Choosing a Foundation
The success or failure of any outbuilding relies heavily on its foundation. No structure—regardless of how well it’s designed or built—will survive for very long on a weak or poorly made base. Therefore, choosing and building a proper foundation is the single most important construction step in the entire project.

On-grade vs. frost-proof foundations
Shed foundations fall into two basic categories: on-grade and frost-proof. On-grade foundations (sometimes called “floating foundations”) sit right on the ground and are sufficient for all but the very largest outbuildings. They’re also the quickest and simplest to build because they don’t require you to dig deep holes or pour concrete footings or piers. On-grade foundations are usually made of pressure-treated lumber (see Lean-to Shed Locker on p. 76) or solid-concrete blocks (see Saltbox Potting Shed on p. 106).

Permanent, frost-proof foundations are more difficult to build, but they’re by far the strongest and longest lasting. These types of foundations are designed for cold-weather regions where ground movement caused by freeze/thaw cycles can affect a building. The most popular material for building frost-proof foundations is poured concrete, which can take the form of a footing, pier, or slab. You can also create a permanent foundation—and avoid frost-heave troubles—with an age-old building technique called pole-barn construction. In this system, several tall round poles or square posts set into deep holes support the structure (see Gambrel Storage Barn on p. 168).

The best foundation to build for your shed will largely depend on what the building inspector recommends, but keep in mind that it’s often based on three key factors: the shed’s size, the region of the country in which you live, and the type of shed floor you desire. To help you choose the best foundation for your shed, let’s take a close look at seven foundation systems: four on-grade types and three frost-proof ones.

On-Grade Foundations
It’s no surprise that most sheds are designed to be built with an on-grade foundation. This base is quick and easy to build, relatively inexpensive, and adaptable enough to accommodate all but the most severely sloping sites. In addition, the components are small and light enough to easily set into place and shift around, making it very easy to get everything square and level. Although it’s not technically a “permanent” foundation, an on-grade foundation can be considered semi-permanent because it’s easier to adjust than a frost-proof foundation. All on-grade foundations are unique because they’re required to be either frost-proof or load-bearing, which means they must support a shed’s weight. This is important enough that the building department might require that you bring in a civil engineer or an architect to verify that your foundation will be safe. However, it’s equally important that the blocks in each row be perfectly aligned. If you can imagine, all this up and down movement isn’t very good for a shed. Frost heave can raise a building 3 in. or 4 in. off the ground, then drop it back down. The problem is, the building seldom settles back into its original, square and level position.

Fine-grained sand and stiff clay soils are more susceptible to frost heave than coarse-grained soils and compacted gravel are, but the phenomenon can occur virtually anywhere, especially if the building site doesn’t effectively drain away groundwater.

The best way to prevent this unsettling condition is to dig past the point where the ground freezes—an area known as the frost line—and then pour a concrete pier or footing. How deep you need to dig depends on how far down the frost penetrates the soil in your particular corner of the world. For example, in New England and the Upper Plains, you may need to dig 42 in. or more. In the mid-Atlantic region, 24 in. to 36 in. may be sufficient. Check with the local building department for the exact frost-line depth in your town.

Frost heave sounds like something that happens after you eat too many snow cones. But if you live in a cold-weather region, it’s no joking matter. Frost heave is a phenomenon that occurs when moisture in the soil freezes and then expands, pushing the ground—and anything buried in it—upward. When the ground thaws, the soil slumps back down. As you can imagine, all this up and down movement isn’t very good for a shed. Frost heave can raise a building 3 in. or 4 in. off the ground, then drop it back down. The problem is, the building seldom settles back into its original, square and level position.

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According to Code
An increasing number of building departments are requiring homeowners to install ground anchors, which prevent a shed from blowing over or sliding off its foundation. The steel-cabled anchors are bolted through the mud sill at each corner of the building. Then a steel rod is used to drive the hold-down spike deep into the ground.
ON-GRADE FOUNDATIONS

PRO TIP
Gravel and crushed stone are available in 50-lb. bags, but it's cheaper if you buy it by the truckload from a garden shop, nursery, or masonry supplier.

WHAT CAN GO WRONG
An on-grade foundation will last a lifetime if the ground beneath remains dry and undisturbed. Never build on a site that collects standing water. Soggy soil will eventually swallow up the foundation. And don't set the foundation too close to any trees. The roots can grow underneath the shed and lift the foundation right off the ground.

