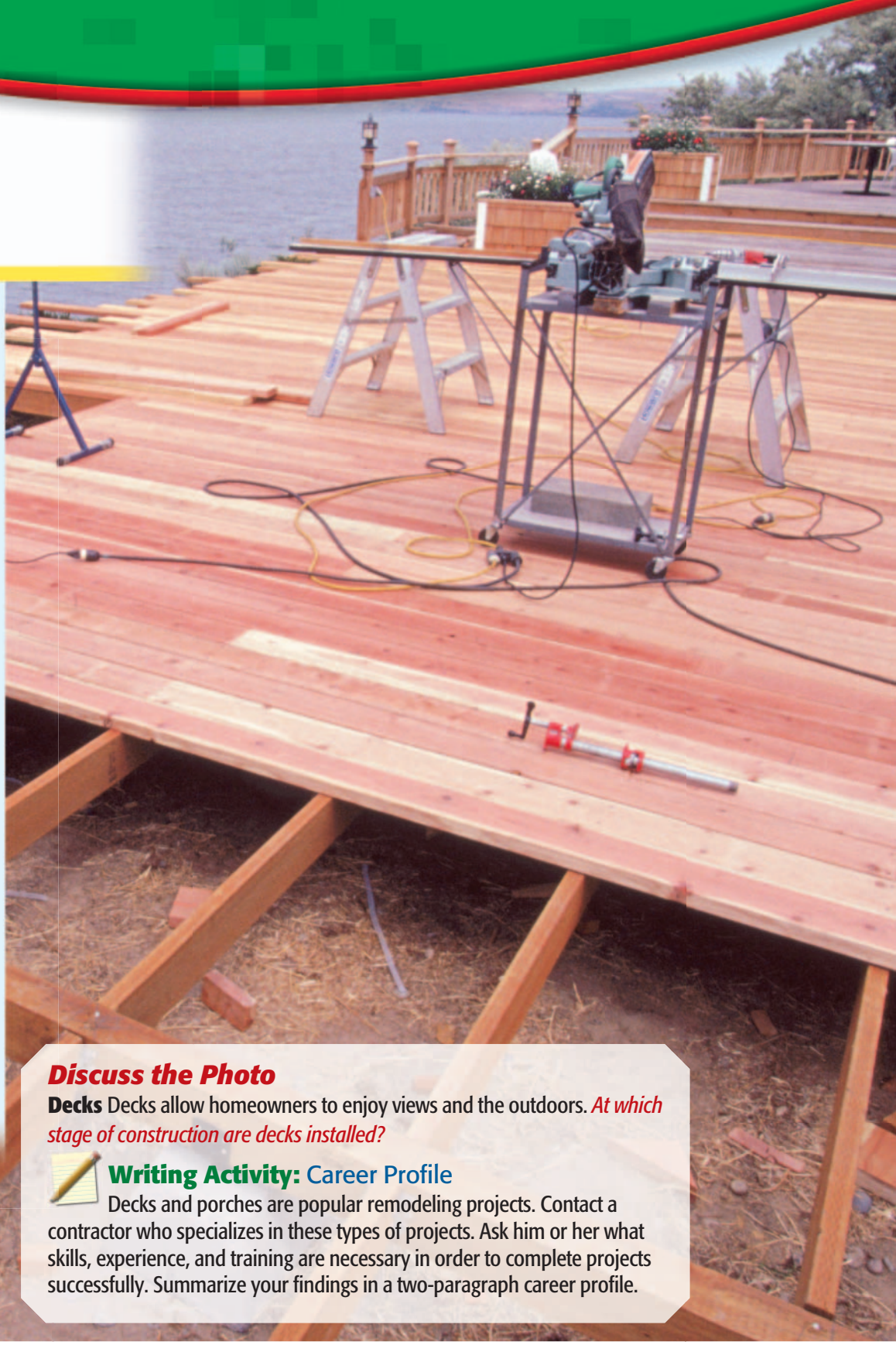
CHAPTER 35

Decks & Porches

Chapter Objectives

After completing this chapter, you will be able to:

- **Name** the basic types of materials used for decking.
- **List** the basic elements of a deck.
- **Describe** how to lay out piers.
- **Demonstrate** how to plumb a post.
- **Summarize** the proper way to handle and cut preservative-treated wood.
- **Describe** two methods for installing concrete porch steps.



Discuss the Photo

Decks Decks allow homeowners to enjoy views and the outdoors. *At which stage of construction are decks installed?*

Writing Activity: Career Profile

Decks and porches are popular remodeling projects. Contact a contractor who specializes in these types of projects. Ask him or her what skills, experience, and training are necessary in order to complete projects successfully. Summarize your findings in a two-paragraph career profile.

Chapter 35 Reading Guide

Before You Read Preview

Decks are constructed of several types of materials. Before reading the chapter, use the knowledge you have gained throughout the textbook to guess which materials are typically used for decks. After you have read the chapter, review your guess and revise it if necessary.

Content Vocabulary

- deck
- ACQ (Alkaline Copper Quaternary)
- heartwood
- sapwood
- galvanizing
- pier
- ledger
- stoop
- precast

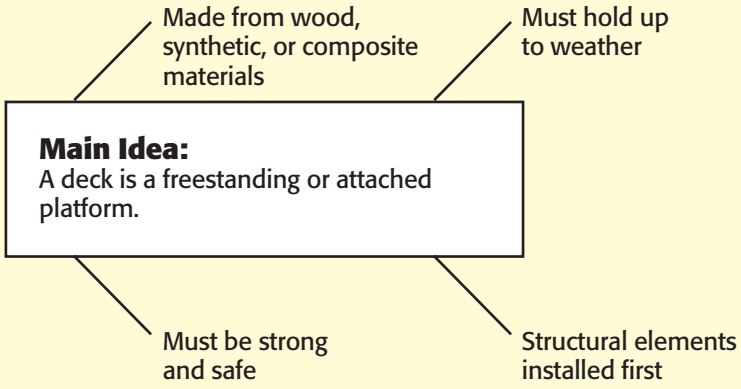
Academic Vocabulary

You will find these words in your reading and on your tests. Use the academic vocabulary glossary to look up their definitions if necessary.

- exposed
- maintains

Graphic Organizer

As you read, use a chart like the one shown to organize main ideas and supporting details.



Go to glencoe.com for this book's OLC for a downloadable version of this graphic organizer.

Academic Standards

Mathematics

Geometry: Use visualization, spatial reasoning, and geometric modeling to solve problems (NCTM)

Geometry: Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships (NCTM)

English Language Arts

Conduct research and gather, evaluate, and synthesize data to communicate discoveries (NCTE 7)

Use different writing process elements to communicate effectively (NCTE 5)

Science

Science in Personal and Social Perspectives: Environmental quality (NSES)

Science as Inquiry: Abilities necessary to do scientific inquiry (NSES)

Physical Science: Structure and properties of matter (NSES)

Physical Science: Chemical reactions (NSES)

Industry Standards

Framing and Constructing Porches and Decks

NCTE National Council of Teachers of English
NCTM National Council of Teachers of Mathematics
NSES National Science Education Standards

Section 35.1

Deck Materials

Structural Materials

What are the basic types of decks?

Decks are often built by the carpenters who framed the house or by contractors who specialize in the construction of decks. A porch is another desirable feature. Depending on the house's architectural design, a porch may be built in various ways. It may resemble a deck with a roof over it, or it may be more enclosed.

A **deck** is a platform made from wood, synthetic, or composite materials fastened with nails, screws, bolts, and metal brackets. The primary requirements of a deck are weather resistance, strength, and a safe design. Because a deck is entirely **exposed** to the weather, joints must not trap water and the structure must resist wind uplift forces.

Deck construction techniques are straightforward. The structural elements are installed first. Deck boards, often called *decking,* are then attached to the structural elements. A railing ensures the safety of people using the deck, and steps or stairs allow access from the deck to the yard.

The decking itself is the most visible portion of a deck project. Many new types of decking materials have become available in recent years. These include tropical hardwoods as well as a wide variety of plastics and composites.

Types of Decks

There are two basic types of decks. A *freestanding deck,* or grade-level deck, is not attached to the house. It is low to the ground and does not require a foundation. It is usually on only one level. An *attached deck,* or elevated deck, has at least one side permanently connected to the structure of the house. It is partly supported by the house and partly by a network of concrete piers that extend below the frost line. This type of deck, shown in **Figure 35-1**, may have more than one level.

Posts, Beams, and Joists

Materials used for the structural elements beneath the decking are chosen primarily for their strength and durability. Appearance is usually a lesser concern. Preservative-treated wood is durable, inexpensive, and readily available. That is why it is generally used for structural members. It can also be used for decking itself. However, some treatment chemicals are more corrosive than others. This is a factor that must be considered when specifying metal fasteners, connectors, and other metal hardware that will be in contact with the wood.

Preservatives Prior to 2004, the most common preservative for lumber was CCA (chromated copper arsenate). However, studies indicated that the arsenic in CCA-treated wood could leach out and contaminate

Figure 35-1 An Attached Deck
Safety Is Important An attached deck is supported by posts and anchored to the house. A strong and well-designed railing makes a deck safe to use.

soil and ground water. Beginning in 2004, CCA-treated wood was no longer allowed for use in residential construction.

