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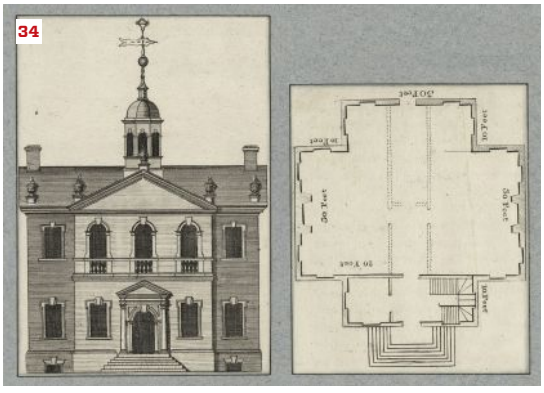

On the cover: Lead carpenter Aaron Butt teaches a stair-building workshop at the Grand Banks Building Products yard in Gloucester, Mass. For a look at the transformation of skilled labor in the building trades, see the story on page 34. Photo by Monica Banks.

FEATURES

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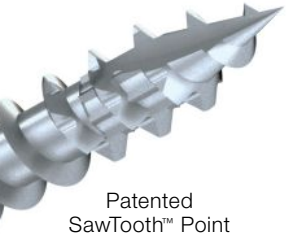

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BY BRUCE GRAY

Rough Terrain Forklift Training

The presence of rough terrain forklifts on jobsites has become much more common over the last decade. Whether rented or owned, these forklifts save time, labor, and money; their appeal is undeniable. Reaping those benefits, however, requires an array of skills and knowledge to operate these vehicles responsibly on site—skills and knowledge that have to be validated, either by third-party safety trainers, like myself, or by individuals who have attended training-the-trainer-type classes (more on this below), or by the vendors renting the equipment.

I've been involved in industrial safety training and education since 1983, and for the last 16 years, I've been a self-employed safety consultant. My clientele has ranged from small businesses to Fortune 500 companies. A significant portion of my business deals with forklift operator training (or more precisely, powered industrial truck operator training). OSHA defines powered industrial trucks (PITs) as any mobile power-propelled vehicle that is used to carry, push, pull, lift, stack, or tier materials, and that can be ridden or controlled by a walking operator (see "Forklift Classification Explained," page 10).

In this article, I'll focus on Class VII rough terrain forklifts (particularly variable-reach types with telescoping booms) as they relate to home builders and remodelers. While it's true that safety officials (OSHA) are more likely to inspect large commercial jobsites than residential or multifamily ones, they will visit any site where incidents have occurred or where complaints have been made. Aerial lifts tend to attract watchful eyes.

The good news is there are steps you can take (which I'll outline in the following article) to prepare for that hypothetical day when they visit, though it will cost some money and take some time to be "legal" in the eyes of OSHA. Training costs are far cheaper than OSHA fines, and I believe most contractors want to build correctly and keep their people safe, but they may not always know where to begin.

Training the trainers. In the region where I work, small businesses (as opposed to the large manufacturing and commercial construction companies I normally consult with) often lack the resources for safety training. To help close that resource gap, I run "Train the Trainer" courses several times a year. The goal of the course is to help

Photos: 1, Roe Osborn; 2, Seth Stafford

Rough terrain forklifts (or telehandlers) were designed to move material from off-loading zones closer to jobsites **(1)** and to lift manageable loads to elevated work areas **(2)**. Numerous makes and models with varying reach and load-lifting capacities can be found on residential sites today. They can be challenging to operate; drivers have to contend with stability issues related to projected loads from telescoping booms and uneven surfaces. Vehicle tip-overs can occur if load limits are not adhered to.

small businesses become self-sufficient regarding forklift operator training (upon successfully attending the class, individuals are certified to train fellow workers at their own place of employment).

"Train the Trainer" is a six-hour course in which I review OSHA regulations; how to evaluate an operator's performance during a driving test; and how to properly operate and maintain forklifts in terms of their controls, attachments, maintenance, rules of the road, and so on. I charge $175 per person, but similar programs can range anywhere from $150 to $600 per person.

Also worth noting, I teach to OSHA's forklift standard 1910.178 and cover material related to general industry and not construction-specific subject matter. I can have anywhere from 20 to 30 attendees representing 15 different companies (in the industrial, manufacturing, and construction fields) with each company using several types of forklifts. Check with local home-builder associations, safety councils, and even insurance companies (which sometime sponsor safety training for small businesses) for similar opportunities.

OSHA 1910.178 (Preventing Forklift Accidents)

Why do we need forklift training? Powered industrial truck (PIT) accidents frequently make OSHA's Top Ten Serious Violations list, with approximately 100 fatalities and 20,000 lost workday injuries per year across U.S. industry. OSHA standard 29 CFR 1910.178 covering PITs requires employers to develop and implement a training program based on the general principles of safe truck operation. It is an old safety standard (but well written) and is "performance oriented." This means that if you have an accident or are observed to be driving unsafely, you need to be retrained. And it has a mandatory training and performance evaluation default of every three years. It's not just one and done; training is an on-going discipline.

Standard 1910.178 covers all aspects of forklift operator training, from fuel handling and charging batteries to truck operation and maintenance. A few examples of 1910.178 rules pertaining to builders operating rough terrain forklifts (or telehandlers) follow.

Never work or pass under extended or elevated forks (whether loaded or empty). This might seem like common sense, but let's say hypothetically, you and your crew are installing a small beam with the help of a telehandler. It's easy to forget this rule in the moment as you pass under the forks while struggling to precisely place the beam from below. Operator error or hydraulic failure are not out of the realm of possibility while operating these vehicles.

Never leave a vehicle unattended with a load engaged. OSHA's definition of an unattended vehicle is when the operator is 25 feet or more away from the vehicle while it is remaining in his or her view, or whenever the operator leaves the vehicle and it is not in his or her view. Again, hypothetically, you may have gotten in the habit of suspending a dumpster from an unattended telehandler during demolition. This is not legal. Technically, when the vehicle is unattended, the load engaging means must be fully lowered, the controls neutralized, the power shut off, and brakes set. Also, if parked on an incline, the wheels must be blocked.

Never operate a vehicle in need of repair. If a forklift is in need of repair, is defective, or is in any way unsafe, it should be taken out of service until it has been restored to safe operating condition, with all repair work done by authorized personnel. The margin of error

Forklift Classification Explained

Forklift terminology is fairly complex. Descriptive, task-oriented names (such as "side loader, high-lift pallet" forklift) aside, forklifts are often referred to in more colloquial terms. In my region, paper mills call them "tow motors," warehouses may refer to them as "stackers," and builders tend to use "telehandlers" in lieu of "rough terrain forklifts." OSHA uses the all-encompassing phrase "powered industrial trucks," or PITs, when referring to forklifts in its 1910.178 standard.

PITs can be defined as any mobile power-propelled vehicle used to carry, push, pull, lift, stack, or tier materials, and that can be ridden or controlled by a walking operator. Within 1910.178, OSHA categorizes all forklifts into seven PIT classes (broken down by their various functions, fuel sources, and even tire types). They are:

Class I: Electric Motor Rider Trucks
Class II: Electric Motor Narrow Aisle Trucks
Class III: Electric Motor Hand Trucks or Hand/Rider Trucks
Class IV: Internal Combustion Engine Trucks (Solid/Cushion Tires)
Class V: Internal Combustion Engine Trucks (Pneumatic Tires)
Class VI: Electric and Internal Combustion Engine Tractors
Class VII: Rough Terrain Forklifts

For more information on forklift types, go to osha.gov.

Class VII: Rough terrain forklifts can be defined as PITs with large flotation tires for outdoor use on difficult surfaces. They're often used on construction sites to transport (and lift) materials from off-loading areas to various jobsite locations. There are three basic types:

- **Variable-reach (or telehandler) forklifts** are used to lift pallets or other objects to heights using a telescoping arm. The arm allows the operator flexibility in picking up and placing loads (at various distances and lift heights) from the front of the machine.

- **Vertical-mast rough terrain forklifts** are ruggedly constructed and are designed to be used outdoors. They are common at lumberyards, auto recyclers, and commercial construction sites.

- **Truck/trailer-mounted forklifts** are portable self-propelled forklifts that are typically transported to the jobsite. They are mounted on a carrier to the back of a truck (or trailer) and are used to unload heavy items from the truck (or trailer) at the jobsite.

One last note: Personnel lifts are not considered PITs; they're covered by their own, less-defined standard. When asked about them in relation to training, I tell people to use the forklift standard to evaluate a new employee's operating skills. Also, it is recommended to use a pre-use inspection sheet. — *B.G.*

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Rough Terrain Forklift Documentation	
Proof of Training	• Mandatory: Typically, a card or certificate from a trained safety person noting when training occurred and expiration date. Recommended that operators possess card while on jobsite; keep copy on file. • Employers are responsible to make sure each vehicle operator has received training and a performance evaluation at least once every three years.
Vehicle Load Charts	• Mandatory: Vehicle load chart shows rated capacity of vehicle and maximum weight that may be safely lifted depending on vehicle's boom angle and extension arc (as a rule, a vehicle's carrying capacity is reduced the further out the telescoping boom is extended). • Most likely thing OSHA will look for first during an inspection (especially if an attachment such as a jib boom is observed being used on telescoping forklift—see below).
Attachment Load Charts	• Mandatory: Attachment load charts show rated loads when using an attachment (as a rule, a vehicle's carrying capacity is significantly reduced when an attachment such as a jib boom is used). • Only approved attachments can be used—made either by the forklift manufacturer or by an approved third-party manufacturer. Custom or site-built attachments are not legal. • Again, most likely thing OSHA will look for first; they'll want to see a load chart specific for attachment in use.
Pre-Use Checklist	• Not mandatory, highly recommended: Get into habit of documenting the vehicle's maintenance; it's good practice and shows safety officials that the operator (and employer) is on top of the vehicle's maintenance. • Keep it simple; complex checklists are less apt to be filled out by operators (the goal is to find a system that works for employer and operator to fill out a pre-use checklist on a regular basis). • Keep the Pre-Use Checklist or maintenance log on file, especially if you own the vehicle. • Don't let maintenance issues slide; act quickly on items noted on checklist. Rough terrain forklifts are complex vehicles with little margin for error when operating in the field.
Vehicle Inspection	• Mandatory: A yearly vehicle safety inspection is required and must be performed by authorized third-party vendors.
Nameplate Legibility	• Mandatory: Equipment nameplates (as well as all plates, tags, or decals noting carrying capacity, operation, and maintenance instruction) are required to be in place and in a legible condition. • Though not required, keeping a photograph clearly showing the vehicle's nameplate information on file is recommended, in case the nameplate becomes damaged or marred during years of use.
Operator Manual	• The vehicle's operator manual should be in the vehicle's cab regardless of whether the vehicle is rented or owned by the operator.

You should have these documents on hand (and on file) if you own, rent, or operate a rough terrain forklift. Most are mandatory; maintaining a pre-use checklist is not, though I highly recommend doing so (it's the biggest omission I encounter).

is narrow when using telehandlers to lift material; don't let maintenance issues slide.

Documentation. So, what documents do you need to be "legal" and what items should you keep on the jobsite? At a minimum, you should have a card or certificate of proof of training and the vehicle load charts (and attachment load charts as well, if applicable) on the jobsite—OSHA will look for these items first. Also, though not mandatory (but highly recommended), keep a pre-use checklist and maintenance log. It's a good habit to have and it'll demonstrate to a safety official that you're on top of things. For more information on what documentation you should have, both on site and in the office, see "Rough Terrain Forklift Documentation" at left.

Resources. Operating these complex vehicles in the field starting from scratch is not wise (or legal); familiarize yourself with them first. OSHA's "Powered Industrial Trucks - Operator Training" slideshow presentation on its website is a good starting point for an overview on the topic. Also, professional safety groups (such as the National Safety Council, American Society of Safety Professionals; and American Industrial Hygiene Association) are good sources to contact. They have local chapters and can help to find training opportunities similar to ones I've outlined above.

I used to say, "If it has forks on it and you're lifting up pallets, it's covered by the forklift standard." But that's not 100% true anymore. For instance, skid steers with forks are now in a gray area and may not be covered by the forklift standard (depending on the safety jurisdiction). The point is, rules change and training requirements evolve. It's good business to be legit in the eyes of OSHA and to keep on top of your (and your employees') training.

Bruce Gray is a career safety person. He has 36 years experience training related to chemical safety, working in confined spaces, and powered industrial trucks. He owns and operates Landrock E&S Consulting, in Plattsburgh, N.Y.

For a more detailed discussion of rough terrain forklift training, go to **www.jlconline.com/training-the-trades/rough-terrain-forklift-training**

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Q Why are there so many different drywall compounds, and which ones are best for taping?

A Myron Ferguson, a drywall and home-performance contractor from Middle Grove, N.Y., responds: The combination of tape and compound is what connects the drywall seams and inside corners together. So it goes without saying that you should use the products that create the strongest seams. But all the different compound choices can be mind boggling.

Drywall compounds fall into two general categories: setting compounds and drying compounds. Setting compounds come as powders that mix with water and harden through a chemical reaction. Drying compounds come premixed—in either a bucket or a box—and harden by air drying.

As a professional drywaller, I usually use setting compounds only when I need a product that will set quickly, such as when prepping a room (see "Prep Work Before Taping," Aug/19). For most of my drywall work, I prefer drying compounds, especially for embedding paper or fiberglass-mat tape. Drying compounds are available in many varieties, including all-purpose compounds (in various weights) and specialized taping and topping compounds.

Taping compounds are formulated to have excellent bonding strength and crack resistance for embedding paper tape, although they work well with fiberglass-mat tape as well. Taping compounds are slick and easy to work with for embedding tape, but I would not recommend them for finish coats. They are difficult to smooth and feather, and they are tough to sand.

The next best product for embedding tape is standard all-purpose compound, which can also be used for finish coats. This is the compound you see most often at lumberyards and home centers. All-purpose heavyweight compound goes on slick and doesn't dry out, which gives you a longer working time for embedding paper or mat tape. Although this compound can be used for finish coats, it doesn't feather out and sand as easily, so I try to use it only for taping.

Lightweight all-purpose compound can be used for embedding tape, but it is not as strong as taping compound or heavyweight compound, so I try to use it only for fill and finish coats. Topping compounds formulated specifically for the finish coats are not nearly as strong as taping compounds, so I never use topping compound for embedding tape. Because topping compounds and lightweight all-purpose compounds are easier to smooth and feather, easier to sand, and shrink less, they make the best choices for the fill and finish coats.

I also recommend using the same lightweight or topping compound for both the fill coat and finish coat. The final finish coat or coats tend to be quite thin, and they are the coats that get sanded. When sanding the finish coat, you often sand through at high spots, ridges, or tool marks. If the fill and finish layers are the same material, they will sand the same, which results in a smoother finish. If you've used a harder compound for a lower layer, then the layers will not sand the same and the finish could have imperfections.

The "three bears" version of drywall compound is the midweight all-purpose compound. Midweight compound sands more easily than heavyweight compound and is better than lightweight compound for bedding tape. Many tapers use this product for the convenience of having just a single product on the jobsite.

If you're looking for a specific type or weight, be aware that individual brand names for different compounds and formulations can be a bit misleading, and some products may not be available in certain parts of the country. Always read the label carefully to make sure the compound you're buying will do the job you want it to do.

Photos by Roe Osborn

Companies such as USG and National Gypsum offer joint compound in a wide variety of weights and formulations. A few examples from USG are shown above: All-Purpose compound on the left can be used for embedding tape as well as for finish coats. Plus 3 is lighter weight and is for finish coats. Midweight is between the two and can be used for both taping and finish.

Q We replaced an old yellow-pine ceiling with T&G hickory last winter. This summer, the boards warped and literally started popping off. We don't want to replace them until we understand the problem.

A Clayton DeKorne, editor of *JLC*, responds: Hickory is not the most stable wood, so it moves a lot with changes in humidity. In winter, when you installed the ceiling, the air (and wood) were very dry, but as indoor humidity climbed in summer, the boards swelled and buckled. The "problem" is likely in the material selection. True hickory is strong and hard, but its cell structure reacts to moisture.

First, the basics with any solid-wood paneling or flooring: Nail one side only through the tongue to allow each board to move without splitting. Before installation, bring the wood indoors for a few days to acclimate to indoor conditions. Test the moisture content (MC); hickory should be installed at 6.5 to 7.5 percent MC. But unless indoor humidity levels are stable, dry wood will swell as it takes on moisture from the air. This is more pronounced in humid-summer climates, especially if there is no AC in the home. (And even if there is, the HVAC system may be oversized and not run long enough to dehumidify. Maintaining a stable indoor climate in a humid climate usually happens only with dedicated dehumidification.)

Wood does not change much in length (parallel to the grain). Hickory expands about 0.1%, or about 3/32 inch in 8 feet. A shorter board moves less, but the expansion is cumulative across the total length of the ceiling. Wood moves a great deal more in width (perpendicular to the grain). Space must be left on all sides of any wood-paneled area to accommodate total expansion.

The width of that space can be calculated using the wood's dimensional-change coefficient: board width x annual change in MC x dimensional-change coefficient, which for hickory is .00411. (For a list of other woods, see Table 13-5 in the USDA *Wood Handbook*; free from the Forest Products Laboratory; fpl.fs.fed.us.) Expansion across the width of a single 5-inch hickory board can be 3/32 inch (almost 1 3/4 inches over 8 feet). By comparison, a 5-inch yellow (long leaf) pine board, with a coefficient of .00263, expands less than 3/64 inch, or half as much.

These numbers assume flat-sawn boards and an annual change of moisture content at 4%. If your indoor climate isn't stable, you should probably choose a wood other than hickory with its relatively high dimensional-change coefficient. To find an alternative flat-sawn wood in the *Handbook* table, look for a dimensional-change coefficient in the C_t (tangential) column in the range of .0025. Quarter-sawn wood (in the C_r (radial) column) has lower coefficients and is even more stable.

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Siding a Library With Boral

BY CHRIS DUBUQUE

A few months ago, my nephew, Josh Goodrich, and I completed work on a new library in my hometown of South Hero, Vt. The building was designed by architect David Roy of Wiemann Lamphere Architects in Colchester, Vt., and his plans called for it to be clad with Boral TruExterior poly-ash siding—with vertical shiplap covering most of the building and horizontal Dutch lap (cove) on a small section on the front of the building.

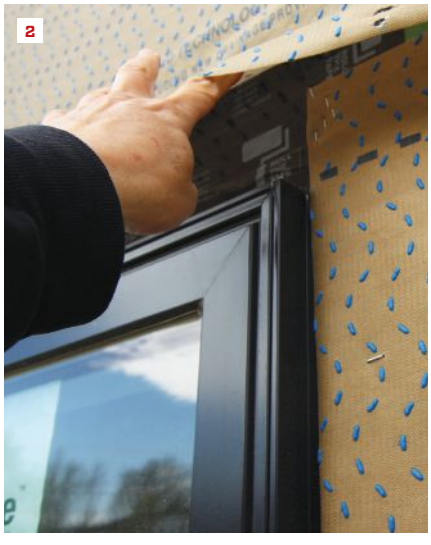
I've installed Boral trim on a number of residential projects over the past five years, but this was my first time out with its siding. In the area I work, it's not common to side homes with Boral, due to its price point. Lack of awareness about the product may also play into this (a number of local builders and homeowners dropped by the fairly high-profile site to ask about it—a few even took home offcut pieces to play with).

Key takeaways. Here are a few postmortem tips regarding installation: Use quality stainless steel fasteners that will last as long as the siding; snap lines for all face-nailing to line up nail heads (for both the vertical and horizontal profiles); use inexpensive tools for cutting, as grit from the Boral tends to get into motors and the sliding mechanisms of saws; use quality blades and bits for cutting (coarse jigsaw blades lasted much longer than fine ones); and take care handling long lengths, supporting them as required.

Since the overall structure was built to be highly durable, the Boral siding plays a large role and is worth the investment. Our town is excited about its new library; we expect it (and the Boral siding) to last long time.

Chris Dubuque owns and operates Dubuque Construction in South Hero, Vt. He worked in collaboration with Hayward Design Build on the project.

The library was built to be highly durable with 2x8-framed walls sheathed with 1/2-inch OSB and 2-inch Zip System R-Sheathing (with dense-pack cellulose). Wide windows reduced the number of long grade-to-soffit runs of vertical siding **(1)**.



Head and jamb window flanges were taped to the sheathing with Zip flashing tape, then a drainable WRB was installed **(2)**. Metal drip cap and Siga Rissan and Fentrim tapes folded onto the sills' frames **(3)** were incorporated into the drainable WRB.

Photos by Tim Healey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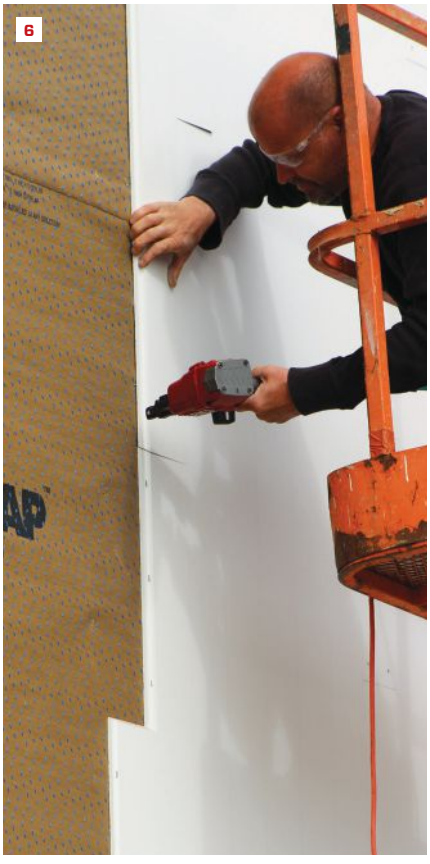
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Vertical seams were cut at 30-degree angles (a quality dust mask was a must while cutting) **(4)**. The siding was installed with 2-inch-long ACQ staples 8 to 10 inches on-center, blind-nailed along the sides **(6)**. Joints were face-nailed with 8d stainless steel ring-shank nails **(5)**. Jigsaws and drills with Forstner bits **(7)** were used to cut the siding around penetrations **(8)**.


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Due to wind, the HydroGap WRB was installed vertically on the north elevation as the siding was installed. The author nailed by hand near windows to avoid damage to underlying flanges and flashings **(9)**. At the stair tower **(10)**, the siding was installed with a 1-inch gap between the roofing and bottom edge of siding; note the kick-out flashing formed into the roofing pan **(11)**.

Dutch-lap siding was face-nailed with 8d SS ring-shank nails (heads flush with siding) and installed tight against trim; gapping wasn't required (cut ends don't need priming) **(12)**. Large penetrations were blocked with Boral; head trim was run over jamb trim **(13)**, similar to window **(14)**. Approved filler was used for holes **(15)**. Nails were installed 14 inches o.c. along snapped lines **(16)**.

Vertical siding lapped over a fiberglass-reinforced plastic protection barrier at grade. Snapped lines helped line up 16-inch-o.c. face-nailing **(17)**. Hole filler and raw Boral were spot painted (gaps were sealed with urethane-based, paintable caulk), followed by a finish coat of Sherwin Williams Resilience (two coats of paint had been applied to the siding offsite prior to delivery) **(18)**.

Using the formula shown in the illustration (right), the author calculated the radius of the lower step roughed out by the framer **(1)**. With the stair blank clamped to the bench, he found the center point using a trammel beam set at the radius **(2)**. He then scribed the arc on the blank to be sure that it fit properly **(3)**.

Crafting a Curved Stair Tread

BY GARY STRIEGLER

In "Custom-Built Radiused Starter Steps" (Jul/19), I described how to make two starter steps with radiused ends. It turns out that those were not the only curves this project would throw at me. At another location in the house, the floor stepped down two steps to a lower level. Instead of calling for standard steps, the plans had the floor above ending in an arc with a radiused step below that. I had to draw on a completely different set of skills from those I wrote about in the July article.

