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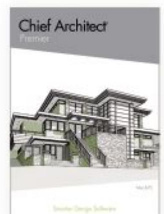
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On the cover: Finding the right-size cabinets is an important step in a kitchen remodel and was especially integral to Roe Osborn's update of a compact kitchen. See the story on page 21. Photo by Gary Striegler.

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AZEK Exteriors

Builder BRAND LEADER 2020

HEAT FORMING PVC TRIM ADDS UNEXPECTED VALUE

Unique design features are a sure-fire way to stay two steps ahead of competitors.

Hany Nasr knows exactly how to compete in a red-hot suburban northern Virginia home construction and remodeling market: you outflank competitors with talent and building innovations they can't match.

Nasr owns and operates **NCD Group** of Arlington, Va., keeping two crews busy working on gut-rehab projects and pop-top home additions. He works hard to differentiate NCD Group in a hyper-tough market. Uncompromising building standards help. The real edge may be his commitment to innovative, let's-see-you-top-this construction applications that win projects and referrals.

CURVED SENSATION

Take a tiny three-bedroom cottage he bought in partnership with another local remodeler, Ryan Rodger, owner, and CEO of Orion of Virginia, as a teardown. Nasr's team built a new 3,830 SF, 5-bedroom/4.5-bathroom neighborhood showcase. The killer exterior feature is a pair of eye-catching, gently-curving trim applications.

"Ryan Rodger came up with the idea, a look he borrowed from his mom's house. Our installer wanted to use sheet goods to piece the curve together," Nasr recalls. "That would have left multiple seams. Thomas suggested a reduced seam heat-bending method using AZEK PVC trim."

Thomas is Thomas Hartman, an area sales rep for AZEK, a leading trim and molding manufacturer. He suggested heat forming the trim in lengthy sections to minimize seams.

HEAT FORMING 101

The team set-up "… on a very cold winter's day in the home's garage," Hartman says. The key to the process is a heat forming kit:

- 2 heat blankets (available in various widths and lengths)
- 2 cement boards or rolled insulation (specifically during cold weather)
- 1 infrared surface thermometer
- 2 clamps
- 1 form/jig that will shape the PVC

The process itself is straightforward, though an experienced trainer is recommended the first time:

1. Create a wooden jig or template conforming exactly to the desired curve.
2. Use the two heat blankets to soften a length of AZEK trim to about 300° F for seven to 10 minutes. The trim will have the consistency of cooked spaghetti.
3. Gently place the softened trim in the wooden template.
4. Clampdown. Let cool. The curved trim will hold its shape indefinitely.

ONE DAY, $1.47 MILLION

"The curved trim helped me sell the home in a single day for $1.47 million. The owner and I will never have to worry about the trim," Nasr explains. "We glued it and screwed it. A hurricane would blow the roof off before that trim would move. And, the owner absolutely loves the look."

Nasr also credits another small but critical feature: the peel-off protective film. "Ryan Rodger and I are very, very fussy about the way material arrives at the jobsite. Trim must be perfect. The AZEK film guarantees that and stays on right through nail eraser. The price difference isn't much. Why wouldn't you use it?"

The easy peel-off protective layer ensures the usual shipping and jobsite panel scratches, nicks, dirtying, and touch-ups are eliminated. It's a simple thing. But it's exactly the kind of quality touch and differentiator Nasr likes to point out at closing time.

Nasr's latest home project is a front exterior makeover. "I still have to add the curved front trim," Nasr says. After all, what better way to stay two steps ahead of the competition?

Photo Credit: Courtesy of AZEK Exteriors

Learn more about the trim heat-forming process at **AZEKexteriors.com**

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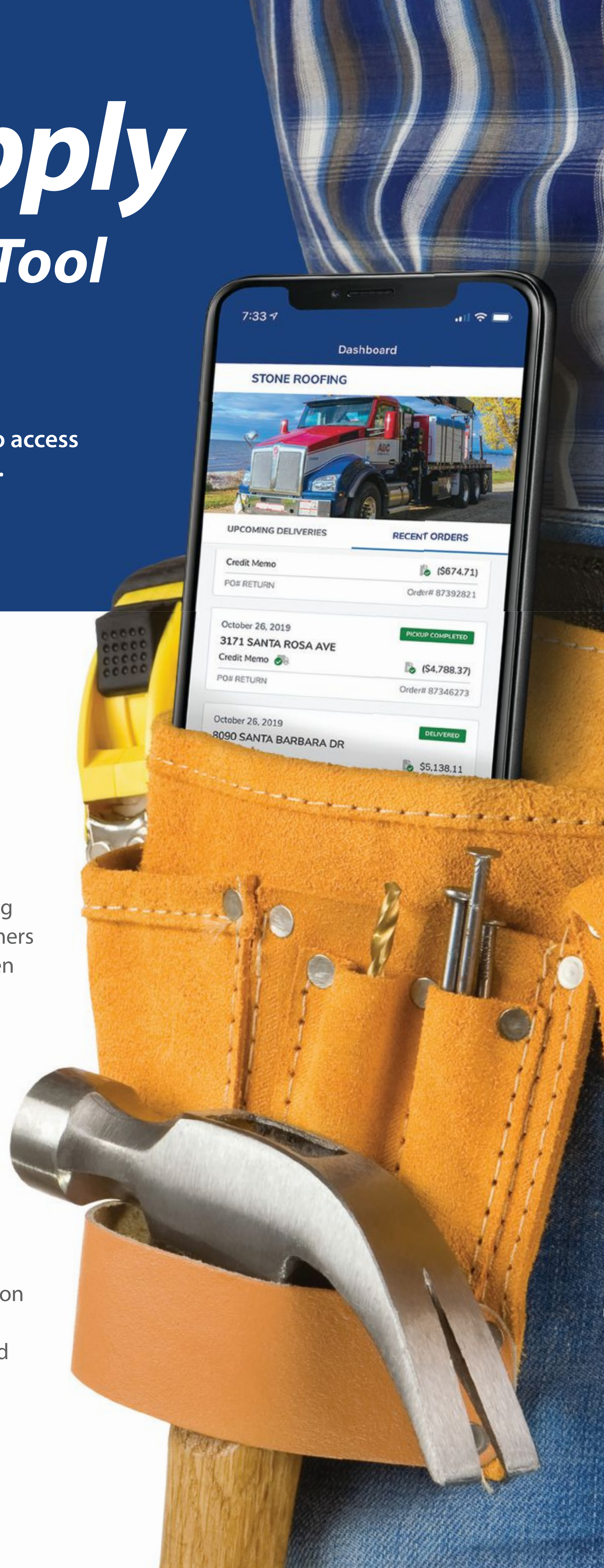

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BY JOHN SPIER

Level, Square, and Plumb

Framing straight and square buildings is simply a matter of following a few fundamental and interrelated rules. There are five basic concepts: level, square, plumb, parallel, and straight. Get any two of the first three, and the third will follow automatically; and anything you make parallel to those three will also be right. Straight is just a further refinement to doing a good job.

Level starts with the foundation or base. If the concrete crew does a good job, you can bolt the sill plates down, and everything you do from there up will be level. If the concrete crew doesn't do a good job, however, you need to start by shimming, planing, wet-setting, or otherwise leveling the plates **(1, 2)**.

A basic rule for tolerances in framing is to aim for perfection at the sills and to accept some inaccuracy as you go up. For example, sill plates and diagonals should be as close to perfect as you can get them, say within 1/8 inch of perfectly level

1


2


3


4


Start with a level foundation—no more than 1/8 inch out of level throughout the building. After confirming that the foundation walls are parallel **(1)**, lay out and snap chalk lines for the mudsills **(2)**. If the diagonal measurements for the opposing corners are equal, the foundation is square **(3)**. If not, you'll need to adjust the wall layout until the diagonals are equal **(4)**.

Photos by Gabriela Gazzo Spier

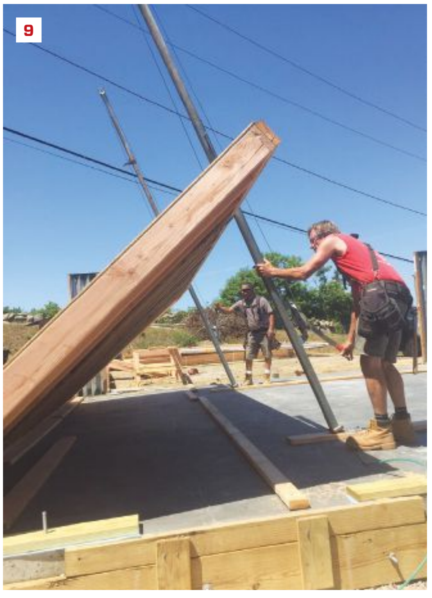
The plate measurements are determined by the layout lines **(5)**. To allow for slight adjustments, cut the plates 1/8 inch short and hold the end studs of butting walls 1/8 inch from the ends of the plates to allow corners to be pulled tight. Before starting to assemble the wall, pin or tack the bottom plate along a straight line. Square up the wall by measuring the diagonals from the corners of the plates **(6)**. As the sheathing is installed, use its edges to keep the studs **(7)** and plates **(8)** as straight as possible.

throughout the building. If things are out by 1/4 inch at the second or third floor, or 1/2 inch in the roof framing, most of us can accept that. There is an important corollary to this rule—errors always seem to multiply, not cancel each other. That's why we aim for perfection in the beginning.

Square and parallel begin at the layout stage. A basic rectangular building will have two pairs of sides of equal length, and the diagonal measurements across the corners will also be equal **(3, 4)**. More complex building shapes can usually be broken down into component rectangles, starting with the largest and adding the details.

You can create this perfect rectangle by starting with two parallel sides and using a construction calculator (or some trigonometry and geometry lessons that you remember from school) to obtain the diagonals. The Pythagorean Theorem ($a^2 + b^2 = c^2$) is the basic formula for square or rectangular buildings. So, if you have the length of a side and the length of an end, multiply each by itself, add the two results, and calculate the square root of the sum. That will be your diagonal measurement. Most of us have long since forgotten how to calculate a square root longhand, but any phone or calculator will do it for you. If you don't have an app that works in feet and inches, you'll need to convert.

Don't try to measure diagonals on a long, narrow rectangle, such as a wall 32 feet long and 8 feet high, because it will be difficult to adjust the diagonals so that they are equal. It's better to break a long wall section into two shorter rectangles, which will result in diagonals with less acute angles that are easier to accurately measure and



After the wall sheathing is nailed off, the wall can be lifted into place on top of the sill plate (here, the author is using wall jacks) **(9)**; leaving the anchor bolts loose allows for adjustment as the remaining walls are raised. Diagonal bracing holds the walls in position **(10)** as the project moves into the next phase: roof framing **(11)**.

adjust. You can also start by trusting the foundation, snapping two sets of parallel sides, checking the diagonals, and adjusting to fit. I sometimes use blue chalk until I'm satisfied, and then permanent red chalk for my final layout.

I almost always snap the inside walls for the sill plates, because the outside lines are too close to the edge, and because I won't be able to see them when the walls are sheathed and stood. Remember that almost all pressure treated lumber is 1/8 to 1/4 inch wider than regular lumber. You can keep the extra inside or out, but be consistent and allow for it **(5)**.

When the foundation is less than perfect, you will have to shift, twist, or adjust the size of the entire layout to fit. It's almost always easiest to expand a building slightly if the foundation is a little bit out of square—that way, you don't need to fight with getting water table trim, siding, door thresholds, and other elements to fit. If it's way out of square, you need to figure out where to hide it, or where it'll be easiest to fix. Often, additions, bump-outs, and wings are not square to the main part of the foundation; you can shift the main rectangle to make these parts fit better.

Most walls are built lying flat, following the same process as for the plate layout. If the plates are exactly the same length, and the studs are all the same, then the top, bottom, and ends of the wall will be parallel. Then, if the diagonal measurements from the corners of the plates are the same **(6)**, the wall will be square. It's good to have the wall fairly square as you build it and to "fine-tune" the diagonals with a sledgehammer right before putting on the sheathing **(7, 8)**.

Plumb. If you start with a level sill plate, and you stand up a square wall on top of it, you will automatically have plumb (vertical) ends. And if everything in the wall—studs, doors, windows, nailers, partition posts—is parallel, then all of it will be plumb, too. If you then build and stand all four walls so that they are level and square, the four corners of your building will necessarily be plumb, and the tops of the walls will form exactly the same rectangle as the bottom sill plates. The corners will be square, the diagonals will match, and the opposite walls will be parallel **(9)**.

Straight is a relative quality control that is incorporated into every stage of the process. When laying out the plates, stretch your chalk lines very tight. Select the best material for your longest sill and wall plates, and the straightest studs for your corners. And before you start building the second floor or the roof on top of your new walls, use string lines and braces to hold them perfectly straight.

Don't trust short walls to stand perfectly plumb—check and brace them. You can tack the sheathing temporarily and nail it off after the wall is braced plumb. Long walls that are going to support opposing rafters should be braced with a slight bow inward in the middle (1/8 to 1/4 inch, depending on length, height, and pitch). The rafters will inevitably push them outward slightly as the building settles **(10)**. Finally, don't tighten anchor bolt nuts completely until everything is nailed together and checked for plumb **(11)**.

John Spier owns Spier Construction, a building and remodeling company on Block Island, R.I.

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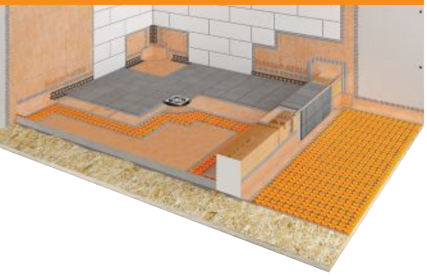

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Q What is the difference between a ridge beam and a ridge board?

A *Cole Graveen, a senior engineer with Raths, Raths and Johnson of Willowbrook, Ill., responds*: Stated very simply, a ridge beam supports vertical roof loads while a ridge board does not. Both are roof framing members that are located at the peak formed where two sloped roof areas intersect. However, a ridge beam is a structural member that receives a vertical load from roof rafters and transmits the load to structural supports. A ridge board is not a structural member; its primary purpose is served during construction to make it easier to install the rafters.

A ridge beam is commonly used when the space immediately below the roof framing is open to the interior, such as with vaulted ceilings. Either a ridge beam or a ridge board can be used with flat, recessed, or tray ceilings that create an attic space between the ceiling joists and the roof rafters.

Ridge beams support the upper ends of the roof rafters (at the peak) and span between structural supports such as posts or columns. If the rafters are simple span members between the ridge and bearing walls (as shown below), the ridge beam will support one-half of the roof area. In order to support the imposed design loads (dead, roof live, and snow), the ridge beam will need to have a larger cross section than the rafters do, and in conventional light-frame construction, it will typically be a multi-ply or engineered member.

A ridge board joins the ends of opposing roof rafters. During the construction of the roof, it supports the peak end of the rafters both vertically and laterally. Typically, the ridge board is set to its intended position and temporarily supported. Then the rafters are placed in pairs, one on each side of the ridge board. This method allows for small offsets between the rafter ends that would not be possible if there were no ridge board and the opposing rafter ends butted up to each other at the peak.

In the completed roof structure using a ridge board, the lower end of the roof rafter is connected to a rafter tie that resists the outward thrust. The rafter tie spans parallel to the rafters and connects each pair of rafters at the bottom end, creating a triangle with the two roof rafters. The rafter tie is in tension, resisting the outward thrust force, while the ridge board at the roof peak is compressed between rafters, serving as an infill piece. Ceiling joists may double as rafter ties.