Other non-arsenic preservatives have replaced CCA in the wood treatment process. One that is used extensively is **ACQ (Alkaline Copper Quaternary)**. Wood that is treated with ACQ does not contain arsenic. It is sometimes brownish in color. Many different softwoods can be treated with ACQ, but Southern yellow pine and Western hemlock-fir are common. Preservative-treated lumber is graded and stamped to indicate its suitability for various uses.

Three levels of preservative treatment can be applied. Treatment levels are specified by the number of pounds of treatment chemical used per cubic foot (pcf) of wood.

- ***Above Ground*** Wood in this category is treated at 0.25 pcf. This is the lightest treatment level. It is used for decking lumber and other wood that will be exposed to the weather but not to soil contact.
- ***General Use*** This is a utility grade that can be in moderate ground contact. The wood is treated at 0.40 pcf.
- ***Ground Contact*** The highest standard treatment level is 0.40 pcf. It is used for wood that will be in constant contact with the ground and where maximum durability is required.

Other treatment chemicals are available in addition to ACQ. They include CA (copper azole), micronized-copper (MCQ), and various trademarked formulations. Each treatment chemical imparts specific characteristics to the wood.

Softwood Decking

The most popular types of solid lumber decking are made from softwood lumber. Three different softwoods are commonly used.

Redwood This wood is highly resistant to decay and insect attack. However, it is fairly expensive and not readily available in all parts of the country.

Cedar Several species of cedar are resistant to decay and insect attack. Western red cedar is the species used most often for decking. It is medium-priced and readily available throughout the country.

Preservative-Treated Wood When preservatives are forced into softwoods such as Southern yellow pine, the wood becomes very resistant to decay and insect attack.

Sizes Softwood decking lumber is specified by its nominal size. The most commonly available sizes are 2×4 and 2×5 (actual thickness 1⅝"). Wider stock is more likely to cup as it weathers. In some areas, preservative-treated decking lumber is also available in an actual thickness of 1¼". Decking lumber is readily available in lengths of 8', 10', 12', and 14'. Softwood joist lumber is readily available in sizes from 2×5 through 2×12 and in lengths up to 14'.

Explain *What is the difference between a freestanding deck and an attached deck?*

Grades Grading policies for exterior lumber

WORKING WITH WOOD PRESERVATIVES Any wood preservative contains chemicals that can be harmful to workers. Always wear work gloves when handling preservative-treated lumber and wear a dust mask when cutting it. To prevent chemicals in the sawdust from contaminating the soil, cut preservative-treated wood over a tarp. Dispose of the collected sawdust as directed by local regulations. Avoid sanding preservative-treated wood. Always wash your hands thoroughly with soap after working with it, particularly before eating.

Go to glencoe.com for this book's OLC for more on job safety.

are not uniform. Redwood lumber, for example, is available in over 30 different grades.

Cedar lumber is graded with a different system and preservative-treated wood with yet another system. In general, however, exterior softwood lumber is graded according to certain characteristics.

Appearance This describes the size, type, and number of knots permitted in a board. Other surface flaws may be identified as well. Wood of the highest appearance grade is completely free from knots and is sometimes referred to as *clear*. This grade is often used for deck railings and skirt boards and sometimes for the decking itself.

Strength This describes the lumber's ability to support loads. Higher strength grades are important for joists and beams.

Moisture Content Deck lumber is often kiln-dried to a moisture content of either 19 or 15 percent. This reduces the tendency of the wood to shrink after installation. Some preservative-treated lumber is kiln-dried twice: once before and once after treatment. This grade is stamped KDAT (Kiln-Dried After Treatment).

Decay Resistance The most decay-resistant portion of a tree is called the heartwood. **Heartwood** is the portion of a tree nearest the core. It is dark in color. The least decay-resistant part of the tree is the sapwood. **Sapwood** is the outer growth layer. It is lighter in color than heartwood. When maximum decay resistance is required, grades containing larger proportions of heartwood should be used. Because heartwood and sapwood differ in color, decay resistance also has some bearing on appearance grading. The highest grades are the most uniform in color. For more on the decay resistance of woods, see Chapter 12.

Hardwood Decking

Many tropical hardwoods, such as mahogany, teak, and Ipe, are strong and highly resistant to decay and insect attack. The trees grow in Central and South America but are now readily available in North America.

Builder's Tip

SAVING MONEY ON LUMBER The cost of various grades of lumber can vary dramatically. To minimize the costs of deck construction, always choose the grade that is most suitable for a particular use. The highest grades of wood should be reserved for places where appearance is important, such as decking and railings. Lower grades can be used where they will not show.

Most hardwood decking ranges from ¾" to 1¼" thick. No special tools are required when cutting these woods. However, holes for nails and other fasteners must be predrilled because the wood is so dense. Also, some tropical hardwoods are not easy to finish because of their density.

Other Decking Materials

Many synthetic decking products are now available, and more are introduced each year. These products usually require little maintenance. However, they can be used only for decking, not for the structural portions of a deck. Check local codes before specifying synthetic decking. There are two basic types of synthetic decking products.

Plastic Decking These products are made entirely of plastic. Products are shaped into boardlike planks that are hollow or partially hollow, as shown in **Figure 35-2**. Chemical additives in the plastic improve its durability

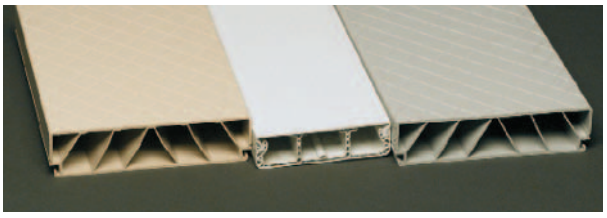


Figure 35-2 Plastic Decking
Special Fastening Plastic decking consists of hollow extrusions. Each type uses a fastening system supplied by the manufacturer.

outdoors. This is important to help the material resist the harmful effects of UV radiation. Plastic cannot be nailed, so various concealed fastening systems are supplied by the manufacturers. These secure the decking to wood joists. Decking ranges from about 4" to 8" in width.

Composite Decking This material is a blend of recycled plastic and wood dust or fibers. It is denser and heavier than solid wood but usually not as stiff. Boards should be cut with carbide-tipped saw blades. Sizes include 5/4×5, 2×4, 2×5, and 2×8 planks. Some composite boards are solid, as shown in **Figure 35-3**. Solid products can be attached to wood joists with nails or screws. However, some types of screws cause the surface of composite boards to deform slightly around the screw head. The deformation is sometimes called a *volcano*. Always follow the manufacturer's recommendations when choosing fasteners. Special composite lumber screws are available.

Build It Green Extensive cutting of tropical hardwoods can cause environmental damage. To discourage this, programs have been developed to certify that tropical hardwoods have been harvested responsibly. Certification means that the wood comes only from well-managed forests or plantations that adopt sustainable and ecologically sound forestry practices.

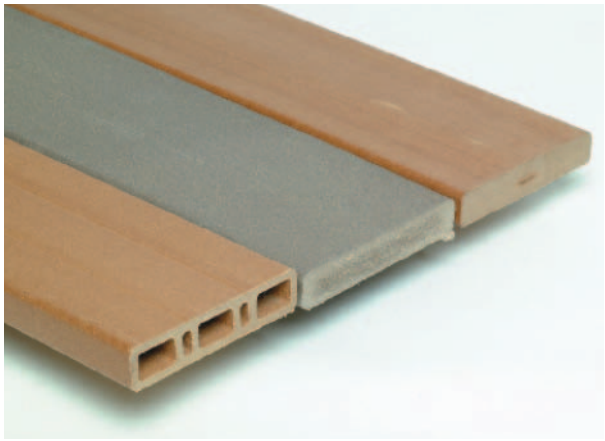


Figure 35-3 Composite Decking
Solid or Hollow Composite decking is available in various dimensions, shapes, and colors. Skirt boards or special end caps are used to conceal the open ends of hollow composite decking.

Reading Check

Recall *Which grading characteristic should be of greatest concern when choosing wood for joists and beams?*

Hardware

What is the most common fastener used in deck construction?

The parts of a deck are fastened together with nails, screws, lag bolts, through bolts, and structural metal connectors. Structural connections should be made in a way that **maintains** the strength of the connections over time. Any joint that tends to trap moisture against the wood should be avoided.

Types of Fasteners

The most common fastener used to assemble a wood deck is the nail, but screws and bolts are also commonly used. See examples in **Figure 35-4** on page 1006. Connections between posts and beams or joists and rim joists are often made with metal connectors, such as brackets or joist hangers. These provide a stronger connection than nails or screws alone. They are often required by code in areas exposed to earthquakes or severe weather. For more on metal framing connectors, see Section 14.3.

Hidden Fasteners The traditional method for attaching decking to joists is face nailing. This method of attachment is easy and quick, but many people do not like the appearance of exposed nail heads. Another problem is that the nails create paths that allow water to soak into the wood. Manufacturers have developed a wider range of specialty fasteners that avoid these problems. They are generally called *hidden deck fasteners*, or sometimes *blind-nailing systems*.

