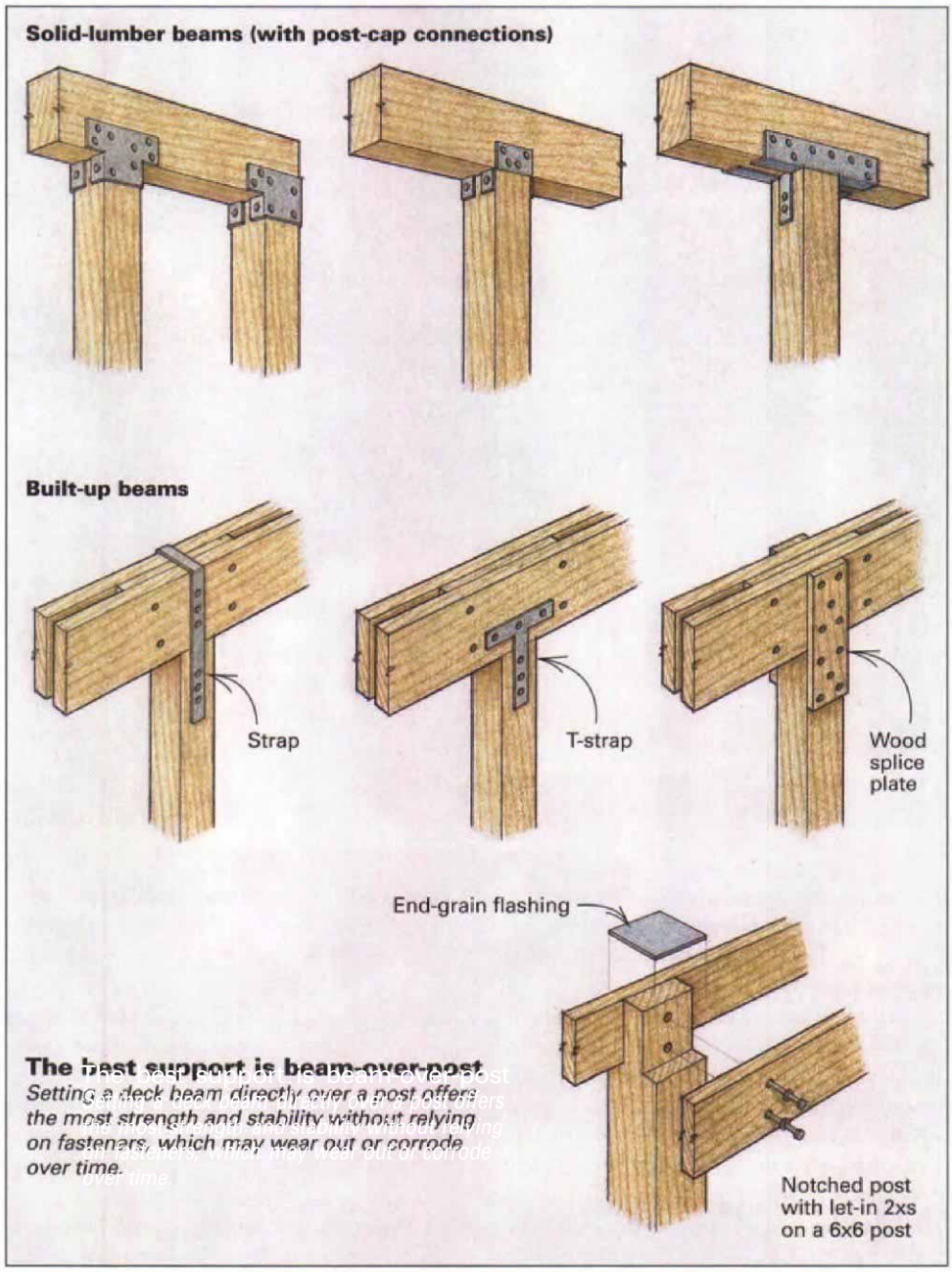
Details for a Lasting Deck

Government scientists study outdoor structures and report on which details, fasteners and finishes hold up best

by Bob Falk and Sam Williams



The best support is beam-over-post
Setting a deck beam directly over a post offers the most strength and stability without relying on fasteners, which may wear out or corrode over time.