TRADE SECRET
It's often necessary to stack two or more solid-concrete blocks on top of one another to create a level foundation. To keep the blocks from sliding out of position as you set the floor frame in place, use a caulking gun to apply a generous bead of construction adhesive between the blocks. You can also use the adhesive to glue shims to the tops of the blocks.

A shallow bed of gravel placed underneath concrete foundation blocks aids drainage and helps prevent them from sinking into the soil. (Photo © Joseph Truini.)

In most cases, you'll need both 2-in.-thick patio blocks and 4-in-thick solid-concrete blocks to build an on-grade foundation.

Eight solid-concrete blocks are arranged in two rows to form this on-grade foundation. Identical diagonal measurements indicate a square layout.

It's important to note that you must use only solid-concrete blocks for this type of foundation. Standard wall block or any other hollow block will eventually crack and crumble under the weight of the shed. If you have trouble finding solid blocks at a home center or lumberyard, visit a masonry supplier.

The blocks measure 8 in. wide by 16 in. long and come in 4-in.- and 2-in.-thick units. The thicker blocks are placed first, with the thinner “patio” blocks laid on top when you need to raise one block even with the others. In some cases, you may need to stack two or three 4-in. blocks on top of each other to raise the lowest corner of the foundation so it is even with the highest corner.

If the building site is high and dry, you can set the blocks directly on the ground. However, if there's any chance that rain runoff will occasionally drain under the shed, you'll need to use a shovel to remove a patch of grass under each block, compact the soil with a hand tamper, then cover the exposed dirt with 2 in. or 3 in. of gravel before setting the blocks. The gravel bed will ensure that the soil beneath the blocks won’t wash away or become soggy.

A series of precast pier blocks, arranged in three straight rows, provides a simple, secure way to support a floor frame. (Photo courtesy of DEKBRANDS™.)

Precast pier blocks
This building method is similar to the solid-concrete block foundation discussed above. However, instead of using flat blocks, a series of precast concrete pier blocks are used to support the shed’s floor frame. The pyramid-shaped blocks are designed for building decks, but they work great for sheds, too—provided you choose the right type.

There are a few styles of pier blocks available, including one that has a square hole molded in the top through which a vertical 4x4 post can be inserted. Another type has a flat wood block set

Leveling a Sloped Site
After laying out all the blocks for the shed foundation, use a long straight 2 ft and a 4-ft. level to make sure each block is level with the others. If you need to raise a block just a little bit, place a thin shim of wood or asphalt shingle on top.
CONSTRUCTION METHODS

PRO TIP

For maximum strength, dig pier holes about three times wider than the post or concrete block they will support. That’s usually 12 in. to 18 in. in diameter.

IN DETAIL

Many do-it-yourselfers mistakenly use the words concrete and cement interchangeably. Although concrete is made with cement, the two materials aren’t the same. Concrete is a blend of cement, sand, and an aggregate, such as gravel. Cement is a ground mixture of lime, clay, shale, silica, and iron ore.

TRADE SECRET

Anchor bolts must be held in exactly the right spot until the concrete hardens. Suspend the bolts from small plywood hangers screwed to the top of the form (see below). Bore a hole near one end to hold the bolt.

FITTING A POST TO A PIER BLOCK

Dek-Block pier blocks can accept either a post or a post, making them useful on very uneven sites. After setting a 2½ post into the top so you can toenail a joist in place. For building shed foundations, I prefer to use Dek-Block piers. Each block measures 8 in. high by 12 in. sq. and weighs about 45 lbs. Molded into the top surface are a 3½-in.-sq. recessed socket and a pair of 1½-in.-wide slots. The socket accepts a 4 × 4 post; the slots are used to support a 2 × 4 floor joist. Because Dek-Block piers can accept either a post or a post, they can be used on very uneven sites and badly sloping terrain.

Skid foundations

When it comes to time-tested building methods, it’s hard to beat a skid foundation. Builders have been using this type of on-grade foundation to support outbuildings for more than three centuries. The technique is surprisingly simple in both concept and application: Two or more long, straight timbers (skids) are laid on the ground in parallel, evenly spaced positions. The building’s floor frame is then built on the skids, which are sometimes called runners or deadmen.

Skid foundations are still popular today, and it’s easy to see why: They’re very fast and easy to build, and they distribute the building’s weight evenly over a broad surface. Unfortunately, because the timbers are long and straight, this type of foundation is suitable only for sites that are relatively flat.