Some hidden deck fasteners are installed as

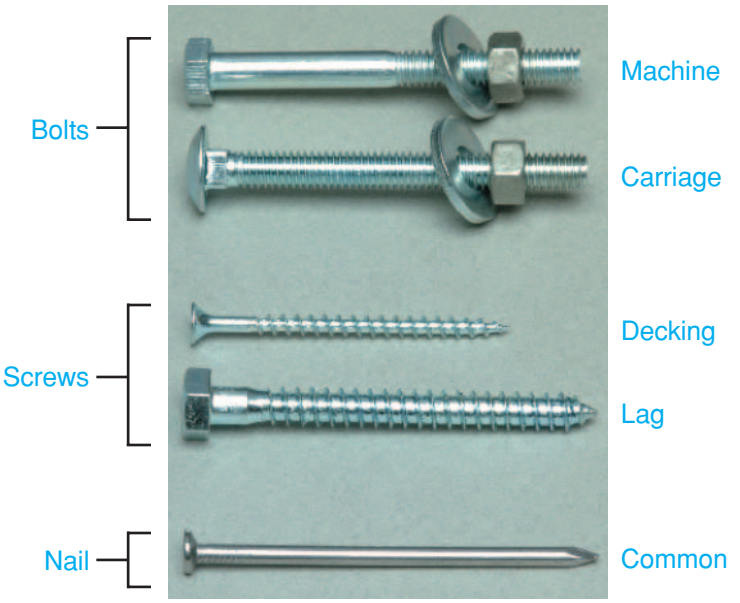


Figure 35-4 Common Fasteners
Standards These are the types of fasteners used most often on deck projects.

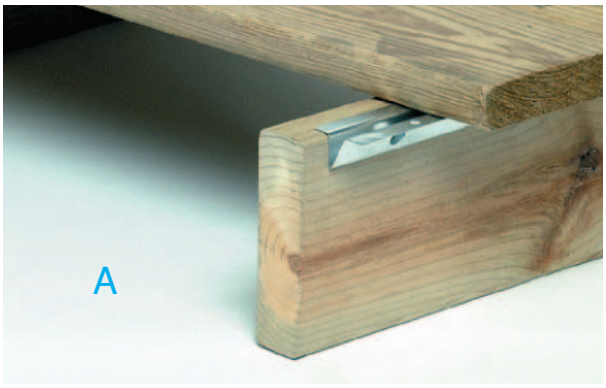
continuous metal strips that are screwed to the underside of the decking, as in **Figure 35-5**. However, most are attached to the top edge of the joists and to the edge of the deck boards.

Corrosion Resistance

Some wood treatment chemicals are highly corrosive to metal. In addition, the risk of environmental corrosion is high in many regions. For example, the salty air along the Pacific and Atlantic coasts can be very corrosive. To prevent deck fasteners andconnectorsfromfailing,alwaysusecorrosion-resistant products, especially when using preservative-treated wood.

Galvanized Steel The least expensive and most common type of corrosion resistance is provided by galvanizing. **Galvanizing** is the process of coating the steel with a protective layer of zinc. The thicker the coating, the better the protection. There are two methods for applying zinc to steel.

Electroplating This type of galvanizing coats the steel with a thin, smooth, and very uniform layer of zinc. It is available on all metal products, including metal connectors. Standard galvanized deck hardware is electroplated with 0.90 ounce of zinc for every square foot of metal surface area. This may be referred to as G90 Zinc. This level is weather resistant but not suitable for use with treated wood. G185



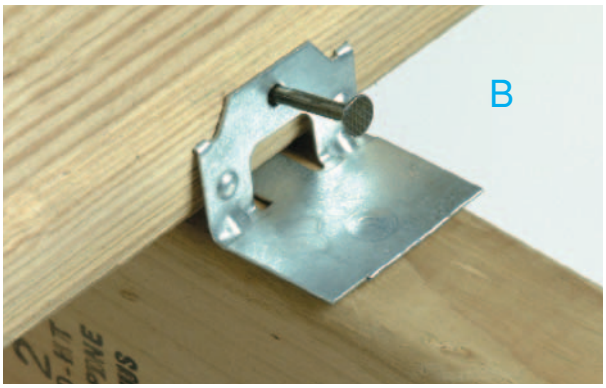


Figure 35-5 Hidden Decking Fasteners
Strong But Invisible A hidden decking fastener can be made of plastic or metal. Some types (**A**) are fastened to the underside of decking. Others (**B**) are fastened to the edge of each deck board.

Builder's Tip

USING THROUGH BOLTS Through bolts used to make a connection should be approximately 1" longer than the combined thickness of the lumber. This ensures that the threads on the nut will be fully engaged. Always place a flat washer under each nut. This prevents the nut from crushing wood fibers and reduces the chance that the connection will loosen over time.

Science: Chemical Reactions

Salt and Corrosion Corrosion is an electrochemical process. Fill two clear glasses with water. Stir one tablespoon of salt into one glass. Label the glasses "unsalted" and "salted" with pieces of tape. Put a piece of aluminum foil in each glass and leave the glasses alone for one day. Record your results.

Starting Hint Be sure to not get any salt into the unsalted glass with your fingers.

galvanizing provides 1.85 ounce of zinc per square foot of steel. It is the minimum recommended for use with treated lumber.

Hot-Dip Galvanizing Hot-dip galvanizing produces a slightly irregular layer of zinc that is thicker than an electroplated finish. It offers greater protection but is more expensive than electroplating. However, it is not used on through bolts because the thicker coating clogs their threads.

Stainless Steel Hardware made of stainless steel does not require galvanizing. Stainless steel is used where maximum corrosion resistance is necessary. It is ideal for use in coastal areas, particularly where salt spray is a factor. Stainless steel hardware is available in many forms, including through bolts and framing connectors. However, stainless steel is much more expensive than galvanized steel. Stainless steel structural connectors should always be fastened using stainless steel nails or screws.

Section 35.1 Assessment

After You Read: Self-Check

1. What supports an attached deck?
2. Name the three basic types of softwood lumber used for decking.
3. What preservative has been phased out of use for residential construction?
4. What is galvanizing?

Academic Integration: Science

5. **Sustainability and Certification** Certain programs have been developed to certify sustainable building materials. For example, one certification program might certify that only a certain percentage of trees in an area may have been harvested within a specific time period. What does it mean to say that a resource is *sustainable*? Brainstorm examples of how to increase the sustainability of wood as a building material.

Go to glencoe.com for this book's OLC to check your answers.

Section 35.2

Planning & Construction

Codes & Layout

Why are there various sources for span information?

The elements of a simple attached deck are shown in **Figure 35-6**. Decking usually runs parallel to the house. However, this is primarily for installation convenience and appearance. It is not a requirement. Decking is supported by joists and usually runs perpendicular to them.

Building and Zoning Requirements

Decks are governed by local building codes as well as zoning restrictions. Building codes are concerned with such details as:

- The span of beams, joists, and decking
- The diameter and depth of foundation piers
- The design of railings and steps
- The deck's connection to the house.