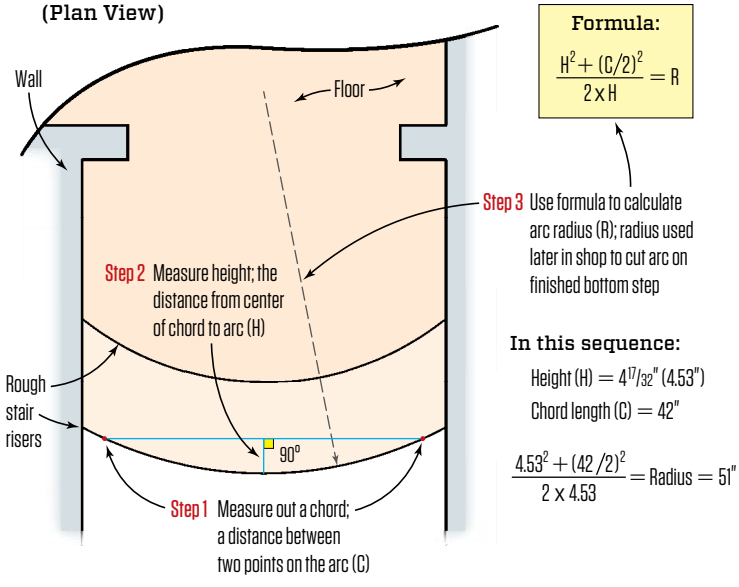
The same framer who had built the rough starter steps roughed out these steps, creating sturdy rough risers from 2-by stock installed vertically **(1)**. However, he set the height of the rough tread so that the tread blank needed to be 3/4 inch thick—probably figuring that I would use standard-thickness oak flooring for the tread. The flooring contractor ran the oak flooring over to the edge of the top step, so it was up to me to calculate and cut the arched tread from the blank I glued up out of 3/4-inch stock.

Mathematical formula. I could have scribed the inside and outside curves for the tread, as I did with the radiused ends of the starter steps, but I needed the curve of the tread and the nosing to be as perfectly even as possible. The easiest way to make that curve would be to swing the proper radius with a router, but to do that, I needed to calculate the radius of the outer curve of the step.

I recalled a mathematical formula that I'd seen in the past for calculating the radius of an arch—something that comes in handy if you need to make curved trim for an existing archway in a home. The formula is actually quite simple (see Finding a Radius, below).

First, mark out a chord (C in the formula), which is a line between any two

Finding a Radius



Photos by Gary Striegler; Illustration by Tim Healey

points on a curve—in this case, the outer curve of the rough step. For our purposes, let's make that chord 42 inches long. From the center point of the chord, draw a perpendicular line to the curve. The measurement of the line between the center of the chord and the curve is the height, or H in the formula, which in this case turned out to be 4 17/32 inches. Applying those numbers to the formula gave me a radius of close to 51 inches. (Note that the height changes with the length of the chord, so the radius stays constant with any chord length).

Router setup. Armed with that info, I headed to my shop to cut the curve on the tread blank. After clamping the blank to one end of my worktable, I set trammel points on a straight length of 1-by, using a solid metal point and a pencil point set 51 inches apart. To find the pivot point, or center point, of the arc, I put the steel point on the blank about 5 inches away from the corner and swung an arc with the pencil end on the benchtop **(2)**. I repeated the same thing from the other side of the blank, and where the two pencil arcs crossed was the center point for marking and routing the arc. To make sure the arc fit within the step blank, I reversed the trammel with the metal point at the pivot, and I swung the arc to mark the outside edge of the step **(3)**.

I chucked a 1/2-inch-diameter dado bit into a router and mounted the router on a length of 1x6 that would act as a trammel board. I drilled a hole in the center of the board 51 inches from the inside edge of the router bit. After putting down a scrap of 1-by to raise the trammel board even with the surface of the blank, I screwed the trammel board to the bench with pivot points aligned.

Cutting the curve. With the board secured at the pivot point, I started the router off the stair blank and swung the router to cut a 3/8-inch-deep groove at a perfectly even arc **(4)**. The inside edge of the groove was the proper arc, but rather than cut through the blank in one shot, I rough-cut the rest of the way through with a jigsaw, keeping the blade away from the inside edge of the groove **(5)**. To finish the arc, I flipped the blank over, and after mounting a bottom-bearing flush trim bit in the router, I routed the edge with the bearing riding on the inside edge of the groove that I'd cut before **(6)**.

After attaching a router to a 1x6 trammel board set at the proper radius, the author cut a groove along the arc with a dado bit **(4)**. He followed the groove with a jigsaw **(5)**, then finished cutting the arc with a bearing-guided flush trim bit in the router **(6)**.

Using the arc as a form, the author glued up strips for the nosing **(7)**. After planing the nosing **(8)**, he glued it to the tread **(9)** and routed a bullnose on the edge **(10)**.

To rough-fit the tread, the author scribed an arc 11 1/2 inches from the outside arc **(11)**, fine-tuning the fit after setting the tread in place **(12)**. After scribing and cutting the ends of the tread for the skirtboard **(13)**, he applied glue to the rough step and screwed the tread into place **(14)**. Then he made the curved nosing for the top step, which was installed by the flooring contractor **(15)**.

Tread becomes form. With the tread cut to a perfectly smooth arc at the right diameter, I could use it as a form to make the 1-inch-thick bullnose edging that attached outboard of the tread. For the edging stock, I ripped strips about 1/4 inch thick, keeping the strips in their original orientation so the grain would be consistent once the strips were glued together. (I always plane the strips on at least one side to create the tightest joints for the edging). I put the strips side by side on the workbench and applied carpenter's glue to the exposed side. I then stacked the strips together and clamped them to the stair blank to attain the right curve **(7)**. I used the corners I'd cut off for the arc to let the outermost clamps draw the strips in radially.

After the glue had cured, I removed the clamps and cleaned up the surface with a hand planer. I then planed the curved stock down to the desired thickness with a thickness planer **(8)**. I used dominoes to join the edging to the stair blank, gluing and clamping them together **(9)**. With the edging attached to the tread, I sanded the assembly and routed a bullnose in the outer edge of the step **(10)**.

Inside arc. At the jobsite, I rough-scribed a line 11 1/2 inches—the total width of the tread with nosing—from the outside edge **(11)**. Because the inside arch would be covered by the riser, the curve was not as critical, but I wanted to get it close to the rough riser. So, after cutting the inside curve and cutting the length of the tread to fit just inside the walls, I set the tread in place and fine-tuned the scribe of the back arc using a spiling block **(12)**. After cutting the curve to fit, I scribed the sides of the tread to fit inside 1-by skirtboards **(13)**.

With the cutting done, I installed the step the same way I had installed the starter steps—by applying adhesive to the rough step and then driving finish-head screws to hold the tread in place **(14)**. The curve of the step was gentle enough that I was able to bend layers of 1/4-inch plywood for the risers.

Knowing the radius for the lower step, I fabricated the built-up nosing for the top step on the workbench with clamping cauls set to the proper curve. The flooring contractor cut back flooring to the exact curve and installed the nosing for a nice decorative accent to this transition of levels in the house **(15)**.

Gary Striegler owns Craftsman Builders (craftsmanbuildersnwa.com), in Fayetteville, Ark., and teaches workshops at the Marc Adams School of Woodworking. Follow him on Instagram @craftsmanbuilders.

Replacing a Tool Switch

BY BARRETT SITES

I had owned my Milwaukee hammer drill for about 17 years when it suddenly stopped working. It had been a reliable tool up to that point, so I wanted to keep it in my arsenal and not just throw it away. I enjoy the challenge of figuring out how to fix a tool when it stops working, so on a rainy day I decided to check out what was wrong with it.

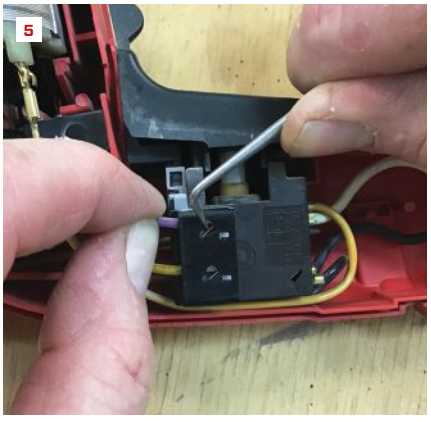
Check the warranty. It may be overstating the obvious, but before jumping into a repair on any power tool, check to be sure that the tool is no longer under warranty. I've been impressed by some of the warranties I've seen on tools these days, and it doesn't make sense to attempt a repair that the manufacturer will handle with little or no cost. And attempting a repair on a warrantied tool is a surefire way to void that warranty. It should also be noted that some manufacturers just charge a flat fee (bench charge), plus any parts that need replacing. For this old hammer drill, though, the warranty had long since expired, and I was confident that I could get the tool working for just the price of some parts.

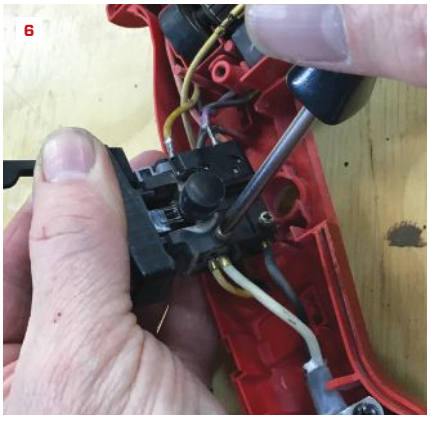
Disassembly. Before starting to dismantle the tool, I put it through my usual protocol of initial checks—I plugged it in, shook it, worked the switch, and turned the chuck—but had no success. Next, I unplugged the tool and started removing parts to get to the tool's inner workings. I removed all of the exposed screws holding the two halves of the handle together **(1)** and found an additional screw hidden under the rubber handle grip **(2)**. I also took off the two machine screws coming into the handle assembly from the chuck end. I don't own any long, skinny torx drivers, but instead I was able to use a 7/64-inch Allen wrench (hex key) to remove those screws without stripping the screw drive.

Electrical check. I carefully separated the two halves of the handle **(3)**. My son-in-law (an electrical engineer) happened to be in the shop that day, and we began by checking the switch with his multimeter. We checked the continuity of the hot wire (usually black) coming into the switch and then the wire going from the switch to the motor **(4)**. (When you depress the switch, it should show continuity between the wires). Our tests confirmed that the switch was indeed bad. I bought a replacement switch from a local tool repair shop for around $35—a lot cheaper than buying a new tool. Similarly priced parts are available from several online companies.

To access the switch, the author removes the screws holding the handle together **(1)**, including one below the rubber grip **(2)**. He then separates the halves of the handle **(3)**. To confirm that the switch is bad, the author depresses the switch while a helper checks the continuity through the switch **(4)**.

Photos by Aaron Powers





Before removing the wires, the author takes pictures of the switch and wires so he can make sure that he puts them back together properly. To remove the wires from the switch, he depresses spring-loaded metal keepers with a pick **(5)**. On the opposite side of the switch, he backs off screws that hold the wires in place on that side **(6)**.

Remove the wires. Before disconnecting the switch, I took a couple of pictures with my phone to reference the wire placement for installing the new switch. Then I removed the wires one at a time. The switch fit into guides in the plastic handle, and separating the halves of the handle allowed the switch to be removed. While the old switch was still in the handle, I used a pick on the exposed side to release the wires that were held in place by spring-loaded metal keepers **(5)**. Then I pulled the switch out of the handle and backed off the screw holding the wires in place from that side **(6)**.

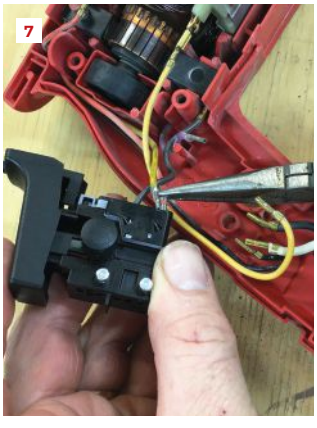
I've replaced a few switches and have found that there are only slight differences in tools from different companies. I find it helpful to try to leave the wires in their original pathways to the switch for as long as possible, although in some cases, it's difficult to remove the wires from the switch without taking them out of their original configuration in the handle.

Connect the new switch. With the faulty switch removed, I reversed the process to connect the wires to the new switch. The wires held in by the spring-loaded keepers have solid metal ends, and small needle-nose pliers were helpful for inserting those ends into the new switch **(7)**. As I reconnected the wires, I double-checked the connections against the cellphone pictures I'd taken.

Reassembly. When all the wires were reconnected, I carefully pushed the switch into position in the handle. The lock button on this switch fit into a hole molded into the handle to help align the switch properly. I made sure I routed all the wires properly around the switch, so the wires wouldn't be pinched when I reassembled the handle **(8)**. Finally, I mated the other half of the handle in place and replaced all the screws **(9)**, including those from the chuck area **(10)**, and reinstalled the rubber handle cover.

As a final test, I plugged the tool in and made sure that everything, including the switch lock and reverse switch, worked as it should. The best part was that I could keep this trusted tool in my arsenal.

Barrett Sites is a remodeling contractor in Chambersburg, Pa.



Reversing the process, the author uses needle-nose pliers to insert wires into their slots **(7)**. Checking against the photos he had taken earlier, he repositions the switch and makes sure the wires are routed through the handle without being pinched **(8)**. Then he screws the handle back together **(9)** and replaces the screws from the chuck end of the tool **(10)**.

BY KRISTOF IRWIN

Radiant Cooling in a Hot, Humid Climate

I'm founder and principal of Positive Energy (positiveenergy.pro), a building science consulting and engineering firm headquartered in Austin, Texas. Our company motto is "Design around people, a good building follows." One of our functions in the local and national market is mechanical system design, which we do partly because we recognize that this is an area where the industry and our society generally is due to evolve.

For these reasons, we've been taking a close look at radiant heating and cooling for the past few years; we have a working system in our office and several designs on the books.

Radiant cooling is a new idea for most people, but in principle, it's the same as radiant heating: It's an efficient way to deliver outstanding thermal comfort. But just as radiant heat is fundamentally different from forced-air heat, radiant cooling is a radically different concept from traditional air conditioning.

Air conditioning is aptly named. It's not the same as occupant conditioning. Air conditioning systems cool and dry your air, but they don't directly cool you. When you live or work in an air-conditioned space, you don't experience the air temperature directly. Your predominant thermal experience in any space is of the temperature of the surrounding surfaces in that space. In a room with radiant heat, your skin directly receives the warm infrared rays that radiate from the radiant floor, wall, or ceiling surfaces. In a space with radiant cooling, you have the same experience in reverse. Your body becomes the radiator, and cooler surrounding surfaces absorb your heat.

This works because the main way that human bodies shed and absorb heat is through radiation: Long-wave infrared radiation goes in a straight line at the speed of light from the radiator (your skin) to the absorber (the cooler surfaces that surround you). Your skin, at about 90°F, is like a radiator that radiates heat to those floor, wall, and ceiling surfaces, and that's what cools you off. When we operate an air conditioning system to cool the people who live or work in a space, we're accomplishing the same thing, but indirectly: We're cooling large volumes of air and moving them through the space in order to absorb heat from the interior surfaces in that space, which in turn cool off the building occupants by absorbing the radiant heat that those occupants emit plus the heat that leaks in from the outdoors.

So why not cool the surfaces directly? That's the idea behind radiant cooling, one that imbues the enclosure with more of an active, engaged role with those inside. Instead of moving high volumes of air through the living space to cool the interior surfaces of a structure, we move low volumes of glycol and water coolant through the surfaces themselves to do the same thing, more efficiently. Exposed to those cool surfaces, people's bodies cool themselves by radiating heat. If you've ever experienced the coolness inside an old stone building, or even a new parking garage, you have experienced radiant exchange

Photos by Ted Cushman

The radiant-panel ceiling, left exposed in the author's offices for educational purposes, consists of a gypsum board layer over aluminum heat-transfer fins, backed by a 1 1/2 -inch layer of EPS insulation. Ink patterns on the surface of the drywall help installers avoid screwing into and puncturing coolant-circulating tubing within the panels.

A manifold (above, left) allows the system to be zoned room by room. In a lower-floor mechanical room (above, right), a buffer tank isolates the indoor side of the system from the outdoor side, allowing the heat pump that powers the system to run efficiently without having to directly answer calls for cooling from the occupied space.

with cooler surrounding surfaces. In our offices in Austin, we have installed what we believe is the first radiant cooling system in the state of Texas. We built the system using components generously supplied by Messana Radiant Cooling (radiantcooling.com). Let's take a walk through the system.

OVERVIEW

The radiant system uses cool ceiling panels as the heat-absorbing surface. These are premanufactured panels that consist of aluminum heat conductors sandwiched between a layer of gypsum board and a 1 1/2-inch layer of EPS insulation that isolates the cool fins and gypsum board from the framing of the building. Polyethylene tubing filled with glycol and water fluid runs through the aluminum fins in a serpentine pattern to transport heat into or out of the panels. Because of the EPS insulation, the radiant exchange from the hydronic tubing occurs more strongly with the room-facing panels than the framing-facing structural members. This allows for a rapidly variable panel surface temperature—important in a humid, cooling-dominated area like central Texas.

In operation, the gypsum-board ceiling is maintained at about 68°F. Humans (and their dogs) in the space radiate heat to the gypsum board, which absorbs the heat and conducts it into the aluminum fins, which conduct it to the tubing. The fluid circulating through the serpentine tubing at about 60°F absorbs the heat and transports it to a manifold, which directs the warmed fluid into the return line leading to a buffer tank in the mechanical room. We have four rooms in our office, so our manifold has four loops. But you could manage as many zones as you wish by extending the manifold.

The buffer tank in the basement separates the source side from the system side. The buffer tank plays an important role in maintaining equilibrium for the system, because the fluid in the system maintains a reserve of heat and cooling that is always available to answer short-term demands. Our system has a 30-gallon buffer tank, maintained at about 60°F during the summer cooling months. If there were to be a massive call for cooling upstairs, and we needed to send an increased volume of thermally absorptive fluid up there, the reserve in the tank would be available to answer that call and our cooling source (an air-to-water heat pump located outside) would be able to carry on at its usual measured, consistent pace.

So we separate the source from the system using the buffer tank. The buffer tank can be considered a thermal battery, and could be larger than 30 gallons if needed for the application. For example, we could design an off-grid system with sufficient thermal storage that the high-COP (coefficient of performance) heat pumps run only when solar photovoltaic power is available during the day. In that case, we could use an array of 80-gallon or 100-gallon buffer tanks to store cool water that could answer the demand for cooling without the need for an energy-hungry compressor to operate. For larger

Outside the building, a 3-ton SpacePak Solstice air-to-water heat pump dumps excess heat from the building to the outdoor air—just one of many possible solutions that are possible with radiant cooling.

projects or projects with critical loads, these thermal storage reservoirs can be extremely well insulated and hold thousands of gallons of thermal fluid, or even a combination of thermal fluid and phase change materials (PCM), capable of absorbing or delivering tens of thousands of Btu of energy.

The buffer tank provides a thermal mass that lets the system smoothly ride out fluctuations in the demand for cooling or heating. Outside the building is our heat source and sink: a 3-ton SpacePak Solstice air-to-water heat pump. Here, the heat that was originally absorbed as direct radiation from the bodies of people in the space into the ceiling panels is finally shed from the system out into the outdoor air. This same energy could have been shed directly into the ground around our building using a ground-coupled heat exchanger and a pump to circulate the hydronic fluid. In our climate, we can avoid the installation cost, soil ecosystem disruption, and embodied resource use with ground loops by rejecting the waste heat into the air. We can even first shed waste heat into a domestic hot-water storage tank, while maintaining high coefficients of performance.

Of course, radiation between people and their surroundings is not the only way that people get warm or cool. You're also affected by direct contact with the air in a space. In a room with radiant cooling, such as our offices, this process also takes place. Warm air in the rooms expands, becomes buoyant, and rises to the ceiling; when it contacts the ceiling, it cools off and falls toward the floor. So people in the space are continually bathed in a gentle cascade of cooled air falling from the ceiling and trickling over us. But there's no need for fans or ductwork to move that cool air around.

It is important to bear in mind that a radiant cooling or heating system is focused on occupant thermal comfort. The fact that we also live our indoor lives immersed in an indoor pool of air means that reliable supplemental systems for ventilation, filtration, and dehumidification for healthy indoor air quality (IAQ) are a must.

WHAT ABOUT CONDENSATION?

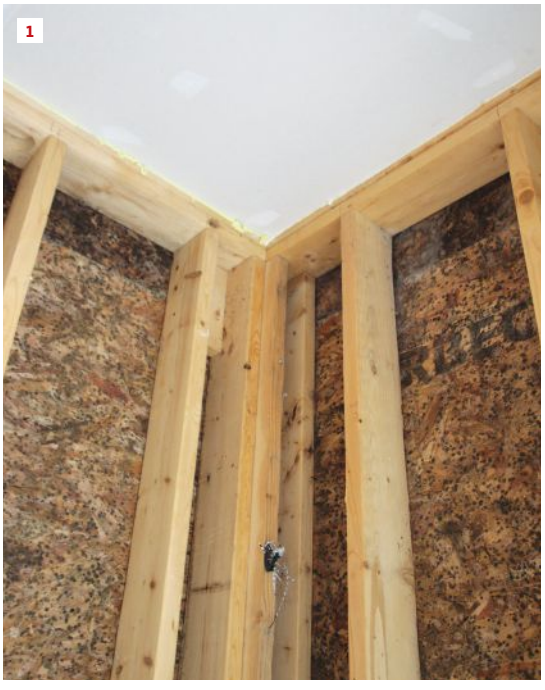
Outdoor air here in Austin, Texas, can be very humid in the summer (we regularly hit 78°F dew point and even into the low 80s). Thus, cool radiant surfaces are well below outdoor dew points and run the risk of significant condensation and sorption into materials. The last thing we want is for moisture in our building to condense on our ceiling drywall and support mold, mildew, bacteria, and other indoor microbiomes associated with damp buildings and poor occupant health. Fortunately, the system is designed to prevent that.

In the first place, we control humidity in the space using a dedicated, ducted dehumidifier (an Ultra Aire 98H). That unit is continually paying attention to humidity and removing any excess moisture. We have a MERV-13 filter on our 98H and benefit from full-time particulate capture because it's always circulating and filtering air in order to measure humidity. The indoor dew point is held at or below 56°F, so the 68°F temperature of our ceiling radiant absorbers is well above the dew point. Of course, dedicated dehumidification is important in humid climates generally, and not just when radiant cooling systems are used.

Even with the dedicated dehumidifier, if someone were to open up the doors and windows and let a blast of humidity into the building, there could be a risk of condensation on the ceiling drywall. However, this is a low-mass system that can be controlled very rapidly to maintain the surface temperatures above dew point. The controls for the radiant system include humidity sensors that know if there's a sudden spike in the indoor relative humidity. If so, the flow of cooling water is instantly halted and the cool drywall surface is allowed to equilibrate with the space conditions so that it remains above the dew point in the space. At that point, it's time for the occupants to close the doors or windows so that the dedicated dehumidifier can remove the excess humidity until the cooling system can start up again.

Kristof Irwin is the principal of Positive Energy, a building science consulting firm headquartered in Austin, Texas.

BY JIM BRADLEY



Moisture led to mold discoloration on this OSB sheathing **(1, 2)**. After gearing up with protective equipment, the author pours mold stain remover into a hand-pump sprayer **(3)** and applies it to the affected areas of the OSB **(4)**. Within minutes, the solution has eliminated the staining and restored the OSB to a like-new appearance **(5)**.

Cleaning Up Moldy OSB

Over the years, I've encountered mold-stained or mildewed wood on more than one occasion. During my career as a home-performance contractor, I used to see mold-blackened surfaces from time to time in locations where moist air was contacting a cold surface, such as the underside or back of OSB roof or wall sheathing. These days, I work as a project manager in a new-construction environment, but I still sometimes see surfaces where moisture has allowed mold to grow. In all of these cases, dealing with the situation requires two steps: Remove the source of moisture, and clean up the mold-blackened surface.

