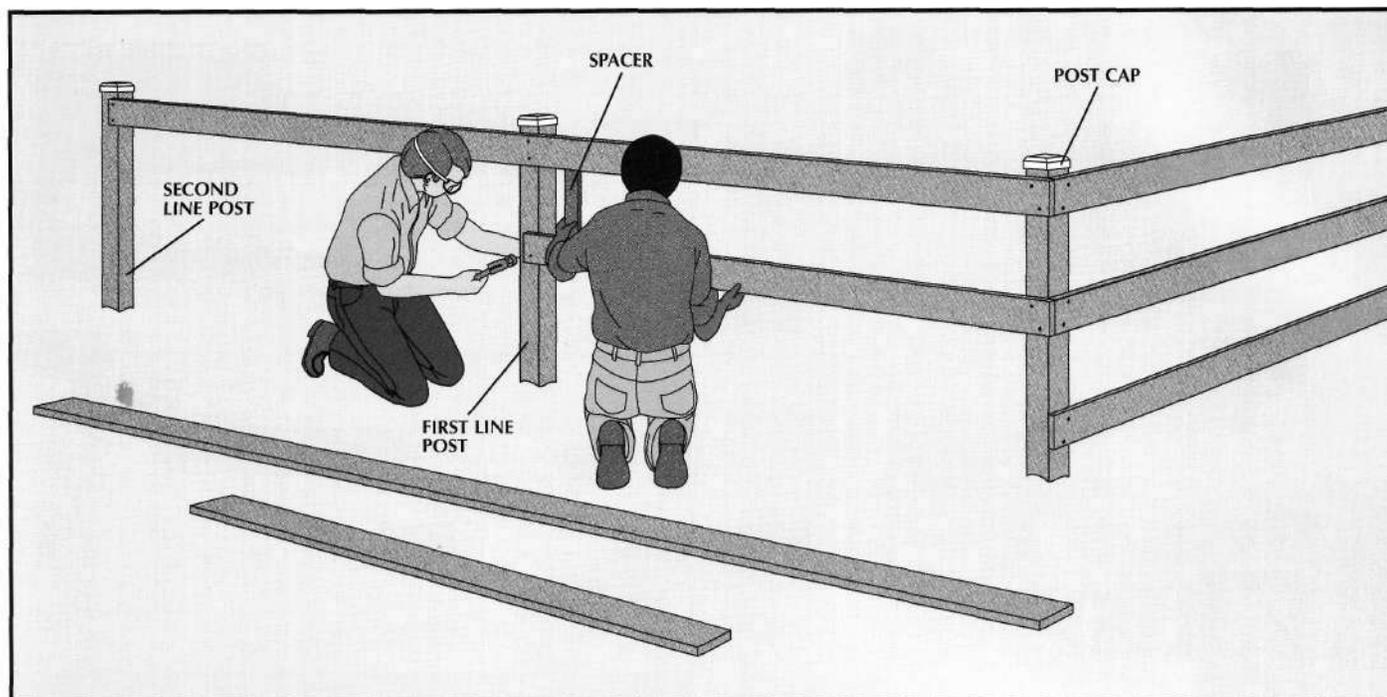
- Fence posts and rails
 - 1x4s, 1x6s
 - 2x3s, 2x4s
- Wooden stakes
- Dowels (3/4")
- Galvanized common nails (2 1/2", 3 1/2")
- Galvanized wood screws (1 1/4" No. 6; 3/4", 2 1/2" No. 8)
- Angle irons
- Mason's line
- Sandpaper (medium grade)
- Wood glue (exterior)



SAFETY TIPS

Protect your eyes when hammering nails, using a circular saw, or operating a router. Wear gloves when handling pressure-treated lumber, and add a dust mask when cutting it.

A SIMPLE POST-AND-BOARD FENCE



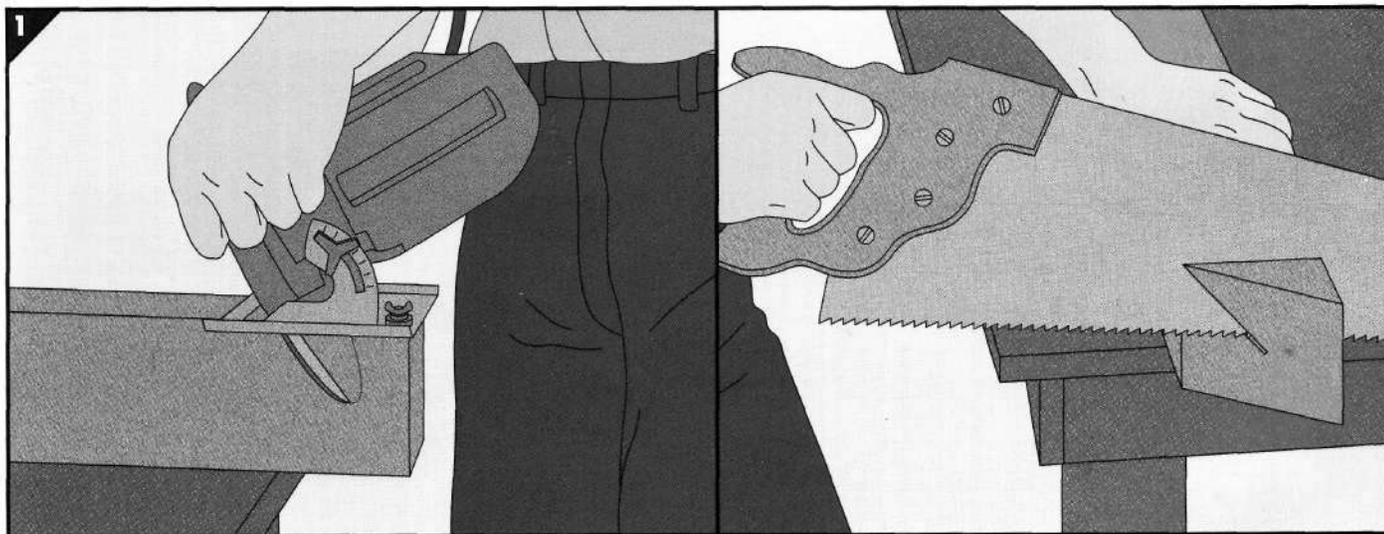
Building a post-and-board fence.

- Trim a 1-by-4 or 1-by-6 to extend from a corner or end post to the center of the second line post.
- Nail this board to the posts with 2 1/2-inch galvanized common nails.
- Trim the board for the next course so it fits from the corner

to the center of the first line post, then nail it in place with the aid of a spacer cut to the appropriate length (*above*). This will result in staggered joints that will make for a more rigid fence.

- Work toward the opposite corner, attaching boards cut to span three posts until you need short pieces for ends.
- Finally, nail metal or plastic caps onto the posts.

THE FINISHED LOOK OF A CAP RAIL

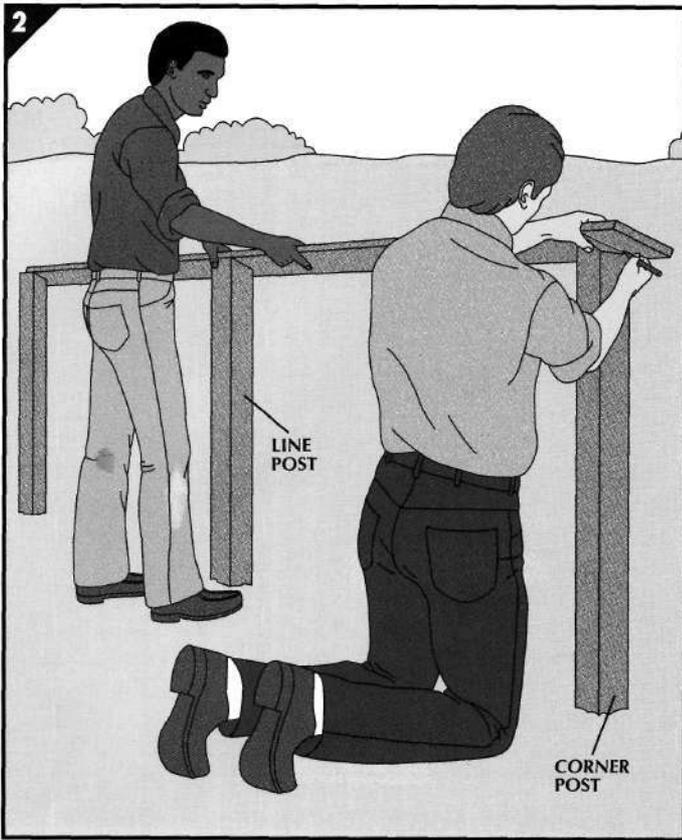


1. Beveling the posts.

Prepare each post for the cap rail by sawing a 30-degree bevel at the post's top end before you set the post in the ground.

- Set your circular saw to cut a 30-degree angle across the post about 3 inches from one end (*above, left*). The saw will cut only partway through and you must finish with a handsaw.

- To prepare a corner post, make a second cut at a 30-degree angle across an adjacent side (*above, right*).
- To set the posts, refer to the instructions on pages 26 to 31.

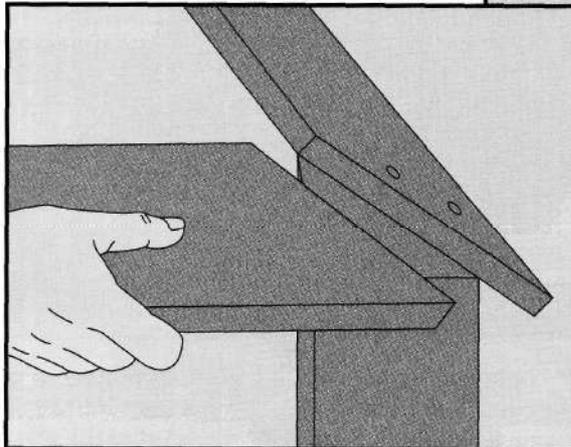
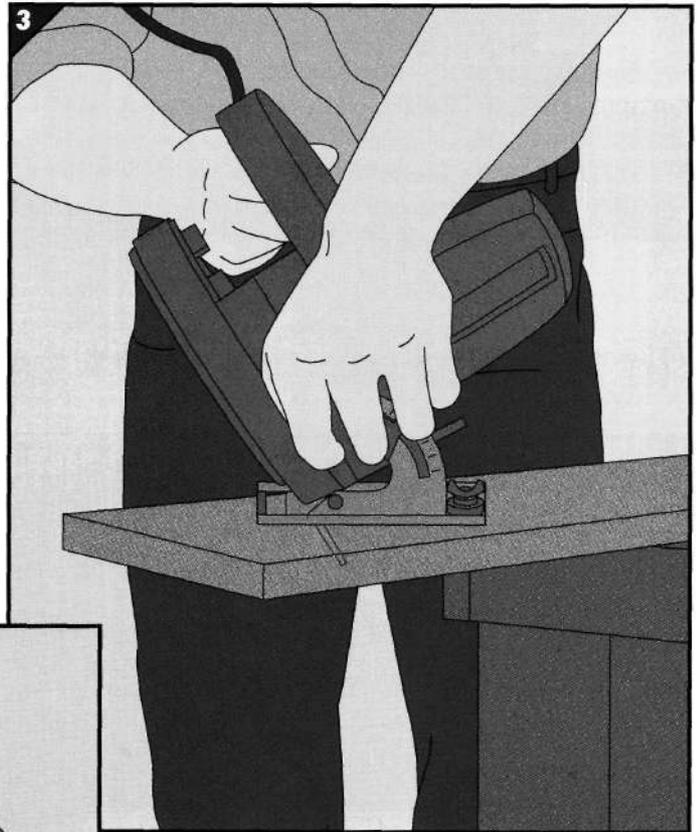


2. Marking the cap rail.

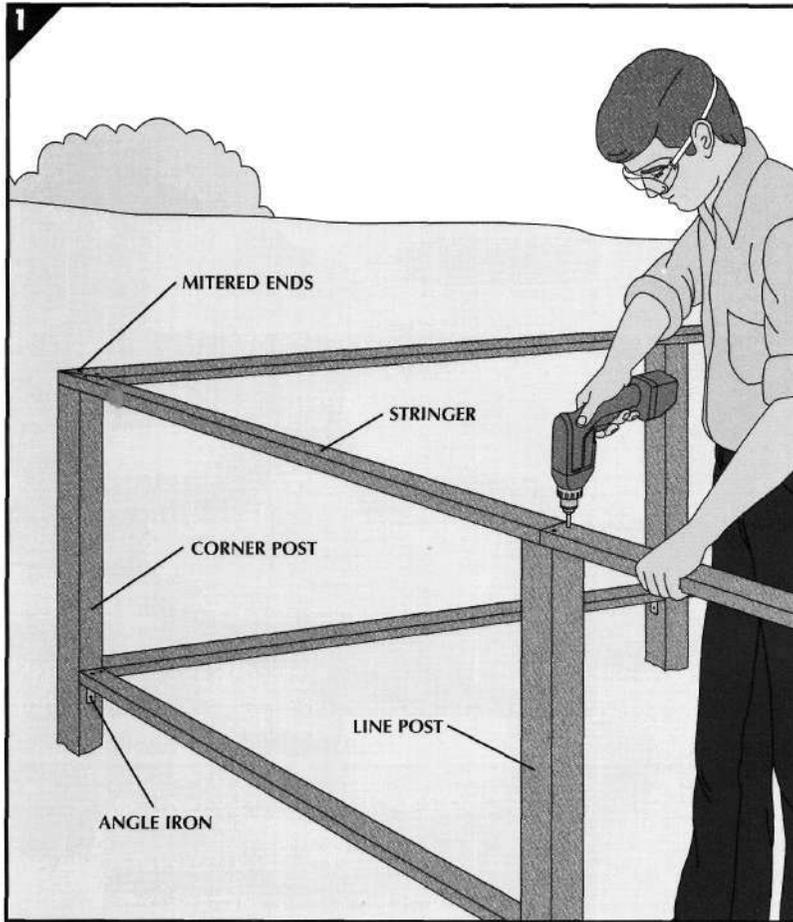
- With a helper, hold a 1-by-6 in position on top of a corner post and a line post.
- Have the helper set one end of the board at the center of the line post while you mark the underside of the board along the angle of the top of the corner post (*left*).
- Mark the matching cap-rail board to fit across the other angled face of the corner post.
- With a combination square, transfer the marks to the other face of each board to facilitate sawing.

3. Cutting the cap rail.

- Set your circular saw to cut a 30-degree angle.
- Saw the rails along the marks you made in the previous step (*right*).
- Fasten one of the cap rails with 25-inch galvanized common nails to the corner post and line post, aligning the tops of the rails with the top edges of the beveled posts.
- Place the other cap rail in position and test the fit (*below*). If necessary, trim the board with a block plane.



A BASIC PICKET FENCE

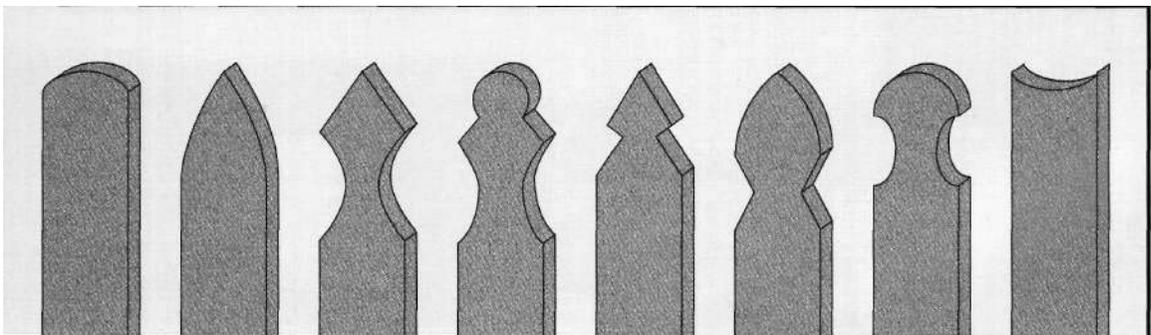


1. Installing the stringers.

Stringers can be installed face down as shown or on edge. The former method is more prone to sag under the weight of the fence while the latter one is more likely to bow from wind pressure.

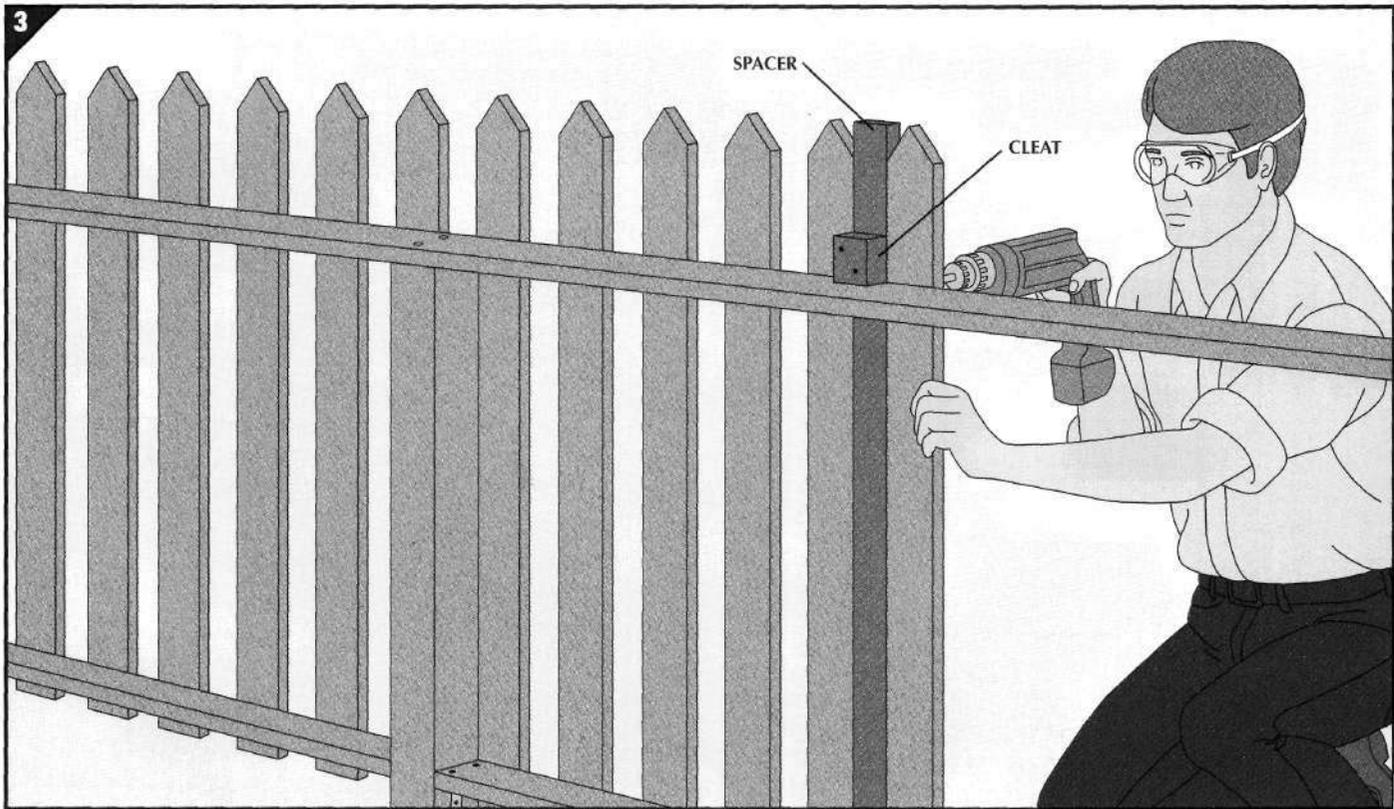
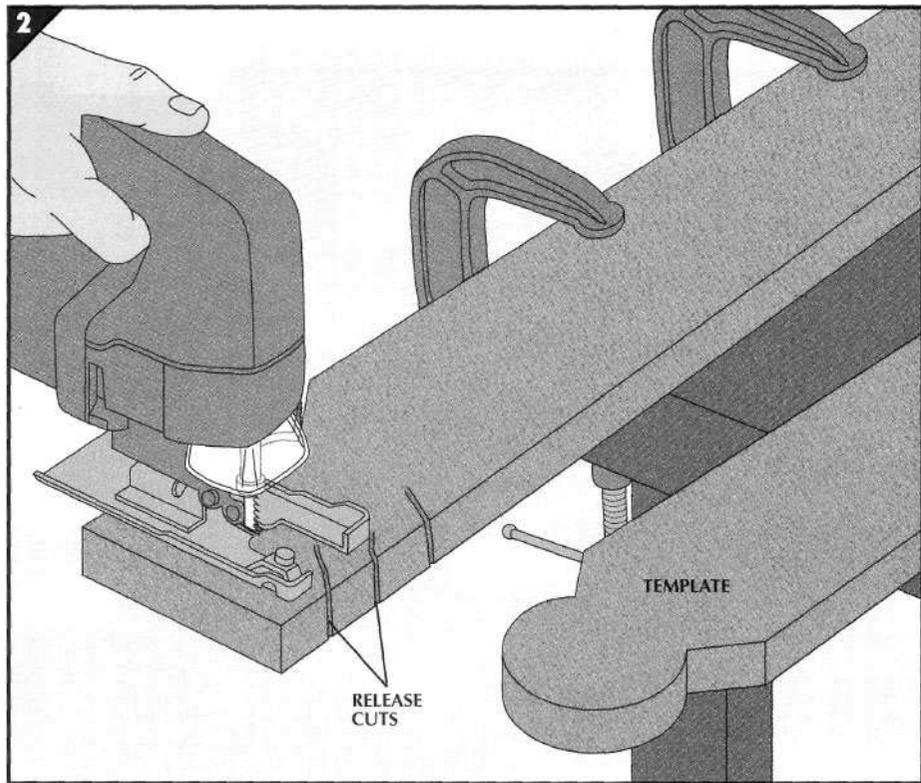
- For the bottom stringers, trim 2-by-4s to fit between each pair of posts and secure an angle iron to each end with 3/4-inch galvanized No. 8 wood screws.
- Attach these stringers to the posts about 8 inches above the ground: Drive screws through the angle iron and toenail the 2-by-4s with 3 1/2-inch galvanized common nails.
- Cut the first top stringer to length to stretch from the corner post to the middle of the first line post. Miter one end of the board at 45 degrees so it will match the stringer on the adjoining fence line.
- Drill two clearance holes in each end of the stringer, then fasten it to the posts with 2 1/2-inch No. 8 wood screws (*left*). Continue to install stringers in this way, using long 2-by-4s to span as many posts as possible.
- Cut the pattern in the top of your pickets (*below and Step 2*); if you have purchased pre-cut pickets, go to Step 3.

From the simple rounded shape to more complicated patterns, the gallery below shows just a sample of the possible forms of picket (top)s you can cut yourself. The first step is to design the pattern on paper. Then transfer it to a 1-by-4 board and cut out the shape with a saber saw. Sand any rough spots. You can use this as a template to draw the pattern on the picket stock before cutting out each one with a saber saw (*page 36*). A faster method would be to cut the shape out of 1/2-inch plywood and use it as a router template (*page 37*).



2. Cutting a pattern freehand.

- Outline the template pattern onto a picket, then clamp the picket to a work table.
- To keep the saber-saw blade from binding in the kerf, make release cuts from the edge of the picket to the tightest turns.
- Align the blade with the beginning of the cutting line, then feed the saw into the stock, guiding the tool to keep the blade on line (*right*).
- Smooth any rough spots on the picket with medium-grade sandpaper.



3. Attaching the pickets.

- Make a spacer to help you set the height and spacing of the pickets: Cut a piece of scrap wood to the same length as the pickets, then rip it to the desired width of the gap between the pickets. Attach a cleat to the spacer

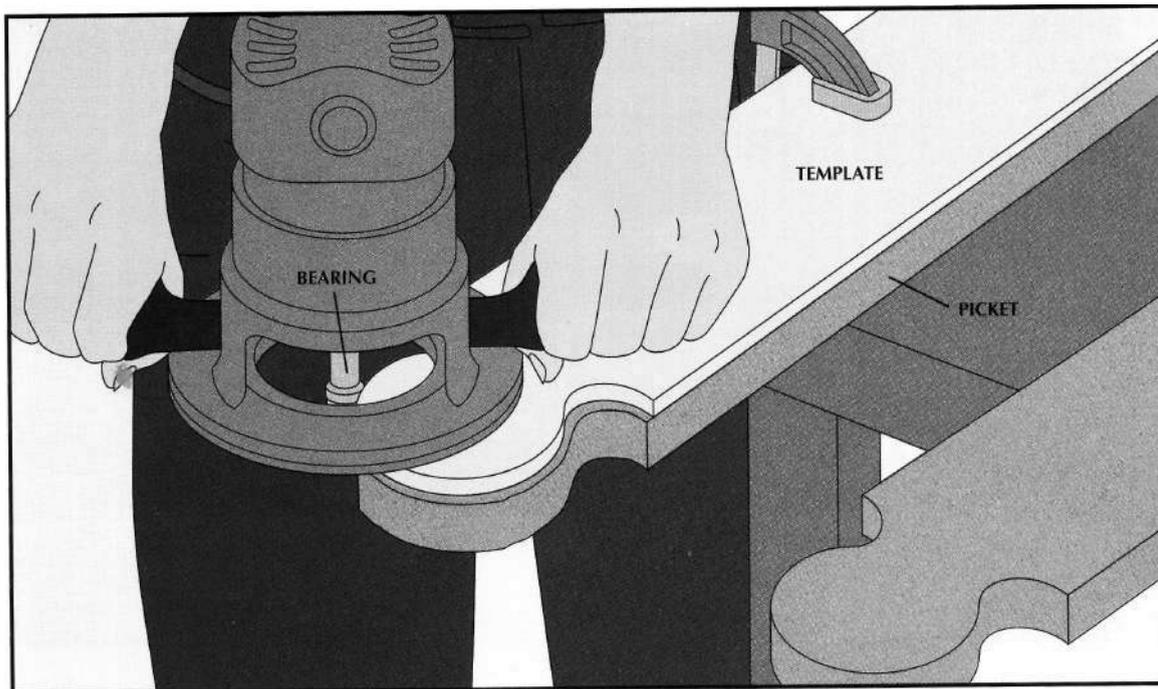
so it will hang from the top stringer at the correct height.

- Drill two clearance holes in each picket at the spots where they will contact the stringers.
- Set the first picket against the edge of an end post and align its point with

the top of the spacer. Plumb the picket with a level and secure it with a 1 1/4-inch No. 6 screw.

- Continue in this manner (*above*), checking with a level every few pickets to make sure they are not straying out of plumb.

SHAPING PICKETS WITH A ROUTER



Cutting along the template.

- Outline the template (page 35) on the picket, then cut out the pattern roughly with a saber saw staying about 1/4 inch outside the line.
- Align the template over the picket stock and clamp the assembly to a work surface.
- Fit the router with a top-piloted flush-trimming

bit and adjust the cutting depth so the bearing will be in line with the template.

- To make the cut, slide the router toward the picket until the bearing touches the template. Move the router around the picket against the direction of bit rotation, keeping the bearing pressed against the template.

Vinyl fencing offers several advantages over the traditional wooden version, the main one being longevity. Most manufacturers offer at least a 20-year warranty on their fences; some even guarantee them for the life of the original owner. Available in a huge variety of styles, vinyl fencing requires little upkeep. And at the end of its useful life, it is 100 percent recyclable. All these advantages come at a price: vinyl fencing costs approximately three times as much as a comparable wood fence. However, in the long run, the maintenance-free nature of the product may make it an economical option.

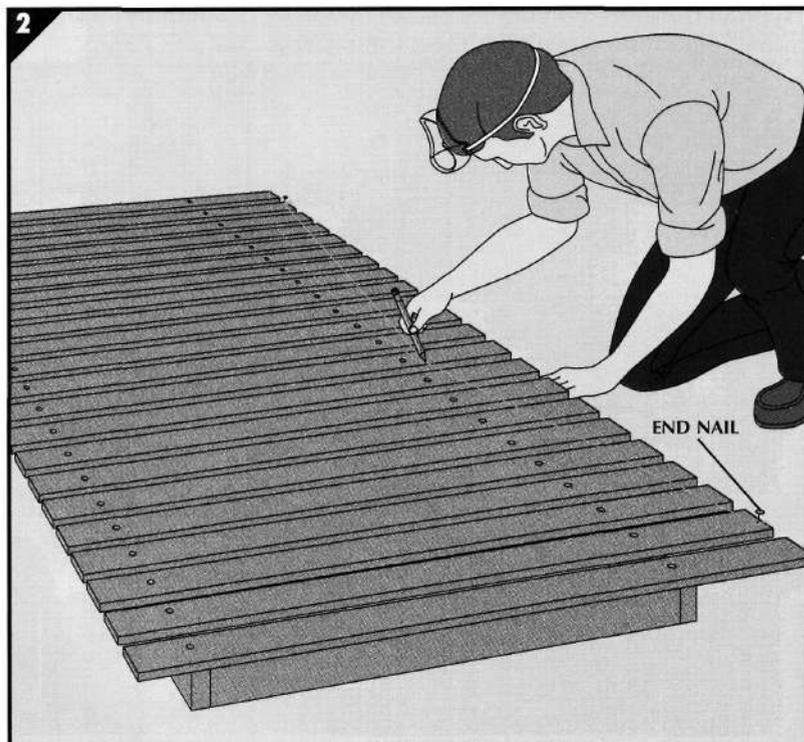
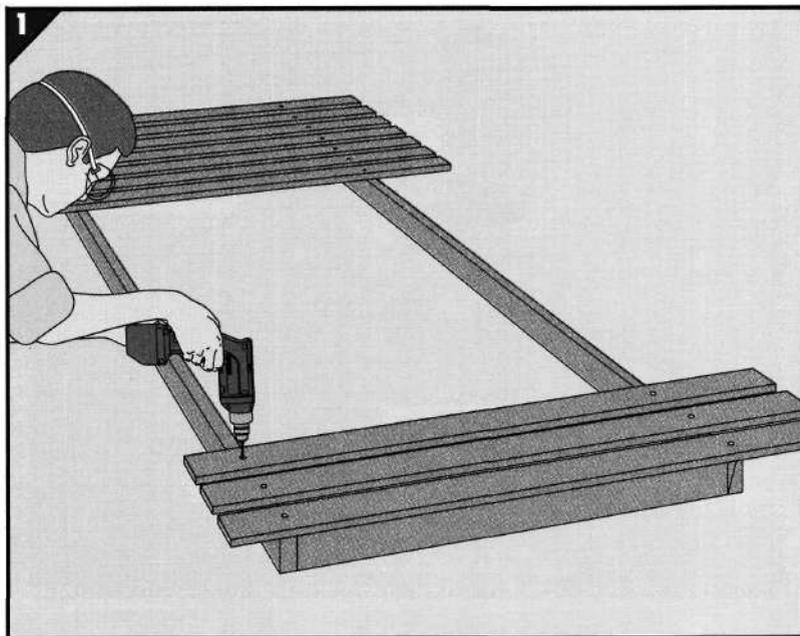


PLAIN PICKETS IN A CURVED PATTERN

1. Building panels of pickets.

Panel frames are built of 2-by-3s so that the pickets will fall flush with the outer face of a 4-by-4 post (Step 3). If you want a stronger frame and do not mind the pickets sticking out a little from the posts, use 2-by-4s.

- Build rectangular frames of 2-by-3s to fit between each pair of posts.
- For each frame, cut pickets to the length of your longest picket and drill clearance holes where they will cross the stringers. Plan to situate the bottom stringers 8 inches above the ground.
- Lay one picket in the middle of the frame and check it for squareness to the stringers with a carpenter's square.
- Lay out the remaining pickets evenly spaced, and mark their locations on the frames.
- Secure the pickets with 1 1/4-inch No. 6 galvanized wood screws.



2. Marking a curved pattern.

- On the first panel, measure down from the top center picket the desired depth of the curve and drive a nail.
- Drive two end nails at the top of the picket panel, each a distance from the central nail equal to half the panel length.
- Tie a length of mason's line to one end nail, pull it around the central nail, and fasten it to the other end nail. Remove the middle nail.
- Keeping the line taut, pull a pencil along it to draw a curve on the picket panel (above).
- Mark each panel this way and cut the curves with a saber saw.



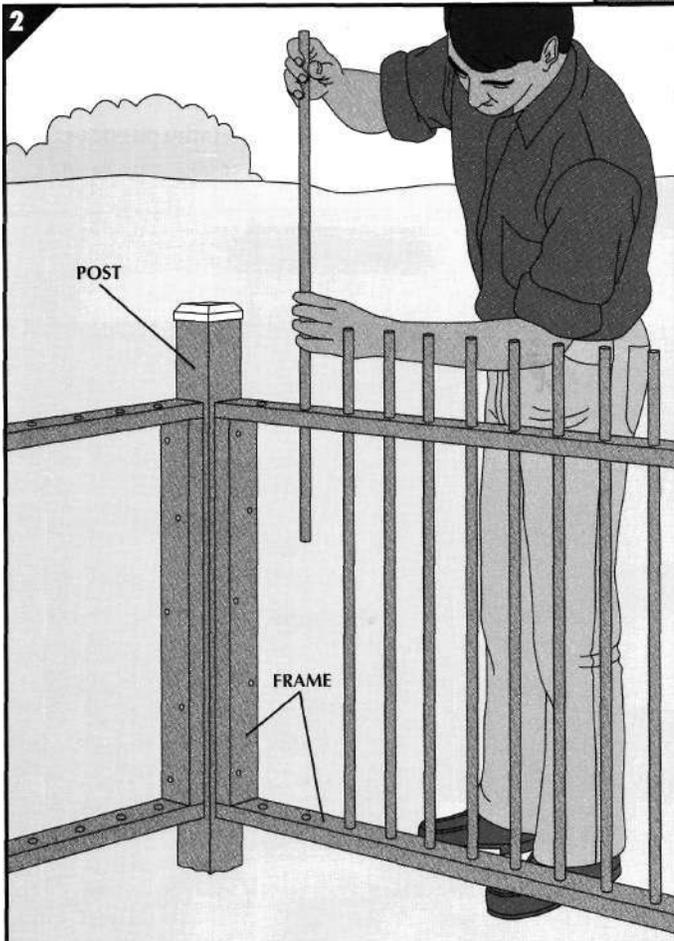
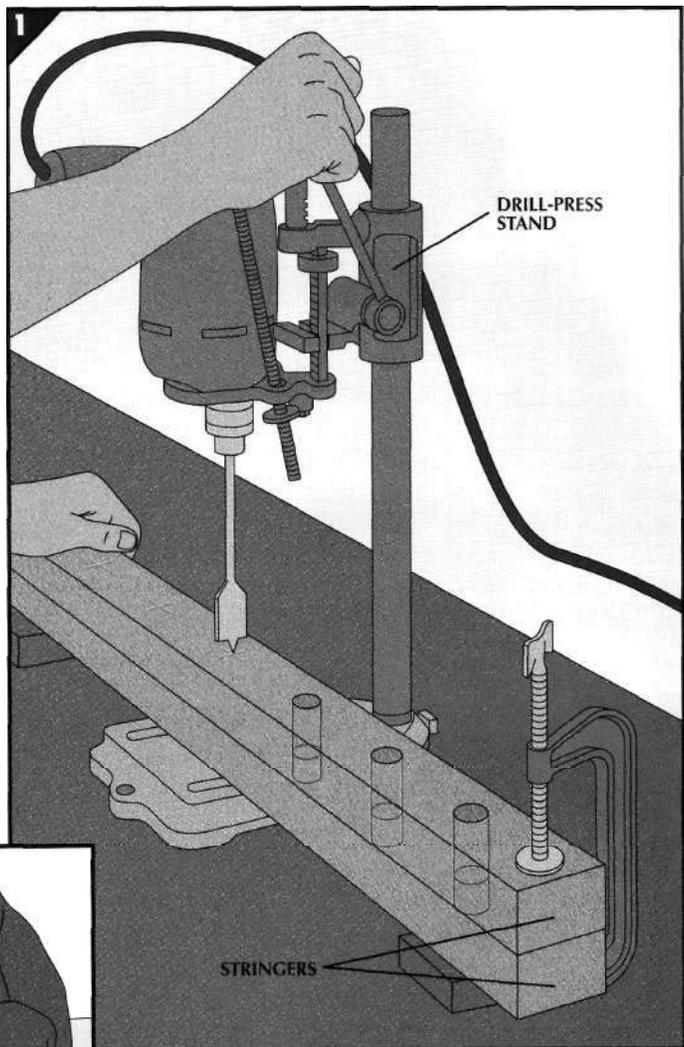
3. Installing the panels.

- Position a panel between the posts. Rest it on a pair of 4-by-4 blocks so the tallest picket is at the desired height. Clamp the panel to the post at each end.
- Drill several clearance holes into the frame then fasten it to the post with 2 1/2-inch No. 8 wood screws (above).
- If the panel sags over time, add another 2-by-3 under the top one, positioned on edge with its face against the pickets.

A RACK OF DOWELS

1. Preparing the stringers.

- Cut 2-by-3 or 2-by-4 stringers to fit between the posts, clamp each pair together, and mark the positions for 3/4-inch dowels spaced 3 inches apart.
- With a 3/4-inch spade bit, bore holes through the top stringer and one-third of the way into the bottom one at each marked point. The holes must be straight so make them with a drill press or an electric drill fitted with a drill guide or installed in a drill-press stand (right).
- Attach the stringers to vertical members to make a frame, then fasten the frame to the posts (Step 3, opposite).