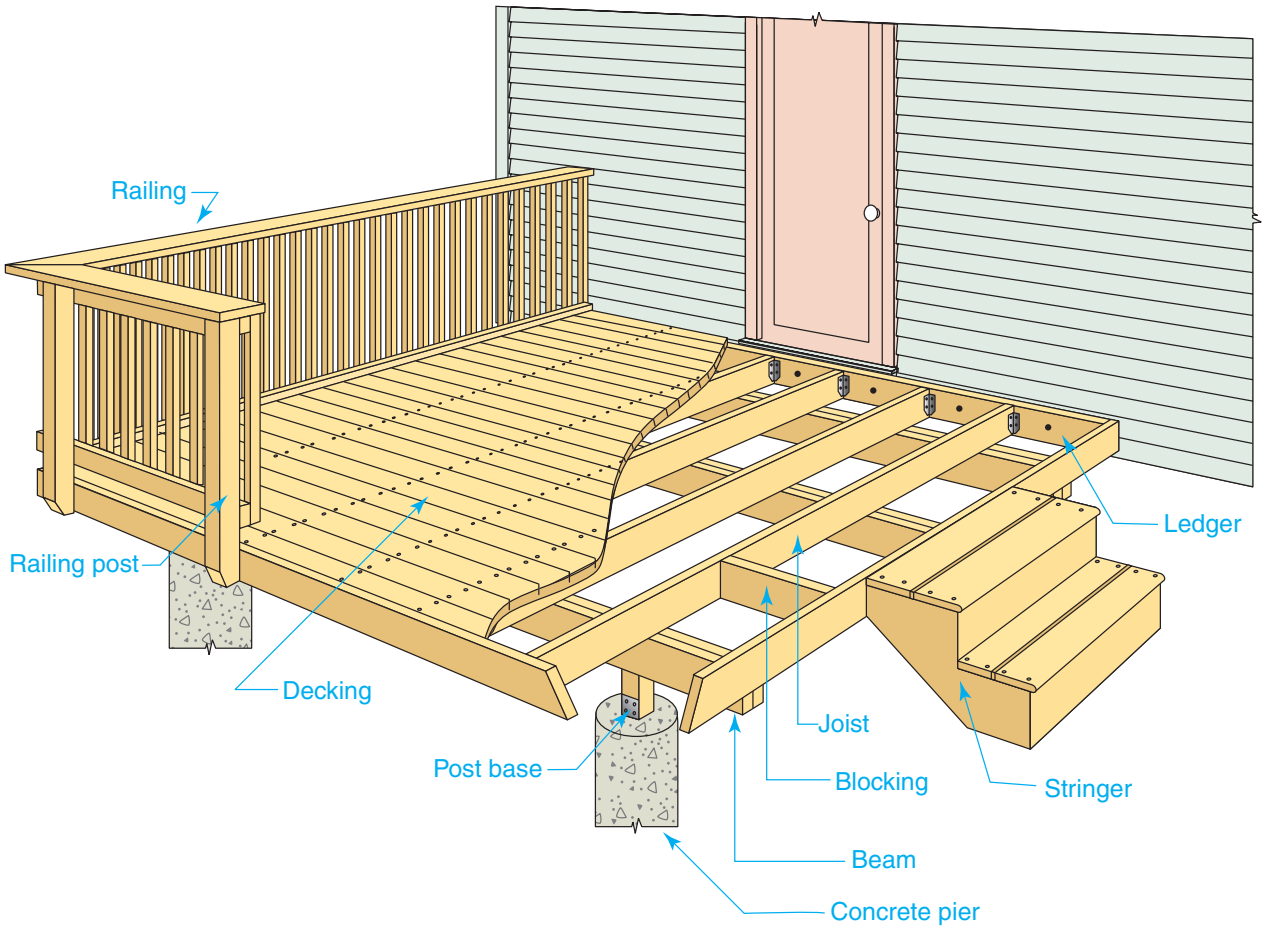


Figure 35-6 A Basic Deck
Outdoor Floor An attached deck is supported on at least one side by the house. Joists, beams, and concrete piers complete the support system.

Construction details for the deck should be included in the construction drawings for the house. The location of the deck would show up in a plan view. Assembly details would be included on a detail sheet. Check these details carefully, particularly in regions of high winds or frequent seismic activity. Deck construction in these areas calls for additional measures to prevent deck collapse.

Zoning ordinances affect deck location. These restrictions differ from community to community. However, they specify the minimum allowable distance between the deck and such features as streets, lot lines, septic systems, wells, and utility easements. They may also limit the height of a deck.

Deck Planning Unlike a house, a deck is typically planned from the top down. Once the overall shape and size of the deck has been designed, each deck material chosen determines the size and spacing of the supporting materials. For example, the type and dimension of deck boards determines their maximum span. Their span determines how closely spaced the joists must be. The maximum span of the joists determines where beams must be located, and their location determines where the posts and piers must be positioned. Depending on the materials chosen, span information may come from various sources, including the following:

- code books
- trade associations, such as the California Redwood Association or the Southern Forest Products Association
- manufacturers of specific decking products.

The process of building the deck proceeds from the bottom up. Once all the elements of the deck's structure have been double-checked to ensure that they meet or exceed building codes, construction begins with the piers.

Summarize *Why do most decks run parallel to the house?*

Locating Piers

Unlike the house, a deck does not require a continuous concrete foundation. Instead, it rests on piers. A **pier** is a concrete column that supports a concentrated load, such as a post. It is a type of foundation. Piers are typically cylindrical due to the method in which they are formed. However, the shape of the pier is less important than its ability to support loads. The bottom of a pier is generally wider than the rest of the pier in order to distribute loads to the soil. In this sense it serves as a footing and should be approximately 6" below the frostline. The frostline is determined by local climate and its depth can be found in local building codes.

The approximate location of piers is determined by the shape of the deck as well as the location of beams and posts. It is specified on building plans. However, it is up to the deck builder to determine the precise location of each pier based on measurements taken at the site.

An exact location for each pier can be determined by using the 3-4-5 method to ensure a right-angle layout in relation to the house (see Chapter 9). When the centerlines of the outermost piers have been determined, string lines can then be used to locate the centerlines of other piers as shown in **Figure 35-7** on page 1010.

Once the string lines are in place, the exact location of individual piers can be determined. This requires the use of a tape measure and a plumb bob as shown in **Figure 35-8** on page 1010. A small stake or marker is placed at the center point of the pier location to identify it for excavation.

Deck Construction

What factors might affect the height chosen for a pier?

When the basic layout of the deck is complete, string lines can be removed and excavation can begin. The tools used to excavate holes for piers will depend on the depth and diameter of the pier, as well as how many are required. Hand-digging with

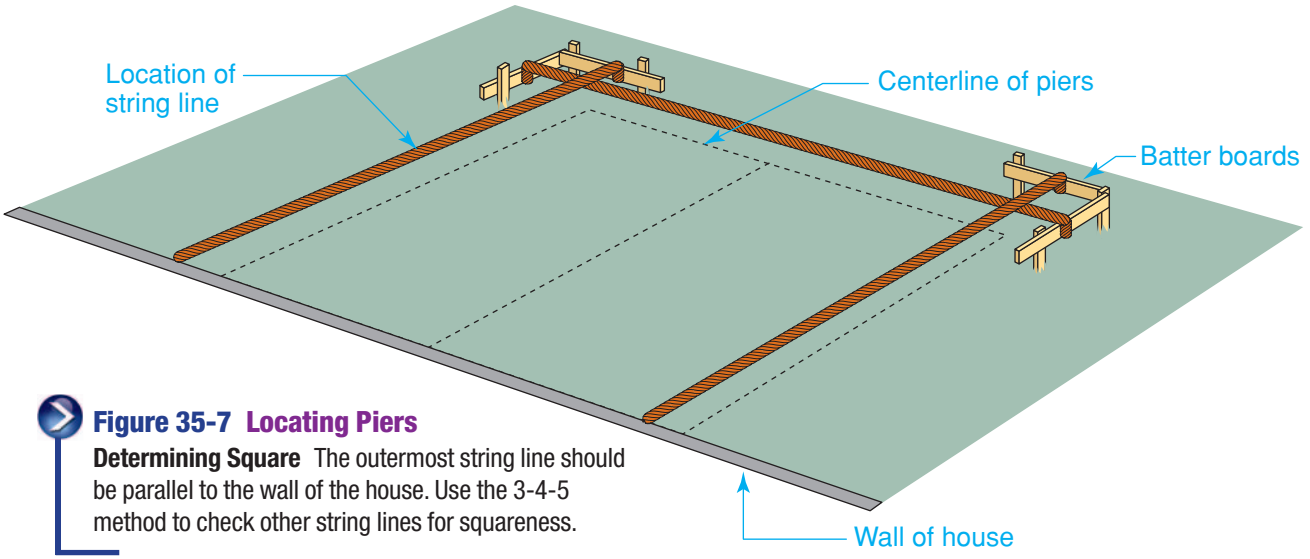


Figure 35-7 Locating Piers
Determining Square The outermost string line should be parallel to the wall of the house. Use the 3-4-5 method to check other string lines for squareness.

shovels and post-hole diggers is sufficient where piers are shallow or only a few are necessary. Power equipment such as the tractor-mounted auger in **Figure 35-9** is generally preferred in other cases. Augers of various diameters are available.

Installing Piers

Forms for piers can be made of removeable steel or fiberglass sections. However, the most common method is to use inexpensive cylindrical single-use forms such as the one shown in **Figure 35-10**. These products are

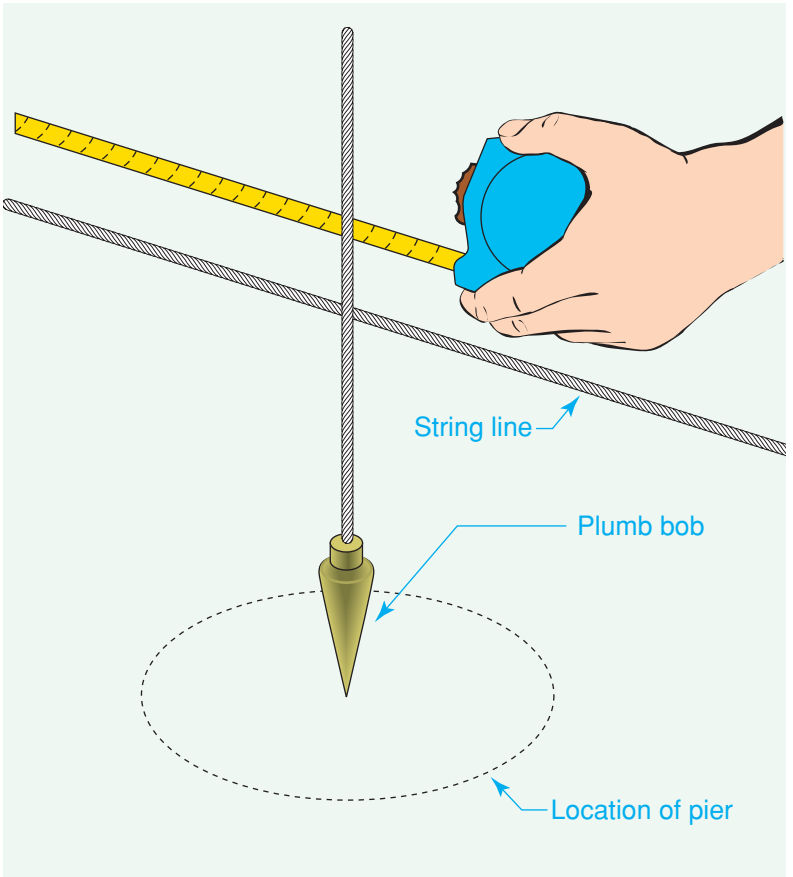


Figure 35-8 Positioning Piers
Exact Position After string lines have been set up, use a tape measure and a plumb bob to locate the center point of individual piers.