Ridge Beams vs. Ridge Boards

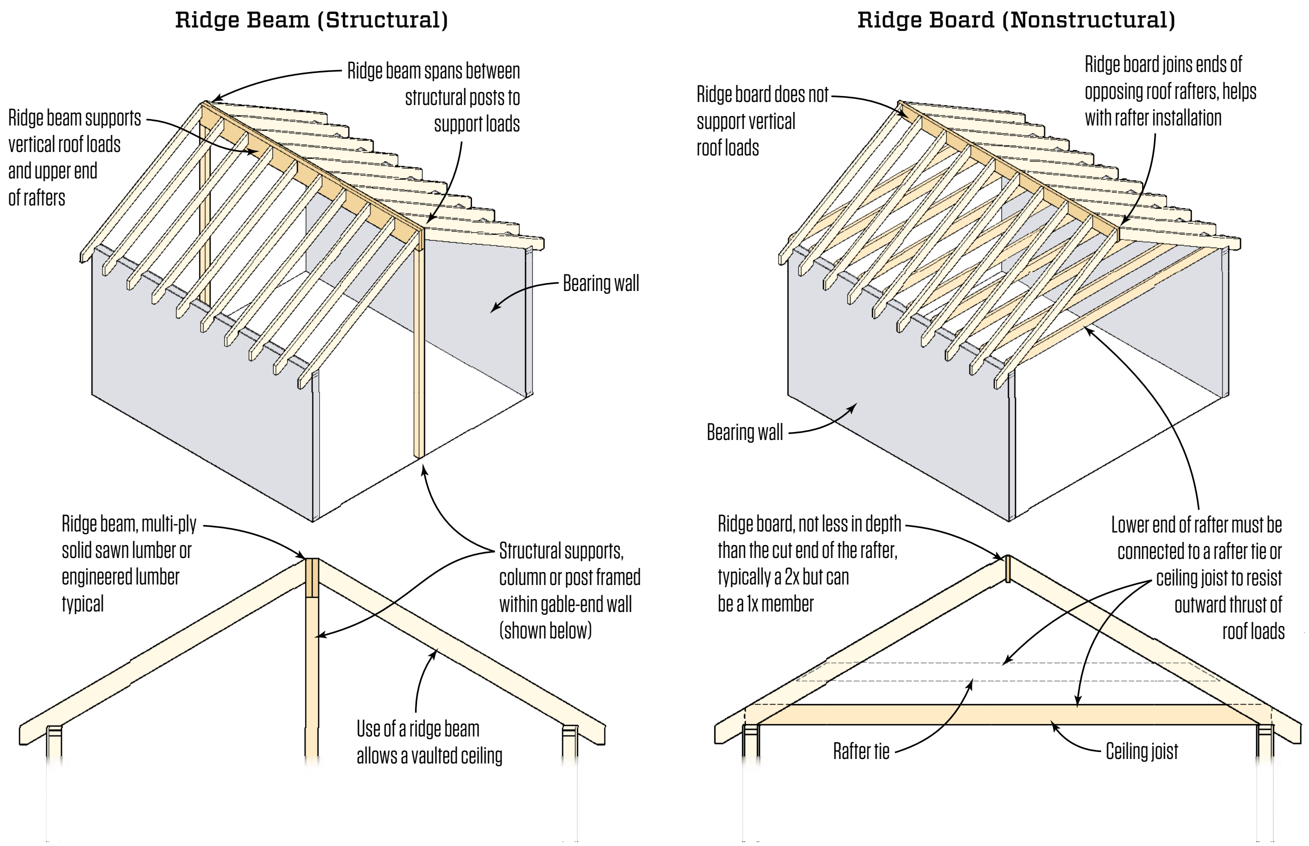


Illustration: Tim Healey

Updating a Compact Kitchen

BY ROE OSBORN

For as long as I'd known her, my friend, Laurie, had talked about redoing the kitchen in her tiny cottage on Cape Cod. Each time the topic came up, I looked around the minute space and just shook my head. She'd always reply, "I have a plan."

New plan on the same basic layout. On a recent visit to the cottage, I noticed that her tone regarding the kitchen upgrade had gotten more serious. Standing in the confines of less than 70 square feet, she gave me her wish list for the new kitchen, which included new, smaller appliances, a dishwasher (she'd always washed dishes by hand), and an added countertop space extending along one wall, with open shelves above.

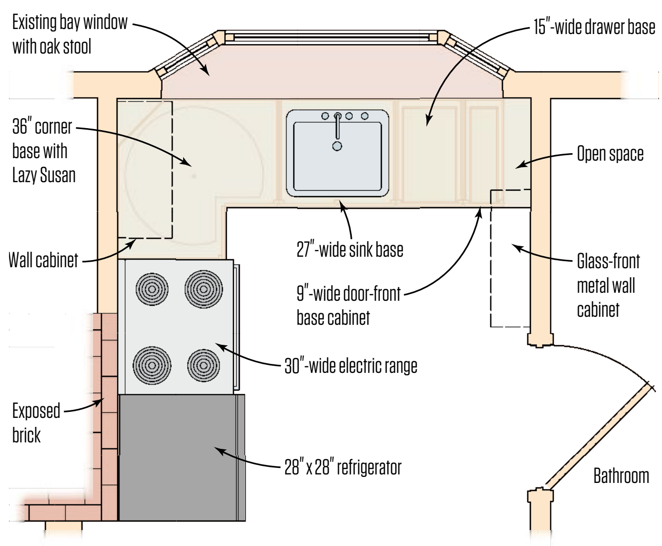
The most prominent feature—and the biggest challenge of this kitchen—was a large bay window that took up the lion's share of the biggest wall. Below the window, the existing cabinets consisted of a 36-inch Lazy Susan in one corner with a 27-inch sink base and a 15-inch drawer base next to it. A narrow door-front cabinet and an odd, unfinished, leftover space completed that wall. Wall cabinets included a stock two-door cabinet on one flanking wall and a vintage glass-front metal cabinet that Laurie had rescued from a friend's trash on the opposite wall.

As I began to sketch out the layout for the new kitchen, I started by reducing the footprints of the full-sized appliances and replacing them with more compact versions. A 24-inch refrigerator would replace the existing 30-inch model, and the stove would shrink from 30 inches to 20 inches. I reduced the Lazy Susan to 32 inches and kept the 27-inch sink base. As a result, I gained space for a 12-inch drawer base between the stove and fridge, a narrow pullout spice rack on the other side of the stove, and an 18-inch dishwasher next to the sink. To make use of the other blind corner, I had just enough space for a 12-inch pull-out pantry cabinet. Enclosing the fridge would allow for extra storage above (see plan on page 24).

Online cabinets. Armed with my sketch, Laurie and I went on a cabinet quest. The budget for this kitchen was limited, so custom cabinets were out of the question. But with all the odds and ends and precise space requirements, we even had to rule out cabinet outlets and big box stores after receiving several proposals that were well out of the budget.

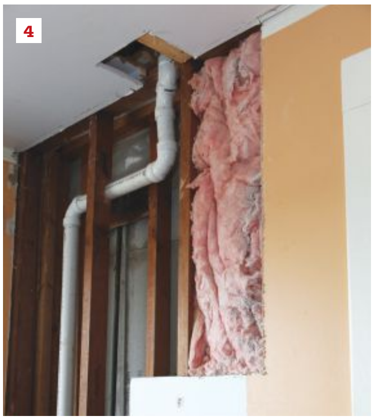
Then I remembered the *JLC* article "Ready-to-Assemble Cabinets" (Dec/16). It included a list of online companies for purchasing cabinets. I went through the list, trying to find a company that could provide exactly what we needed. We

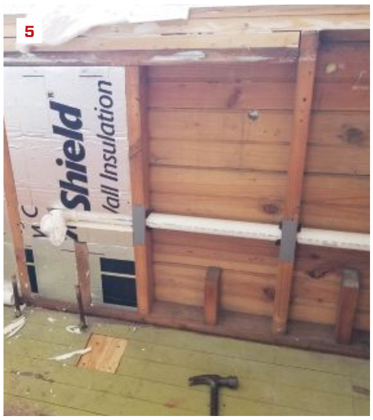
Original Kitchen



Before. Last renovated in the 1990s, the existing kitchen **(1)** had full-size appliances, a tile countertop, and stock cabinets that left an open space on one side that was barely usable.

Photos by Roe A. Osborn; illustrations by Tim Healey





The existing sink was unvented, with an S-trap drain **(2)**. The plumber installed a new P-trap drain **(3)**, which he vented through a shared bathroom wall **(4)** before the open walls were insulated **(5)**.

The vintage, glass-front metal cabinet in the original kitchen **(6)** was relocated and replaced with shop-built oak shelves (shown here without the edging or wall cleats installed) in the remodel **(7)**.

settled on cabinets.com, which seemed to have all the different cabinets on our list. The order arrived on time with nothing missing, including all the various specialty items. Best of all, the cabinets were already assembled.

Adding a sink vent. Just after ordering the cabinets, we brought in a plumber. The first thing he pointed out was an S-trap with an air admittance valve on the kitchen sink drain. Adding a dishwasher would require a new, properly vented sink drain. But with the window in place, the drain would have to travel below the window and into an adjacent wall shared by a bathroom in order to be vented properly.

After stripping the window wall and the bathroom wall back to the framing, the plumber was able to run the drain through the floor, and the vent up into the attic. I took care of drilling the hole in the roof and installing the boot and final length of vent pipe.

Cooking with gas. Part of Laurie's wish list was converting the stove from electric to gas (propane). So the next item on the plumber's list was adding gas lines. This time, his inspection revealed that the existing piping for the cottage's propane heaters was undersized. All of the piping would need to be replaced before the new stove could be installed. Luckily, none of that work impeded the cabinet installation.

Electrical work in the kitchen was minimal. The two sets of GFCI-protected outlets from the original kitchen remained in place. The electrician removed the 220-volt stove circuit, which was no longer necessary, and added a 110-volt receptacle that was required for the new gas stove, as well as a receptacle under the sink for the dishwasher.

After insulating and replacing the drywall on the two walls, the cabinet installation proceeded quickly and easily. I first installed the Lazy Susan and the sink base. Then I assembled and installed the cabinet and side panels for the refrigerator, also part of the cabinet package. The fridge backed onto an existing brick chimney, so I had to anchor cleats to the brick to attach the panels. At the other corner, I set the 12-inch pull-out cabinet in place and then built legs to support the new countertop section that would be installed.

Repurposed wall cabinet and built-in shelves. Laurie insisted that her quirky glass-front metal cabinet be part of the new kitchen. As it turned out, its shallow depth was nearly perfect for the wall above the Lazy Susan. The space next to the opposite side of the window wasn't nearly as wide. The shelves Laurie wanted would need to be custom made to blend in with the window trim. After reviewing several mock-ups, we settled on a detail in which the ends of the shelves tapered back to the window.

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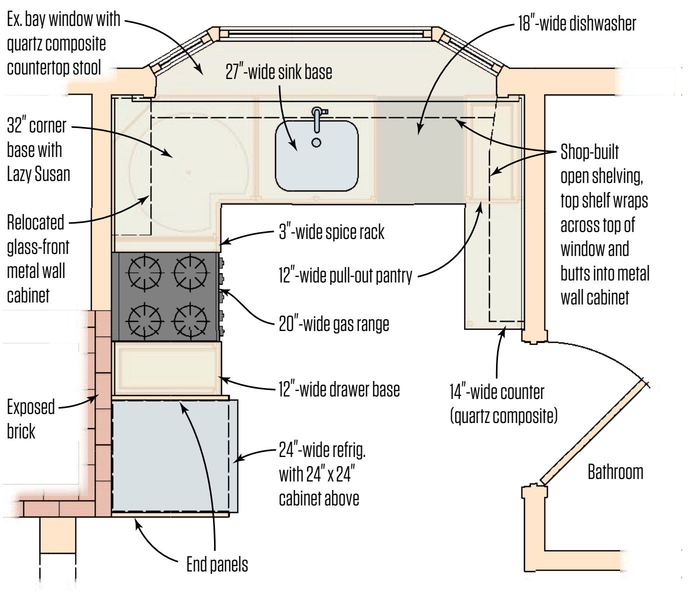
Smaller appliances free up valuable cabinet and countertop space, while the relocated glass-front cabinet fits snugly in the corner adjacent to the window **(8)**. Adding a dishwasher frees up the counter space that had been used for dish draining, and extending the quartz countertop creates a mini workstation above a pull-out pantry **(9)**.

New Kitchen



After. The plan of the kitchen stayed basically the same, but smarter-size appliances and a better cabinet selection made room for a dishwasher and more usable work space.

I fabricated the shelves and brackets in my shop, ripping the shelves from stain-grade white-oak plywood and strengthening them with 1-inch-by-3/4-inch solid oak edging. I used a jigsaw to cut the arched brackets from white oak 1-by stock. The top shelf wraps across the top of the window and butts into the metal cabinet.

Laurie chose a blue-green quartz-composite countertop for the kitchen—perhaps the single biggest extravagance but also the most visible part of the project. This being the last kitchen renovation in her lifetime, I urged her to make a choice that she'd be totally satisfied with. According to plan, the countertop wraps up the backsplash and into the bay window sill; the countertop installers had to work a bit of magic to scribe the quartz around the housing for the casement window cranks.

Despite the similar layout, visually the updated kitchen could not be more different. Visitors now swear that the new kitchen is bigger than the old. And Laurie reports that with the added countertop space, two people can actually work quite comfortably in the tiny kitchen at the same time.

Former JLC editor Roe Osborn is a writer, photographer, musician, and sculptor who lives and works on Cape Cod.

New Life for Old Eaves

BY NICK PORTNOY

One of the challenges in doing an exterior overhaul to an old house is that, more often than not, the house is out of level and you're left, as the builder, to make a judgment call on whether to run the siding parallel to the important benchmarks, such as window head casings, or install the siding level and manipulate the trim back to level.

On this project, we took the latter approach. For the most part, it worked quite well, but I knew that as we approached the eaves, we would ultimately have to resolve both that our siding and wall trim were level while the house was not and (perhaps even more challenging) that the eaves waved up and down like a roller coaster **(1)**.

In this article, I'll walk through the steps we took to build out new eaves that would lay over the old wavy roof edge. I was more than happy to lay over the old soffit and fascia because tearing apart the eaves on a 100-plus-year-old house is an incredibly dirty undertaking and would require opening up the edge of a roof that was otherwise in good shape.

Roller coaster eaves. This house got an entirely new face lift, which included a tear-off and replacement of all the old siding and trim. But rather than demolish the eaves and rebuild them, the author chose to lay over the old eaves with a new assembly.

VENTED ASSEMBLY

After installing new, level siding up the wall, we scribed the frieze board tight into the old soffit to lock it in. We now had a clean slate on which to build a nice, level soffit. The illustration on the opposite page shows the assembly we would lay over the old eaves. Keeping it straight and level on our undulating eaves was the tricky part.

The first step was to add soffit ventilation: We drilled a tight series of 1-inch holes through the old soffit in a line adjacent to the new frieze. We covered those holes with strips of mesh screen (to keep out the insects), and then installed Cor-A-Vent, stapled with 7/16-inch stainless-steel crown staples **(2)**. To ensure a nice, level soffit, we installed the Cor-A-Vent to a level line snapped on the frieze board, although there were some areas where we did cheat level—a necessity since the eaves were so out of whack.

SOFFIT

We milled up a piece of 5/4 primed pine that rabbeted onto the Cor-A-Vent on one

Photos by Nick Portnoy

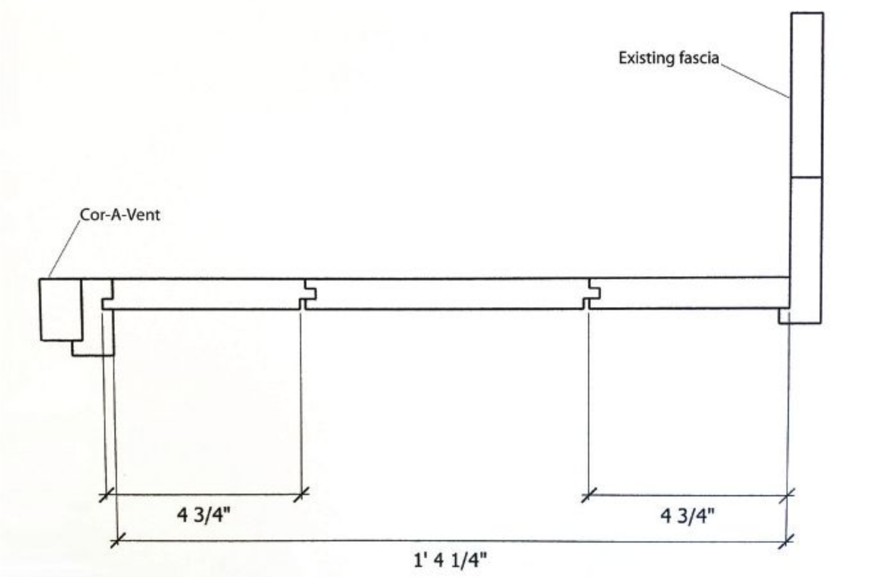
side and had a corresponding groove for the soffit on the other **(3)**. The soffit was wider than a 1x12, and I didn't want to use sheet stock. Instead, we used a preprimed tongue-and-groove shiplap board. It's sold in two sizes—1x6 and 1x8. Since the depth of our soffit was around 18 inches, we used the 1x8 in the middle with ripped 1x6 product on each side. We milled a tongue in the first board that allowed it to slip into the groove of the board (which I will call a frieze mold, for lack of a better term) that covered the Cor-A-Vent.

Soffit support. Because the old eaves were all over the place, there were sections where we cut and installed tapered strips of framing stock to act as a substrate for the new soffit **(4)**. There were also sections where we had to remove portions of the soffit (reluctantly) and sister framing to create the new soffit plane **(5)**.

Adjustments. Also, because the house wasn't exactly straight, we ran a dry line that was parallel with the outside edge of the fascia and set the first T&G soffit board parallel with that. Having the tongue-and-groove connection between the soffit and frieze mold provided some room for adjustment on this. This proved particularly helpful at corners where the boards need to visually align **(6)**.

