Deck Design

A guide to the basics of deck construction

by Scott Grove

A properly built deck should last a lifetime. But for this to be possible, you must constantly think about nature's elements as you design and build it. If you don't, trapped moisture can promote bacterial degrade that will slowly eat your deck away.

Planning the deck—A deck is an intermediate space between the controlled environment of a house and the raw elements outdoors. Since a deck can expand the living area of the house and serve as an entry, it's important to consider traffic patterns in your planning. Avoid paths that cross through activity areas, and arrange for them to be as direct as possible. A path improperly located can isolate small areas and render them nearly useless.

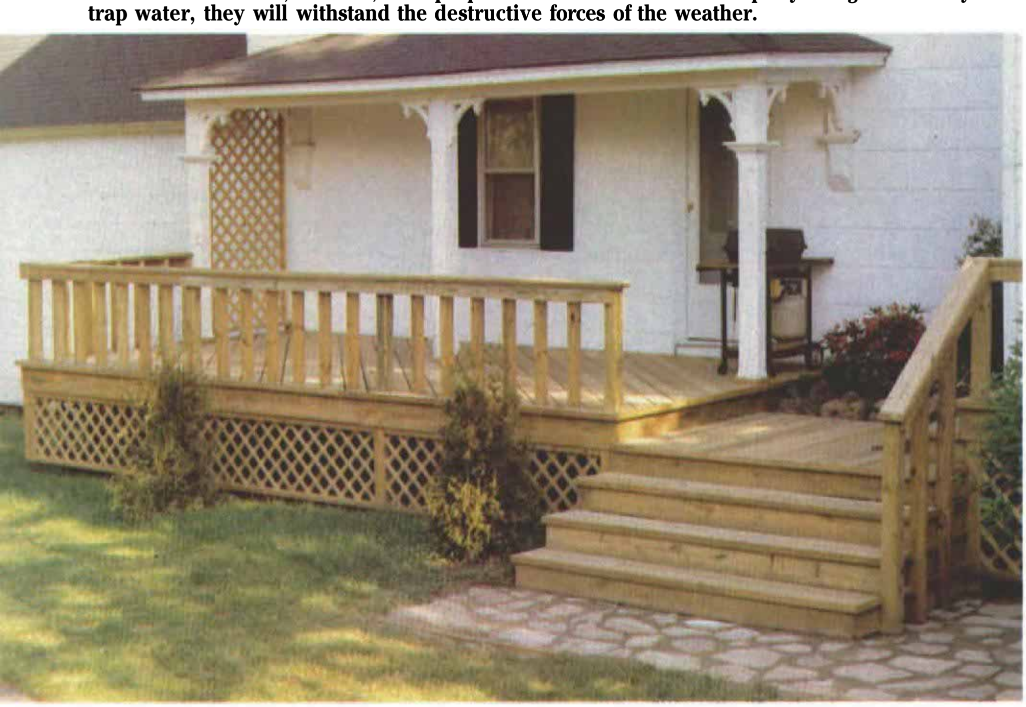
A deck can accentuate the good features of an area and minimize the bad ones. It can conceal a fuel tank or snuggle around a tree. Decks are great for hiding ugly foundations, service meters or old concrete patios. Let these existing elements influence your deck design and they'll make your job easier. The space under a deck can be used to store firewood, too.

Safety is an important consideration when designing a deck. For instance, a landing in front of a door needs plenty of room to allow the door to open with at least one person on the landing. A low walkway that may be just fine without a railing in the summer can be most dangerous in the winter, when snow conceals its edges. Define these edges and all corners, using posts, trees, bushes, rocks or any other visual device on or off the deck that will help make the feature more obvious.

Designing a deck can seem complex if you've never built one before, so beginners should make a detailed drawing of the entire layout, board by board. Once the design is on paper, it's fairly easy to compile a list of materials. Planning the layout and orientation of a deck is at least as important as building it.