Figure 35-9 Excavation
Quick and Precise The use of heavy equipment to *drill* holes for piers improves their accuracy and speeds the work when many holes are required.

made of multiple layers of recycled paperboard laminated with adhesive. The interior surface is very smooth, and the outside surface has a moisture-resistant coating. It comes in various lengths and diameters that range from 6" to 60". Forms are typically 12' long but can easily be cut to shorter lengths.

Once a form has been cut to length and placed in an excavated hole, it must be supported by temporary support braces at the desired height. The braces also keep the form steady. Once the form has been plumbed, it can be backfilled just enough to hold it in position. Immediately after the concrete has been placed, a metal post anchor should be embedded in the top. Check local codes to see if reinforcing bar must also be inserted.

Some form manufacturers provide online volume calculators to help builders determine how much concrete to order for a given diameter and length of pier. Another way to calculate concrete volume for a cylindrical form is to consult **Table 35-1** on page 1012.

Posts

Posts should be made of solid lumber graded for structural use. Common dimensions are 4×4, 4×5, and 6×5. Most often posts are made from preservative-treated lumber, but redwood is common in some areas of the country. The bottom of a post must be secured by a metal post anchor embedded in a pier. Once a post has been plumbed, it can be secured to a beam in various ways. In some cases, it can be sandwiched between a pair of joists that serve as a beam. In this case, holes

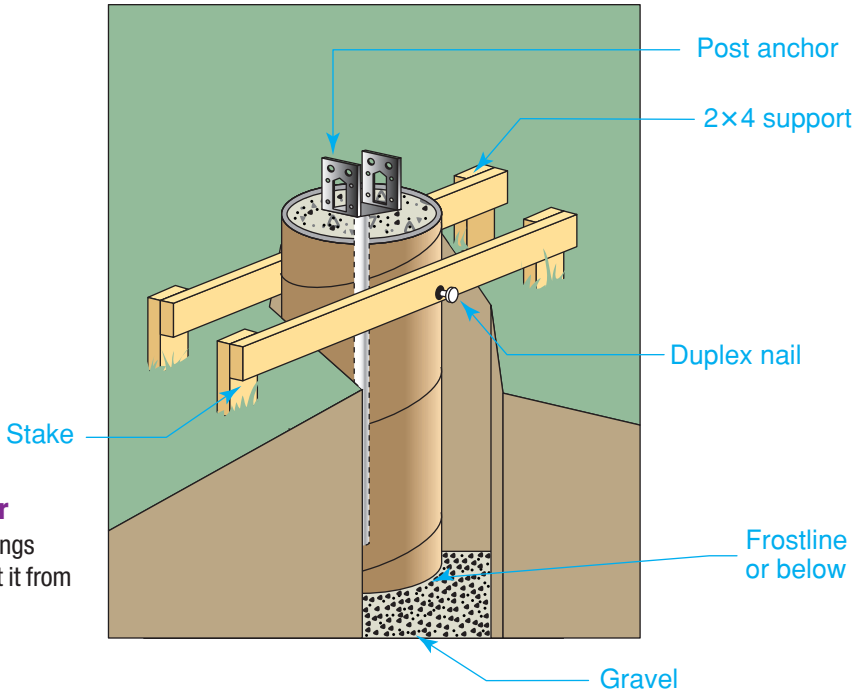


Figure 35-10 Forming a Pier
Keep It Plumb Formwork for footings must be braced properly to prevent it from moving when concrete is placed.

Table 35-1: Estimating Concrete for Cylindrical Forms	
Form Diameter (inches)	Concrete Required per Lineal Foot (cubic yards)
6	.0073
8	.0129
10	.0202
12	.0291
14	.0396
16	.0617
18	.0654

for through bolts would be drilled through each joist and the top of the post. Another method to secure posts is to use a metal post connector, as shown in **Figure 35-11**.

Beams

Beams and girders may be solid wood or a built-up assembly of 2× lumber. Solid beams come in limited lengths. Nominal beam depths of 6" and 8" are common. Built-up beams are made of two or three layers of 2×8, 2×10, or other dimension lumber. The layers should be spiked or bolted together. Built-up beams are sometimes preferred because they are assembled in place. This makes them easier to position. Another advantage is that a built-up beam can be any length. One disadvantage of a built-up beam is that water can be trapped between the pieces of stock. This can cause rot. To eliminate this problem, two-layer beams are often assembled with an airspace between the pieces. This can be done by inserting

Builder's Tip

STRIPPING FORMS Most portions of a single-use form are biodegradable and eventually disintegrate. Portions above grade may be stripped off after the concrete has cured for at least 24 hours, though most builders wait longer. However, do not wait longer than five days to strip above-grade portions of the forms.

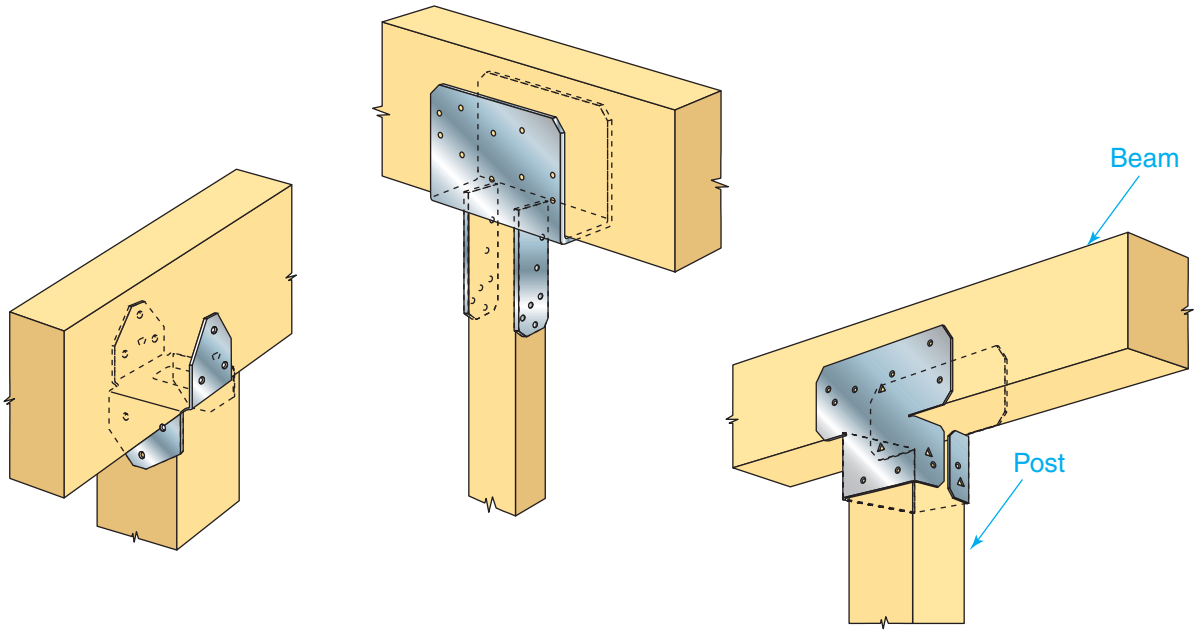


Figure 35-11 Post Connectors
Strong Connection Post caps come in various shapes. Always use the number and type of fasteners recommended by the post cap manufacturer.

Step-by-Step Application

Plumbing a Post An out-of-plumb post puts unnecessary stresses on the deck structure. Plumb posts with a 3' level or by using the following method:

Step 1 Tack a small wood block to the side of the post at its top. Then place a plumb line over the block so that it hangs alongside the post.

Step 2 At the bottom of the post, measure the distance from the post to the line. If the distance is not the same as the thickness of the block, the post is not plumb.

Step 3 Tilt the post as needed until the distance from the post to the line is exactly the same along the entire length of the line.

Step 4 Nail a temporary brace to the post to hold it in position. Repeat Steps 1, 2, and 3 on an adjacent face of the post. When this face is plumb, secure a second brace.

Step 5 Double-check the post on two adjacent faces. If they are both plumb, the post is plumb.

Go to **glencoe.com** for this book's OLC for additional step-by-step procedures, applications, and certification practice.

treated-wood spacers or stacked washers between the pieces as they are nailed or bolted together.

Whatever the type of beam, it should be straight and made of structural-grade wood. If the beam will be visible when the deck is complete, its appearance should also be considered. The cut ends of solid or built-up beams should be coated with a water repellent to increase their durability.

Reading Check

Recall *How are the tools chosen for excavating holes for piers?*

The Ledger

One of the most important but least understood parts of a deck's substructure is the ledger. The **ledger** is the length of lumber that connects the deck to the house, as shown in Figure 35-6 on page 1008.

Proper installation of the ledger is critical. If not attached properly, the ledger can rip away from the house when stressed. This can cause the entire deck to collapse. Never secure a ledger to a house with nails alone. Nails are not strong enough to prevent the ledger from pulling away. Instead, use lag bolts or through bolts connected to studs, plates, or rim joists, as shown in **Figure 35-12** on page 1014. Do not rely on any connections made to the sheathing alone. Such connections do not provide sufficient strength. Metal flashing prevents water from rotting the siding, the sheathing, or the structural framing of the house.