FASCIA

With the soffit installed, we were faced with the question of what to do with the fascia. I didn't want to demo the fascia in its entirety. There was a relatively new roof installed on this house, and I was concerned there would be nails, which we didn't want to disturb, from the drip edge down into the fascia. Also, because of the irregularity of the old eaves, I didn't want to have to scribe a new fascia board up underneath an existing drip edge. That would have been time-consuming and, frankly, I'm not that patient.



The author's sketch of the assembly he used to lay over the old eaves (top). He started with a line of 1-inch vent holes drilled through the existing soffit, over which he installed bug screen and Cor-A-Vent **(2)**. He then milled a "frieze mold" from 5/4 stock with a rabbet to lap over the Cor-A-Vent and a groove to accept the soffit **(3)**.

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To accommodate the out-of-level eaves, new soffit was supported with tapered blocks in some areas **(4)**, but in others, the old soffit was torn out and a new soffit plane was created with sistered framing **(5)**. Three soffit boards allowed for some adjustment in width, but the boards had to align at corners **(6)**. Part of the old fascia was left in place, ripped level, and joined to new fascia **(7, 8)**. The joint between old and new is flashed with coil stock **(9)**.

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With nail holes filled and the new assembly painted out, the crisp lines of the new assembly come to light **(10, 11)**. When completed with new gutter all around, the 100-plus-year-old home looks as straight and new as the day it was built. You would have no clue that old, multilayered, out-of-whack eaves were behind the new work **(12)**.

12

We decided to leave the top portion of the old fascia in place and ripped the bottom 3 inches off, snapping a cut line parallel with our new soffit. We then milled a rabbeted piece of 5/4x4 stock that lapped our new soffit and sat flush with the existing fascia **(7, 8)**.

To cover the joint between the old and the new fascia, we slid some aluminum coil stock underneath the roof drip edge **(9, 10)**. We secured this with 7/16-inch staples at the location of the rafter tails. This flashing would eventually be covered by the gutter. I told the gutter contractor to look for the staples in the aluminum flashing to know where the framing would be for his gutter hangers.

Finally, because we have all seen aluminum get torn off eaves in heavy winds, we milled a 5/16-inch piece of Azek (from 1-by stock ripped on edge) and slid it underneath the drip edge, lapping on top of the aluminum. This provided the dual benefit of a drip board and a more robust connection of the aluminum flashing.

Once everything was painted **(10, 11)** and the gutter was installed **(12)**, you would have no clue that there was a multilayered assembly behind it.

Nick Portnoy owns Nick Portnoy Builders based in Watertown, Mass.


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BY STEVE EASLEY

Continuous Insulation: Problems and Solutions

If you've watched the evolution of energy codes over the past couple of decades, you've probably noticed an increasing emphasis on exterior insulation for walls. As early as 2006, the International Energy Conservation Code (IECC) specifically referenced exterior insulation as an option in its insulation tables. By 2012, the prescriptive insulation requirements had mandated only continuous insulation options for climate zones 6, 7, and 8. The upcoming 2021 IECC, which recently passed, will allow a "fat" (R-30) cavity insulation option for zones 6, 7, and 8, but it has stepped up requirements in climate zones 4 and 5, where all insulation options require some continuous insulation.

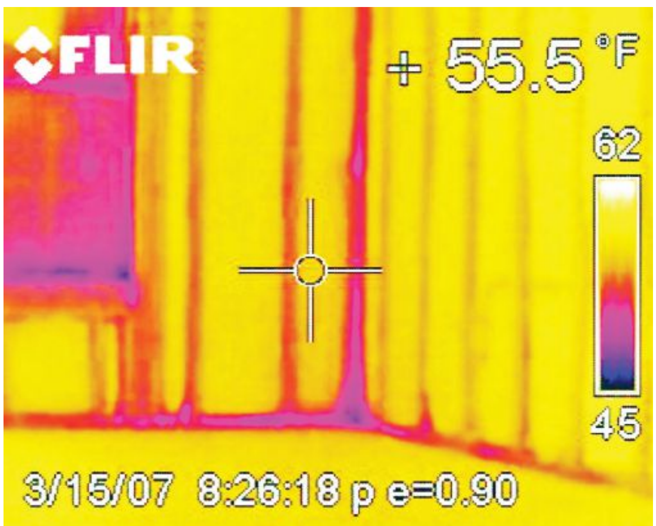
Continuous exterior insulation has advantages. First of all, it substantially increases the true R-value of walls at a fairly low cost. For example, adding one inch of R-5 exterior insulation raises the real (whole wall) R-value of a 2x4 wall with R-13 cavity insulation from just R-10.7 to R-16. Second, most homes have framing factors of 25% (meaning that the true R-value of 25% of the windowless walls is the R-value of the wood, or R-3.5). Exterior insulation reduces thermal bridging across the wall through framing members, and it keeps the sheathing warmer (which reduces the risk of condensation and mold growth on the sheathing).

The practice of applying foam insulation to wall exteriors can be complicated, however, and it comes with some drawbacks. In particular, plastic foam is vapor impermeable, which means walls can't dry to the outside if they do get wet. To avoid callbacks, you have to address water and moisture management with greater diligence when you make the move to exterior foam insulation. And you may have to rethink the way you attach and flash your windows.

THE ADVANCING CODE

In the prescriptive tables of the upcoming 2021 IECC, a combination of cavity insulation with exterior insulation is strongly favored. In climate zones 6, 7, and 8, you can have either R-30 in the wall cavity, or a combination of R-20 cavity insulation with R-5 exterior insulation (R-20+5), or a combination of R-13 cavity insulation and R-10 exterior insulation (R-13+10). In climate zones 4 and 5, continuous exterior insulation will be the only option: R-20+5 or R-13+10. In climate zone 3, you can choose among R-20 in the cavity, R-13+5, or R-0+15. And in climate zones 1 and 2, you can choose between R-13 in the cavity or R-0+10.

Extruded polystyrene foam is rated at R-5 per inch and polyiso at R-6.5 per inch. So depending on the options they choose, builders may need to apply an inch, 2 inches, or sometimes even



Photos by Steve Easley

An over-framed wall like this (above left) is a good candidate for exterior foam insulation. The infrared image (above right) shows the cold studs in a heated house on a winter day. Exterior foam insulation could prevent this source of heat loss.

Studs conducting heat (above left) stand out on a frosty morning. Exterior insulation would eliminate this heat loss. Air-sealing is critical when walls are vapor-closed to the outside. Here, a builder has correctly air-sealed a bottom wall plate (above right).

3 inches of foam. The energy benefit aside, there are practical problems to applying that much foam to a building exterior.

MOISTURE RISKS

In the 1980s, we built a demonstration home at Purdue University that had heating and cooling costs of less than $200 a year. Part of how we accomplished that was by sheathing the exterior of the building with polystyrene. At that time, structural codes allowed us to install wood structural panel sheathing only at the building corners. But modern wall bracing codes in most regions require more extensive use of structural panels, and using continuous structural wood panel sheathing is the best way to get a rigid building. Even though I believe installing exterior insulation is key to getting a high-performing building, there's an increased level of risk when you cover a hygroscopic material like OSB sheathing with an impermeable material like rigid polystyrene foam. To forestall this risk, follow good moisture management principles and inspect everything before cladding is installed.

Moisture problems come from two places—they come from inside the home, or from outside. Interior moisture is the trickiest. Most air has moisture in it, and when moisture-laden air comes in contact with a cold surface, the moisture condenses out and dampens the surface. But if the sheathing has an impermeable layer of foam over it, the building can't dry so well to the outside.

To avoid problems, you need to pay close attention to three things: First, you need to air-seal before the insulation is installed. Most of the moisture that enters the wall cavity from the interior is driven by air currents. Second, don't install vinyl wallpaper on interior wall surfaces. Since the wall can't dry to the outside, you have to give the wall a chance to dry to the inside. Third, you need to reduce the indoor moisture load with ventilation. If enough moisture condenses on the sheathing to raise the surface relative humidity in the 70%-to-80% range, mold can start growing. Effective spot ventilation—good bathroom and kitchen exhaust fans—will go a long way towards reducing indoor moisture levels. Ideally, you should install technology that can automatically sense and control humidity.

The good news is that because exterior insulation is outboard of the sheathing, that sheathing stays warmer. Warmer sheathing surface temperatures mean lower surface relative humidity, so the sheathing is less likely to dampen to the point that it reaches the threshold for mold growth. Even so, when you apply impermeable foam insulation to the outside of a building, you need to be fastidious about air-sealing before the insulation is installed so that air currents across the wall are minimized. In addition, it's critical that the home is watertight before the cladding is installed.

One option is to install the foam board first, then sheathe over it. That lets the sheathing dry to the outside. But if you build in a location where higher levels of wall bracing or shear walls are required, you'll want to check with an engineer to make sure that the shear capacity of your sheathing is adequate. When sheathing is held away from the studs by insulation, its ability to resist racking forces is reduced.

THE WINDOW INSTALLATION PUZZLE

Controlling indoor humidity and building an airtight enclosure reduces the moisture risk from inside the home. That leaves the risk from outside the home—which is primarily found at penetrations like windows, doors, and roof-wall intersections. Most builders have plenty of experience installing windows in a wood-frame

Sheathing can be applied outboard of the foam (above left). This lets the sheathing dry to the outside. ThermalBuck (above right), an insulated window mounting system, creates a positive attachment for the window while limiting thermal bridging.

wall without exterior insulation. But many builders may not have a usual method for installing windows when the wall has been packed out with an inch or two of extruded polystyrene.

And while the code may require exterior insulation, the code doesn't tell you how to fasten and flash the windows into a foam-insulated wall. However, there is a resource for this: a document called FMA/AAMA/WDMA 500-16, which goes by the title "Standard Practice for the Installation of Mounting Flange Windows into Walls Utilizing Foam Plastic Insulating Sheathing (FPIS) with a Separate Water-Resistive Barrier." In addition to following the guidance in this document, you should cross-check the window, housewrap, and flashing manufacturers' guidelines for their products. If there's a conflict, code will defer to the window manufacturer's instructions.

A lot of testing and thought went into the creation of FMA/AAMA/WDMA 500-16. Recognizing that the sequencing of the trades varies from builder to builder, the standard practice offers multiple alternatives for how to install the windows. In one method, housewrap is applied to the building before the window bucks and foam are attached; in another, the housewrap goes on after the bucks and the insulation. In a third method, the window is applied directly to the wall with no bucks. In every case, the flashing and housewrap are designed to direct water down and out of the wall assembly.

Method A. In one version of Method A from the standard practice, the foam is applied directly to the sheathing and the housewrap is applied over the foam. The window buck (termed a "Rough Opening Extension Support Element," or "ROESE," by the document) goes on the wall first. The full sequence is as follows: window buck; insulating foam; housewrap (WRB); sill flashing; window; jamb flashing; head flashing; head tape.

In another version of Method A, the housewrap is applied after the window is installed. In this version, the sequence is: window buck; insulating foam; skirt; sill flashing; window; jamb flashing; head flashing; housewrap (WRB); jamb tape; head tape.

If you are concerned about thermal bridging at the window buck, consider a prefabricated rigid-foam product that is designed to take the place of the wood buck, such as the one shown above.

In Method B, the window is installed into the window buck over the housewrap, and the foam insulation is applied next. This method uses either fluid-applied or peel-and-stick flashing.

Method C takes a different approach, applying the housewrap and the window to the wall before the foam is applied. In this case, there's no window buck.

For added security, I recommend that builders consider a rainscreen wall assembly. With a rainscreen, water striking the cladding has to jump across a $1/4$- to $3/4$-inch gap to reach the weather barrier, and even if that happens, the water just hits the weather barrier and runs down. So rainscreens provide you with exponentially better protection against water getting behind the foam.

Steve Easley is principal of Steve Easley Associates, a company based in Scottsdale, Ariz., that provides building-science consulting, training, and quality assurance for builders nationwide.

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Common Code Mistakes

Ignorance of the IRC is no excuse

BY GLENN MATHEWSON

Photos by Glenn Mathewson

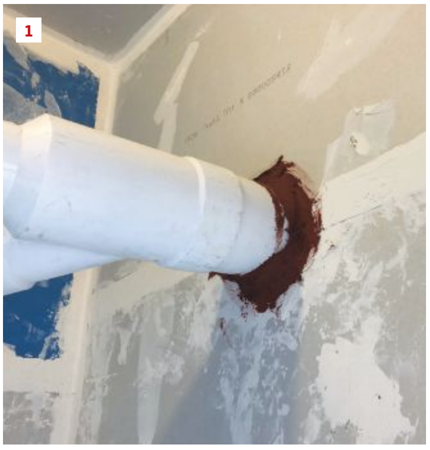
The International Residential Code is widely adopted in the United States, across all but one of the 50 states (what's up Wisconsin?), and though it is amended in an unlimited variety across the country, there are some commonalities that can still be found. Along with these common provisions, there are also common mistakes that can lead to a failed inspection.

These mistakes, however common, are not necessarily obvious. Often mistakes come from impatience and innocent ignorance of the code—and from forgetting that the way we once did things is not always the way we should do things. Based on my experience as a longtime (and former) building inspector, here are some of the mistakes that often get flagged on residential building sites.

FAILURE TO FOLLOW DIRECTIONS

The best way to avoid inspection problems is to both read the manufacturer's installation instructions and keep copies on file. Many failed inspections result from simply not having instructions on site for the inspector to review. Many re-inspections fail as a result of not following the instructions. As smart as many of us think we are, we can all stand to learn something from the product manufacturer.

Consider pipe threads, for example (see photos, above). Of course, the code requires that they be sealed … or does it? For air-admittance valves, it's the manufacturer that calls out the thread sealant between the valve and valve fitting. On the other hand, any



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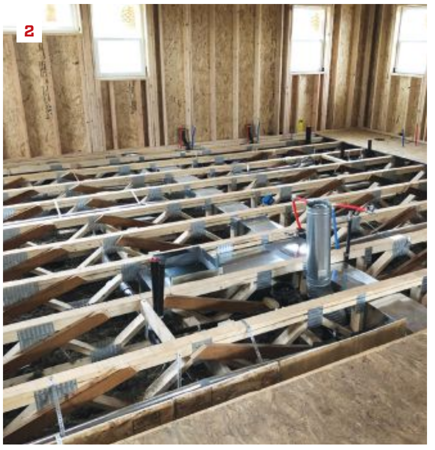

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Fire-stopping materials are intumescent (meaning they expand when heated) products used to stop the spread of fire, smoke, and gas through penetrating materials that can burn or melt in a fire **(1)**. Draft stopping is needed to divide floor areas exceeding 1,000 square feet into smaller, equally sized areas **(2)**. Fire blocking is used to seal up holes through the framing members that divide concealed cavities into separate compartments, to slow the passage of flames and combustion air **(3)**. Acceptable fire-blocking materials include drywall, fiber-cement board, and certain types of expanding foam **(4)**. Filling holes with densely packed fiberglass insulation is OK; loosely stuffing it into framing gaps is not **(5)**.

joint compound, tape, or sealant on the threads of the flare joint on a fuel-gas appliance connector is specifically prohibited in the installation instructions and listing of the product. That's just one example of why it's important to read the instructions and have them available for review by your inspector, in case there is any question. (See "Paper Tools," *Tools of the Trade,* jlconline.com.)

FAULTY FIRE BLOCKING/FIRE STOPPING/DRAFT STOPPING

These three construction elements are one word away from each other, but the relationships end there. To make matters even more confusing, what was once called "fire stopping" is now called "fire blocking." Whether called fire stopping or fire blocking, the practice has been around since the 1800s, when it was first called "filling of walls at floors" before taking on the name fire stopping. In the 1990s, fire blocking became the more common terminology, but it has always been the same thing: material inside the concealed cavities of wood-framed buildings that slows and compartmentalizes the hidden spread of hot gases and fire. A hundred years ago, it was bricks and mortar in the wall; today it can be 2-by wood material, 23/32-inch WSP (wood structural panels), 1/2-inch drywall, or even particle board or an assortment of other materials.

Whichever materials are selected, the care in their installation is more critical. Applying fire blocking isn't glamorous work, so it is often done sloppily, either through lack of skill or lack of interest.

Guards are needed to prevent falls from elevated walking surfaces that are higher than 30 inches above grade. This measurement is taken from a point that is 36 inches horizontally away from the edge of the walking surface, which is why a guard was required for the deck shown here **(6)**. In addition to being located at the right height—between 30 and 38 inches above the walking surface or stair tread—handrails must be easily reached and easily graspable, unlike this one **(7)**. In addition, stair rails must be continuous from the bottom to the top of the stairs **(8)**. This one would clearly fail inspection.