Estimating costs—We've been building decks in New York State for seven years, and we use the following figures for rough estimates of the materials and labor needed to build a deck: $8 per sq. ft. for decking (including the framing and footings), $7 per sq. ft. for stairs, $10 per lin. ft. for simple railings, $15 per lin. ft. for bevel-cut railings and $20 per lin. ft. for benches. These figures reflect our company's wage scale, construction speed and craftsmanship, and if a deck design is particularly unusual we'll adjust the figures upward. For those who work alone or with minimal help, the following materials-only estimate, based on prices for #1 pressure-treated lumber in New York State, will help determine approximate costs: $3.00 per sq. ft. for the decking lumber, $4.50 per sq. ft. for stairs, $2.25 per lin. ft. for railings, and $8.25 per lin. ft. for benches. The type of construction you use, and the level of detail you include, will have a significant effect on the expense of your deck.

Decks ease the transition between the house and the landscape, and also serve as an entry. Decks should be functional, durable, well proportioned and attractive. Properly designed so they won't trap water, they will withstand the destructive forces of the weather.



Choosing lumber—Water is the worst enemy of woodwork, and this fact should be foremost in your mind as you select lumber for your deck. Remember that water does the most damage when it rests undisturbed on or in the wood, especially in places that are slow to dry out. Warping is the number-one problem with decks, and water contributes to the problem. Checks channel water inside a board to accelerate the decay process, and so when we're building a deck we routinely cut back boards with serious end checks. We allow for these cuts when we design a deck by making sure that our plans call for material about 6 in. shorter than standard lumber lengths.

The amount of moisture within new lumber determines how much it will shrink. In wood that's continually exposed to the weather, shrinkage can be considerable. Try to buy kiln-dried lumber, even if this means purchasing from a supplier other than the one you usually use. If dry wood is not available, or if its added cost is not in your budget, at least make sure that the moisture content is consistent throughout your selection. You may not be able to prevent shrinkage, but if you plan for it ahead of time the deck will look better because the gaps between the boards will look uniform. Different-size gaps will make the work look sloppy.

The grade and species of lumber you select will directly affect the longevity of your deck. In parts of the West, decks are frequently built from cedar or redwood. These species are readily available and quite resistant to decay. But in the eastern part of the country, pressure-treated lumber is used most often because it withstands our harsh climate, and is generally more available and less expensive than cedar or redwood.

There are two grades of pressure-treated lumber suitable for decks. We strongly recommend using #1 yellow pine, particularly for the railings, benches and decking. The quality of #1 pressure-treated lumber is fairly consistent, and the material is easier to work than #2 grade. The #2 grade has a greater number of open knots, and these weaken the boards and encourage water to accumulate. Large knots that span more than half the width of a board are very dangerous in either grade, since the pressure of a footstep or rough handling during construction will sometimes snap the board in half. One problem with pressure-treated lumber is warpage. It can twist severely, cup and bow if not handled correctly. Keep it covered and out of the sun until you use it.

Pressure-treated lumber often has a greenish color, due to the chemicals it's impregnated with (usually chromated copper arsenate). This tint will weather away into a pleasing light grey in about two years, though the treatment chemicals still protect the wood. Some people want more color to their deck, however, so we recommend a semi-transparent stain (see *FHB* #27, pp. 54-55). If you wait a year or so before the first application of stain, the wood will have a chance to dry out a bit and will accept a fuller coating. We prefer stain to paint because paint traps moisture and requires more maintenance.

When you order the lumber for a deck, include about 10% more than you think you'll need. This will prevent time-consuming trips to the lumberyard if your estimate was slightly off, and allow you to cull out badly warped boards with too many knots.

When the lumber is delivered, remember that moist lawns and delivery trucks are a bad combination. There are better ways to find out where the septic-system drainfield is than to have a truck crush the drain tiles. And since the chemicals in pressure-treated lumber can kill grass, make sure you relocate lumber piles after three days to a different location on the lawn.

Nails—We use only galvanized nails on deck projects, 10d for the decking and 16d for framing. Two types of galvanized nails are available. Electro-plated nails have a smooth finish and take less effort to pound in, but hot-dipped nails, with their rough surface, grip much better and are also more rust-resistant. To save time in laying down decking, we use a pneumatic nailer and resin-coated galvanized nails. The resin coating heats up when the nail penetrates the wood, and then hardens like glue for a firm grip.

If you have problems with lumber splitting as you nail into it, use your hammer to blunt the end of your nails. This way they will puncture the wood instead of piercing and splitting it.

Piers—Like the foundation of a house, the foundation of a deck must transfer loads from the structure to the ground. But unlike the foundations of most houses, deck foundations are not continuous. To support the deck, a system of concrete piers is used. The piers extend from grade level to below the frost line—32 in. to 48 in. in our climate. A pier that does not go below the frost line will eventually heave and push the deck out of level.