A number of decks have failed in recent years due to inadequate ledger connections, and in some cases people on the deck were killed in the collapse. That is why a great deal of research is being devoted to this subject, including full-scale laboratory testing of ledger connections. Specific recommendations for ledger installation may become part of the International Residential Code in the near future.

To avoid problems with ledger connections, some builders avoid ledgers entirely. Instead of connecting the deck to the house, they install an extra row of concrete piers along the house wall to support the deck independently of the house. A slight gap between the house siding and the deck allows water to drain between them.

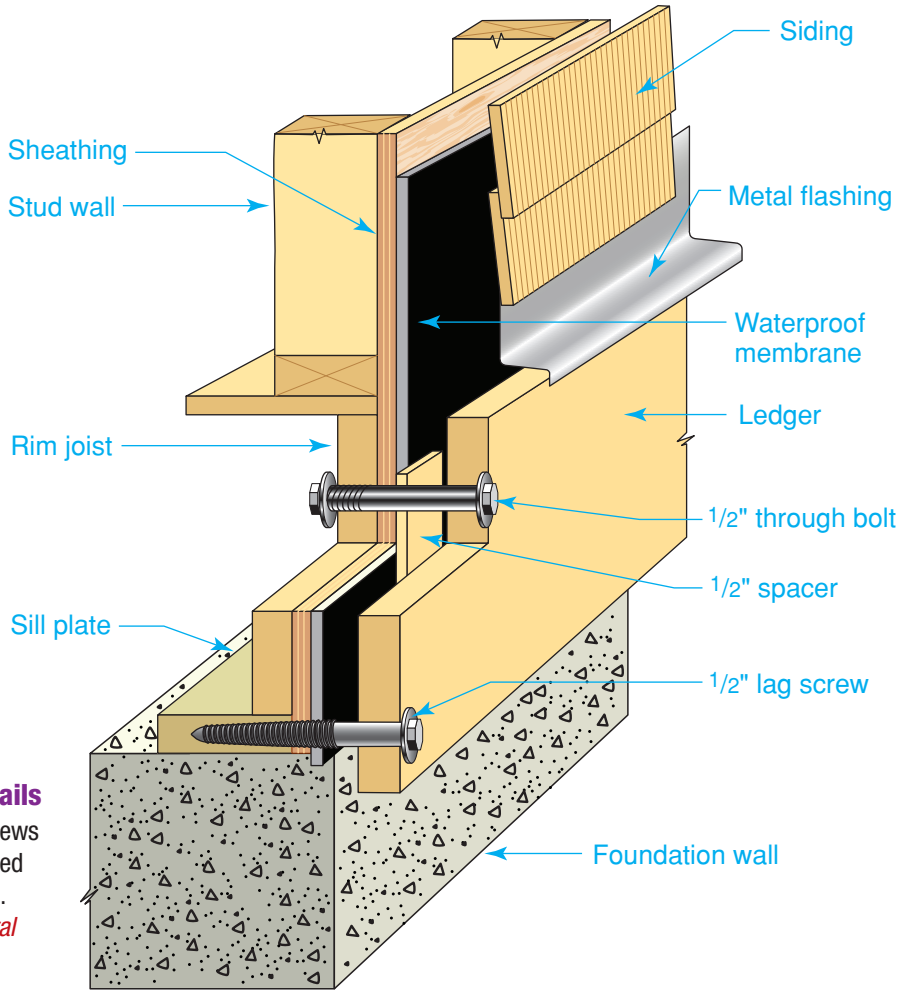


Figure 35-12 Ledger Details
A Strong Connection Lag screws and through bolts should be used to secure a ledger to the house. *What is the purpose of the metal flashing?*

Joists

Deck joists are laid out and installed much like floor joists (see Chapter 15). They are usually spaced 16" OC but may also be 12", 20", or 24" OC. When synthetic decking is used, always consult the manufacturer's instructions for joist requirements. Some types of synthetic decking are not as stiff as wood, and thus joists may have to be closer together.

Joists are generally connected to other structural elements using metal joist hangers, brackets, or by toe-nailing joists to support beams. Continuous solid blocking is often required between joists that are more than 8" in depth.

Decking

Softwood decking with a nominal 2" thickness is often surface-nailed with 10d galvanized or stainless steel nails. Decking that is 1¼" thick is nailed with 8d nails. Use one nail at every joist connection when installing 2×4 decking. Use two nails when installing 2×5 decking.

Galvanized or stainless steel screws make a stronger connection than nails. Screws made especially for attaching decking have a slender shaft, a sharp self-drilling point, and a fairly small head that sinks flush with the surface of the decking. They should be long enough to penetrate at least 1" into the joists. When installing synthetic decking, follow manufacturer's instructions carefully for using nails or screws.

Spacing Gaps between deck boards ensure that water will drain freely. Generally this space is about ⅛". If hardwood, composite, or kiln-dried decking is used, gaps must be created as the boards are installed. However, when installing preservative-treated lumber,

butt boards tightly during installation. As the boards shrink across their width, suitable gaps will eventually open up between them.

The thickness of a 12d or 16d nail can be used to gauge gaps between decking boards. Drive a nail through a small scrap of thin plywood to create a spacing jig, as shown in **Figure 35-13**. This prevents the nail from slipping through the gap as the board is positioned. Use several of these reusable devices to maintain a uniform gap thickness. Always follow the manufacturer's spacing recommendations when installing plastic or composite decking.

Stairs, Railings, & Porches

Why do stairs for decks require less finishing work than interior stairs?

All elevated decks require stairs and railings. Because these elements play a large role in the safety of a deck, local codes should be followed carefully.

Stairs

Most decks will require at least a few steps down to grade level. In the case of low decks, such as the one in **Figure 35-14** on page 1016, the steps can be constructed simply. Instead of supporting the treads on stringers, as in standard stair construction, they are often supported by a box-like assembly made of framing lumber. This is called *platform stair construction.*

Elevated decks require steps as well as stair railings. The steps are supported by stringers made of preservative-treated lumber or a naturally decay-resistant wood such as redwood. These stringers are laid out just as those for interior stairs (see Chapter 25). However, the degree of finish work is not as great. This is because stairs to a deck are exposed to the weather.

Exterior stairs may be of the cut-stringer type or the cleat-stringer type. Both types are discussed in Chapter 25. Stringers can be cut on site, but pre-cut pressure treated stringers are also available. This ensures that treatment chemicals will protect the cut edges

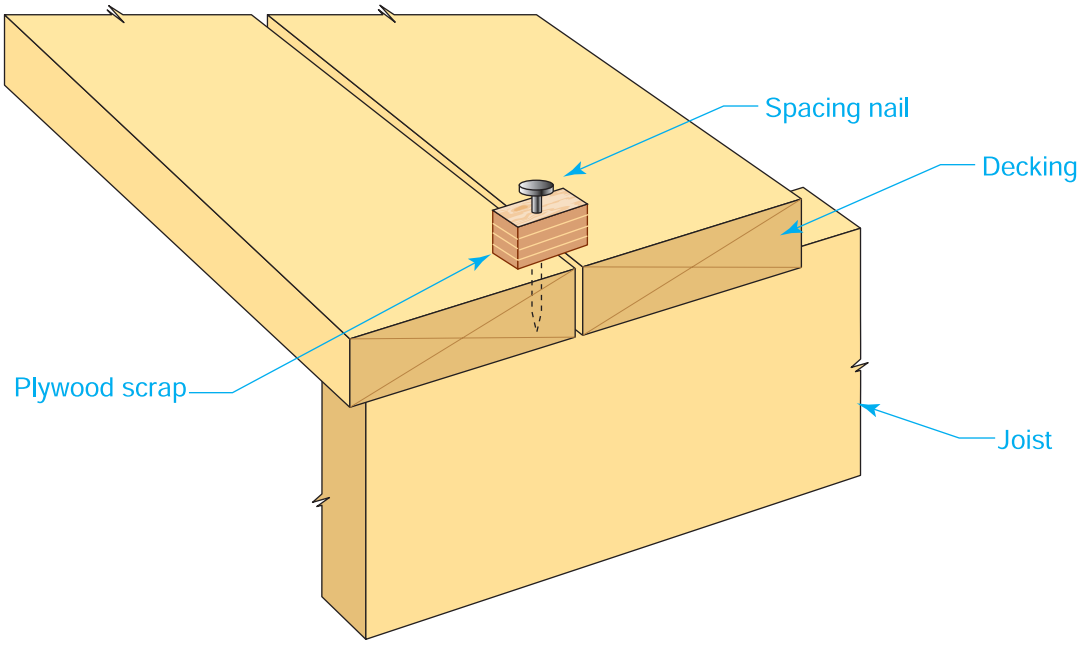


Figure 35-13 Spacer for Decking
Inexpensive Spacer Use this site-made jig to ensure consistent spacing between deck boards.

Figure 35-14 Platform Steps
Simple Construction A low-level deck sometimes incorporates steps that form a border around the deck. This deck features composite decking and a railing system made of composites.

of the stringer. Stringers are often attached to adjacent structures using metal framing connectors.