Apparently, that has been true for some time. Consider this quote from a 1920's building code:

> *Because such work does not show when a building is completed, and because its importance is usually entirely underestimated, it is common to delegate it to a boy, or some other careless incompetent person. The result is that the fire-stop [fire blocking] is so in name only; it being merely a delusive imitation which if called upon to fulfill its purpose, fails completely. Such work does not require any high degree of mechanical skill, but it is absolutely necessary that it be done by an intelligent and conscientious workman if it is to be efficient.*

In today's building code, fire stopping is something completely different. The IRC requires certain fire-resistive-rated wall and floor assemblies between different dwelling units, such as the wall in the middle of a duplex, or the party walls separating town houses. No matter how these walls and floors are constructed and from what materials, they must resist the passage of fire from one side to the other. Holes in these walls—for plumbing, electrical boxes, and other features—create paths for gases and smoke to sneak through, so the code requires a "listed penetration firestop assembly." Fire stopping refers to the tested proprietary products that are approved for sealing these holes against a fire and can be anything from a caulk material to a pad of putty that wraps around the back of an electrical box.

Draft stopping is similar to fire blocking but in the IRC, only in reference to the size of the concealed space inside a floor/ceiling assembly. When assemblies such as floor trusses create a concealed horizontal space greater than 1,000 square feet, draft-stopping materials must be used to divide the space into smaller, near-equal areas. [In the IRC, draft stopping is significantly different and simpler than it is in the International Building Code, or IBC, for commercial or multifamily residential buildings.] Draft-stopping materials can be less robust than fire-blocking materials, but if gypsum board is used, it must be the same 1/2-inch thickness, due more to the strength of the product to span the top and bottom truss chords rather than draft resistance. With that consideration, thinner, 3/8-inch WSP sheathing (minimum) can also be used as a draft-stopping material, along with other materials that are approved by the building official.

GUARDS AND HANDRAILS

There are a number of common mistakes when it comes to guards and handrails, but sometimes the mistake stems from simply not knowing what these features are and what each aims to accomplish. Both terms are defined specifically in Chapter 2 of the IRC. A handrail is defined as a "rail" designed for grasping for guidance or support. These are only required at the sides of certain stairs and ramps. Guards, on the other hand are not "guardrails" as is commonly stated, since no "rail" is required.


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When the gap between a supporting framing member and a truss or sawn joist supported by a joist hanger exceeds 1/8 inch, either between the two framing members **(12, 13)**, or between the framing member and the joist-hanger saddle **(14)**, the hanger's published load capacity no longer applies and must be reduced according to tables published by the hanger manufacturer.

As defined by the IRC, a guard is a component or system of building components at the edge of an elevated walking surface to help prevent a fall to a lower level. A guard can be a rail, and—inside of a house—it often is. In deck construction, however, a guard may be a bench with a back, a planter box, a fireplace, a barbecue kitchen counter, or a privacy wall. It just needs to be a barrier that meets the other geometric and structural requirements for a guard.

At the sides of stairs, guards and handrails are often joined together, but they serve separate functions. The top of the guard can also be a functioning handrail, but then the top of the guard must also follow the handrail provisions. This is where things often go wrong.

A guard is simply a barrier, but a handrail is something that must be located, aligned, sized, and arranged to be easily reached and held tight by the hand and to not be obstructive to the use of the ramp or stairway it serves. A person must be able to grasp a handrail, as if it were a pull-up bar, as opposed to pinching it from the sides or hooking it by fingers but no thumb. A handrail also must be continuous from the top to the bottom, such that a person does not need to let go of it or adjust their hand. The ends of a handrail must be turned back to a post or wall or otherwise architecturally rolled out into a larger shape; this reduces the likelihood of the end jabbing something or catching baggy clothes or purse straps. The key concept is that a handrail helps prevent falls not as a barrier, but as a feature to hold on to for stability.

HANGER GAPS

In deck construction, the shrinkage of wet, treated lumber often leaves the joist hovering over the saddle of a joist hanger that was once tight beneath it, but that's not the problem I am discussing here. The gap I am focusing on isn't quite as obvious; it's the gap above your head, between the end of a truss and the girder truss carrying it. Though this gap can appear in floor and deck construction, it is very common in trusses.

Trusses are large and heavy and are typically moved and placed while suspended from boom cables. They are a 3D puzzle of 2D triangles and other shapes. When joined together, they can meet at different portions along their vertical height. Top chords, webs, and bottom chords can—and should—all fit together tightly. However, any twists, curves, bows, or out-of-plumb or out-of-level installations can cause the bottom chords, where the hanger is located, to not meet.

A maximum 1/8-inch gap is permitted in a hanger between the carried and carrying members. When mistakes are made, a gap larger than 1/8 inch can't be feasibly closed, which is why manufacturers provide load reduction tables and repair techniques. When those tables are ignored and the required adjustments are not made, an inspector has no choice but to red-flag the problem.

IMPROPERLY INSTALLED FLOOR OR ROOF SHEATHING

Throwing down sheets of CDX plywood or OSB onto floor joists or roof rafters seems simple and basic, like there is little to consider other than covering the area. At face value, the code provisions and span tables could seem to suggest that … until you read the footnotes.

For example, the footnotes to Table R503.2.1.1(1) require that sheathing be continuous over two or more spans and be supported by at least three rafters or joists. Often overlooked is footnote "c," which states that the spans and loads in the table only apply to sheathing that is 24 inches wide or more; narrower panels—such as at the ridge or at the edge of a floor system—require support from solid blocking or edge clips, depending on the width of the panel and the location. This is identical to what is found in the E30 standard by the APA, an approved alternative to the IRC provisions. Because this is a common mistake, the APA prepared a Technical Note titled *Panel Edge Support for Narrow-Width Roof Sheathing*. Last revised in 1997 but still applicable (and still overlooked) today, this Technical Note offers solutions such as additional edge clips for and blocking beneath noncompliant sheathing.

OVERDRIVEN NAILS

Builders should be familiar with the fastening details for sheathing on exterior walls found in Table RR602.3(1) of the IRC. Sheathing on exterior walls is most likely providing the house with lateral stability. Before WSP sheathing, let-in diagonal braces were notched into the studs to create a triangle and brace the wall. Today, a sheet of OSB or plywood (the technical term is Wood Structural Panel, or WSP) does this effectively, as it's not easy to reshape it from a rectangle to a parallelogram.

Where a WSP-braced wall is most likely to fail is at the nailing. This is where the forces must transfer between the studs and the WSP. When nails are overdriven, it greatly reduces the thickness of WSP they engage. The strength of the bracing follows the weakest connection, so overdriven nails are similar to thinner sheets of bracing. Depending on the depth of the fastener head in the sheathing, this can be a significant reduction. Fortunately, similar to the case with narrow roof sheathing, a technical report called *TT-012: Effect of Overdriven Fasteners On Shear Capacity*, from the APA, Engineered Wood Association, provides detailed

15

16

17

Sheathing that doesn't span more than two rafters or joists **(15)** as required by code can't adequately support a concentrated load. When sheathing is between 16 and 24 inches wide **(16)**, the edges must be supported by clips or blocking; solid blocking is required with narrower panels **(17)**.

There should be a 1/8-inch gap between sheathing joints, which should occur over the centerline of the framing, with nails installed per the recommended nailing schedule and 3/8 inch from the panel edges (seismic and wind zones require closer spacing) **(18)**. Depending on how many overdriven nails there are and how deeply they are embedded in the sheathing, they may reduce the shear capacity of a panel **(19, 20)**.

While fiberglass batts are noncombustible, their kraft paper facings are combustible. Whether located in a semi-enclosed space such as an attic **(21)**, or in an open non-living space such as a garage **(22)**, the paper facing should either be removed (or non-faced batts used) or be in close contact with drywall or another substantial material, rather than air, to reduce the risk of fire.

and reputable information, including guidance about when overdriven depths are not significant and when they are.

EXPOSED PAPER

One of the most common and obvious (at least, it should be) mistakes is leaving the paper facing of kraft-faced batts of insulation exposed. This paper is treated with a bituminous material to function as an effective vapor retarder. The dry paper and vapor retardant are combustible. The warning not to leave it exposed is printed all over it. Even when enclosed in a construction cavity, it must not be exposed to air within the cavity. It must be in substantial contact with another material, such as the back of the wall covering.

In inspection practices for permitted work, inspectors should identify this exposed paper for correction. However, grabbing a roll of insulation from the local home improvement store to install in a cold garage or as an upgrade in an attic or crawlspace is a common DIY, weekend-warrior type of job that doesn't usually include a professional inspection. Though I have found this code violation many times, I have rarely found it during an insulation inspection.

Glenn Mathewson is a consultant and educator with BuildingCodeCollege.com, and a frequent presenter at JLC Live.

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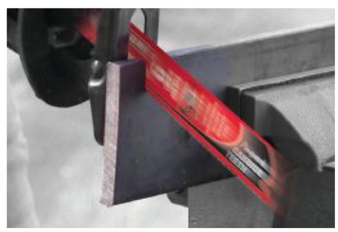

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CARPENTRY

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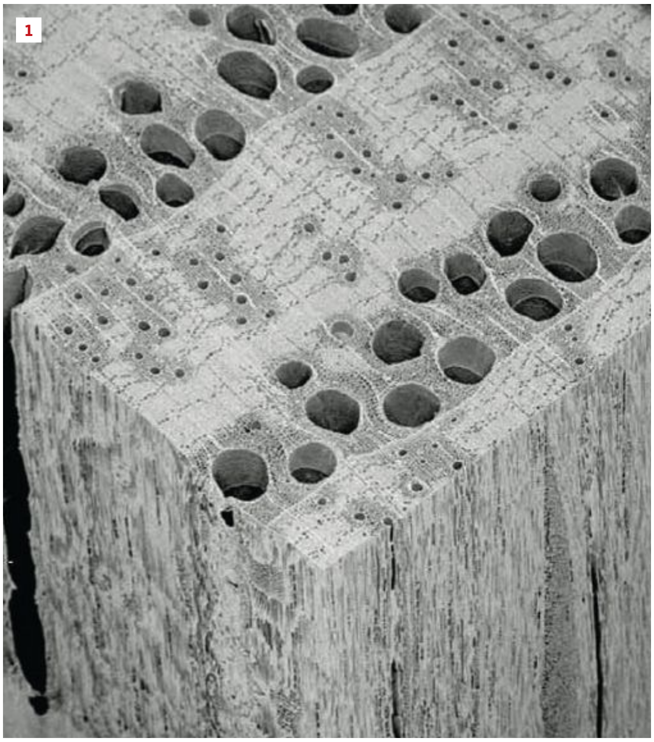
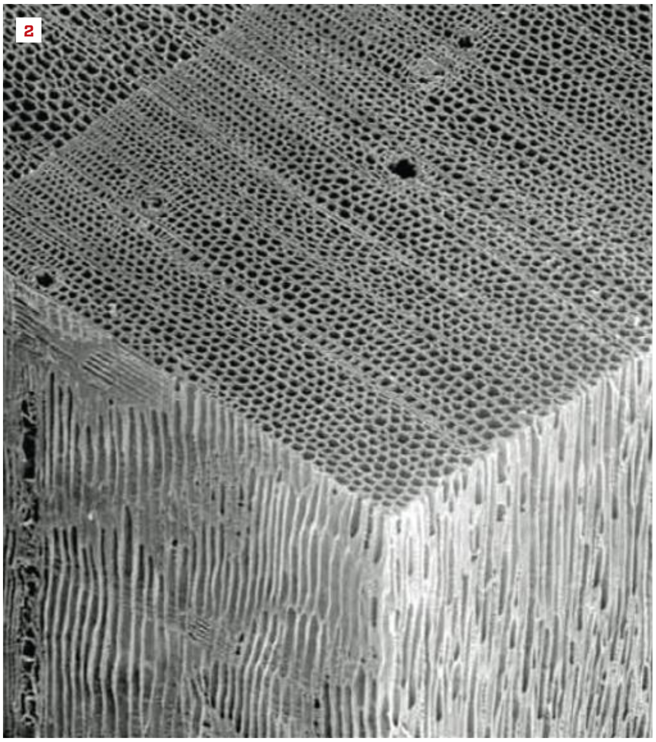
Wood Basics
A primer of how wood works

BY JLC STAFF

Editor's note: The single best resource every carpenter should consult to understand wood is the Wood Handbook, *published by the U.S. Department of Agriculture Forest Products Laboratory (available free online). The current edition is all of 590 pages. The article here is intended as an introduction to the basic properties of wood, and only begins to scratch the surface of the engineering and material-science knowledge in the* Wood Handbook. *Our goal with this overview is to give you a footing on which to explore this extraordinary but hefty resource. Part 2 in this series (to come) will go into greater detail about the dimensional stability of woods. Part 3 will go into detail about the mechanical properties, primarily the strength, of wood.*

Early builders learned by trial and error which wood species to use and which wood from trees grown in certain locations and under certain conditions was stronger, more easily worked—or finer grained—than wood from other locations. White oak, for example, is tough, strong, and durable, which made it a prized choice for shipbuilding, bridges, barn timbers, fence posts, and flooring. Woods such as black walnut and cherry, on the other hand, were primarily valued as cabinet woods. Hickory was made into tough, resilient tool handles. Black locust was prized for barn timbers and trunnels (or "treenails,"the stout pegs used for joining timber frames). Modern research—much of it performed by the Forest Products Laboratory and through wood





In each photo above, the top of each block sample represents the transverse, or "end," surface. On the white oak sample **(1)** the vessels stand out as the most prominent cells. On the softwood sample **(2)**, the corresponding tracheid cells are much smaller in size but make up the bulk of the wood.

research programs at a handful of universities worldwide—has substantiated that location and growth conditions significantly affect wood properties and has given us the means to understand and predict wood performance.

SOFTWOODS VS. HARDWOODS

The differentiation of softwood and hardwood stems from the difference in two broad classes of trees defined by how they reproduce. The softwoods we use for building in the U.S. come mostly from conifers—the needle-leaved evergreen trees, such as pine, spruce, and fir. In botanical terms these trees are gymnosperms, which produce "naked" seeds in cones. Hardwoods come from angiosperms—flowering trees that produce seeds covered by a protective fruit of some sort (nuts, acorns, and samaras—aka "keys," such as those from maple trees—are all fruits). The hardwood trees used for building are typically broad-leafed, deciduous trees, such as maple, birch, and oak.

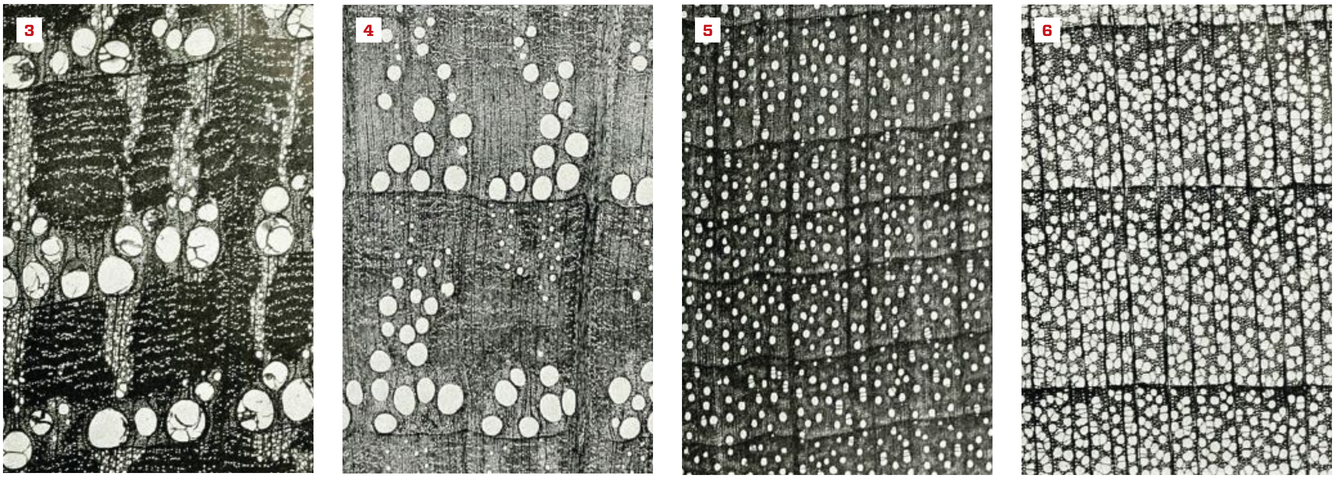
Softwoods and hardwoods have very different component cells (see photos, above). Hardwoods have greater structural complexity with both a greater number of cell types and great variability within the cell types. Softwoods have a simpler, basic structure with only two cell types and relatively little variation in structure within these cell types.