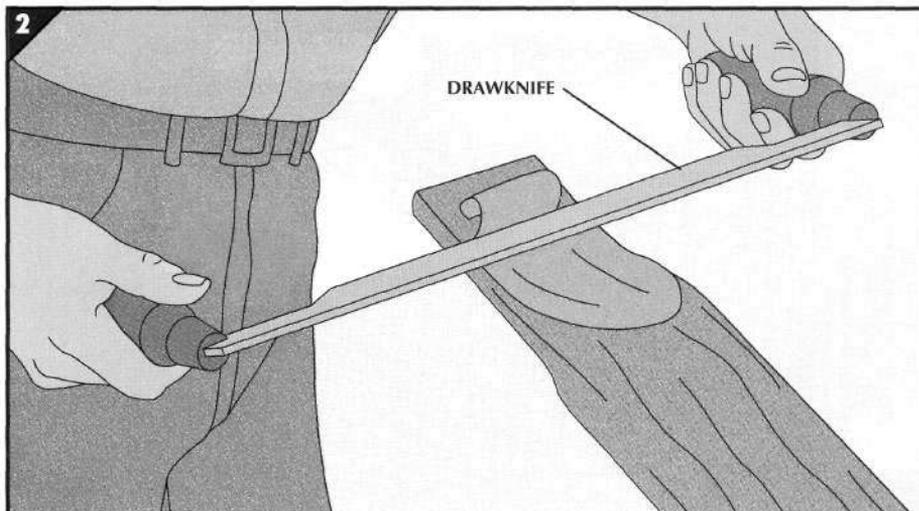
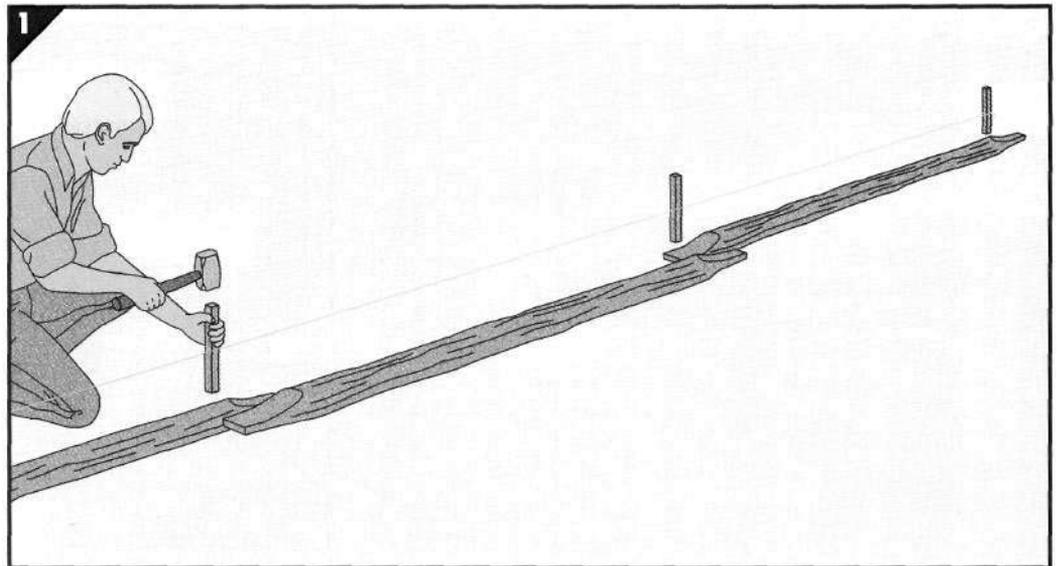
2. inserting the dowels.

- Apply exterior-grade wood glue to the hole in the lower stringer.
- Push a 3/4-inch dowel through the top stringer, resting it in the hole in the bottom stringer (left).
- Tap the dowel lightly with a hammer to drive it home.

FITTING TOGETHER A RUSTIC RAIL FENCE

1. Laying a dry run of rails.

- Drive stakes for the corner or end posts and string a mason's line between them (*page 27*).
- Lay pre-cut rails on the ground along the fence line, overlapped as in the mortised posts. If the rails do not fit evenly, reposition the stake, if possible, or cut shorter rails for one or two sections.
- Mark the position of each post with a stake (*right*).



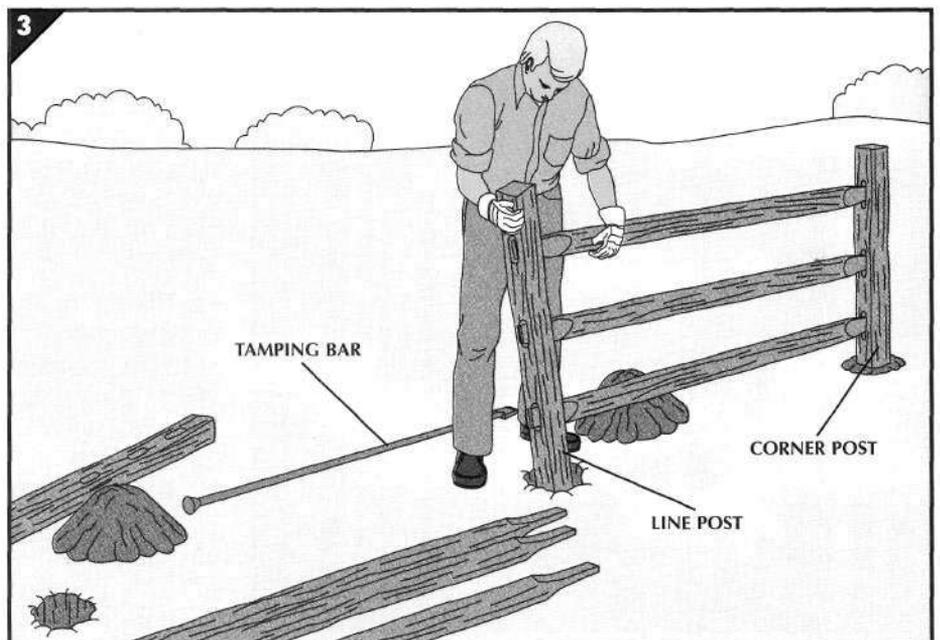
2. Shaping rail ends.

If the rails were cut to fit a shorter section or if a particular rail is misshapen then you will have to retaper it.

- Support the rail so the end to be shaped is facing you. Have a helper hold it in place.
- With a drawknife taper the end by removing a series of shavings (*left*).

3. Fitting the rails in place.

- Dig the postholes, set a corner post in tamped earth (*page 30*), and drop the first line post into its hole.
- Insert the ends of the rails into the slots of the corner post.
- Fit the other ends of the rails into their mortises in the line post (*right*).
- Plumb the post, secure it with tamped earth, and set succeeding sections the same way.



Tall Fences for Privacy

Most privacy fences are built like the picket fences shown on pages 35 to 36. Standard pressure-treated lumber nailed to simple post-and-stringer frames will yield a variety of attractive fences; prefabricated panels can be nailed directly to posts or framed inside posts and stringers.

Tall fences are typically supported on frames of 4-by-4 posts and 2-by-4 stringers. The simplest privacy fence is made of vertical boards or tall narrow slats nailed directly to the top and bottom stringers (and to a middle stringer if the fence is taller than 6 feet). Almost as simple is a fence of horizontal boards or plywood panels face-nailed to the posts and to 2-by-4 studs that are toenailed to the top and bottom stringers 24 to 36 inches apart.

Louvered Fences: Some fences require more sophisticated carpentry. A tall louvered fence, for example, is heavier and more prone

to warp than some of the simpler designs; it requires sturdier joints. To build the louvered fence on pages 42 to 43, you will need a router to cut grooves in the posts and the stringers.

Strengthening the Fence: Since the stringers are attached face down, the fence is weaker than if the boards were set on edge. To compensate for this, use the lightest possible materials and reduce the distance between posts to 6 feet or less. Another approach is to screw an extra 2-by-4 on edge underneath one or both of the stringers.

Working with a Router: When routing in tandem with a jig, clamp or nail the jig to the workpiece and make sure the lumber is steady. Keep the router at chest height or below. To make the high cuts in the posts, stand on a stepladder steadied by a helper



TOOLS

T-bevel	Hammer
Combination square	Screwdriver
Water level	Circular saw
Clamps	Router and 3/4" straight bit
	Paintbrush



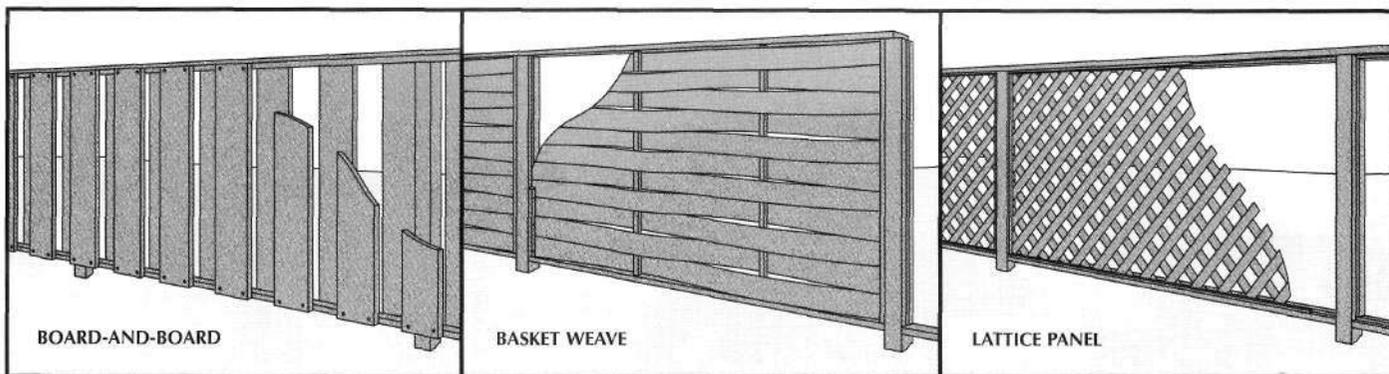
MATERIALS

1x2s, 1x4s, 1x6s	Wood screws (1 1/4" No. 6)
2x4s, 2x6s	Wood glue (exterior)
Galvanized common nails (2", 3 1/2")	Wood preservative



SAFETY TIPS

Put on goggles when routing. Wear gloves when handling pressure-treated lumber; add a dust mask when cutting it.



Three screens for your yard.

A board-and-board fence admits a breeze and looks good from either side. Vertical boards are nailed to both sides of the frame, separated by less than their own widths. The

thin slats (1/2-by-6 inch) that make up a basket weave fence are woven around vertical 1-by-1 boards, and fastened in vertical grooves on each post. The boards on one side are positioned opposite the spaces on

the other. Ready-made panels in elaborate styles like latticework are mounted against 1-by-2s nailed to the posts and stringers. Instructions for building a latticework panel are on page 83.

Adapting to Uneven Ground

Building a fence that follows the ups and downs of your property often depends on choosing the right style of fence for your land and modifying the design as necessary. A post-and-rail or post-and-board fence (*below*) conforms to any terrain and is best for sharply sloping or rolling ground; a fence with vertical members face-nailed to a post-and-board frame follows the ground almost as well.

Pickets Along the Slope: On rough but relatively level ground, a fence with pickets or slats (*opposite, top*) can smooth out small dips and rises; its bottom follows the earth's contours while the top remains level. For such a

fence, buy enough long pickets to fill in the low spots.

Adapting Rectangular Panels: Rectangular-paneled fences are not suited for rough or rolling ground, but they adapt well to steady slopes if built in steps (*opposite, bottom*). Uniform stepping requires a few calculations, but once the posts are in position, attaching stringers and siding is straightforward.

Normally, the top of each fence section is set level. But on a steep hill this can create the illusion that the section is actually higher on the downhill end. In this case, some fence builders lower the downhill end of the stringer 1 or 2 inches below level until it looks right.



TOOLS

Tape measure	Plumb bob
Carpenter's level	Clamps
Line level or water level	Hammer
	Circular saw



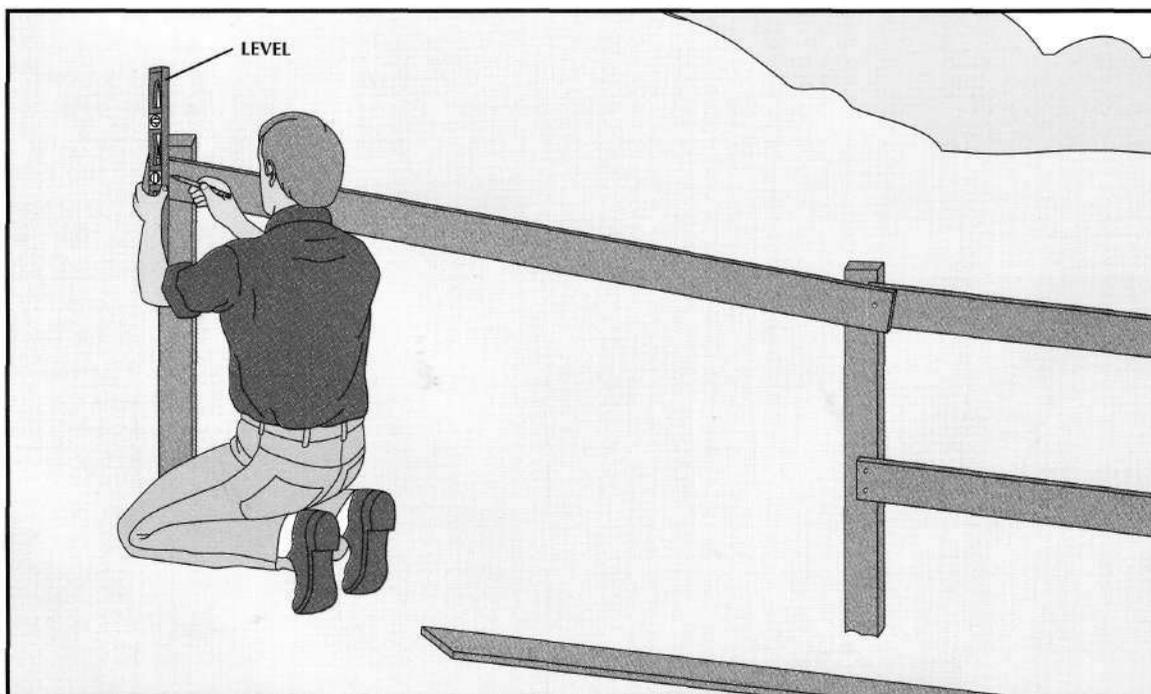
MATERIALS

Masons line



SAFETY TIPS

Wear safety goggles when hammering.



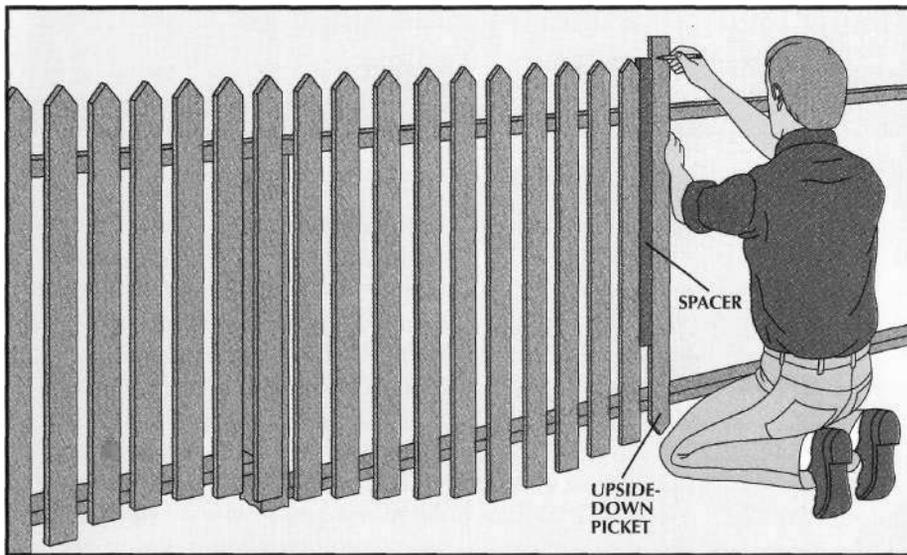
Going up and down hills.

- Set posts on each rise and in each depression, then space the remaining posts between them (*page 27*).
- For a post-and-board fence like the one shown, clamp or tack the boards in position against the posts and use a level to make vertical marks on

the boards at the post centers wherever two boards meet (*above*).

- Trim the boards at the marked angles.

Before attaching vertical slats or pickets, align them evenly above the top stringer with a spacer (*page 36*) then plumb each one.

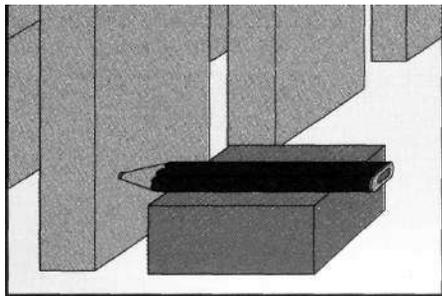


Leveling bumps and dips.

- Make a spacer as shown on page 36.
- To line up pickets on uneven ground, hold each one upside down against the stringers with its shaped top 11/2 inches off the ground.
- Mark its bottom end even with the top of the spacer (*left*), then trim to the mark.
- Install the pickets as you would for a standard picket fence (*page 36*).

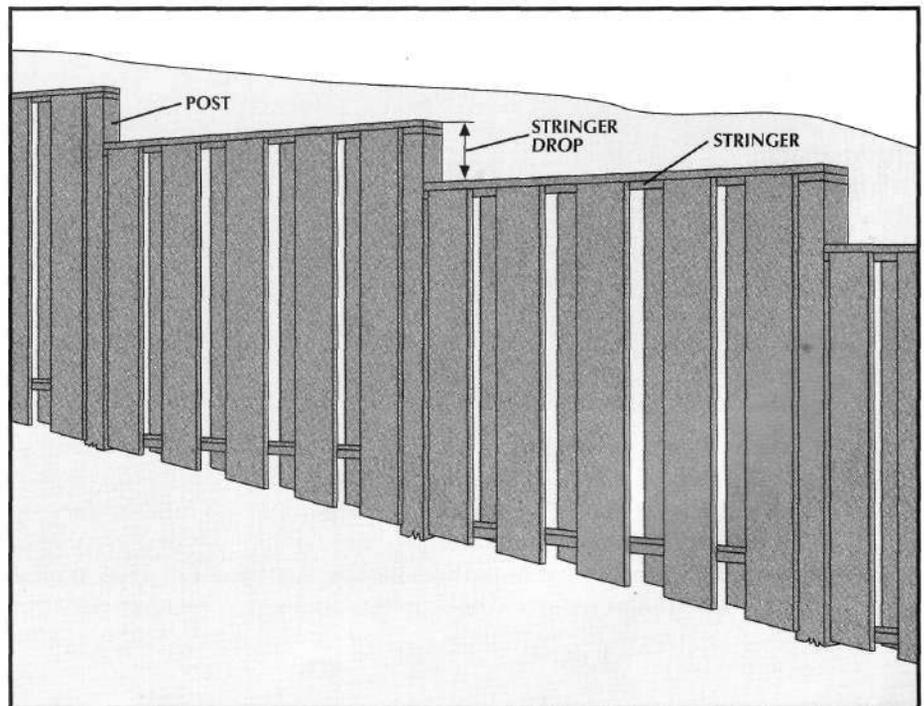
Scribing the Picket Bottom for a Close Fit

While a picket fence does not have to follow the exact profile of the ground, incorporating this feature is a nice professional touch. Simply trim the pickets to length using the method shown above, but let the pickets touch the ground. Place them in position against the fence, right-side up. Hold a carpenter's pencil on a short piece of scrap 2-by-4 (*left*). Slide the block along the ground to scribe any variation in the terrain on the bottom of the picket. Trim the picket with a saber saw. The gap between the pickets and the ground will be uniform all along (ho fence).



Stepping down a slope.

- Run a level line from the top of the hill to a tall stake at the bottom (*page 27*). The height of the line on the bottom stake is the hill's vertical drop.
- Lay out the fence line and mark the post locations as shown on page 27.
- Divide the number of fence sections into the total vertical drop to calculate the "stringer drop" from one section to the next.
- Set the first post at the top of the hill to the intended fence height, and the rest of the posts to the fence height plus the stringer drop.
- Mark the stringer drops on the posts, then attach the stringers (*page 35*).
- For a fence with vertical boards, trim each one so its bottom conforms to the slope, the top is even with the top stringer, and there is a 1/2-inch gap between the board and the ground (*right*).



Building Gates

Gates lead a tough life and most show it by eventually sagging, binding, and refusing to latch. But by observing three basic rules you can greatly increase the useful life of your gate.

Gateposts and Braces: The first requirement is a pair of strong, plumb gateposts, set in concrete (*page 30*) to a depth equal to one-half the height of the part above-ground. Space the posts to accom-

modate the gate width plus a 1/2-inch clearance for the latch as well as enough clearance for the kind of hinge you plan to install.

The second critical element is a frame that is braced by a diagonal board between the top rail at the latch side and the bottom rail at the hinge side. To provide bottom clearance, hang all gates at least 2 inches above the highest point of ground within the arc of the opening gate.

Hardware: Choose strong hardware, particularly the hinges; weak hinges are the most frequent cause of gate problems. To prevent rusting, use stainless steel or galvanized items.

Among latches, the simplest and most trouble-free is the self-latching type shown opposite; sliding bolts are not recommended because even a slight sag in the gate will throw them out of alignment. A gate spring can be added to automatically close the gate.

T TOOLS

Tape measure
Carpenter's square
Hammer

Screwdriver
Awl or large nail
Circular saw
Electric drill
Screwdriver bit

M MATERIALS

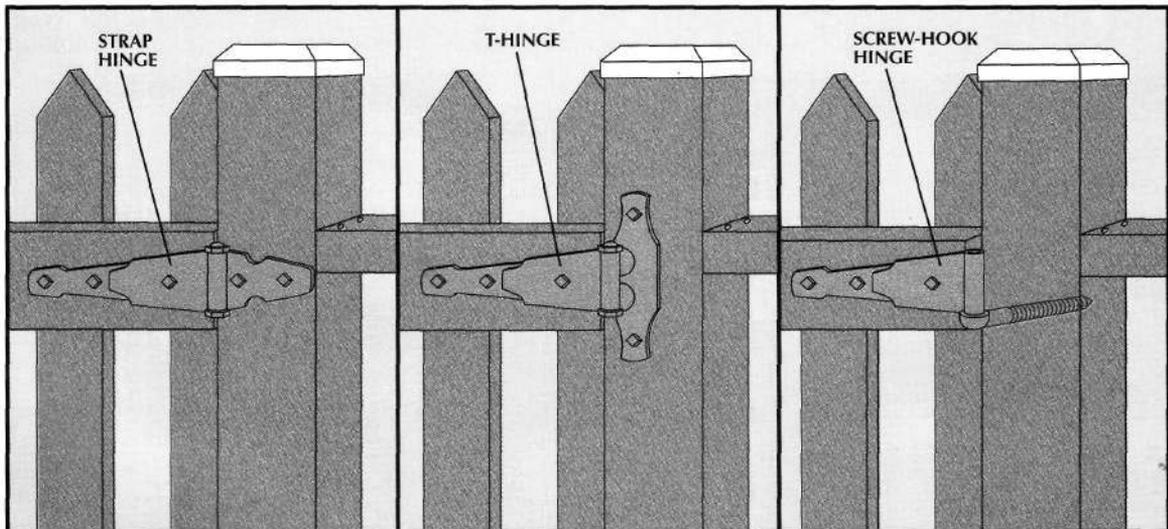
1"x11/2" board
Pressure-treated 2x4s
Pickets
Galvanized common nails (3")

Galvanized wood screws (1 1/4" No. 6; 1", 4" No. 8)
Lag screws (5/16") and washers
Gate hinges
Gate latch



SAFETY TIPS

*Wear goggles when drilling.
Wear gloves when handling pressure-treated lumber; add a dust mask when cutting.*



Three types of hinges.

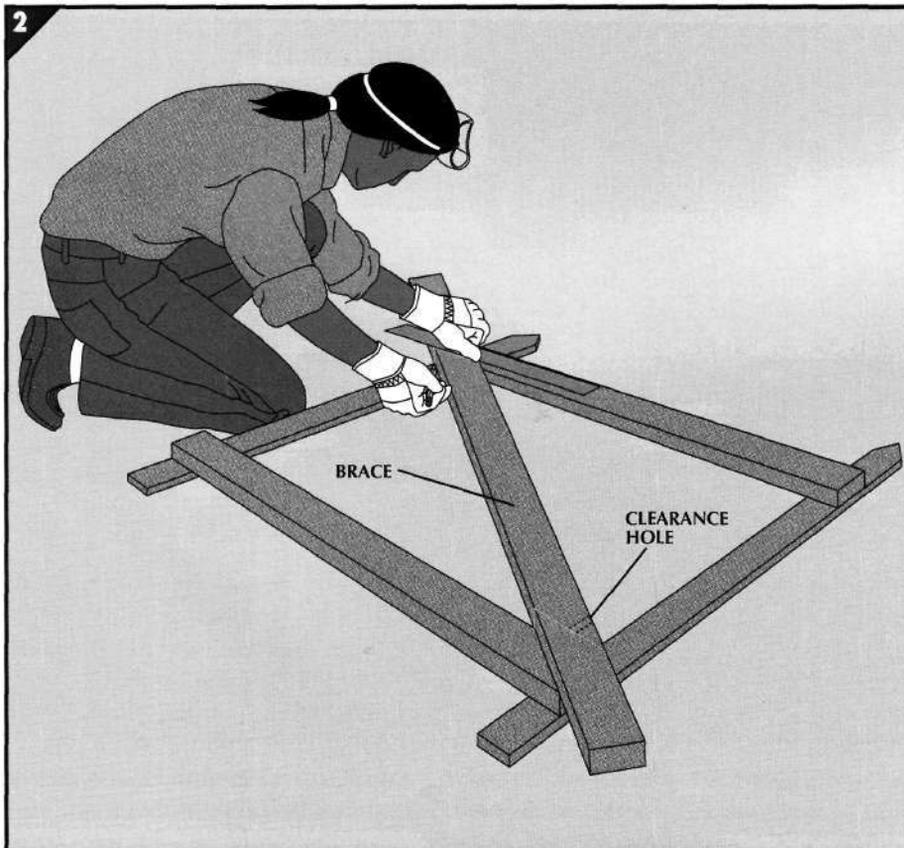
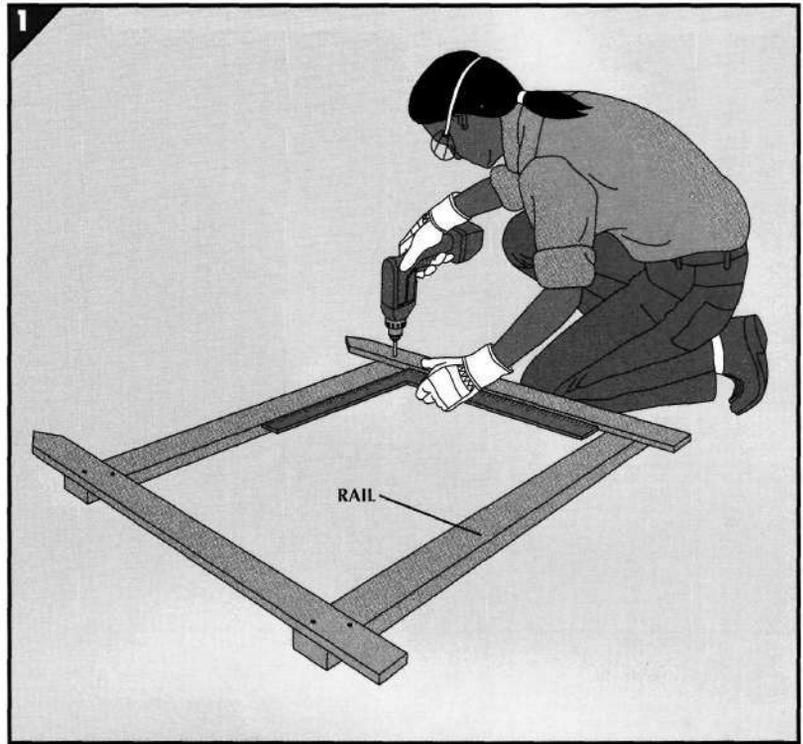
These three styles of hinge attach to the gate with a strap at least 7 inches long but they differ in the way they are secured to the post. The strap- and T-hinges are fastened to the post and gate with lag screws; screw-hook hinges are fixed

with screw hooks as shown on page 48 (*Step 3*). The strap hinge has a post strap running the full width of the post. The T-hinge has at least a 7-inch-high strap, which makes it more stable. The screw-hook hinge is even stronger and makes the gate easy to remove for minor repairs.

MAKING AND HANGING A GATE

1. Assembling the frame.

- Cut pressure-treated 2-by-4s the width of the gate for rails.
- Position the end pickets so that the gate rails and pickets will align with the fence. Drill clearance holes in the pickets.
- Screw the pickets to the rail with 1 1/4-inch No. 6 galvanized wood screws, checking with a carpenter's square to guarantee right angles (*right*).
- For a fence 6 feet tall or more, add a third rail in the middle of the frame.



2. Bracing the gate.

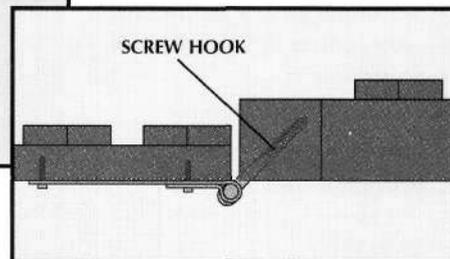
- Turn the gate over picket-side down.
- Position a 2-by-4 brace on the gate from the top corner on the latch side to the bottom corner on the hinge side. Mark the 2-by-4 to fit between the rails, aligning a straightedge with each rail (*left*). Cut the brace to length.
- Drill two clearance holes through the edge of the brace about 2 inches in from each end, then secure it with 4-inch No. 8 wood screws.
- Secure the remaining pickets to the rails and the brace.
- Bolt the hinge straps to the ends of the rails with 5/16-inch lag screws.

3



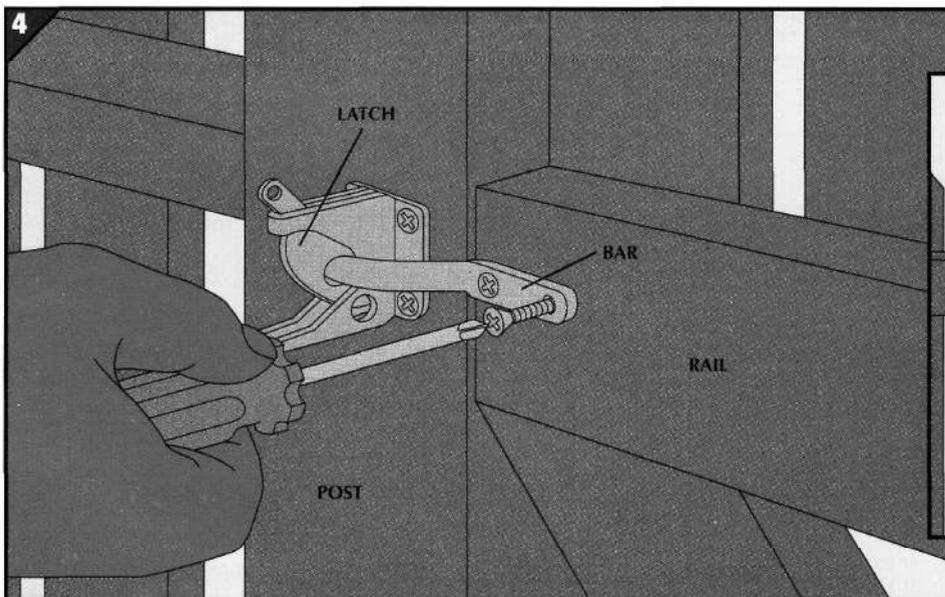
3. Hanging the gate.

- Set the gate on wood blocks to align it with the fence and, holding the back of the frame flush with the back of the post, mark the post at the bottom of both hinges (*left*).
- Bore a 1/2-inch-diameter hole in the corner of the post at a 45-degree angle, starting the hole with an awl or large nail so the drill will not slip off the corner. With the hook set at an angle (*inset*) the gate can swing a full 180 degrees without binding against the post.
- Drive the screw hooks into the post.
- Slip the hinge straps over the screw hooks to hang the gate.



SCREW HOOK

4

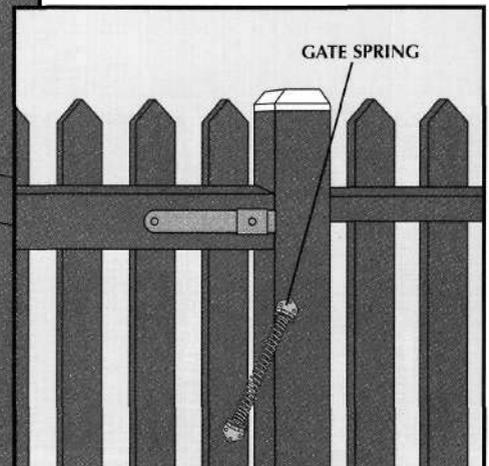


LATCH

BAR

RAIL

POST



GATE SPRING

4. Installing a latch and a gate spring.

- Position the latch on the post opposite the top rail on the gate. Secure the hardware with 1-inch No. 8 wood screws.
- Hold the gate closed and fit the bar in the latch, pressing it against the rail as it would normally sit. Mark the screw holes with a pencil, then drill a pair of pilot holes.
- Fasten the bar to the gate with 1-inch wood screws (*above*).
- To make a gate stop, nail a 1-by-11/2 board to the front of the latch post with 3-inch galvanized common nails, positioned so the gate will stop just before the bar strikes the base of the latch. This will keep the latch from bearing the brunt of the force when the gate is closed.

- To operate the latch from outside the gate, first bore a hole through the post, then attach a cord to the hole in the latch bar, thread it through the post, and tie a pull ring to the cord on the other side of the post.

If you want to add a gate spring, set it across the gate post and gate in as vertical a position as possible so the movable bracket is on top and tilted to the right. Mark and drill pilot holes, then fasten the spring in place with the screws supplied (*inset*). Tighten the spring by turning the hex nut at the top clockwise, then fit the metal stop between the nut and bracket to prevent the nut from loosening.

Blocks and Bricks for a Strong High Wall

Because of its solidity and weight, a masonry wall calls for very careful planning. It must sit on soil firm enough to support it, and not block natural drainage. If you have any doubts about the site of your wall, consult your local building authority. In many areas, codes prescribe strict standards for masonry structures more than a few feet high, specifying materials, dimensions, reinforcement, and depths of footings.

Digging Trenches for Footings: The footings must be at least 18 inches below grade and must rest on earth not affected by frost. Before digging, mark the borders of the footing trench and the centerline of the wall with stakes clear of the digging area to fix the marks. In loose soil, you may have to bank the trench walls back from the bed by as much as 45 degrees to keep them from caving in. Keep the bed as level and flat as you can, but do not smooth it off by filling loose earth back in: The footing must rest on undisturbed earth. If the virgin soil at the proper depth is loose, tamp it (*page 24*).

A footing's width and height depend on the thickness of the structure it supports and local soil conditions; consult your building code.

Pouring Concrete Footings: In any but the loosest soil, wooden forms are not needed to contain the concrete poured for a footing. In most soils, widen the trench on one side to allow for smoothing the concrete and laying blocks and mortar from the footing up to the surface (*below, left*). But if the soil is firm enough to keep the trench walls vertical for their full height, you have a convenient but expensive alternative: You can dig the trench no wider than the footing and fill it with concrete to just below ground level (*below, right*).

Both types of footing need strengthening with two lines of steel reinforcing bars (rebar) laid along the trench—and both probably need enough concrete for an order from a ready-mix firm. When the truck arrives, have plenty of helpers on hand. Pouring and leveling concrete is heavy work that must be done quickly.

T TOOLS

Tape measure	Maul
4' level	Rebar cutter
Water level	Square-edged shovel
Hammer	

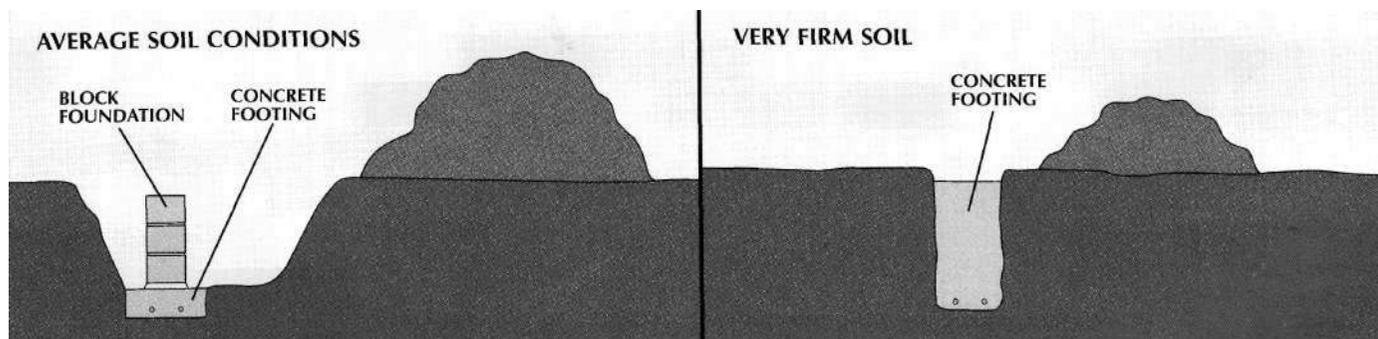
M MATERIALS

2x4s for floats	Sand
Wooden stakes	Bricks or stones
Common nails (4 1/2")	Ready-mix concrete
Rebar	Polyethylene sheeting
Tie wire	



SAFETY TIPS

Check with utility companies about pipe and wire locations before digging a wall's foundation. Wear gloves and a long-sleeved shirt when working with concrete.



Two types of concrete footing.