An exterior stair often does not have risers. This allows water to drain quickly and snow to be removed with relative ease. To aid drainage, each tread can slope up to two percent. For example, for a tread with a depth of 12½", the back of the tread would be ¼" higher than the front. All hardware used to assemble exterior stairs must be weather resistant.

The basic layout of exterior stairs generally follows that of interior stairs. However, building codes applicable to exterior stairs differ in some respects and should be checked. For example, there may be more flexibility in the dimensions of treads and risers when laying out porch steps or the approaches to low-level decks.

The need for a good support or foundation for outside steps is often overlooked. If the steps are located over backfill or disturbed ground, the bottom end of the

Builder's Tip

MAINTAINING CONNECTIONS Wood exterior stairs are often assembled using lag bolts or through bolts. As the wood weathers, it shrinks somewhat. This can cause threaded fasteners to loosen over time. Fasteners should be tightened securely during construction. They should then be tightened again later. Tightening such bolts should be a part of the homeowner's annual maintenance for an exterior stair.

stringers should rest on concrete piers or on a small concrete support slab. In any case, stair stringers should never rest directly on the ground because this will encourage rot. Such placement would also allow the stair to move up and down slightly during weather cycles of freezing and thawing.

Railings

The primary purpose of a railing is safety. It should be installed on both sides of a stairway, as well as around elevated decks. Local codes determine the minimum height of the railing and the spacing of balusters. However, height generally ranges from 32" to 38" above the decking.

A typical railing consists of a handrail, or cap, a series of support posts, and balusters. The railing posts provide strength for the system, so they must be solidly screwed or bolted to the deck structure. Though some builders notch the bottom of posts to fit over the top of the decking, this weakens the post and should generally be avoided.

Recall *When is platform stair construction used?*

Porches

A porch is a roofed structure that is attached to a house. It is often open on the sides or front. To aid drainage, the flooring is often installed like decking, with a gap between each board. If the porch flooring is made of tongue-and-groove boards, the surface must be sloped slightly away from the house to aid drainage. Be sure to use a rot-resistant wood.

A porch often serves as the main entry to a house, as shown in **Figure 35-15**. Construction often involves wall framing, roof framing, roofing, and concrete slab methods described elsewhere in this book.

Figure 35-15 Full-Length Entry Porch

Double Duty This porch fits the architectural style of the house. It serves as a protected main entry. It is also large enough to use as a sitting area.

Consider the following when building a porch:

- Porches supported on continuous foundation walls should have a clearance of at least 8" between the exterior finish grade and the nearest wood. Floor joists and beams should have a clearance of 18" or more from the bottom of the joists to the grade, unless preservative-treated lumber is used.
- Porch columns should be designed to avoid any details or joints that might trap water. Treated structural posts are often cased with untreated finish lumber for better appearance, as shown in **Figure 35-16**.
- It is important to protect the end grain of finished trim wood at joints, because this area absorbs water easily and is prone to rotting. The ends of porch flooring should be brushed, dipped, or soaked in a water-repellent preservative.

Concrete Steps and Stoops

Many porches, particularly those that serve as the main entrance, feature concrete steps and a stoop. A **stoop** is an enlarged landing at the top of the steps. Concrete is a durable, low-maintenance material that is ideal for this use. Horizontal concrete surfaces should be sloped to promote runoff of water.

Many builders prefer to install precast steps and stoops, shown in **Figure 35-17**. **Precast** refers to any concrete object that is cast in a factory, cured under controlled conditions, and then delivered to the job site. They are lifted into place by a small crane mounted on the delivery truck. Precast units are hollow to reduce their weight. They are available in various sizes but are usually 48" wide. Precast units rest on footings or piers.

Porch steps may instead be cast in place. This work is done by masons or carpenters who build the formwork for risers and treads on site. After the concrete is placed

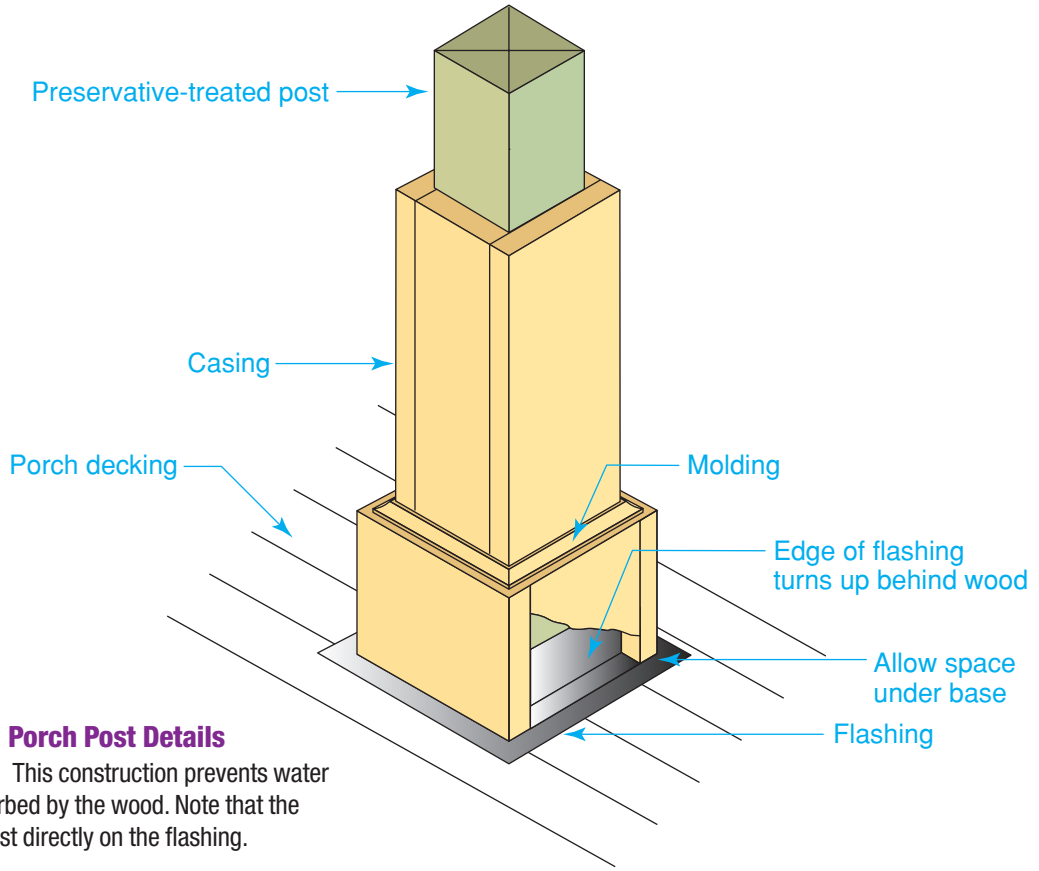


Figure 35-16 Porch Post Details
Durable Details This construction prevents water from being absorbed by the wood. Note that the base does not rest directly on the flashing.

and has partially cured, the forms are removed. Formwork may be made of lumber, but reusable forms called *edge forms* are typically made of metal. Wood formwork calls for a high degree of craftsmanship to ensure that the forms are strong and properly designed. For example, each tread and the stoop must be level side-to-side but sloped forward slightly to encourage drainage, as shown in **Figure 35-18**. Risers are sometimes slanted inward toward the next lower tread. Like the nosing of a wood step (see Chapter 25), this provides clearance for using the step.

Figure 35-17 Precast Steps
Ready to Use Precast step units are hollow to reduce weight. However, they are still heavy enough to require placement by crane.

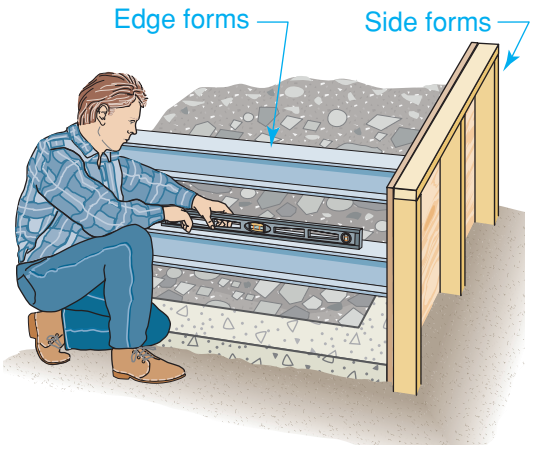


Figure 35-18 Forming Concrete Steps
Careful Craftsmanship The risers are leveled from side to side and positioned so the back of each tread is ¼" higher than the front.

Section 35.2 Assessment

After You Read: Self-Check

1. Name two advantages that built-up beams have as compared to solid beams.
2. What step should be taken with the cut ends of built-up or solid beams to increase their durability?
3. When installing a ledger, what factors should be kept in mind?
4. How are porches designed to allow for proper drainage?

Academic Integration: Mathematics

5. **Estimating Concrete** Use the formula for the volume of a cylinder to estimate the amount of concrete needed for 6 piers that are 12" in diameter and 4 ft. long. Round your answer up to the nearest ¼ cubic yard. Then show how to check your work using Table 35-1.

   Math Concept The volume of a cylinder is found by first finding the area of the circular opening, then multiplying by the length of the cylinder. $V = \pi r^2 h$.

   Step 1: Find the volume of one pier. Use 3.14 for π.

   Step 2: Multiply the result by 6 piers. Express your answer in cubic yards.

