Foundations

Like a house, a shed or gazebo needs a foundation to provide a sturdy base to build upon and to protect the structure from the damaging effects of moisture and soil. In some cases the foundation ties the building to the earth (an important requirement for umbrella-like gazebos) or keeps the building from shifting during seasonal freeze-thaw cycles.

You can build a shed with a variety of foundations; the most commonly used types are the wooden skid and the concrete slab. In addition to being far easier and cheaper to construct, a skid foundation allows you to move the shed if you need to. It also ensures—in most areas—that the building is classified as a temporary structure. A concrete slab, by contrast, gives you a nice, hardwearing floor as well as an extremely durable foundation. But a concrete foundation means the building is considered "permanent," which could affect the tax assessment of your property; you'll also most likely need a permit for the project.

Gazebos must be securely anchored to the ground, as mentioned, and are typically built on concrete pier or slab foundations. For very small projects you probably won't need a foundation—just make sure the base or posts that sit on the ground are made of rotresistant lumber.

Wooden Skid Foundation

A skid foundation couldn't be simpler: two or more treated wood beams or landscape timbers (typically 4 × 4, 4 × 6, or 6 × 6) set on a bed of gravel. The gravel provides a flat, stable surface that drain well to help keep the timbers dry. Once the skids are set, the floor frame is built on top of them and is nailed to the skids to keep everything in place.

Building a skid foundation is merely a matter of preparing the gravel base, then cutting, setting, and leveling the timbers. The timbers you use must be rated for ground contact. It is customary, but purely optional, to make angled cuts on the ends of the skids—these add a minor decorative touch and make it easier to *skid* the shed to a new location, if necessary.

Because a skid foundation sits on the ground, it is subject to slight shifting due to frost in coldweather climates. Often a shed that has risen out of level will correct itself with the spring thaw, but if it doesn't, you can lift the shed with jacks on the low side and add gravel beneath the skids to level it.

TOOLS & MATERIALS

Shovel
Circular saw
Rake Square
4-ft. level
Treated wood timbers
Straight, 8-ft. 2 ×4
Compactible gravel
Hand tamper
Wood sealer-preservative

HOW TO BUILD A WOODEN SKID FOUNDATION

Step A: Prepare the Gravel Base

1. Remove 4" of soil in an area about 12" wider and longer than the dimensions of the building.

2. Fill the excavated area with a 4" layer of compactible gravel. Rake the gravel smooth, then check it for level using a 4-ft. level and a straight, 8-ft.-long 2 × 4. Rake the gravel until it is fairly level.

3. Tamp the gravel thoroughly using a hand tamper or a rented plate compactor. As you work, check the surface with the board and level, and add or remove gravel until the surface is level.

Step B: Cut & Set the Skids

1. Cut the skids to length, using a circular saw or reciprocating saw. (Skids typically run parallel to the length of the building and are cut to the same dimension as the floor frame.)

2. To angle-cut the ends, measure down 1 1/2" to 2" from the top edge of each skid. Use a square to mark a 45º cutting line down to the bottom edge, then make the cuts.

3. Coat the cut ends of the skids with a wood sealer-preservative and let them dry.

4. Set the skids on the gravel so they are parallel and their ends are even. Make sure the outer skids are spaced according to the width of the building.