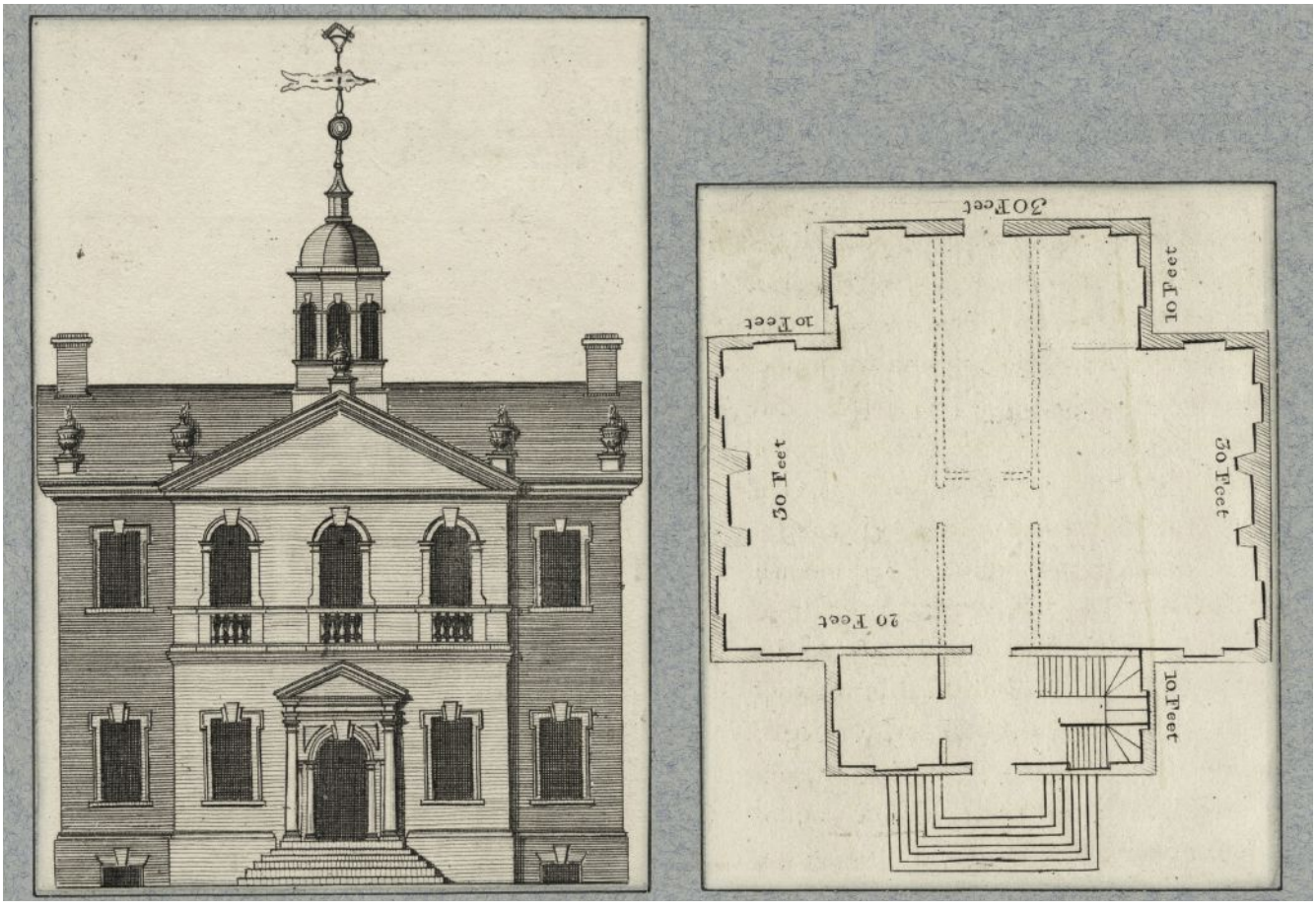
From experience, I've learned to rely on one particular cleaning product for cleaning up moldy OSB: MMR mold stain remover from Bad Axe Products (badaxeproducts.com). The formula for MMR includes sodium hypochlorite (which bleaches the wood and cleans up the mold stains) and some proprietary surfactants (which help the formula soak into the surface).

Before you handle this powerful chemical, you should be prepared. I follow manufacturer recommendations and suit up with DuPont Tychem 2000 full-body chemical protective coveralls and a full-face respirator with a P100 organic vapor cartridge, available online from Jon-Don janitorial products (jondon.com), which also supplies MMR. I don plastic gloves and tape the gloves to the protective suit sleeves. Then I pour the MMR into a hand-pump sprayer and spray it full strength onto any surfaces I need to clean.

The product requires no scrubbing. The powerful bleach starts to work within seconds and brings the blackened wood surface back to a lumberyard-clean, bright condition in less than a minute. Once the material dries (in a day or so), it leaves no residual trace.

Jim Bradley is a project developer and manager for Hayward Design Build in Colchester, Vt. He is the president of the Vermont Builders and Remodelers Association.

Photos by Tim Healey



How Will Construction Solve Its Skilled Labor Crisis?

Technology will no doubt be part of the solution, but we have a much deeper, older problem to solve first

BY CLAYTON DEKORNE

A severe shortage of skilled labor in construction has been ramping up for a decade now, but as an industry, we seem to be just as far from solving it as we were when it started. The National Association of Home Builders (NAHB) characterized the shortage this way:

"More than four out of five builders expect to face serious challenges regarding the cost and availability of labor in 2019 ... Just 13% of builders cited labor issues as an important concern in 2011, with the rate steadily rising over the ensuing years and peaking at 82% in each of the last three years (2017–2019)."

The NAHB/Wells-Fargo Housing Index surveyed builders in July, reporting that 83% of builders are hindered by shortages of framing crews and rough carpenters, 78% by a lack of finish carpenters, and 70% to 73% by shortages of bricklayers, masons, and concrete workers. Nearly every trade is listed in the report—including all mechanical trades, interior finishing trades, even landscapers, excavators, and weatherization workers—with more than half of builders feeling hindered by not being able to fill these key positions.

The McKinsey Global Institute, a think-tank that has surveyed construction progress worldwide for decades, assesses the damage this way:

"Labor availability is the primary concern of homebuilders ...

New York Public Library

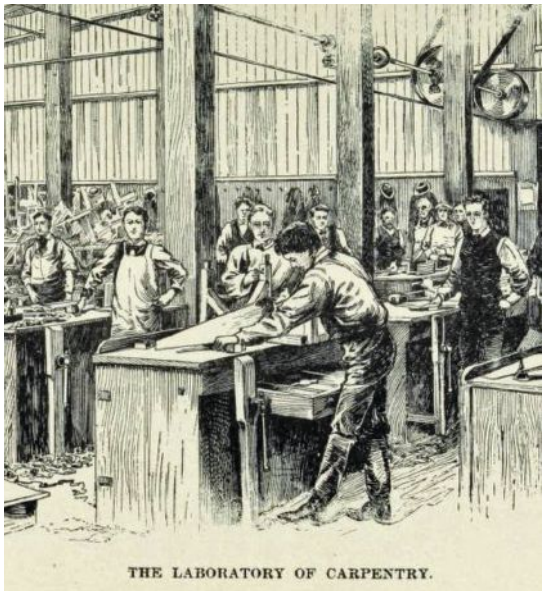
Due in part to a 70 percent decrease in new housing starts from 2009 to 2011, a large number of skilled workers left the industry. Demographic shifts, from an aging population to a lack of interest from young workers, are also reducing the pool of skilled workers. To compound the challenges, productivity growth in construction has been flat over the past 20 years, compared to 3.5 percent for the manufacturing sector and a global average of 2.8 percent."

In this article, I want to unpack those demographic shifts and focus, ultimately, on the root causes underlying the "lack of interest" from younger participants in the building trades. What never gets discussed in industry reports, but may prove to have a great impact on the lack of youth participation, is the issue of social class. Young people today don't want to align with outmoded, underserved, and culturally marginalized social groups. Where those groups—specifically, the various sectors of the construction industry—do align with positive media and technologically sophisticated challenges, young participants are showing a high degree of interest, even leading with innovation and leadership. In the pages here, I am not going to have room to touch on all the examples available, but we will continue to build this out as an on-going thesis for leading change at JLConline.com. Here, the focus is on dampening myths and pointing to prospective solutions, however uncomfortable they might be to consider.

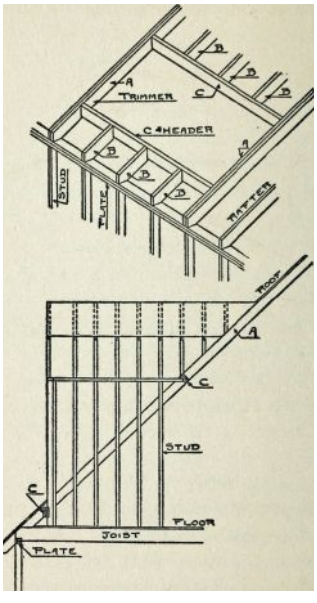
IS TECHNOLOGY A SOLUTION?

The McKinsey group (among others) point more and more often to modular and off-site building solutions that lean on robotic and other highly technological processes as the answer that will take home building out of its slump. Following on the quote above, the McKinsey report continues:

"These intersecting realities leave many companies no choice but to implement significant innovations (often digital) to their products and processes. One such innovation is off-site home building. An analysis of 14 leading modular (off-site) builders reveals more than $2 billion of disclosed funding in the market—not including investments by



THE LABORATORY OF CARPENTRY.



Photos by Lewis Hine, including *Glassworks. Midnight.* (top), drew attention to child labor in industry at the turn of the last century and set in motion radical education reforms. Often overlooked is that prior to, and during, the industrial revolution, trade knowledge was seamlessly passed from parents and relatives to children. *The Carpentry Laboratory* (above) from Charles Ham's *Mind and Hand: Manual Training, the Chief Factor in Education* (1900) is representative of a push to integrate academics with trade practice that did not survive education reforms.

Library of Congress

During WWI, military "vocational units," like this carpenter's squad at Tufts College, trained at colleges and universities. The need for precollegiate skills training helped pass laws to appropriate federal funding for vocational education.

incumbents—led by private equity funds and large technology firms."

To be clear, the "no choice" part of this boils down to this important fact: The home-building industry, and perhaps the global construction industry as a whole, is not standing by while the next generation of carpenters and masons is trained. While many in the residential sector remain nostalgic about what used to be, the world roars on. Yet I think the industry think-tanks are overoptimistic about off-site building. Despite the seemingly massive funding going there, the numbers just aren't there yet. Currently, only 3% of the houses built in the U.S. are produced using off-site methods. There are some intriguing examples of off-site techniques from companies like Entekra and Unity Homes (see "Factory Building: The Next Wave," Feb/19). These companies show that high-quality, off-site-built homes rival stick-built, high-performance homes. But the capital investments needed to scale this production method for the entire nation far exceed the low-single-billion dollar investments disclosed.

One point undervalued in the McKinsey report is this statement: "Incumbents are also starting to innovate: building-products manufacturers have created products that save on labor by combining process steps or lowering the skill level required to install appropriately, and distributors are experimenting with new digital selling tools for contractors."

By "incumbents," the report means established building product manufacturers, not start-ups. Our industry is no stranger to the trend towards component manufacturing, beginning with trusses, plywood, and window and door units. (Remember, there was a time at the beginning of the last century when joiners built windows and doors on site. We have come a long way from that, and the consolidation of steps and joining of systems will continue to bring efficiency to home building and remodeling.)

Building products continue to get more sophisticated, and this brings enormous impacts, both positive and negative, on labor and productivity. Those impacts have positively increased productivity: Standout examples include MiTek's Sapphire system that has made truss and panelization quicker and easier to customize; Zip System sheathing that has zipped two processes and two passes around the exterior of buildings into one; and Ready-Frame, which has essentially done for entire house frames what precut studs first did for walls. But the impacts of material sophistication have also had a negative effect on productivity and raised the bar on the training demand. The number of "engineered" building components that have specific installation instructions defined by Technical Service Reports grows by the day, amplifying the need for a more astute, fast-thinking, problem-solving workforce. The technical sophistication of an increasing number of "engineered" products demands that installer-lever workers need a broad understanding of the impacts that specialized systems can have on the overall build. But the education system designed to support the trades for the last century has been much more focused on increasing specialty—an ideal born out of manufacturing that is ill-suited to efficiency or quality on building sites.

HOW DID WE GET HERE?

The history of public education for the U.S. building trades traces its roots to a few key sources that I'll touch on here. However much we have progressed as an industry, our legacy not only has a bearing on how we got where we are, but also suggests steps in a path forward.

As with much of U.S. history, we have a historical "ethos" established in pre-Revolutionary America that has had a lingering effect on trade knowledge. History also delivered the Smith-Hughes Act—a Federal law passed in 1917 that forged our national outlook but doomed the performance of vocational education in America. Both deserve attention. The ethos of home building was established by the Carpenters' Company, the oldest trade guild in the U.S.—founded circa 1724 with ties to similar European guilds. Mark Luzio presented a lucid description of the business climate for GCs in the early period in America (see "The Carpenters' Company," Jan/17); it was a time of intense cooperation among builders and widespread public trust in the building professions, and created a strong basis for the transfer of knowledge though the trades from Europe to Colonial America that leaked into business practices during the westward expansion. In the new rural communities, the building trades flourished on practical

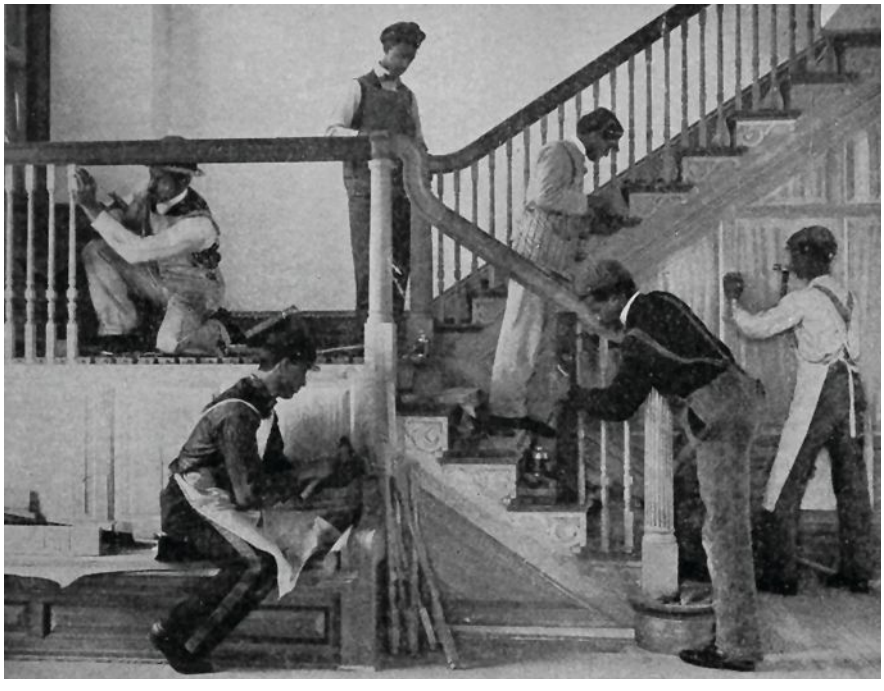
National Archives and Records Administration (NARA)

ingenuity and self-taught knowledge. References like Asher Benjamin's *The Architect, or Practical House Carpenter* (the professions were largely the same then) and *The Farmer His Own Builder* (we were mostly an agricultural-dominated country in previous centuries) provided an important transfer of technical knowledge across the U.S.

Fast forward to the early 1900s, when the sheer velocity of technological change created skilled labor shortages in almost every sector of the economy. Home building was disrupted by innovations in industrial lumber processing and early component manufacturing, but these disruptions paled in comparison with what was happening in retail product manufacturing. What once belonged to home craft—the making of clothes, home goods, farm implements, and tools—became the domain of start-up corporate enterprises using steam-driven technology at first, and then electricity, to create entirely new industries.

The biggest disruption of all came from laws aimed at curbing child labor and keeping kids safe. It's hard to argue with the need for these laws now, but the disruption on the transfer of practical knowledge was profound and often overlooked. Children were no longer taught skills and crafts by working alongside their parents. The solution was to reform public education, and the big change came in 1917 with passage of the Smith-Hughes Act—a bill that provided massive amounts of federal funding to states for vocational education and immediately set in motion programming at colleges and high schools across the U.S. It even allowed the development of vocationally focused Normal Schools in rural areas previously underserved by formal education.

John Hillison at Virgina Tech describes the political atmosphere that allowed passage of the Smith-Hughes Act as a "powerful coalition of unlikely allies ... with initially antagonistic perspectives." This coalition included the National Education Association (NEA), the National Association of Manufacturers (NAM), The American Federation of Labor (AFL), US Chamber of Commerce, Farmers Union, National Grange, American Home Economics Association, and publications (which at the time, before radio or any



The Smith-Hughes Act of 1917 provided matching funds to states for vocational training set up in comprehensive high schools (top) and rural Normal Schools (above) but required strict accounting on how states spent the money. Most states created separate boards to oversee vocational training programs, a system that stifled a unified education for all, and helped reinforce segregation by gender, class, and race.

Library of Congress

Rather than complain about or ignore vocational school graduates, Scott Burt and his business partner Todd Pudvar got involved at their local technical school teaching their own program, and have hired some of the graduates.

other electronic media, were the forms of knowledge transfer with the widest distribution), including *Wallace's Farmer* and *Hoard's Dairyman*. (Imagine media having a direct role in any Congressional alliance today.)

Unfortunately, the way the Smith-Hughes Act was written, it controlled the salaries of vocational teachers and set limits on what vocational instructors could teach. The intent was to prevent schools from raiding vocational funds to promote academic programs, but the effect led to tracking—educational programming that sorted students into either a college-prep track or a career-training (vocational) track. Educational philosophers argued they were "fitting people to their probable destinies," but in effect, these reformers perpetuated, and even grew, a huge class divide. Kids from poorer families who could not afford college tended to be shunted down the vocational track while kids from more elite families were prepped for college. This social divide, more than other pressure, remains an obstacle by limiting the social will to advance "mind and hand" educational solutions today.

A LIST OF PROPOSED SOLUTIONS

Politics is an issue we at *JLC* tend to avoid. We welcome the fact that we have readers from all facets of the political spectrum, and we don't mean to support or alienate one perspective over another. But on this topic, we are seeking a complete upheaval of public systems and a rewiring of the social consciousness, touching on topics that are political dynamite. Small, palatable gestures, such as fat scholarships to trade schools, or hashtags that foster goodwill, are not enough to move the needle on the change required for our industry. In reviewing the points below, I ask for your open mind. I have made every attempt to balance the options to entertain both public and private options. This is certainly not a problem the government alone can solve; any meaningful solution will require commitments from government, corporations, associations, individuals, and small businesses.

Top of the list is the pointed suggestion that companies that pay employees well and on time do not report much of a problem with skilled labor. If we want to create viable careers for young people in the trades, make jobs as lucrative as possible. These are not so much "dirty jobs" as they are lucrative and challenging, comparable to other top professions. The challenging part is not a problem for our industry, but making it lucrative for all involved is not often written into the business models of builders, developers, and contracting firms. But there are viable exceptions.

David Gerstel is an admirable example of someone who gained financial independence early in his career and retired wealthy after running what he has coined as an "employee-centered company"—not only paying higher than average wages but also instituting benefits like the four-day work week that allowed his carpenters to prosper as families and individuals in the community. This one shouldn't be political. The labor demand for business owners certainly weighs heavily on the bottom line, but what is this work without labor? This one is solved by employers putting themselves in their

Tim Healey

employee's shoes: What opportunities would you want? Why aren't your employees or prospective hires where you are? Compassion and team building go hand in hand.

Mind and hand. As a nation, we could be doing much more to support trades-inclusive public education. If we did, we would have much more bandwidth to entertain ways to integrate "mind and hand" solutions—integrated academic and technical programs. At the high-school level, technical instruction should not be a separate discipline. Instead, building-science, statics, and business administration should be academic electives, and most STEM courses could be combined with hands-on training that provides students with first-hand knowledge of tools for all industries.

Funding. By "support" for mind-and-hand curriculum, I mean not just a nod of approval but real dollars. The idea of a charter solution to overhauling public education is compelling, but evidence of large-scale progress is still forthcoming.

Traditionally, as a nation, we have supported education with taxation, and that is the political hot button we need to get clear about. Currently, corporate charter solutions for education are fraught with under-performance and corruption. Show the public results. Countries like Germany, Sweden, and Poland and other countries in Scandinavia and Europe do show results with apprenticeship programs in the building trades that are completely ingrained in the social fabric and public education systems, and the building professions in those countries tend to not have quite the same social stigma they do in the U.S. But if we as an industry continue to marvel at these apprenticeship programs, we need to be willing to provide the same level of public support for such programs.

Or not. Show us something that performs as well without public funding. I am skeptical that can be done with a growth-oriented, for-profit educational model. But real change might come from corporate foundations. If Google.org or the Ford Foundation were to focus on trade education, or, better yet, join forces and solicit foundational help from Amazon, Apple, Berkshire-Hathaway, and others, there would be ample support for overhauling public education to include feasible "mind and hand" high-school and early college programming. As a society, we enjoy enormous generosity from our nation's corporate leaders, evidenced by the likes of Bill and Melinda Gates, Ted Kaiser, Gordon Moore ... the list is long. So why hasn't the goal of ensuring affordable, high-performance, healthy housing ranked just as high on the list of needs as any other health initiative? Maybe asking that question is a start.

Carpenter Aaron Butt (@aaronthomasaquinas) leads a stair-building workshop at Grand Banks Building products in Gloucester, Mass.—one example of the new Chautauqua that, with the help of social media, is attracting young carpenters.

Unions. If we look to apprenticeship programs from abroad for inspiration on effective educational methods, a tip of the hat is owed to the United Brotherhood of Carpenters. The Carpenters run one of the most sophisticated and effective training centers in the country in Las Vegas, which is free to union members.

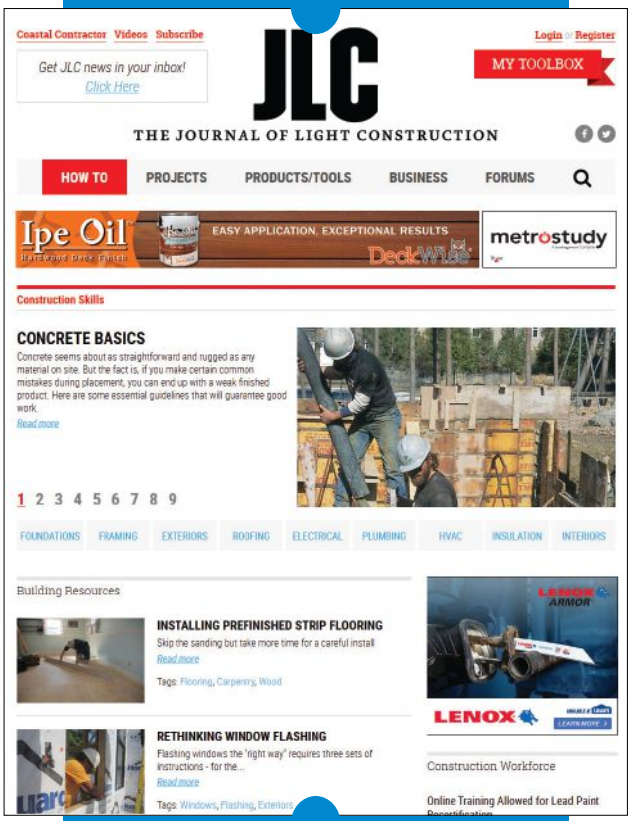
Yes, in the residential sector, union labor is widely discounted. But it shouldn't be. There are examples, chief among which is Neil Kelly—one of the top-rated remodeling firms based in Portland, Ore., that run exclusively on union labor. Tom Kelly runs a tight ship focused on high-performance homes that marries well with the generation of bottom-line revenue. Union labor is his choice in large part because of the skill quality the company can tap.

But the union has to bend, too. Not every location can support union-only labor, so why do the Carpenters insist that every member work for union shops? Membership would surge in areas where chapters are non-existent or withering if carpenters could work for either a non-union or union company. Membership in locations that don't have enough union companies would rise along with incentives for companies finding skilled labor. When taking a non-union job, workers wouldn't enjoy the wage and benefit protections that union jobs provide. But in areas with marginal union participation, there is zero union action in the residential sector. Some participation is better than zero, and it would likely grow the number of companies hiring union workers once they saw the increase in the talent pool.

No doubt other solutions will emerge when we start to look beyond technology for answers, and more towards reshaping the social fabric. Look on JLConline.com for an enhanced version of this article that points to a broad base of resources.