The standard method of determining where the piers will go requires string, a collection of stakes and some basic geometry (see *FHB* #11, pp. 25-28). This method works well on decks with simple rectilinear forms, but complex forms are considerably trickier to deal with. When we are faced with the task of building elaborate forms, we've found a way to locate piers that works quite well, and that allows for design flexibility as the project progresses.

Rather than spend a lot of time and effort to locate all the piers at once, we use a locate-build-locate process. The idea is to define the limits of the deck, locate and then pour perimeter piers. Once this is done we can frame the perimeter of the deck, bracing it in place. After that, we locate the rest of the piers.

The easiest piers to locate are the ones that must be placed at a particular point. If you know, for example, that you want the edge of the deck to change direction about 10 ft. from the house and 14 ft. from the oak tree, dig and pour a pier there. The process is empirical: you build what you know in order to answer questions about what you don't know.

After the concrete has partially cured in about 24 hours (it will take nearly a month to gain most of its strength), we begin framing. This method may seem somewhat backward, but we often find it much easier and more accurate in the long run to dig some piers to support interior spans after the perimeter is established.

You will need a long-handled shovel, a digging bar and a post-hole digger to dig the holes for piers. There are two kinds of manually operated post-hole diggers, and you may end up using both of them on your deck project. A post-hole auger looks and works somewhat like a giant corkscrew; as you turn it into the earth it pulls dirt from the hole. An auger works particularly well in hard ground, but is easily stymied by rocks. A clamshell post-hole digger looks like two long-handled spades hinged together at the ferrule, with the blades opposing each other. The work goes quickly in soft ground, but more slowly in packed or clay soils. The clamshell is less likely to stall when you hit rocks, since it can reach into a hole to remove them, but large rocks can cause problems.

If you have a lot of holes to dig, you can rent a gasoline-powered hole digger. This is basically a power auger, and we prefer the one-person model with a torque bar because it won't take you for a ride when it hits a rock.

A long digging bar comes in handy for loosening dirt and breaking rocks that can't easily be removed from the hole in one piece. It also helps loosen tightly packed soil. This solid, heavy, steel persuader is pointed on one end, and can also be used to pry out rocks.

Rocks are the main problem in digging footings around here, but roots can also be a nuisance since decks are frequently near large trees. Use an old handsaw or sharp ax to cut the roots cleanly, but don't seal the cut ends. A botanist once told me that a root or branch will heal itself, and that tar and other sealants interfere with this process.

The shape of the holes you dig is nearly as important as their depth. They should generally be round, and about 8 in. to 12 in. in diameter. The sides of the hole should be reasonably smooth, and the bottom of the hole should be slightly larger than the top to distribute loads well. If there are any ledges or if the hole narrows at the bottom, the freeze/thaw cycle will lift or tip the pier as much as 12 in. over time. Make sure that the floor of the hole is undisturbed earth, because a layer of soft earth here will allow the pier to sink.

We usually pour concrete directly into the hole, using the sides of the hole to form the pier. You can also use Sonotubes to line the hole. These cardboard tubes, available in various diameters from masonry-supply stores, are especially handy if you want the concrete to extend above grade to form a pier. If you suspend the tube 6 in. above the bottom of the hole when you pour, the concrete will ooze out the bottom to widen the base of the pier and increase its bearing ability. Piers should include #4 reinforcing bar if they extend more than 6 in. above grade.

A good concrete mix for piers is 1:2:3, which means one part portland cement, two parts sand, and three parts gravel (¾-in. or 1-in. gravel will be fine). An alternative to mixing your own concrete is to purchase ready-mix, which is a pre-proportioned cement, gravel and sand mixture that usually comes in 90-lb. bags. The portland cement will sometimes settle to the bottom of ready-mix bags, so its a good idea to dry-mix the contents of each bag before adding water. A wheelbarrow is great for mixing concrete in, but be sure to wash it out afterwards, along with your mixing tools.

Finding level—Building a deck can be an exercise in elementary civil engineering, and many beginners are frustrated by having to find the proper relationship between posts and boards that aren't connected. You can't always use a carpenter's level to do this—how would you check two posts, 15 ft. apart, to see if they are at the same height? We often use a 2-ft. level on a long, straight board to check for level, but other tools can be used as well.