A standard trench (*above, left*) is suitable for most soils. One of its wads is as steep as the firmness of the soil allows; the bottom is squared off to the width and depth of the footing,

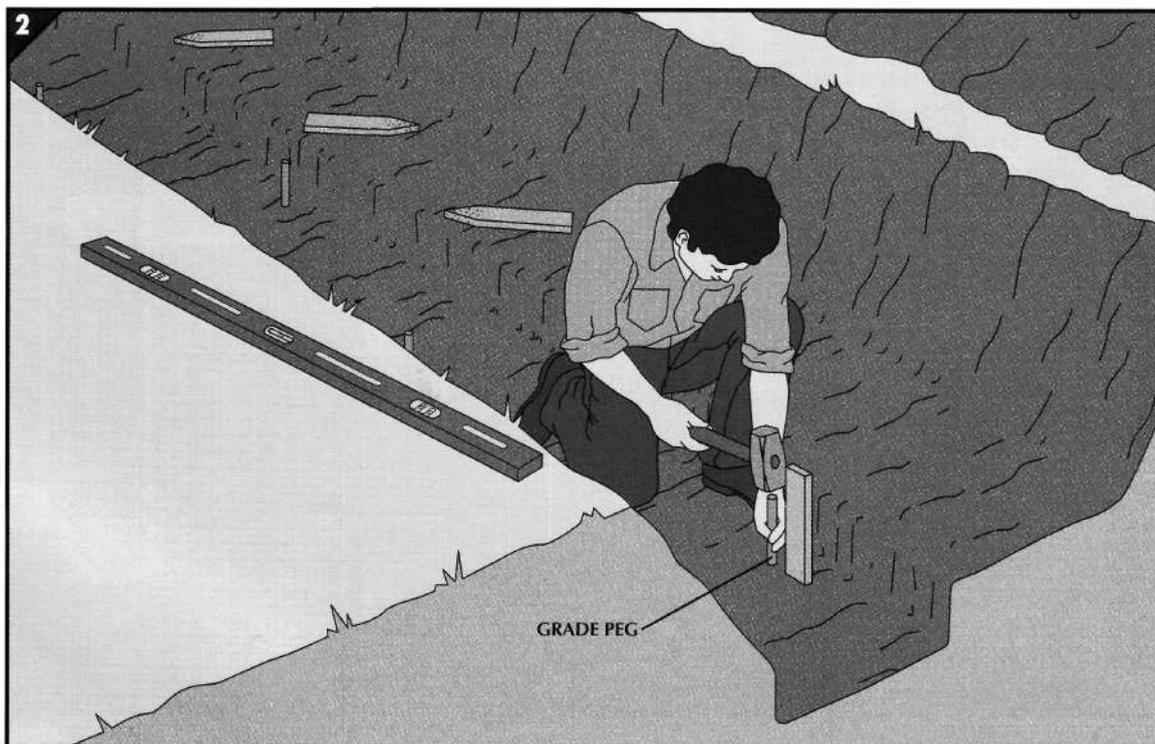
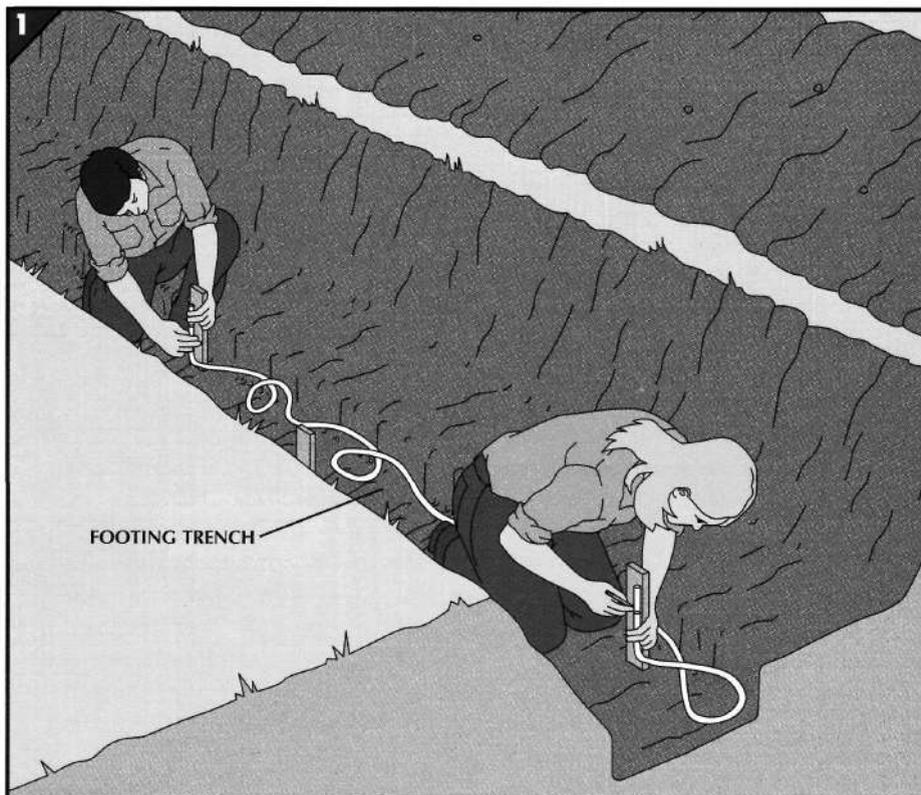
and above that the trench gets a foot or two wider to create working space. Reinforcing bars are laid, concrete is poured and leveled, then a block foundation is built up to within a few inches of ground level.

A trench dug in very firm soil (*above, right*), has vertical walls separated by the width of the footing. Reinforcement is laid and the trench is filled with concrete almost to the surface; it needs no block foundation.

POURING A CONCRETE FOOTING

1. Marking the top of the footing.

- Dig the trench for the footing (*page 49*). If you must move a large amount of soil to dig beyond the frost line and you plan to build a high wall more than a dozen feet long, hire a professional. To move a relatively small amount of earth, consider renting a gasoline-powered trencher, which you can operate yourself.
- Along the sides of the footing trench, drive 12-inch stakes into the ground in a zigzag pattern every 3 to 4 feet.
- Mark the stake at the highest spot in the trench, 8 to 10 inches above the bed.
- Mark all the stakes at that height with the help of a water level (*right*).



2. Installing grade pegs.

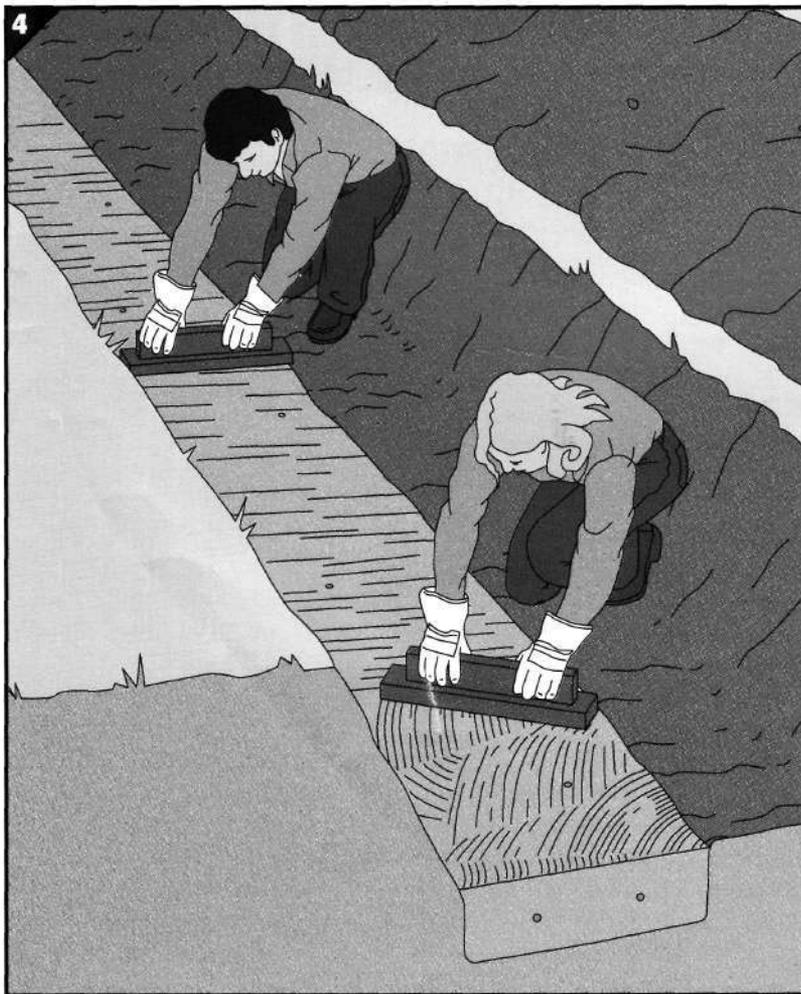
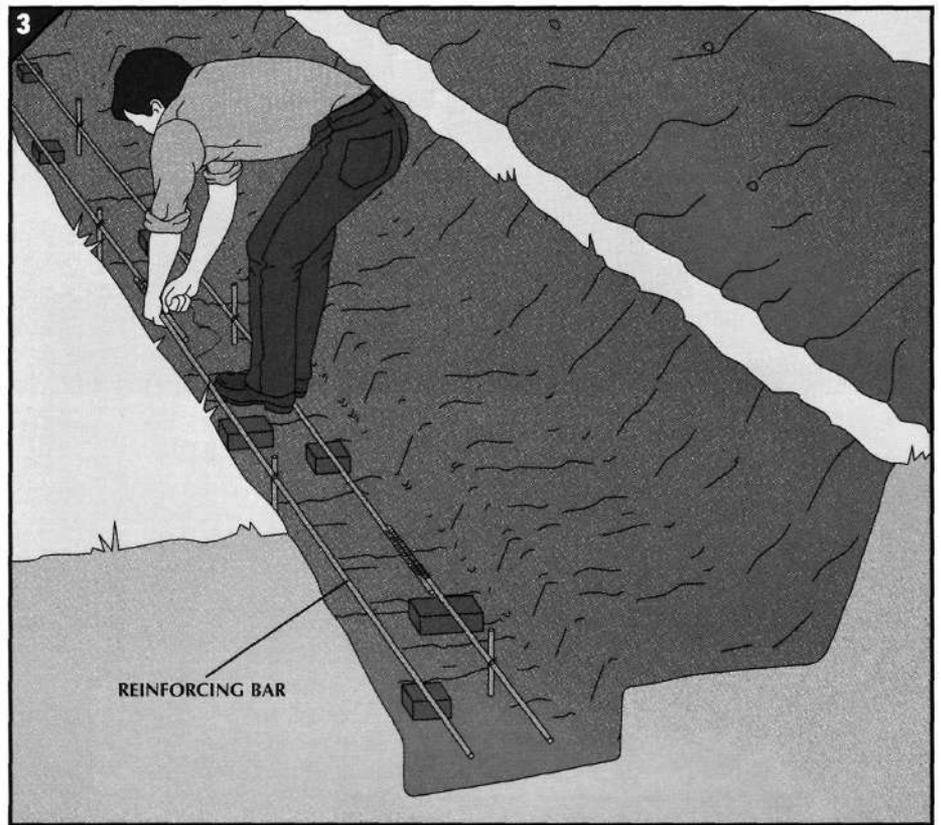
- Make grade pegs by cutting a rebar into 18-inch lengths, one for each stake, with a rented rebar cutter.
- Drive a peg into the trench

bed next to each stake so that the top of the peg is level with the mark on the stake (*above*). Do not drive the pegs too deep—pulling them up to the correct height will loosen them.

- Remove the stakes as you go, filling in the holes they leave with soil.
- Check the level of the pegs with a 4-foot level. If any is too high, tap it down.

3. laying reinforcing bars.

- Check your building code for the correct size rebar—usually between No. 4 and No. 8.
- Set lengths of rebar in the trench bed alongside each row of grade pegs, supporting the bars 2 to 3 inches above the soil with bricks or stones. Where two bars meet end to end, overlap them 12 to 15 inches. Cut bars to length if necessary with a rebar cutter.
- Lash the bars together with tie wire, then tie the bars to the grade pegs.
- Once all the bars are in place, remove the bricks or stones.



4. Completing the footing.

- Working with helpers, pour concrete into the trench, taking care not to dislodge the grade pegs. Spread the concrete with square-edged shovels.
- Break up large air pockets in the concrete by pushing a shovel into the mix, again avoiding the grade pegs.
- Fill the trench so that the level of the concrete is at least 1/2 inch above the tops of the grade pegs.
- Level the footing with floats fashioned from 2-by-4s nailed together (*left*). Working on one small area at a time, even out the concrete with a patting motion. Continue, compacting the concrete and spreading it into the corners of the trench until the tops of the grade pegs become visible.
- Smooth out the concrete by sweeping the trailing edge of the float across the surface, pulling the float toward you in wide arcs. Again, continue until the tops of the grade pegs and footing are at the same level.
- Cover the footing with polyethylene sheeting and let it cure for seven days.

Designing a Wall for Strength and Beauty

Masonry walls need not always present a solid, unvarying face. Bricks and masonry blocks can be laid in patterns to enliven a wall's appearance and in open designs to admit light and air while screening a view.

Building with Blocks and Brick: The decorative block patterns shown opposite feature stacked bond and blocks of standard sizes. Bricks, too, can also be used to make open work, but such walls require a skilled mason to make them structurally sound. An amateur bricklayer, however, can build a solid-brick wall with

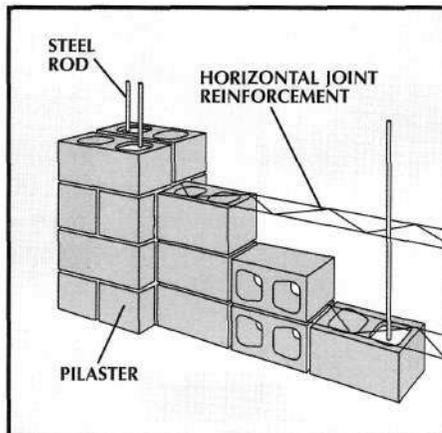
a decorative pattern based on the interplay of headers (bricks laid crosswise on the wall) and stretchers (bricks laid along the length of the wall), like those shown on page 54. Such designs strengthen an ordinary two-course-thick garden wall, since the headers tie the front and back courses of brick together, performing part of the function of joint reinforcement.

A Two-Color Pattern: Most large brickyards stock many different colors of brick, but to create a simple design, you can use two different colors, one for a back-

ground and the other for the pattern (page 54).

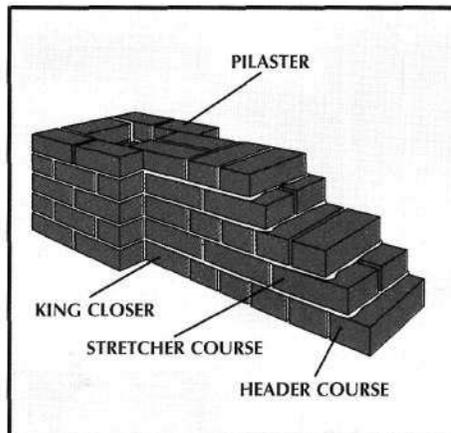
To plan the design, draw an outline of a full section of the wall on graph paper. Make the wall an odd number of courses high—the course that serves as a horizontal axis for the design must have an even number of courses above and below it. Find the squares that represent the center brick of the section. Fill in the pattern unit over this center brick, then fill in the rest of the section. You can now tell how many pattern units or parts of units will fit into the section and the wall, and how to begin laying the bricks.

LAYING MASONRY UNITS FOR STRENGTH



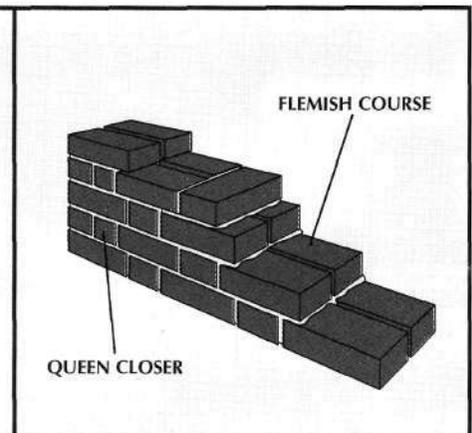
Reinforcing a brick wall

Block walls of stacked bond (above) need both horizontal and vertical reinforcement. The pilasters—thick columns built into the wall—bracing this wall are pairs of double-corner blocks knitted to the wall with continuous stretches of joint reinforcement laid after every second course. Steel rods run up through the cores of the blocks of each pilaster and at 4-foot intervals between pilasters; these cores are filled with grout—a mortar thinned with water for filling spaces.

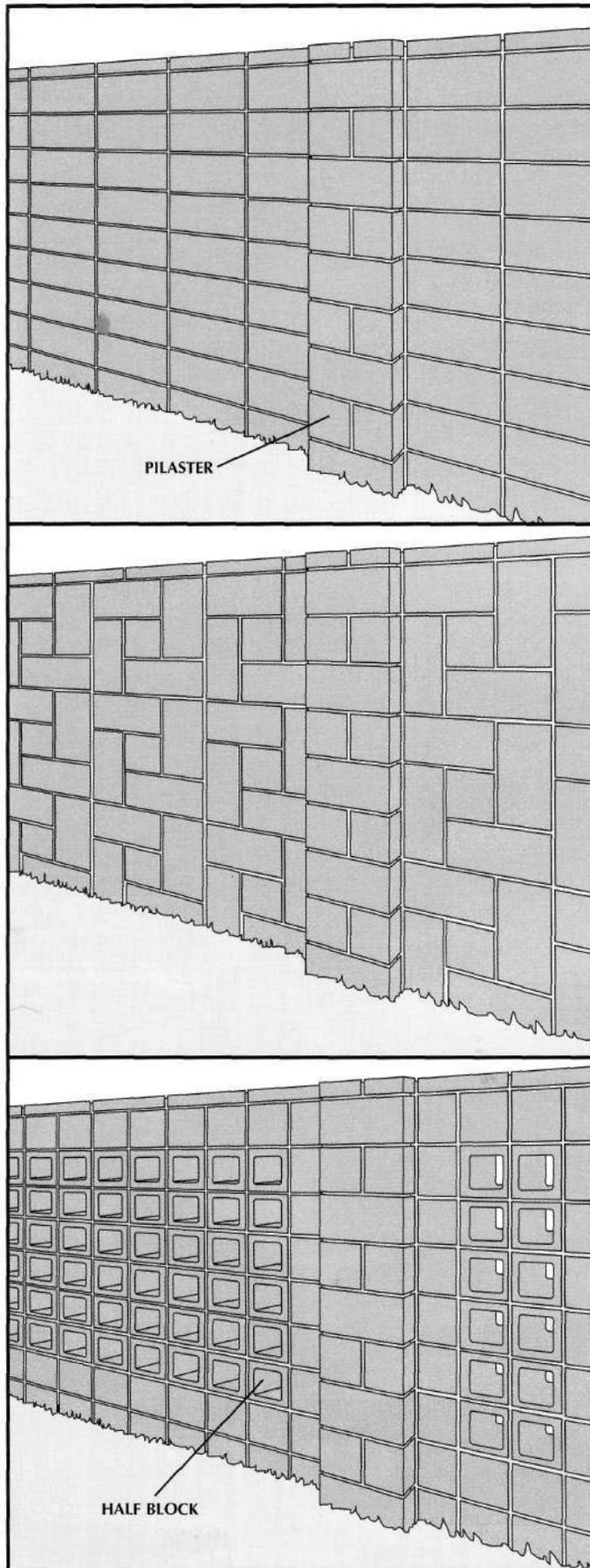


Strengthening a brick wall

Most traditional brick patterns are developed either from English bond (above, left), in which courses of headers and stretchers alternate, or from Flemish bond (above, right), which has alternating headers and stretchers in each course. Variations of these two bricklaying styles produce an enormous range of ornamental patterns, which can be heightened by using bricks of contrasting colors. In either pattern, alternate courses must begin and end with either a quarter brick, called a queen closer, or a three-quarter brick, called a king closer. The odd sizes can be made by setting bricks more or less halfway into a pilaster or by cutting bricks. If you cut queen closers, locate them near—but not at—the end of a course. To save time, cut all the closers before you start laying bricks. Both types of wall can be braced with pilasters every 8 to 10 feet (page 55).



ATTRACTIVE BLOCK WALLS



Decorative walls from blocks.

Standard masonry blocks can be arranged to form a number of attractive designs. Despite vertical joints that align, ordinary stretcher blocks in stacked bond (*left, top*) make a surprisingly good-looking wall. Odd sizes give you more complex patterns. A basket-weave pattern (*left, middle*) is made from units of four stretchers and a half block. Half blocks laid on their sides (*left, bottom*) can be arranged in a wide variety of patterns to form openings for light and air.

To allow for vertical reinforcement, the blocks in all these patterns must be laid out so the hollow cores align at least every 4 feet. Work this out on paper before pouring the footing (*page 51*). When you pour the footing, insert a 4-foot length of reinforcing bar into the concrete at 4-foot intervals. As you raise the wall, fit the blocks over the bar and fill the hollows with grout. For a wall taller than 4 feet, attach extra lengths of reinforcing bar with tie wire. Alternatively, add pilasters to your design every 8 to 10 feet. Install horizontal reinforcement after every second or third course.

HOW MANY BRICKS OR BLOCKS?

To determine the number of standard concrete blocks (8-by-16 inches) required for a wall, multiply the square footage of the wall by 1.125.

A typical brick wall (*page 57*) needs 14 bricks for every square foot of wall face and 90 more for a capped 6-foot pilaster. For a two-color wall, first diagram the pattern on graph paper. Make each course one square high; let two horizontal squares represent a header and four squares a stretcher. Draw enough courses (usually two or three) to show the bond pattern, count the total number of odd-colored bricks, and multiply the figure by the number of pattern repeats you will need for the wall. Double the number of odd-colored stretchers if the pattern must show on both sides of a wall two courses thick; add the odd-colored headers and subtract the total from the number of bricks needed for the wall. Buy 5 percent extra in both colors to allow for breakage.

A Brick Wall on a Block Foundation

A freestanding brick wall more than 4 feet high requires lateral support against wind and climbing children. The 8-inch-wide wall shown on the following pages is reinforced with square pilasters that measure 16 inches per side. The footings are 24 inches wide and 10 inches deep. However, specifications in your area depend on the local building code.

A Concrete Block Foundation:

Regardless of the type of wall you are planning aboveground, it is most economical to build from the top of the footing up to ground level with concrete block. Buy standard "stretcher" blocks measuring 8 by 8 by 16 inches. To avoid having to cut the stretchers, you will also need half blocks measuring 8 by 8 by 16 inches. Purchase flat-ended "double-corner" blocks and "partition" blocks measuring 4 by 8 by 16 inches for the pilasters as well. A

few inches below ground level, lay the masonry units for the wall itself.

Spacing Pilasters: For ease in positioning pilasters 8 to 10 feet apart, make the length of the wall and the distance between pilasters divisible by 8 inches. Fill the cores of the blocks in the pilasters with grout. For added strength, run two lengths of reinforcing bar down through the cores of the foundation blocks in each pilaster before filling them. No. 4 to No. 8 reinforcing bar is usually required, depending on the local code. Keep in mind that a pilaster is useful as a wall support only if it is perfectly plumb.

Cutting Bricks: With a mason's chisel and a hammer, score a line on the brick at the point where you want it to break. Turn it over and tap the other side a few times. The brick should split on the second or third blow.



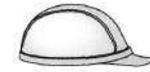
TOOLS

Tape measure
Chalk line
Straightedge
4' level
Torpedo level
Shovel
Mortar hoe
Mason's trowel
Mason's blocks
and line
Line pins



MATERIALS

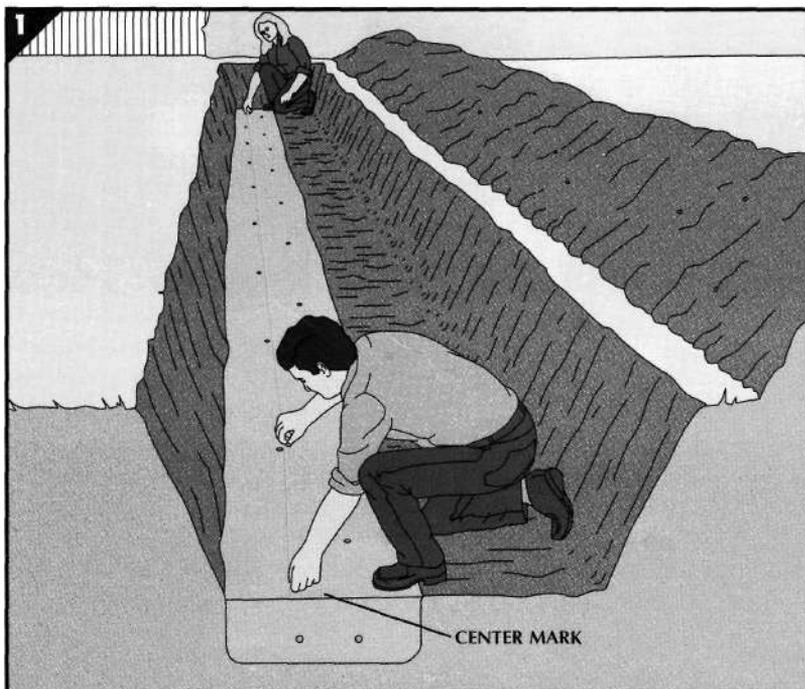
1 -by board for story pole
Mortar ingredients (Portland cement, lime, masonry sand)
Premixed grout
Concrete blocks
Bricks
Truss-type horizontal joint reinforcement



SAFETY TIPS

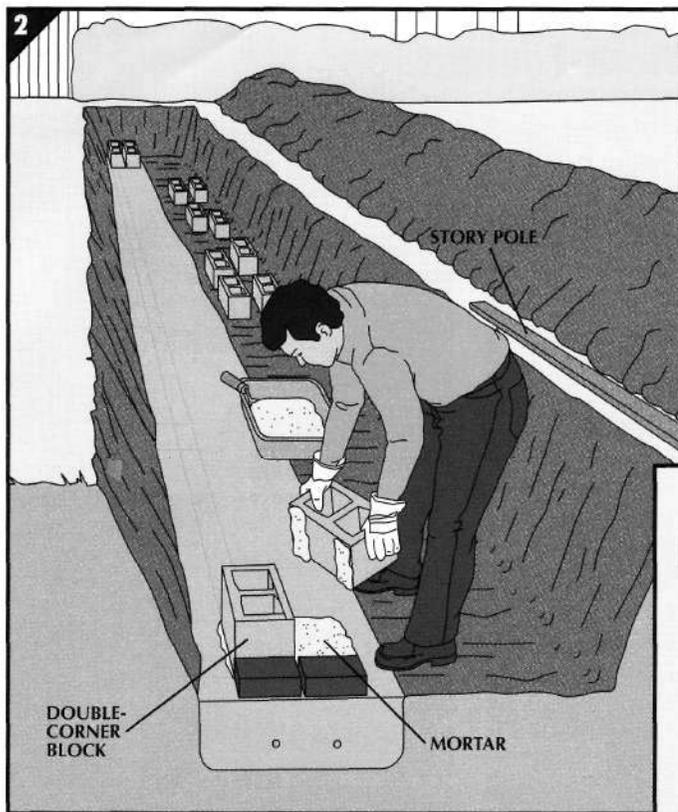
Always wear safety goggles when mixing mortar, and long sleeves and gloves when working with mortar and concrete. Wear gloves and safety goggles when cutting bricks.

BUILDING A BLOCK FOUNDATION



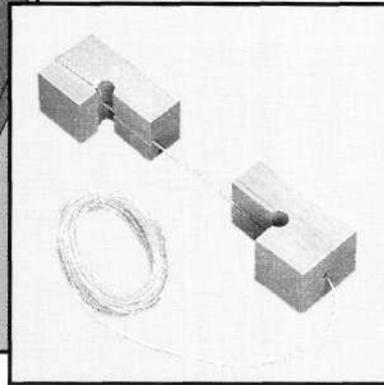
1. Aligning tie blocks.

- Snap a chalk line 4 inches from the center of the footing to mark the edge of the bottom course of blocks (*left*); snap a second line 4 inches outside the first for the edge of the pilasters.
- Lay a dry run of blocks for the first course, aligning them with the first chalk line. Lay a pair of blocks at the appropriate interval for each pilaster, as shown in Step 3. Leave a 3/8- to 1/2-inch gap between the blocks to allow for mortar joints.
- If necessary, adjust the thickness of the joints to bring the course to the correct length.
- Mark the location of each pilaster on the footing with chalk.



2. Starting the first course.

- Prepare a batch of mortar. As you build the wall, spread just enough mortar for one or two blocks at a time with a mason's trowel.
- Lay two double-corner blocks side by side in a full mortar bed at one of the end pilaster marks. To gauge how much space to leave between the blocks, set two bricks end to end across the footing, aligning the end of one brick with the second chalk line and leaving $\frac{3}{8}$ inch between the bricks. Lay the blocks so that their outside edges are even with the ends of the bricks (*left*), leaving about 1 inch between the blocks.
- Plumb and level the blocks with a 4-foot level. With a story pole made by marking the desired height of the blocks and the thickness of the mortar bed on a stick, check the block height. Make adjustments if necessary.
- Lay two more double-corner blocks for the other end pilaster, run a mason's line (*photograph*) between the two ends, and lay the other pilaster blocks in position. Fill the cores of the blocks with grout.



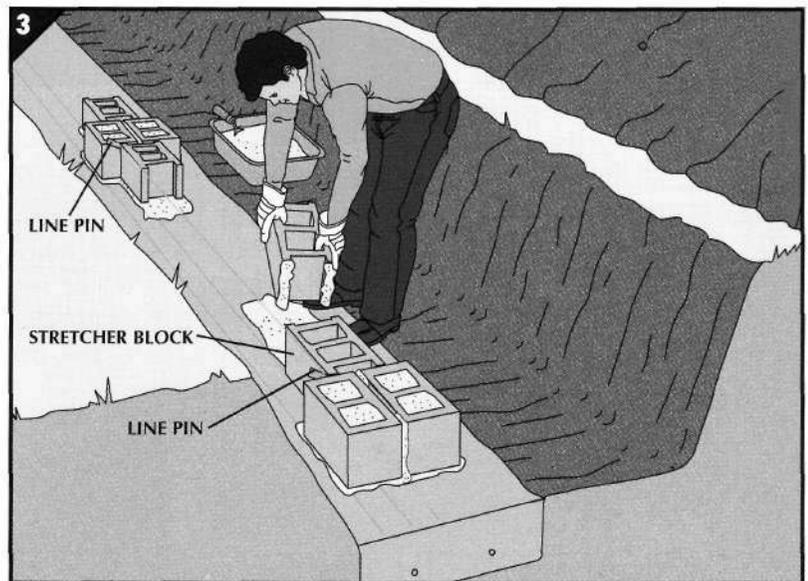
PREPARING MORTAR

Mortar holds masonry walls together, sealing out the elements and compensating for variations in the size of the materials. Pre-mixed bags of mortar are useful for small projects, but uneconomical for larger projects like the wall featured here.

Mortar is a mix of Portland cement, lime, sand, and water. The exact formula will vary with local conditions, particularly climate. Check with the code requirements in your area or consult local brick suppliers, masons, or contractors.

To prepare a batch of mortar, combine the dry ingredients in a wheelbarrow with a mortar hoe. Blend in the water—adding just the right amount to obtain a workable mix. To check its consistency, raise a series of ridges in the mortar with a shovel or hoe, if the ridges crumble, the mix is too dry. If they slump, there is too much water.

You can keep a batch of mortar workable for up to two hours by sprinkling water on it as needed and remixing. After two hours, prepare a new batch.

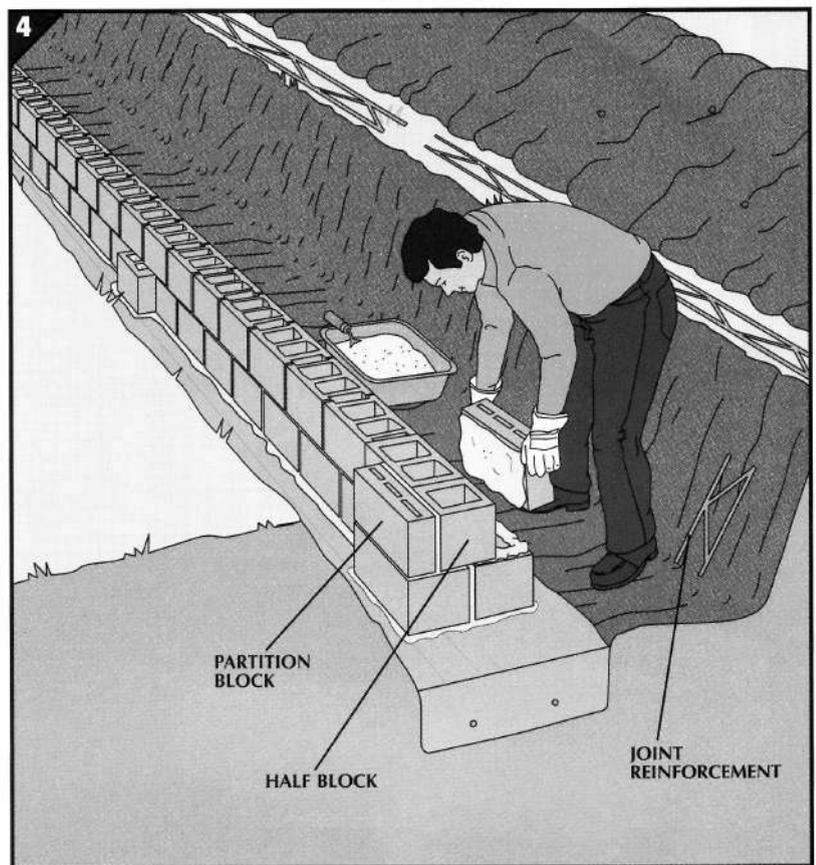


3. Completing the first course.

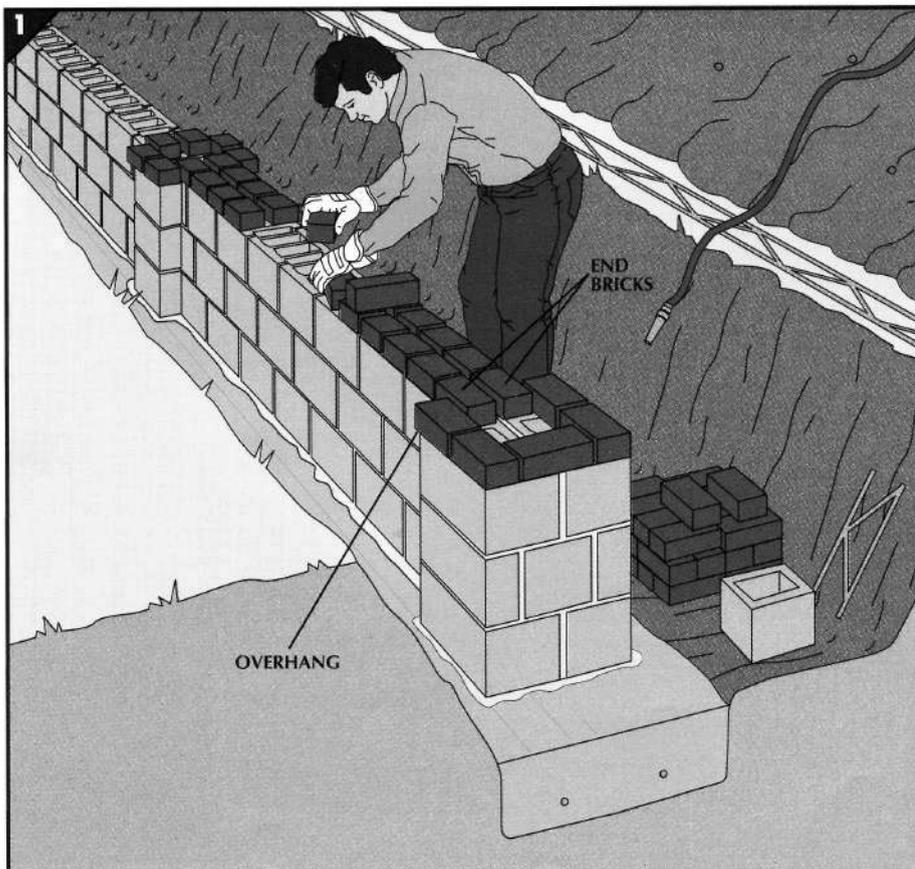
- Lay a stretcher block on the footing against each end pilaster and on both sides of the other pilasters. Center the blocks on the joint between the two pilaster blocks and align them with the inside chalk line.
- Once the mortar has begun to set, place a line pin in each joint between the pilasters and the stretcher blocks. Available at masonry suppliers, the pins will anchor a mason's line to align the remaining stretcher blocks along the footing.
- Continue laying stretcher blocks (*above*), completing the first course. Remove the line pins and plug the holes they leave with mortar.

4. Completing the foundation.

- Begin the second course with a half block at each end, centering the blocks over the joints between the pilaster blocks. Check the height of the block with your story pole.
- Lay a corner block inside each half block, run a mason's line from one end of the wall to the other, and fill in between them with stretcher blocks.
- Lay partition blocks at each pilaster, sandwiching the newly laid second-course blocks (*right*). The partition blocks must be flush with the double-corner blocks beneath them.
- Lay the third course as you did the first, but at each pilaster, embed a 15-inch length of truss-type joint reinforcement in the mortar across the wall before laying the blocks.
- Once the mortar has set, fill the openings in the blocks at each pilaster with grout so that there is a continuous column of grout from the footing up to a few inches from the top of the third course.
- Continuing in this manner, build the foundation to within a few inches of ground level. Check the first block you set in each new course with the story pole.

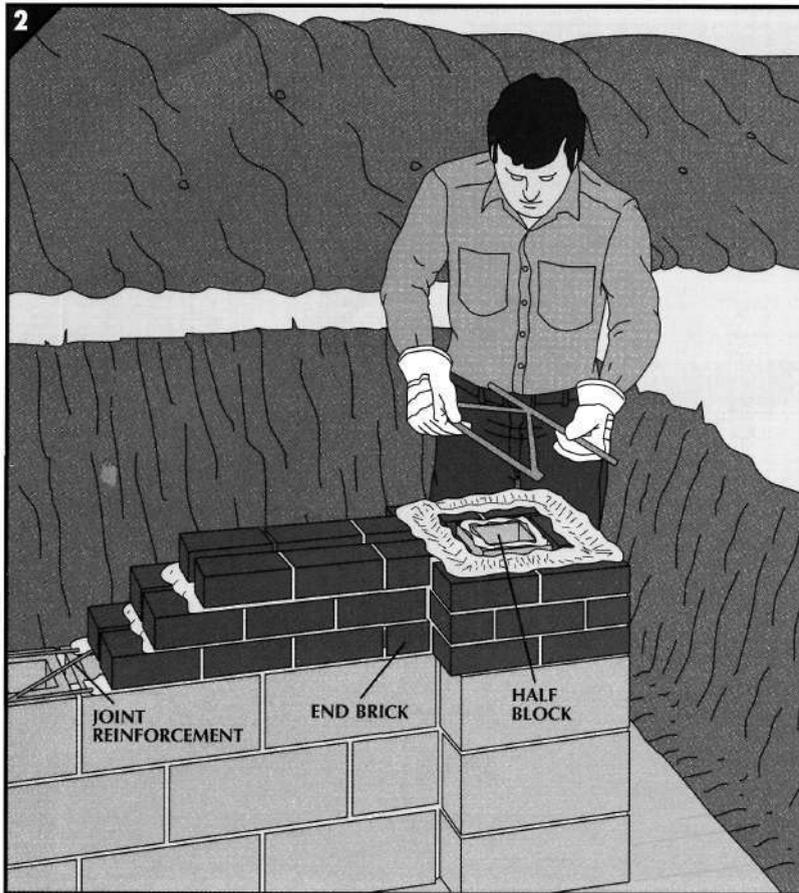


ERECTING A BRICK WALL



1. Making a dry run.

- Lay a dry run of the first course of bricks from pilaster to pilaster to check and adjust their placement.
- Lay the bricks in the pattern shown at left, starting with two end bricks set halfway into the core of each pilaster. Leave a gap of about 1/2 inch between the bricks.
 - Lay bricks around the perimeter of each pilaster, ensuring they are flush with the outside edges of the pilasters. If the bricks project beyond the blocks, set them so the overhang is ail on one side.
 - Lay the remaining bricks of the run in pairs so their combined width equals the length of a brick (*left*). Again, locate any overhang on one side of the foundation.
 - Mark the location of the end bricks on the pilasters, note the gap between bricks, and remove the dry run.