Monica Banks

JLC



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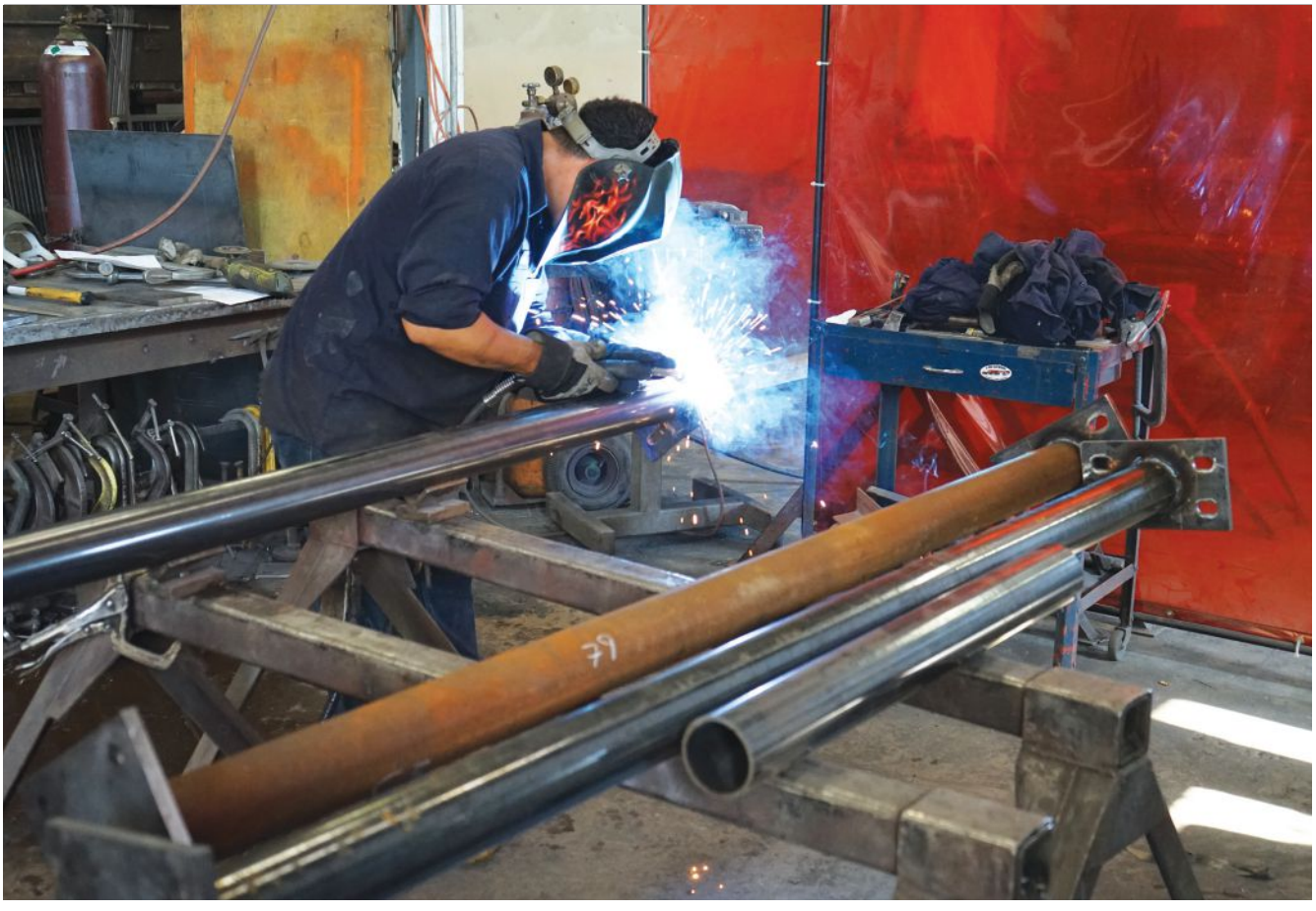


Builder's Guide to Working With Steel

How to get the right piece of steel for the right purpose

BY JAKE LEWANDOWSKI

Structural steel seems to be playing a larger role than ever before in homes. From supporting vast open floor plans to bridging expansive exterior openings, structural steel allows us to turn creative designs into reality. Over the last 17 years, the company I work for, Great Lakes Builders, has installed hundreds of beams. In that time, 30% of our jobs have been repairing competitors' work. This article should give you a basic working knowledge of steel and hopefully keep you out of that 30% club.

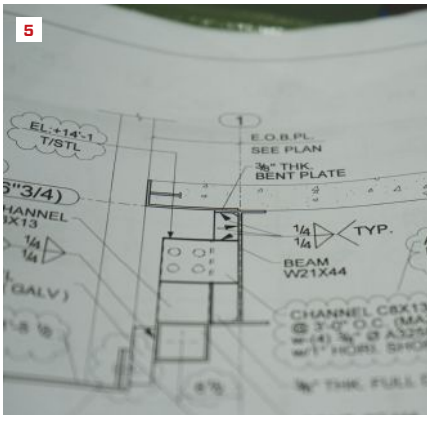
WHAT IS STRUCTURAL STEEL?

Structural high-strength steel used in construction comes in a variety of shapes and configurations. In residential construction, the steel shapes specified most often are elongated beams that have profiles with specific cross sections and weights. These beam profiles and weights allow engineers to incorporate the correct beam for specific purposes in specific spaces within a house.

In this country, structural-steel shapes, sizes, chemical composition, and mechanical properties are regulated by the American Institute for Steel Construction (AISC), which works in conjunction with the American National Standards Institute (ANSI) and the American Society for Testing and Materials (ASTM) to establish the set of standards for working with steel in construction. In comparison to steel structures like bridges and skyscrapers, residential use of structural steel is about as simple

Photos by Jake Lewandowski

In residential steel work, contractors are likely to encounter steel plate **(1)** and columns of various shapes **(2)**, shown here in their racks at a metal yard. One example of using the two together is a connection plate welded to a steel column **(3)**.



Engineers often specify steel I-beams to carry heavy loads or to span large distances in a home **(4)**. On plans, beams are labeled according to size and weight **(5)**. Steel channel is often specified for support instead of I-beams **(6)**.

as you are going to get. Let's start with an overview of the types of steel you're likely to see in residential construction.

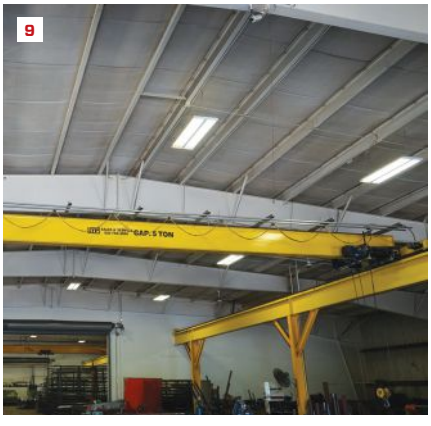
STEEL PLATE

The steel plate that you are most likely to encounter in home construction comes in the form of top plates and base plates (at the top and bottom of a steel column), bearing plates (which help to transfer loads onto beams), and flitch plates (usually sandwiched between or alongside layers of wood and bolted to them to increase their bearing capacity). In all of these cases, the steel plate will be specified ASTM A36, which means that the plate has a minimum yield strength of 36,000 psi (pounds per square inch) **(1)**.

COLUMNS

For residential steel, the columns most often specified have a round cross section, and on some occasions, square **(2)**. Round columns are specified both by schedule, which refers to the thickness of the column walls (typically either 40 or 80), and by nominal diameter (3 inches, for example). The thicker the walls and greater the outside diameter, the more the columns can support. The dimension for round steel columns refers roughly to inside diameter, or I.D. The steel industry refers to square columns as HSS, or hollow structural sections; as with the round columns, HSS columns come in a variety of interior dimensions and wall thicknesses.

When an engineer specifies steel columns, top plates and base plates should always be included in the discussion. When you give a set of plans to a steel fabricator, be absolutely positive that they are bidding on and building what is actually on the plans. In the field, I regularly see undersized top plates or missing base plates, and most often, those mistakes stem from a lack of detail on the drawings. In many cases, the plans don't call out the size of the base plate or top plate, or the plates have been deliberately undersized or



Cleanliness **(7)** and order **(8)** are signs of a well-run shop and a quality fabricator. Overhead cranes help move heavy beams safely around a shop **(9)**. Tools typically found in a metal shop include beam saws **(10)** and punches called "ironworkers" **(11)**.

omitted due to value engineering—trying to reduce costs—without an understanding of the ramifications. Either way, as the builder or contractor, you will be responsible for these mistakes.

If there are no specifications for the top and bottom plates and I need to get pricing, I typically tell the fabricator to figure on a plate thickness that is twice the thickness of the column wall, and I always specify that the plates be fully welded to the column. This strategy should get you close to the actual price of having the columns prepared. If the dimensions are missing on the plans, I request that information from the engineer and have them put the dimensions in writing. I also let the fabricator know that the base plates for our columns will have round holes for anchor bolts, while the top plates usually have slots that give us a little leeway when we're aligning them with the fastener holes in the beams **(3)**.

I-BEAMS

The most common structural steel elements used in home construction are beams, generically referred to as I-beams because of their profile **(4)**. The names given to various versions of I-beams, such as W-beams, S-beams, and the like, can vary by region. The important thing is that the engineer or architect provide the profile dimensions and weight dimensions of every beam that they include on the plan.

I-beams consist of two elements: top and bottom horizontal elements, called flanges, and a vertical element, called the web. Changing the dimensions of the elements as well as the thickness of the steel can affect how the beam functions. Architects and engineers can usually manipulate these dimensions as well as the weight to let a beam do its job while fitting into a specific area in a house, such as when a beam is concealed in the ceiling framing.

I-BEAM SIZES

I-beams are available in a wide variety of weights and dimensions. On the plans, the engineer or architect should specify the beam size, as well as any column sizes and footing sizes. For example, a typical I-beam label on a set of plans would be W6x25 **(5)**, where "W" indicates a wide flange beam, "6" means that the beam is 6 inches tall, and "25" indicates the beam weighs 25 pounds per foot.

The steps for basic metal-shop work are set by standards to ensure consistent work throughout the industry. Here, a fabricator follows the standard procedures for laying out bolt-hole positions **(12)** and marking them with a center punch **(13)**.

Bolts for residential steel work should all have an ASTM number stamped on the head, which means that they have a specific strength rating. A307 is a non-high strength bolt **(14)**, while A325 may be specified for high-strength applications **(15)**.

Similarly, an S8x23 label specifies an American standard beam (S) with a height of 8 inches and weighing 23 pounds per foot.

In my experience, most steel beams specified for residential construction are wide-flange beams between W6 and W10. But it's not uncommon to see W12, W14, and even larger sizes specified in certain situations. Be aware that there is a standard allowance for height variance, sweep (bend in the vertical axis), camber (bend in the horizontal axis), and out-of-square conditions in beam stock. Whenever possible, I try to get all the beams needed for any single job out of one continuous beam, and in a sequential order. If the fabricator makes sequential cuts from a beam, it would be difficult for the naked eye to pick up a 1/8-inch difference over a 40-foot run. But if beams are cut at random, or if the steel company uses several drops (steel beam remnants) to make up your order, it's possible to have unsightly height differences at your connection points. It may not seem like a big deal, but with a little planning, these discrepancies can be avoided.

OTHER COMMON STEEL SHAPES

While I-beams are the most common type of beam specified in residential construction, C-channel **(6)**, structural tees, and structural angle may also be specified. The top and bottom flanges of a C-channel beam extend from one side of the web (creating the "C" shape), while a structural tee has just a single flange at the top or bottom of the web. A structural angle is the shape of an "L." Situations where these shapes are specified is up to the discretion of the engineer or architect.

The industry uses the same basic nomenclature for these other types of beams. A C6x20 label would indicate steel channel that is 6 inches high and weighs 20 pounds per foot. For tee beams, architects and engineers generally use the prefix "T" or "WT" (the latter indicating a tee beam with a wide flange). Angle is usually indicated by the length of its legs; for example, each leg of a 6x6 angle is 6 inches long.

Torsion control (TC) bolts maintain specific torque settings. After threading on the nut **(16)**, a special wrench tightens it while gripping the splined end **(17)**, which breaks off at a given torque **(18)**. Washers should always be made from hardened steel **(19)**.

FINDING A FABRICATOR

Depending on where you live, finding a steel fabricator can be challenging. In cities where a lot of commercial fabrication is being done, you will probably have more choices. If a fabricator doesn't seem to be available in your area, look to other industries that might use the services of a fabricator, such as the marine industry near the coast, or the agriculture industry in rural areas. The bottom line is that you should always choose a fabricator based on competence, not price.

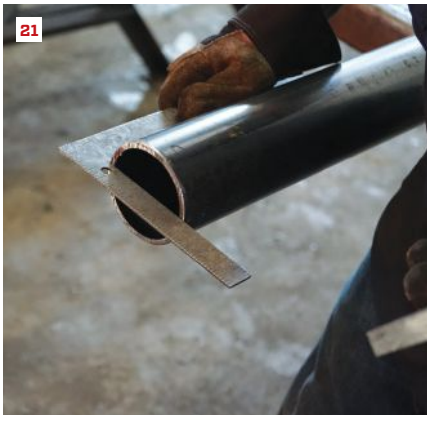
When looking for a fabricator, I look at the condition and organization of the shop and yard as an indication of the quality of work that they might produce **(7, 8)**. Steel shops can vary from places that look like junkyards to well-groomed shops that are almost hospital-like. Random pieces of steel in disorganized piles are an instant red flag for me. Because steel work is dangerous, I look for shops that are equipped to handle large pieces of steel safely **(9)**.

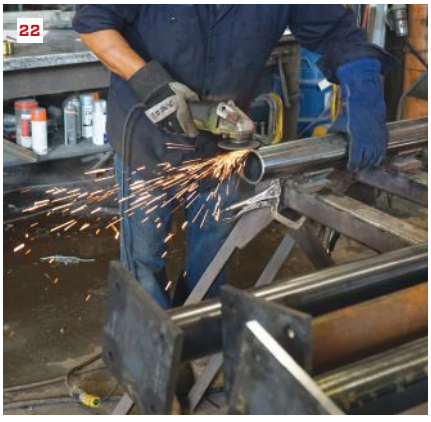
I also look at the shop's tools and the condition they're in. There are several tools that every good fabrication shop should have. One is a beam saw for making clean and square cuts at the ends of beams **(10)**. Others include a shear for cutting metal plate and an ironworker for making holes or slots in steel plate **(11)**. Steel fabrication shops should also have a brake for bending steel plate. I check that the tools are well maintained, too. Shop tools that aren't taken care of can break down, which can have a negative impact on your schedule.

Quality fabricators follow a standard procedure for tasks such as laying out fastener holes in plates. Watching the fabricator go through that type of procedure can tell you instantly whether they know their craft **(12, 13)**.

FASTENERS

There's nothing more upsetting to me than seeing big-box-store bolts used in structural steel work. Structural bolts are graded differently and are much stronger than conventional bolts. Structural bolts are stamped as A307 **(14)**, A325 **(15)**, or A490. A307 bolts are a significant upgrade from regular bolts, but in structural-steel terms, they are considered ASTM non-high strength bolts (even though your engineer may deem them strong enough for the task at hand). A325 and A490 are ASTM high-strength bolts. Engineers





Most residential steel welding is done in the fabrication shop with a MIG welder **(20)**. Welding a connection plate onto a column starts with checking the cut for square **(21)**. The fabricator then cleans the end of the column with an abrasive wheel **(22)**.

With the plate positioned at the layout marks, the fabricator tack welds the plate to the column in four places. Before completing the weld, he makes sure the plate is square to the column on one side **(24)**, then he flips the column to check the other side **(25)**.

and architects most often specify A325 bolts for steel in residential projects. These bolts have a heavy hex head that gives you a large bearing surface, and they come in a wide variety of lengths and diameters. A325 bolts are pretty affordable, and most fabricators will have a good selection of these bolts readily available. A325 bolts are also available galvanized, for steel work that is going to be exposed to the elements.

On occasion, you may see TC (tension control) bolts specified on plans. These bolts come in ASTM A325 and A490 ratings and have a splined shaft that extends beyond the bolt threads **(16)**. A special wrench holds the bolt by the splined end and tightens the nut **(17)**. When a certain predetermined torque has been attained, the splined section breaks off **(18)**. On large commercial projects, this type of bolt makes it easy to verify that all fasteners have been tightened to a specified torque. For most residential projects, TC bolts are probably overkill, and if called for on the plans, I would ask the architect or engineer if I could substitute a comparable hex-head bolt tightened with a regular torque wrench.

Washers are a very important part of the fastening system, but they often get overlooked. When working with structural steel, you should always use hardened steel washers **(19)**. Bevel washers have a tapered profile and are used when bolting together uneven or nonparallel surfaces to create a tight and stable fit. For C-channel or S-beams, these washers fit inside the beam flange to provide a parallel bearing surface, with the tapered shape of the washer compensating for small differences. The hardened steel washers for A325 or A490 bolts will have the F436 stamp.

When sizing bolts, make sure that the grip length or unthreaded part of the shaft extends just past the materials you are bolting together, but is not long enough to interfere with being able to properly tighten the nut. The bolt should be long enough that the thread extends about 1/4 inch past the nut. In general, an expert architect or

When satisfied that the base plate is tacked square to the column, the fabricator completes the weld along the entire joint **(26)**. Setting the column in a vertical position provides a more comfortable position for the fabricator to weld. The finished weld should have a consistent width, shape, and pattern along its entire length **(27)**. The standard finish for residential steel is red oxide primer **(28)**, an anti-corrosive coating that helps prevent rust.

engineer will specify the correct grade and diameter of any bolts that are needed on a project, and most competent fabricators will supply bolts that are the correct grade and proper length for the project.

WELDING

For residential steel work, the fabricator will do most of the welded connections in the shop using a MIG (metal inert gas) welder **(20)**. Welding is where fabricators really get to display their craftsmanship, taking their time to go through each of the proper steps. A typical welding job for a residential project would be attaching plates to a column. After cutting the column square **(21)**, the fabricator takes the surface of the column down to clean, bare metal with a grinder **(22)**. He then tacks the plate to the column **(23)** and checks to make sure the plate is perfectly square to the column in both directions **(24, 25)**. When satisfied, he runs a weld around the entire joint where the column contacts the plate **(26)**. The finished weld should have an even width with a consistent look and pattern along the entire joint **(27)**.

Most welding done on site is done with a stick welder. Instead of the wire used in a MIG welder, a stick welder uses a metal rod or "stick," known as an electrode. Electricity then melts both the stick and the metal in the joint to fuse the two together. The most common rod for structural work is 7018, the 70 indicating that it has a tensile strength of 70,000 psi. 7018 rods come in many different diameters, and an experienced welder will determine what rod size is needed. It's important to note that I always make sure that any welder working on our jobsites has the proper American Welding Society (AWS) D1.1 structural welding certificate.

FINISH

I always ask the fabricator to deburr any metal work that is done for me. Deburring is typically done with an abrasive wheel that softens the sharp edges where the metal has been cut. For most shops, deburring is standard practice, and it greatly reduces the chances of being cut with a sharp edge or getting painful metal splinters.

Unless I request differently, most fabricators that I work with apply a coat of primer to the metal before it is delivered **(28)**. In the industry, we joke that you can get structural steel painted any color you want as long as that color is red oxide primer. Red oxide primer is an anti-corrosive coating that helps prevent rust from forming.

Jake Lewandowski is a construction manager with his family's business, Great Lakes Builders (greatlakesbuildersinc.com), specializing in structural repairs, in Elk Grove Village, Ill.

Ten Tips for Great Stucco

From framing to finishing, craftsmanship makes the difference

BY BRUCE BELL

I've been in the plastering industry for almost 50 years. I started out as a hod carrier, worked for 18 years as a journeyman plasterer, served as the Executive Director of the Sacramento Valley Bureau for Lath and Plaster, and served on the Northern California Apprenticeship Committee. Although I'm retired from those positions, I still work as a consultant to architects, contractors, and the Wall and Ceiling Alliance and Wall and Ceiling Bureau covering the Northern California area.

Before I talk about quality control, I'll start with a quick overview of how to apply and finish Portland cement plaster. The process of applying starts with mixing enough material for the job. The plasterer sets up mud boards so that he can put mud on his hawk, take mud off his hawk with his trowel, and smooth it on wire lath with enough material and pressure to bed the lath and provide enough material on top of the wire for a superior "scratch coat."

The scratch coat is the first coat of plaster applied in any plaster system. It's the structural component to a stucco wall, and it provides the most strength to the plaster lamina in a three-coat system. The plasterer scarifies or scores ("scratches") this coat to create grooves into which the "brown coat" will adhere. Once applied, the scratch coat is moist-cured morning and evening for 48 hours.

The brown coat, the second coat of plaster, brings the plaster out to the thickness of the trim at the base of the wall and the edges of the doors and windows. The worker spreads plaster on the wall, and

Photos by Bruce Bell

After the scratch coat has been moist-cured for at least 48 hours, the brown coat is applied with firm pressure to create a strong mechanical and chemical bond between the coats. The brown coat should be rodded flat with a darby and straightedge, then moist-cured and checked for hardness.

uses a darby to smooth the material as flat as he can while it is still plastic. When the brown coat sets, the wall is "rodded": The plasterer takes a long straightedge, or "rod," and works it over the wall to knock down high spots, fill in low spots, and ensure flatness. He then "floats" a rubber float across the surface to compress the material and to knock off any minor high spots and fill in minor flaws. This coat is then moist-cured morning and evening for 48 hours in preparation for the finish coat.

Taken together, the scratch coat and brown coat are called the "base coat."

The third step in a three-coat stucco system is the finish coat. If stucco finishing is done using a trowel, the walls need to be cool and moist with no standing water. Another common option is a "dash coat," which is produced with a machine that sprays a fine, tight texture on a wall using a soft slurry of stucco material. The texture is sand-finished, without float marks, and needs a well-prepared base coat. If the finish is a dash coat, the area around the walls needs to be covered to protect it from overspray.

If the plasterer is using a crack-reduction lamina, he spreads acrylic adhesive in a tight skim coat and trowels in fiberglass netting. He then applies additional trowels of material to embed the mesh completely.

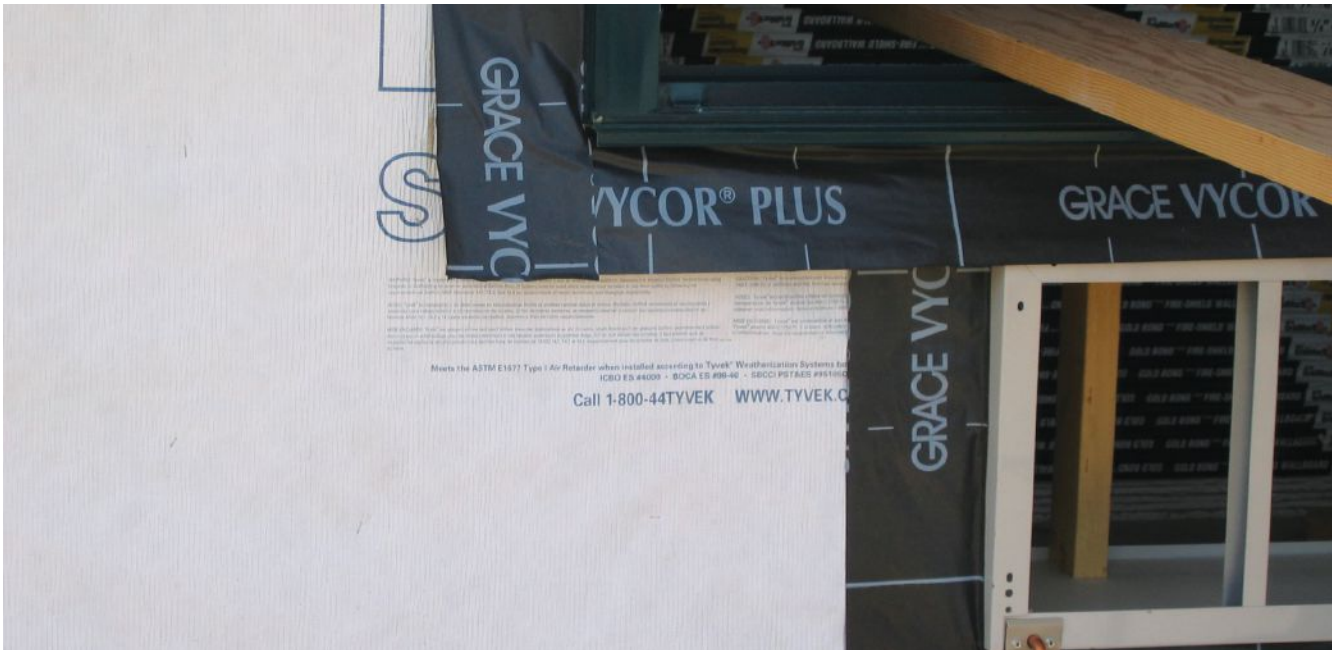
Quality-control issues abound in the stucco industry. The bullet-point takeaways are that stucco cracks, it's not flat, and it leaks. But over the last decade, the plastering industry has made progress in developing protocols for Portland cement plaster that produce flat, nearly crack-free panels. Here are the top 10 keys to achieving a great stucco job.

START WITH GOOD FRAMING

Concrete masonry or brick is the ideal foundation for plaster and is the most common substrate for stucco in Europe. But in the United States home-building industry, wood framing predominates. To get good performance from stucco over wood framing, you need to take steps to minimize movement of the substrate.

Three-coat cement stucco weighs in at about 10 pounds per square foot; when framing is set without any dead load, adding stucco adds significant weight to the structure. As the framing settles, the weight of the plaster helps compress the joints of the framing. Then, as the wood dries out, volumetric shrinkage occurs: All your lumber loses length and width. As a result, when the plaster that was spread over one area of wall dries, it ends up covering a smaller area. This creates stress that can cause cracking in the base coat.