A string level is a small spirit level that hooks onto a length of layout twine. When the twine is pulled taut, a rough estimate of level can be determined by raising or lowering one end of the twine and watching the bubble in the level.

An optical pocket level is something of a cross between a telescope and a transit. Looking through it, you align a small leveling bubble with cross hairs to determine an approximately level visual line.

A water level is an inexpensive and very accurate homemade device used to check the relative heights of widely separated items. It's made from clear plastic tubing filled with water (a few drops of food coloring will make the water easier to see). Because of atmospheric pressure, the water level at one end of the tubing always matches the water level at the opposite end, no matter how many twists and turns the tubing takes. It's particularly useful over long distances, as when you want to compare the heights of ledger and posts.

A transit is a precision instrument used by surveyors, and this is what we use to determine level, plumb and the relative heights of widely distant objects with a high degree of accuracy. The transit is fairly expensive, but if you do a lot of decks, the money is well spent.

The ledger—The ledger is a length of 2x lumber that is attached directly to the house, allowing a portion of the deck to "borrow" the foundation of the house for support. It's usually the first framing member to be installed and should be selected from the straightest stock available, since it serves as a reference point for much of the work to follow. When you install the ledger, don't rely on siding or the foundation to be level, because often they're not.

The top of the ledger supports the decking, and if you think of it as a rim joist, you'll get the idea. If the ledger has to be attached to the house foundation in order for the final deck elevation to be where you want it, you'll have to fasten it with lag bolts and lead expansion shields or some other masonry-anchor system. Masonry nails won't work very well, particularly in poured foundations that have had many years to cure. When using a standard masonry bit in an electric drill to bore holes for the expansion shields in a concrete foundation, use a star drill to break apart any pieces of aggregate you can't drill through. We've found that a roto-hammer speeds this job considerably.

Sometimes the plans will call for the ledger to be fastened above the house foundation, and in this case, 4-in. by ⅜-in. galvanized lag bolts spaced about 24 in. apart and fastened to studs or a rim joist will usually do the job: Slide flashing under the existing siding and over the ledger, if possible, to keep water from seeping behind it. If the ledger is going to be mounted to some sort of concrete patio or walkway, use shims to hold the board away from the concrete to allow the water to pass freely by.

Allow at least 1 in. between door sills and the decking surface to prevent any water from running back off the deck into the house. If you include a step, use the same step rise used elsewhere on the deck for the sake of consistency.

Posts—Posts transfer the loads from the deck structure to the piers. One end of each post is attached to a beam or a joist, and the other end rests on the pier. We usually don't anchor posts to the piers, since the weight of the deck is enough to keep them in position. Though many people embed posts in concrete, we feel this technique can create serious problems if water collects between the post and the concrete. Posts are usually 4x4s, 4x6s or 6x6s. A 6x6 post is generally more than needed for bearing purposes, but it enables us to notch beams or joists into it for added strength.