Some decks need major overhauls after less than 10 years. Others stay strong and good looking for decades. What's the secret? Well, besides the obvious first choice of suitable lumber (we recommend either a naturally durable species or preservative-treated lumber), a lasting deck is put together with strong, durable fasteners, and it gets regular applications of a penetrating finish to repel moisture and to minimize the effects of the weather.

Although the structure of a deck is a lot like the skeleton of a conventionally framed wood house, a deck doesn't have the stability of sheathing, and there's no roofing and siding to protect it from the elements. That's why decks require extra care and attention to detail. As wood researchers at the U. S. Forest Service Forest Products Laboratory, my colleagues and I have studied lumber, construction techniques, fasteners and finishes. From this research, we offer some recommendations for building decks that last.

Start with good connections—In wood construction, connections often limit strength; so many common failures of deck construction lead back to connection performance. Proper connections of deck joists to beams, beams to posts and decks to houses are critical.

Because fasteners and hardware in wood decks can corrode, it's prudent to minimize dependency on them. Wherever possible, joists and beams should bear directly on posts. This type of connection requires more vertical space, but it's more reliable than transferring load through fasteners.

There are a number of ways to connect beams to posts (drawing left). Two-by lumber can be used as a beam if either set directly on top of the post or let into a notched post. This notched connection only works when the posts are 6x6 or better because notching a 4x4 post with 2x side members leaves only ½ in. of post for you to bolt through.

A better option when supporting a built-up beam with a 4x4 post is nailing a ½-in. treated-wood spacer between the two 2xs and setting the beam directly on top of the post. You also can tie the connection together with a hot-dipped galvanized beam-to-post connector. Just remember, though, that whenever you cut notches or install lag screws or bolts in deck lumber—even if it's preservative-treated lumber—you should treat the openings in the lumber with a wood preservative.

The connection at the house must be detailed carefully—Attaching a deck to a house is risky business. Screwing or bolting into a house opens the siding's protective envelope to moisture, which can lead to decay and insect

Drawings: Vince Babak

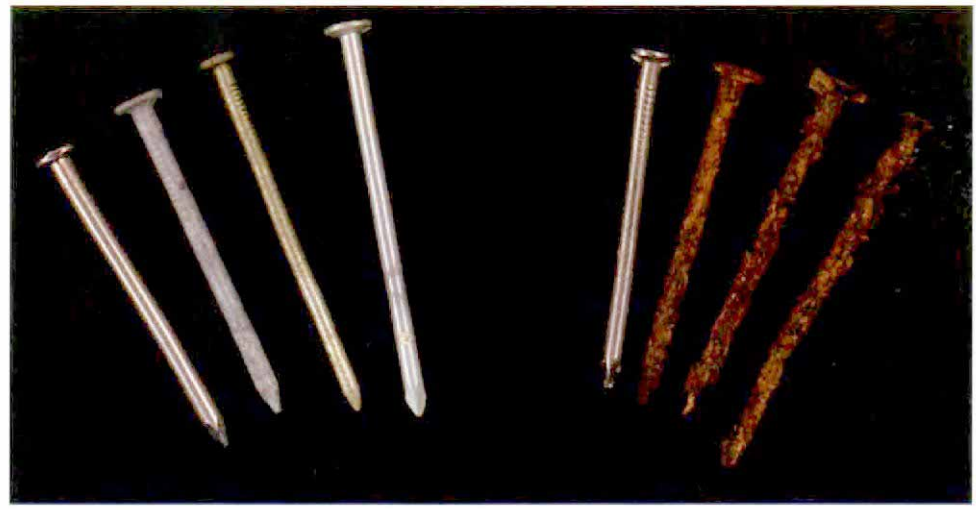
attack. Wherever practical, it's best to build a freestanding deck.