2

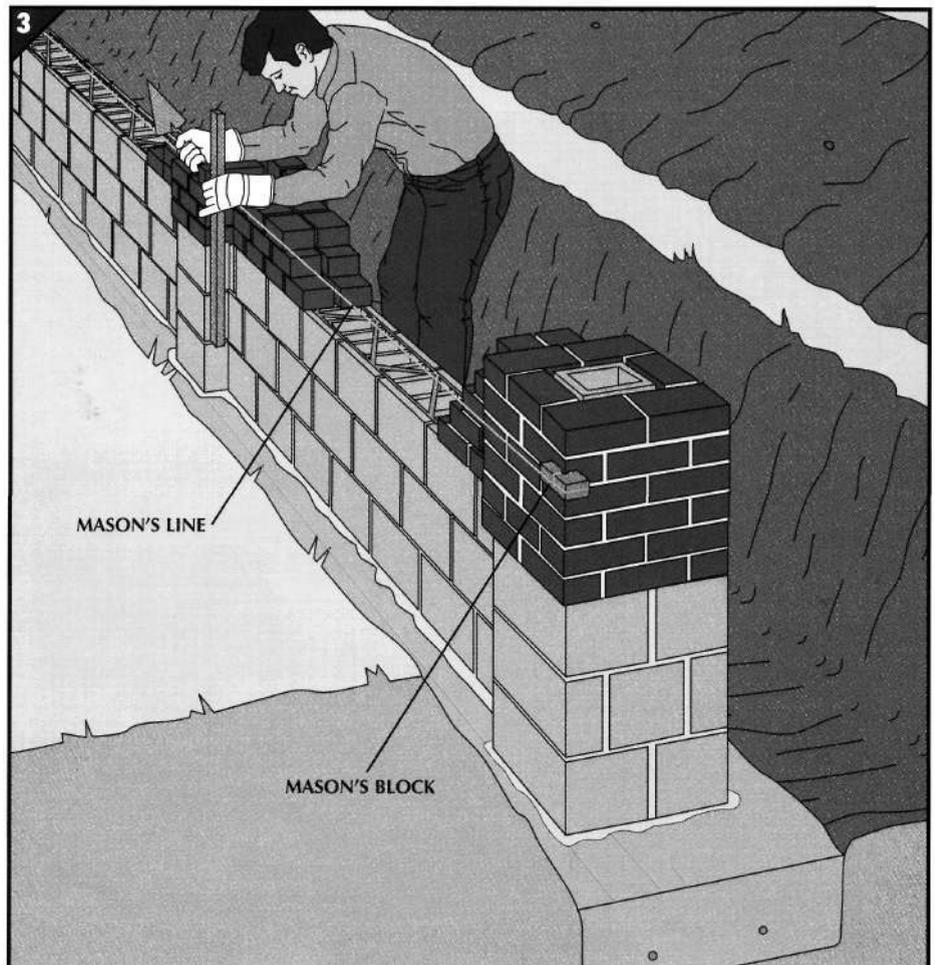
2. Laying the leads.

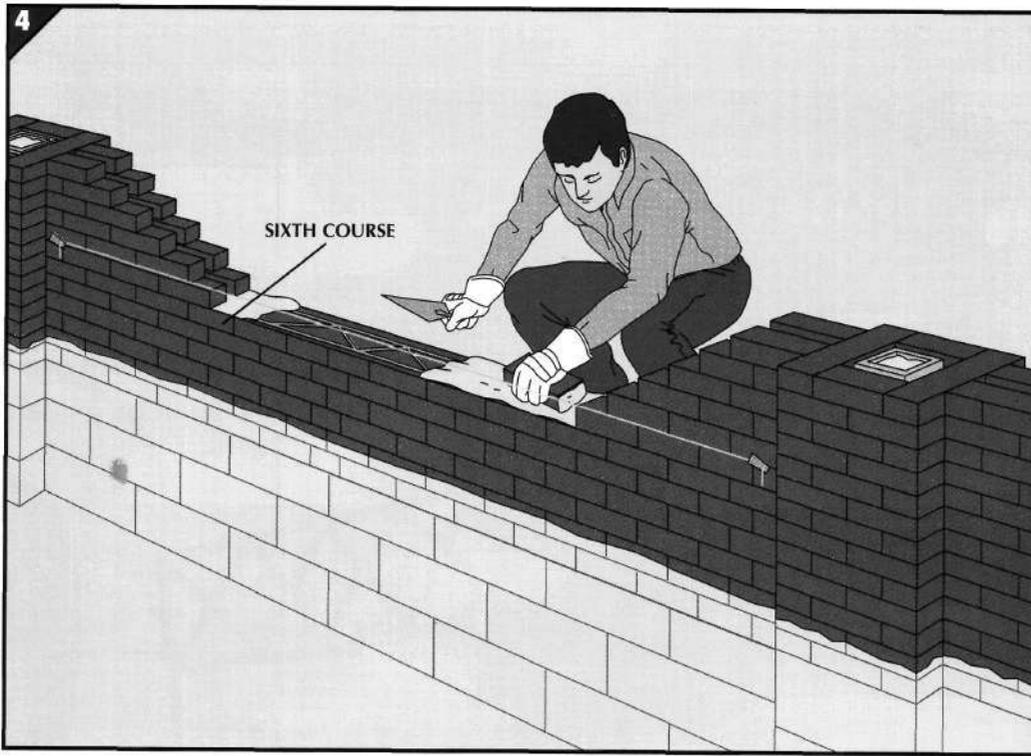
Start the wall by building a lead—or end structure—six courses high at each end of the wall.

- Spread mortar on the tops of the end pilaster blocks and along 21/2 feet of the adjoining blocks. Set a 10-foot length of joint reinforcement 1 inch in from the end of the lead.
- Following your dry-run pattern, lay a row of bricks around the rim of the pilaster. Lay the end bricks, aligning them with the marks on the pilaster, and add three more pairs of bricks along the wall. Level and plumb each brick with a torpedo level.
- Set a half block in the middle of the pilaster.
- Begin the second course, altering the pattern so each brick is centered over a vertical joint of the course below. Stop the second course a half-brick's length from the end of the first.
- Start the third course, aligning the bricks with those in the first course, but make this row a full brick shorter.
- Set a 15-inch length of joint reinforcement across the pilaster (*left*), then begin three more courses of bricks, staggering the vertical joints between successive courses.

3. Building up the pilasters.

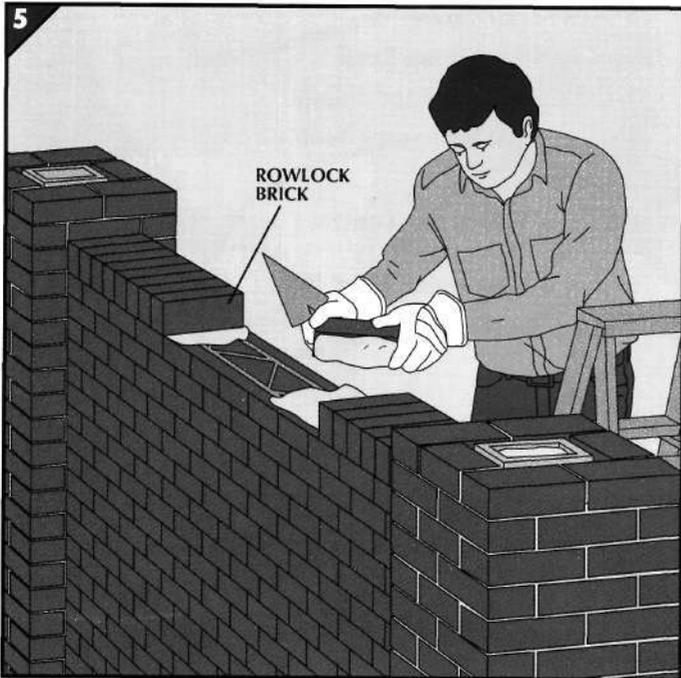
- Lay 10-foot lengths of joint reinforcement along the top of the block foundation, overlapping their ends 12 to 15 inches.
- At each pilaster between the ends, build six-course double leads—ones that step up from the wall on both sides as described above. To help maintain horizontal alignment, stretch a mason's line between the end pilasters. For vertical alignment, butt a straightedge against the bricks and foundation wall (*right*), tapping the bricks flush, as necessary.
- Fill the cores of the pilaster blocks with grout.
- Complete the courses between the pilasters, running a mason's line from line pins stuck in the vertical mortar joints next to the pilasters.
- Fill in the soil you dug out for the footing trench and compact it well with a tamper (*page 24*).





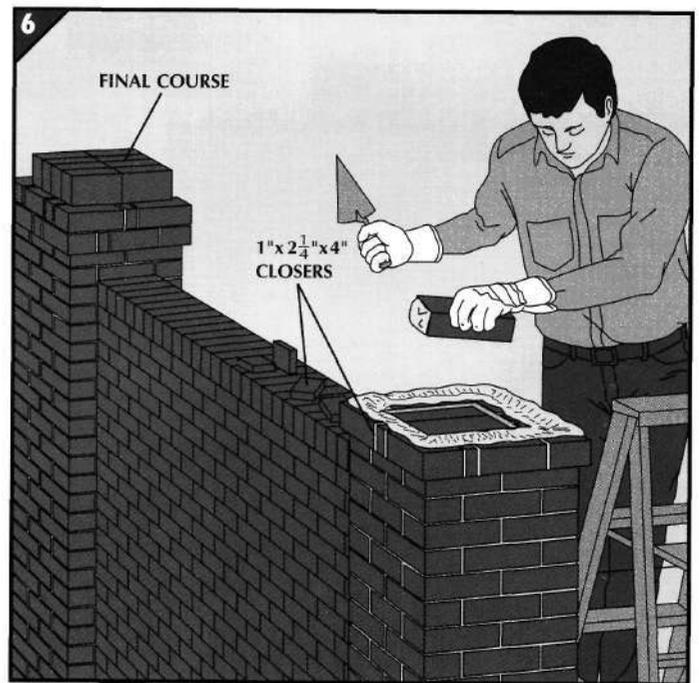
4. Extending the wall upward.

- Once you have completed six courses of bricks, lay joint reinforcement along the wall. Then, build six-course leads at each pilaster as in Steps 2 and 3.
- Grout the lead cores, fill in the courses between the pilasters, and repeat the process, adding joint reinforcement after every sixth course. If you laid one or two courses of brick below grade, four six-course leads will take the wall to 5 feet; an additional three courses plus a cap (Steps 5 and 6) will take it to 6 feet.



5. Capping the wall.

- Once the wall is 4 inches short of the desired height, lay joint reinforcement along the top, build the pilasters up three more courses, and fill in their cores.
- Start with a dry run of rowlocks (bricks laid on edge) along the wall between the pilasters to determine the required thickness of the remaining mortar joints.
- Lay the rowlocks in a mortar bed (*above*).



6. Capping the pilasters.

- For each pilaster, cut eight 1-inch-thick pieces of brick, called closers. These serve to widen the two courses that cap the pilasters. Cut the bricks as described on page 55.
- Lay the first course of the cap around the rim of the pilaster with full-sized bricks; follow the basic pattern, but ensure the bricks overhang the rim by 1 inch all around. Fit closers in the gaps between the bricks.
- Set two bricks in the middle of the pilaster and fill the gaps with mortar.
- Alternating the pattern, lay the second cap course flush with the first (*above*). Set two more bricks in the center.
- For the final course, center eight bricks across the pilaster.

Post-and-Beam: A Classic Method Revived

Post-and-beam structures are an elegant complement to outdoor living. Built with pressure-treated wood and left without sheathing, the post-and-beam framework can be used as an arbor or a trellis; roofed and sheathed with openwork materials (page 83), it becomes a garden shelter. With weatherproof siding and roofing, the structure can be a workshop, shed, or studio.

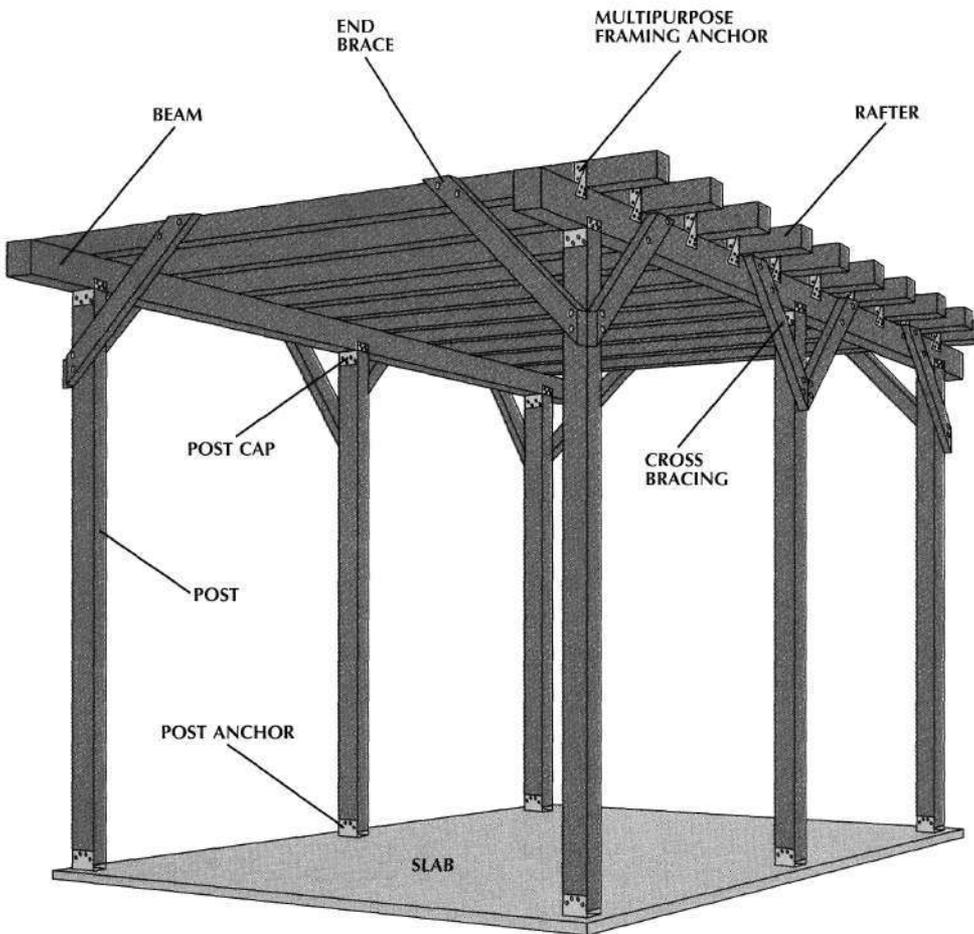
Foundations: For an open-roofed structure, a simple concrete slab or set of precast concrete piers is adequate foundation (pages 63-64). A closed-roofed structure, particularly one that must bear the weight of snow, requires a turned-down slab (pages 105-111) or concrete piers

with footings set below the frost line. The latter is similar to the footings for the brick wall except the blocks are built at each post location rather than along the whole outline.

The Posts and Beams: The size of the posts for an unroofed structure is determined by the building's width. Long, narrow structures are easier to build; if the width is less than 8 feet, 4-by-4 redwood or pressure-treated posts suffice. If the structure is wider than 8 feet but less than 12 feet, use 4-by-6 posts. Determining the size of posts for a roofed post-and-beam structure requires more precise calculations and varies from area to area. Consult your local building code.

The size of the beams is determined by the span between posts. The width in inches of a 4-inch beam should equal its span in feet. Thus, a 4-by-6 beam can span distances up to 6 feet, a 4-by-8 up to 8 feet, and so on.

Choosing Rafters: Rafters to bridge the beams can be spaced as far apart as 48 inches in an unroofed structure; use the table below to determine the spacing and lengths of rafters for an open roof. If you plan to roof the structure, the rafters should be set no more than 16 inches apart. Use 2-by-4s for a structure up to 5 feet wide, 2-by-6s for up to 9 feet, 2-by-8s for up to 11 feet and 2-by-10s for up to 14 feet.



Spacing	Maximum Rafter Length		
	8 ft.	10 ft.	12 ft.
16 in.	2x4	2x6	2x6
32 in.	2x6	2x8	2x8
48 in.	2x6	2x8	2x8

Anatomy of a post-and-beam structure.

Metal connectors hold together the basic post-and-beam framework. The posts are attached to post anchors fastened to a concrete slab (left) or to precast concrete piers (page 64), typically available with a post anchor already embedded. At the tops of the posts, metal post caps secure the beams. Rafters are attached to beams with metal framing anchors. The beam ends overhang the posts below them, and the rafters overhang the beams. Diagonal 2-by-4 cross braces are attached to posts and beams and the end rafters with lag screws.

**TOOLS**

- Hammer
- Maul
- Tape measure
- Wrench
- Carpenter's level
- Circular saw
- Electric drill
- Chalk line
- 1" masonry bit

**MATERIALS**

- 4-by posts
- 4-by beams
- 2-by rafters
- 2x4 braces
- Wooden stakes
- Common nails (2 1/2")

- Lag screws (3/8 "x3"; 1/2"x31/2") and washers
- Post anchors and post caps
- Framing anchors
- Framing-anchor nails (1 1/2', 2 1/2', 3 1/2')
- Lead shield

**SAFETY TIPS**

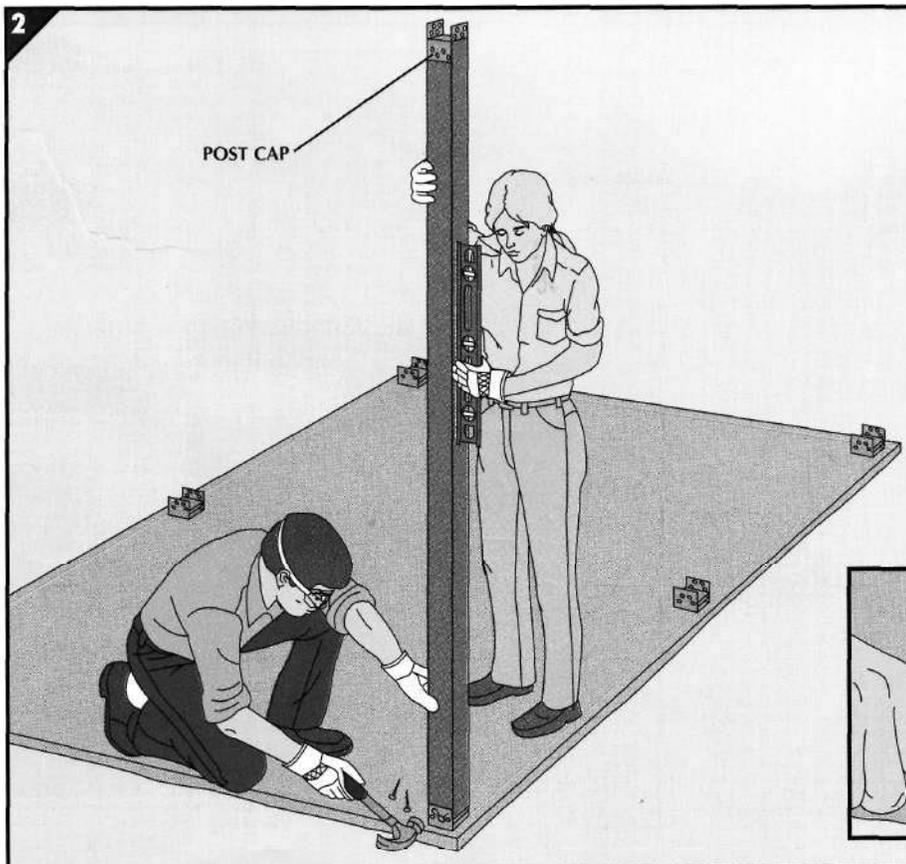
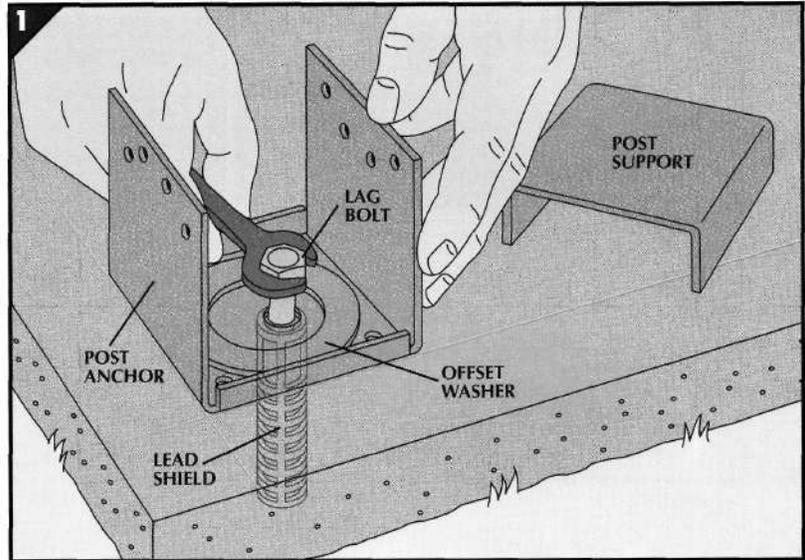
Wear goggles when hammering and drilling, and hard hat when working with materials overhead. Put on gloves when handling pressure-treated lumber; add a dust mask when cutting it.

ERECTING POSTS

1. Setting the post anchors.

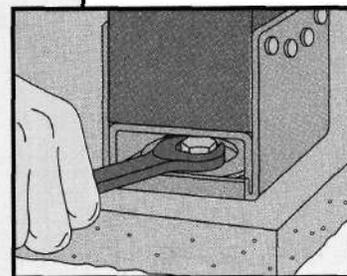
The U-shaped anchors are bolted to the concrete slab with an offset washer that permits post positions to be shifted slightly for alignment.

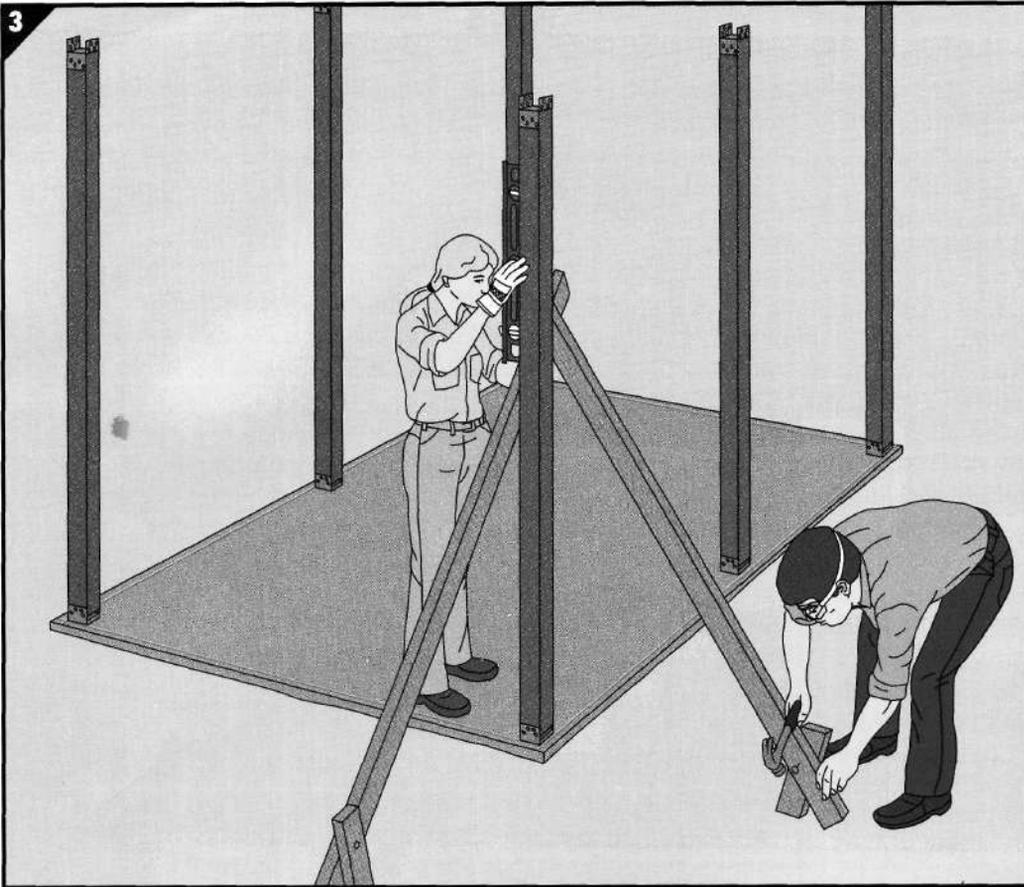
- Snap chalk lines 2 inches in from each side of the slab.
- Place anchors and washers at each post position and mark the location for the lead shield.
- Drill a 3/4-inch hole 4 inches deep at each mark with a masonry bit. Drop a 3/4-inch lead shield into the hole.
- Place the post anchor and washer over the hole, then tighten a 1/2-inch lag screw into the shield until it is snug but the anchor can still be shifted.
- Set a post support inside each anchor.



2. Raising the posts.

- Install post caps on the top end of the posts with 3 1/2-inch framing-anchor nails. Place a post onto the post anchor.
- Have a helper hold the post plumb, checking with a carpenter's level on two adjacent sides.
- Secure the bottom of the post to the anchor (left).
- Align the outside post edges with the building lines and tighten the lag screw (inset). Repeat for all the other posts.





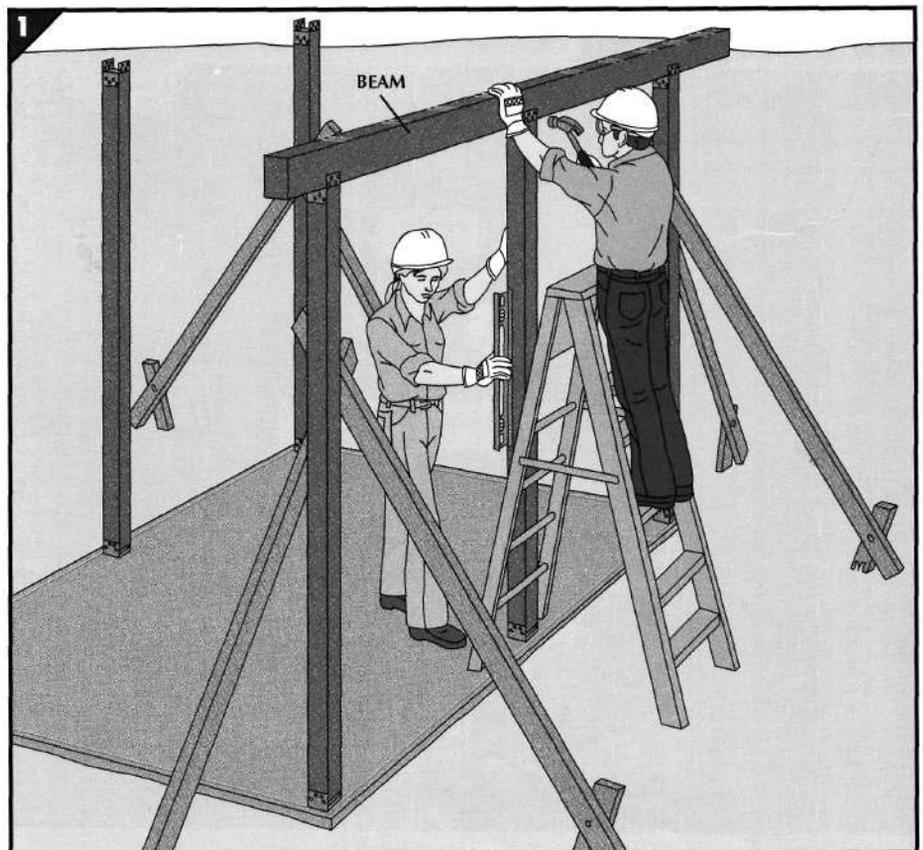
3. Plumbing and bracing the corners.

- While a helper holds the corner post plumb—checking with a level—brace the post with 2-by-4s nailed to stakes and to the post at least 20 inches from the top.
- Repeat for each corner.

RAISING BEAMS

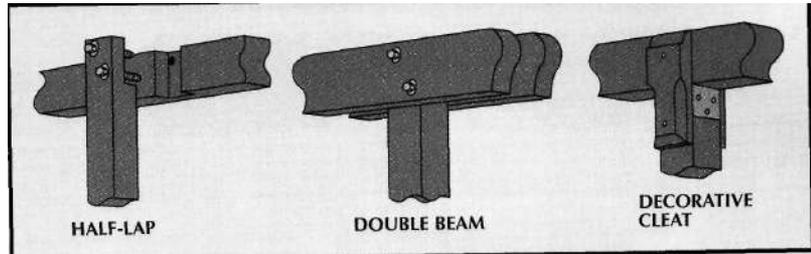
1. Attaching the beams.

- Mark the tops of the beams for rafters, spacing them as desired; refer to the table on page 68 for maximum spacings and spans. Make the first mark to position the outside edge of an end rafter flush with the outside edge of a corner post.
- Set each beam in the post caps atop a row of posts, marked-side up, aligning the outermost marks with the outside edges of the corner posts.
- Have a helper hold the beam steady while you nail the corner post-cap flanges to the beam with 3 1/2-inch nails designed for connectors.
- Plumb the intermediate posts with a level, then nail them to the post-cap flanges (*right*).



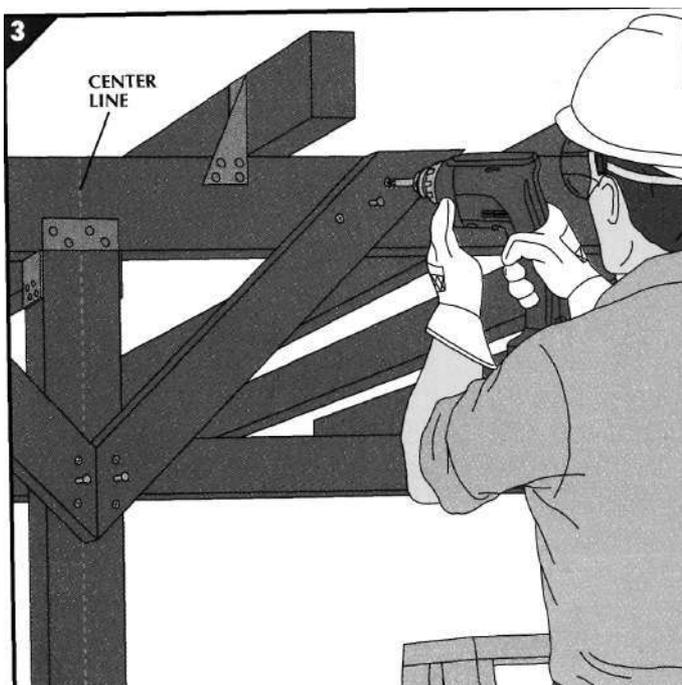
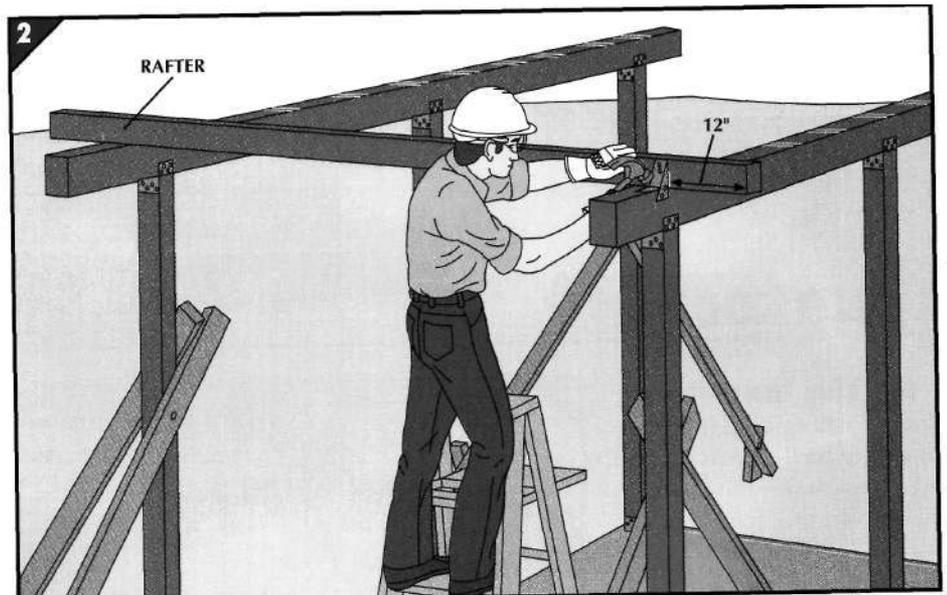
Galvanized metal connectors are a strong, utilitarian, and relatively foolproof way to hold the beams to the posts. But there are more attractive solutions, including the three shown at right. The half-lap is the strongest joint, especially with the addition of

lag screws. The double beam works by bolting two beams to both sides of the post. The decorative cleat partially conceals a metal post cap connector.



2. Putting up rafters.

- Measure and cut the rafters following the table on page 68, adding 24 inches to the total length to give a 12-inch overhang on each side.
- Nail a framing anchor to the top of one beam on one side of an end-rafter mark with 25-inch connector nails.
- Nail another anchor on the top of the opposite beam, on one side of the mark.
- Make a mark on the side of a rafter 12 inches in from each end, set the rafter against the anchors, and nail it in place with 11/2-inch nails (*right*).
- Attach the remaining rafters the same way.



3. Mounting the braces.

The 2-by-4 braces can be cut ahead of time. For most applications cut them at a 45-degree angle at each end and 26 inches in length along their longest edge.

- Tack the braces in position so one end is flush with the top of the beam and the other is aligned with the center line of the post. (For the end post align the lower end of the brace with the outside edge of the post.)
- Drill a 1/4-inch-diameter pilot hole through the brace and into the beam or post (*left*).
- Secure the braces with 3/8-by-3-inch lag screws and washers, driving the screws in with a socket wrench.
- Attach the end braces similarly, but position the higher end flush with the top of the rafter, as shown on page 68. This will mean cutting longer pieces than the standard cross braces.
- Remove the temporary nails and bracing.

Erecting Sloping Roofs

- or small-scale post-and-beam structures, roof rafters can be measured and marked in position. Lumber sizes given in this section are guidelines; consult the building code in your area for possible variations. For an open roof like the ones shown on page 85, buy pressure-treated wood for all the parts.

A Shed Roof: This type of roof is defined as one that slopes because one side of the structure is built higher than the other. To calculate how much higher, start with the desired roof pitch, which in the example below is 1-in-12 (or 1 inch

of rise for every foot of roof width). In this method, the 2-by-6 rafters butt against the crossbeam on the high side, but one-half their width ($2\frac{5}{8}$ inches) fits into notches cut in the lower crossbeam. You will need to add this amount to the high side, or subtract it from the low side, when building the sides.

A Gable Roof: In this type of roof, the rafters rest on beams and meet at a 1-by-8 ridge beam, which forms the peak of the roof. This type of roof is easier to lay out than the shed because the sides are built at the same height. A simple marking

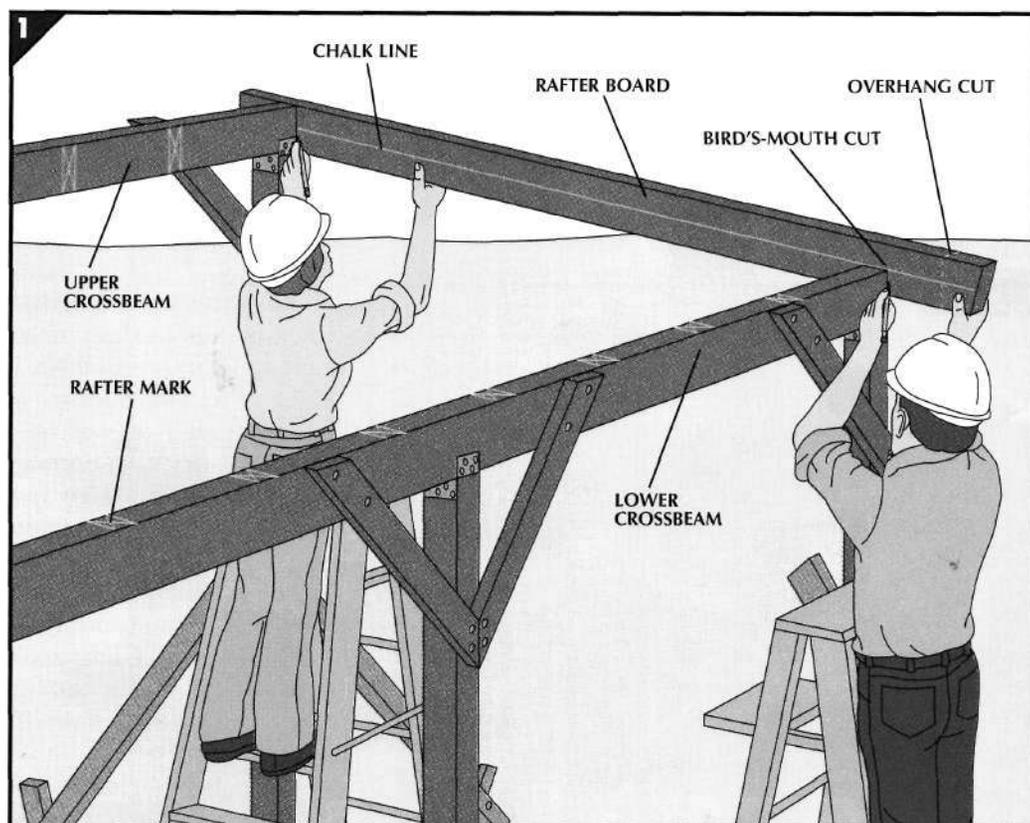
guide (page 74) will enable you to mark the rafters accurately with no calculation or guesswork.