Originally, skids were nothing more than logs placed on the ground. Today, they’re usually made of pressure-treated 4 × 6s, 6 × 6s, or 8 × 8s. You can also make skids by gang-nailing together three or four 2 × 8s or 2 × 6s and setting them on edge. Although skids are often set directly on the ground, I prefer to lay them on a bed of gravel. The stone creates a very stable base that’s not likely to settle or wash away. Begin by laying the skids in position on the ground, then mark around each one using spray paint or flour sprinkled from a line in the same way as an anchor bolt in a concrete footing.
Frost-Proof Foundations

Frost-proof foundations extend deep into the ground to prevent freeze/thaw cycles from upsetting the building. They’re generally required by code in cold-weather regions for sheds larger than 200 sq. ft. or taller than 12 ft. However, building codes differ from state to state, so be sure to check with the local building department for the exact requirements in your area.

Frost-proof foundations are typically more difficult to build than on-grade types, but how much harder depends on the soil. If the ground is soft and sandy, you may be able to excavate it with a shovel to remove the sod and about 2 in. of soil from the marked areas. Check the excavated areas to make sure they’re close to being level. If they’re not, remove a little more soil from the high spots. Next, add 3 in. to 4 in. of gravel. Compact the gravel with a hand tamper or gas-powered plate compactor, then replace the skids.

There’s a wrong way to dig a hole. If the site is out of level by more than 4 in. or so, it’s easier to block up the low end of the shed than it is to concrete beneath the high end. The two best ways to do that are to make up the difference with solid-concrete blocks (A) or stack two skids on top of each other at the low end (B).

**Trade Secret**

For extra protection against frost heave, take this step when building a frost-proof foundation. Wrap the wood posts or fiber-form tubes in thick plastic sheeting before setting them in the ground. Make sure the plastic extends all the way to the top of the hole. The frost won’t be able to grasp onto the slippery plastic, thus greatly reducing the chances it’ll upset the shed.

**What Can Go Wrong**

I t doesn’t seem possible that even the slightest chance that you may someday want to move your shed to another location, make the job easier by modifying the skids before you set them in place. Start by trimming off the bottom corners of the skids at a 45-degree angle so they slide more easily over the ground. Also, bore a 15/8-in.-dia hole about 4 in. from each end. That way, you’ll have a convenient place to hook up a tow chain or steel cable.

Modify the ends of the skids, as shown here, if there’s even the slightest chance that you may have to move the shed to another location.

**Hitting the Skids**

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Modify the ends of the skids, as shown here, if there’s even the slightest chance that you may have to move the shed to another location.
When working with large timbers, swap your 16-oz. hammer for a 22-oz. to 26-oz. framing hammer, which has a longer handle and heavier head.

**TRADE SECRET**

Hardware can be attached to cured concrete with specialty masonry fasteners, which can make layout a little easier during a messy concrete pour. It’s always best to avoid drilling into concrete if you don’t have to, and screw-down brackets aren’t nearly as strong as cast-in-place ones. You’ll find a variety of systems for fastening hardware to concrete at your local hardware or building supply store. I’ve found that specialty masonry fasteners, which aren’t nearly as strong as cast-in, provide a quick, easy way to create strong, lasting joints between the concrete piers and the wooden posts, posts, or carrying beams.

**PRO TIP**

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Calculating Concrete

To figure out how much concrete you’ll need for pouring a slab or footing, refer to the chart below or use the following formula: Multiply the length times the width times the thickness of the slab, then divide by 12. Divide again by 45 for the number of 60-lb. bags of ready-mix concrete you’ll need. If you’re using 80-lb. bags, divide by 60 for the number of bags needed.

<table>
<thead>
<tr>
<th>Depth of Hole</th>
<th>60-lb. Bags</th>
<th>80-lb. Bags</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 in.</td>
<td>36</td>
<td>27</td>
</tr>
<tr>
<td>30 in.</td>
<td>52</td>
<td>44</td>
</tr>
<tr>
<td>36 in.</td>
<td>89</td>
<td>67</td>
</tr>
<tr>
<td>42 in.</td>
<td>124</td>
<td>93</td>
</tr>
</tbody>
</table>

To estimate how much concrete you’ll need for the piers, use the chart below. Note that there’s information for both 60-lb. and 80-lb. concrete bags and for holes ranging in depth from 24 in. to 42 in. and in diameter from 8 in. to 18 in.