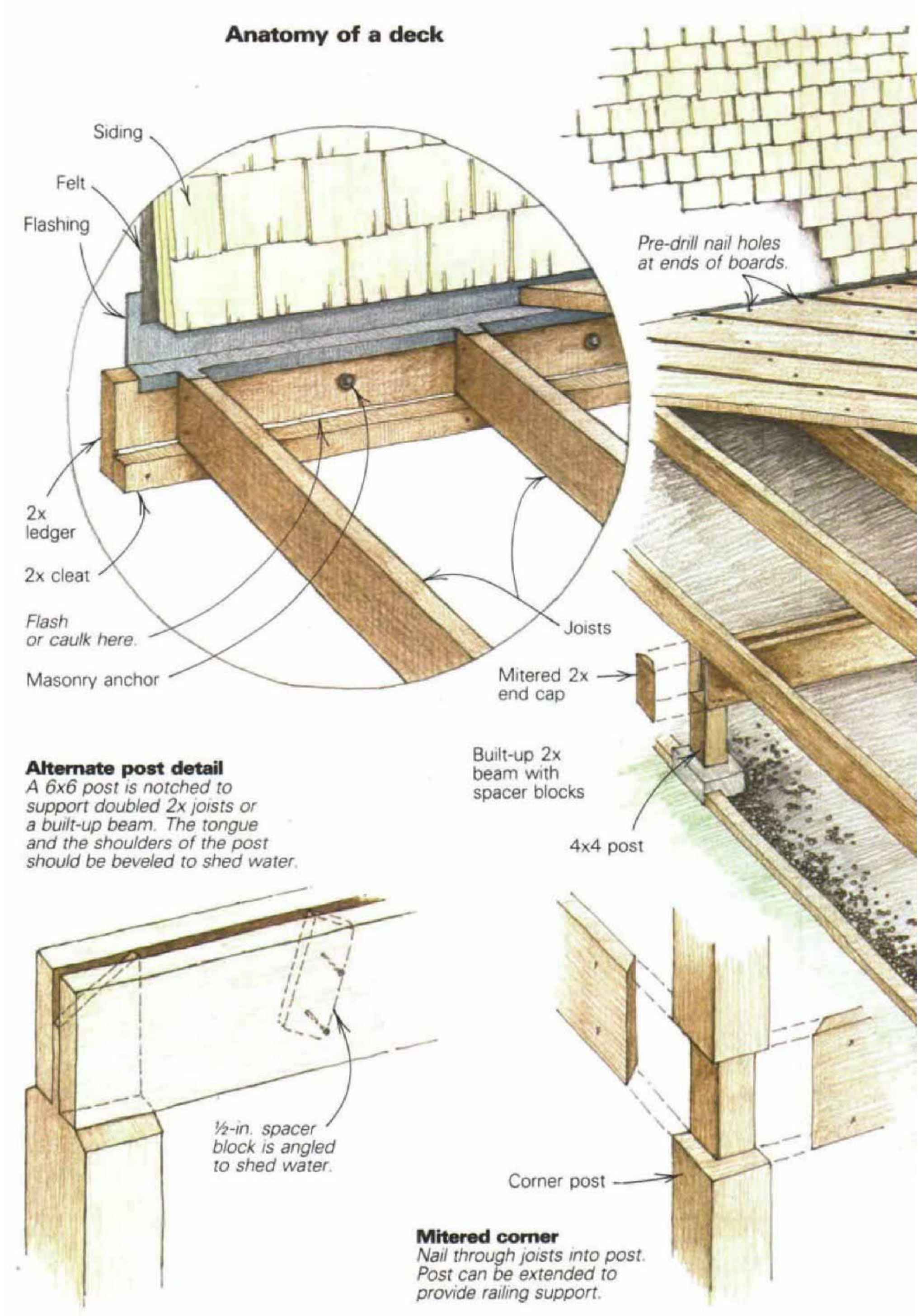
Beams—Beams are an intermediate structural member, used to support joists. They can be solid lumber, usually 4x6 or 4x8, or they can be built up out of 2x lumber. When you're fabricating built-up beams, a common mistake is to nail the individual 2x material face to face, which allows water to get trapped between these boards. Instead, you should sandwich blocks of ½-in. pressure-treated wood between the boards to create a void for water to run through.

Joists—Joists are the uppermost structural element supporting the decking. They are generally 2x lumber, and should be reasonably straight. When laying joists into place, make sure that any crown in the board is facing up; in time, gravity and the weight of the decking will straighten the joists.

There are at least two good techniques for attaching joists to the ledger, and at least one that should not be used. One reason many decks decay at this location is that the joists are toenailed into the ledger; nails split the ends of the joists, allowing water to collect exactly where it shouldn't. Joist hangers minimize splitting at the joist end, and will prevent water from getting trapped in this crucial joint. We first nail the hangers to the joists, and then fit the assembly to a level chalkline. This compensates for slight variations in joist width.

A cleat can also be used to support the ends of the joists. You still need to toenail the joists, but splitting is reduced because the nails can be a smaller size since they do not carry the weight of the deck. If you use this technique, the ledger should be one dimension wider than the joists. For example, use a 2x8 ledger with 2x6 joists. This will allow room for a 2x2 cleat to be attached to the ledger. Run a bead of silicone caulk along the cleat/ledger seam to keep the water out.