Bracing with Collar Ties: Both types of roof suffer an inherent weakness. Since the rafters meet the beams at an angle, their weight and the loads they bear tend to push the sides outward. This can be overcome with collar ties. Brace a shed roof by attaching 2-by-6 collar ties to each pair of end posts, as shown on page 85, with $\frac{3}{8}$ by-31/2-inch lag screws. For gable roofs, which are more prone to spreading, join every third pair of rafters with a collar tie (page 75).

A SHED ROOF

1. Marking the rafters.

- Make rafter marks 16 inches on center on the crossbeams.
- Snap a chalk line down the middle of a rafter board. With a helper, align the board so its top is flush with the top of the upper crossbeam and the chalk line touches the top edge of the lower crossbeam.
- Tack the rafter to the upper crossbeam, and outline the edges of the lower crossbeam for a bird's-mouth cut, a notch that fits the rafter snugly to the crossbeam.
- Mark the rafter along the inner face of the upper crossbeam for the ridge cut, the cut that fits the rafter to the upper crossbeam.
- With a level, mark a vertical overhang cut on the end of the rafter.



T TOOLS

Tape measure
Carpenter's level
Chalk line
1x2, 1x8, 2x6
for marking guide

Hammer
Hand saw or
saber saw
Circular saw
Electric drill

M MATERIALS

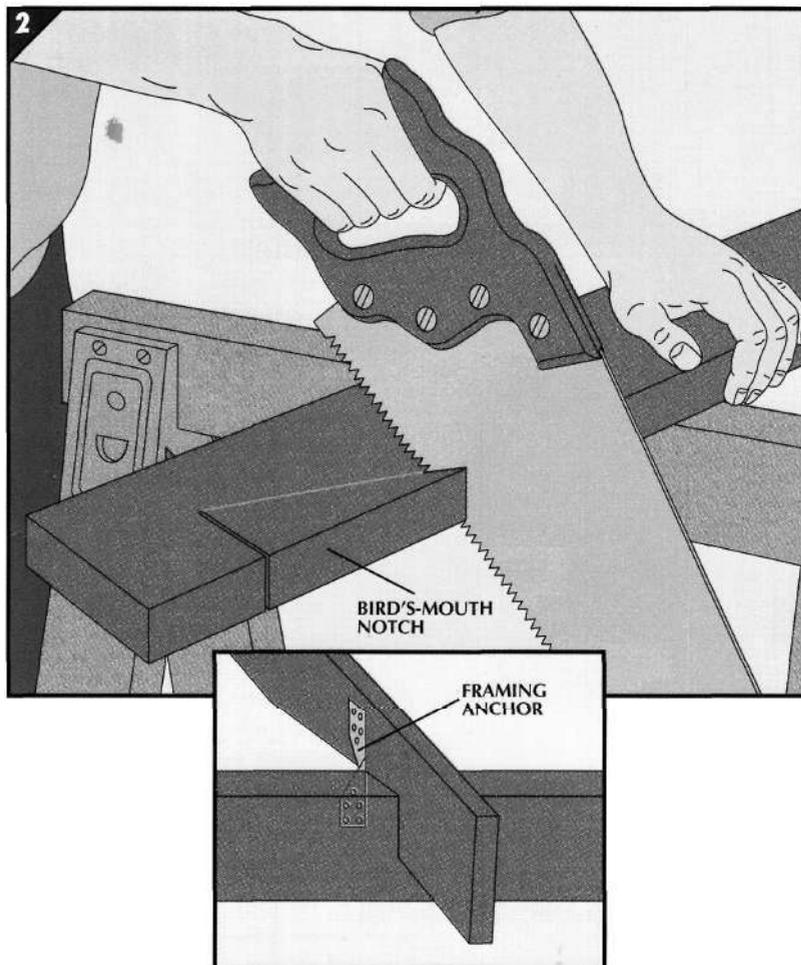
1x2s, 1x4s
1 x8 ridge beam
2x6 rafters and
collar ties

Galvanized common
nails (3", 31/2")
Lag screws (3/8"x31/2")
Multipurpose framing
anchors and nails
(11/2, 21/2)



SAFETY TIPS

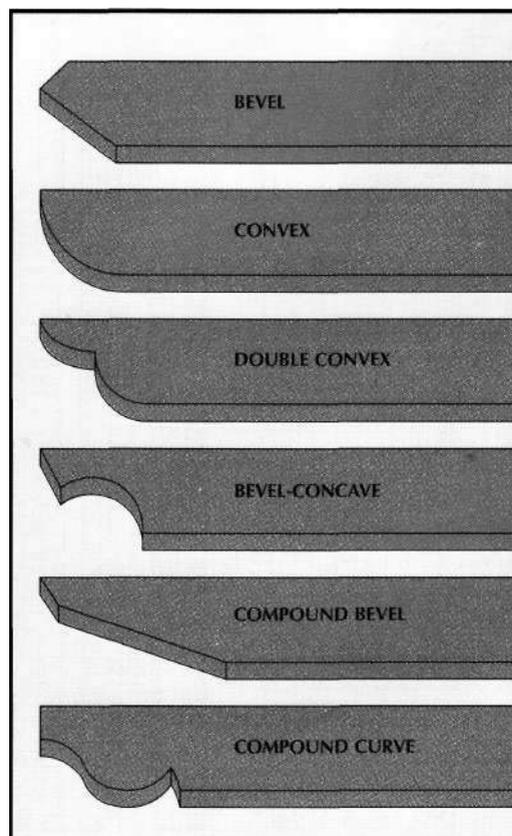
Wear goggles when nailing and a hard hat when handling materials overhead. Put on gloves when handling pressure-treated wood; add a dust mask when cutting it.



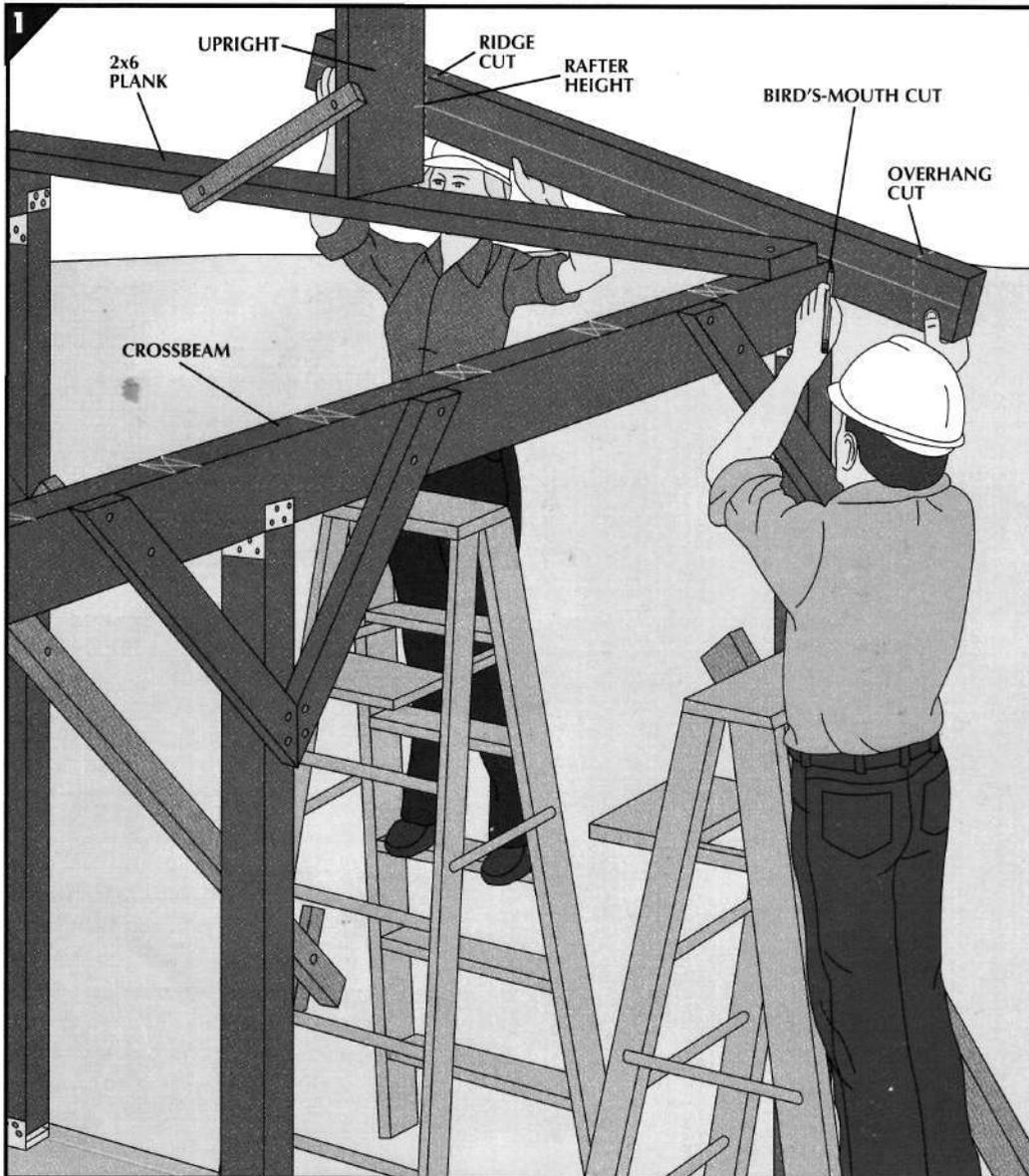
2. Cutting and installing the rafters.

- Support the rafter on a pair of saw horses and cut along the marked lines with a hand saw (*left*) or a saber saw.
- Mark out the remaining rafters, using the cut rafter as a template.
- To raise the rafters, toenail them with 31/2-inch galvanized common nails to the upper and lower crossbeam at the marked spots.
- For additional support, secure each rafter to the lower beam with a multipurpose framing anchor (*inset*) with the nails recommended by the manufacturer.

These six patterns are common choices for adding a decorative touch to the plain ends of open-structure rafters. Enlarge the pattern you plan to use on graph paper and transfer it to a rafter. Cut out the patterns with a saber saw, then smooth the shape with medium-grit sandpaper. Another approach is to make a template of the pattern on 1/2 plywood. You can then cut the rafter ends using the pattern-routing method shown on page .57.



A GABLE ROOF

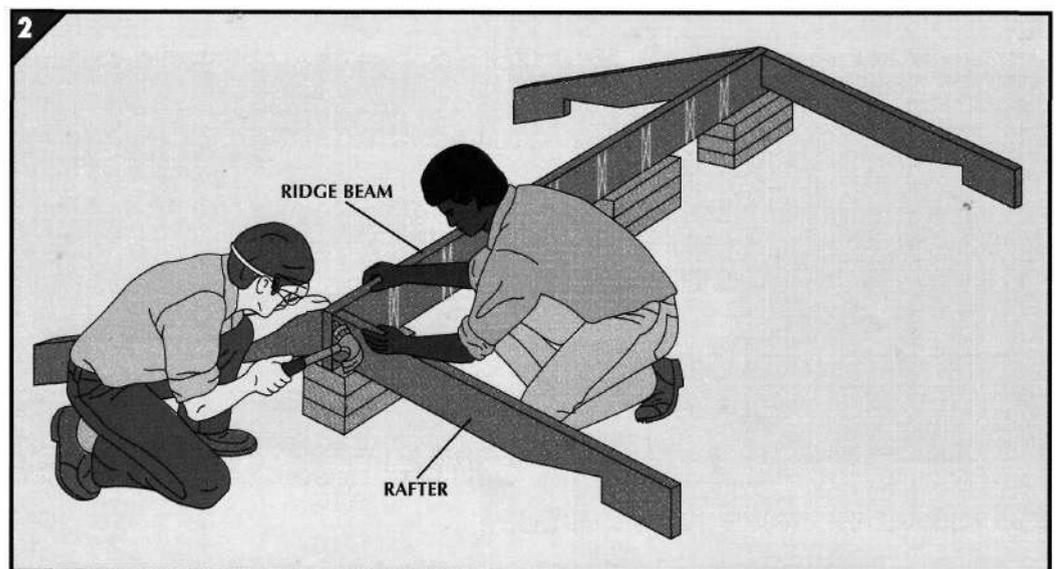


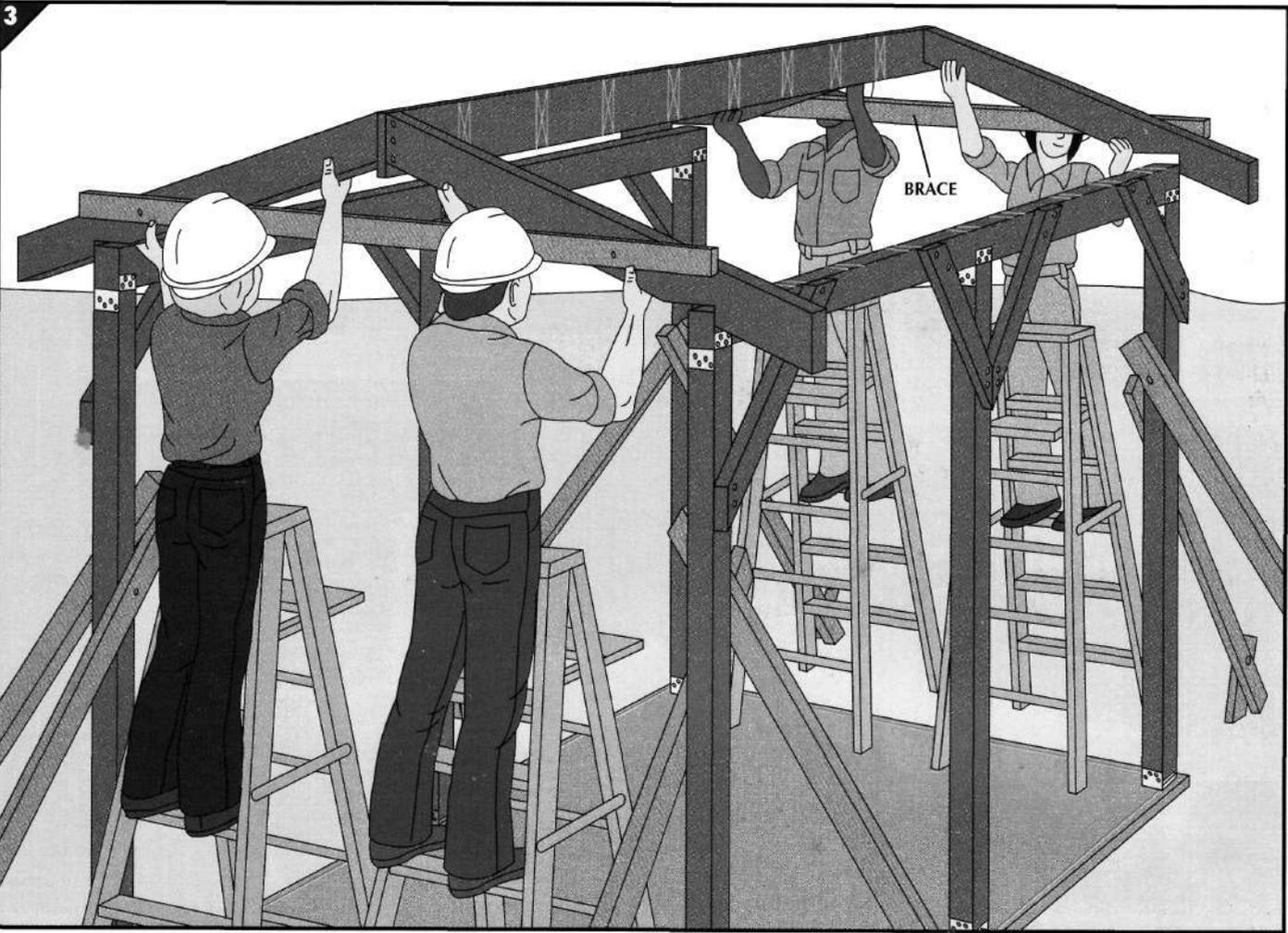
1. Marking rafters for a gable roof.

- Construct a marking guide by attaching a 1-by-8 upright to the center of a 2-by-6 plank long enough to span the structure. Secure the upright at 90 degrees to the plank with a 1-by-2 brace. Mark the desired height of the peak on the upright.
- Set the marking guide on the crossbeams, 11/2 inches in from the edge, with the upright centered between the sides. Tack the guide in place.
- Check that the upright is plumb and adjust the brace as needed.
- Snap a chalk line at the center of a rafter board and position the board against the guide as shown (*left*).
- Mark the bird's-mouth cut, the ridge cut, and, with a level, the overhang cut (*page 72*). Remove the marking guide.
- Cut the bird's-mouth (*page 73*), ridge, and overhang, then mark and cut the other rafters using the first one as a template.

2. Assembling the frame.

- Cut a 1-by-8 ridge beam to the same length as the crossbeams and mark it for rafters every 16 inches.
- On one side of the beam, fasten a rafter to each end, nailing through the beam into the end of the rafter with three 3-inch galvanized common nails.
- Toenail rafters to the opposite side of the beam (*right*).





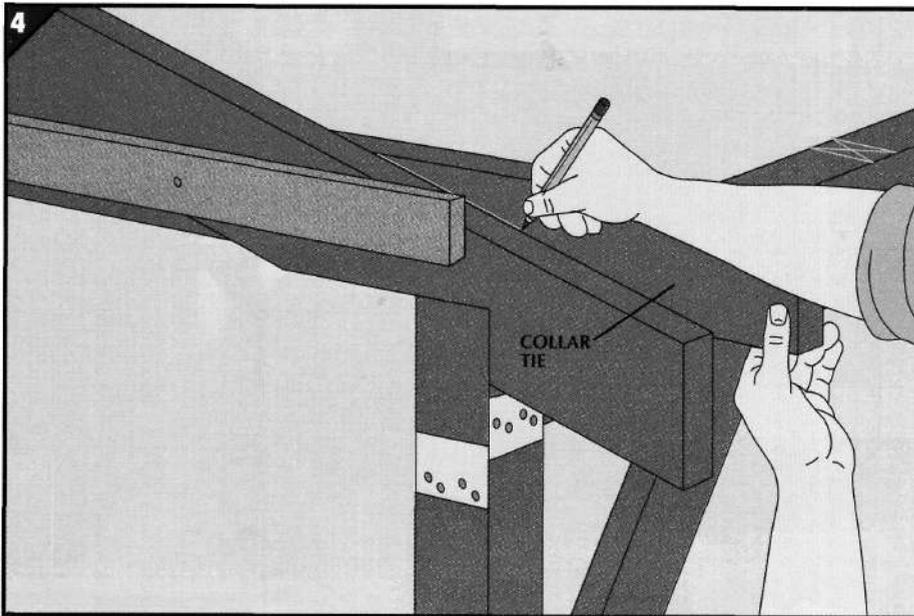
3. Positioning the frame.

- Brace the end rafters temporarily with 1-by-4s nailed across them.
- With three helpers, lift the frame into place, setting the bird's-mouth

cuts onto the crossbeams.

- If necessary, remove the temporary bracing so you can adjust the fit of the rafters, and replace it when they are correctly positioned.

- Toenail the rafters to the crossbeam with 3 1/2-inch common nails.
- To strengthen the rafter-and-beam joints, add framing anchors with the nails suggested by the manufacturer.



4. Fitting the collar ties.

- Set a 2-by-6 equal to the width of the structure atop the crossbeams and against a pair of end rafters, and mark it along the top of the rafters (*left*).
- Cut the board at the marks and use it as a template for the other collar ties.
- Nail the collar ties to the end rafters with six 3-inch common nails.
- Mount the rest of the rafters, nailing a precut collar beam to every third pair of rafters as you go; then remove the temporary bracing.

A Glassed-in Frame to Nurture Seedlings

Cold frames are miniature greenhouses for seedlings. By shielding tender plants from spring frosts while permitting the sun to warm the air and soil beneath its hinged glass or plastic top, a cold frame lets keen gardeners get a jump on the growing season.

Building the Frame: For the cold frame's top, recycle an old storm window or build a frame of 2-by-2s with a plastic "window." Make the cold frame from either rot-resistant or pressure-treated wood. For the latter, check that the preservative employed is safe for plants.

Slope the side walls of the frame from a height of 12 inches at the back to 5 1/2 inches in front. Paint the interior of the frame white so it will reflect the sunlight and heat. Install a prop to hold the top open during hot spells—a temperature above 70 degrees inside the frame could harm the seedlings.

Positioning the Frame: Situate the frame so the window faces south and slants toward the noon sun. To prevent the frame from losing heat on frosty nights, drape a tarpaulin over it in the evening or pile leaves or straw around it.



TOOLS

Tape measure
Combination square
C-clamps
Maul

Shovel
Jack plane
Circular saw or
saber saw
Electric drill
Screwdriver bit



MATERIALS

1x2s
2x2s, 2x6s, 2x12s
Storm window

1/2" dowels
Galvanized wood
screws (3" No. 8)
Butt hinges
Wood glue (exterior)

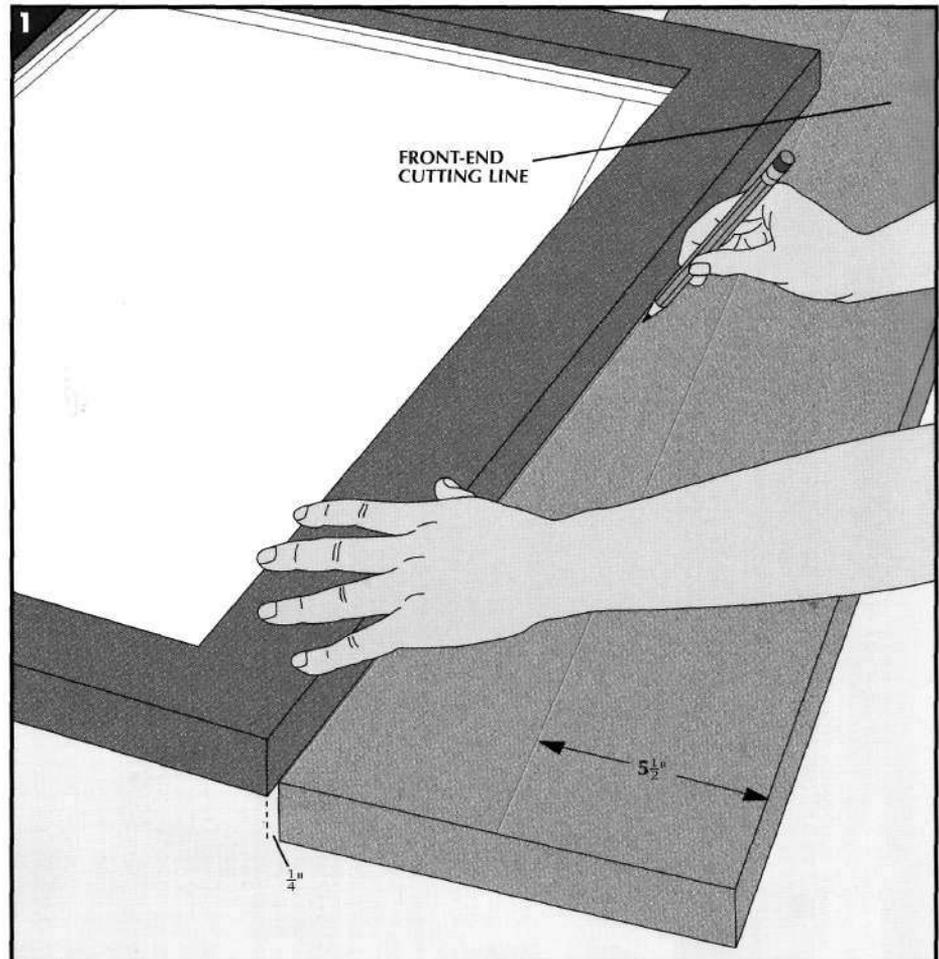


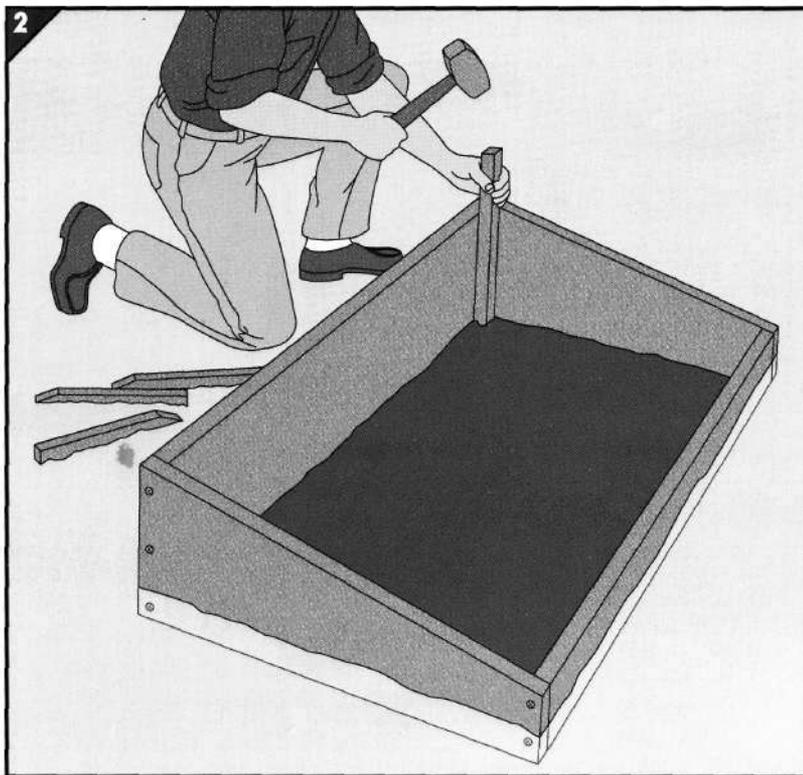
SAFETY TIPS

Wear gloves when handling pressure-treated wood; add a dust mask when cutting it.

1. Preparing the frame pieces.

- For a side piece mark a line along the length of a 2-by-12 5 1/2 inches from one edge. Set a window sash on the board as shown so that one corner touches the line and the other extends 1/4 inch beyond the board's corner. Run a pencil along the edge of the sash to mark the slope (*right*).
- To indicate the front end of the side piece, make a mark across the board through the point where the two lines intersect.
- Secure the board to a work surface, then cut at the slope and the front end marks with a circular saw or saber saw.
- Using this as a template, mark and cut the other side.
- For the back and front pieces, cut a 2-by-12 and a 2-by-6 3 inches shorter than the length of the window sash.





2. Assembling the frame.

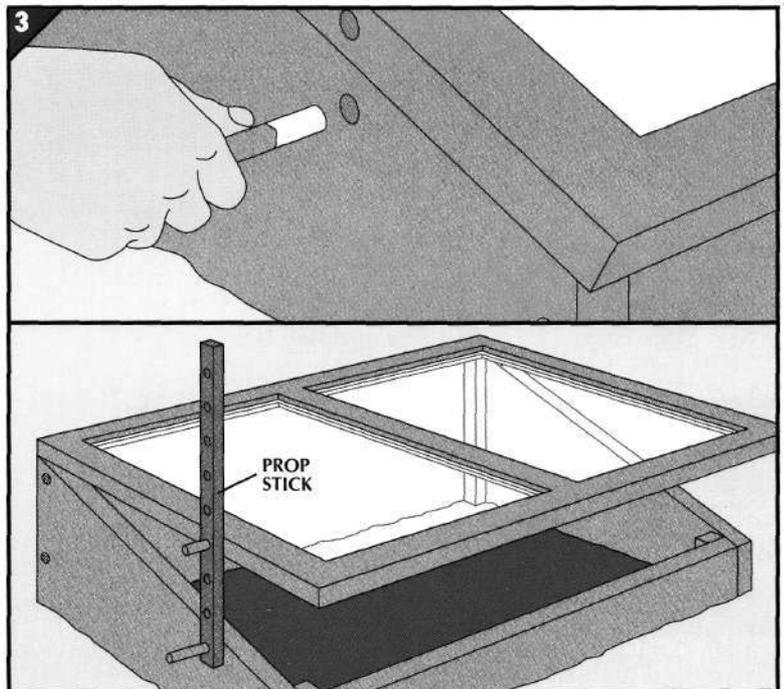
- Fasten the side pieces to the front and back with 3-inch galvanized No. 8 wood screws.
- Plane the top edges of the front and back pieces to match the side slope.
- To anchor the frame in the ground, dig a 2-inch trench in the soil, sink the frame in place, then drive 2-by-2 stakes (12-inch stakes at the front and 18-inch stakes at the back) at the inside corners with a maul (*left*). Screw the frame to the stakes.
- Attach the sash to the back of the frame with butt hinges.

The easiest, most economical way to grace your property with a full-scale greenhouse is to buy one in kit form. Kit models range from compact units, 4 feet by 6 feet, to structures that enclose areas as large as 1,000 square feet.

The least expensive greenhouse kits contain parts of lightweight aluminum and rest on a frame of pressure-treated 4-by-4s. This type of greenhouse is covered with a plastic film and is often regarded as temporary.

More expensive greenhouses are often permanent, secured with appropriate foundations *and* relying on tempered glass instead of plastic coverings. These structures are often equipped with some form of automatic climate control and ventilation.

Almost all greenhouses need devices to keep the temperature within a limited range. Greenhouse manufacturers and garden-supply stores sell heaters, coolers, *and* automatic ventilators, but you can keep heating and cooling costs down by locating your greenhouse with its long axis running east and west, ideally underneath a large deciduous tree. This will keep it cool in the summer but give it full winter sunlight, when the leaves have fallen and the sun is low.



3. Rigging prop sticks.

- Bore a 1/2-inch diameter hole into each edge of the sash about 8 inches from the front of the frame. To avoid drilling into the glass or plastic, make the holes no deeper than 1/2 inch. Bore holes directly below these through the frame sides.
- Glue a 1/2-inch-diameter dowel into each hole (*above, top*).
- Make two prop sticks from 24-inch-long 1-by-2s, drilling a row of 9/16-inch holes through them at 2-inch intervals.
- Slip the sticks over the dowels to hold the sash open as desired (*above, bottom*).

A Versatile Structure

Large outbuildings like the one shown below can serve as garages, storage areas, studios, workshops, or some combination of all of these. Almost any purpose can be accommodated except living quarters. Each use, however, has requirements that should be considered early in the planning process.

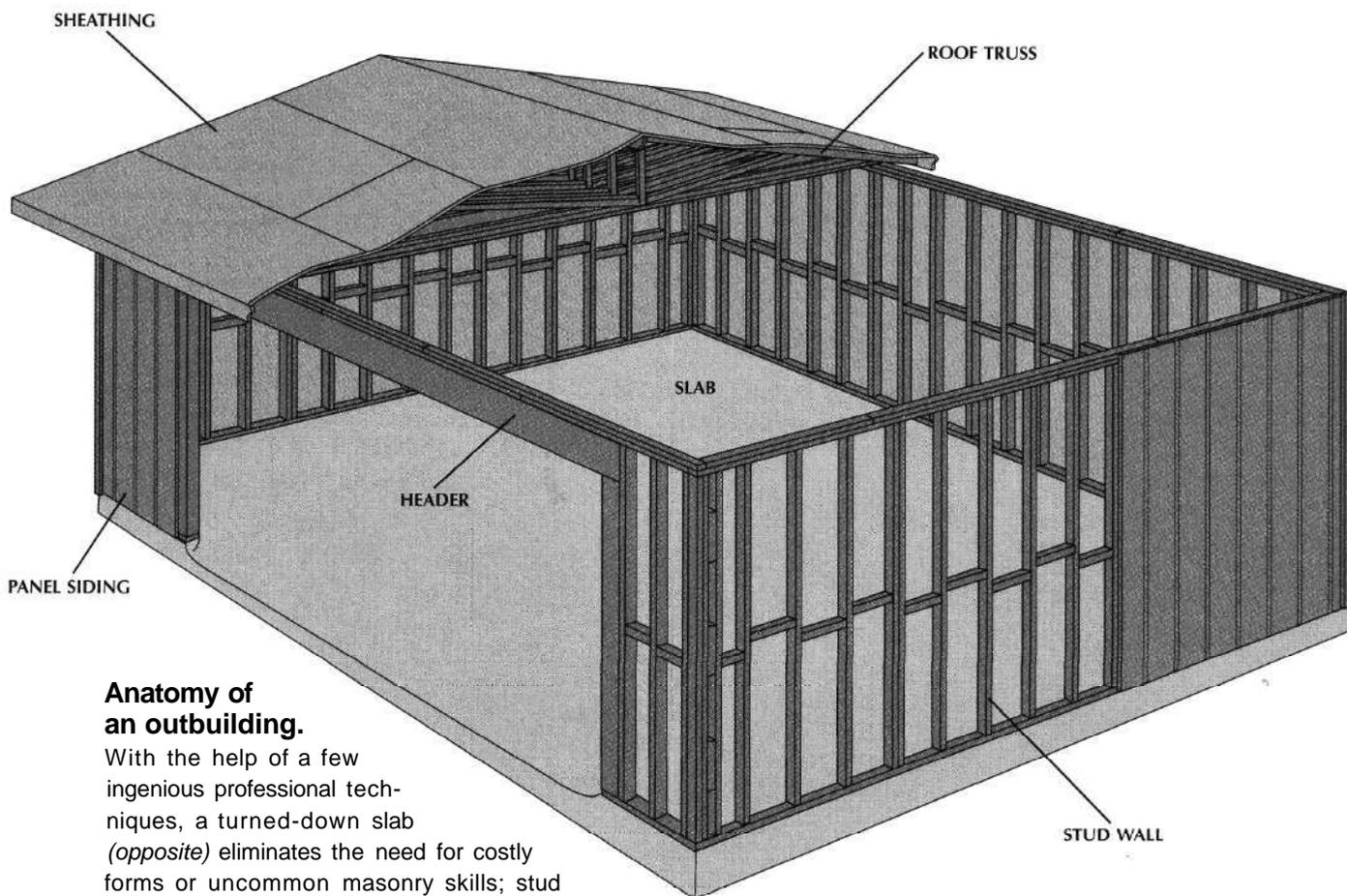
A garage needs a driveway, walkways, a main entrance, and perhaps a side door. The floor must be sloped for drainage. For garden storage, include a door that provides easy access to the garden. A studio or shop should have windows, and pos-

sibly a loft for storage. If you need electricity and water, consult your local utility companies about preparing the structure for their installation.

Planning the Construction:

Draw a floor plan of the building on a map of your property to ensure it is located at least as far from the house and the property lines as local codes require. Then sketch front and side views of the building on graph paper to determine whether the building will harmonize with the main house and surrounding property. You will probably need a building permit.

Bring along your diagrams and sketches, and be prepared to describe the type of foundation, wall construction, and roof design that you propose. Some localities require a soil test to determine whether it will support the proposed structure. And set up an inspection schedule well in advance so that work will not be delayed.



Anatomy of an outbuilding.

With the help of a few ingenious professional techniques, a turned-down slab (*opposite*) eliminates the need for costly forms or uncommon masonry skills; stud walls (*pages 112-116*) can be built on the ground and erected as units; and prefabricated trusses (*page 118*), which require no tricky rafter cuts or a ridge beam, make the installation of a sloping roof a simple assembly process.

A Slab Combining Floor and Foundation

For a sizable building, the simplest base is a turned-down slab—a concrete slab with its edges set in trenches. The rim serves the same function as poured footings or a foundation wall of concrete block.

The turned-down slab has its limitations, however. It requires trenches little wider than a shovel blade, but deep enough to meet footing requirements for your area—which may be impossible in regions where frost penetrates deeper than 2 feet. The concrete in the trenches must be re-

inforced by rebar; check your building code for the correct size. If your local building department advises against a turned-down slab, use a deep concrete footing like those described on pages 49 and 55.

Preparing for Construction: Plan an expedient route for the heavy trucks bringing in materials and concrete. On the job itself, save time and work more effectively with rented professional tools. A transit level enables you to establish lines and

angles quickly and accurately. A power tamper helps compact the soil before the concrete is poured; a power troweler speeds the job of finishing the concrete.

Creating a Slant: The structure shown on these pages has a sloped floor. The forms are installed level, then a long notch is cut out along the door opening to lower it 1 inch for every 8 feet from the back wall. While the concrete is still wet, it can be shaped to slope toward the door.

T TOOLS

Tape measure	Circular saw
Carpenter's level	Rebar cutter
Water level	Electric drill
Transit level	Shovels
Hammer	Power tamper
Maul	Mason's hoe
Handsaw	Bull float
	Power troweler

M MATERIALS

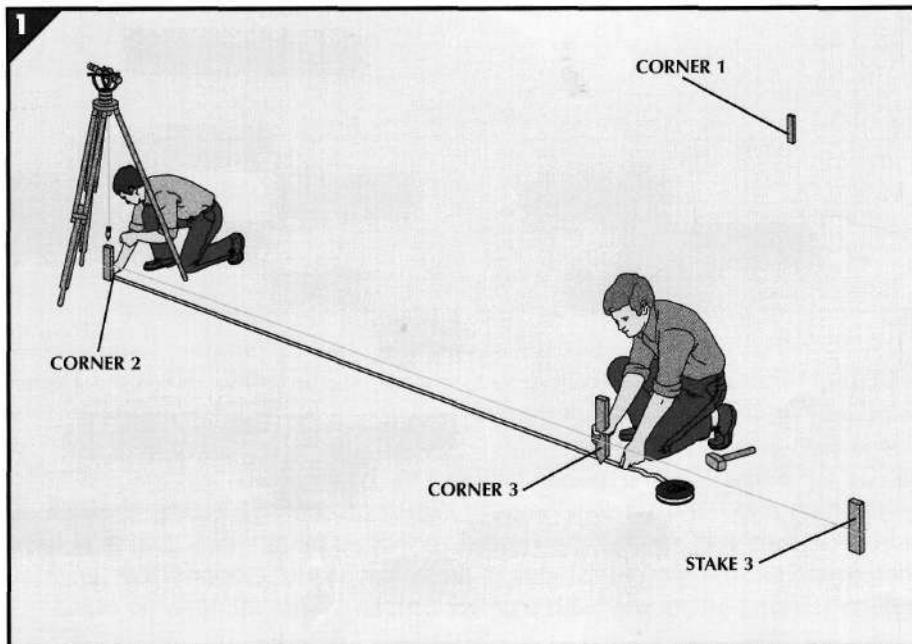
1x2s, 1x6s	Reinforcing mesh
2x4s, 2x8s	(6"x6" 10-gauge)
5/8" plywood	Gravel
Common nails (2", 3")	Bricks
Anchor bolts, (1/2"x12"), washers, nuts	Ready-mix concrete
Rebar	Polyethylene sheeting
Tie wire	String



SAFETY TIPS

Wear goggles when nailing and a long-sleeved shirt, gloves, and rubber boots when working with concrete. Wear gloves when handling pressure-treated wood; add a dust mask when cutting it.