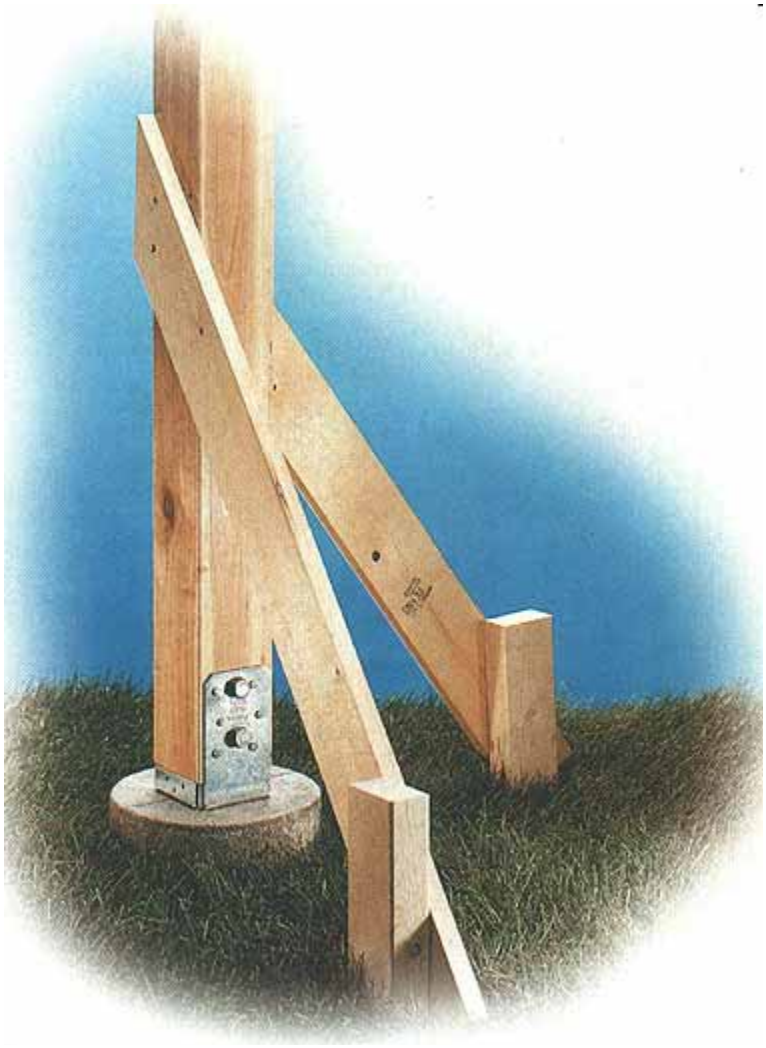
Step C: Level the Skids

1. Level one of the outside skids, adding or removing gravel from underneath. Set the level parallel and level the skid along its length then set the level perpendicular and level the skid along its width.

2. Place the straight 2 × 4 and level across the first and second skids, then adjust the second skid until it's level with the first. Make sure the second skid is level along its width.

3. Level the remaining skids in the same fashion then set the board and level across all of the skids to make sure they are level with one another.

Concrete Pier Foundation



A concrete pier foundation consists of poured concrete cylinders that support wood posts. The piers, or *footings*, are the same as those used for deck construction. They are easy to make using cardboard forms that you cut to size.

To anchor the posts to the footings, it's best to use galvanized metal post bases. There are several easy-to-use adjustable types available, which are secured to the footing by means of a J-bolt set into the concrete. After the concrete is dry, you bolt down the base, set and plumb the post, and fasten the post to the base.

Pier foundations work well for gazebos because they allow you to build an elevated floor while keeping the structure securely planted in the earth. For sheds, piers offer a permanently fixed foundation

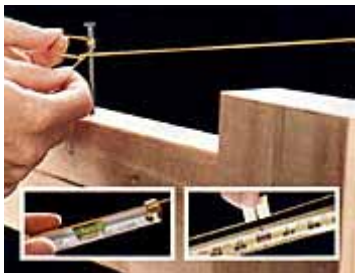
and protection against frost heaves. If you're building a shed on level ground, use pads made from pressure-treated 2 × lumber instead of posts. Anchor the pads to the piers using the J-bolts and build the floor frame on top of the pads.

Constructing a pier foundation is not difficult work, but it's important that the pier layout is accurate and the concrete forms are set properly. Use batter boards and mason's lines to lay out the pier positions and check your work by taking measurements and applying some simple geometry.

Before starting your project, ask the local building department about the required diameter and depth of your piers and what type of post anchors to use. In most areas, concrete piers must extend into the ground below the frost line and stand at least 2" above the ground to protect the posts from moisture. Cardboard forms for piers are commonly available in 8", 10", 12", and 16" diameters.