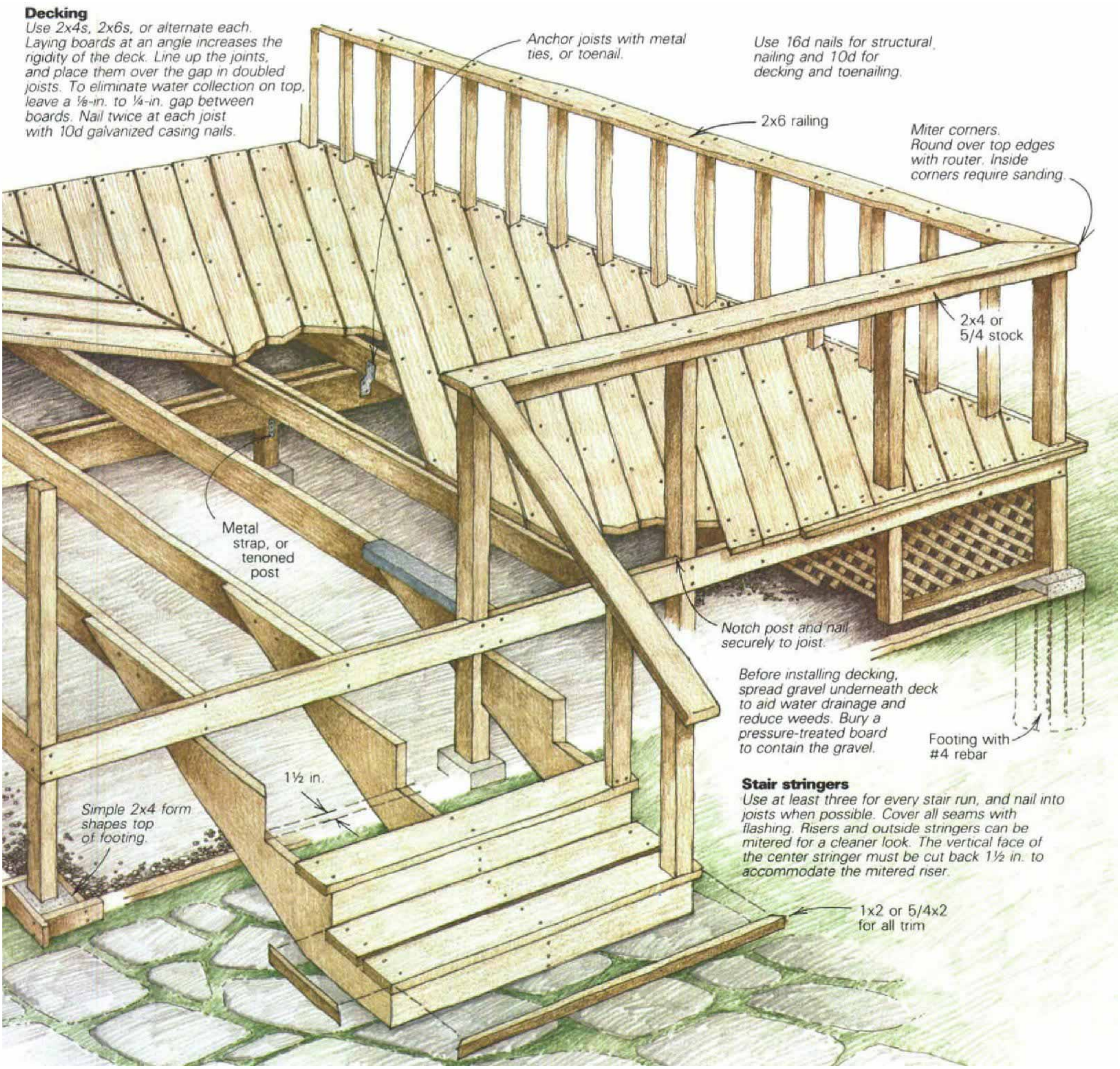
Decking—If the decking surface is not applied properly, it will be the first thing to deteriorate, causing a chain reaction of decay throughout