SETTING UP BATTER BOARDS



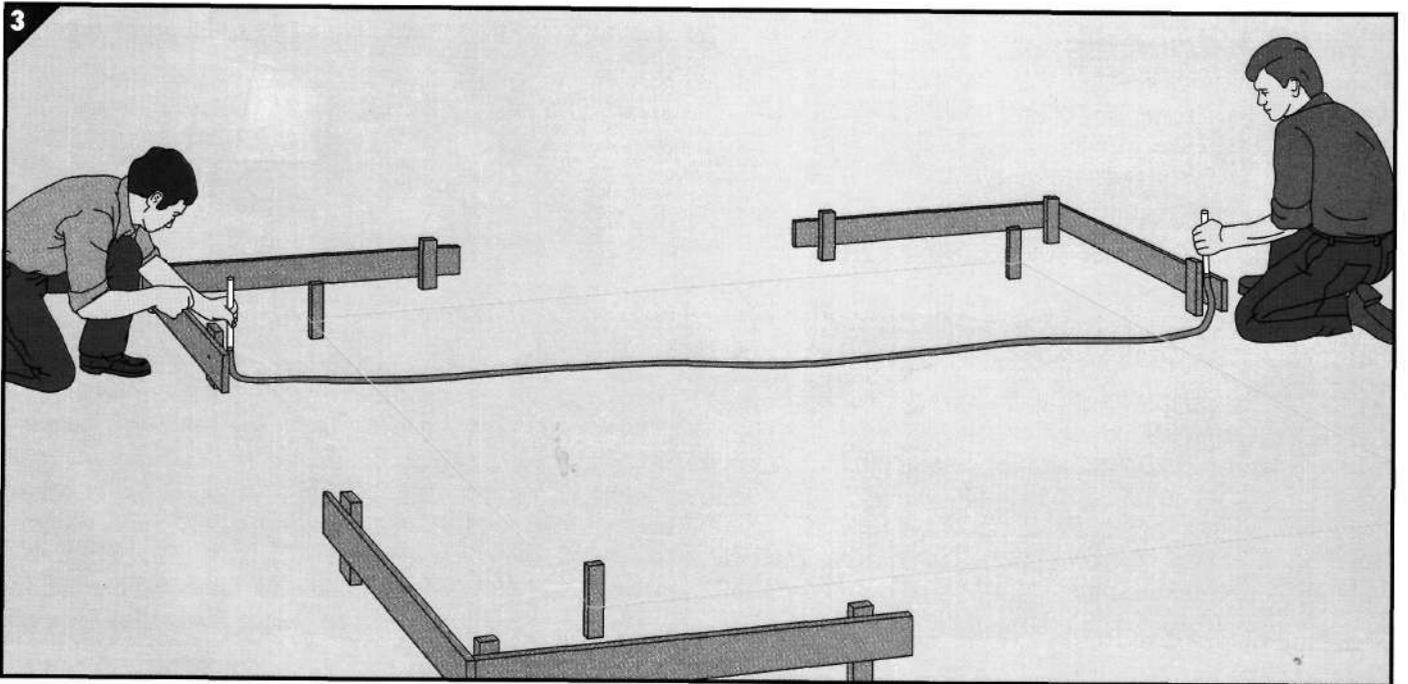
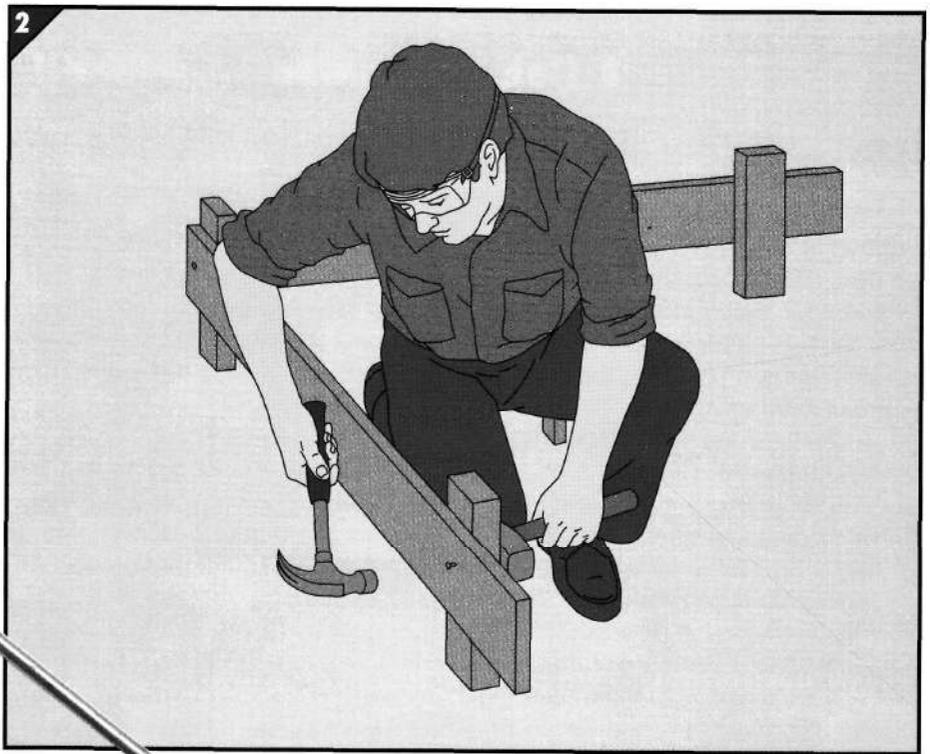
1. Finding the building lines.

- Drive stakes to mark two adjacent corners of the slab.
- Centering a transit level over one of the stakes, set a third stake at a right angle to the first two (*page 12*).
- From the stake under the transit level, string a line to the third stake. Measure the desired distance along the line with a tape measure to mark the third corner (*left*).
- Drive a stake at your mark, set the transit above the stake, and repeat the operation to locate the fourth corner.
- Run a string boundary about 4 inches off the ground around all the corner stakes.

2. Building batter boards.

At each corner of the slab, set up a batter board to which you can anchor the string boundary.

- Drive three 2-by-4 stakes about 2 feet outside the strings so they form a right angle at the corner.
- Fasten 1-by-6 boards to the outside faces of the stakes with 2-inch nails so the top edges of the boards are about 10 inches above the ground. Double-headed nails (*photograph*) simplify later disassembly of batter boards and forms, because they are easy to pull out; a maul or a brick makes a solid backing for nailing (*right*).



3. Leveling the batter boards.

- With a water level (*page 9*), determine which set of batter boards is the lowest (*above*); this will be your reference set. Check whether both boards of the set are at the same height: Lay a carpenter's level across the boards' top edges and, if necessary, drive down the stake on the high side.
- Keeping one end of the water level against one reference batter board, level the other three sets. Then level both boards of each set with the help of the carpenter's level.

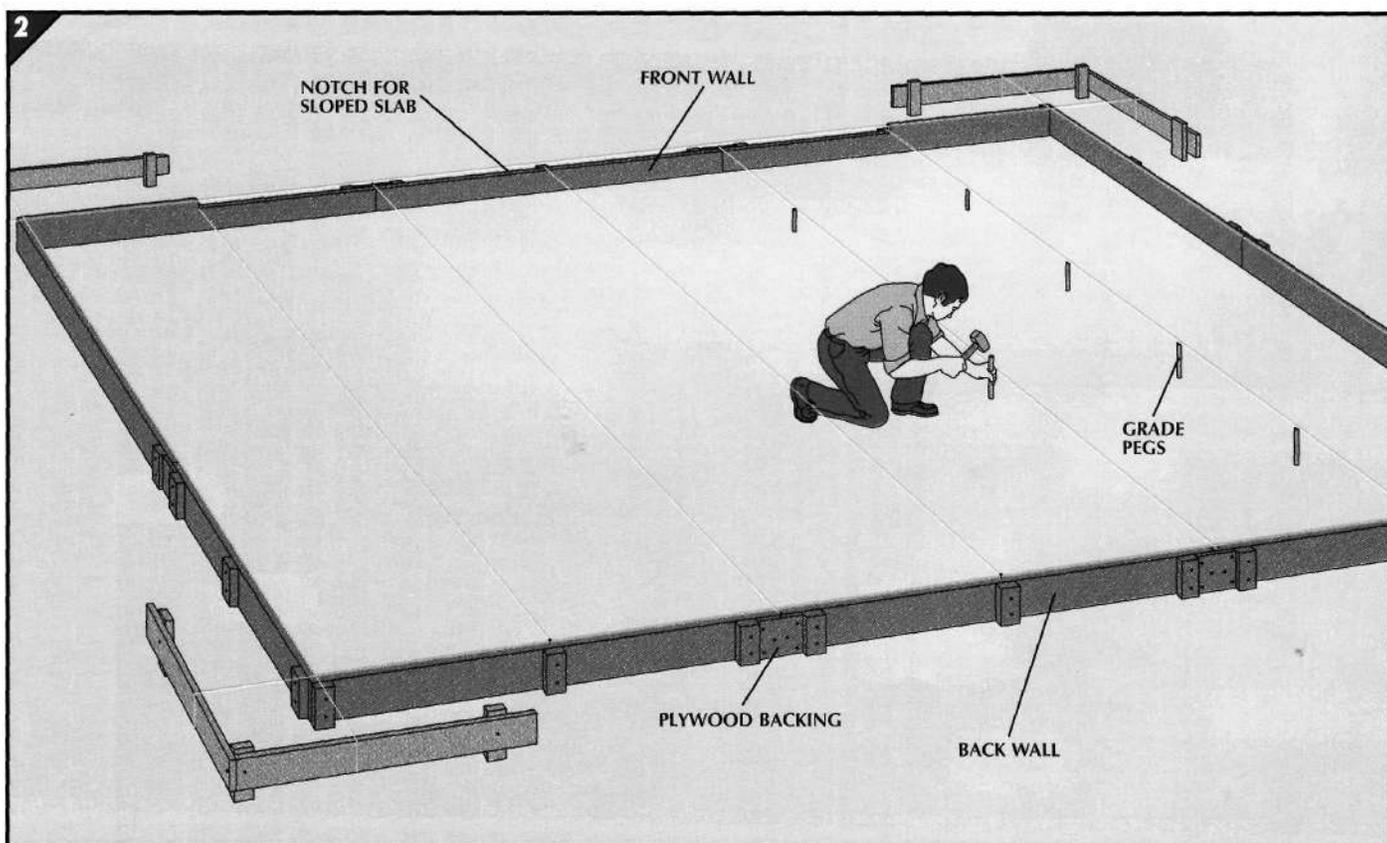
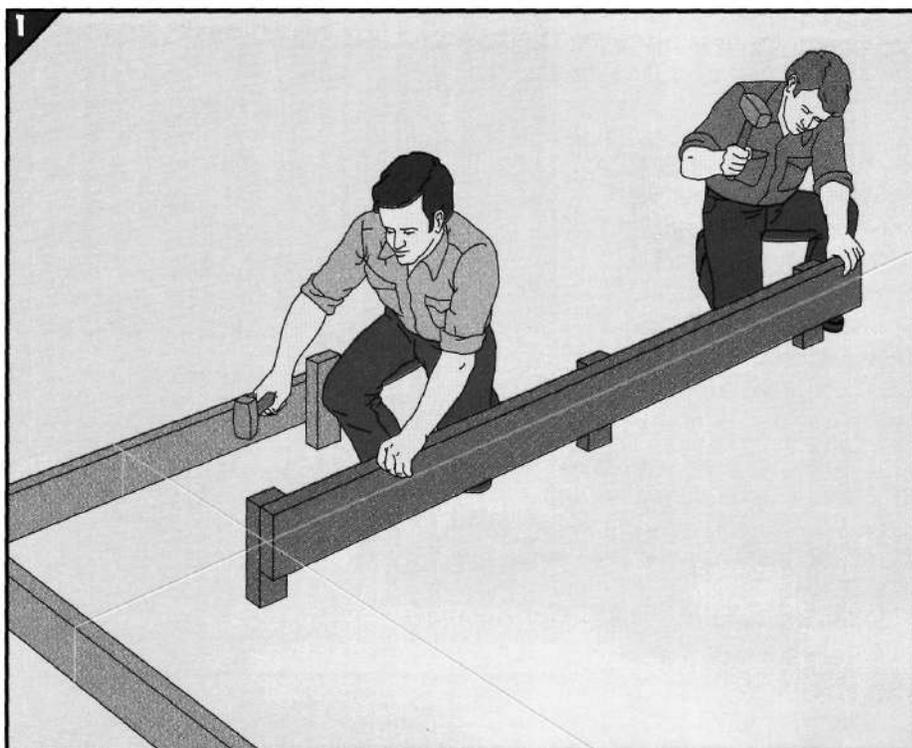
- String lines between the batter boards directly above the lines attached to the corner stakes, then remove the corner stakes and their strings.

If the ground between the batter boards and the new lines is uneven, smooth high spots and fill depressions with clean 1-inch gravel so that no point is less than 8 inches below the tops of the batter boards. Compact the soil thoroughly with a power tamper.

LAYING OUT THE FORMS

1. Placing and leveling forms.

- Make the forms for the slab from 2-by-8s, fastening three 2-by-4 stakes to the outside face of each board with 3-inch common nails. Attach the stakes so they are at least 6 inches from the board ends, except at the corners of the slab, where they must be flush.
- Starting at a corner, position a form with its inside face flush with the string line. Drive the stakes into the ground (*right*) so the top of the form is even with the line.
- Continue placing the forms, nailing them together at the corners; elsewhere, butt them end-to-end, reinforcing the seams with 5/8-inch plywood backing fastened with 2-inch nails.



2. Setting grade stakes.

- For a sloping floor, mark the door opening on the forms and notch their top edges between the marks. Make

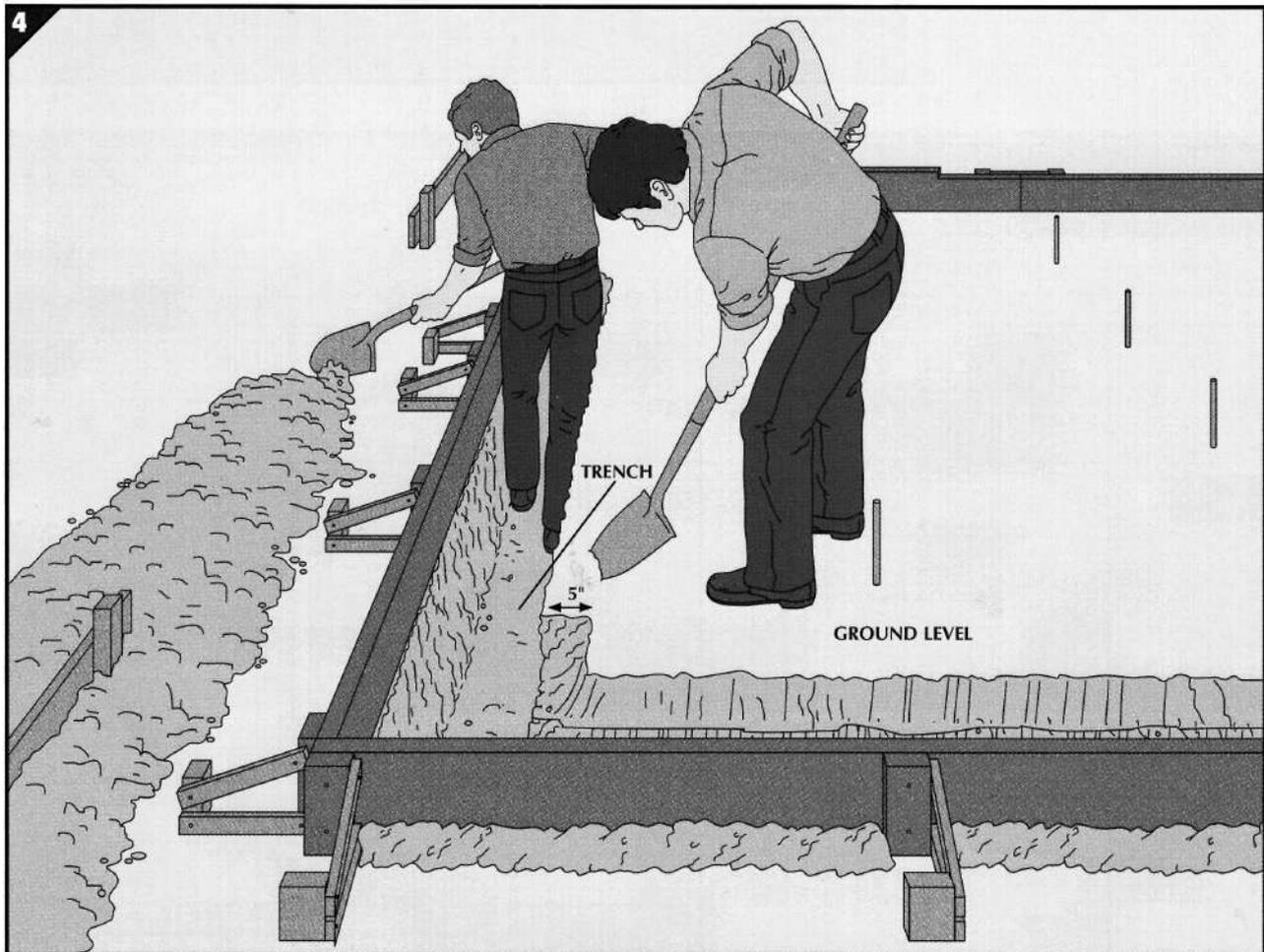
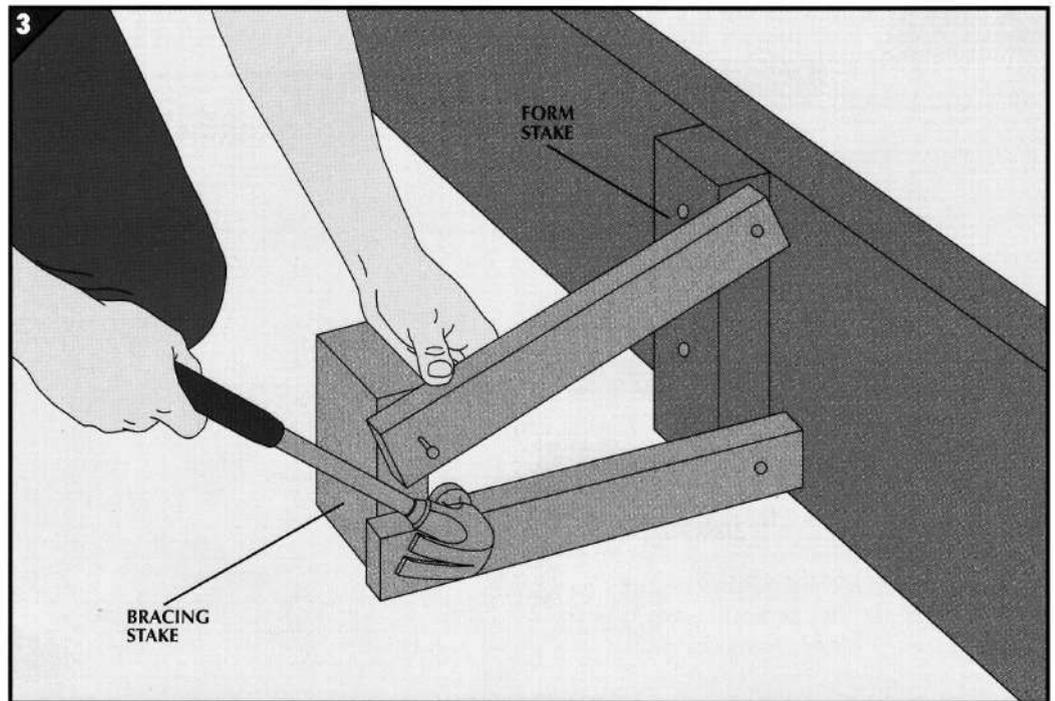
the notch 1 inch deep for every foot between the front and back walls.

- String lines between the back- and front-wall form boards every 4 feet.

- To make grade pegs, drive lengths of rebar along the strings 4 feet apart so the tops of the spikes are level with the strings. Remove the strings.

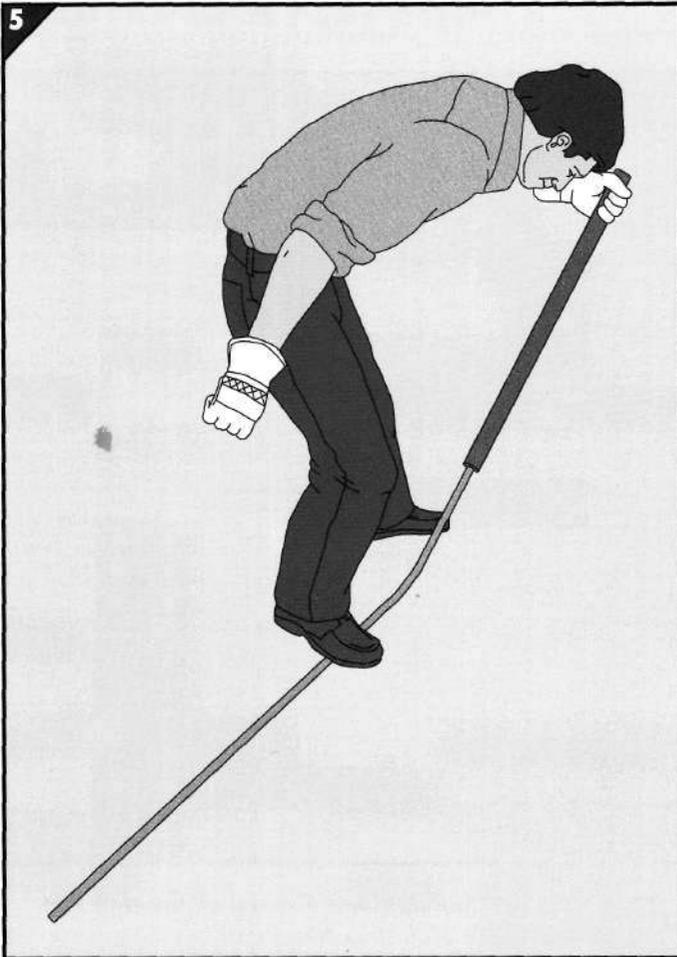
3. Bracing the forms.

- Drive a 2-by-4 bracing stake into the ground 12 inches behind each form stake.
- Fasten two 1-by-2 braces between each bracing stake and form stake (*right*).



4. Digging the trenches.

- Beginning 5 inches inside the inner lip of the trench, slope the lip at a 45-degree angle (*above*).
- To prevent concrete from leaking out between the forms and the ground, pack a layer of dirt or gravel against the forms where they meet the ground.

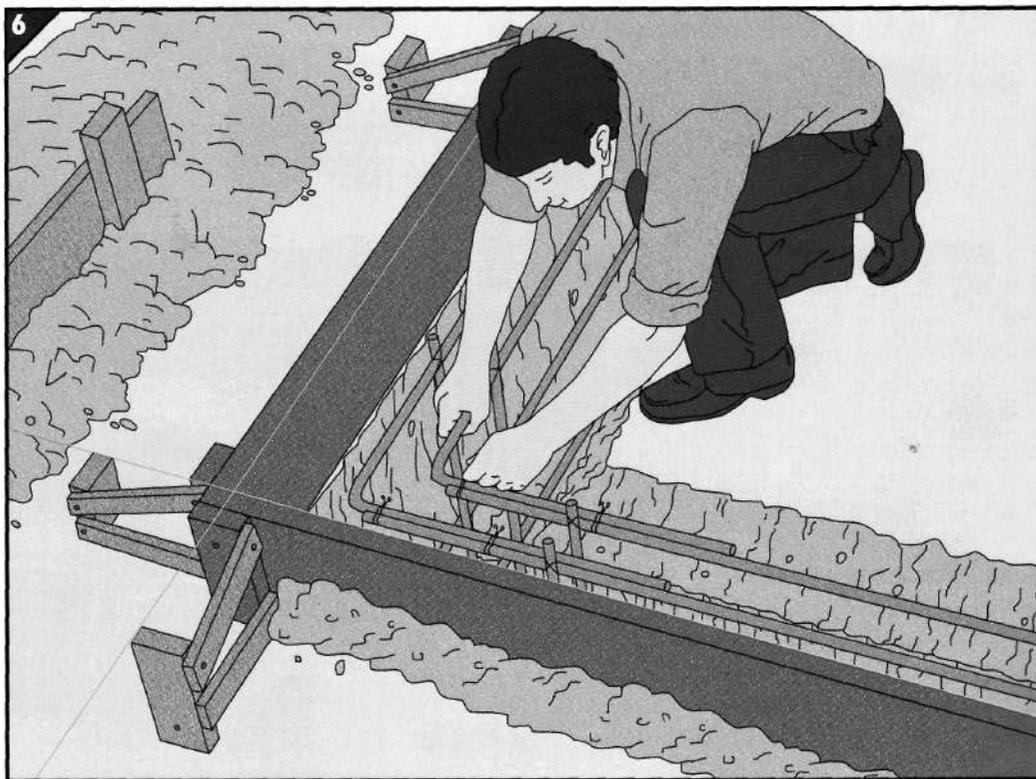


5. Bending lengths of rebar.

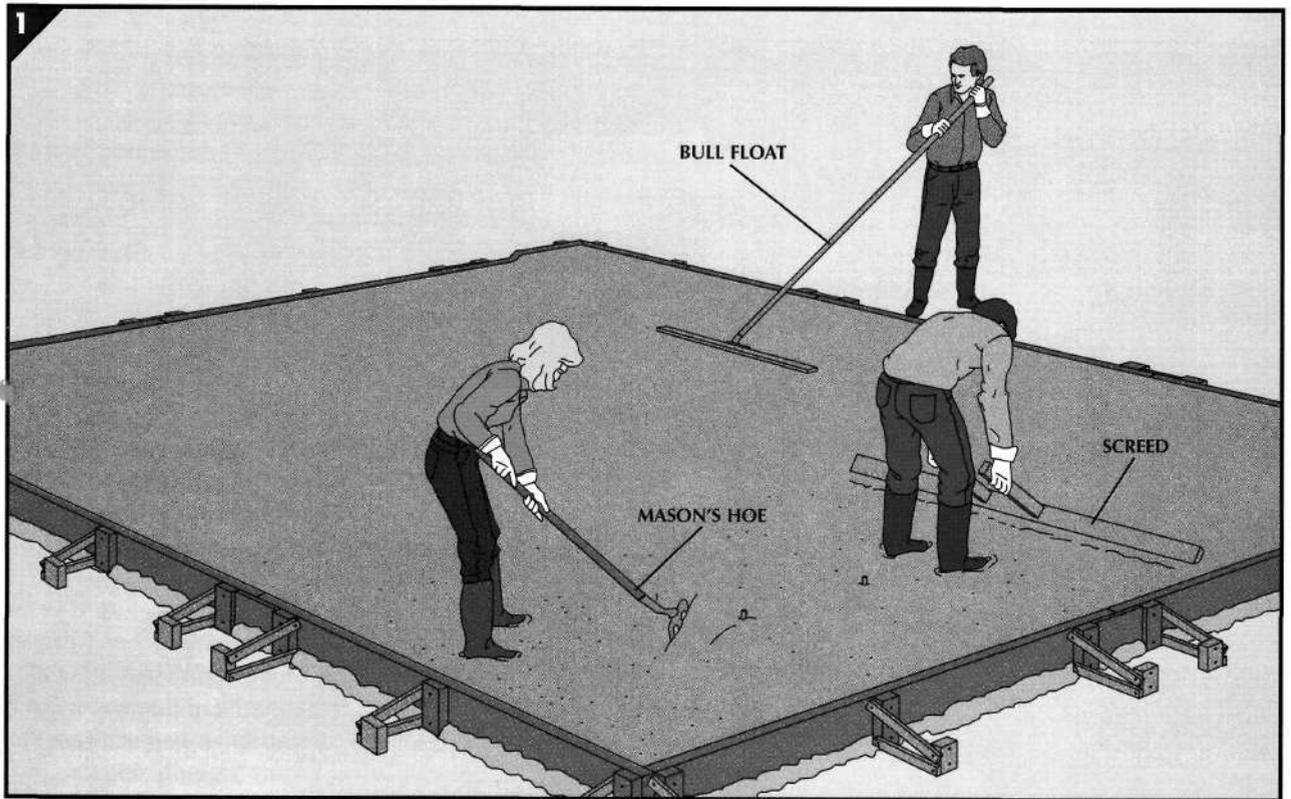
In preparation for Step 6, bend four lengths of rebar to turn each corner of the trench. To do so, slide a length of rigid plumbing pipe over the end of a rod, step on the rod, and gradually pull the pipe toward you.

6. Laying the rebar.

- Every 4 feet along the trench bottom, drive a pair of rebar spikes into the ground 5 inches apart so their tops are 5 inches below the top of the form.
- Fasten horizontal rebars to the vertical ones with tie wire about 2 1/2 inches from the trench bottom, overlapping the ends by at least 15 inches. At the corners, lay lengths of bent rebar.
- Attach a second course of horizontal rebar 1 inch from the tops of the vertical ones.
- Spread a 3-inch layer of clean 1-inch gravel over the floor site, but avoid getting gravel in the trench. Cover the gravel with sheets of 4-mil polyethylene followed by 6-inch by 6-inch 10-gauge mesh supported on bricks and extending to the inside edge of the trench.



CASTING THE SLAB



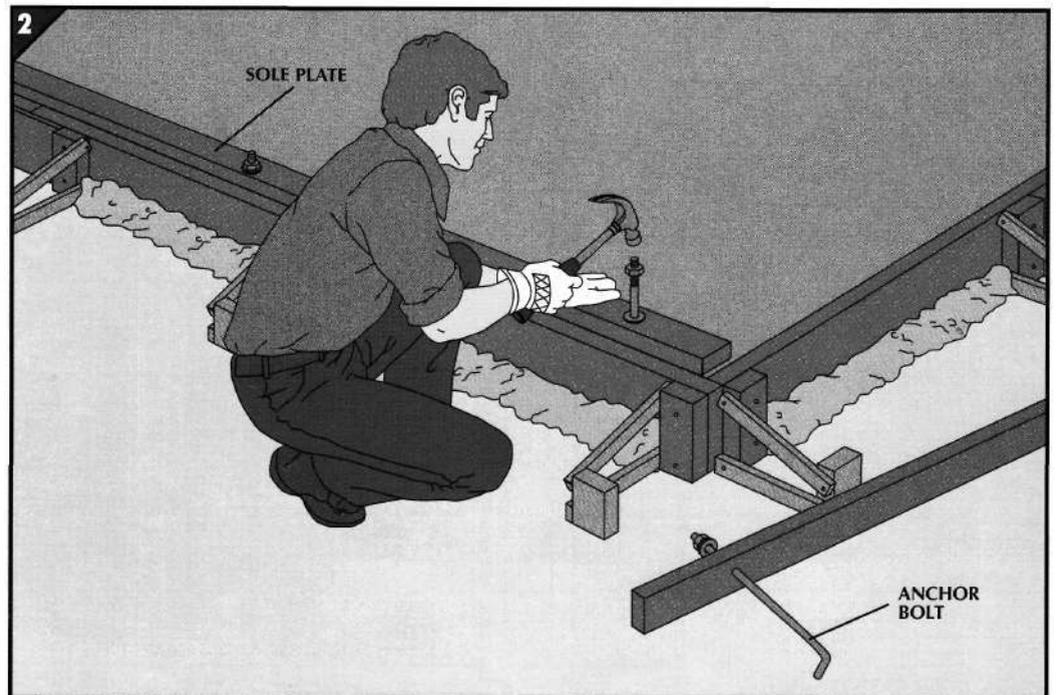
1. Pouring the concrete.

- Cut lengths of pressure-treated 2-by-4s to fit around the perimeter of the slab as sole plates. Starting 12 inches from the board ends and at 5-foot intervals in between, bore 5/8 inch holes through the pieces.
- Pour the concrete, filling the trenches first. Work with a square-edged shovel to break up air pockets in the trenches and push the concrete against the forms.

- Pour the concrete over the rest of the slab and spread it with a mason's hoe.
- Meanwhile, have a helper level the surface and create the slope toward the door opening with a screed of 2-by-4s so the slab is even with the tops of the forms and grade pegs. Have another helper smooth the entire slab, including the slope, with a bull float.

2. Bolting the sole plates to the slab.

- Fit 1/2-by-12-inch anchor bolts through each hole in the sole plates and install a washer and nut.
- Set the plates on the wet concrete, 3/8 inch in from the forms with the threaded end of the bolts facing up. Do not place sole plates across the door opening.
- Tap the bolts into the concrete with a hammer (*right*).
- Cover the slab with polyethylene sheeting. Let the concrete cure for seven days, then remove the forms.

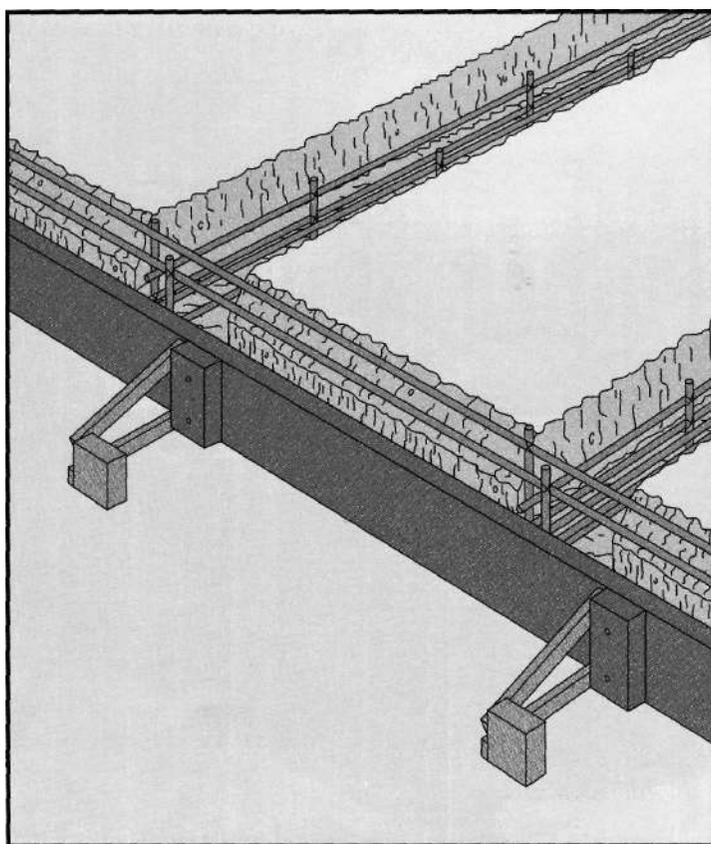
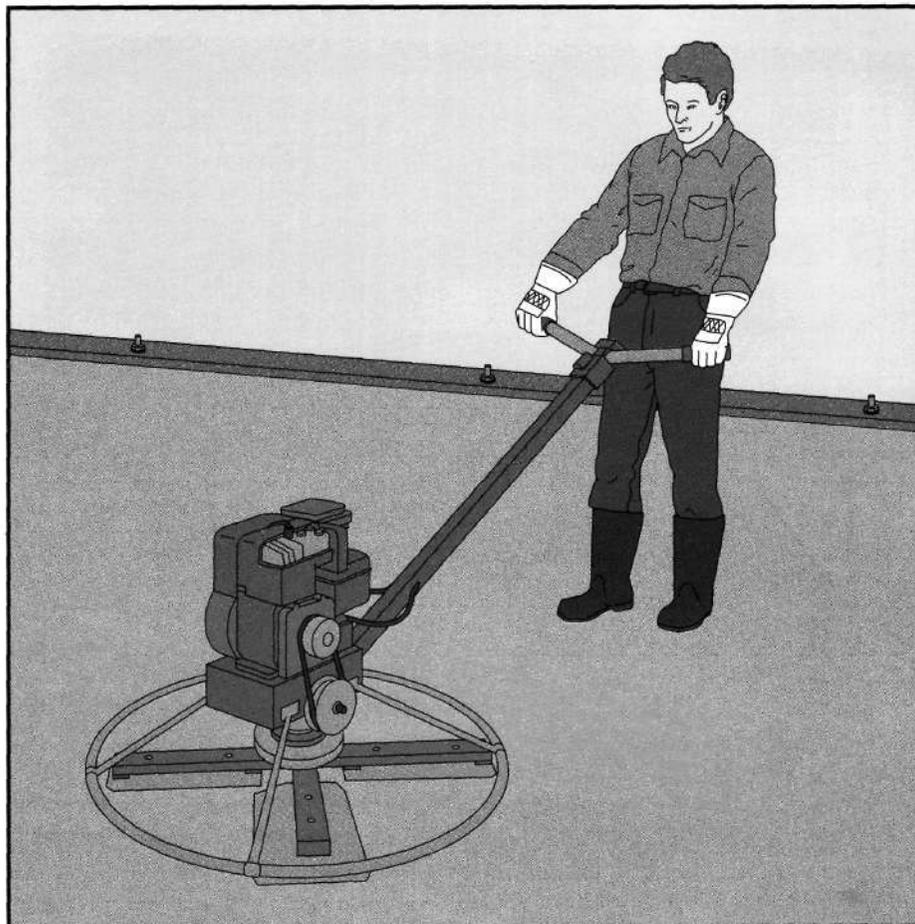


FINISHING A FLAT SLAB

Smoothing the surface.

A flat slab can be finished to a very smooth surface with a power troweler. This technique cannot be used on a slab with a sloped surface.

- Wait until the concrete is hard enough to walk on without sinking more than 1/4 inch. Remove the polyethylene sheeting from the slab.
- Set the troweler's blades flat against the slab and run the machine over the surface. Then, angle the blades upward and smooth the surface again.
- Sprinkle the slab with water, replace the sheeting, and let the concrete cure for the remainder of the curing period before removing the forms.



Concrete is a strong building material, but if a slab is poured on marshy soil, clay, or a site that has been leveled with fill, it may settle and eventually crack. In such situations, professional masons often support a slab with grade beams—trenches filled with concrete and reinforcing steel. The grade beams shown at left are the type generally used with a turned-down slab. The trenches are 8 inches wide and deep, and spaced at 4-foot intervals between the perimeter trenches. First, two 1/2-inch rebars are wired to vertical rods about 3 inches from the trench bottoms and to rebars in the rim trenches. Two more rebars are attached to the vertical rods 2 inches from the top. Next, the concrete is poured, filling all the trenches then forming the slab.