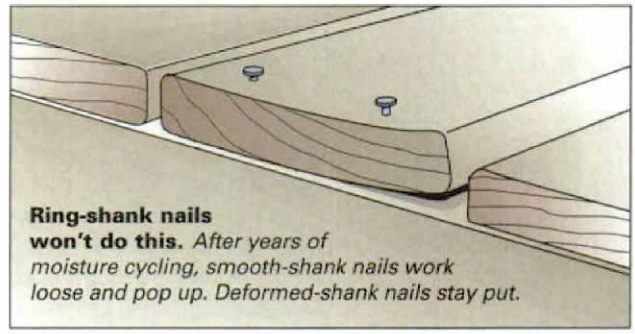
If a freestanding deck isn't feasible, take extra care attaching the deck to the house. And although it probably goes without saying, nails aren't adequate to make this connection.

To prevent water from entering the house, it's important to caulk pilot holes in the band joist of the house before installing screws or bolts. It's also prudent to add spacers, such as a few washers, between the two structures to allow the gap between the deck and the house to dry. You also should extend metal flashing under the siding above the deck and over the siding below the deck (drawing p. 80).

If the deck is attached to the house, it may be necessary to reinforce the band joist of the house to resist lateral forces that tend to pull the deck from the house. Sixteen-d nails at 8 in. o. c. that are driven through the sole plates and mudsills, from above and from below, add support to the band joist in new construction.

It may also help to provide additional bracing on the deck; however, our recommendation to reinforce the band joist highlights the need to transfer adequately the deck loads to the house framing. There have been cases where the deck was firmly attached to the band joist, but the band joist was not secured to resist the deck loads and was ripped from the house when the deck failed. Of course, we recommend X-bracing between the posts for freestanding decks. This topic is covered in our deck manual in more detail *(Wood Decks: Materials, Construction, and Finishing,* published by The Forest Products Society; 608-231-1361).





Ring-shank nails won't do this. *After years of moisture cycling, smooth-shank nails work loose and pop up. Deformed-shank nails stay put.*

Stainless steel lasts longer. The nails on the right side of each pair were nailed into solid-wood blocks and subjected to 14 years of exposure to high humidity. From left, stainless steel, hot-dipped galvanized, mechanically galvanized and electroplated galvanized.

Proper size and spacing of fasteners is critical—Wherever you use bolts in a deck, the strength of the connection depends on the correct size and spacing of the fasteners.

To attach decks to the band joist of a house, where you use 12-in., 16-in, or 24-in, joist spacing, two ⅜-in. dia. lag screws are needed every 24 in. for a 6-ft. span. Two ½-in. dia. lag screws are needed every 24 in. for spans of 6 ft. to 16 ft.

Don't skimp on fasteners—The two most important things to remember when choosing deck fasteners—framing nails, decking nails, screws, joist hangers, bolts and lags—are their holding capacity and their resistance to corrosion. Inadequate fasteners or improperly installed fasteners can cause connections to loosen, and when they corrode, they weaken the surrounding wood.

Most fasteners are made of mild steel or stainless steel and are produced in a variety of styles. Protective coatings are often applied to mild steel fasteners. Stainless-steel fasteners last the longest, followed by hot-dipped galvanized-steel fasteners. There are newer types of fastener coatings on the market, but we haven't extensively evaluated their longevity.

It's important to remember that aluminum fasteners can be used for fastening untreated wood but that aluminum can rapidly corrode in wood treated with preservatives containing copper.

Make sure your galvanized fasteners wear a heavy coat—Galvanized coatings protect the steel underneath, so when the coating is gone, the underlying steel corrodes. That makes the thickness of this protective coating critical.

To galvanize fasteners, manufacturers apply coatings of zinc, cadmium or zinc/cadmium by electroplating, mechanical plating, chemically treating or hot dipping (dunking the fastener in molten zinc). The thickness of these coatings varies significantly; hot-dipped coatings are typically the thickest and in our experience give the best corrosion resistance.

Unfortunately, many builders use electroplated nails for outdoor construction because they are available for use in nail guns. Our research found that electroplated nails don't last as long as hot-dipped galvanized nails (top photo).

In addition to nails, there are lots of hangers, post supports, hidden deck-board fasteners and other metal hardware available for use in deck construction. Just as with nails, screws and bolts, metal deck hardware should have a thick, durable, protective coating.

Despite the cost, stainless steel is a bargain—Stainless-steel nails, bolts and screws can cost many times what conventional fasteners cost, but considering the overall investment of lumber and time put into a deck, they're worth the price, especially in wet or salty environments. Our research shows that even after years of severe exposure, stainless steel holds up well.