Making sure that the framing meets the engineering requirement of L/360 maximum deflection is a start. In addition, the framing needs to be constructed of wood products with no greater than 19% moisture content. Framed walls can rack if shear resistance is insufficient for the loads and floor framing can twist, shrink, or deform, and the plaster reflects the way the framing behaves. If the framing is solid, the plaster will have minimal cracks.



Flashing should be applied so as to direct water out and down on the drainage plane. Weep screeds at the bottom of the wall allow any water that soaks into the plaster to escape.

Framing and flatness. The code-specified maximum variation in the plane of the base coat is 1/4 inch in 5 feet. A reasonable tolerance for the final product is 1/8 inch variation using an 8-foot straightedge. In Northern California, that is what the architects I work with specify. Good, flat framing makes it easy to create a flat wall; conversely, variations in plane in the framing can end up being reflected in the plaster panel.

MAINTAIN THE DRAINAGE PLANE

A good drainage plane is essential for allowing the plaster to manage moisture during wet weather. The weather resistive barrier (WRB) is the paper behind the lath that moisture hits before it migrates down the wall, keeping the interior safe and dry. We insist on a continuous weatherboard-fashion (shingle-fashion) installation of any WRB to ensure that the plaster weeps incidental moisture down the wall and out at the weep screed.

FLASH CORRECTLY

Flashing of penetrations should incorporate one guiding principle: All the flashing should be installed weatherboard style (shingle style) so that moisture will slide down the wall away from the windows, doors, electrical boxes, vents, and pipes.

One of the mistakes we see all the time is not detailing a horizontal condition to drain to the outside. Heads of windows and doors need Z flashing extending past the vertical jambs to kick moisture in the wall out onto the surface of the plaster. Horizontal reveal screeds need to be attached gingerly to keep from compressing the spine of the trim into the WRB and creating a dam.

MAINTAIN THE PROPER FURR

The furr, which is the amount of space beneath the field of the lath, should be at least 1/4 inch. The object is to make sure that enough plaster can get behind the wire to create a good foundation for the brown coat. There is an easy test for correct furr: Take a pencil with an eraser, push it against the wall, and look at where the lath meets the eraser collar. If they match, the lath has been installed with enough furr to allow for full embedment.

SAND-TO-CEMENT RATIOS

The wrong ratio of sand (aggregate) to cement can mess up a good job without the general contractor even being aware of it. I was called out to a school built during the summer, and the maintenance guy who asked me to check the ceilings and walls wondered why the stucco was falling off a brand-new elementary school. The sand-to-cement ratio was 7 sand to 1 cement. In checking the plaster keys in the ceiling, I brushed my palm against some plaster that turned to powder, and a chunk of the ceiling fell down. It was a beautiful job, but there wasn't enough cement to bind the sand together or enough moisture to harden the cement if there had been enough of it. All the plaster had to be removed.

Wire or mesh lath should stand proud of the drainage plane by 1/4 inch. This allows space for the scratch coat of plaster to fully embed the lath. The scratch coat should cover the lath by another 1/8 inch.

ASTM Standard C-926, "Standard Specification for Application of Portland Cement-Based Plaster," specifies that for the scratch coat, one part Portland cement should be mixed with 2 1/2 to 4 parts aggregate by volume, and for the brown coat, one part Portland cement should be mixed with 3 to 5 parts aggregate by volume. The principle is to have just enough cement to coat each granule of aggregate to bind it into a solid mass. Too much cement and the plaster mix is too rich and is prone to shrinkage cracking. Too little cement and the mix is too lean—there isn't enough cement to coat each grain of aggregate and the material will lack strength.

Counting the number of shovels of sand in a batch of plaster is one way to ensure that you get a good sand-to-cement ratio. Thirty-two #2 shovels per 90-pound bag of cement is a good gauge while watching a hod carrier mix mud.

BASE-COAT THICKNESS

The thicker the scratch coat, the better the overall strength characteristics of the finished plaster panel. According to ASTM C-926, this means that enough material should be applied on the lath "to embed the metal base, and with sufficient thickness of material over the metal to allow for scoring the surface." The furr should be at least 1/4 inch. The amount of material needed to fill that void and cover the metal base is approximately 3/8 inch of plaster. Using sufficient pressure ensures that enough material is pushed under and over the metal base, which we define as "embedment." Covering the wire and being sure to apply a good scratch-coat thickness is critical for a successful stucco job. Scarifying (scoring) or grooving the surface of an unset plaster coat to provide a key for the subsequent coat then ensures that the mechanical bond, as well as the chemical bond, between the scratch coat and brown coat is strong.

PREPARATION OF THE BROWN COAT

According to ASTM C-926, "the second (brown) coat shall be applied with sufficient material and pressure to ensure tight contact with the first (scratch) coat and to bring the combined thickness of the base coat to the nominal thickness ..." and "... shall be brought to a true, even plane with a rod or straightedge, filling surface defects in plane with plaster." Then, "the surface shall be floated uniformly to promote densification of the coat and to provide a surface receptive to bonding of the finish coat."

One of the ways to achieve a superior stucco job is to make sure that the float used prepares the brown coat for the type of texture and finish that your customer demands. That means that if you want a sand finish texture, your brown coat need only be floated with a hard rubber float or a shingle float. If you are going to apply a dash-coat finish, you need to float the brown coat with a green float, or rod, skim, and float it to ensure that you fix any voids or humps prior to the dash-finish application, because the dash coat will reflect every variation in the plane.

Above left, an inferior scratch coat does not fully cover the wire lath and has not been properly cured, allowing the coat to scale away from the wall. Above right is a superior scratch coat that fully covers the lath and has been scored (scarified) to create grooves that will provide a mechanical bond with the brown coat.

MOIST CURING THE BASE COAT

In the 1940s, when my father was plastering, curing was never done. There were instances where the brown coat was so soft, the finish would pull off the surface of the brown coat during finish application. Now we know that curing the scratch coat and brown coat is essential to developing the strength characteristics that assure the stucco will last.

After the scratch coat is set, the plasterer uses a hose with a misting nozzle to soak the newly plastered wall right before going home. In the morning when he arrives on site, he soaks the wall again to return the moisture that has evaporated from the wall or soaked into the building paper. Forty-eight hours of moist-curing morning and evening normally does the trick, but during the winter, curing or hardening slows, so it takes longer. On the other hand, when it is scorching hot, you may have to continually moist-cure the walls so they don't flash dry out, and in foggy situations, you might have to wait a week for the plaster to dry out, harden, and cure.

When the plaster dries out without enough moisture to cure, the wall stays uncured until enough moisture is added back. I have cured walls that were soft six months after application just by adding moisture.

Plaster takes a long time (some say years) to fully cure. The majority of the strength comes during the first 30 days of application, and with premium cements, like Omega Super Cement (omega-products.com), a well-cured wall can be achieved in less than 30 days. Curing is a function of time and moisture; without both, the process stops. Curing slows as the temperature drops, so curing during the winter in wet weather can take longer than during the summer. Drying is as critical to hardness as adding moisture. A good stucco job needs the right balance of both.

The Mohs Hardness Test confirms the cure. Any GC can do the test at any time during a workday: Take a penny and scratch the surface of the plaster. If the wall scratches the penny, the wall is cured; if the penny scratches the wall, it needs more curing. Mohs compares the hardness of substances, talc being a 1, and a diamond being a 10. Plaster panels should be in the 4 to 5 range, whereas a penny is a 3. So if the wall scratches the penny, you have prima facie proof of the cure.

LEVELING COAT

Using a leveling coat creates a flatter wall than almost any other way of preparing a brown coat. The process can include skimming in a thin layer of stucco right after floating the wall to fill minor voids in the panel, if you are machine-applying a finish coat. It can include rodding the brown coat and letting it set, but prior to moist-curing, skimming a tight coat of acrylic bonding material to fill aggregate voids and capture all the moisture in the panel so there is no evaporation. This creates a hard, shell-like finish that has no suction, a perfect base for an acrylic finish.

Finally, you can moist-cure the floated brown coat, let it dry,

Above left, a well-applied brown coat has been smoothed flat with a straightedge ("rodded") and floated with a green sponge trowel to bring out the sand aggregate. Above right, a brown coat has been scratched by a penny, indicating that the cure is incomplete. Curing should continue until a penny will not scratch the cured cement plaster.

trowel fiberglass netting into a bed of acrylic bonder, skim the netting with another layer of bonder, and create a lamina that minimizes cracking by a huge factor. Some manufacturers will provide a warranty period for this application.

FINISH-COAT PREPARATION

Taking care with the stucco finish is one of the best ways to ensure a successful stucco job. If you are applying three-coat stucco with a lime-based finish, making sure that the wall you're plastering is moist ensures that you won't have cold joints (hard, discolored joints where the plaster above meets the plaster below at the scaffold line). This might mean you start wetting the wall an hour before you start finishing the wall.

Having enough workers to keep a wet edge is also critical. If you are smooth-troweling a wall, the wall must be wet without standing moisture, so you need enough workers to scratch and double back, applying a skim coat of stucco material into which the second coat of finish aggregate can be compressed. Some of the most beautiful plaster jobs are smooth-troweled stucco with a good paint coat to bridge the fine, tight cracks that occur with that method. Those cracks, which we call "alligator cracking," are a performance characteristic of this type of finish coat. If you are sand-finishing a wall, having enough foam floats to create an even sand finish is also critical.

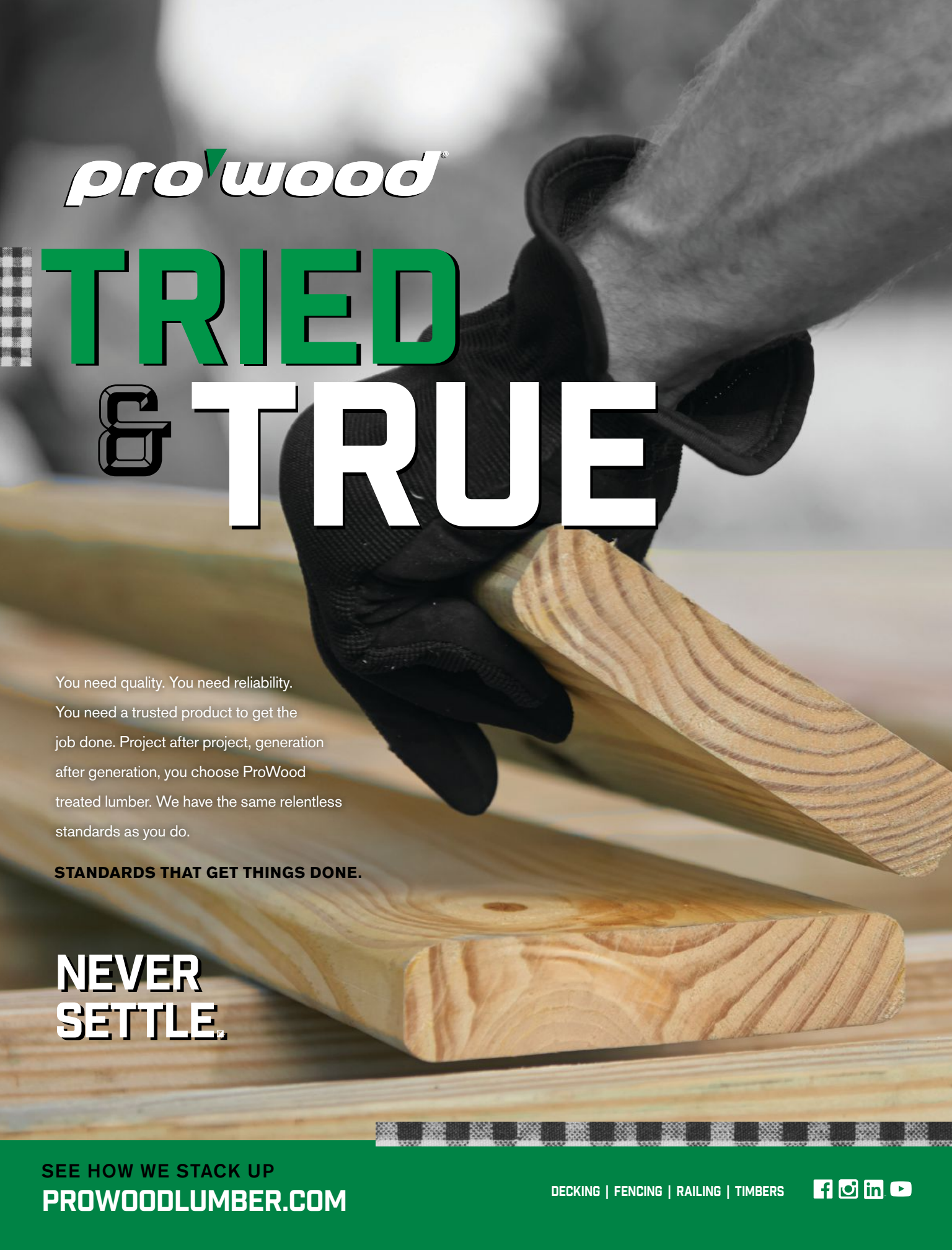
For a synthetic finish coat, you don't wet the wall before you start plastering, but you do need to keep a wet edge during application. In this case, rolling on a coat of primer would be your first step. The primer does two things: It kills the suction from the brown coat that dries out the edge, making it easier to keep a wet edge; and it ensures that floating the aggregate that creates the texture does not produce blackheads (small, unsightly pinholes in the finish).

With cement stucco finishes, you can fill minor voids in the brown coat by scratching and doubling back with the same material. But synthetic finishes reflect every variation in the plane, and also sometimes need a rolled-on prep coat to ensure full coating of the color.

The Cadillac treatment is to float the brown coat, cure the brown coat, embed fiberglass netting into the base with an acrylic-modified cement adhesive, and then apply your acrylic finish coat. Called a crack-reduction coat, this creates a surface with significant tensile and flexural strength, which minimizes building movement stress-related cracking.

It doesn't take magic to produce a great stucco job, but there are a few things that you can't skimp on: watching to make sure you have good framing and lathing; using good materials; assuring that the application of the material is done by well-trained lathers and plasterers; watching and checking to ensure that the material gets hard; and using good finishing techniques. Follow all those steps, and when you're done, you'll have a great stucco job.

Bruce Bell is a consultant based in Northern California.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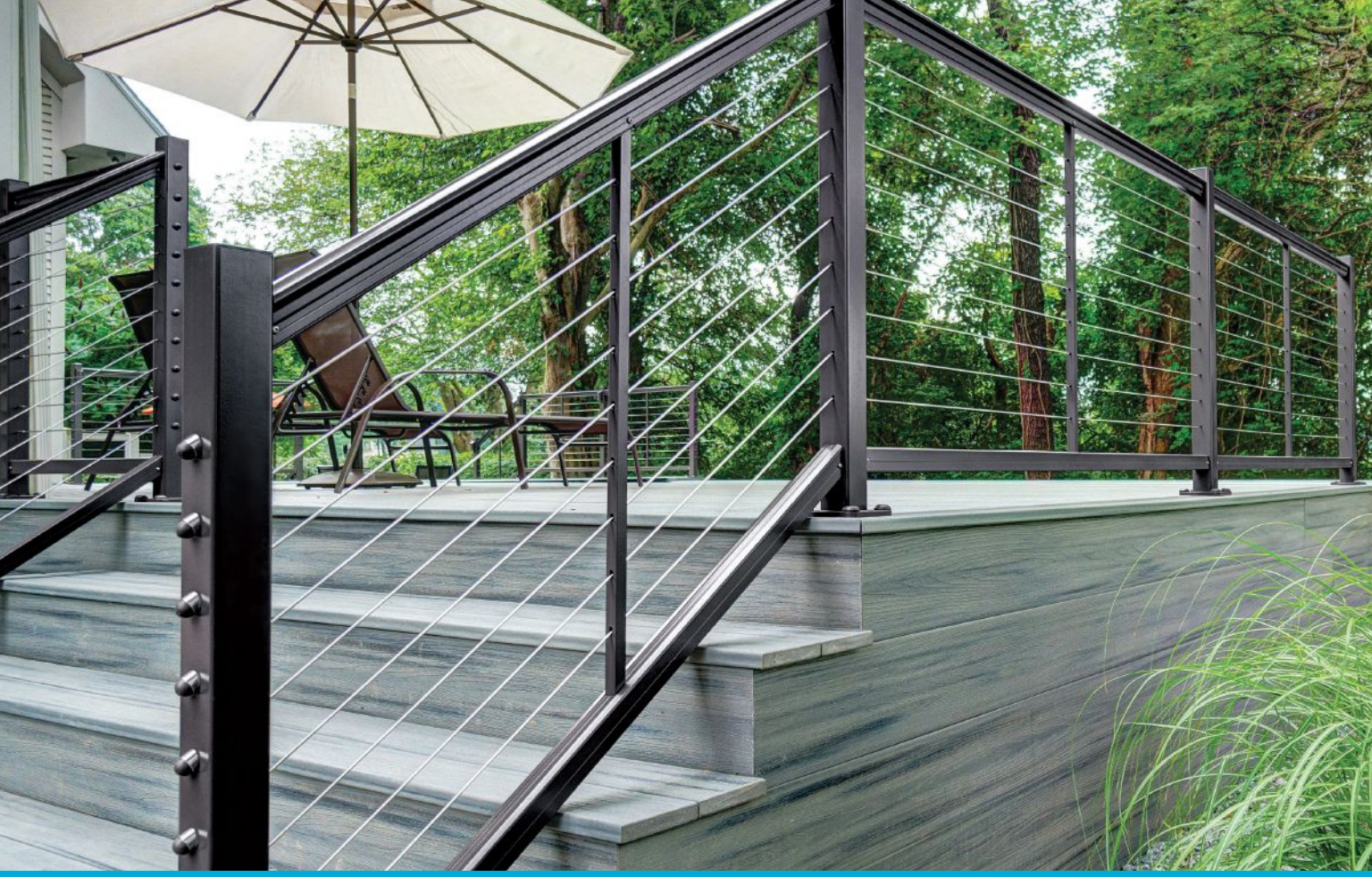

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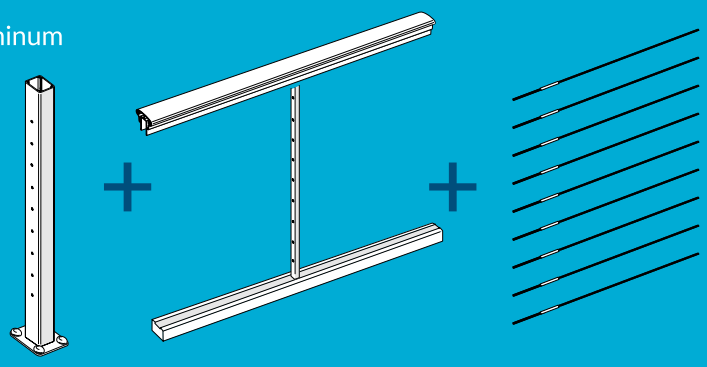

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Transform a Garden Hose Into a Water Level

by Joseph Ponessa

I use a water level only occasionally, so rather than buying a long length of vinyl tubing that would then sit on a shelf somewhere largely unused, I decided to simply adapt my garden hose to the task. To do this, I fitted the hose with a pair of threaded hose barbs, which are readily available at any hardware store and cost only a couple of dollars each (they can be made from either brass or plastic, but plastic is a lot cheaper). The fittings have a male or female thread on one end (you'll need one of each, sized to fit your hose—typically 3/4 inch) and a serrated barb on the other that can be inserted into flexible vinyl tubing. I bought fittings with 3/8-inch barbs, but other sizes are available depending on the size of vinyl tubing you have on hand. You won't need much; a length of a foot or so at each end works fine. ❖

Joseph Ponessa is a former extension specialist and professor emeritus of Housing, Indoor Environment and Health at Rutgers University in New Jersey.

PHOTOS OF WATER LEVEL BY JOSEPH PONESSA

Send Us Your Tips

We want your best deck-building tips and are partnering with different tool manufacturers to give away a power tool to the reader who sends the best tip to prodeck@hanleywood.com. The prize for the October 2019 issue is a Camo Drive three-way stand-up fastener tool. So, write up those tips. Don't sweat the grammar or the spelling—that's what editors get paid for. Take a photo (your camera's best setting, please), or send a sketch on the back of a napkin.

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Sizing Deck Posts

by Glenn Mathewson

Among the dozens of proposals under consideration for the next (2021) edition of the International Residential Code, of special interest to deck builders is RB184-19, a comprehensive reworking of section R507, the part of the IRC that addresses residential decks. If the proposal passes as written, expect to see some big changes, including new guidelines for determining deck post height.

The Back Story

Until 2015, building codes pretty much ignored deck posts except to establish a minimum 4x4 wood (or a 3-inch-diameter steel) cross section. But in 2015, the IRC introduced Table R507.8, which limited the height of a 4x4 deck support post to 8 feet, without any consideration for how much area of deck the post was supporting (**Figure 1**).

TABLE R507.8
DECK POST HEIGHT[a]

DECK POST SIZE	MAXIMUM HEIGHT[a]
4 × 4	8'
4 × 6	8'
6 × 6	14'

For SI: 1 foot = 304.8 mm.
a. Measured to the underside of the beam.

TABLE R507.4
DECK POST HEIGHT[a]

DECK POST SIZE	MAXIMUM HEIGHT[a, b] (feet-inches)
4 × 4	6-9[c]
4 × 6	8
6 × 6	14
8 × 8	14

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm,
1 pound per square foot = 0.0479 kPa.
a. Measured to the underside of the beam.
b. Based on 40 psf live load.
c. The maximum permitted height is 8 feet for one-ply and two-ply beams. The maximum permitted height for three-ply beams on post cap is 6 feet 9 inches.

Figure 1. A deck-post sizing table was first added to the IRC in 2015, establishing a minimum 4x4 cross section and a maximum height of 8 feet for deck posts (top). In the 2018 version of the IRC, Table R507.8 was renamed R507.4, and 8x8 posts were added to the table (bottom). Footnote "c" in the 2018 table allows for a maximum 4x4 post height of 8 feet as long as the post is supporting either a one-ply or a two-ply beam.

The engineering behind post sizing is based on how much weight the post can support without starting to bend out of plane. The longer the post, the less it can support. To illustrate, consider standing a toothpick on end and pressing on it with your finger; it hurts, doesn't it? But if the same toothpick is 2 feet long instead of 2 inches long, it will bow to the side and snap long before you flinch. This is the basic principle behind the science of post sizing.

As critics of the 2015 sizing table pointed out, the problem with the 8-foot maximum post height is that it was based on the worst-case loading scenario: a center post carrying a maximum-spanning two-ply 2x12 beam from both sides and supporting maximum-spanning 2x12 joists with a maximum cantilever. That's a lot of maximums for a minimum-size post, one that may be supporting only the corner of an intermediate stair landing. The 2015 IRC doesn't differentiate between the two scenarios; it's a one-size-fits-all approach.

Fast forward to the next edition, the 2018 IRC, and at first glance it appears things got worse, since the 4x4 maximum height limit in Table R507.4 (renamed from Table R507.8 in the previous edition) dropped to 6 feet 9 inches. What actually happened is that the code provided more flexibility, but only if you carefully read the fine print in new footnote "c."

Codes have long required that all plies of a built-up beam bear on the post, so naturally a 4x4 (at only 3 ½ inches wide) can carry only a 3-inch-wide two-ply beam. Thus, the area of deck that can be supported by a 4x4 post is limited to two-ply beam spans. The 2018 height reduction recognizes proprietary post-to-beam connection hardware that will fully support a three-ply beam on a 4x4 post. With larger beams, the limit of deck area that could be supported increased, therefore decreasing the maximum post height. This is all explained in footnote "c," which allows the previous 8-foot height only when the more common two-ply (or one-ply) beam is installed.