Sturdy Walls Assembled Flat Then Tilted Up

Stud walls provide a sturdy framework suitable for any structure, from a shed to a garage. The method is simple: Evenly spaced studs are nailed to top plates, then the walls are tilted upright in sections and the studs are toenailed to sole plates.

Header Beams: At each door or window opening, the roof load is carried by a horizontal header supported at its ends by posts or studs. For most headers, a board-and-plywood sandwich 3 1/2 inches thick and up to 11 1/2 inches wide is generally appropriate. Check your code requirements. Wider spans like the garage door opening shown below may require an engineered wood such as laminated veneer lumber (LVL). A wood dealer can tell you the required size; two pieces of LVL can be fastened together to create a thicker beam.

Following a Plan: Draw a set of plans to show the building inspector when you apply for a permit and for reference as you work. Start by drawing a simple floor plan on graph paper; indicate the

overall dimensions of the structure, the distance between the center of each opening and the nearest corner of the building, and the size of each rough opening (usually specified by the manufacturer of the finished door or window). Then draw head-on views of the walls that have openings; indicate the height of the walls, the height and span of each opening and the sizes of the studs, posts, and headers that will support the roof.

Use the plan to determine exactly what materials you need when you order lumber. Studs—generally 2-by-4s cut 8 feet long at the sawmill—are usually spaced 16 inches apart. The 2-by-4 top plates should be straight pieces of structural-grade lumber at least 14 feet long.

Bracing the Walls: Plumb the walls accurately and brace them firmly. The temporary braces must hold the entire structure rigid while the roof trusses are put in. When the roof has been sheathed, remove the braces one by one as you apply the wall sheathing.

T TOOLS

Tape measure	Plumb bob
Carpenter's square	Hammer
Carpenter's level	Chisel
	Mallet
	Circular saw

M MATERIALS

2x4s	Common
4x4s	nails
LVL	(3", 3 1/2")

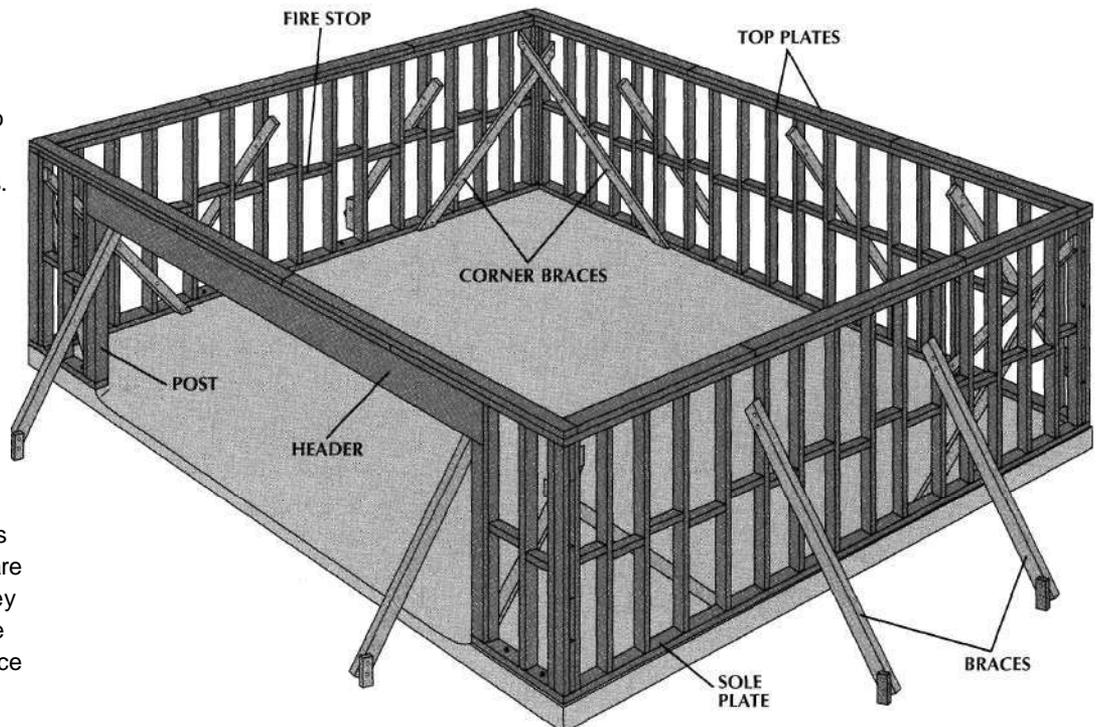


SAFETY TIPS

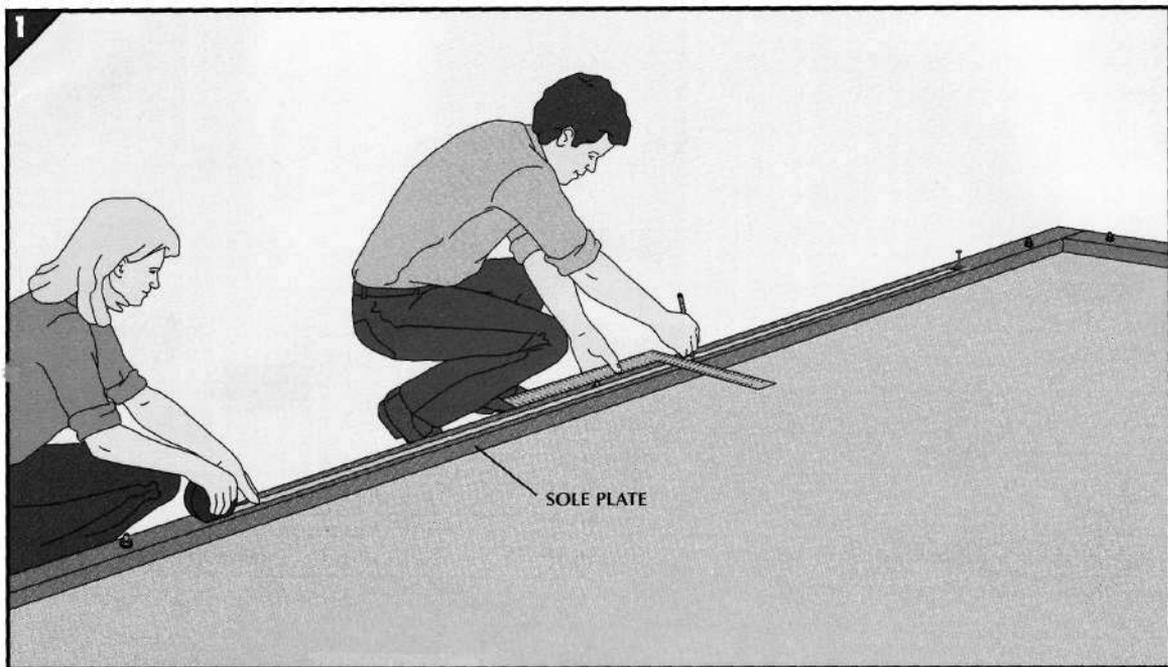
Wear goggles when nailing or cutting with a circular saw.

Anatomy of stud-wall framing.

In the structure shown at right, the studs are nailed to the bottom layer of the top plates then to the sole plates. The second layer of the top plates ties the walls together at the corners and at the joints in the first layer. Temporary diagonal bracing holds the walls and corners plumb. The long span of the garage door is bridged with an LVL beam supported by 4-by-4 posts. Horizontal 2-by-4 fire stops nailed between the studs are required in some areas; they add rigidity to the structure and provide a nailing surface for exterior sheathing.

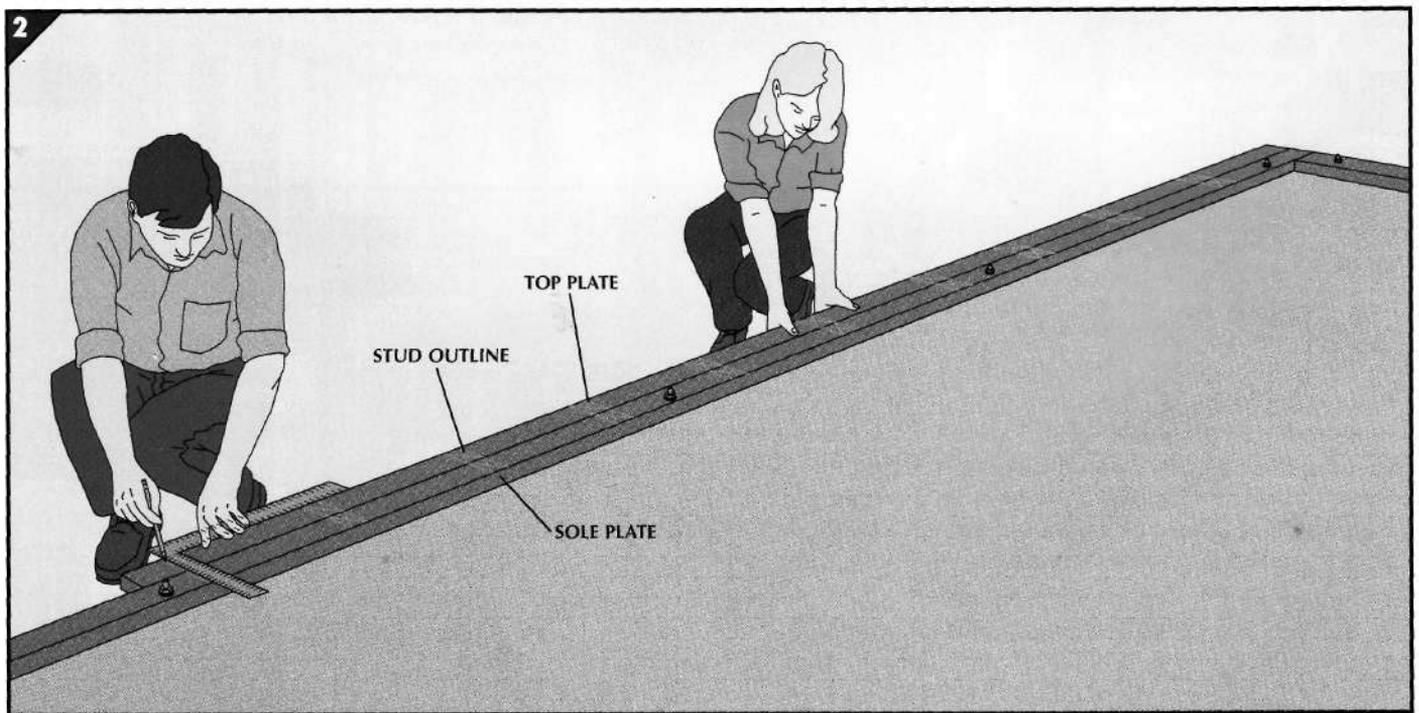


PREPARING THE SOLE AND TOP PLATES



1. Marking the studs on the sole plates.

- Drive a nail into the sole plate of a side wall 151/4 inches from the outside of the back wall.
- Holding the tongue of a carpenter's square across the sole plate at the nail, run a pencil along both edges of the tongue, outlining the first stud location.
- Hook a long tape measure on the nail and outline the next stud 16 inches from the first, while a helper holds the tape taut (*above*).
- Mark the remaining stud locations at 16-inch intervals on all the sole plates. On each side of the garage door opening, mark the 4-by-4 posts.



2. Marking the top plates.

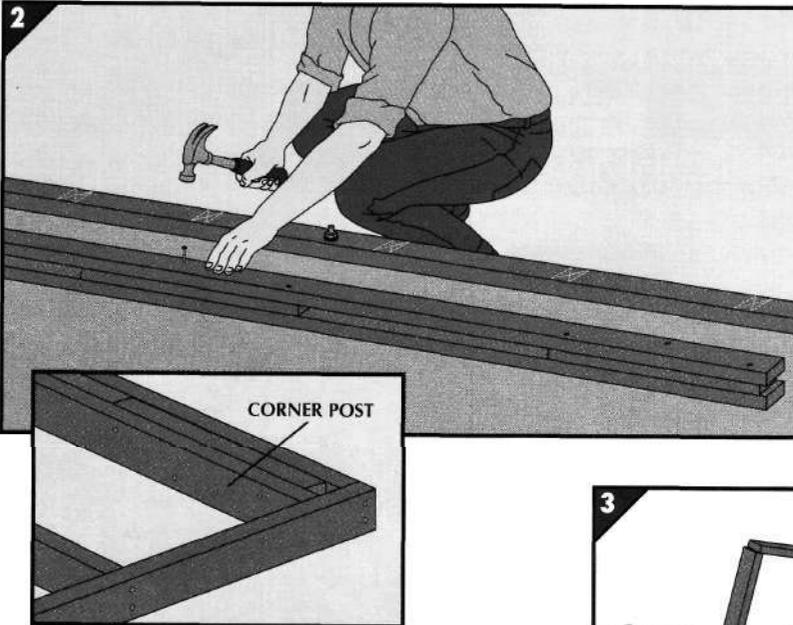
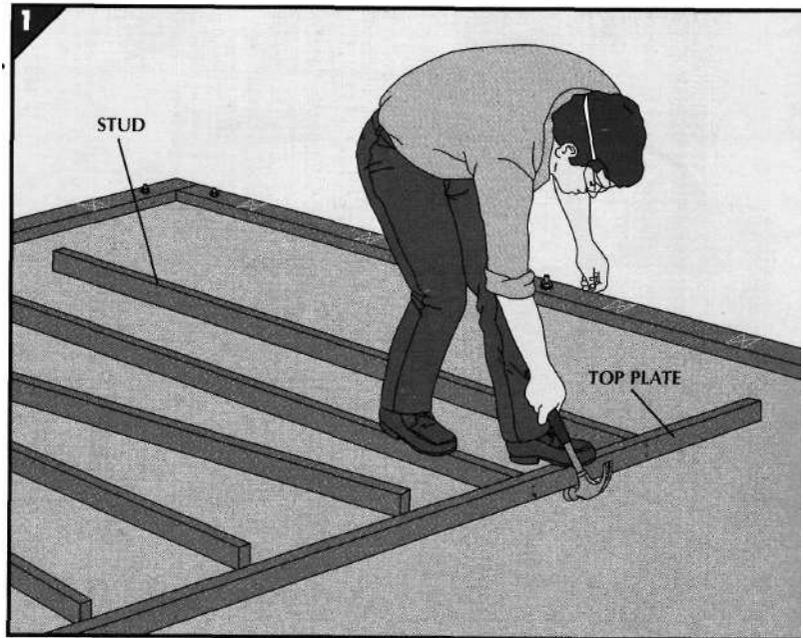
- Working with a helper, butt a top plate against the sole plate with the ends flush at a corner.
- Transfer the stud outlines from the sole plates to the top plates with a carpenter's square (*above*).
- With a circular saw, trim the ends of top plates in the middle of stud outlines to ensure that seams in the plate are centered over a stud.
- Make sure that sections of the top plate abutting a corner are at least 8 feet long and perfectly aligned with the end of the sole plate.

RAISING THE WALLS

1. Nailing studs to the top plate.

Build and raise *the* back and side walls (Steps 1-3) then the front one (Step 4).

- Lay studs on edge on the slab—one for each outline on the sole plate—and position a top plate along the tops.
- Stand on the stud and top plate, align the stud with its outline, and drive two 31/2-inch common nails through the plate into the stud. If a stud aligns with a seam in the top plate, center the joint on the stud, and angle the nails toward its middle.
- For a stud that lines up with an anchor bolt in the sole plate, notch the stud with a chisel to fit over the bolt.

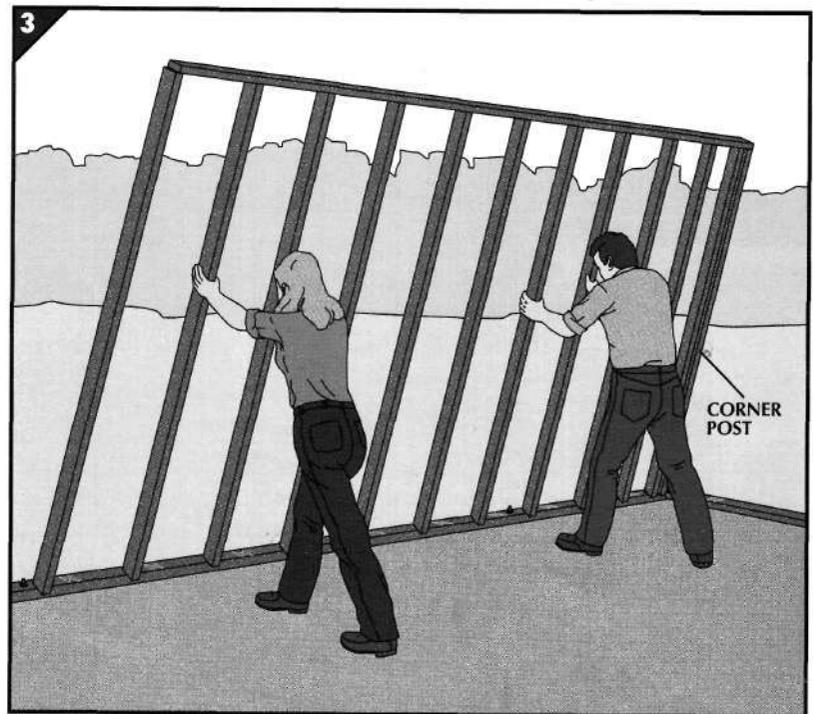


2. Preparing corner posts.

- For each corner, sandwich three, evenly spaced 18-inch-long 2-by-4s between two studs and fasten the assembly together with 31/2-inch nails (*left*), making a corner post.
- Nail the post to the end of one of the top plates at each corner (*inset*).

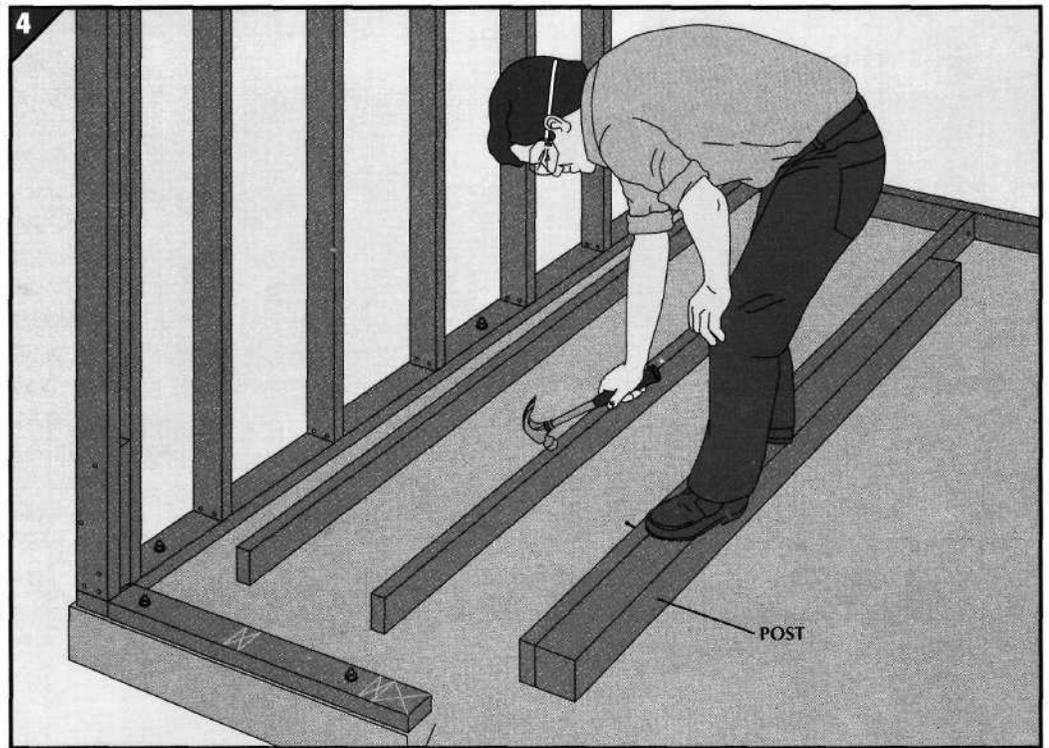
3. Erecting the walls.

- With one helper for every 8 feet of wall, tilt one wall upright.
- Set the studs on their marks on the sole plate and brace the wall with long 2-by-4s at 6-foot intervals (*page 70, Step 3*), keeping the wall roughly vertical with a carpenter's level.
- Toenail each stud to the bottom plate with 3-inch nails, driving two fasteners from one side of the stud and one from the other.
- At each corner, face-nail the outside stud of one wall to the corner post of the adjoining wall, tying them together.

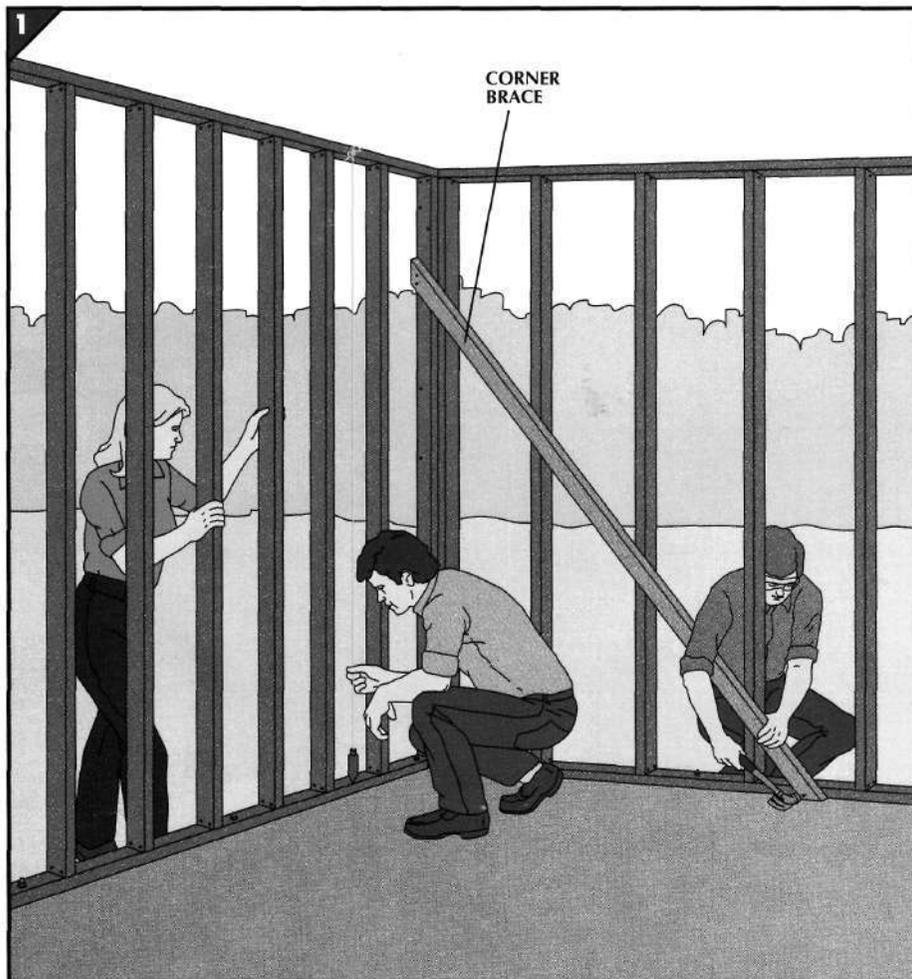


4. Fashioning the front wall.

- Assemble the front-wall sections on either side of the door, nailing studs to top-plate sections that extend over the door opening by at least 3 feet.
- Cut two 4-by-4 posts to the height of the wall studs, less the height of the header for the door opening (page 112).
- Fasten a stud along the inside edge of each post with 3 1/2-inch nails spaced 10 inches apart in a zigzag pattern (right).
- Erect and brace the front wall sections as you did the other walls.

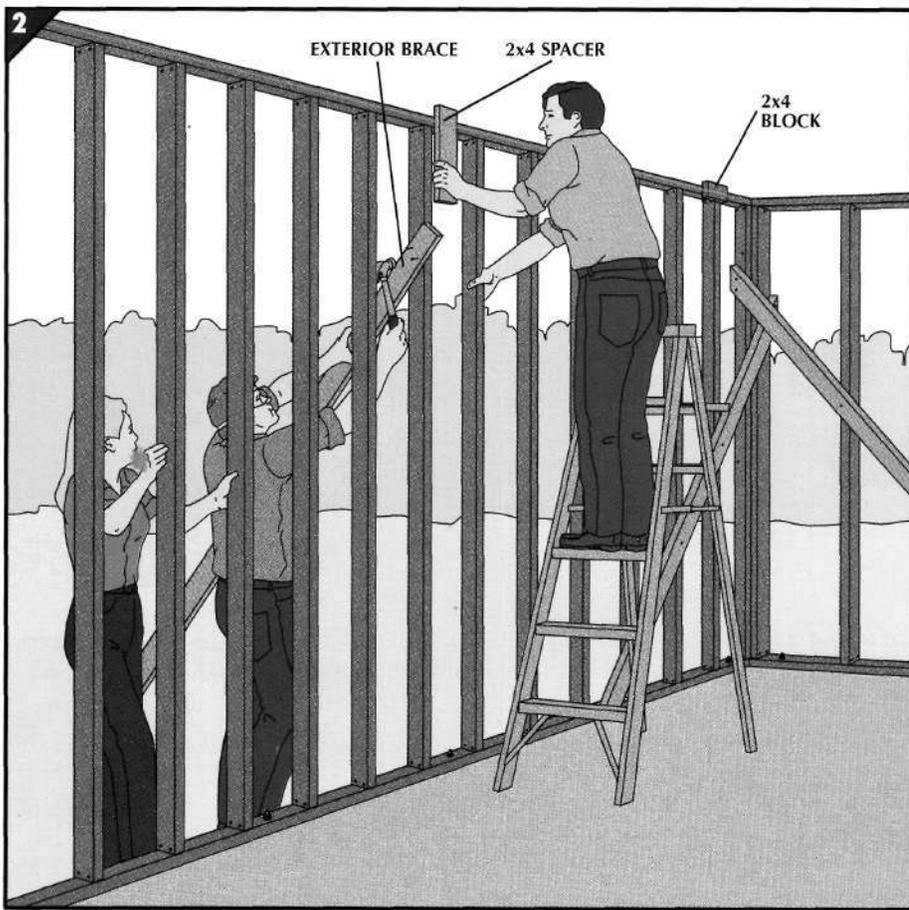


ALIGNING THE FRAMEWORK



1. Plumbing the corners.

- Hang a plumb bob from the top plate near a corner so the tip of the bob is slightly above the bottom plate.
- Make a corner brace by mitering the ends of a long 2-by-4 at 45-degree angles. With a 3-inch common nail, secure the brace to the last stud of the wall being plumbed so one mitered end is flush with the outside edge of the stud.
- With one helper supporting the wall and another eyeing the plumb bob, remove the exterior bracing you set up when raising the wall (page 114, Step 3). Have your helper tilt the wall so that the plumb bob aligns with the edge of the sole plate, then face-nail the brace to the sole plate of the adjoining wall, holding its bottom end against the slab (left).
- Plumb the other walls the same way.



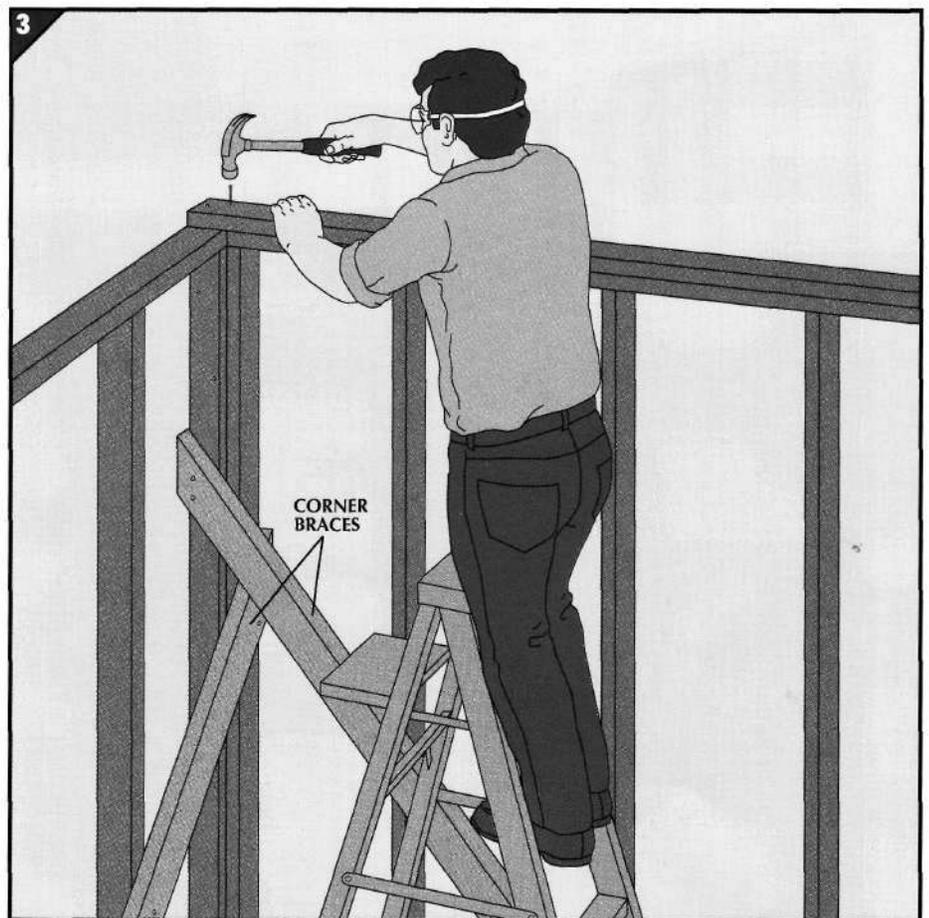
2. Straightening the walls.

- Nail a 2-by-4 block to the inside edge of the top plate at each end of one wall.
- Drive a nail into one end of each block and stretch a string tautly between the nails and across the face of each block.
- Working on a stepladder near the middle of the wall, hold a scrap 2-by-4 between the string and the top plate. If there is a gap between the string and the board, or if the board pushes out the string, have one helper tilt the wall as necessary while another re-installs exterior bracing to hold the wall in position (*left*).
- Straighten the other walls this way.

3. Completing the top plate.

To reinforce the corners, arrange the second top-plate layer so the boards overlap as shown on page 112.

- Position a 2-by-4 over the first top-plate layer, aligning one end with the outside edge of the adjoining wall. Cut the other end so it is at least 4 feet from a joint in the first layer.
- Nail the second top-plate board to the lower one with 3 1/2-inch common nails spaced every 8 inches in a zigzag pattern. At the corners, drive two nails where the top layer overlaps the bottom one of the adjoining wall (*right*).
- Continue nailing the second top-plate layer around the perimeter, except over the door opening where the header must be installed first (*opposite*).
- Nail the corner braces to every stud they cross with 3-inch nails.

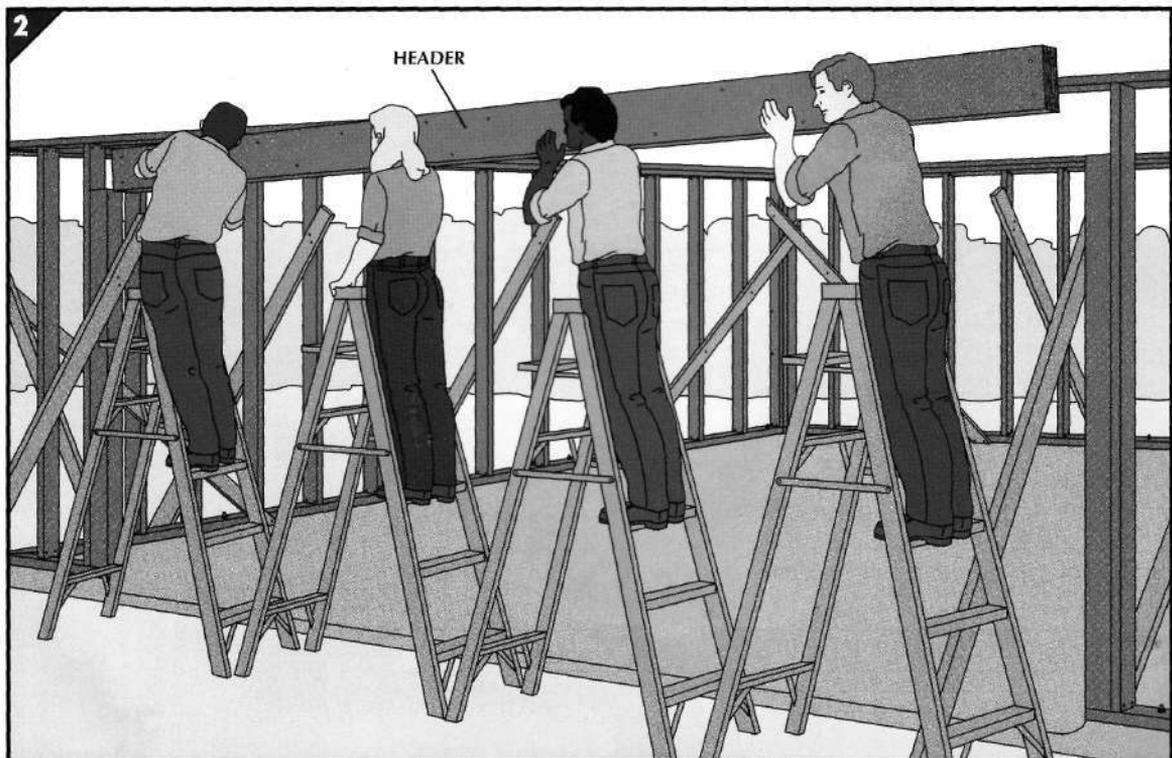
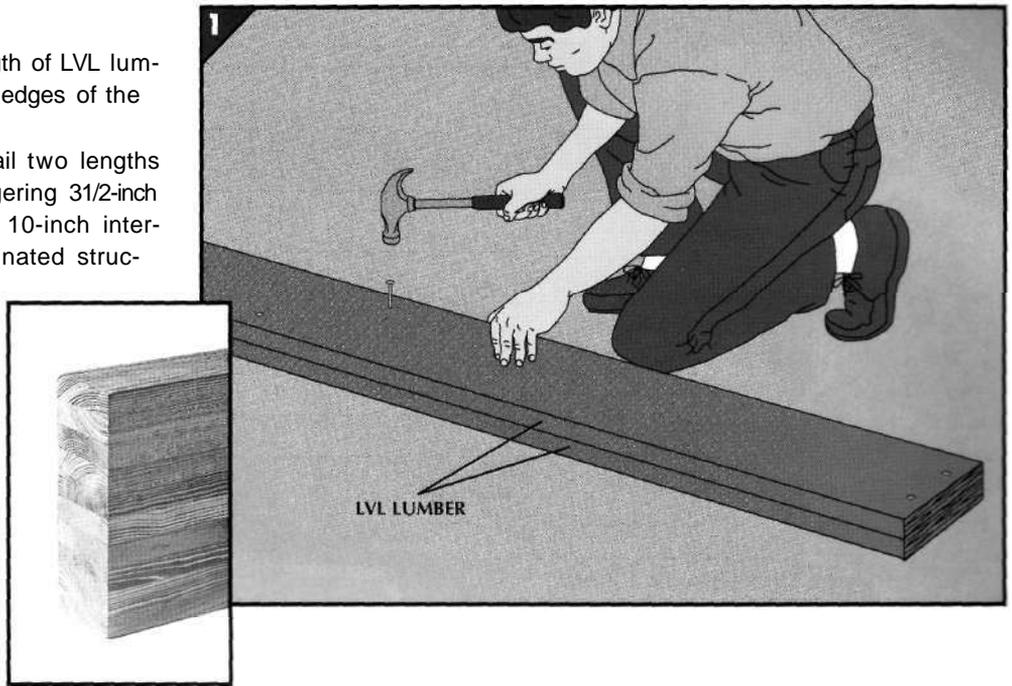


BRIDGING THE DOOR OPENING

1. Building the header.

- For a span over 8 feet, cut a length of LVL lumber to fit between the studs at the edges of the door opening.
- For a double header, you can nail two lengths of LVL together face to face, staggering $3\frac{1}{2}$ -inch common nails along both sides at 10-inch intervals (*right*). Or, order an LSL (laminated structural lumber) beam (*photograph*) as required for your span.

For a span up to 8 feet, build a header from a pair of 2-by-12s with a strip of $\frac{1}{2}$ -inch plywood of the same width and length sandwiched between them. Nail the header as you would a doubled LVL beam, adding construction adhesive to the surfaces that will be in contact.



2. Lifting the header into place.

- With one helper for every 5 feet of header length, lift the header and slide it onto the posts at the edges of the door opening. Although the typical header is a manageable load for four people, as shown above, you can rent a hoist to make the job easier.

- Have your helpers hold the ends of the header in place while you fasten it to the studs adjoining the posts, the posts themselves, and the top-plate sections with $3\frac{1}{2}$ -inch nails.
- Finish installing the lower top-plate layer, then nail the upper top-plate layer over the door opening.

Ready-Made Trusses to Support the Roof

The most rapid and economical way to frame the roof of a rectangular structure is to install prefabricated trusses. In addition to eliminating the need for heavy structural joists and rafters, trusses save you from having to cut rafters at complex angles and erecting a ridge beam.

Truss Parts: Trusses typically consist of three chords—the pieces that form the triangular shape—and webs that fit between the chords to support the top chords and transfer stress to the bottom chord and to the exterior bearing walls. The

corners of a truss are joined with metal gussets.

Purchasing Trusses: When ordering trusses, specify the span between the exterior walls, the length of the overhang, and the type of end cut—plumb or square—you desire. Also specify the pitch of the roof. The standard pitch for trusses spaced at 24-inch intervals is 4 inches to 1 foot, but local codes in areas with heavy snowfall may require a greater pitch or more closely spaced trusses. Consult your local building code for this information.

Installing the Framing: Trusses rely on sheathing for stability. In areas with little snow, 1/2-inch plywood is acceptable. In others, 1/2- to 1-inch may be required. Check the code. In either case, bolster the joints with plywood sheathing clips (*page 124*).

You will need at least three helpers to lift, roll, and secure the trusses. When lifting the trusses, carry them in a vertical position with one helper at each end. Trusses can be damaged easily if mishandled.

The final step involves weather-proofing and adding ventilation.