The problem with stainless steel is that the metal is softer and more difficult to drive than carbon steel, which may result in more waste from bent nails or damaged screw heads.

Avoid smooth-shank nails, and avoid nail pop-up—After years of getting wet and drying out, smooth-shank box and common nails can lose their withdrawal resistance, pop up and loosen connections, especially if they're used to secure deck boards (bottom photo). So for deck boards, we recommend deformed-shank nails, such as spiral-groove and ring-shank nails, or screws.

These deformed-shank nails resist withdrawal effects from cupping and from wetting-and-drying cycles. Pop-up can also occur when nails are too short. We recommend the use of at least 3-in, long nails (10d) to secure 1-in, thick deck

Drawing this page: Dan Thornton

boards and 3½-in. long nails (16d) for thicker deck boards.

Screws-especially drywall-type or bugle-head "multipurpose" screws—seem to have found a niche in deck building, too. Like other metal fasteners, screws used outside must be able to withstand the wetting-and-drying cycles that can cause weakening of metal and loosening of connections. Screws have advantages over nails: They are effective in drawing down cupped or twisted decking, and they can easily be removed. For screws, the length recommendations given previously apply. A word of warning about multipurpose screws, however: They are not intended to fasten joist hangers. Use only manufacturer-specified hanger nails to attach joist hangers.

Use lag screws where bolts can't go—For fastening a 2x to a thicker member where a through bolt won't work, lag screws work well. Just remember that pilot holes should be 60% to 70% of the diameter of the threaded portion of the screw. Therefore, a ⅜-in. dia. lag screw would get a ¼-in. pilot hole for the threaded portion, followed by a ⅜-in. pilot hole for the unthreaded portion.

Lag screws need to be long enough so that at least half of their length penetrates the thicker member. A flat washer should be used under the head, but not tightened so much that it crushes the wood.

Bolts are more rigid and typically stronger than lag screws. Just remember to drill the pilot hole no more than 1/16 in. larger in dia. than the bolt. It's best to use flat washers under both the bolt head and the nut to distribute the force over a larger area and to reduce crushing of the wood.

It's also a good idea to saturate pilot holes with wood preservative or a water-repellent preservative (such as ISK Woodguard, Daps Woodlife or Cuprinol). Water can collect around fasteners and promote decay. Check lag screws and bolts periodically for tightness.

We haven't tested many of the newer fasteners, such as hidden fasteners, so we have no data. However, the use of hidden hardware may make it more difficult to replace a problem deck board should the need arise. On the plus side, these products don't puncture the top of the deck board with a fastener, eliminating a site for water collection.

After all of that time and money, give your deck a proper finish—A lot of time and money goes into building a deck. To keep it looking good and to ensure that it lasts, the deck needs a good finish. Unless you apply a finish, discoloration, checking and permanent damage can occur even with preservative-treated wood.

In general, wood finishes fall into two categories: those that form a film and don't penetrate the wood, and those that don't form a film and penetrate the wood. After a great deal of research, we recommend penetrating finishes (bottom photo, facing page).

Film-forming finishes include paints of all descriptions, solid-color stains, varnishes and lacquers. Penetrating finishes include solvent-borne, oil-based water repellents, water-repellent preservatives and oil-based semitransparent stains. Film-forming finishes usually lead to failure because the film can't tolerate the moisture cycling of deck lumber (top photo, facing page). Once the film is cracked, water gets under it, and the finish blisters and peels.

Choose a finish that really soaks in—Water repellents and water-repellent preservative pretreatments penetrate to protect wood. These products contain a moisture inhibitor, such as paraffin wax, and a binder, but not necessarily pigment. The amount of water repellent in the mixture varies among brands. A low concentration of repellent is about 1%, so it can be used as a pretreatment. Others have a high concentration of water repellent-about 3%-and are stand-alone finishes. If the label says "paintable," the finish probably contains the lower concentration of water repellent.