   Step 3: Round up to the nearest ¼ cubic yard. Check your work using Table 35-1.

Go to glencoe.com for this book's OLC to check your answers.

CHAPTER 35

Review and Assessment

Chapter Summary

Section 35.1

In addition to traditional softwoods, decking materials include hardwoods, plastic decking, and composite decking. Decking materials should be weather and decay resistant. The hardware used to install decking must be corrosion resistant.

Section 35.2

Construction of a deck calls for several layers of structural support. All construction details must be installed to minimize the decay caused by trapped water. A ledger, the length of lumber that connects the deck to the house, is a very important element of an attached deck. It must be installed with great care. Porches are built with framing, roofing, and concrete-slab work that are similar to parts of a house.

Review Content Vocabulary and Academic Vocabulary

1. Use each of these content vocabulary and academic vocabulary words in a sentence or diagram.

Content Vocabulary

- deck (p. 1002)
- ACQ (Alkaline Copper Quaternary) (p. 1003)
- heartwood (p. 1004)
- sapwood (p. 1004)
- galvanizing (p. 1006)
- pier (p. 1009)
- ledger (p. 1013)
- stoop (p. 1018)
- precast (p. 1018)

Academic Vocabulary

- exposed (p. 1002)
- maintains (p. 1005)

Speak Like a Pro

Technical Terms

2. Work with a classmate to define the following terms used in the chapter: *decking* (p. 1002), *freestanding deck* (p. 1002), *attached deck* (p. 1002), *volcano* (p. 1005), *platform stair construction* (p. 1015), *edge forms* (p. 1019).

Review Key Concepts

3. Identify the basic types of materials used for decking.

4. Recognize the basic elements of a deck.

5. Demonstrate how to lay out piers.

6. Show the proper method to plumb a post.

7. Tell how to handle and cut preservative-treated wood safely.

8. Summarize the process of installing concrete porch steps.

Critical Thinking

9. Explain Why are porch steps sloped when they are cast in place?

Academic and Workplace Applications

STEM Mathematics

10. Planning a Deck How many support posts are needed for a 12 ft. × 15 ft. deck, attached to the house along its 12 ft. length, if the posts are laid 3 ft. OC?

Math Concept Use the problem solving strategy "Draw a Picture" when solving problems involving the use of space.

Step 1: Draw a rough plan of the deck. Place a post at each unattached corner.

Step 2: Divide the length of each unattached side by the desired spacing between the posts.

Step 3: Subtract 1 from each side because the corner post is already placed.

Step 4: Add the number of side posts and corner posts.

Step 5: Check your work by completing your drawing showing the location and spacing between the support posts.

STEM Science

11. Corrosion An ion is an atom or molecule which has lost or gained one or more electrons, making it positively or negatively charged. When a solution contains free ions, it is called an electrolyte. When two metals come into contact in the presence of an electrolyte, corrosion occurs. Corrosion of metal fasteners used to hold a deck together was less of a problem with CCA, the pressure treated lumber no longer used in residential construction because of its arsenic content, than with newer preserved lumber such as ACQ. Research what happens to galvanized nails in exterior wood during the corrosion process. Describe your findings.

Starting Hint Look for information about rust and how it occurs.

21st Century Skills

12. Career Skills: Public Speaking As the newest member of a safety committee, your first assignment will be to give a five-minute talk to a group of carpenters about the dangers of working with wood preservatives. The main objective of your talk will be to highlight safety guidelines for working with wood preservatives. To prepare for your talk, write an outline on what you will say to the group of carpenters. Share your talk with the class.

Standardized TEST Practice

CERTIFICATION PREP

True/False

Directions Read each of the following statements carefully. Mark each statement as either true or false by filling in T or F.

(T) (F) **13.** Posts are rarely made from preservative-treated wood.

(T) (F) **14.** Materials used for the structural elements beneath the decking are chosen primarily for their strength and durability.

(T) (F) **15.** One problem with precast steps is that they are only available in one size.

TEST-TAKING TIP

Analyze multiple-choice questions carefully. Note key terms. Use your knowledge and anticipate what the answer should be. Find an answer choice that looks like the one you predict.

*These questions will help you practice for national certification assessment.

Unit 7
Hands-On Math Project

Professional Green Painting

Your Project Assignment

You will spruce up a room at your home or school with new paint this weekend. You will choose a paint and estimate how long the job will take.

- **Measure** the square footage of the walls and ceiling of the room you will paint.
- Build It Green **Research** paints certified by Green Seal for quality and safety.
- **Select** a paint and calculate how many gallons you will need based on the room's size and the paint's spread rate.
- **Estimate** the time needed for the job based on the manufacturer's recommendations and the forecast temperature and humidity.
- **Create** a three- to five-minute presentation.

Applied Skills

Some skills you might use include:

- **Compare** the features and advantages of various brands of paint.
- **Explain** why temperature and humidity are important factors in planning a paint job.
- **Determine** the square footage of walls and ceilings minus doors, windows, and trim.
- **Calculate** the time required to complete a multi-step project.
- **Describe** the steps in making a time estimate.

Math Standards

Number and Operations: compute fluently and make reasonable estimates

Algebra: represent and analyze mathematical situations and structures using algebraic symbols

Geometry: use visualization, spatial reasoning, and geometric modeling to solve problems

NCTM National Council of Teachers of Mathematics

The Math Behind the Project

The traditional math skills for this project are geometry and algebra. Remember these key concepts:

Square Footage

Estimating a paint job requires calculating the number of square feet to be painted. First calculate the square footage of the walls and ceiling. For walls, multiply length by height. For the ceiling, multiply length by width. Then measure the square footage of the areas you will not paint or that will require a different paint, such as doors, windows, and trim. Subtract these areas from the total. To calculate how many gallons of paint you will need, divide the square footage to be painted by the paint's spread rate. For example, if you are painting 480 square feet and your chosen paint has a spread rate of 350 square feet per gallon, you will need 1.37 gallons. You will therefore need to buy two gallons.

Algebra

At 75°F and 50% percent relative humidity, flat latex paint usually dries to the touch in about one hour. Eggshell and satin latex paint usually dry in about two hours. High humidity and low temperature slow the drying process. Consult the weather forecast for the day you plan to paint. For this project, we will assume one added minute of drying time for every 1% of humidity above 50% and one added minute of drying time for every 1° of temperature below 75°F. You do not need any extra drying time if the temperature is above 75°F or the humidity is below 50%.

We can use algebra to express this relationship as an equation. Let m represent additional minutes of drying time, let t represent forecast temperature, and let h represent forecast humidity. The equation is: $m = (75 - t) + (h - 50)$. If the forecast indicates 52°F and 69% humidity, we would solve for m using the following steps:

1. Set up the equation with the stated values.	$m = (75 - 52) + (69 - 50)$
2. Complete the operations within parentheses.	$m = (33) + (19)$
3. Calculate the total.	$m = 52$

You will need to let the paint dry for 52 minutes ($\approx$1 hour) beyond the standard drying time.

Project Steps

Step 1 Research

- Choose a room to paint. Create a sketch that represents the three dimensions of the room and indicates the position of windows and doors.
- Determine an appropriate color and finish (flat, eggshell, satin, semi-gloss, or gloss).
- **Build It Green** Research interior latex paints certified by Green Seal. Compare at least three paint brands on color selection, spread rate, scrubbability, durability, toxicity, ease of application, and price. Choose one that meets your needs.
- Locate the forecast temperature and humidity for your planned painting day.

Step 2 Plan

- Select a paint brand, color, and finish.
- Determine how many coats of paint you will need to apply based on the paint and the surface.
- Measure the walls, ceiling, windows, and doors. Label your sketch with these measurements.
- Calculate the total square footage to be painted. Multiply the total by the number of coats required.
- Read the label to determine how long each coat of paint will need to dry.

Step 3 Apply

- Determine how many gallons of paint you will need by dividing the square footage by the spread rate of your chosen paint.
- Calculate the total price of the paint.
- Estimate how long it will take to apply a single coat.
- Multiply your time estimate by the number of coats required. Allow for the recommended drying time between each coat.
- Use the forecast temperature and humidity to calculate any necessary additional drying time.
- Create a total time estimate for the paint project.

Step 4 Present

Prepare a presentation combining your research and calculations using the checklist below.

PRESENTATION CHECKLIST
Did you remember to…
✓ Describe how you chose a paint brand, color, and finish?
✓ Determine the number of paint coats needed?
✓ Demonstrate how you calculated any extra drying time?
✓ Use a spreadsheet for your cost and time calculations?

Step 5 Evaluate

Assess yourself before and after your presentation.

1. Did you measure and calculate square footage?
2. Was your research thorough?
3. Was your paint choice suitable for the room?
4. Did you take temperature and humidity into account?
5. Was your presentation concise and easy to follow?

Go to **glencoe.com** for this book's OLC for an evaluation rubric and Academic Assessment..

Green Seal

Mission: To safeguard the environment and transform the marketplace by promoting the manufacture, purchase, and use of environmental responsible products and services.

Go to **glencoe.com** for this book's OLC for more information on this organization.

McGraw-Hill CONSTRUCTION Construction.com CONNECTION

Go to **glencoe.com** for this book's OLC to read an article titled "Case Study: Plaza Apartments" to learn more green housing projects. Write a summary of this article.