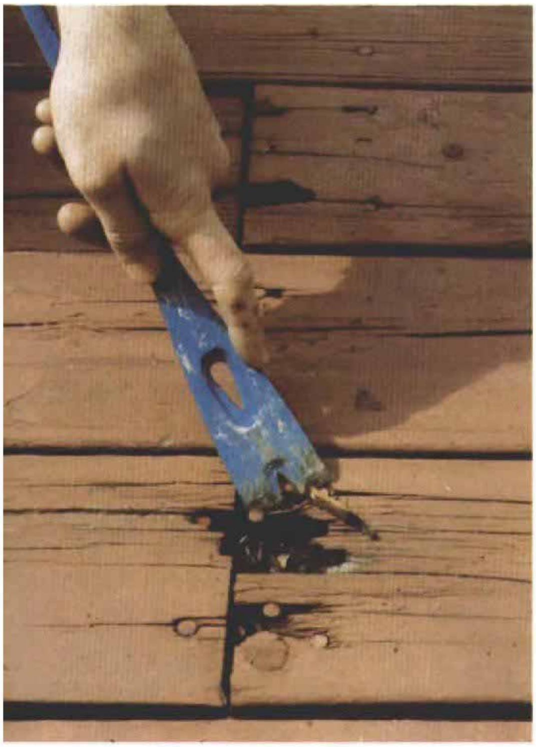
Drawing: Frances Ashforth

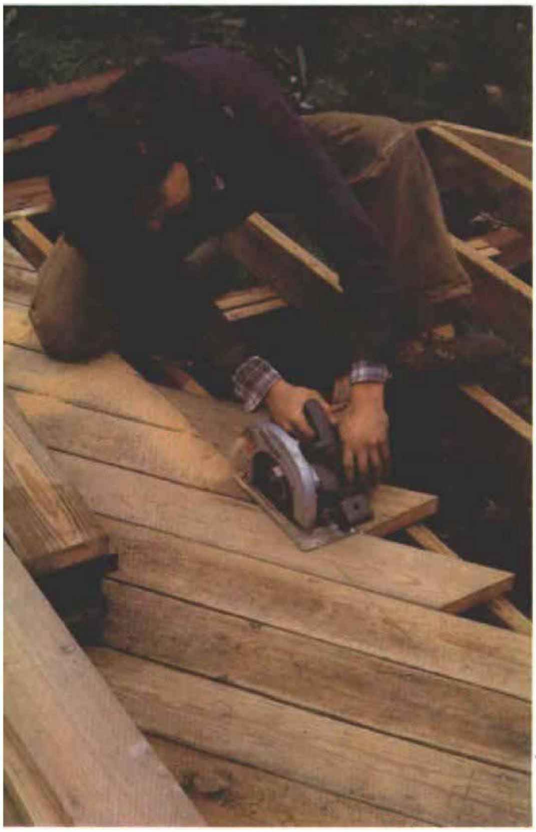
the rest of the structure. *Never* butt the ends of two decking members together and nail into a single joist. This is one of the major causes of decking failure (top photo, next page). The reason is that water collects in the seam between the butting boards and enters their end grain. And when two boards butt over a single joist, the problem is intensified. With only ¾ in. for each deck board to be nailed into, the nails must be placed very close to the end of the board, encouraging splitting. We get around these problems by doubling up strategic joists, using a block of wood between them to create a 1½-in. space. The end of each deck board cantilevers over this space so water can't collect. This also allows the boards to be nailed farther from their ends, which minimizes splitting. If

Bench supports **built from 2x8s can be trimmed to a width of about 3½ in. where they form the backrest. The supports should be securely nailed or bolted to the decks supporting structure.**



The premature failure of decking is often caused by nailing too close to the end of the board. This encourages splitting, and allows water to accumulate around the board ends.





Cutting the decking to length after nailing it in place ensures a clean, uniform edge and saves time otherwise spent cutting boards one by one. Run the boards long and snap a chalkline to mark the cutting path, or use a straightedge to guide the shoe of the saw. A built-up beam and a mitered joist corner can be seen in this photo. Wherever joists along the perimeter of the deck meet, a mitered connection protects end grain from direct exposure to the weather.

you must nail closer than 2 in. to the end of a board, predrilling the nail holes can also help to reduce splitting.

For the decking surface, we like to use 2x6s or sometimes 5/4 by 6s if the quality is good. You can also use 2x4s, but you'll have a lot more nailing to do. If you have the choice, nail the decking cup-side down to prevent any water from pooling on the individual boards.

We like to space the decking boards about ⅛ in. apart (the thickness of a 10d nail). The boards will shrink, depending on their moisture content, and we have seen this space expand up to ¼ in. If there are a lot of deciduous trees with small leaves close to the deck, you might want a wider spacing to allow the leaves to fall through. When you're installing the decking, some boards will most likely be crooked. With a flat bar and some lever action, one person can easily straighten out each board while nailing.