While the 2018 IRC version of the deck-post sizing table did expand on the 2015 version by allowing larger beams on 4x4 posts, it still didn't solve the one-size-fits-all problem of limiting the height of all posts based on the heaviest loading possible. This is exactly why the code, which has been revised every three years since 1927, will continue with that tradition. There

Proposed Table R507.4 (for inclusion in 2021 IRC)
Maximum Deck Post Height[a]

Load[b] (psf)	Post Species[c]	Nominal Post Size[d]	Tributary Area[e] (sqft)							
			20	40	60	80	100	120	140	160
			Maximum Allowable Deck Post Height (feet-inches)							
40 Live	Southern Pine	4x4	14-0	14-0	13-11	12-0	10-8	9-8	8-10	8-2
		4x6	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
		6x6	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
		8x8	14-0	13-6	10-10	9-3	8-0	7-0	6-2	5-3
	Douglas Fir[e], Hem-fir[e], SPF[e]	4x4	14-0	14-0	13-10	11-10	10-6	9-5	8-7	7-10
		4x6	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
		6x6	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
		8x8	14-0	13-2	10-3	8-1	5-8	NP	NP	NP
	Redwood[f], Western Cedars[f], Ponderosa Pine[f], Red Pine[f]	4x4	14-0	14-0	13-6	11-4	9-9	8-4	6-9	4-7
		4x6	14-0	14-0	14-0	14-0	14-0	14-0	13-7	9-7
		6x6	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
		8x8	14-0	14-0	13-11	12-0	10-8	9-8	8-10	8-2
50 Ground Snow	Southern Pine	4x4	14-0	12-2	9-10	8-5	7-5	6-7	5-11	5-4
		4x6	14-0	14-0	12-6	10-9	9-6	8-7	7-10	7-3
		6x6	14-0	14-0	14-0	14-0	14-0	14-0	14-0	13-4
		8x8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
	Douglas Fir[e], Hem-fir[e], SPF[e]	4x4	14-0	12-1	9-8	8-2	7-1	6-2	5-3	4-2
		4x6	14-0	14-0	12-4	10-7	9-4	8-4	7-7	6-11
		6x6	14-0	14-0	14-0	14-0	14-0	14-0	14-0	12-10
		8x8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
	Redwood[f], Western Cedars[f], Ponderosa Pine[f], Red Pine[f]	4x4	14-0	11-8	9-0	6-10	3-7	NP	NP	NP
		4x6	14-0	14-0	12-0	10-0	8-6	7-0	5-3	NP
		6x6	14-0	14-0	14-0	14-0	14-0	14-0	10-8	2-4
		8x8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
60 Ground Snow	Southern Pine	4x4	14-0	11-1	8-11	7-7	6-7	5-10	5-2	4-6
		4x6	14-0	14-0	11-4	9-9	8-7	7-9	7-1	6-6
		6x6	14-0	14-0	14-0	14-0	14-0	14-0	12-9	11-2
		8x8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
	Douglas Fir[e], Hem-fir[e], SPF[e]	4x4	14-0	10-11	8-8	7-3	6-2	5-0	3-7	NP
		4x6	14-0	13-11	11-2	9-7	8-4	7-5	6-8	5-11
		6x6	14-0	14-0	14-0	14-0	14-0	14-0	12-2	10-2
		8x8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
	Redwood[f], Western Cedars[f], Ponderosa Pine[f], Red Pine[f]	4x4	14-0	10-6	7-9	4-7	NP	NP	NP	NP
		4x6	14-0	13-7	10-9	8-9	7-0	4-9	NP	NP
		6x6	14-0	14-0	14-0	14-0	14-0	9-9	NP	NP
		8x8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
70 Ground Snow	Southern Pine	4x4	14-0	10-2	8-2	6-11	5-11	5-2	4-4	3-4
		4x6	14-0	12-11	10-5	8-11	7-10	7-1	6-5	5-10
		6x6	14-0	14-0	14-0	14-0	14-0	12-9	10-11	8-7
		8x8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
	Douglas Fir[e], Hem-fir[e], SPF[e]	4x4	14-0	10-1	7-11	6-6	5-3	3-7	NP	NP
		4x6	14-0	12-10	10-3	8-9	7-7	6-8	5-10	4-11
		6x6	14-0	14-0	14-0	14-0	14-0	12-2	9-9	5-9
		8x8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
	Redwood[f], Western Cedars[f], Ponderosa Pine[f], Red Pine[f]	4x4	14-0	9-5	6-5	NP	NP	NP	NP	NP
		4x6	14-0	12-6	9-8	7-7	5-3	NP	NP	NP
		6x6	14-0	14-0	14-0	14-0	10-8	NP	NP	NP
		8x8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. Measured from the underside of the beam to top of footing or pier.
b. 10 psf dead load. Snow load not assumed to be concurrent with live load.
c. No. 2 grade, wet service factor included.
d. Notched posts shall be sized to accommodate beam size per R507.5.2
e. Includes incising factor.
f. Incising factor not included.

Figure 2. If the new Table R507.4 proposed for inclusion in the 2021 IRC is adopted, post sizing would be based on tributary loads, snow loads, and the species of the deck posts. The comprehensive new table is based on engineering by the American Wood Council.

is always potential to make the code more flexible and better reflect changing technology, knowledge, and design trends in a way that maintains it as a minimum standard.

More Flexibility

The more comprehensive post-sizing Table R507.4 proposed by NADRA and other members of the Deck Code Coalition for inclusion in the 2021 IRC was developed with generous engineering contributions from the American Wood Council (**Figure 2**). If approved, the new table will allow posts to be sized based on the tributary area each post supports and the different snow loads that a region may require. (The tributary area is determined simply from half the joist spans, half the beam spans, and all the cantilevers that a post is within; the area of the geometric shape within those lines is the tributary area.) For small areas, such as a stair landing, the new table allows 4x4 posts to be as tall as 14 feet.

As you can see by examining the proposed table, another variable addressed by this new proposal is the wood species of the post. Again, referring back to our toothpick analogy, compare the strength of a hardwood toothpick to one made with balsa wood. Clearly, one would snap before the other, and the new table reflects the fact that different wood species should yield different maximum post heights.

Even if this proposal doesn't win approval, it includes solid engineering from the American Wood Council that I suspect will likely end up in the next edition of DCA 6. So, stay tuned. ❖

Glenn Mathewson is a consultant and educator with buildingcode college.com and a frequent presenter at JLC Live.


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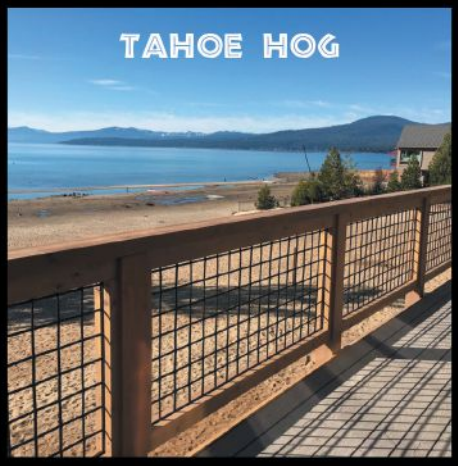

Restoring a Wood Deck

Even with the best finishes, surface prep is still the key to long-lasting success

by Steve Maxwell

PHOTOS BY STEVE MAXWELL, EXCEPT PHOTO 4B ON PAGE 16, BY JOHN PAULIN

Low cost, relatively long life, and wide availability make pressure-treated wood decking the go-to choice for many decks. The downside is that PT lumber can be the most difficult outdoor wood to finish properly. This is true for new PT lumber, which may or may not have had some proprietary water-repellent treatment applied to it at the mill, and for existing PT decking, whether it has a finish that's failing or no finish at all.

My approach to refinishing wood decks applies to most of the widely available types of PT decking. While southern yellow pine is one species that is commonly pressure treated, here in Canada (and I believe in the northern states), spruce, pine, and fir are also milled into PT decking. This approach can be used with cedar and redwood decking too.

Coach Your Client

You might think you're in the deck business, but that's not entirely true. You're actually in the business of making people happy (or happier) about their decks. The thing is, happiness won't happen unless you explain two things that are probably new to most clients you deal with. Skip this teaching and it could come back to bite you.

First, new deck owners rarely realize how much effort and expense some finishes require to keep a wooden deck looking great in the long run. You need to explain. Decks fight a constant battle against UV, moisture, abrasion, and temperature swings. Outdoor conditions are hard on any finish, but deck finishes must withstand the additional challenges of foot traffic and a water-holding horizontal orientation.

The second client-coaching point concerns the range of effort involved in maintaining a deck depending on the finishing regimen. At the easy end of the spectrum, leaving a pressure-treated deck bare or simply cleaning

and brightening it from time to time involves little work. At the other end of the maintenance spectrum, film-forming, furniture-grade deck finishes require complete stripping and refinishing every three or four years. This is especially true in full-sun locations (**Figure 1**).

Every deck finish has pros and cons. Laying those out ahead of time reduces the chance for client disappointment, call backs, and loss of profits. Here's what you need to explain about the different families of deck finishes:

Clear finishes preserve the bright "natural" look of new or newly brightened wood, but clear finishes also have the shortest working life. Clients will need to refinish every year if they want to maintain the look of fresh lumber, with deck brightening necessary as the deck ages. Currently, the best clear product in my testing is Olympic Wood Protector Clear Waterproofing Sealant.

Soak-in stains add color to wood, but without a surface film that has the potential to peel. Lack of peeling makes refinishing easier, but it also reduces the ability of the finish to prevent surface cracking. Soak-in stains typically deliver for two or three years before they need to be reapplied. Wear from foot traffic and abrasion is what typically kills soak-in stain finishes. Cetol SRD is currently my favorite finish in this category.

Tinted film-forming finishes are like a varnish for decks. The protective film can look fabulous because it imparts color while also letting wood grain show through. If your client is aiming for a rich-looking deck, a film-forming finish is the way to go.

Just be sure to explain that all film-forming finishes eventually break down and peel. These finishes need to be stripped, the deck sanded, and the product reapplied when that happens. Any deck pro knows that stripping is especially time consuming on railings with closely spaced spindles, but you need to explain this to clients. The best film-forming finishes deliver three to five years of good looks in sunny locations. Sikkens Cetol Dek has been a long-standing favorite of mine in this category.

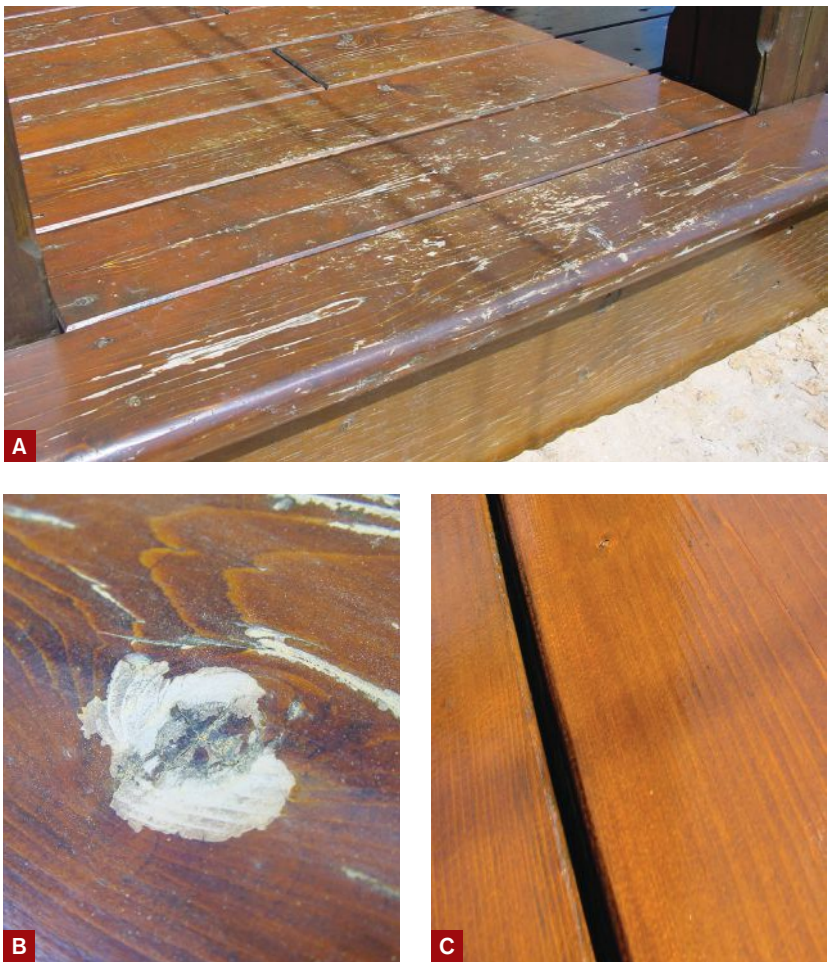

Figure 1. The film-forming finish on this white-cedar decking and PT rim joist is starting to fail (A), particularly around knots (B). After removing the old finish and refinishing with Cetol Dek, the cedar decking looks just like new (C).

Opaque deck finishes are like paints for decks. They completely hide wood grain and that's why some people don't like them. On the plus side, paint-like deck stains offer the highest level of UV protection. That's why the best products look good for five years or more. In my testing, I've found that Cabot Solid Color Oil Decking Stain performs well, but it's currently available only in the central U.S. The acrylic version is available across North America, but it doesn't last as long as the oil.

Elastomeric coatings also fall into this category. Marketed as being a rejuvenating product for older pressure-treated decking with deep weathering and cracks, some coatings have certainly not performed up to expectations. For one thing, they are difficult to apply, and if the decking isn't prepped properly—the substrate has to be bone dry, for example—they tend to fail quickly and dramatically. But I've been impressed with Duckback's SuperDeck Deck and Dock elastomeric coating; I'm four or

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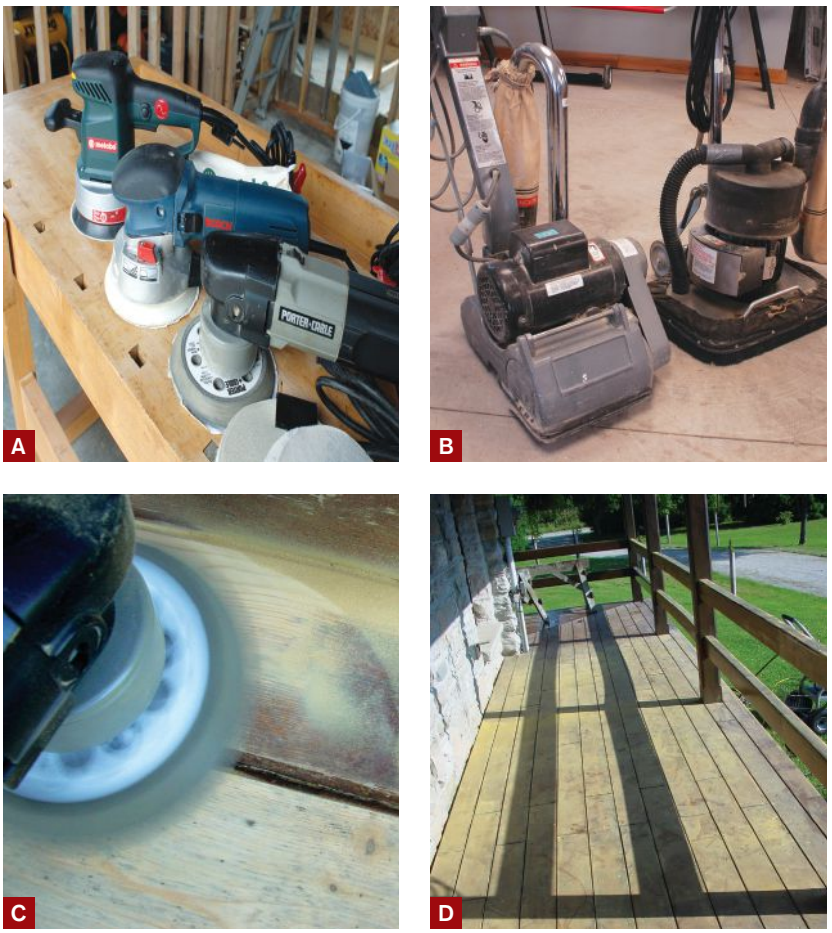

Figure 2. Sometimes a light sanding with a random-orbit sander (A) is enough to prep decking for a new finish. On large decks, you may want to rent a walk-behind drum or orbital sander (B). If fastener heads are flush with the surface, aggressive sanding (C) can remove their protective coating. After scuff sanding (D), be sure to clean up all dust before recoating.

five years into a field test and have been pleased with the results so far.

Prepping the Decking

Refinishing an old deck is similar to finishing a new one, though there are important differences you need to recognize before settling on a strategy. The first is the condition of the existing finish. How bad is it? What kind of old finish are you dealing with? What type of new finish will be applied? Is the wood weathered and cracked?

If the deck finish has lasted decently over the last couple of years and is only beginning to fail, there's no need to strip back to bare wood. Simply sand the surface lightly in preparation for a new top coat of whatever finish was previously applied to the decking. I've found that 120- or 180-grit abrasive in a 5- or 6-inch random-orbit sander works well. Don't sand through the finish; just scuff the surface of the solid-but-failing finish so it accepts and holds a new finish (**Figure 2**).

In those small areas where the finish has peeled down to bare wood (usually around knots), sand off any loose frazzles of finish. Nothing can be left loose. Vacuum up the dust, then recoat with the original product used previously. If the finish is still mostly in good shape, only one coat is necessary. If more than

Two-Step Prep for New PT

Pressure-treated lumber is the trickiest outdoor wood of all to finish well because different species and versions can have different types of treatment applied at the factory. In addition to the preservative chemicals within all PT lumber, some brands have surface treatments to repel water. You've probably seen how water beads up on these boards when they're new. The idea is to make the wood perform better when bare, but surface treatments will cause premature finish failure unless you deal with them correctly.

No finish can bond to wood that has been treated to repel water. The solution is surface preparation that's effective and reasonably fast. According to a five-year study by the deck-finish manufacturer Akzo Nobel, sanding does more to boost absorbency than any other deck surface treatment. Sanding alone, however, is slow, and it can't get into all nooks and crannies of a deck.

This is where two-step prep comes in. Pressure washing with plain water followed by sanding with a 60- or 80-grit abrasive after the wood is thoroughly dry hits the sweet spot of efficiency and effectiveness when it comes to deck prep. —*S.M.*

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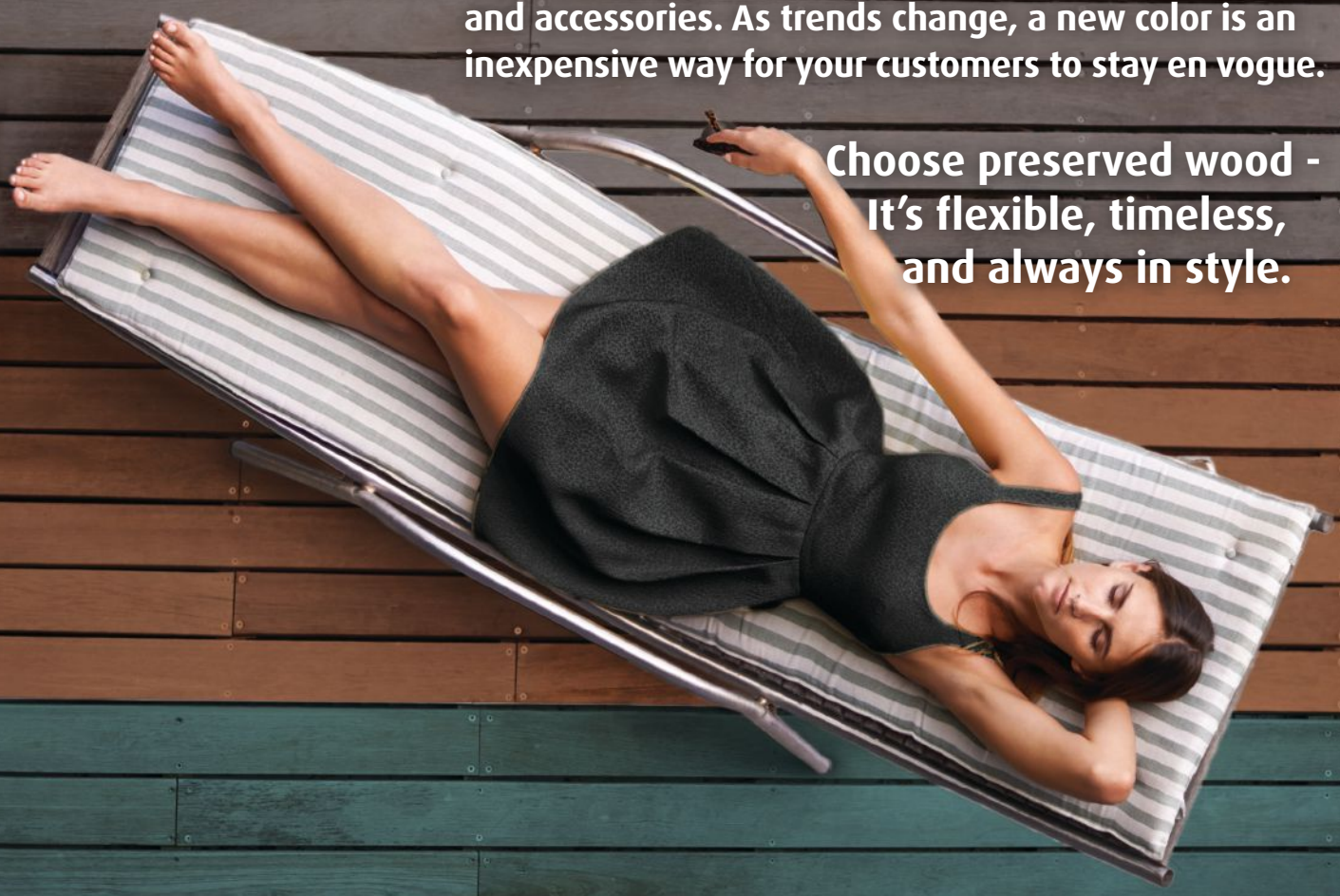

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Figure 3. After removing the old finish, you may need to use a deck brightener to return color to weathered, gray decking. Some brighteners contain oxalic acid and need to be neutralized afterward, but the author recommends Duo Blast, which isn't harmful to plants and requires only a water rinse.

20% of the surface is bare wood, apply two coats. Don't coat more than twice since too much deck finish can encourage peeling by trapping moisture in the wood. In fact, over-coating is a common cause for deck-finish failure.

By the time most deck owners get serious about refinishing, the decking is already suffering from a complete finish failure. To make the wood look good again, you'll have to remove all traces of the old finish and gray wood. After that, the finishing process is the same as if you are dealing with new lumber.

Exactly how you strip off the old finish depends on the size of the deck and the equipment you have available. You could simply sand to remove the old finish, but the fastest approach usually involves a water-soluble chemical deck stripper, such as Extreme Solutions EFC-38 or Restore-A-Deck. Neither of these work perfectly, but they are relatively benign (especially compared with strippers that contain methylene chloride) and are about as good as strippers get. I apply these strippers with a brush or a roller, then clean them off with a pressure washer.

You'll still need to finish up with sanding, and the end result should look pretty much like a deck made of new lumber. The only difference might be if there are deep cracks caused by weathering. If the gray color runs deep and persists after sanding, a traditional deck brightener can be used. In many cases, you'll need to use a neutralizer afterward to balance the pH, as most brighteners contain oxalic acid. I've had good luck with an oxygen-based mold-stain remover called Duo Blast, which works exceptionally well on weathered wood with no need for neutralizing. It also poses no threat to plants, making it a good choice when the deck is surrounded by expensive landscaping (**Figure 3**).

A Deck Finishing Myth

Many people believe that finishing a deck extends its working life and prevents rot. This isn't as true as it seems. Keeping a deck finished will prevent surface cracks from forming in bare deck boards, but it won't do anything to prevent ordinary rot. The rot resistance of a deck has more to do with a design that minimizes wood-to-wood contact areas in the structure than it does with deck coatings. The faster a deck dries out internally after rain, the less prone it is to rot. Finishing a deck just makes it look nicer. —*S.M.*

Pressure Washing

A pressure washer is a nice tool to have for preparing a new deck for finishing, but it's virtually mandatory for stripping an old deck finish. Gasoline-powered versions speed up the work considerably because they deliver a greater volume of water at considerably higher pressures than electric models. At minimum, the pressure washer should put out at least




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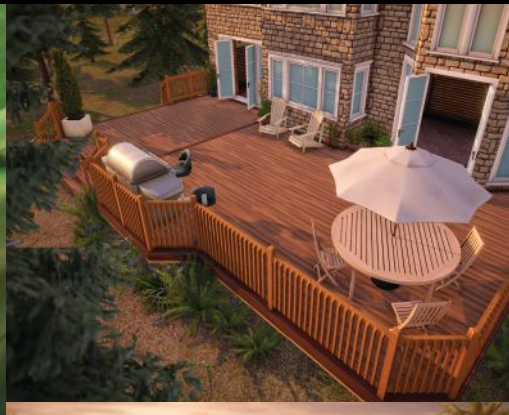


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Figure 4. Pressure washing is effective at removing dirt and failing finishes (A). Be sure to match the tip size (B) to the operating pressure of the unit to avoid damage to the wood (C). After power washing, use a sander to remove the fuzzy wood fibers that have been raised during the process (D).

2,000 pounds per square inch (psi) of pressure; 3,000- to 4,000-psi units are even better.

Pressure washers can easily damage decking if you let the tip come too close to the wood. I recommend using the largest and lowest-pressure tip at first, holding the spray wand at least 18 inches away from the wood, and changing to a more aggressive tip incrementally and only if more power is needed (**Figure 4**).