TOOLS & MATERIALS

Circular saw
2 1/2" screws
Drill Stakes
Mason's line Nails
Sledgehammer Masking tape
Line level
Cardboard
concrete
forms
Framing square
Paper
Plumb bob
Concrete mix
Shovel
J-bolts
Post hole digger
Post bases
Reciprocating saw
handsaw
Straight board
Utility knife
Wood sealer preservative
Ratchet wrench
Scrap lumber for
braces
2 × 4 lumber
Lag screws



HOW TO BUILD A CONCRETE PIER FOUNDATION

Step A: Construct the Batter Boards

1. Cut two 24"-long 2 × 4 legs for each batter board (for most projects you'll need eight batter boards total). Cut one end square and cut the other end to a sharp point, using a circular saw. Cut

2. Assemble each batter board using 2 1/2" screws. Fasten the crosspiece about 2" from the square ends of the legs. Make sure the legs are parallel and the crosspiece is perpendicular to the legs.

Step B: Set the Batter Boards & Establish Perpendicular Mason's Lines

1. Measure and mark the locations of the piers with stakes, following your project plan.

2. Set two batter boards to form a corner about 18" behind each stake. Drive the batter boards into the ground until they are one 2 × 4 crosspiece for each batter board at about 18". secure, keeping the crosspieces roughly level with one another.

3. Stretch a mason's line between two batter boards at opposing comers (not diagonally) and tie the ends to nails driven into the top edge of the crosspieces; align the nails and line with the stakes. Attach a line level to the line, and pull the line very taut, making sure it's level before tying it.

4. Run a second level line perpendicular to the first: Tie off the end that's closest to the first

string, then stretch the line to the opposing batter board while a helper holds a framing square at the intersection of the lines. When the lines are perpendicular, drive a nail and tie off the far end.

5. Confirm that the lines are exactly perpendicular, using the 3-4-5 method. Starting at the intersection, measure 3 ft. along one string and make a mark onto a piece of masking tape. Mark the other string 4 ft. from the intersection. Measure diagonally between the two marks; the distance should equal 5 ft. Reposition the second string, if necessary, until the diagonal measurement is 5 ft.

Step C: Mark the Footing Locations

1. Following your plan, measure from the existing lines and use the 3-4-5 method to add two more perpendicular lines to form a layout with four 90° corners. Use the line level to make sure the mason's lines are level. The intersections of the lines should mark the centers of the piers.

2. Check the squareness of your line layout by measuring diagonally from corner to corner: when the measurements are equal, the frame is square.

Make any necessary adjustments.

3. Plumb down with a plumb bob and place a stake directly under each line intersection. If your plan calls for additional piers, as in the Gazebo project, measure and mark those points on the lines, then plumb down and plant the stakes.

4. Untie each line at one end only, then coil the line and place it out of the way. Leaving one end tied will make it easier to restring the lines later.

Step D: Set the Forms

1. Dig holes for the forms, centering them around the stakes. Make the holes a few inches larger in diameter than the cardboard forms. The hole depth must meet the local building code requirements—add 4" to the depth to allow for a layer of gravel. For deep holes, use a post hole digger or a rented power auger. Add 4" of gravel to the bottom of each hole.

2. Cut each cardboard form so it will extend 2" above the ground level. The top ends of the forms must be straight, so place the factory-cut end up, whenever possible. Otherwise, mark a straight cutting line using a large piece of paper with at least one straight edge: Wrap the paper completely around the form so that it overlaps itself a few inches.

Step E: Pour the Concrete

1. Restring the mason's lines and confirm that the forms are positioned accurately.

2. Mix the concrete following the manufacturer's directions; prepare only as much as you can easily work with before the concrete sets. Fill each form with concrete, using a long stick to tamp it down and eliminate air pockets in the concrete. Overfill the form slightly.

3. Level the concrete by pulling a 2 × 4 on edge across the top of the form, using a side-to-side sawing motion. Fill low spots with concrete so that the top is perfectly flat.