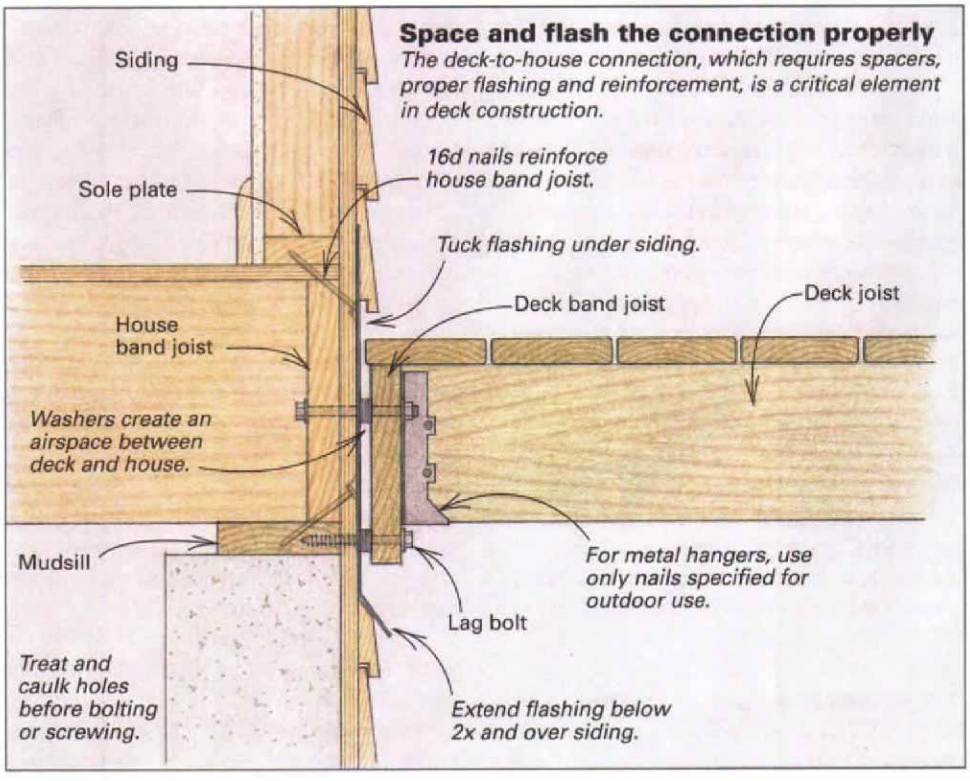
The difference between a water repellent and a water-repellent preservative is that the preservative contains a mildewcide. The use of a mildewcide even in a finish applied to preservative-treated wood is recommended because the wood preservative doesn't resist mildew.

Water-repellent preservatives also are available in forms that contain nondrying oil solvents such as paraffin oil. These products penetrate the wood but don't dry inside the wood.

Several commercial wood treaters are marketing 5/4-in. radius-edge decking that has a dual treatment of water repellent and copper chromated arsenate (CCA) preservative. This lumber is marketed under brand names such as UltrawoodR, Wolman ExtraR and Weathershield. Although this process is relatively new and its long-term performance isn't well-established, we believe these products are probably worth the extra cost.

Generally, dual treatments are used on #1 grade lumber rather than #2, which is a more common grade for treated lumber. Therefore, some of the increase in price reflects the use of this better-quality wood. We believe that the use of water repellents and water-repellent preservatives does increase the life of fasteners; however, we have never quantified this. We have found that these treatments can decrease iron staining if poor-quality fasteners are used.

Stain finishes are good if not overapplied—Semitransparent oil-based stain finishes penetrate wood, provide color and often contain water repellents or water-repellent preservatives. Some manufacturers make semitransparent "decking stains," which have enhanced water repellency and better wearing resistance. Don't confuse decking stains with siding stains, which



aren't for use on horizontal wearing surfaces. If you apply too many coats of stain, a film will form on the wood, and it eventually will crack and cause problems (photo center). If applied properly, semitransparent oil-based stains penetrate into the wood without forming a film.

Semitransparent deck stains last much longer than clear water-repellent preservatives because the pigment protects both the wood and the preservative from the damaging effects of the sun. One problem with stains is that the stain may wear off in high-traffic areas such as steps, and it may be difficult to hide these patterns completely when restaining.