<table>
<thead>
<tr>
<th>Number of Bags of Concrete Needed</th>
<th>60-lb. Bags</th>
<th>80-lb. Bags</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth of Hole</td>
<td>8 in.</td>
<td>8 in.</td>
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<tr>
<td></td>
<td>10 in.</td>
<td>12 in.</td>
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<tr>
<td></td>
<td>18 in.</td>
<td>18 in.</td>
</tr>
<tr>
<td>24 in.</td>
<td>1.5</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>2.5</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>8.0</td>
<td>10.0</td>
</tr>
<tr>
<td>30 in.</td>
<td>2.0</td>
<td>3.0</td>
</tr>
<tr>
<td></td>
<td>4.5</td>
<td>5.0</td>
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<tr>
<td></td>
<td>10.0</td>
<td>10.0</td>
</tr>
<tr>
<td>36 in.</td>
<td>2.3</td>
<td>3.6</td>
</tr>
<tr>
<td></td>
<td>5.25</td>
<td>5.25</td>
</tr>
<tr>
<td></td>
<td>12.0</td>
<td>12.0</td>
</tr>
<tr>
<td>42 in.</td>
<td>2.75</td>
<td>4.25</td>
</tr>
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<td></td>
<td>6.25</td>
<td>6.25</td>
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<tr>
<td></td>
<td>13.75</td>
<td>13.75</td>
</tr>
<tr>
<td></td>
<td>2.0</td>
<td>3.25</td>
</tr>
</tbody>
</table>

Pouring a concrete slab

There are two basic ways to pour a concrete floor, but only one qualifies as a frost-proof foundation. It’s called a monolithic slab, because the floor and the perimeter foundation walls are all

**Frost-Proof Foundations**

There are many ways to pour a pier foundation. Here are three techniques that work well for virtually any size outbuilding:

Poured-Concrete Piers: Three Methods

There are many ways to pour a pier foundation. Here are three techniques that work well for virtually any size outbuilding:  

1. **Solid Pier with Pier Block**
   - Dig 12-in.-dia. holes down to the frost line, then pour concrete piers flush with the ground. Set precast concrete pier blocks or solid-concrete blocks on top. The blocks can be set in the wet concrete or simply laid on top once it cures. If you set them in the wet concrete, make sure all the blocks are level before the concrete hardens.

2. **Sonotube Pier**
   - Pour a 6-in. to 12-in. pad of concrete—a called a footing—into the bottom of the hole and let it cure overnight. Next, stand a round fiber-form tube (commonly known by the trade name Sonotube) on top of the footing. Backfill around the tube with soil, then fill it with concrete. The advantage of this method is that before installing the tube, you can cut it flush with the ground or let it protrude above the hole to create a raised pier.

3. **Formed Pier**
   - Build a square form out of 2×4 lumber and set it over the center of the hole. Hold the form in place with a couple of 1×3 stakes pounded into the ground. Then fill the hole with concrete, keeping 4 right to the top of the form. After the concrete cures, strip away the form to reveal a raised pier.

### Calculating Concrete

- **Total sq. ft.** of Concrete Needed
- Number of 60-lb. Bags
- Number of 80-lb. Bags

<table>
<thead>
<tr>
<th>Diameter of Hole</th>
<th>Depth of Hole</th>
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</thead>
<tbody>
<tr>
<td>ft.</td>
<td>in.</td>
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<tr>
<td>6 in.</td>
<td>10 in.</td>
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<tr>
<td>8 in.</td>
<td>12 in.</td>
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<tr>
<td>10 in.</td>
<td>18 in.</td>
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</tbody>
</table>

- 4-in.-Thick Slab
- Number of 60-lb. Bags
- Number of 80-lb. Bags

<table>
<thead>
<tr>
<th>Diameter of Hole</th>
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<tbody>
<tr>
<td>ft.</td>
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<td>8 in.</td>
<td>12 in.</td>
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<tr>
<td>10 in.</td>
<td>18 in.</td>
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**Plan View of Form**

Just make sure you set the brackets in the piers before the concrete hardens.

**Poured-concrete slab**

The average backyard storage shed doesn’t really need a poured-concrete floor, but it’s the best choice for large outbuildings that will be used to store heavy equipment, such as woodworking machines, tractors, boats, motorcycles, snowmobiles, and antique cars.

**PRO TIP**

Shovel and post-hole digger; if it’s hard-packed clay or very rocky, you’ll have to bring in a backhoe.

**TRADE SECRET**

Some tiles are very porous and absorb water. Late, bluestone, and unglazed clay tile are very porous and absorb water. To find the best solution for large outbuildings that will be used to store heavy equipment, such as woodworking machines, tractors, boats, motorcycles, snowmobiles, and antique cars.

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There are two basic ways to pour a concrete floor, but only one qualifies as a frost-proof foundation. It’s called a monolithic slab, because the floor and the perimeter foundation walls are all
Is Burying Posts a Good Idea?