4. Set a J-bolt into bolt into the wet concrete in the center of the form. Lower the bolt slowly, wiggling it slightly
Position the straight edge of thre paper on the cutting mark, and align the overlapping edges of the paper with each other. Mark around the tube along the edge of the paper. Cut the tube with a reciprocating saw or handsaw.

3. Set the tubes in the holes and fill in around them with dirt. Set a level across the top of each tube to make sure the top is level as you secure the tube with dirt. Pack the dirt firmly, using a shovel handle or a stick.

aligning the post bases. Place a long, straight board across two piers, setting it on the same side of each J-bolt. Hold the board against the bolts and trace along the edge (bolt-side) of the board onto the

to eliminate air pockets. Use a plumb bob to make sure the bolt is aligned exactly with the mark on the mason's line. Make sure the bolt is plumb and extends 3/4" to 1" above the concrete. Smooth the concrete around the bolt and let the concrete cure.

Step F: Install the Post Bases

1. Mark a reference line on the top of each pier to help with

Step G: Set the Posts

1. Make sure the bottom post ends are square; cut them, if

necessary. Seal the bottom ends with a wood sealer-preservative, to prevent rot.

2. Place each post in its base, hold it plumb, and tack in one 16d galvanized common nail.

tops of the piers.

Note: If your footing layout is square or rectangular, make reference marks that follow the perimeter of the building. If you're building a gazebo, set the board across the center pier and each of the outside piers.

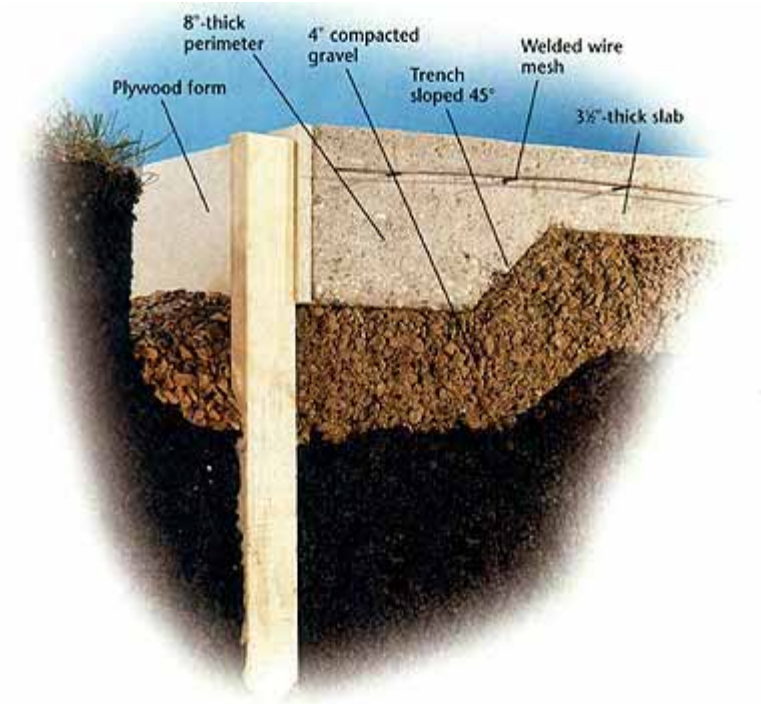
2. Place a post base on each pier so it's centered over the J-bolt. Add the washers and loosely screw the anchor nut onto the J-bolt. Use a framing square to position the base square with the reference line, then tighten the nut with a ratchet wrench.

3. Place the metal pedestals into the post bases.

Have a helper set up two perpendicular cross braces. Use a level to plumb the post, and secure the braces to the post and to stakes in the ground, using screws. Hold the level on two adjacent post faces to make sure the post is perfectly plumb. Nail the post to the base with 16d nails.

3. Drill pilot holes for the lag screws that anchor the posts to the bases (check with the manufacturer for the recommended size of lag screw). Install the lag screws with a ratchet wrench. Leave the braces in place until the top post ends are securely framed into them structure. Cut away the exposed portions of the forms with a utility knife.