The single most identifiable difference between the two types of wood is that hardwoods have pores (or "vessel elements"). Individual pore cells are separated by perforated plates, and align end-to-end up the trunk. Water is conducted up the trunk of a hardwood tree by passing from pore cell to pore cell, driven through the permeable plates by a combination of the following forces:

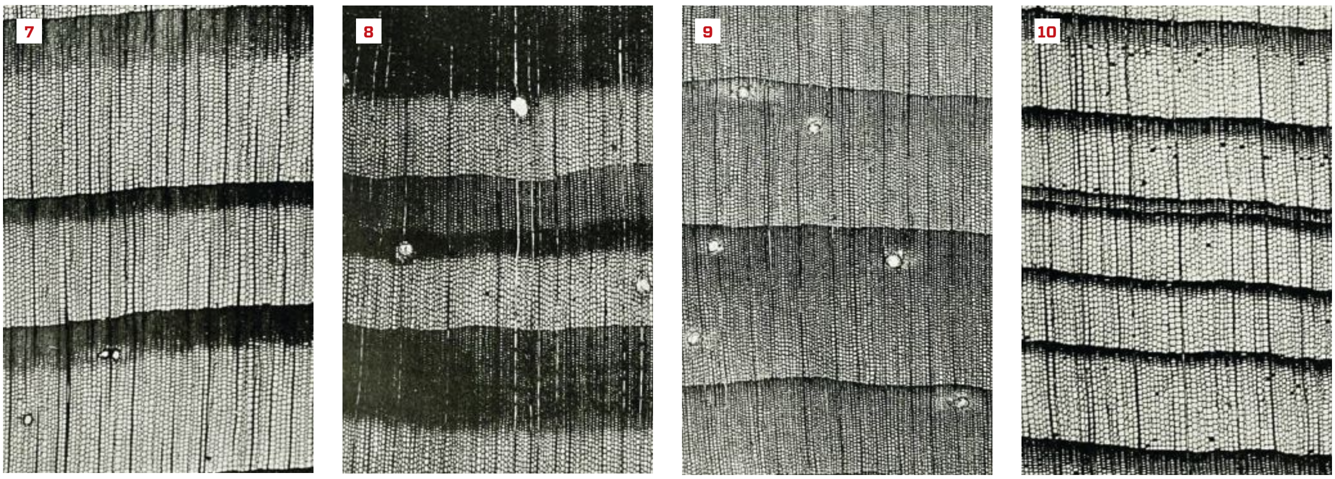
■ Osmosis (the movement across a membrane from a high concentration of water to a low concentration) that pushes water up the trunk, beginning in the roots and continuing cell-by-cell, passing up through each pore cell.
■ Capillary action within the tubular pores.
■ Evaporation pressure, which pulls water up the trunk as water evaporating from the leaves creates suction on each pore cell.

Fibers. The strength of hardwoods comes from fibers—spindle-shaped cells with relatively thick walls and small inner cavities that run vertically around the pores. Wood fiber cells are two to 10 times longer than individual pore cells. The thickness of the fiber cell walls and the mass of fibers surrounding the pores determine the wood's density and strength. Low-density, low-strength hardwoods,

Photos 1-10 courtesy USDA Forest Products Laboratory



Hardwoods (transverse sections). White oak **(3)**; red oak **(4)**; sugar maple—the most common of the maples known as "hard maple" **(5)**; yellow polar **(6)**.



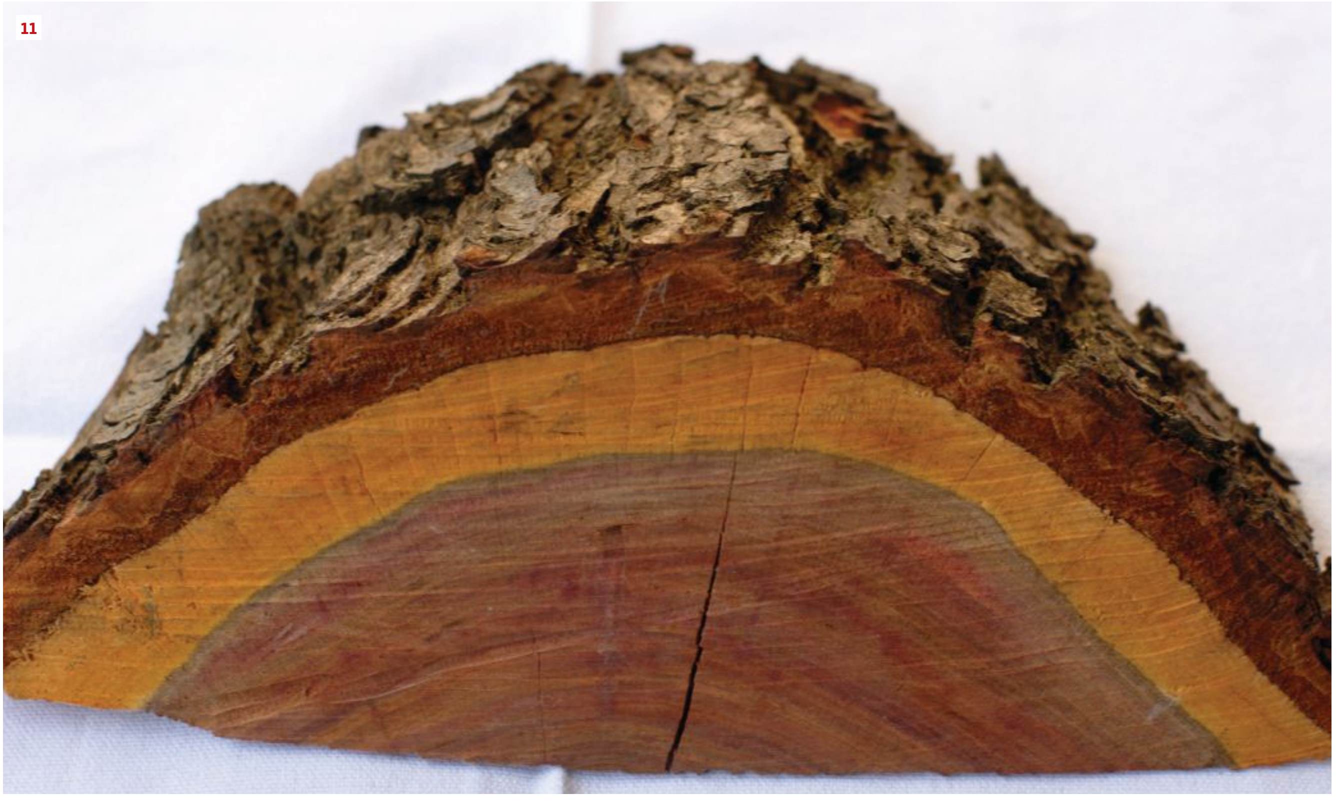
Softwoods (transverse sections). Douglas fir **(7)**; longleaf pine—the most common of the woods known as southern yellow pine **(8)**; white pine **(9)**; redwood **(10)**.

such as cottonwood and basswood, have thin-walled fibers; species with thick-walled fibers include hard maple, black locust, and ipe.

Rays. Fibers are not to be confused with rays. Medullary rays are chains of horizontal cells that extend in bands in a radial direction (perpendicular to the growth rings; in a transverse section, they appear as lines radiating from the center of the trunk). Ray cells in both hardwood and softwood trees serve to store food and distribute it horizontally across the trunk.

Instead of round pores, softwoods have long, rectangular tracheid cells that overlap vertically. These cells serve as both the wood structure and a means to move water. The tracheids have circular "pits" at each end that connect to adjacent tracheids and are covered by a membrane. Water flow up a softwood tree is driven by the three forces described above (osmosis, capillary action, and evaporation pressure), which move water across the pits from tracheid to tracheid in a zigzag fashion through the overlapping tracheids.

Sap vs. resin. Many of the softwoods we use in building also produce resin, which is not the same as sap. All trees produce sap, which is mostly water with dissolved sugars and minerals that serves as the primary nutrient to sustain the tree's growth. Resins,



The sapwood—the lighter ring of wood beneath the bark—is made up of the cells that conduct water (sap) up the trunk. As a tree grows, these cells harden, filling up with deposits of various materials that give the heartwood a darker color and make it stronger and more durable to weathering than sapwood **(11)**.

on the other hand, are secretions from specialized cells within the tree that provide a defense against infection and insects. The resin canals (which are actually voids between cells) are often quite distinct and visible by eye in pines, but they exist in most conifers. (In the photos on the previous page, resin canals are most prominent in the yellow and white pines, but there are a few in the Douglas fir sample, and much smaller but evident in the redwood sample.)

SAPWOOD VS. HEARTWOOD

Sapwood is located next to the bark. It is the active part of a tree that conducts the water (sap) from the roots to the leaves. As a rule, the more vigorously growing trees have wider sapwood layers. Many second-growth trees of salable size consist mostly of sapwood.

Cells in the heartwood, the inner part of the tree, no longer conduct water up the trunk. As a tree grows, the cells harden and fill up with deposits of various materials that frequently give the wood a much darker color. In hardwoods, the pore cells grow tyloses, which appear in the pores like foam. These trap materials (gums and precipitates) and cause the cells to harden, usually making the heartwood stronger and more durable to weathering than sapwood.

Unless treated, all sapwood is susceptible to decay. In some woods, including redwood, western red cedar, and black locust, material deposited in the heartwood makes it heavier and more resistant to crushing than the sapwood.

PHYSICAL PROPERTIES OF WOOD

A spectrum of physical characteristics is available among the many species. Often more than one property is important. For example, when you are selecting an untreated species for a particular use, the wood's texture, grain pattern, or color must be weighed against machinability (does the grain split out when nailed or the surface fuzz up when planed?) and stability (will the wood shrink and warp more than other species for the given use conditions?).

Plainsawn vs. quartersawn lumber. Lumber can be cut from a log in two distinct ways:

■ When cut along a tangent to the annual rings, lumber is called "plainsawn" in hardwoods and "flat-grain" or "slash-grain" wood in softwoods.

Photo: Musskiprozz

Wood Moisture Content Varies With Environment Conditions

Temperature (°F)	Relative Humidity (%)								
	10	20	30	40	50	60	70	80	90
	Moisture Content (%)								
30	2.6	4.6	6.3	7.9	9.5	11.3	13.5	16.5	21.0
40	2.6	4.6	6.3	7.9	9.5	11.3	13.5	16.5	21.0
50	2.6	4.6	6.3	7.9	9.5	11.2	13.4	16.4	20.9
60	2.5	4.6	6.2	7.8	9.4	11.1	13.3	16.2	20.7
70	2.5	4.5	6.2	7.7	9.2	11.0	13.1	16.0	20.5
80	2.4	4.4	6.1	7.6	9.1	10.8	12.9	15.7	20.2
90	2.3	4.3	5.9	7.4	8.9	10.5	12.6	15.4	19.8
100	2.3	4.2	5.8	7.2	8.7	10.3	12.3	15.1	19.5

Wood Shrinkage Values

Species	Shrinkage from green to oven-dry moisture content	
	Radial (%)	Tangential (%)
HARDWOODS		
Cherry, black	3.7	7.1
Maple, black	4.8	9.3
Oak, northern red	4.0	8.6
Oak, white	5.6	10.5
SOFTWOODS		
Cedar, northern white	2.2	4.9
Douglas fir, coast	4.8	7.6
Hemlock, western	4.2	7.8
Pine, eastern white	2.1	6.1

Table 1 (above). The moisture content of wood changes as a function of the temperature and relative humidity. For example, if a space is 30°F and 80% relative humidity (for example, in an attic in winter), the wood there will slowly rise to 16.5% moisture content. **Table 2** (right). Shrinkage values of selected woods along the rings (tangential) and across the rings (radial).

■ When cut radially (parallel or near parallel to a radius of the growth rings), lumber is called "quartersawn" or "vertical-grain" wood.

Quartersawn lumber is usually not cut strictly parallel with the rays, and plainsawn boards are often far from being tangent to the rings. In commercial practice, lumber with rings at angles of 45° to 90° with the wide surface is called quartersawn, and lumber with rings at angles of 0° to 45° with the wide surface is called plainsawn.

Moisture content. Sapwood's moisture content is usually higher than heartwood's (though not in all species). Moisture can exist in wood as a liquid or vapor within cell cavities or as water bound chemically within cell walls. The moisture content at which cell walls are saturated (with "bound" water when no water exists in cell cavities) is called the "fiber-saturation point." This averages about 30% moisture content for all species.

The moisture content of wood below the fiber-saturation point is a function of both the relative humidity and the temperature of the surrounding air. The relationship between equilibrium moisture content, relative humidity, and temperature is shown in Table 1 (above).

Wood in buildings is almost always undergoing at least slight changes in moisture content as the temperature and relative humidity of the surrounding air change. These changes usually are gradual. Short-term fluctuations tend to affect only the wood surface. Protective coatings such as varnish, lacquer, or paint will slow down the moisture content changes but will not stop them entirely. The general goal in seasoning and storing wood is to bring the wood near the moisture content that it will typically have in service. The protective finish then helps to slow down the changes and keep the moisture content within a more stable range over its service life.

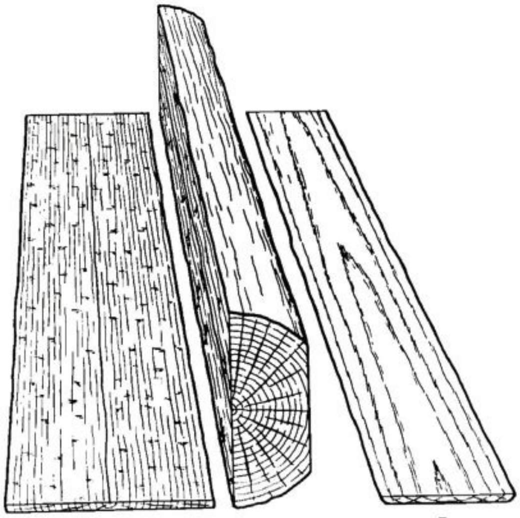
Shrinkage. Wood is dimensionally stable above the fiber-saturation point. But below that point, it shrinks when losing moisture and swells when gaining moisture. This shrinking and swelling may result in warping, checking, splitting, or other performance problems.

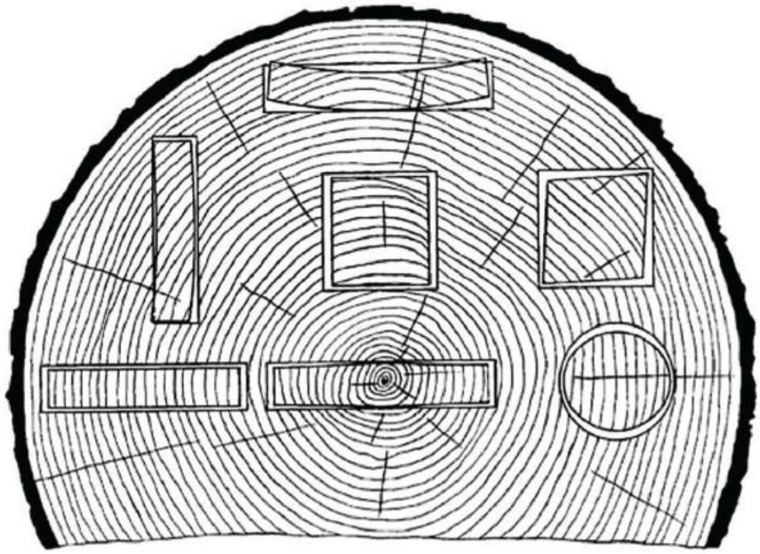
Wood shrinks most in the direction of the annual growth rings (tangentially), about one-half as much across the rings (radially), and only slightly along the grain (longitudinally). The combined effects of radial and tangential shrinkage can distort the shape of wood pieces. The illustration on the following page shows the distortion that is most likely in boards, depending on where they are cut from the tree.

Wood shrinkage is affected by a number of variables. In general, greater shrinkage is associated with greater density. The size and shape of a piece of wood may also affect shrinkage. So may the temperature and rate of drying for some species. Radial and tangential shrinkage for a few common species are shown in Table 2 (above).

Longitudinal shrinkage. Longitudinal shrinkage (along the grain) is generally quite small—between 0.1% and 0.2% for most species of wood.

Certain abnormal types of wood, however, exhibit excessive longitudinal shrinkage. "Reaction wood," whether it is





Above at left, quartersawn, or vertical-grain, lumber (A), cut radially (or near radially) to the rings, is sometimes preferred for its straightness, but plainsawn, or flat-grain, lumber (B) has more interesting grain patterns. At right, wood shrinks most in the direction of the annual growth rings (tangentially), about one-half as much across the rings (radially), and only slightly along the grain (longitudinally). The combined effects of radial and tangential shrinkage can distort the shape of wood pieces. The illustration shows the distortion that is most likely in boards, depending on where they are cut from the tree.

compression wood in softwoods or tension wood in hardwoods, tends to shrink excessively along the grain.

WORKING QUALITIES OF WOOD

The ease of working wood with hand tools generally varies directly with the specific gravity (density) of the wood. The lower the density, the easier it is to cut. A species that is easy to cut, however, does not necessarily develop a smooth surface when it is machined.

Three major factors other than density may affect the production of smooth surfaces during machining:

■ Interlocked and variable grain. Interlocked grain is characteristic of tropical species. It can cause difficulty in planing quartered surfaces unless attention is paid to feed rate, cutting angles, and the sharpness of knives.