Stairways—Stairways can be dangerous areas, and require special attention. Codes usually call for at least one railing at the side of the stairs if they include more than two risers. Wide stairways have a spacious and inviting appearance, so we like to build them at least 4 ft. wide, enough for two people to pass comfortably.

Inconsistency in the height of a step or length of a tread is dangerous and awkward. We have found that a shorter rise and longer tread is easier to walk up, safer and very elegant. A rise of about 7 in. seems to be make a comfortable step, and allows us to use an untrimmed 2x6 for the risers. Sometimes we miter the riser boards into the outside stringers. We're not fond of exposed stringers. We use a pair of 2x6s for the tread; these make a run of a bit more than 12 in. with a trim board.

We use three stringers for deck stairs, even if the stairway is only 30 in. wide. We have seen too many stairways warp and fall apart with only two stringers. Using three-stringer construction isn't too difficult and doesn't cost much more. In fact, the trickiest part of building one is cutting each stringer to identical shape and lining them all up in the same plane on the rise and run. You can buy framing clips (called stair-gauge buttons) to keep your framing square in the right position while you lay out each stringer, but this doesn't always get you past Murphy's law. Our trick is to lay out one stringer only and clamp it to another length of stringer stock. When you cut the first one, the sawblade scores the second one, saving you one layout. Repeat the process with additional stringers. This will duplicate all the stringers and save layout time.

Railings—Railings are important to the safety and appearance of decks. As a design element, they can be the highlight and outline of your project. Railings are one of the places where a designer's creativity can be expressed, and there is no one way to build them. But there are some general rules to follow.

The most important characteristic of a good railing is strength. You can be sure that people will lean against the railing, and often they will sit on it, too. A strong railing is particularly important on elevated decks. We like to play it safe, and build our railings as strong as possible. To do this, we solidly attach the posts or balusters to the deck joists. These structural supports should be located no more than 48 in. apart, and the railing should be about 34 in. above the decking surface. Be sure that the edges of the railing are well sanded, especially in places that will get a lot of use, like stair railings.

Consider the spacing between your railing uprights as part of the project's visual design. Close spacing visually encloses the space, and also prevents small children from falling through. Railings with fewer uprights will visually expand the space and be less inhibiting to your view.

One type of railing we use combines a bevel-cut 2x6 and a matching 2x4 into an "L" shape. We position the 2x6 horizontally, and our clients enjoy the strong visual effect this creates. The 2x6 acts as a cap for the railing uprights, shielding their end grain from the elements. Although tricky, this technique allows for some very interesting joinery at all corners. To clean up the mitered edge, we round it over with a router or belt sander. A simpler railing is shown in the drawing, previous page.

Seating—Built-in seating is a great way to finish the deck. As with railings, there are many ways to build it, and no one way is correct.

You can build seating either with or without a backrest, and the choice will often depend on whether or not an unobstructed view is important. If comfort is more important, you'll want to build at least some of the seats with a backrest. The top of the backrest should be between 30 in. and 34 in. from the deck, which can be designed nicely to tie in with the railing.

A backless bench can function as a physical barrier for a deck edge without acting as a visual barrier as well. We have also used a low, wide railing as a mini-bench, which also makes a good place to display potted plants. And sometimes we'll use a built-in planter to serve as a visual barrier.

Benches can be difficult to build, since they not only have to be strong, but comfortable too. With backless benches, we have used 4x4s or 2x6s as supports. For a bench with a backrest, we use a 2x8 as the seat support, and rip it down to a 2x4 for the backrest support (photo previous page). A 15° backward lean seems to be comfortable. We then run our mitered railing across the top at 32 in. The cross supports for the seat are 2x6s cut into long, wide triangles. For the seat, we use three 2x6s with a 2x4 band. This will give the seat a total width of 18 in. The standard seat height that we use is 17 in. In calculating seating height, don't forget to account for any cushions that you might use. Save your best boards for construction of the seating, because this part of the deck will be well used and very visible.

A final note—Use these tips in combination with your local codes. With a little creativity and your basic construction knowledge, the deck you build should last a long time. □

Scott Grove is a partner in Effective Design, a design/build company in Rochester, N. Y.

Photos: Scott Grove