Pressure washing removes grit (on old decks) and sawdust (on new decks). It also helps break down surface burnishing and repellent treatments that could impair finish absorption.

After pressure washing, a light sanding ensures full absorbency and gets rid of fuzzy wood fibers that might have been raised by the washing. For final cleanup after sanding and before finish application, a gas-powered leaf blower is a great tool.

Moisture Testing

Once upon a time, common wisdom said to wait a year before finishing a new deck, allowing time for even the wettest lumber to weather and dry out. But why wait when you don't have to? Moisture meters are relatively inexpensive and effective at determining the moisture content of wood. Besides reducing the risk of premature finish failure, using a moisture meter makes you look more professional in the eyes of clients (**Figure 5**).

If you're dealing with an older deck, a moisture meter will tell you if you've waited long enough after pressure-washing or wet weather to finish the deck safely. If you're finishing a new pressure-treated deck, a moisture meter is even more important. Get the kind with pins that penetrate into the wood, and measure the moisture content on the fresh face of newly-sawn lumber samples. Wet wood can dry superficially and register an appropriate moisture content on the surface (15% or less), while excess moisture might still remain deep within the wood, ready to migrate out and cause finish failure.

Use a Proven Finish

Unfortunately, most deck finishes on the market don't perform well, so you need to be picky about what you recommend and use. Once you've educated your clients about the differences between deck finishes, reliable results ultimately come down to choosing the best product for your particular application (for a survey of 22 popular deck finishes, see "The

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Figure 5. Measure, don't guess. A moisture meter should be used before applying any finish to make sure the moisture content throughout the decking is within an acceptable range, typically less than 15%.

Figure 6. After being refinished with two coats of Cetol Dek, this decking has the patina of fine furniture. The first coat was with dark oak, while the second coat was a natural finish.

Great Stain Shoot-Out," Sep/Oct 2015).

Generally speaking, deck finishes these days last longer and perform better than they did when I began testing them back in 1990. I've already mentioned several products that have performed well in my testing, but you can read a complete list of my recommended deck finishing options by going to my website, baileylineroad.com.

Regardless of which finish you choose, there are three crucial things to keep in mind during application: temperature, sunlight, and technique (**Figure 6**).

For maximum life, apply the finish as close to normal room temperature as possible. Anything colder than about 55°F or 12°C prevents proper drying, while temperatures that are hotter than 80°F (or 27°C) tend to evaporate crucial, volatile ingredients before the finish has cured.

Avoid applying deck stain in direct sunlight if possible. Sunshine can heat deck surfaces far beyond air temperature, boiling off those vital ingredients. Work during shady times of the day or cloudy weather.

As you work, maintain a wet edge if you're applying any sort of finish that forms a surface film. This prevents brush marks and lap marks where one area meets another. The only exceptions to the "wet edge" rule are for Eco Wood Treatment and Minwax Exterior Teak Oil. Both can be applied in full sun, as temperature doesn't seem to matter much, and there's no need to maintain a wet edge.

All else being equal, brush application of deck finishes results in longer life because the brushing action drives the finish deeper into the wood pores. This is especially true with any kind of film-forming deck finish. ❖

Steve Maxwell has been building decks and more on Manitoulin Island, Canada, since 1985.

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Installing a Deck Ledger

Part 2. Use a belt-and-suspenders flashing approach to prevent water damage to the house framing

by Mike Guertin

[Editor's note: This is the second of a three-part series on installing deck ledgers. Part one took a close look at attachment details, while part two explains how to install leakproof flashing.]

The walls behind the ledgers on nearly every old deck I've repaired or replaced in the past 15 years have had some level of water damage due to the ledger cap flashing leaking or poor installation of the flashing. Often, sections of wall sheathing were rotted, and sometimes, the house rim joist was severely decayed. Luckily, in the latter cases, the owners had noticed that something was wrong and had us inspect the decks before they collapsed.

There's no one "right" way to flash a deck ledger. While the International Residential Code addresses ledger flashing, it does so with a performance standard. Rather than providing prescriptive details, the IRC describes the required outcome.

The ledger-flashing requirement is found in footnote "a" under Table R507.9.1.3(1) in the 2018 IRC: "Ledgers shall be flashed in accordance with Section R703.4 to prevent water from contacting the house band joist." The code doesn't provide an illustration for how to detail the flashing. The only other information in Section R703.4 is that a "... corrosion-resistant flashing shall be applied shingle-fashion in a manner to prevent entry of water into the wall cavity or penetration of water to the building structural framing components." The code also notes that self-adhered and fluid-applied membranes shall comply with certain standards, but leaves it to you and your code official to decide how to design and install a ledger-flashing system suitable for your climate.

In dry climates, a simple metal or plastic cap flashing may be adequate to prevent water from contacting the band joist. But in wet climates, and especially where wind-driven rain is common, a more complex flashing system may be needed. I take a belt-and-suspenders approach and add an extra insurance layer. The material cost is negligible in the overall cost of a new deck, and on an average-sized deck, it takes only about an hour to assemble.

I use a three-layer system (see photos on following pages). First, I apply a sheet of self-adhering, self-sealing membrane to the wall before installing the ledger over the membrane. Then I apply "pre-flashing"—a strip of self-adhering membrane that laps over the top of the ledger and extends up the wall. I finish up the flashing installation with L-shaped metal or plastic cap flashing. ❖

Mike Guertin is a builder and remodeler in East Greenwich, R.I.

PHOTOS COURTESY MIKE GUERTIN

First Flashing Layer. Start by cutting the housewrap away from the ledger area and creating a head flap (1). Next, cut strips of self-adhering membrane to apply to the wall sheathing from a roll of ice-barrier waterproof roof underlayment or wide flashing tape membrane. Strips should be at least 3 inches wider than the ledger; lengths about 5 to 6 feet long are easier to handle than longer ones when you're working solo. Score through the release liner using very light pressure to leave a 2-inch-wide strip of the release liner along the bottom edge of the membrane so that later—when the cladding is installed—the membrane can overlap it (2, 3). After removing the wider pieces of release liner, install the strips to cover the wall sheathing at least an inch above the top of the ledger position, 2 inches below the ledger, and 3 to 4 inches past the ends of the ledger, overlapping the pieces by 4 inches or so at joints (4, 5). Use a "J" roller for additional pressure to aid in bonding in cool weather; in cold temperatures, the wall sheathing may require a special primer. Finally, fasten the ledger to the wall framing using the connection details described in Part 1 of this series (6).

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Second Flashing Layer. Before installing the cap flashing, the author pre-flashes the ledger with another strip of membrane or tape to separate the metal cap flashing from the pressure-treated lumber, which reduces the chance of corrosion and backs up the cap flashing in the event it is ever damaged. Cut in 3- to 4-foot lengths (so they're easier to control when being applied), the pre-flashing membrane is sized to extend over the top of the ledger and about ½ inch down its face, and up the wall about 7 to 9 inches. First, score the release sheet 2 inches from one edge, along the ledger-to-wall corner, then fold the ledger leg of the strip up so the release liner is facing outward as the membrane is positioned above the ledger and against the wall (7). With the first strip oriented so it extends about 1 inch past the first flashing layer, remove the release sheet on the ledger leg (8), making sure the strip is snug to the corner where the ledger meets the wall. Then fold the ledger leg down and over the face of the ledger (9). Next, lower the wall leg of the strip, remove the release liner (10), and lift the leg to the wall carefully, starting in the middle of the strip and making sure the membrane is tight to the corner where the ledger meets the wall (11). Don't bridge the corner with the membrane, or it may rupture when the cap flashing and decking are installed. Detail the end of the first strip by making a diagonal relief cut in the membrane at the corner where the top of the ledger meets the wall (12), then install additional strips of membrane along the top of the ledger, each overlapping the previous one by about 4 inches (13, 14).

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Cap Flashing. The IRC requires metal flashing be at least 26 gauge, or 0.019 inch thick (some stock sold at box stores and lumberyards isn't thick enough to meet code). Because the author hasn't found preformed metal or plastic cap flashing with a back leg that's tall enough, he typically bends his own from standard 0.019-inch-thick colored aluminum coil stock. He sizes his cap flashing to cover the top of the ledger with a drop leg of ½ inch or more on the face of the ledger and with a 6-inch or taller wall leg. While a simple "L"-flashing with a wider ledger leg that extends straight out over the top of the deck joists (instead of being turned down over the face of the ledger) is OK, try to limit the ledger-joist leg so that it is ½ inch shorter than the first joint in the decking that covers it. Otherwise, leaves and other debris that fall in the gap between deck boards will be trapped and accumulate, and be difficult to clean out. Prepare the end of the flashing by making a cut at the wall-to-ledger bend and turning down the ledger portion to cap over the end of the ledger (15). Nail the flashing along the top edge with roofing nails made from the same metal as the flashing (16). After folding the housewrap head flap down over the flashing (17), seal the end of the cuts in the housewrap where the pre-flashing membrane laps onto it, using a piece of acrylic adhesive construction tape (18).

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Integrating With Siding Below. When the deck is above grade level, and siding will be covering the wall beneath the ledger, the loose portion of membrane with the strip of release sheet left on (see photos 5 and 6, page 22) can be lapped over the siding to kick out water to the surface. Install the siding (fiber cement, lap siding, shingles, vinyl) up to the ledger except for the last row (19), then fold the membrane strip over the top of the siding and trim off any excess that will show beneath the overlying cover piece (20). After removing the release sheet, bond the membrane down to the top of the siding and install the last row of siding or trim beneath the ledger (21). If you are concerned about trapping water between the membrane and the overlying piece of trim or siding, slip plastic toothpicks between the last piece and the membrane to provide a weep space. At the ends of the ledger, note how the extended end of the first membrane strip applied to the wall laps over the top of the siding. Any water that gets in at the butt joint between the siding and the end of the ledger will drain out on top of the siding where it won't do any harm (22). If the deck is at grade level and there are only a couple of inches of wall sheathing below the bottom of the ledger, the bottom of the first flashing layer can be bonded down and a piece of trim installed to cover it.

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Common Deck Defects

Here's a look at the framing and flashing details that contractors keep getting wrong

by Bruce Barker

As a home inspector, I examine decks almost every day. Usually, I do this as part of a home inspection following the American Society of Home Inspectors' Standard of Practice for Home Inspections (ASHI SoP). But as more inspectors become specifically trained in ASHI's new Deck Inspection Standard of Practice, I expect to more frequently see deck inspections that are performed independently from a home inspection.

Most decks that I inspect have multiple defects, some of which present serious safety risks. This isn't a surprise on an older deck, but I've also found serious problems on recently built decks. Because I've already examined defects in deck stairs in a previous article (see "Common Deck Stair Defects," Nov/Dec 2016), I'll focus here on defects in deck framing and flashing.

Contrary to what some contractors may believe, home inspectors would rather not find defects during an inspection. Defects cause problems for everyone: the builder, who faces callbacks and the risk of being sued because of a deck failure; the homeowner, who has a potentially unsafe deck; and the inspector, who is faced with writing up a lengthy report.

I don't consider a "defect" simply a failure to comply with the building code. Rather, I consider it a failure to follow current best practices as presented in the American Wood Council's *Prescriptive Residential Wood Deck Construction Guide*, or DCA 6-15. Building codes are the minimum standard; they are not the standard for contractors who build quality decks. Remember, too, that the building official is not responsible for ensuring that a deck is safe, or even that it complies with local building code. You, the contractor, are fully responsible for both of these. A deck that passes local code inspection may still be unsafe; therefore, I consider DCA 6-15 to be the standard to which all decks should be built, regardless of what might be allowed by a code official.

Deck Ledger Attachment

Most of the decks I inspect are supported on one end by a ledger attached to the building. These ledgers are subject to vertical loads (gravity) that try to pull the deck down from the building,

PHOTOS BY BRUCE BARKER

Figure 1. Older decks frequently have ledgers that have been nailed rather than screwed or bolted to the house (A), but the author sometimes finds this problem on recently built decks too (B). Note the nailed double-ledger connection, which is in the process of separating, in photo (C).

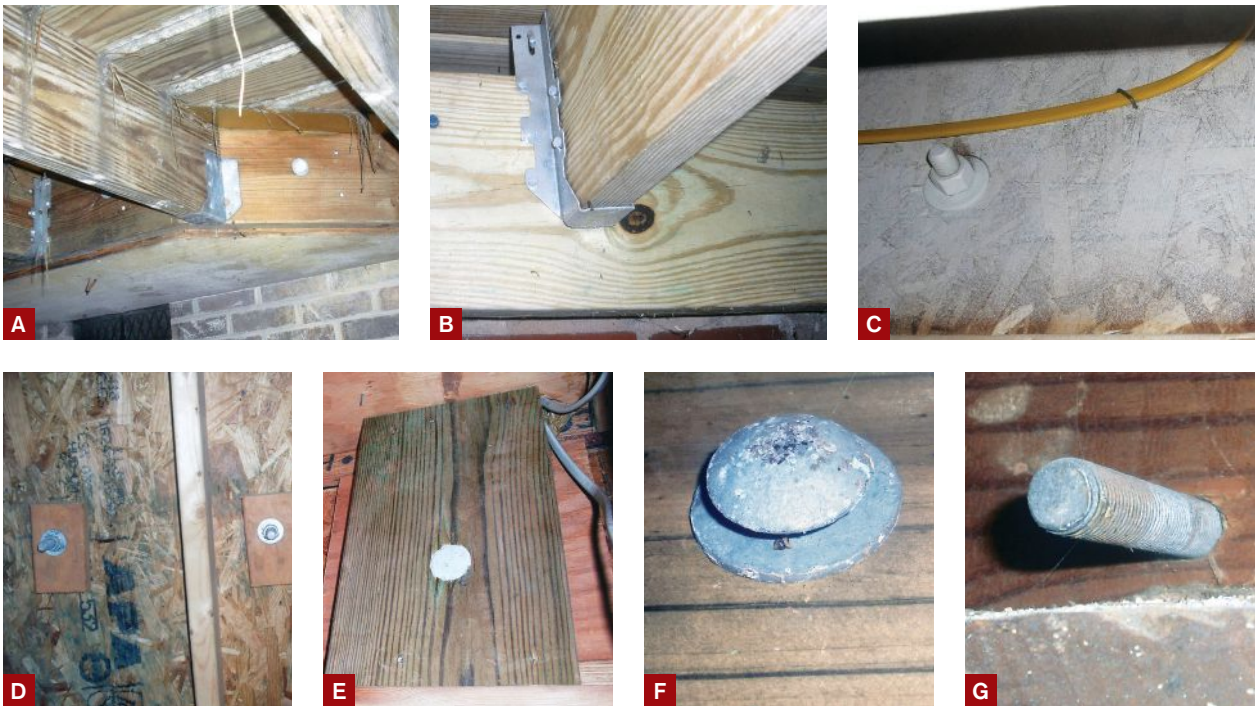

Figure 2. Ledgers shouldn't be fastened to a cantilevered projection (A), to brick veneer (especially with masonry screws) (B), to the web of an I-joist rim board (C), or to OSB sheathing (D). This ledger, on a year-old deck, was fastened to an I-joist rim board with carriage bolts; neither the fasteners nor the method are allowed by code, despite the blocking (E). Adding a washer to a carriage bolt doesn't make the connection code compliant (F), but it's better than forgetting the nut and washer (G). Also note that this bolt is too close to the edge of the rim joist and could cause it to split.

and horizontal—or lateral—loads that try to pull the deck away from the building. The requirement that the deck ledger be positively anchored to the building to resist both loads or that the deck be freestanding has been in the code for many years (R507.8 in the 2018 International Residential Code), but—based on what I've seen—this requirement is still not well understood, and it is still not widely enforced.

For example, surprisingly, I still find ledgers that have been nailed to the framing, which is prohibited by both DCA 6-15 and the IRC (**Figure 1**).

Figure 3. White rust is already forming on this joist hanger, which is only approved for interior use (A). Metal-roofing screws aren't approved joist-hanger fasteners (B), nor are roofing nails (C). All of the holes in metal hardware should be filled with approved hanger nails or structural screws, and the hanger flanges should fit snugly against the joist (D). Metal hardware shouldn't be field-modified; with its seat removed, this hanger provides minimal joist support (E).

When I do, I complete my inspection, then explain the risks to my clients and advise them (and their real estate agent) not to walk on the deck until it is properly attached to the house. In my report, I highlight this defect in red ink to emphasize the importance of this finding and recommendation.

Reactions vary. A few people—usually the agents—believe I'm being overly cautious. On the other hand, most clients seem to appreciate my concern for their safety.

Even when bolts or screws are used to attach the deck ledger to the building, many of these deck ledgers are improperly installed. I've seen plenty of creative—but incorrect—ways to attach a deck ledger to a building. I've discovered ledgers that have been bolted to masonry walls, to OSB sheathing, and even to the web of an I-joist rim board (**Figure 2**).

Another problem is ledgers that are attached to cantilevers. Because cantilevers aren't typically designed to support the loads from a deck, both the IRC and DCA 6 require that the band joist supporting the deck ledger be fully bearing on the structure, effectively prohibiting attachment of a deck ledger to a cantilever.

One of the key details I'm looking for during an inspection is that the deck ledger is solidly attached to a dimensional-lumber band joist or to a 1-inch-thick (or greater) engineered rim board. I also pay close attention to the fasteners, since the primary job of the bolts or screws is to resist the vertical loads imposed on the deck ledger. These fasteners should comply with the requirements in the IRC and meet DCA 6-15 guidelines.

While the bolt and screw rules in the IRC and DCA 6-15 are based on the use of ½-inch-diameter galvanized machine bolts or lag screws, builders sometimes use smaller-diameter fasteners, such as LedgerLoks or Simpson Strong-Tie SDWS and SDWH fasteners. These structural screws need to be installed according to the manufacturer's instructions. You can't simply substitute them one-for-one with the ½-inch-diameter fasteners spelled out in the code. And while larger-diameter fasteners may be used, the location details change (more distance is

Figure 4. The white rust on this ledger bolt indicates that it is still safe but is nearing the end of its service life (A). The extensive red rust on these bolts indicates that the hardware should be replaced immediately (B). Water intrusion is causing wood rot and the red rust on this lag bolt; the connection is likely weakened (C).

required from the edges of the ledger).

Whether or not bolts or screws will provide the necessary lateral load resistance requires a structural analysis of the specific deck. It's a lot easier—and less expensive—to follow one of the prescriptive methods spelled out in the IRC and in DCA 6-15. At around $35 for a set of four SST DTT1Z (or similar) connectors and the necessary fasteners, easy-to-install tension ties are a low-cost way to help ensure full compliance with the lateral-load provisions in the IRC and conform with DCA 6-15.

Joist Hangers and Fasteners

I often find problems with joist hangers and other metal hardware. Sometimes the deck builder has used hangers intended for interior use, when he or she should have used G185 (minimum) galvanized hangers, or even stainless steel hangers in coastal areas. One way to verify that a Simpson Strong-Tie joist hanger is suitable for use on a deck is to look for a Z (galvanized) or an SS (stainless steel) at the end of the model number (**Figure 3**).

It's not unusual to see joist hangers fastened to the framing with roofing nails or drywall screws. Hardware manufacturers typically specify the type and size of fasteners that must be used with their products; in general, screws—except those specifically allowed by the manufacturer—should not be installed, nor should you mix metals.

Curiously, I often find hangers installed with just two or three fasteners. In almost all cases, joist hangers should have a manufacturer-specified fastener in every round and oblong hole.

I often find field-modified hardware too, but in most cases, joist hangers and other hardware should not be bent unless the manufacturer allows bending. Even then, the hardware should be bent only once to the required position.

One of the most important things I look for when inspecting a deck or balcony is white or red rust. White rust appears on metal hardware as white stains, indicating that the protective zinc coating (galvanization) is deteriorating. While white rust indicates that hardware is nearing the end of its service life and should be monitored regularly, significant red rust indicates that the component has reached the end of its service life and should be replaced (**Figure 4**).

Deck Flashing

It won't matter how well a deck ledger is attached to a building if the band joist or rim board it's attached to is water-damaged. The bolts or screws may withdraw from water-damaged wood, and if this occurs, the deck will collapse. Even though flashing details are not spelled out in the IRC, properly installed deck flashing is essential for the long-term structural integrity of a deck (**Figure 5**). Properly installed flashing is also essential for the long-term performance of the building. Water damages building components and provides moisture that is necessary for fungal (mold) growth. Mold claims can be very costly to deal with. Properly installed deck flashing is, therefore, essential on several levels.

When I inspect a deck, I look for deck flashing that is integrated into the wall drainage system and into the flashing for wall penetrations, such as doors, that open on to the deck. The objective is to direct water away from vulnerable wood and away from entry points into the building, but builders often get the details wrong, with serious—and sometimes catastrophic—consequences. Seemingly minor flashing errors can admit a lot of water into a wall assembly.

Deck Inspections

If you're not doing this already, you should recommend or offer an annual

Figure 5. The sheathing and band joists on these homes (A, B) are in rough shape, thanks to moisture intrusion from their decks, and require replacement. Improperly installed ledger flashing on a one-year-old deck was the cause of this water damage (C). Flashing is often improperly installed underneath door thresholds (D) and where ledgers intersect with other building components, such as a roof (E). During a new-home inspection, the author discovered flashing that hadn't been integrated with the water-resistive barrier underneath the home's siding (F).

Cantilevered Balconies

During a home inspection, I pay particular attention to cantilevered balconies and their flashing details, since failure to install proper flashing and ventilation where cantilevered balcony joists penetrate the building wall can contribute to catastrophic balcony failure. That is what caused a balcony to collapse on an apartment complex in Berkeley, Calif., in June 2015, resulting in the deaths of six students.

Cantilevered balconies are vulnerable to deterioration and failure, especially if they are covered on both the top and bottom. The framing that supports these top- and bottom-covered balconies can get wet and stay wet. There is usually no ventilation of these balconies to help the framing dry. This constant wetness hastens deterioration. In addition, these balconies cannot be visually inspected without destructive measures. Deterioration can go on for years until failure occurs.

To head off these problems, I recommend that existing wood balconies that are enclosed be retrofitted with ventilation and inspection openings. These features should also be incorporated into new cantilevered balconies built with wood, along with some version of the flashing details developed by California architect Patrick Burger, which you can find in the *PDB* article "A Path to Safer Balconies" (Mar/Apr 2016), at deckmagazine.com. *—B.B.*

deck and balcony inspection to your clients. This is especially important if the home is near a large body of water or is a rental property. Regular inspections are important to spot visible indications of unsafe conditions and potential failure. A visual inspection is usually adequate for the annual inspection of newer residential decks and balconies. A comprehensive inspection based on the ASHI Auxiliary Standard of Professional Practice for Residential Deck Inspections is better for older decks and balconies, those near water, and those at a rental property. ❖

Bruce Barker is a licensed contractor and certified ICC inspector. He owns Dream Home Consultants, in Cary, N.C.

Editor's note: This article has been reprinted to correct a printer's error in the July 2019 issue.

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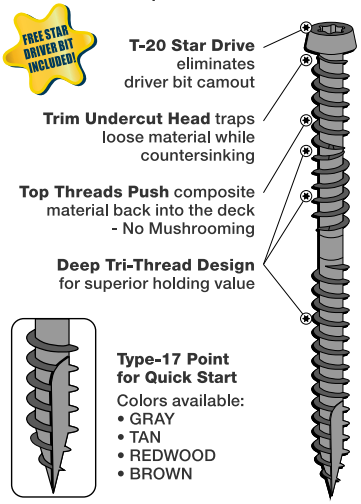

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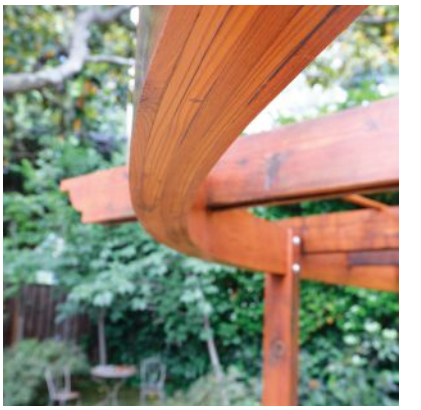


Making a Memorable Redwood Arbor

by David Bullene

Years ago, before California's Filoli estate became a tourist attraction, I spent a lot of time in its beautiful formal gardens. So when my client—a docent at the site, which is now owned by the National Trust for Historic Preservation—approached me about building an arbor similar to one of the structures on the grounds there, I already had an inspired connection to that magical place that I could draw on.