T TOOLS

Tape measure	Hammer
Carpenter's square	Maul
Chalk line	Handsaw
Carpenter's level	Circular saw
	Saber saw

M MATERIALS

1x6s, 2x4s
Plywood sheathing
Plywood panel siding
Prefabricated roof trusses

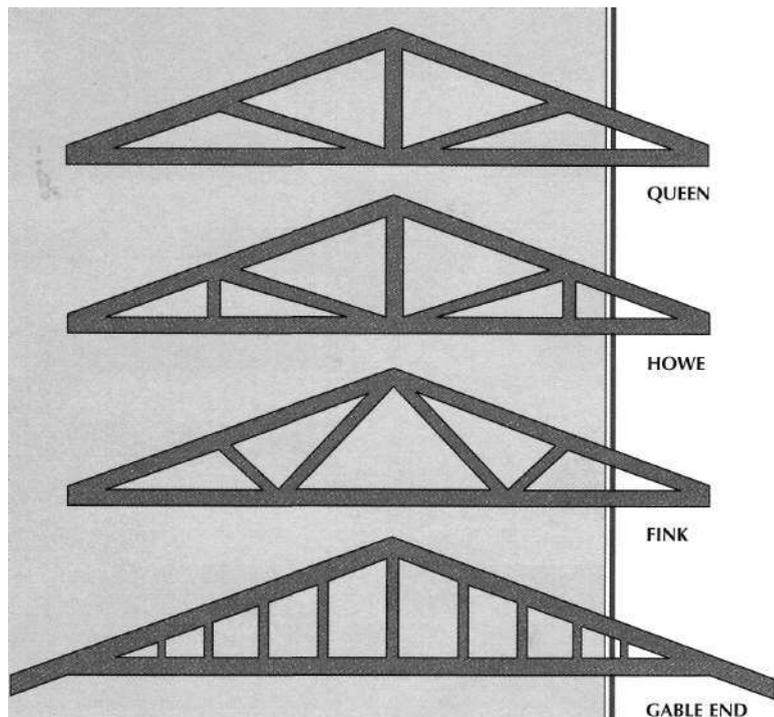
Common nails (2 1/2", 3", 3 1/2")
Galvanized common nails (2 1/2", 3 1/4", 3 1/2")
Plywood sheathing clips
String



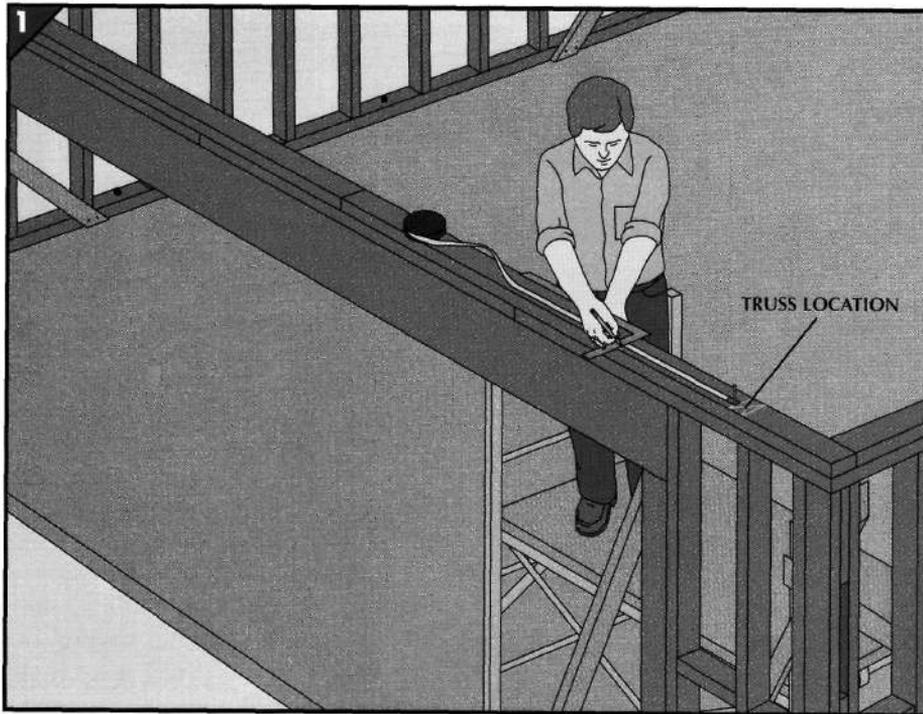
SAFETY TIPS

Wear safety goggles when driving nails or cutting with a circular saw. Put on a hard hat when working overhead. To position and secure trusses, rent two 6-foot scaffolds.

Truss construction is largely dictated by local conditions. Queen is a common style, but Howe might be found in an area with high snowfall. If you plan to build a catwalk above the bottom chords for storage, order trusses without a center web, such as the Fink. You will need two gable end trusses with webs spaced 16 inches apart for attaching the sheathing. Because these trusses rest on a wall, their webs can be modified to create framing for a ventilation opening (*page 121*). A truss manufacturer or distributor will suggest the right trusses for your project.

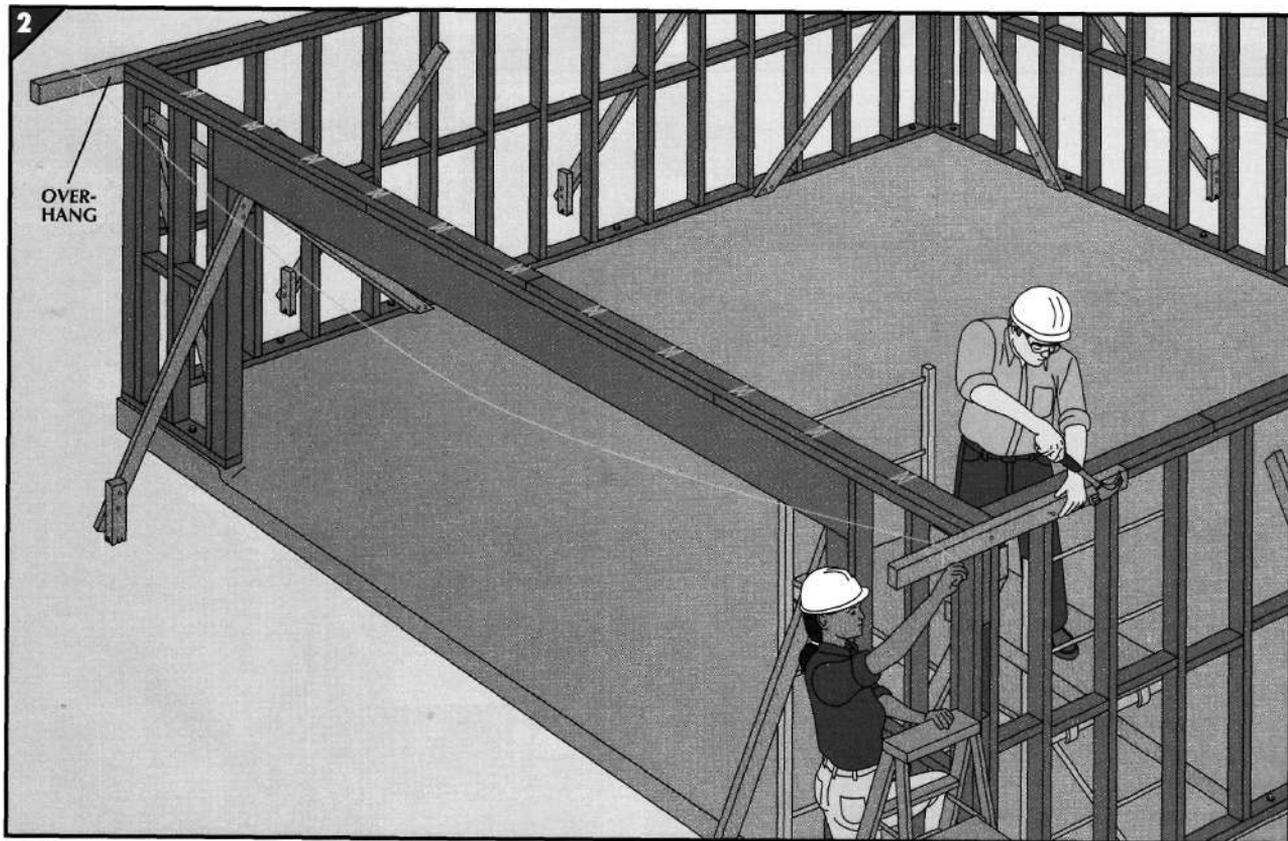


PREPARING THE WALLS FOR TRUSSES



1. Marking the truss locations.

- If required by your building code, add 2-by-4 fire stops, staggering their heights so you can face-nail them to the studs with 3 1/2-inch common nails.
- Standing on a scaffold, measure 24 3/4 inches from a side wall and mark a line across the front wall's top plate with a carpenter's square. Mark a second line 1 1/2 inches away to outline the truss location.
- Outline the remaining truss positions on 24-inch centers, using the first mark as a starting point (*left*).
- Repeat the process to lay out truss locations on the back wall.



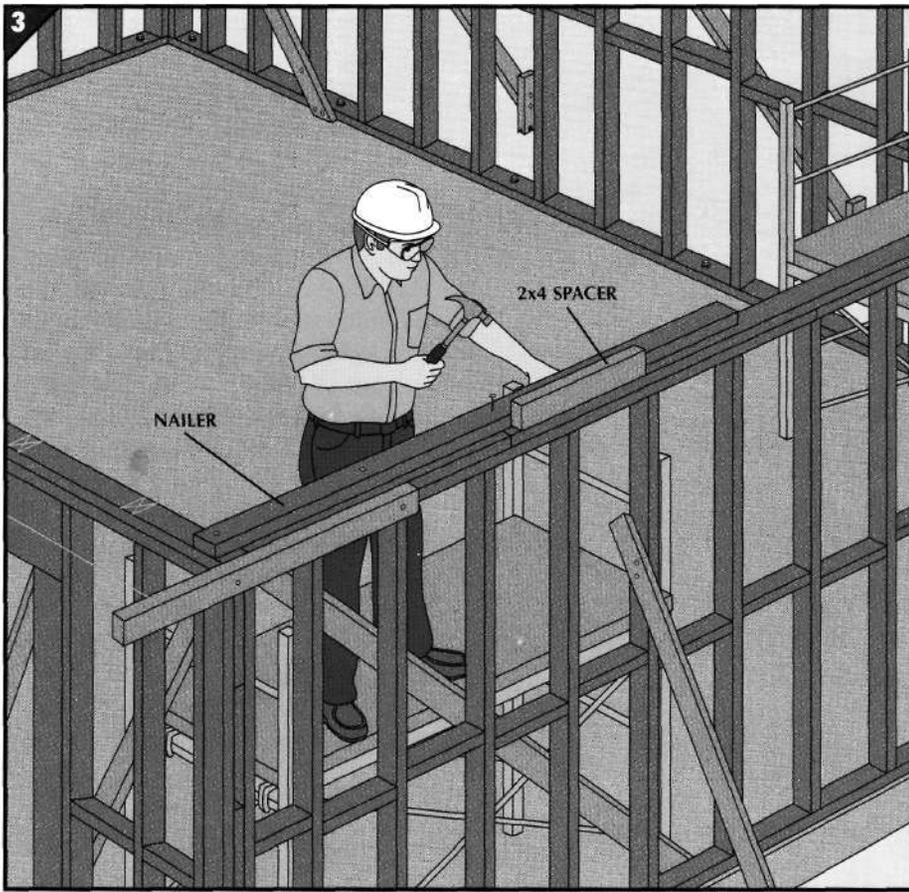
2. Laying out the overhang.

To assist in positioning the trusses, set up a layout line along the front wall. To do so:

- Nail a 2-by-4 to the outside face of each side wall top plate with 3 1/2-inch common nails

so the tops of the board and the top plate are flush. Attach the board so it projects beyond the truss overhang by a few inches.

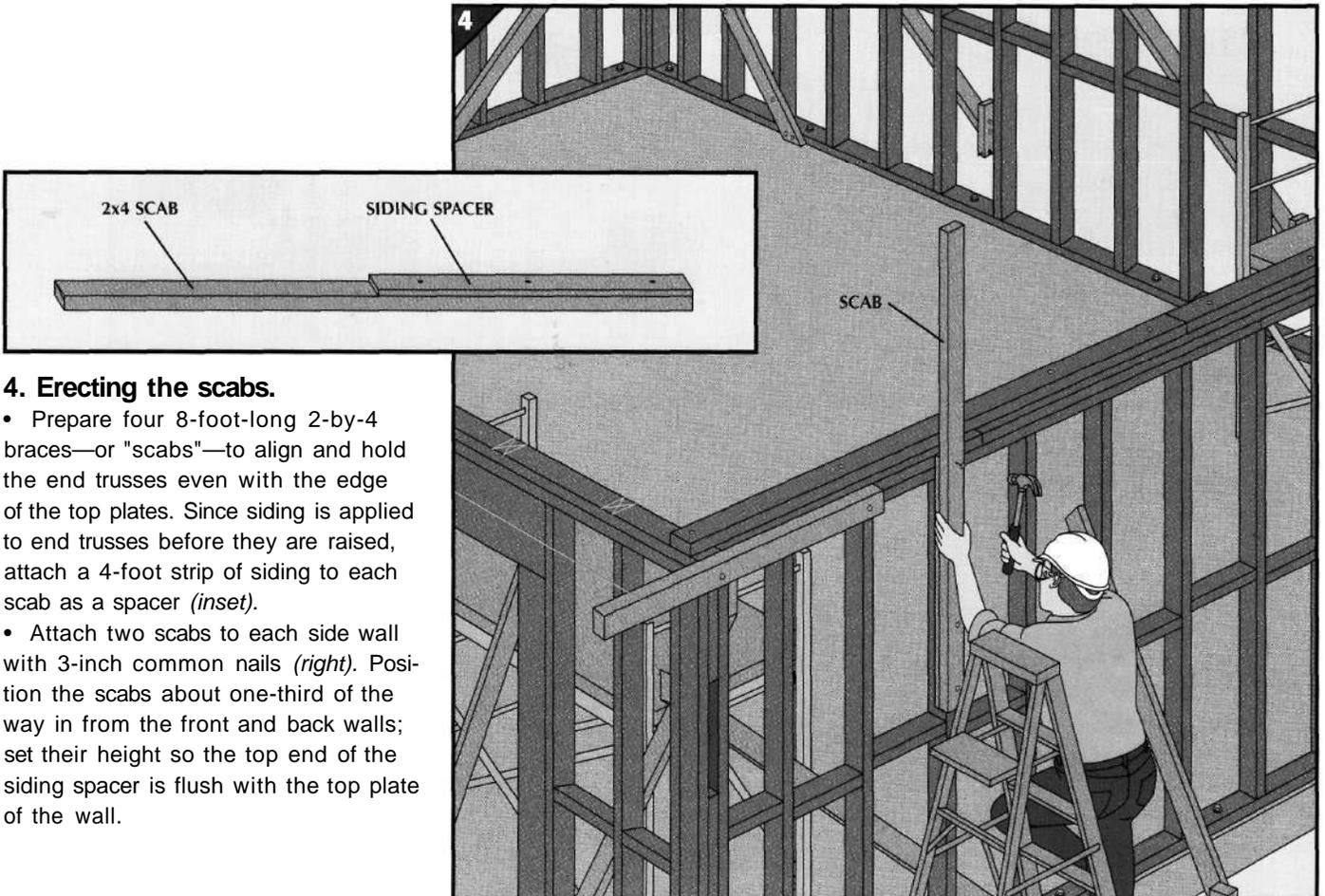
- Mark the overhang on each 2-by-4, then tie a string tautly between the marks (*above*).



3. Fastening the nailers.

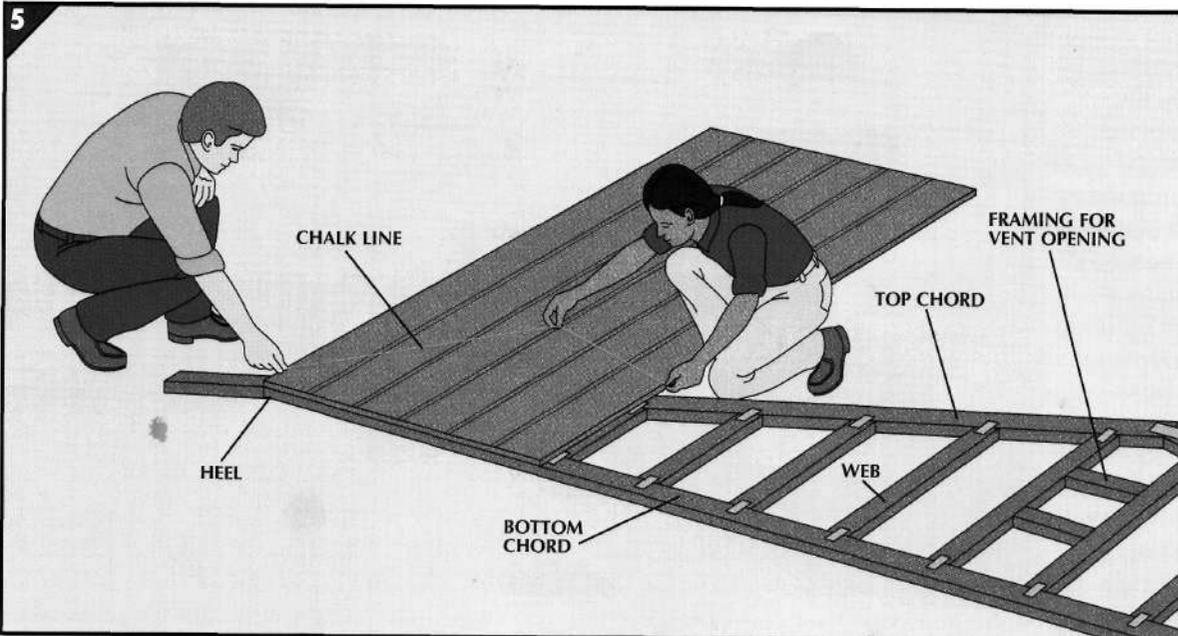
Secure boards to the side-wall top plates as nailing surfaces for the bottom chords of the end trusses.

- Attach 2-by-4 nailers to the top plates with 3-inch nails; hold a 2-by-4 spacer on edge on the top plate while fastening to offset the front edges of the nailer and top plate by 1 1/2-inches (*left*).
- Trim the nailers flush with the front and back walls.



4. Erecting the scabs.

- Prepare four 8-foot-long 2-by-4 braces—or "scabs"—to align and hold the end trusses even with the edge of the top plates. Since siding is applied to end trusses before they are raised, attach a 4-foot strip of siding to each scab as a spacer (*inset*).
- Attach two scabs to each side wall with 3-inch common nails (*right*). Position the scabs about one-third of the way in from the front and back walls; set their height so the top end of the siding spacer is flush with the top plate of the wall.



5. Sheathing the end trusses.

- Install framing in the end trusses for a vent.
- Set an end truss on the ground and lay a 4-by-8 sheet of plywood siding on it, aligning a corner of the sheet with the heel—or bottom corner—at one end of the truss.
- Snap a chalk line across the siding in line with

the top chord of the truss (*above*), then cut the siding along the line.

- Nail the cut section of siding to the truss with galvanized box nails long enough to penetrate 1 inch into the truss.
- Fasten siding to the rest of the truss the same way, then cut the vent opening with a saber saw.

RAISING THE ROOF

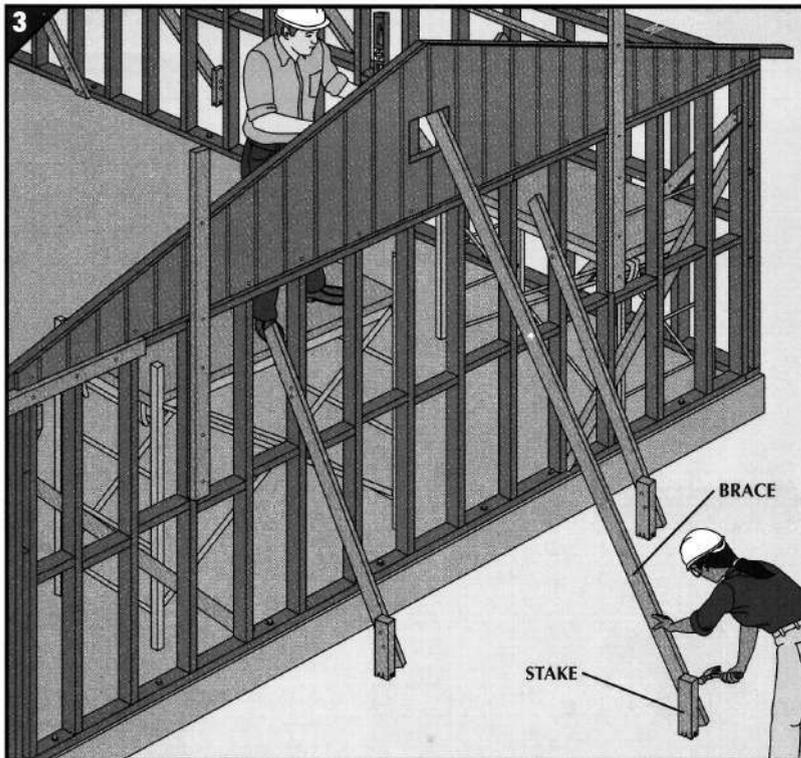
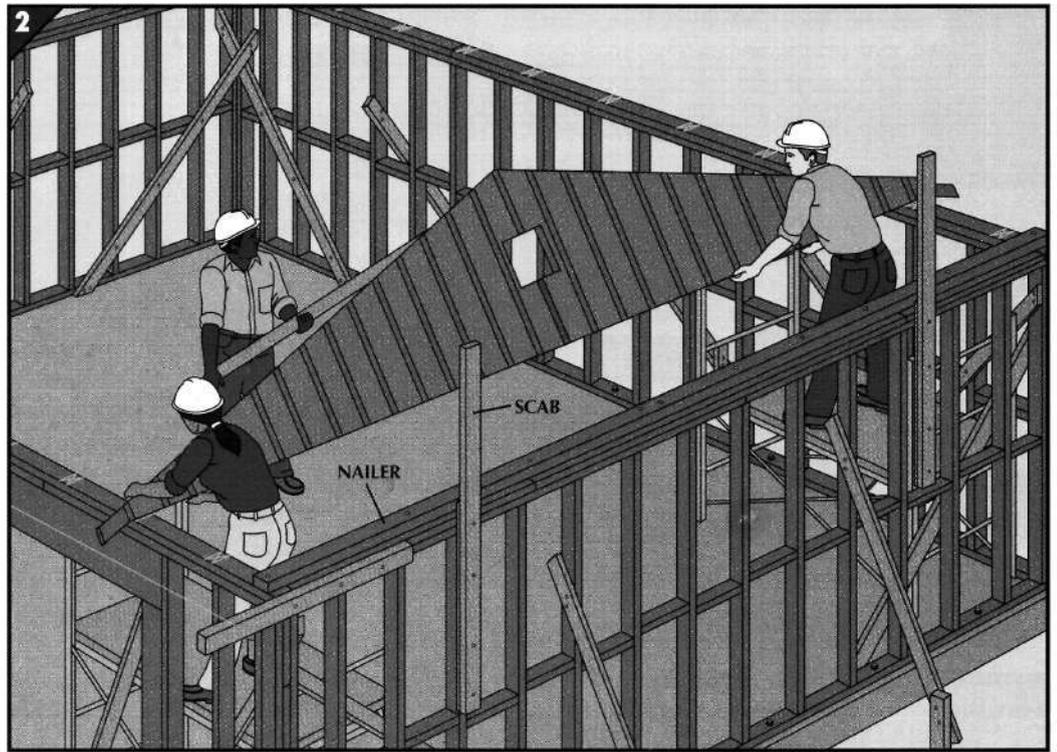


1. Hoisting an end truss.

- With two helpers, carry an end truss upside down into the building. Then, standing on a scaffold, lift one end until the top chord rests on the top plate of one side wall (*left*).
- With your helpers on another scaffold, pivot the other end of the truss onto the opposite side wall top plate.

2. Installing the end truss.

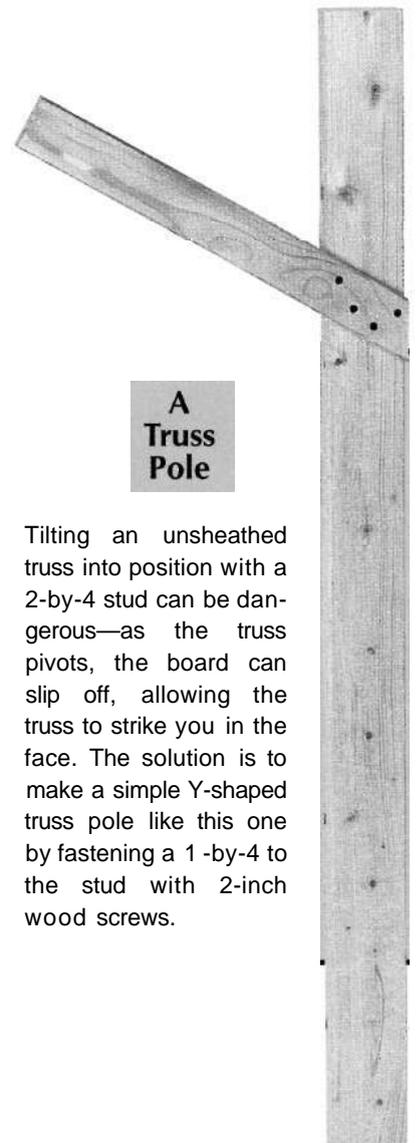
- Have a helper wedge a 2-by-4 into the peak of the truss and tilt it upright (*right*). With another helper on the scaffold, guide the truss so the bottom chord settles between the nailer and the scabs.
- Align the front-wall end of the truss with the overhang line along the front wall.
- On a ladder outside the building, nail the scabs to the top chord of the truss and drive a 3 1/2-inch galvanized common nail through the siding and the bottom chord of the truss into the nailer every 16 inches.



3. Plumbing the end truss.

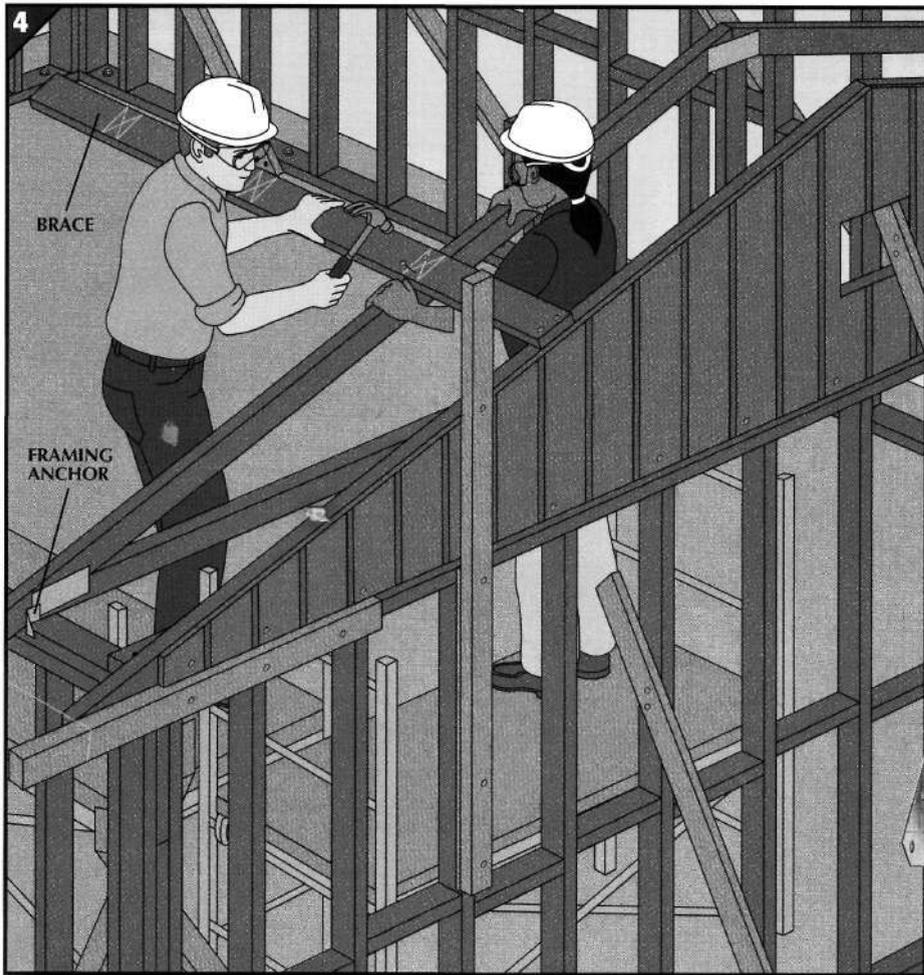
- Support the end truss with a 16-foot-long 2-by-4 brace, nailing one end of the brace to the vent opening framing and the other to a 2-by-4 stake driven into the ground about 8 feet from the wall.

- Loosen the scabs and position a carpenter's level against the top and bottom chords of the end truss. Meanwhile, have a helper reposition the brace on the stake so that the end truss is plumb (*above*).



**A
Truss
Pole**

Tilting an unsheathed truss into position with a 2-by-4 stud can be dangerous—as the truss pivots, the board can slip off, allowing the truss to strike you in the face. The solution is to make a simple Y-shaped truss pole like this one by fastening a 1-by-4 to the stud with 2-inch wood screws.



4. installing truss bracing.

- Tilt the second truss into position over its outlines on the top plates and align an end with the overhang line.
- Toenail the truss to the top plates with 3 1/2-inch galvanized common nails. Attach a multipurpose framing anchor (*photograph*) to each end of the truss with the nails recommended by the manufacturer.
- Outline the truss spacing on an 8-foot-long 1-by-6 brace for each side of the ridge and fasten one end of the brace to the end truss with two 2 1/2-inch nails. Aligning the truss with the first outline, nail the brace to the top chord (*left*). Repeat on the other side of the ridge.

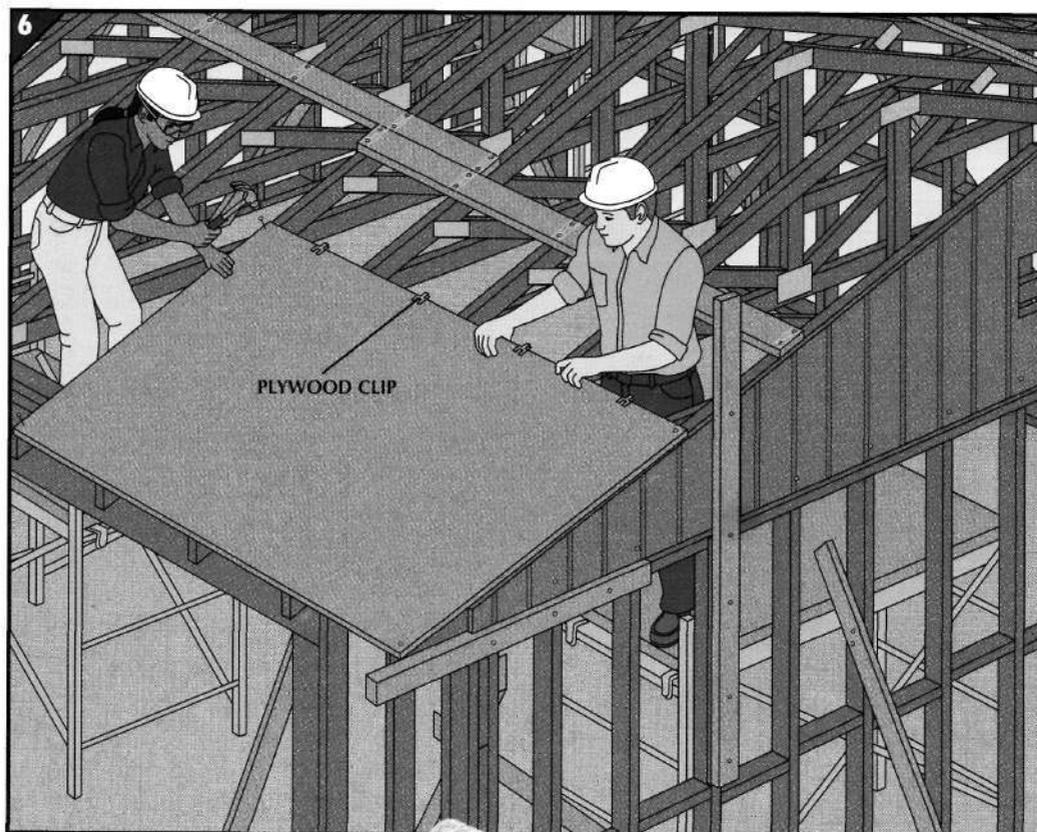
5. Raising the remaining trusses.

- Position and brace the rest of the trusses except the last four, install more braces as needed, fastening them to trusses already in place (*right*).
- Install the remaining end truss.
- Tilt the last three trusses up to the roof before positioning any of them. Then position and brace them one at a time.



6. Sheathing the trusses.

- Set up the scaffolds along the side walls. With a helper, snap chalk lines along the top chords of the trusses 4 and 8 feet from the overhang as guidelines for laying plywood sheathing.
- Align the top edge of a 4-by-8 sheet of sheathing with the chalk line and center it over the fifth truss.
- As a helper slips a plywood clip (*photograph*) onto the top edge of the sheathing between each truss, secure the sheet with 2 1/2-inch galvanized common nails every 6 inches along the top chords (*right*).
- After sheathing the bottom 4 feet of the roof, remove the braces fastened to the trusses and cover the next 4 feet, starting the row with a half-sheet in order to stagger the joints from the bottom row.
- Before installing the last row of sheets, trim their top edges so the sheathing stops 1 inch short of the ridge. Cover the other side of the trusses the same way.



7. Stabilizing the bottom chords.

On each side of the ridge, support the bottom chords of the trusses with the bracing you removed in Step 6. Position a brace across the trusses and, holding the chord in line with its outline, attach the brace to the truss with two 2 1/2-inch nails (*left*).

If your area experiences high wind, diagonal bracing may be required; check the local building code.

Siding with Plywood

Plywood siding is sturdy, economical, and easy to install. Designed to face the elements, it comes in various lengths—but 8 feet is most common—and in a variety of textures and patterns. It is also available with shiplap edges that mesh with adjoining panels.

If your studs are 24 inches apart, make sure the paneling is the thicker kind designed for this spacing. When ordering the paneling, ask your supplier for Z-flashing to fit between the end-truss siding and the wall siding.



TOOLS

Caulking gun
Hammer
Tin snips
Circular saw



MATERIALS

1x3s, 1x4s
Plywood siding panels
Z-flashing

Exterior caulk
Galvanized box nails
Galvanized finishing nails (2 1/4")

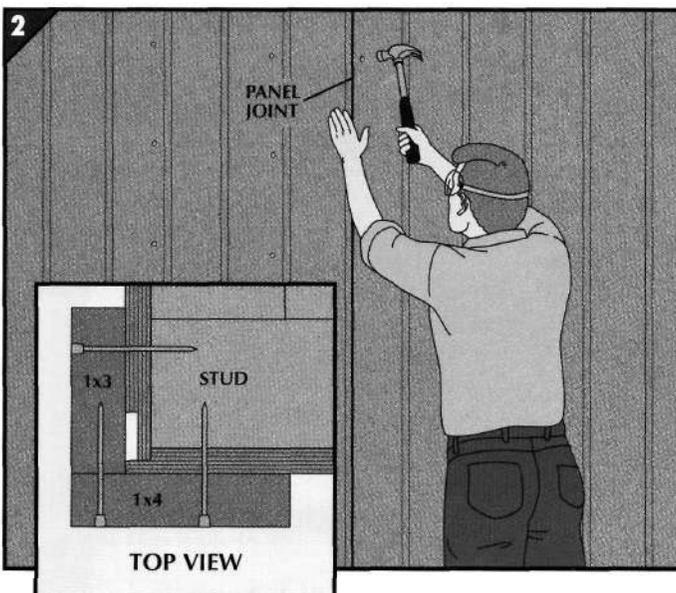
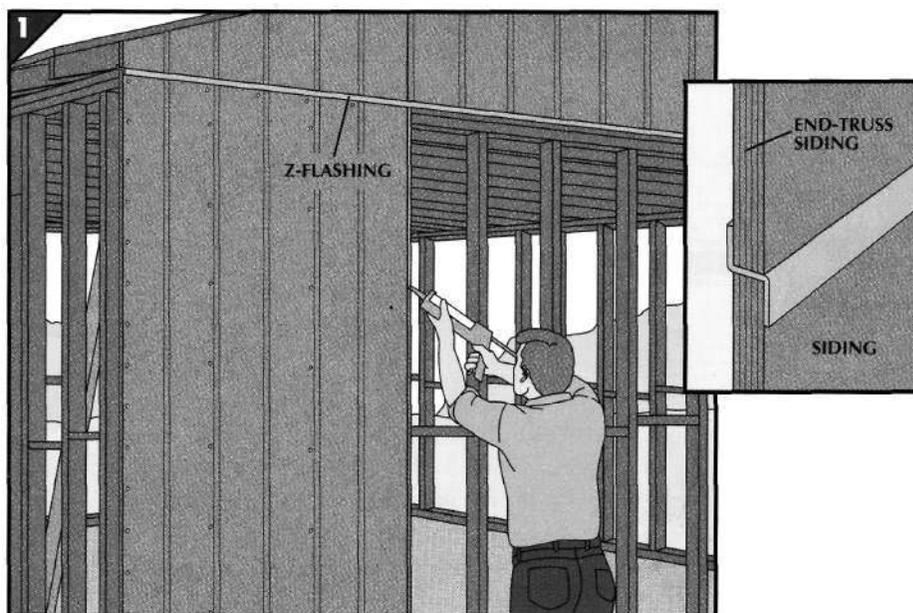


SAFETY TIPS

Wear goggles when nailing.

1. Fastening the first panel.

- Starting at a corner apply exterior caulk to the stud surfaces that will contact the first panel.
- Slip one flange of a piece of Z-flashing behind the sheathing that covers the end truss, then ease the first siding panel behind the other flange (*inset*).
- Secure the panel to the studs with galvanized box nails long enough to penetrate the studs by 1 inch. Space the fasteners 6 inches apart along the starting stud and at 12-inch intervals along the other studs. Rather than driving nails through the lapped edge of the panel, apply caulk along the lap (*right*).



2. Finishing the job.

- Install the next panel so its lapped edge meshes with the first. Avoiding the joint, nail the edge of the second panel to the stud (*left*); this will leave the first panel free to expand.
- Install the rest of the siding this way. Trim the corner panels and Z-flashing as needed using tin snips to cut the flashing.
- Cover the exposed edges of the siding at the corners with 1-by-3s and 1-by-4s fastened with 2 1/4-inch galvanized finishing nails (*inset*).