■ Hard mineral deposits. Hard deposits, such as calcium carbonate and silica, can dull all cutting edges. This is worse when the wood is dried before milling.

■ Reaction wood. Tension wood in hardwoods, especially, can cause fibrous and fuzzy surfaces and can pinch saws due to stress relief. The pinching may result in burning and dulling of the saw teeth.

WEATHERING

The color of wood is soon affected when exposed to weather. With continued exposure, all woods turn gray. This thin, gray layer is composed chiefly of partially degraded cellulose fibers and microorganisms. Further weathering causes fibers to be lost from the surface, but the process is so slow that only about one-quarter inch is lost in a century.

The chemical degradation of wood is affected greatly by the wavelength of light. The most severe effects are produced by ultraviolet light. As wetting and drying take place, most woods develop physical changes, such as checks or cracks. Low-density woods acquire fewer checks than do high-density woods. Vertical-grain boards check less than flat-grain boards.

Boards tend to warp (particularly cup) and pull out their fastenings. The greater the density and the greater the width in proportion to the thickness, the greater is the tendency to cup. Warping also is more pronounced in flat-grain boards than in vertical-grain boards. For best cup resistance, the width of a board should not exceed eight times its thickness.

Biological attack of a wood surface also contributes to color changes. When weathered wood has a dark gray and blotchy appearance, it is due to dark-colored fungal spores and mycelium on the wood surface. The silvery gray sheen often sought on weathered wood occurs most frequently where microorganism growth is inhibited by a hot, arid climate or salt air.

The contact of fasteners and other metallic products with the weathering wood surface is another source of often undesirable color.

Illustrations courtesy USDA Forest Products Laboratory

insinkerator

THE SURPRISING TRUTH ABOUT GARBAGE DISPOSALS & SEPTIC SYSTEMS

Specify a garbage disposal in any new home or kitchen-remodeling project.

The pandemic is shining a bright light on the kitchen garbage disposal as increased home meal preparation becomes the new normal. Families now rely on their disposer like never before. Some cities even urge homeowners and apartment dwellers to use their disposers more to help short-handed sanitation crews on collection day.

And homes on a septic system? All systems "go" for disposers there, too.

That's the advice of wastewater treatment professional Michael Keleman, a 20-year veteran of the water and wastewater treatment industry. The registered Environmental Health Specialist and manager of environmental engineering for garbage disposal manufacturer InSinkErator, has heard his share of misconceptions about the appliance over the years.

6 MILLION REASONS

He cites six million reasons why garbage disposals work just fine in homes with septic systems.

"Over six million U.S. homes on a septic system have a disposer, according to the 2013 American Housing Survey. In general, if the homeowner's home already has a disposer, they're going to replace it because they know the disposer will help keep their home clean," explains Keleman.

SCIENCE, NOT MYTH

Keleman understands why some homeowners might be skeptical about using a disposer with a septic system. He cautions remodelers and contractors be guided by science and fact, not hearsay.

"Food waste is up to 90 percent water. When food is ground in a disposer, most particles are between 1/8-inch and ¼-inch. Solid build-up is insignificant," he says.

SEPTIC FRIENDLY

According to a 2019 University of Minnesota study, what the disposer grinds up hasn't been eaten. Untreated food breaks down far more efficiently and quickly than wastewater. "By definition, wastewater has already been treated once, so it doesn't break down much more. Research shows food waste disintegrates quite easily in the tank. The disposer has no impact on pump-out frequency. The effect on the septic system is negligible," he adds.

4 BENEFITS

Your customers should also be aware of these additional benefits:

- **Cleaner, More Hygienic Kitchen**. Safe, responsible disposal of wet, smelly food scraps that can support the growth of harmful bacteria.
- **Food Waste Reduced up to a Third**. A drastic drop in food waste means less dependence on landfills and all the financial, environmental, and health issues they represent.
- **Composting Buddy**. Disposers can handle bones, eggshells, and dairy products that are off-limits to the composter.
- **Better Environment**. Food left to decompose in a landfill creates methane, a dangerous greenhouse gas. The city of Boston, for example, found a disposer reduces food waste in the trash by 4.1 pounds per week. That could divert 95 tons of food waste from landfills, which could offset greenhouse gas emissions equivalent to more than 28 million auto miles.

Racine, Wis.-based InSinkErator, the inventor and leading innovator of garbage disposals, has even engineered septic-safe disposer technology that offers even more peace of mind. The top-rated **Evolution Septic Assist** model, for example, injects enzymes that accelerate scrap decomposition.

The disposer also comes with an unmatched acoustic bonus: It's so quiet you can hold a conversation next to it.

To learn more about how next-generation garbage disposals are safe to use with septic systems, visit **insinkerator.emerson.com**.

Installing Endless Pools

A backyard upgrade leads to a new profit center for a California remodeler

BY GERRET WIKOFF

Photos by Gerret Wikoff; illustrations by Tim Healey

A few years ago, a client asked me to install an Endless Pool on a project I was working on for her. Much smaller than typical gunite concrete pools, Endless Pools (endlesspools.com) feature a submerged, hydraulically-powered fan to create a current that allows you to swim in place instead of back and forth as in a lap pool. As I researched the modular-style pool she wanted, I decided to take advantage of the free training course the manufacturer offers at its Pennsylvania headquarters. When I contacted the company, I was asked if I was interested in becoming an approved installer; when they told me the company would send me leads to prequalified customers if I were, I said, "Yes."

I attended the company's three-day weekend course, which provided an overview of Endless Pools' various product lines, assembly tips, and shipping requirements. It also included hands-on training, such as how to patch holes in the pool's vinyl liner, and while it wasn't particularly in-depth, I enjoyed the training as well as meeting the Endless Pools representatives.

I've been a builder-remodeler in the Los Angeles area for 40 years, and my experience with lead-generation companies has been pretty so-so. The Endless Pools opportunity, however, is a more reasonable approach that eliminates cutthroat dealing with rival bidders and nearly impossible-to-hit response times to the leads.

Installing these pools has turned out to be a viable additional profit center for my remodeling business. Also, as I near retirement,

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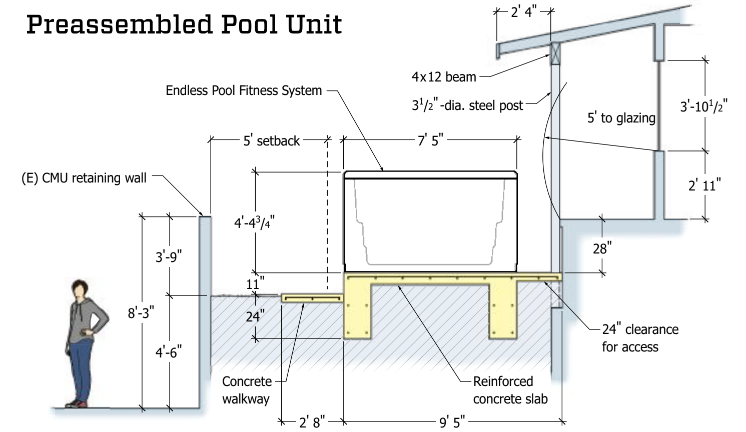

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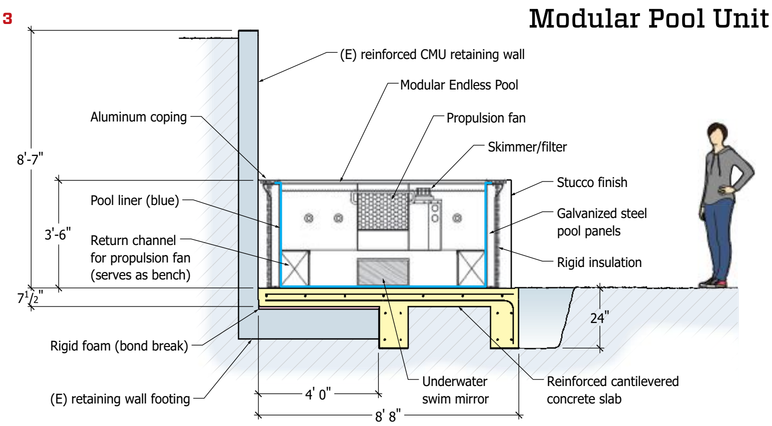

A rigging crew cranes a preassembled E-2000 Endless Pool unit into place **(1)**. In the hilly Los Angeles neighborhoods where the author works, lots are tight and he often has to contend with existing retaining walls. SketchUp modeling was used to locate and design the support slab for the E-2000 preassembled unit **(2)** and the modular unit shown on page 51 **(3)**.

the thought of working on smaller, more manageable projects has become increasingly appealing to me.

ENDLESS POOL OPTIONS

The pools come in three basic types: the "original" Endless Pool, which is available in a variety of sizes and arrives on site as a modular kit that needs assembly; a preassembled, preplumbed "Endless Pool Fitness Systems" jacuzzi-style unit, which is an all-in-one spa and fitness pool; and the Fast Lane, a hydraulically powered fan unit retrofitted into an existing pool. In this article, I'll mostly focus on installing a modular unit, and, to a lesser degree, a preassembled jacuzzi-style unit.

There are three basic scenarios when it comes to the modular-style pool—above ground, partially in-ground, and fully in-ground. It has a few essential components: a remote hydraulic pump that needs 220-volt power; two hydraulic lines that conduct the hydraulic oil to and from the propulsion unit in the pool; the metal pool frame; the propulsion fan unit itself; a water-quality controller unit and filter; "benches" that serve as return channels to funnel the current from the back of the pool around to the propulsion unit; and a vinyl pool liner. Upgrade options include hydrotherapy jets, underwater treadmills, manually-operated or powered "security" covers, and LED lights. The manufacturer's modular product line can be purchased in different sizes, from the smallest, 5-foot-square "therapy" pool (that you stand in and exercise against the current) to larger, 16-foot-square sizes with dual hydraulic fan units (sufficiently sized for a health club).

Support slabs. The pools can be installed on an existing slab, such as in a garage or basement, provided it is sufficiently strong to carry the weight of the pool, the water, and some people in the spa. Water weighs 8.34 pounds per gallon or approximately 62.42 pounds per cubic foot, so when dealing with pools, the weight can add up

The preassembled unit's slab is formed up with the rebar installed **(4)**. All the pool's mechanical equipment and metal frame panels need to be bonded together and grounded. Here, a Ufer ground is bonded to the slab's rebar **(5)**. Concrete (3,000 psi) is pumped to the backyard slab **(6)** and finished off by the concrete sub's crew **(7)**.

quickly. Endless Pools recommends allowing 75 pounds per square foot (psf) for each foot of the pool's depth. So, for a 4-foot-deep pool, you would need to plan for 300 lb. psf. If the pool is, say, 7 feet by 14 feet (98 square feet), then the slab needs to be able to support 29,400 pounds, or approximately 15 tons (about the weight of four Chevy 3500 dually Silverados). So, when I install support slabs, I use plenty of rebar and 3,000-psi concrete.

Though I prefer to have an engineer design the slab (since they have the design experience and insurance), it is not a requirement in the jurisdictions I work in, as long as the soil conditions and designs will support the loads of the chosen pool.

Design. The multitude of options such as decks, patios, trellises, interior pool rooms and other auxiliary features that can be centered around the pool allows you to exercise your artistic side and create some awesome outdoor living experiences for your clients. When planning the installation, though, you need to realize that the pool manufacturer's dimensions are typically inside dimensions. A 7x14 pool requires a space larger than 7 feet by 14 feet; you have to account for the width of the metal panels and the type of pool cover you want. For instance, I repaired a pool in Malibu after the fires there last year, and the original contractor had built a 6-inch CMU wall around the pool and covered that with a stone veneer, so the 7-foot-by-14-foot pool occupied about 10 feet by 17 feet.

Pool security covers. While you can get a pool without a cover (or use a floating cover), installing a manual or powered security cover is a common requirement for safety reasons. Both the manually operated and power security covers are strong enough that a person can walk on them without falling through.

The manual cover has a crank and roller at one end, a track on each side of the pool the cover slides in, and an aluminum bar the cover is attached to. You pull the bar with a rope to close the cover, and use the crank to wind it around the roller to open it. So you have

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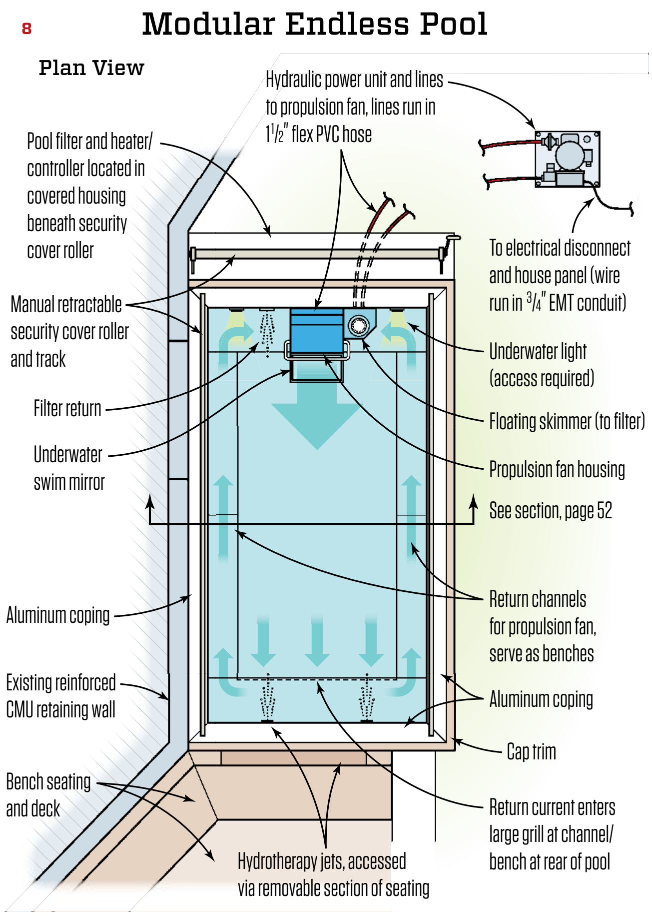

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The hydraulic power unit is located away from the pool, set on a 2-foot-by-2-foot concrete pad, and shrouded in a rain cover. Access to both ends of the pool is required to maintain equipment **(8)**. The galvanized steel panels are installed **(9)** with rigid insulation set in the bays. The unit is fitted with a "Gecko" water-quality/heat controller and filter motor **(10)**.

to plan for the room the crank will need to operate. (Also, you'll need the manufacturer's documents to know how to properly attach it.)

The power cover is another animal altogether. To prevent electrocution of pool users, the electric hydraulic pump motors (which hydraulically power the submerged propulsion fan unit and the cover motor) are located away from the pool. There is a remote 220-volt pump for the swim current propulsion fan, and a separate, smaller, 110-volt pump for opening and closing the power cover. The cover motor, which is activated by a remote key switch, is mounted on the end of the pool with a cable system that opens and closes the cover. Because this mechanism adds to the length of the pool, a power cover takes up more room than a manual one. Also, it has more robust hardware and cover slides than the manually operated one that will need to be accounted for (you'll need the manufacturer's design documents to design this aspect of the pool).

Electrical grounding. Depending on the pool chosen (single propulsion, dual propulsion), you will have to provide GFCI/RCD-protected circuits to the pumps. You will need appropriate grounding, bonding, and in some cases a Ufer ground to the rebar, the cold water line, or the ground rod, or some combination of the three. A Ufer ground is an electrical earth-grounding method developed during World War II that uses a concrete-encased electrode to improve grounding in dry areas. Your electrician should know how to install one. It is important that you follow your local building codes in this regard. This is an area I follow carefully, hiring only licensed and insured electricians to do all of the electrical connections.

INSTALLATION

What is nice about the preassembled fiberglass pools **(1, 2, 4–7)** is their simplicity. You dig the footings, form it up, and place the rebar, then the electrician does the Ufer ground, you have the inspection, and you pour the slab. Then you crane the pool over the

An abutting deck with bench seating was installed, with an access panel to the hydrotherapy jets built into the seating **(11)**. A floating skimmer for the filter intake is housed next to the propulsion fan unit **(12)**. The hand crank for the manually operated security pool cover was mounted to the mechanical equipment housing **(13)**. The finished modular-style Endless Pool **(14)**.

house onto the slab, the electrician wires it up, you fill it up with water, and you're done.

The modular kit **(3, 8–14)** is not difficult to build, but it takes more time. On the project shown here, we started by bolting the galvanized steel panels together, then securing them to the slab after ensuring they were square by checking the diagonals. Next, we drilled holes in the panels for the water supply, the LED lights, and the hydrotherapy jets, according to the locations specified in the installation manual (to access the hydrotherapy jets, I built a removable access panel in the abutting bench). The client had ordered Endless Pools aluminum coping, which simplified that aspect, so next we simply attached the coping to the metal pool walls. Then we put in the liner, making sure it was centered, and pushed its lip into the hanger groove, cut the holes for the jets and lights, and assembled those.