Concrete Slab Foundation



The slab foundation commonly used for sheds is called a *slabon-grade* foundation. This combines a 3 1/2"- to 4"-thick floor slab with a 8"- to 12"-thick perimeter footing that provides extra support for the walls of the building. The whole foundation can be poured at one time using a simple wood form.

Because they sit above ground, slab-on-grade foundations are susceptible to frost heave and in cold-weather climates are suitable only for detached buildings. Specific design requirements also vary by locality, so check with the local building department regarding the depth of the slab, the metal reinforcement required, the type and amount of gravel required for the subbase, and whether plastic or an other type of moisture barrier is needed under the slab.

The slab shown in this project has a 3 1/2"-thick interior with a 8"-wide × 8"-deep footing along the perimeter. The top of the slab sits 4" above ground level, or *grade*. There is a 4"-thick layer of compacted gravel underneath the slab and the concrete is reinforced internally with a layer of 6 × 6" 10/10 welded wire mesh (WWM). (In some areas, you may be required to add rebar in the foundation perimetercheck the local code.) After the concrete is poured and finished, 8"-long J-bolts are set into the slab along the edges. These are used later to anchor the wall framing to the slab.

A slab for a shed requires a lot of concrete: an 8 × 10-ft. slab designed like the one in this project calls for about 1.3 cubic yards of concrete; a 12 × 12-ft. slab, about 2.3 cubic yards. Considering the amount involved, you'll probably want to order ready-mix concrete delivered by truck to the site (most companies have a one-yard minimum). Order *air-entrained* concrete, which will hold up best, and tell the mixing company that you're using it for an exterior slab.

An alternative for smaller slabs is to rent a concrete trailer from a rental center or landscaping company; they fill the trailer with one yard of mixed concrete and you tow it home with your own vehicle.

If you're having your concrete delivered, be sure to have a few helpers onhand when the truck arrives; neither the concrete nor the driver will wait for you to get organized. Also, concrete trucks must be unloaded completely, so designate a dumping spot for any excess. Once the form is filled, load a couple of wheelbarrows with concrete (in case you need it) then have the driver dump the rest. Be sure to spread out and hose down the excess concrete so you aren't left with an immovable boulder in your yard.

If you've never worked with concrete, finishing a large slab can be a challenging introduction; you might want some experienced help with the pour.

TOOLS & MATERIALS

Circular saw
Hand-held concrete float
Drill
Concrete edger
Mason's line
Compactible gravel
Sledgehammer
2 × 3 & 2 × 4 lumber
Line level
1 1/4" & 2 1/2" deck screws
Framing square

3/4" A-C plywood
Shovel
8d nails
Wheelbarrow
6 × 6" 10/10 welded wire mesh
Rented plate compactor
1 1/2" brick pavers
Bolt cutters
J-bolts
Bull float
2"-thick rigid foam insulation

HOW TO BUILD A CONCRETE SLAB FOUNDATION

Step A: Excavate the Site

1. Set up batter boards and run level mason's lines to represent the outer dimensions of the slab. Use the 3-4-5 method to make sure your lines are perpendicular, and check your final layout for squareness by measuring the diagonals.

2. Excavate the area 4" wider and longer than the string layout-this some room to

Step B: Build the form

1. Cut sheets of 3/4" A-C

plywood into six strips of equal width—about 7 7/8", allowing for the saw cuts. To make sure the cuts are straight, use a table saw or a circular saw and straightedge.

2. Cut the plywood strips to length to create the sides of the form. Cut two sides 1 1/2" long so they can overlap the remaining two sides. For sides

work. For the footing portion along the perimeter, dig a cross strings to check the depth as you work.

4. Add a 4" layer of compactible gravel over the entire excavation and rake it level. Compact the gravel thoroughly, using a rented plate compactor.

trench that is 8" wide × 8" deep.

3. Remove 3 1/2" of soil over the interior portion of the slab, then slope the inner sides of the trench at 45°. Set up temporary that are longer than 8 ft., join the strips with 1 1/4" screws.

3. Assemble the form by fastening the comers together with screws. The form's inner dimensions must equal the outer dimensions of the slab.