Preservative-treated wood shouldn't affect the finish—Waterborne preservative treatments such as CCA don't affect the finishing characteristics of wood and may enhance the durability of some semitransparent stains. CCA contains chromium oxides that bond to the wood, decrease degradation of the surface and increase durability of semitransparent stains, often by a factor of two to three.

Other common wood preservatives don't contain chromium oxides, so staining this type of treated lumber is similar to staining untreated wood. Nonchromium treatments include ammoniacal copper zinc arsenate (ACZA) and ammoniacal copper quaternary (ACQ).

Don't put off applying the finish—On a newly built deck, apply the finish after the wood dries below about 20% moisture content. (For more on moisture content in deck lumber, see *FHB* #97, pp. 70-71.) If your lumber is not preservative-treated and is grade-stamped S-DRY (surface dry), KD (kiln-dried) or MC-15 (average moisture content 15%) or is treated and stamped KDAT (kiln-dried after treatment), it can be finished immediately. If treated and stamped S-DRY, KD or MC-15, that only means it was dried before treatment. Ideally, these boards should be finished prior to installation so that the end grain of each board can be coated.

It's often recommended to wait a year to finish a deck. We think a year is too long to wait because checking, cracking and splintering can occur. We don't think you should wait more than two months to finish your deck.

Brushing on the finish is best, but follow the manufacturer's recommendations. You can apply the finish faster having one person spraying and another person following and working the finish into the wood with a brush.

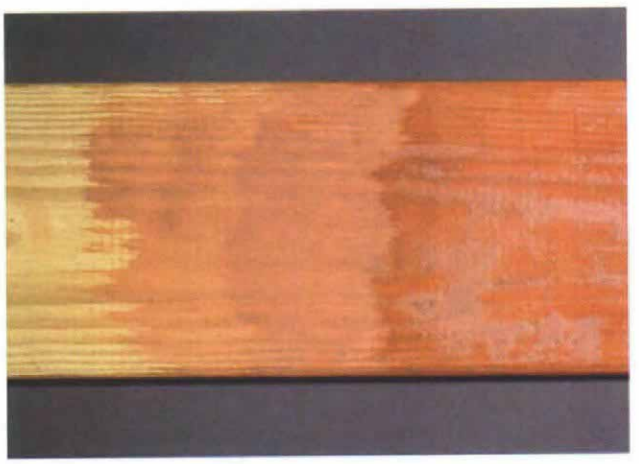
To avoid lap marks in semitransparent stains, brush the stain on only two or three boards at a time and stain along their full length. Second coats of semitransparent stains should be applied while the first coat is still wet (within 30 minutes to 45 minutes), or they won't absorb. If the first coat is dry, it seals the surface, and the second coat forms a film.

To maintain the water-repellent finish of your deck, it's best to reapply a finish annually or semiannually. The most obvious way to tell if your deck needs refinishing is to see if water beads on the surface or is absorbed. If water beads, there is no need to refinish. If it doesn't, apply a water repellent. If mildew is a problem, refinish with a water-repellent preservative. Usually, water repellents and water-repellent preservatives can be applied over existing finishes; however, it's always a good idea to test compatibility in an inconspicuous area.

If you refinish a deck finished with a semitransparent stain, be careful not to build up too much finish. Wait long enough that pigment loss is evident; or apply a clear water repellent or water-repellent preservative over the existing semitransparent stain for extra water repellency. □

Bob Folk, P. E., and Sam Williams are structural engineers at the USDA Forest Products Laboratory in Madison, Wisconsin. Their colleagues Andy Baker and Mark Knaebe contributed to this article. Falk and Williams are coauthors of a handbook on wood decks, Wood Decks: Materials, Construction, and Finishing.

Film-forming finishes aren't good for decks. Paints, varnishes and other finishes that form solid films are bad for use on decks because of exposure to sunlight and moisture cycling.



Too many coats have the opposite effect. More than one coat of semitransparent oil-based stain can be applied as long as subsequent coats are applied while the first is still wet and as long as not so much is applied that a film forms on the surface.

Let the finish soak in. The difference between film-forming and penetrating finishes is clear. The finish on the left is latex paint, which forms a film and isn't recommended for decks. Middle is penetrating water-repellent stain, and on the right is a penetrating water repellent; both are good on decks.