After attaching the cover track to the coping, we were ready for stucco. The retaining wall was white sand finish stucco, but I felt that would be too abrasive for the clients' children. My clients agreed with me and opted for a smooth finish instead. After fitting and gluing all the plumbing together, we put a hose in it and started filling it.

Safety requirements. The state of California, where I work, has certain pool safety requirements, such as 5-foot-high fences, gates that swing out, pool covers, door alarms, and floating alarms in the pool that go off if disturbed. The cover has to be lockable to prevent accidental drownings. Also, the pool must be 5 feet from any glazing such as windows or doors. We needed to install most of these requirements to complete the pool project, but even if they are not required in your area, they are still a good idea.

Gerret Wikoff is a builder-remodeler based in Los Angeles. He also is an approved Endless Pool installer.


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2021 Deck Code Highlights

by Glenn Mathewson

The 2021 edition of the International Residential Code is officially complete and ready for printing. Even though many building authorities are only now adopting the 2018 IRC as the local standard, the new prescriptive design provisions contained in the 2021 IRC can be approved by building authorities and used as soon as published. Here's a look at its main provisions.

Table Updates

The pre-engineered design tables have been completely overhauled in a number of ways. For example, all of the structural components in a deck can now be prescriptively sized for more than just a 40-psf live load, with the addition of 50-, 60-, and 70-psf snow loads in all of the design tables.

Tributary area. Previously, for sizing footings, the smallest tributary area of deck listed was 20 square feet, so something as small as a stair landing needed a minimum 14-inch-diameter footing for each corner post. Now, Table R507.3.1 has been expanded to provide a smaller, 5-square-foot area to size from, bringing the minimum diameter down to as small as 8 inches.

Post sizing. Table R507.4 was greatly expanded. Previously, it did not consider any load or post species, so a 4x4 post was limited to an 8-foot height. Now allowing for variables such as snow load, species, and tributary area of deck supported, the table can more accurately size support posts. The common 4x4 post can now, under certain circumstances, extend as high as 14 feet.

Beam design. Table R507.5 was modified to include single-ply beams in all listed species, including redwood and cedar. Single-ply beams are useful for lighter loads and shorter spans, and they eliminate the potential for decay caused by water trapped between two or more beam plies.

Joist span. Table R507.6 was reorganized completely to better present the variables of joist span and joist cantilever. In addition, the "one-fourth-the-backspan" rule for joist cantilevers has been replaced with a maximum allowable cantilever for each common joist span. This change provides for more flexibility in design and more accuracy in the minimum sizes and spans.

Guards

For decades, guards and handrails have been combined together in the specifications for minimum load resistance, though each one supports people in different ways. The minimum live load table, R301.5, now separates these features, primarily so the loading direction of guards can be independently evaluated. While graspable stair handrails are meant to support us and must resist forces in all directions, guards that wrap around a deck are only meant to keep us from falling outward off the edge. Until the 2021 IRC, guards have had to resist 500-lb. loads "in all directions," which has resulted in some robust connection details that wouldn't be necessary for an inward load. Under the 2021 IRC, guards will no longer be required to resist forces pulling inward or upward.

The 2021 IRC will be the first I-code to provide any guidance on guard construction other than the load target and the geometry.

The 2021 IRC will be the first I-code to provide any guidance on guard construction other than the load target and the geometry. Though guards function foremost as a safety feature, they are also an architectural feature, and the market for deck guard design is enormous. This makes prescriptive guard design a difficult and controversial subject.

Nevertheless, the new code specifically prohibits notched 4x4 guard posts, which historically have been attached to rim joists or beams with anything from lag screws to nails and with little validation of their performance beyond a small shove soon after construction. Time and tragedy have taught us that these guards don't work, so the first step towards prescriptive design is prohibiting the notching of 4x4 guard posts at the connection point. In addition, code now requires that the connection extend back into the framing in some manner to help prevent a guard from pulling a rim joist off the ends of the joists or from rotating a single side joist. ❖

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

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Adding a Quakeproof Deck to a Stucco Home

Lateral support comes from a grade-beam footing

by Michael Walter

We recently completed a project that we only half-jokingly referred to as the M.O.A.D., or mother-of-all-decks. While the size—more than 700 square feet with all the bells and whistles—was impressive, there were a couple of structural challenges that helped earn the deck our nickname. The first was that the homeowners wanted the 37-foot-wide elevated deck to be supported by a minimal number of columns in order to preserve the views from the living space underneath the deck. The second challenge was that the deck would be built in a seismic zone.

Living and working in California southeast of Los Angeles, we have a lot of experience building earthquake-proof decks. Often the decks are located on the side of a hill, because that's where the views are, so they require substantial engineered footings and plenty of diagonal bracing.

In this case, however, the deck would be located on flat ground on top of an existing concrete patio. Instead of breaking up the patio to dig holes for individual footings that were deep and wide, we planned to install a continuous grade-beam footing that would allow us to tie the steel support posts to the foundation. The lateral support for the deck framing would come from the grade-beam footing and structural connections between the footing, the columns, and the deck frame, eliminating the need for diagonal braces.

Grade-Beam Details

Working from the architectural plans drawn by the engineer of record, we laid out the foundation directly on the concrete patio. We contracted with a saw cutting company to open up a one-foot-wide slot for the grade beam around the patio perimeter and to clean up the broken concrete afterward (**Figure 1**).

Before excavating through the slot in the patio for the footings with a backhoe, I checked with the homeowner about utilities. He brought out a pair of dowsing

Figure 1. A 12-inch-wide slot was cut through the concrete patio for the new grade-beam footing engineered to provide lateral support for the freestanding deck (A). The rebar cages were partially assembled, then delivered to the site (B), where the crew finished tying them together after the steel reinforcement was placed in the 24-inch-deep trenches. The crew carefully formed up the piers for the deck's steel support columns to ensure that the deck ended up at the proper elevation (C). Rebar dowels were added to the cut edges of the patio to tie the concrete slab to the grade beam after the new concrete was poured (D). Before the steel columns were installed, nuts were threaded onto each of the pier's four anchor bolts, which would later be used to fine-tune the height of the columns and adjust them for plumb (E).

rods and immediately identified the location of water lines for the sprinkler system. Skeptical, we carefully dug down in the location that he had marked, and sure enough, the water line was right where he indicated it would be. Still skeptical, I tried the rods myself, and when I put them over the pipe, they closed, and when I pulled them away from the pipe, they opened. They worked without a doubt. I always had laughed off dowsing rods, but even though I'm baffled as to how they actually work, I'm now a believer.

After cleaning up the 24-inch-deep trenches for the grade-beam footing, we turned our attention to the pad footings for the steel support columns. The columns would be bolted to the footings, which in turn would be tied into the grade beam, a seismic design that would allow us to eliminate knee bracing.

We spent the better part of a day fine-tuning the trench for the footing and chipping away any concrete that was in the holes. Meanwhile, because we would need rebar cages to reinforce the grade beam, WC Rebar (our local rod busting company) fabricated as much of the rebar cages as they could in their shop, then delivered them to the site. The rebar plan had an overlapping splicing detail that didn't require any field welding, and we were able to complete the assembly on site when we placed the cages in the trench.

To provide support for the cut edges of the concrete patio, we doweled the footing and slab together, drilling holes for rebar in the slab every 16 inches and alternating sides every 8 inches.

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ELECTRICAL CORDS CAN BE SUCH A DRAG.

Figure 2. Fabricated by a certified welding shop, each of the engineered steel columns weighed about 250 pounds; a portable contractor's lift was used to hoist them into position on top of the concrete piers (A). The lift would also be used to hoist heavy 7x14 PSL beams into place on top of the columns once the columns had been bolted to the piers (B). Workers turned the nuts supporting the columns with a box wrench to adjust the columns' height and plumb, then packed the voids between the column base plates and piers with non-shrinking grout (C).

Once we had placed the steel for the grade beam and built the forms for the pad footings, we tied off the connections between the rebar cages and footing reinforcements per the engineering plans. Then we called the building department for our foundation inspection and ordered 16 yards of 4,500-psi concrete for the pour, which was delivered by pump truck.

I wanted to wait until the grade beam was poured and we had stripped the forms from the piers to determine an exact height for the steel columns that would support the deck framing. Fortunately, the tops of all of the piers were within $\frac{1}{8}$ inch of each other, well within dry-packing tolerances, so all of the columns could be specced at the same height.

While we waited for the concrete to cure and the fabricator to assemble and deliver the steel columns, we stripped off the stucco cladding from the house wall where the deck would be located to expose the sheathing and weather-resistive barrier. Though the deck would be freestanding without a structural ledger, we needed to tie the deck's underdeck waterproofing to the house's WRB, and we needed to prep the wall for the deck-to-wall flashing detail. In addition, the bottom of the beam along the house would be acting as a stucco-covered soffit, and we needed to be able to tie that finish to the wall stucco.

Steel Columns

The steel columns that support the deck's carrying beams are the key to the seismic design. Weighing about 250 pounds each, they were fabricated, from the base plates to the special top brackets, by certified welders at Schorr Metal. Their overall height was critical to accommodate a spiral staircase that I had already ordered.

Before setting each column, I sprayed its bottom face with red rust primer. Because of their weight, we lifted the columns into position using a Sumner portable contractor lift, which can lift loads of as much as 650 pounds almost 13 feet high. The lift is heavy, weighing more than 250 pounds, so it's a bit of work to transport it to and from a jobsite. But on this job, it proved invaluable, as we also used it to lift the heavy beams into position once the columns were bolted in place (**Figure 2**).

The columns sit on nuts threaded onto the $\frac{3}{4}$-inch-diameter bolts embedded in the piers, allowing us to use a wrench to fine-tune the column heights and make sure they were plumb. Afterward, we packed the bases with non-shrinking grout.

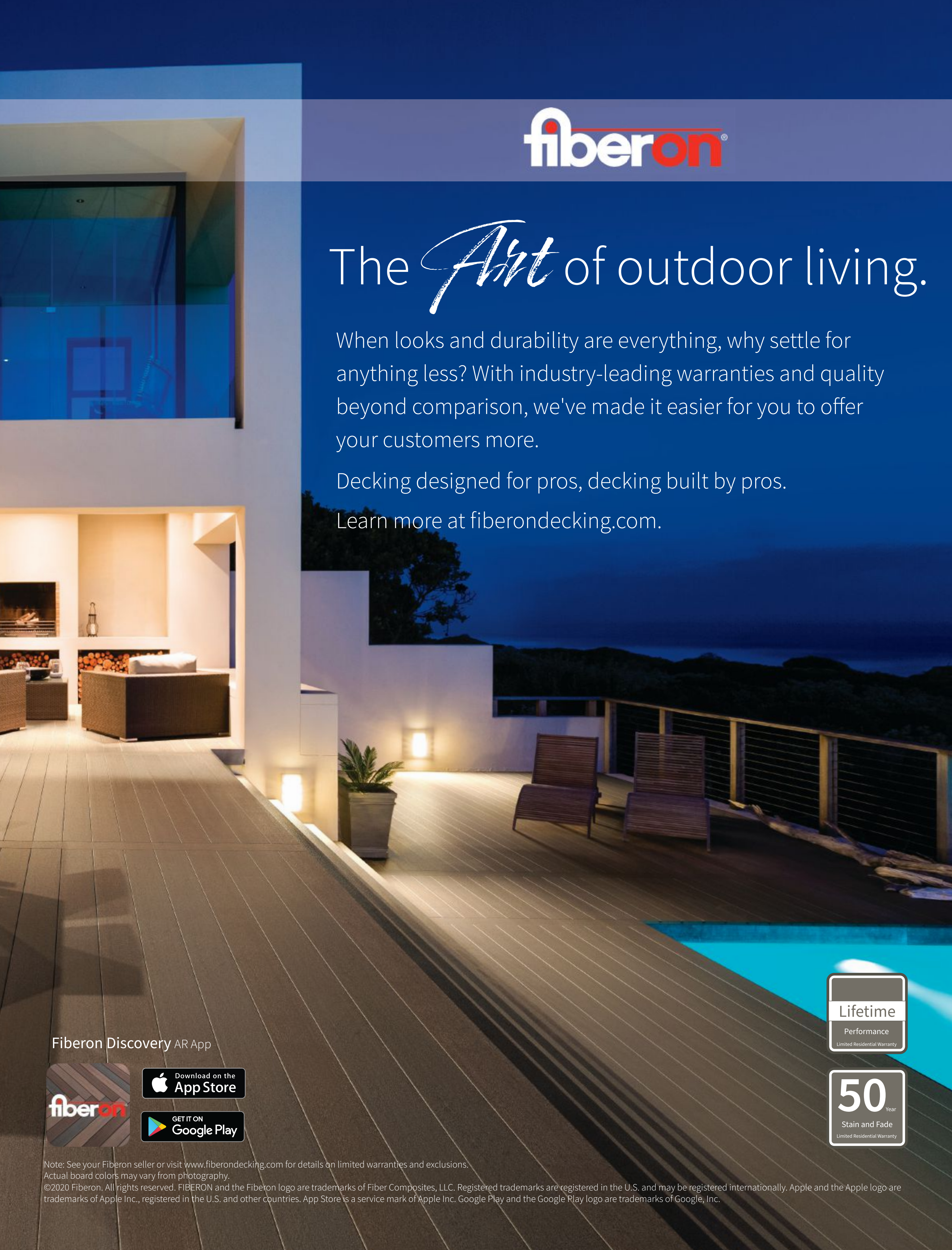
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Figure 3. Instead of a ledger, a 7x14 PSL flush carrying beam (one was also installed at the outside edge of the deck) provided support for the freestanding deck at the house (A). To complete the seismic design, the inside and outside carrying beams were connected to each other with 6x12 Doug fir beams, which were fastened with ¾-inch-diameter through-bolts to brackets welded to the steel columns (B). 2x12 Doug fir joists were hung from the carrying beams, which were blocked out with 2x12s sandwiched around the 4x4 deck posts bolted to the framing (C). Because the entire deck would be protected by a waterproofing system, non-PT-treated material and engineered lumber was used in its construction.

Framing

The next step was to lift the heavy beams into place, through-bolt them to their brackets with ¾-inch-diameter bolts, and begin framing the deck. Most of the deck framing is non-PT Doug fir, with solid-sawn No. 1 Doug fir 6x12s for the seismic beams, but we used 7x14 PSLs (parallel strand lumber) to assemble the main carrying beams. The center post is actually off-center, to maintain views from one of the house windows under the deck, so the longest PSL span is 19 feet. With a very dry climate, the deck protected by an under-deck drainage system, and the beams completely boxed in and 100% impervious to the elements, treated lumber wasn't required (**Figure 3**).

Typically, we install the joists first using toenails, and then go back later to install the hangers. That way we can ensure that the tops of the joists are flush with the tops of the beams, regardless of any dimensional discrepancies in joist depth. Also, we like to wait a few days to allow for any shrinkage that might occur. In the past, we've installed joist hangers as we've installed the joists, only to return after a week or so to find that the joists have shrunk and left ⅛-inch gaps or more between the seat of the hanger and the joist, which is unacceptable both to us and to our building inspector.

After the joists were installed, we blocked out the outer flush beam and seismic beams with 2x12s, to which we through-bolted the 4x4 guard posts. Then we blocked out the base of the posts with another 2x12, which created a rock-solid post-to-framing connection and plenty of bearing for the decking under the post, and ensured that the post sleeves that we used to finish the posts sat properly on the decking.

One detail that threw a major monkey wrench into the project was a support column that the engineer had located too close to a doorway into the house. While the problem wasn't apparent on the plans, the homeowner felt that the column would unacceptably crowd the entry area and hoped that the column could be moved or eliminated altogether.

The solution that my engineer and I came up with was to open up the wall of an angled bump-out next to the column location and install a new 4x12 header. Then the 7x14 PSL could be extended a bit so that it could bear on that header.

Flashing that detail proved to be a challenge, but my stucco guy did an outstanding job with the metal around that area.

Water Management

When we laid out the mounting bolts for one of the corner columns, we offset

Figure 4. Water collected by the under-deck drain system flows toward the outside edge of the deck, where it empties into a one-piece gutter (A). The gutter slopes toward a corner column, where it is drained by a 3-inch-diameter downspout concealed within the boxed column (B). Trex RainEscape downspouts (C) empty the water collected by the troughs, which are draped over the tops of the joists (D). At the house, a custom-fabricated flashing and weep screed tie the WRB behind the stucco to the deck waterproofing system.

them to accommodate the downspout that connects to the gutter that drains the water collected by the Trex RainEscape under-deck drainage system. The downspout runs down inside the OSB box we built around the column, the substrate for the eventual stucco finish. Because I was concerned about the system's ability to handle runoff from the roof above, as well as from the deck, I consulted with several gutter experts for sizing help and to make sure our installation would be able to handle the volume of water that could be expected to run off the deck and from the existing roof above the deck **(Figure 4)**.