Step C: Set the Form

1. Cut 18"-long stakes from 2 × 3 lumber—you'll need one stake for every linear foot of form, plus one extra stake for each corner. Taper one end of each stake to a point.

2. Place the form in the trench and align it with the mason's lines. Drive a stake near the end of each side of the form, setting the stake edge
against the form and driving down to 3" above grade.

3. Measuring down from the mason's lines, position the form 4"above grade. Tack the form to the stakes with partially driven 8d nails (driven through the form into the stakes). Measure the diagonals to make sure the form is square and

Step D: Add the Metal Reinforcement

1. Lay out rows of 6 × 6" 10/10 welded wire mesh so their ends are 1" to 2" from the insides of the forms. Cut the mesh with bolt cutters or heavy pliers, and stand on the unrolled mesh as you cut, to prevent it from springing back. Overlap the rows of mesh by 6" and tie them together with tie wire.

2. Prop up the mesh with pieces of 1 1/2"-thick brick pavers or metal bolsters.

3. Mark the layout of the J-bolts onto the top edges of the form, following your plan. (J-bolts typically are placed 4" to 6" check that the top of the form is level. Drive the nails completely.

4. Add a stake every 12" and drive them down below the top edge of the form. Secure the form with two 8d nails driven into each stake. As you work, check with a string line tomake sure the form sides are straight and measure the diagonals to check for square.From each comer and every 4 ft.in between.)

Step E: Pour the Slab

1. Starting at one end, fill in the form with concrete, using a shovel to distribute it. Use the shovel blade or a 2 × 4 to stab into the concrete to eliminate air pockets and settle it around the wire mesh and along the forms. Fill with concrete to the top of the form.

2. As the form fills, have two helpers screed the concrete, using a straight 2 × 4 or 2 × 6 that spans the form: Drag the screed board along the top of the form, working it back and forth in a sawing motion. Throw shovelfuls of concrete ahead of the screed board to fill low spots. The goal of screeding is to make the surface of the concrete perfectly flat and level, if not smooth.

3. Rap the outsides of the form with a hammer to settle the concrete

Step F: Finish the Concrete &
Set the J-bolts

1. Immediately after screeding the concrete, make one pass with a bull float to smooth the surface. Add small amounts of concrete to fill low spots created by the floating, then smooth those areas with the float. Floating forces the aggregate down and draws the water and sand to the surface.

2. Set the J-bolts into the concrete 1 3/4" from the outside edges of the slab. Work the bolts into the concrete by wiggling them slightly to eliminate air pockets. The bolts should be plumb and protrude 2 1/2" from the slab surface. After setting each bolt, smooth the concrete around the bolt, using a magnesium or wood concrete along the inside faces of the form. This helps smooth the sides of the slab. float.

3. Watch the concrete carefully as it dries. The bull-floating will cause water (called *bleed water)* to rise, casting a sheen on the surface. Wait for the bleed water to disappear and the surface to become dull. Pressure-test the concrete forfirmness by stepping on it with one foot: if your foot sinks 1/4" or less, the concrete is ready to be finished. Note: Air-entrained concrete may have very little bleed water, so it's best to rely on the pressure test.

4. Float the concrete with a hand-held magnesium or wood float, working the float back and forth until the surface is smooth. If you can't reach the entire slab from the sides, lay pieces of 2"-thick rigid foam insulation over the concrete and kneel on the insulation. Work backwards to cover up any impressions.

5. Use a concrete edging tool to round over the slab edge, running the edger between the slab and the form. If you want a

very smooth finish, work the concrete with a trowel.

6. Let the concrete cure for 24 hours, then strip the forms.
Wait an additional 24 hours before building on the slab.
Calculate the amount of concrete needed for a slab of this design using this formula: Width × Length × Depth, in ft. (of main slab) Multiply by 1.5 (for footing edge and spillage) Divide by 27 (to convert to cubic yards) Example—for a 12 × 12-ft. slab:
12 × 12 × .29 (3 1/2") = 41.76
41.76 × 1.5 = 62.64
62.64 ÷ 27 = 2.32 cubic yards