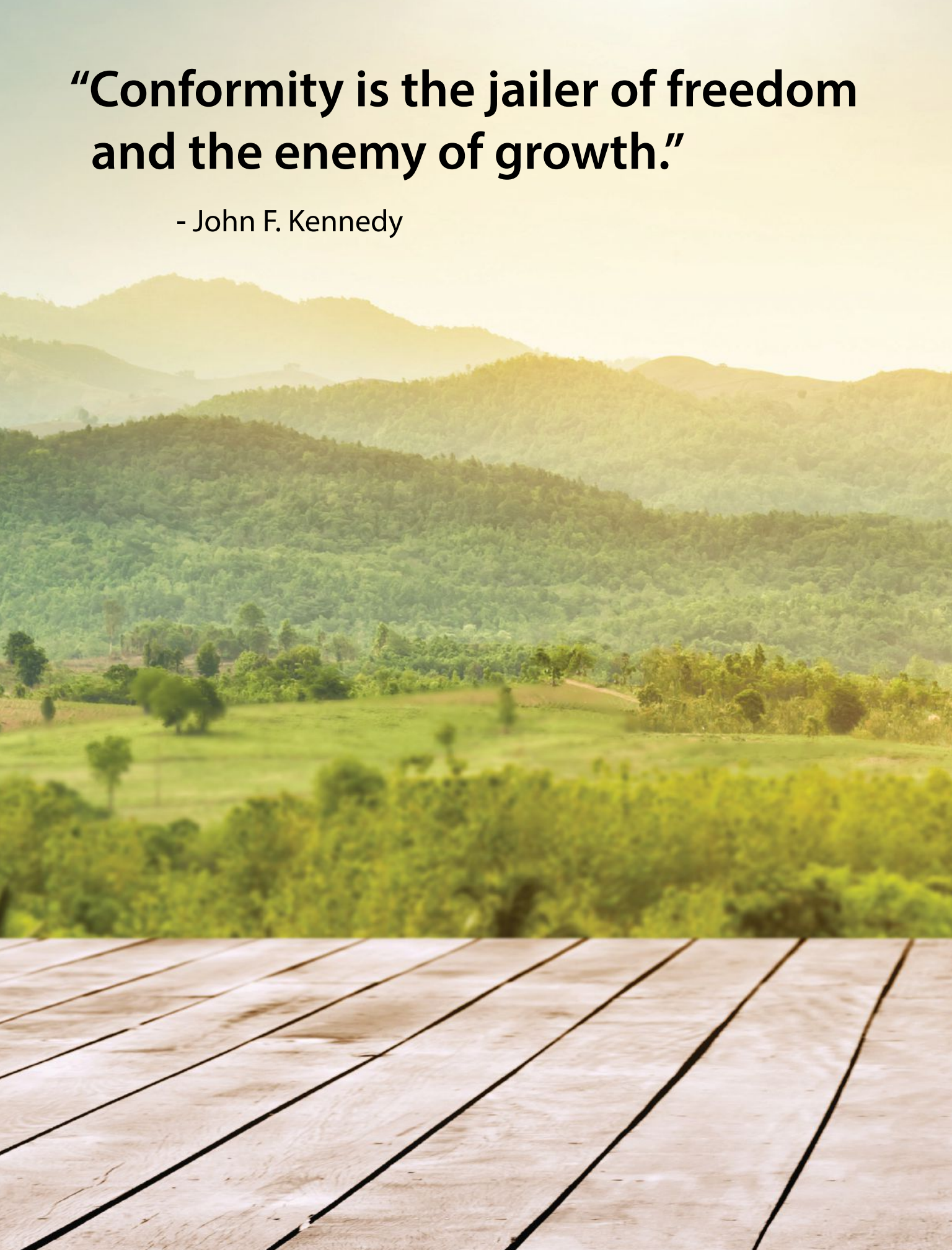
The heart of the design is a 37-foot-long laminated redwood beam, which follows the curve of the home's existing half-round concrete patio. I formed the glulam beam on site, using the patio as my template as I drove stakes into the ground to support the glue-up. The 4x10 beam is made up of six plies of ½-inch- to 9/16-inch-thick redwood, which I planed down from 20-foot lengths of 1-by stock purchased from iconic Redwood Lumber & Supply Company in nearby San Carlos. While the cost for clear, milled-to-spec redwood was prohibitive, we were able to hand select rough-sawn #2 grade redwood at the lumberyard, then mill it on site.

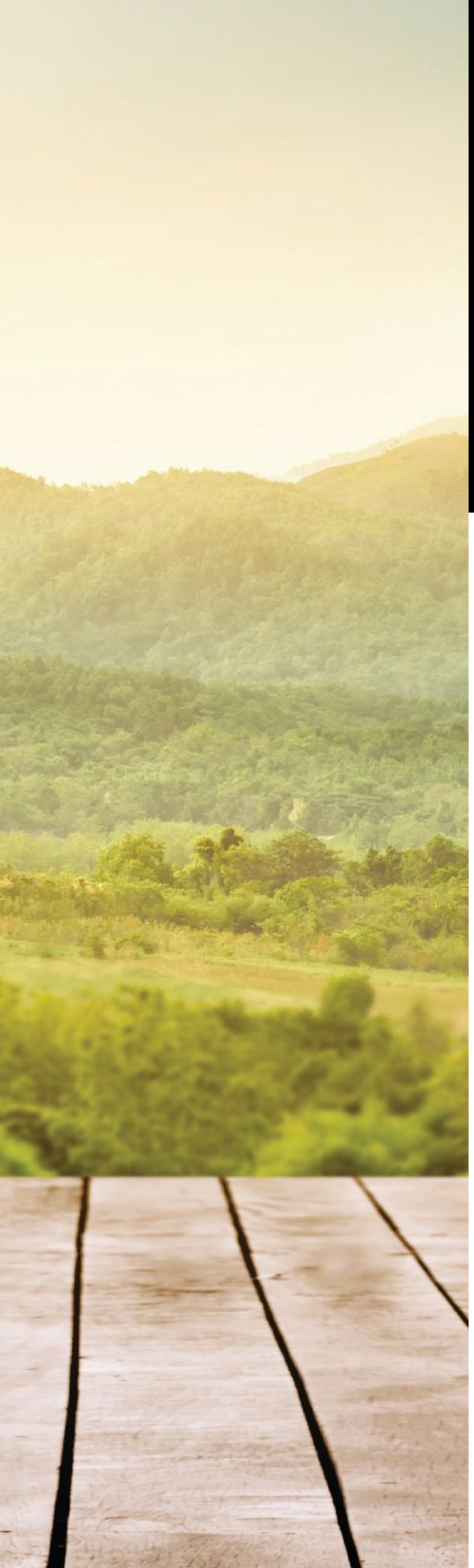
I used Titebond III waterproof glue applied with a roller to bond the laminations together, working from the outside in and gluing together two plies (one lamination) at a time. I allowed each lamination three or four days to cure before moving to the next, and checked carefully for plumb and level at each step of the process to avoid twisting the beam. Afterward, I cleaned up the top and bottom edges with a power hand planer.

The 4x10 arbor framing is supported by 6x6 posts, which in turn bear on 28-inch-deep footings. Before assembly, I sanded the 6x6 columns, 4x10 beams, and 2x8 purlins smooth, starting with a belt sander fitted with an 80-grit belt, and finishing up with a random orbit sander and 220-grit disks. Then I applied one coat of Sikkens clear matte finish. As I assembled the arbor, I filled the screw holes with black-walnut plugs, and then gave everything a final coat of finish. To wrap up the project, I installed 2x2 vine holders across the top of the arbor, for the bougainvillea that my client will plant to add color to the design. ❖

David Bullene is a custom builder living in Redwood City, Calif.

PHOTOS: TONY CANADAS


“Conformity is the jailer of freedom
and the enemy of growth.”
- John F. Kennedy



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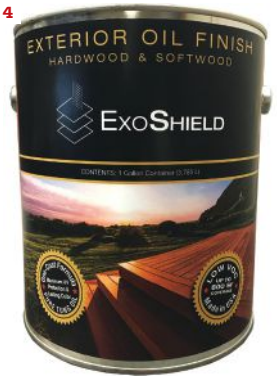

1. Folding Patio Door

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2. Sleek Deck Lighting

Deckorators has collaborated with Hinkley Lighting to provide a line of low-voltage lighting for outdoor living spaces. The Luna Collection delivers a wide selection of 12-volt LED post-cap lights and step lights (pictured) that coordinate with Deckorators composite decking and railing. All options offer solid die-cast-aluminum construction, ease of installation, bright illumination, and a five-year LED and manufacturing defects limited warranty, says the company. Pricing ranges from $60 to $120. deckorators.com

3. All-in-One Heat Pump

Bosch Thermotechnology's new Inverter Ducted Packaged (IDP) air-source heat-pump offers peak efficiency and the latest compressor technology packaged in a single unit, says the company. The IDP features a 19 SEER rating, 12.5 EER rating, and 10 HSPF rating. Its two-way design allows for both horizontal and down flow installations, and it is compatible with most standard 24 VAC heat-pump thermostats. Contact a local distributor for pricing. bosch.com

4. Tung-Oil Wood Stain

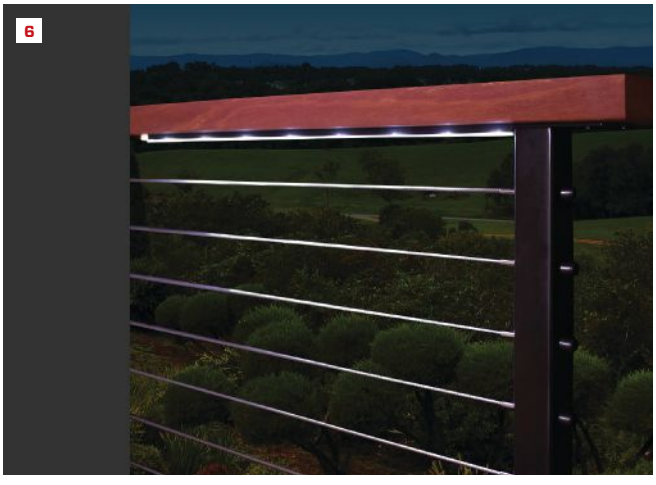
Nova USA says its ExoShield tung-oil wood stain, which is made with a proprietary blend of tung oil, UV blockers, fungicide, and trans-oxide pigments, can be used on siding and outdoor furniture as well as hardwood and softwood decking. The penetrating low-VOC oil finish is available in clear and natural formulations, as well as antique bronze, walnut, black walnut, platinum, and mahogany. A gallon covers as much as 800 square feet and costs $125 on the company's website. novausawood.com

5. Primerless Air Barrier
GCP Applied Technologies' Perm-A-Barrier VPS 30 air barrier is a primerless, permeable, self-adhering air barrier membrane for wall assemblies requiring vapor permeability. The product delivers the same installed performance as the previous Perm-A-Barrier VPS system but now provides an advanced adhesive to enable primerless installation on concrete, CMU, or exterior gypsum. According to the manufacturer, the air barrier's primerless technology cuts installation time by 35%. Pricing ranges from $0.85 to $1 per square foot. gcpat.com/en

6. LED Light Bar
Atlantis Rail's new Micro Star LED light bar is designed to fit underneath a flat handrail, creating a functional and decorative lighting option. Available in 18-inch, 30-inch, and 42-inch lengths, the light bar consists of a powder-coated aluminum channel fitted with a clear plastic lens to protect the flexible, natural-white LED light strip. The fixture is compatible with other Atlantis Rail Micro Star wiring harnesses and transformers and is available in black, bronze, metallic silver, and white. Pricing ranges from $25 to $43. atlantisrail.com

7. Finger-Operated, Locking Drawers
Diamond Cabinets, in collaboration with The Master Lock Company, has launched a cabinet drawer with an installed self-locking mechanism. The Secured Drawer features sensor biometric technology and grants or restricts access with a fingerprint reader. When a user pulls the drawer, the cabinet will open slightly, revealing only the fingerprint sensor and battery. Once the correct fingerprint is used, the drawer will open fully. The product is available in 18-, 21-, and 24-inch-wide base drawer cabinets measuring 24 inches deep. Contact a local distributor for pricing. diamondcabinets.com

8. Drainage Solution
Drainage and stormwater-management provider NDS has launched an attachment for catch basins that deflects debris and prevents clogs downstream. Called the Downspout Defender, the product is made with high-density polyethylene and attaches to homes' catch basins beneath downspouts. Its self-cleaning grate and patent-pending design sheds leaves, needles, twigs, nuts, and seeds, prevents water from splashing back onto building walls, and protects properties by eliminating standing water. Pricing starts at $77. ndspro.com



9. Multicolored Vent Fan
The ChromaComfort ventilation fan is the latest addition to Broan's Roomside series, featuring a fan cover equipped with a ring of multicolored LEDs that can be controlled via an in-wall unit or smartphone app to create custom color schemes. Designed for chromatherapy use in bathrooms, showers, and other high-humidity environments, the fan may be installed in new construction or in retrofit scenarios with an EzDuct Connector, which does not require access to the attic. Pricing starts at $180. broan.com

10. Recessed-Handle Refrigerators
The newest addition to Thor Kitchen's pro-style kitchen appliance collection is the 4-Door French Door Refrigerator with recessed handles. The door's handles are designed to be easy to open and to create a sleek, seamless design for modern kitchens. The refrigerator measures 36 inches wide and 28.7 inches deep, with a 16-cubic-foot refrigerator compartment and two 6.5-cubic foot freezer drawers. The unit comes equipped with adjustable temperature controls, an automatic ice maker, and a door alarm. The refrigerator is available in two finishes and priced starting at $2,500. thorkitchen.com

11. Neutral Quartz Counters
Wilsonart has added six new quartz designs to its surfacing options. Quartz is stain-resistant, nonporous, food-safe, and Greenguard Gold certified for low emissions. The six new tones in Wilsonart's 2019 Quartz Collection include two whites, three grays, and a charcoal black with white veins. Each part of the collection's neutral color range is inspired by patterns and features found in nature. A 52-square-foot countertop costs about $65 to $85 per square foot, installed. wilsonart.com

12. Exterior Awning Kits
Feeney recently introduced a pair of awning kits that can be used to provide weather protection for entryways. The frames are made from powder-coated aluminum, while the canopies are polycarbonate. The canopies are engineered to withstand snow and wind loads of 35 psf and have built-in rain gutters to direct runoff. The awnings are available in two styles: Icon (a contemporary look) and Era (a traditional design). The frames come in 14 standard colors, while customers have a choice of clear, frosted, or gray-tint polycarbonate panels. Contact a local retailer for pricing. feeneyinc.com

Classifieds

Kirby Talks Safety

BY JEFF KIRBY

I'm a project manager for a custom home builder at the Delaware beaches. I usually have several jobsites going on high-end custom homes, and sometimes on commercial fit-outs. I came to this job after working as a superintendent for a large construction-management company in New York City, mainly building high-end office spaces. Some of those projects were large enough that each trade had crews with as many as 20 to 30 people working on them. Managing any construction project can be complex, but throw in the responsibility of maintaining a safe site and your plate is now overflowing, not just "full."

In New York, safety was more formalized than it is here in Delaware on the residential side. I went from a company that had a dedicated "Safety Director" and "Assistant Safety Director" to a company where just one of my many responsibilities is safety.

I have always prided myself on having a clean record with zero safety infractions. To maintain that record, I have a set of site safety rules; some of the basic ones—those I won't back down on and may be tough, even "dictator tough," about enforcing—I'll outline in this article. Complying with OSHA is not the point. These rules protect my crew and their families. They also protect my company from workers' comp and other insurance claims that provide an endless paper chase. I do not have the time to fill out accident reports; I'd rather prevent an accident in the first place. Call it "employment insurance" for everybody involved.

Preconstruction meeting. This meeting is mainly to line-out the crew on the many framing and system details we need to get right. But among the items we discuss, we also cover safety, beginning with the locations of the fire extinguishers and first-aid kits.

First-aid kit. During framing, I usually tuck one out of the way somewhere; sometimes the only spot is in the Port-A-John **(1)**. I also carry one in my truck **(2)**. Smaller jobs require the typical first-aid kit shown here, but on large jobs, first-aid kits can be as big as or bigger than a roll-aboard suitcase. Once a house or project is dried-in, I move the first-aid kit from its glorious position in the Johnny to a central location inside the house. I then review that updated location during the next site meeting.

Fire extinguishers. I make sure everybody knows where the fire extinguishers are. We keep a simple, 20-pound fire extinguisher located at every exit. It's worth checking with your insurance agent: It could save you money. If your insurance company does surprise walk throughs (ours does) and sees properly placed extinguishers, you may qualify for a premium discount.

Clean up. This is my refrain: "Your mother doesn't work here—clean up." It may look like just a harmless empty water bottle lying

The author's crew always knows where the first-aid kit is. Until the job is dried in, the author keeps it in the portable toilet **(1)**. After the job's dried in, he brings it inside and tells everyone where the first-aid kit will be. Having it on site is a start, but it's not enough. Everyone needs to be told where it is, at every step of the job.

The author also keeps a 118-piece 3M first-aid kit in his truck at all times **(2)**. It has enough variety of supplies to be useful in a number of situations. Because it is never not in his truck, he always knows where it is.

Photos: 1 and 2, Jeff Kirby; 4, Nathan Rinne

3

Check the panel on your temporary power first to see if it is GFCI-protected. If it isn't, then see if the quads are. And if those aren't, cords like this Bad Ass Extension Cord (above) now come with in-line GFCI protection.

4

There are also GFCI-protected multi-outlets, like this DeWalt Power Station from DeWalt Shelving.

5

The author requires everyone to wear hard hats until drywall is on every ceiling. The ones shown are Ergodyne Skullerzs.

there on the ground. But if the cap is screwed on, that's no longer a water bottle; now, it's an ankle breaker. Boards with nails in them, core drill plugs, wrappers, cut-offs—clean them up. A clean jobsite is a safe and productive one.

The old saying "perception is reality" applies here, as well. During inspections, building code enforcement officers notice when you have a clean site. It shows that you care, and if you care about keeping the joint clean, you probably care that things are done right. On the other hand, if your site is comparable to a teenager's bedroom, they may think you are lazy or that you don't care. That perception carries over.

Temporary power. First, check if the breaker in the temp panel is GFCI-protected. If it isn't, make sure the quads coming out of it are. And if they're not, use a cord with an in-line GFCI **(3, 4)**. I have never been electrocuted, but I have heard it isn't fun.

Ladders. If I find a green ladder on my jobsite at the end of the day, I will throw it in the dumpster. I don't care if it's brand new. Green ladders are not rated for commercial work. They are not considered "heavy duty." Orange and blue stepladders are the only ones that are acceptable. If you're using aluminum extension ladders, make sure that they are rated for a weight that is higher than your body weight combined with whatever you may be carrying with you. For the life of me, I will never understand why anyone would buy a residential-rated ladder to save $100 and potentially wind up spending days in the hospital. The math doesn't work.

Hard hats. I wear mine, and I require every sub and crew member to wear one until there is drywall up on the ceiling **(5)**. In commercial jobs, they are required until the ceiling is "whited out." You don't want to wear it, that's fine, go home. I will send people home until they come back with a hard hat.

Harnesses and lanyards are required for all roofing and siding work. I also check the equipment expiration dates. I prefer an actual tie-off bracket to an eye-screw bolted into the ridge. If I get push back about wearing it, it's an easy argument: "Are you going to chance living the rest of your life as an invalid? Why would you do that to yourself or your loved ones?"

Construction is risky enough without adding more risk. I want my crew to go home at the end of the day. I don't need the thought of a kid or a spouse looking at an empty chair at the end of the dinner table. I take having my personal name on a project seriously, and I also want my job to be safe and secure and my boss's business and success to be secure.

Jeff Kirby is a project manager with Graulich Builders in Lewes, Del.

September Advertising Index

*Advertising appears in regional editions

BY ELIOT LOTHROP

Bullard's Hard-Boiled Hat

This year marks the 100th anniversary of the invention of the hard hat by San Francisco–based mining-equipment-manufacturer E.W. Bullard, who first patented his "hard-boiled hat" in 1919. A forerunner of today's safety helmet, Bullard's hat was made from steamed canvas, glue, and waterproof paint (with an asphaltic base). On his 1930 patent, he stated, "My invention relates to hats, and especially to those worn by persons working in localities where there is danger of being struck by falling objects ... [the hat shall possess] a sufficient degree of rigidity to protect the wearer and still light enough to be worn without discomfort."

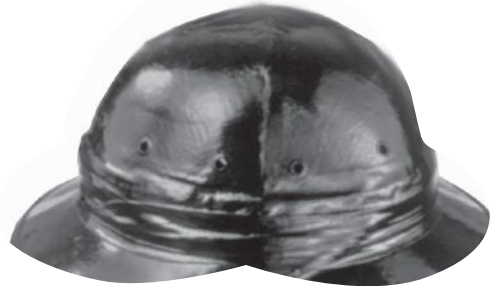
Until the 1930s, wearing personal protective equipment (PPE), such as hard hats, was often considered of a sign of weakness—even cowardice. For hazardous work, workers were known to relent and stuff their hats with cotton or paper to provide some semblance of protection against blows to the head and falling objects. They also made makeshift protective hats by smearing tar on the cloth hats and letting them harden. What made Bullard's hat distinctive was that it was the first foray into the manufacture (and standardization) of safety hats in the U.S. With this, a nascent PPE industry had begun, though wearing head protection routinely would take decades to catch on in industry.

Big projects. When E.W. Bullard returned from World War I, he rejoined his family's mining equipment company. In 1917, the U.S. Navy asked the Bullard Co. to provide it with a protective cap for shipyard workers. Bullard drew upon his experience wearing a "doughboy" (M1917 Brodie) steel helmet to design his new hat. Along with its patented outer, "steam-boiled" construction, Bullard developed an inner suspension system similar to the one used in the Brodie helmet, and thus created the first commercially available, industrial head protection.

The first major project for which construction workers wore Bullard's hat (though not mandatory to wear) was building the Hoover Dam, which broke ground in 1931. The second was erecting the Golden Gate Bridge, which began work in 1933. That project's chief engineer, Joseph Strauss, required the hats to be worn at all times to reduce accidents.

Eliot Lothrop operates Building Heritage, specializing in timber-frame restoration, in Huntington, Vt. He and his crew wear hard hats most days while working.

1



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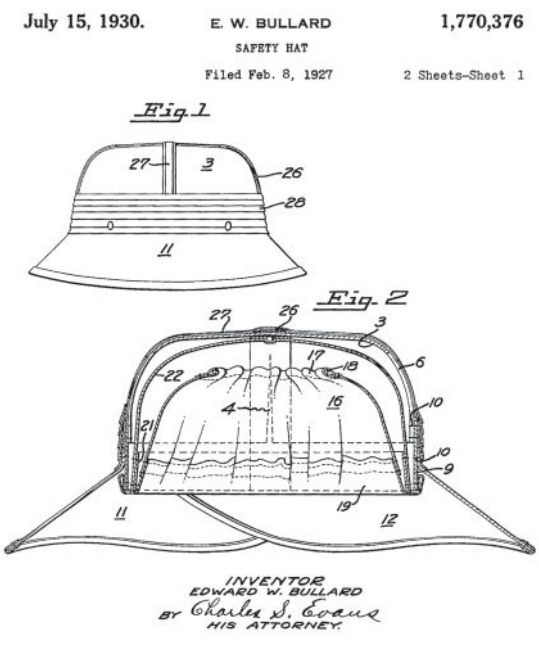

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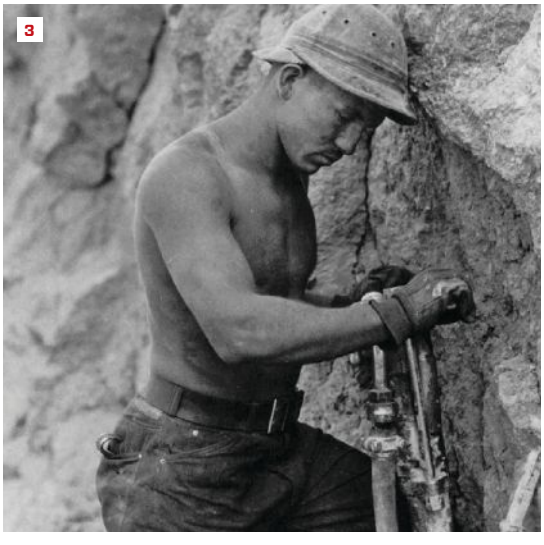

Bullard's hard-boiled hat **(1)**. Patent drawings show a hat that looked more like Sherlock Holmes' deerstalker cap than a modern hard hat **(2)**. The hats were first worn during construction of the Hoover Dam; here, a "scaler" jackhammers bedrock **(3)**.

Photos: 1, courtesy E.D. Bullard Co.; 2, U.S. Patent Office; 3 U.S. Bureau of Reclamation (USBR)

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