There’s some debate about whether or not you should bury a wood pole—even a treated one—in concrete, where it may eventually rot. Some builders prefer to pour raised concrete piers and set the poles on top. (See the drawing on the facing page.) This method does help the poles last longer, but much of the structural integrity of a pole-barn foundation comes from the fact that the poles extend deep into the ground. Raising them out of the ground can weaken the structure.

Ordinarily, I don’t like to bury wood in the ground, but it’s definitely the best way to gain the strength needed when building a pole barn or setting a gate post or an end-of-the-run fence post. I’ve buried many pressure-treated posts over the years and have always questioned the process, but on the other hand, I’ve never had to replace any of them. I spoke with a local pole-barn builder who has been burying wood—pressure-treated and creosote-soaked—for more than 30 years and continues the practice to this day with confidence.

Pour the same time. The walls extend down to the frost line and are usually between 12 in. and 16 in. thick. The floor itself is only 4 in. to 6 in. thick, but it’s reinforced with wire mesh or metal reinforcing bars.

The second type of concrete floor is known as a floating slab or on-grade slab. It’s nothing more than a 4-in. to 6-in. layer of concrete sitting on the ground. This type of floor should never be used when the plans or local building codes call for a frost-proof foundation.

Pole-barn foundations

All the foundations discussed so far are designed to support the floor of an outbuilding. The floor, in turn, supports the walls. A pole barn is completely different. In fact, it technically doesn’t even have a floor.

Pole-barn construction starts with a series of holes dug below the frost line around the perimeter of the foundation. Concrete footings are poured into the bottom of each hole, then tall, decay-resistant round poles or square timbers, which extend all the way to the tops of the walls, are set in the holes. Horizontal beams are bolted along the tops and bottoms of the poles to tie everything together and support the walls and roof framing. (See the bottom left photo on p. 176.)

Instead of a wood-framed floor, a pole barn’s floor is actually the ground. To keep it from wearing away or turning muddy, the area is covered with several inches of processed stone, pea gravel, or wood chips. As a result, the floor is basically flush with the surrounding grade, making a pole-barn foundation perfect for outbuildings that house lawn tractors, boat trailers, farm machinery, horses, and livestock.

As with other types of foundations, there are several ways to build a pole barn. For the Gambrel roof framing, (see the bottom left photo on p. 176.)

Frost-Proof Foundations

There are several ways to build a pole barn. For the Gambrel roof framing, (see the bottom left photo on p. 176.)

Pressure-treated wood poses no health hazards if you follow a few simple precautions. Be sure to wear gloves when handling treated lumber, and wash up thoroughly before eating or drinking. Always wear safety goggles and a dust mask when cutting or drilling treated wood, and be sure to properly dispose of all scraps; never burn treated wood.
Storage Barns (see p. 168), fiber-form tubes were placed in the holes, then an 8-in.-thick concrete footing was poured into the bottom of each tube. After the concrete cured, 4/4 pressure-treated posts were placed on top of the footings and another 12 in. or so of concrete was poured in. The rest of the tube was then filled to the top with a mixture of crushed stone and sand. I like this technique because the poured concrete creates a solid, frost-proof base and the sand and stone mixture leaves little for frost to adhere to.

Wall-Framing Techniques

There are three common construction techniques used to build shed walls. A vast majority of outbuildings—probably more than 90 percent—are stick-built out of 2x4s. To be honest, it’s hard to justify using any other technique, especially if you’re building a basic storage shed. However, if you’re building a workshop, writer’s studio, or home office, you may want to put up a post-and-beam building. The exposed timbers lend a more finished, handcrafted look to the interior. This is also a more interesting and challenging way to build.

A pole-barn building, as discussed previously, is suspended off the ground by several round poles or square posts. The wall framing is fastened to the poles and can be made out of large timbers or 2x4 lumber. The exact wall-framing technique depends on the type of poles or posts used and your choice of siding material.

PRO TIP

A power miter saw won’t replace your portable circular saw, but it will offer a quicker, more accurate way to crosscut framing lumber.

IN DETAIL

I prefer using tongue-and-groove plywood for shed floors, even though it costs more and is more difficult to install than standard square-edged plywood. The reason? When the plywood sheets are butted together, the tongue on one sheet locks tightly into the groove on the adjoining sheet. The result is a strong, rigid seam that won’t sag, even where it spans open spaces between joists.

Wall Framing Techniques

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shed walls are typically framed with 2x4s. Save time by building the walls on the ground, then tip them up into place.