With 2x12 joists over a 14-foot span, the pitch of the RainEscape troughs is less than 4 degrees. That's fairly shallow, which means that water drains very slowly off the deck, into the one-piece gutter, and down the 3-inch-diameter round downspout. We always water-test our waterproofing systems before installing the decking, and our initial testing showed that this one was able to handle rapidly dumped 15-gallon loads, with more than enough gutter and downspout capacity for that volume of water.

To raise the underside of the decking up away from the troughs near the house and promote drainage, we had installed ground-contact-rated pressure-treated 1-by furring over the joists after the RainEscape system was installed. The 1½-inch-wide rippings were nailed to the joists through the butyl seam tape used to seal the troughs, which self-sealed around the fasteners. Finally, we laid down sheathing over the joists and covered everything with a protective plastic wrap to prep the site for the stucco guys and then the painters. We've learned the hard way that cleaning stucco overspray off composite decking is no fun.

Unfortunately for me—but fortunately for the job—it was during this stage in the project when I had an unrelated ladder accident (stringing Christmas lights up with my family). This had the effect of stalling our work on the project while I recuperated. Southern California isn't known for its wet weather, but several winter downpours while the decking installation was on hold indicated that everything was leakproof.

Stucco

We subcontracted out the stucco work, which including patching the wall where we had tied the deck waterproofing to the house. Here, we had installed 2-by framing on the flat to bridge the gap between the structural beam next to the house and the house sheathing. Covered

Figure 5. Underneath the perimeter of the deck, workers framed a soffit and covered it with OSB in preparation for a stucco finish (A). After covering the soffit and boxed columns with building paper and wire lath for the stucco (B), workers installed the tongue-and-groove wood plank ceiling (C). J trim was installed at the corners where the ceiling would meet the stucco to give the installation a clean look.

Figure 6. The Trex decking was fastened down with FusionLoc fasteners, installed with FastenMaster's FiveShot collated nail gun (A). To provide extra clearance between the underside of the decking and the RainEscape troughs and to improve drainage, 1-by PT rippings were installed on top of the butyl tape used to seal the troughs where they lapped over the joists. Note that the worker is standing on a double joist, the location of a seam board in the middle of the 37-foot-wide deck that provides a transition point for the decking (B). After the post sleeves and railing system were installed, workers screwed on sections of drink rail fabricated from the same decking, which span between posts (C). The screws thread into inserts installed on the underside of the drink rail.

with self-adhered flashing, this provided a solid backing for the custom metal flashing and weep screed that integrated the home's WRB with the deck drainage system (**Figure 5**).

On the underside of the deck, we had framed out a soffit next to the house and boxed in the gutter and columns with OSB sheathing before starting the ceiling installation and turning the project over to the stucco guys and painters.

Because the ceiling height is 9 feet, the space underneath the deck doesn't feel like a cave. For the owners, the space offers welcome shade from the sun, which hammers that spot in the summer.

A Slow Leak

After we resumed work on the project and my crew had almost completed the decking install (**Figure 6**), we discovered a small drip (one drop every 20 seconds or so) coming from a knot hole in the wood ceiling. To track down and fix the leak, we needed to remove almost half of the decking to redo a complete bay with a new trough and butyl tape. The culprit? A screw through metal flashing around a hose bib that we had installed on the second level. The metal

Figure 7. While the spiral stair assembly was straightforward, accurately calculating the bottom landing elevation when placing the foundation was critical because the stair parts were ordered in advance and fabricated off-site (A). The stair rail came in a coil, and we had to carefully stretch it out to avoid kinking it (B). The stairs came with precut treads to match the decking, but the upper landing was picture-framed on site; because of the dimensions of the decking, a narrow strip was needed between the picture-frame detail and the edge of the decking (C).

Figure 8. The new stucco finish on the columns and soffit was painted to match the existing house (A, B). To wrap up the project, the old concrete patio was prepped to receive new plank-style patio tiles patterned to match the deck's wood ceiling (C). Though not shown in the photos, a new door that provides access to the upper level was installed in a follow-up project.

flashing had mushroomed up around the screw, preventing the butyl flashing tape from self-sealing around the screw. Lesson learned.

Finish Details

Besides the decking and railing installation, our final major task was to install the Trex spiral stair, which had already been fabricated and delivered to the site. We were anxious that we had nailed our elevation for the stair landing, as there is no adjusting of the rise or run after the stairs have been fabricated. Happily, the landing elevation was spot on and the stairs installed without a hitch, except for the tricky landing detail at the top of the stairs (we wish that Trex made wider tread stock, so that we could have more cleanly finessed the picture-frame detail with the rest of the decking). Next time, I'll run the decking wild at the landing and allow the ends to come all the way to the landing (**Figure 7**).

After that, our tile installer finished the patio with a plank-style wood-grain tile, and our job was done (**Figure 8**). ❖

Michael Walter owns MLW Construction, in Anaheim Hills, Calif.

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Widow's Walk, Pacific Northwest Style

Special framing hardware supports the deck surrounding this unique structure

by Mark Meyer

PHOTOS BY MARK MEYER

In one of our more interesting projects, the clients wanted to reclaim an unused atrium, which was open to the sky and surrounded on all four sides by the rest of their house. The home is located at the top of a hill in Silverton, a quiet rural area about a 40-minute drive from our offices in Salem, Ore.

The plan was to remove an existing hot tub from the ground level, repurpose the first level into a large pantry (part of an extensive kitchen remodel), and transform the second floor of the former atrium into office space. The whole structure would be capped by a quiet reading room on the third floor, with access via a spiral staircase from the office below. On three sides, the reading room would be flanked by a wrap-around deck extending out over the roof below. Instead of gazing out over the ocean, like 19th-century New England wives awaiting the return of their sea captain husbands, occupants of this widow's walk would be gazing out over the surrounding hills and the broader Willamette Valley.

Demolition and Framing

A large hot tub occupied the atrium, so the first order of business was removing the tub and cleaning out the leaves and debris that had collected on the slab supporting the tub. We also demoed a small deck that surrounded the tub and was ledgered to the exterior walls.

Once we'd removed the windows and the exterior trim from the atrium well, framing the new space was straightforward. We removed and relocated an existing exterior wall on the first floor, which required a new support column in the basement to carry the redistributed loads from the floor system above. We also removed an exterior wall on the second floor, replacing it with a framed entryway into the new office space.

Where one second-floor wall supported an existing shed roof, we cut back the asphalt shingles and roof sheathing as needed to install blocking and new framing to prevent roof joist rotation. Then we extended the knee wall with new 2x6 studs to bring the wall up to full height, tying the studs to the double 2-by knee-wall top plate below with 15-inch-long Simpson Strong-Tie SDWH structural screws driven through DTT1Z hardware installed 24 inches on-center (**Figure 1**).

On the full-height wall supporting the other rafters, we used a similar approach. To stabilize the rafters, we installed blocking as needed above the double 2-by plate, then installed the new rim joist and floor joists for the third-floor deck. Then we used DTT1Zs to tie the new floor joists to the old wall framing below, driving long, 3/8-inch-diameter lag screws through the DTT1Zs and into the top plate.

Once the floor system was in place, we framed up the new 2x6 stud walls for the widow's walk. The new space is capped with a 5-in-12 hip roof.

Figure 1. An existing atrium was surrounded by four walls and open to the sky (A). The author's crew extended the second-floor atrium knee walls to full height, then added cantilevered beams to the new third-story floor system (B) to help support the deck that would surround the new structure (C).

SkyLift Solution

When we framed the third-level floor system, we installed two cantilevered beams

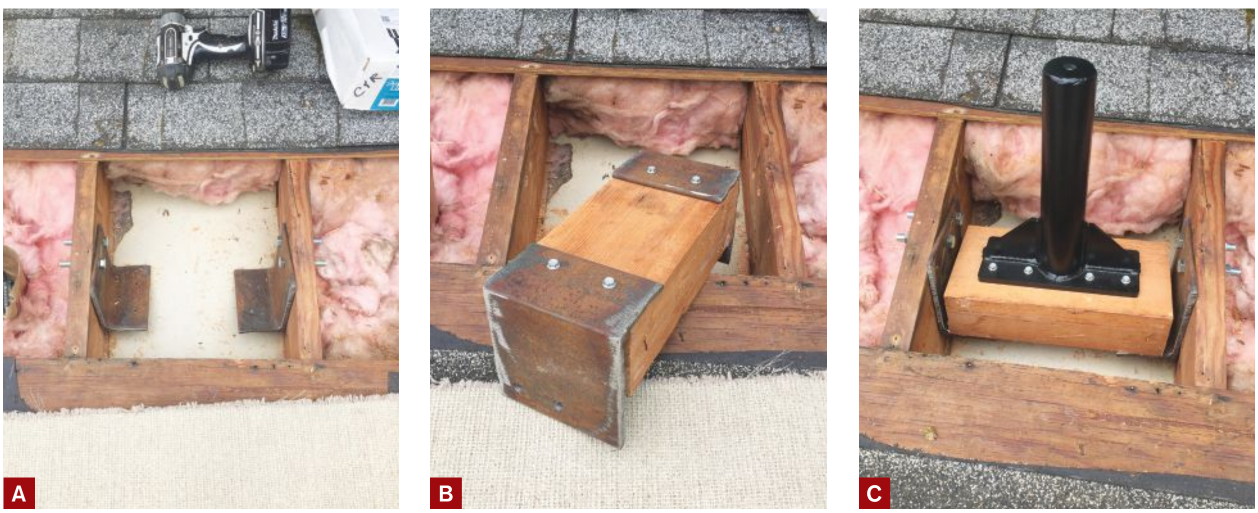

Figure 2. The crew opened up the roof sheathing and bolted steel angle brackets to the roof framing (A), with 4x6 Doug fir blocks bolted to the steel angles (B). SkyLift risers were then bolted to the blocks to help support the deck (C).


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Figure 3. Part of the wraparound deck is supported by cantilevered beams (A), with the rest bearing on beams supported by 4x4 PT Doug fir posts bolted to SkyLift risers (B). After bolting 4x4 and 4x6 clear cedar guard posts to the framing (C), the crew installed a 2x4 subrail and began installation of the capped composite decking that would complete the project (D).

to help support one side of the framing for the U-shaped deck that flanks the widow's walk. But we also needed to install four columns to support the rest of the deck framing. To ensure that loads from this small deck were properly supported by the roof framing below, we installed four SkyLift #12-HD 12-inch Heavy Duty Designer steel roof risers. These are engineered metal brackets designed to support elevated patio supports and similar structures. In this case, we used the risers to support the beams carrying the deck framing.

Most of the time, SkyLift risers are installed directly on top of the wall plates through access holes cut through the roof sheathing, but in this case, the risers needed to be supported by the roof framing midspan, underneath the deck. After plumbing down from the deck beams once they were installed and opening up the sheathing to verify the exact location of the rafters, we cut 4x6 Doug fir blocks to length to fit between the rafters at each riser location. Then we mounted the blocks to the rafters per the architect's drawing using 5/16-inch steel angle brackets with 6-inch-tall vertical legs and 3 1/2-inch-wide horizontal legs, through-bolting the brackets to the rafters with 1/2-inch-diameter bolts (**Figure 2**).

We fastened the riser bases to the support blocks with 1/4-in. x 3 1/2-in. SST SDS structural screws. After patching the roof sheathing and slipping the flashing boots over the risers so that we could reshingle these sections of roofing, we bolted the 3 1/2-inch saddles that hold the beams to the risers.

The SkyLift risers are connected to the deck framing with 4x4 PT Doug fir posts. At the top of the posts, we reinforced the post-to-beam connections with pairs of Stanley-National heavy-duty 1/4-inch steel decorative corner braces, which we fastened to both the posts and the beams with 1/2-inch-diameter bolts. The longest column is also braced with a diagonal PT 2x4 fastened to the post and deck framing with 3/8-inch-diameter through-bolts (**Figure 3**).

Finishing Details

We bolted the 2x8 PT deck ledgers to the widow's walk's rim joists, spacing the ledger away from the sheathing with 1/2-inch-thick polypropylene Deck2Wall spacers. After hanging the 2x8 deck joists, we reinforced the deck-to-house connection in several locations with pairs of SST DTT2Z lateral load anchors fastened to a deck joist and corresponding floor joist, each pair connected with a 1/2-inch-diameter threaded rod.

We through-bolted clear cedar 4x4 intermediate posts and 4x6 end posts to the rim joists of the deck every 36 inches, reinforcing each post connection with a pair of DTT2Z anchors. In preparation for the cable railing, we installed a 2x4 subrail, reinforcing the corners with SST 55L strap ties, then installed the clear cedar 2x6 top rail.

After we finished installing Wolf capped composite decking, we completed the Type 316 cable railing install (approximately 2 13/16 inches on-center). Where the end of the deck is close to roof level, we installed an aluminum gate and a short ramp for occasional access (to clean gutters and a metalbestos chimney). After the widow's walk was trimmed and painted, we stained the deck framing and rail posts to match (**Figure 4**). ❖

Mark Meyer is a lead carpenter for C&R Remodeling, located in Salem, Ore. In his spare time, Mark enjoys the Oregon outdoors along with his wife and two sons.

Figure 4. The widow's walk—a quiet reading room with views of Oregon's Willamette Valley—and surrounding deck and railing were finished to match the existing house.

Artillery Tools Demolition Tool System

by Mike Guertin

Demolition, dismantling, deconstruction—however you phrase the chore, it's a big part of the remodeling and replacement industries. And pros know the smashing, crashing, and sledgehammer wielding on construction entertainment programs is just for show. We have to be thoughtful in our approach and have the right tools to work efficiently and safely. Over the years, I've accumulated dozens and dozens of prying and demolition tools—various types of flat bars and crowbars for general work, along with tools that are more specialized to remove decking, pull embedded nails, or strip roofing. Loading up the right ones for a project can be hit or miss. There's always a tool back at the shop that I need.

Artillery Tools demolition sets make mobilizing for the deconstruction phase simple. They have a series of multi-function blades and heads of different shapes that can be configured with fulcrums for the best angle of attack and with handles and extensions for the right length and leverage. It only takes a minute to screw one of the 10 blades to one of the four fulcrums. Then a handle or handle-extension combination threads onto the fulcrum to customize the assembly. The configurations are almost endless.

Fulcrums Connect Handles to Blades

There are four fulcrums—standard, scraping, mini, and decking. The standard fulcrum sets up the blade-to-handle angle at roughly 45 degrees. We threaded it to a handle with an extension and various width blades to pry up wood and laminate flooring and tile backer board. The scraping fulcrum lowers the handle's angle of attack to about 22½ degrees. We used it when working close in prying siding off walls. The decking and drywall fulcrum positions the handle at 90 degrees to the blade shank. And the mini fulcrum pairs with a mini blade—it's a simple and lightweight setup.

The fulcrums are 1⅜ to 1½ inches wide. When using the wide blades, I find that sometimes the tool rocks sideways, but the rocking can be stabilized by adding fulcrum extensions for a 3-inch footprint on the standard and decking fulcrums. Toe-kick bars, 1 inch by 3½ inches long, can be added to the fulcrums so you can kick the blade deeper under materials.

Assortment of Blades

There are 10 sizes of blades, from ¾ inch to 8 inches wide, and special-function blades. All but the ¾-inch-wide blade have nail slots in the center. The 1⅜-inch-wide spike puller has a wider and deeper nail slot. The 8-inch-wide blade has slots spaced an inch apart, and its leading edge is ground sharp, so it works well at prying up roofing and pulling out nails.

The U-shaped decking and drywall removal blade has a 2-inch space between blades to straddle a joist or stud. It can be used with the standard fulcrum for prying into the decking boards from the joist side or with the deck fulcrum when you're standing on the decking side. The center space and both blades have nail-puller slots so you can clear the remaining nails

Here, the Artillery Tools kit has been fitted with the deck and drywall fulcrum, the U-shaped removal blade, and both a 12-inch handle extension and a 25-inch handle.

The fulcrums, which determine the angle of attack, can be fitted with different blades (above, from left to right): scraping; mini; standard; deck and drywall.

PHOTOS BY MIKE GUERTIN

The salvage blade is useful for stripping siding (above left). Other blades include (above right, top row) finish nails; salvage; decking; 8-inch; and (bottom row) ¾-inch; 1¾-inch; spike puller; 3-inch; 6-inch; and buried nail-head puller.

The standard, 25-inch-long steel handle (at top in photo, above left) can be fitted with a ball grip and shorter extensions for more comfort and better leverage. Specialty heads like this nail puller (above right) screw directly onto the handle.

and screws without having to grab a separate tool and make a second pass.

The finish nail and stapler blade has a center probe with a slot to slip under and trap the crown of standard 16-gauge staples so both legs come out at the same time. And two different sized slots on either side of the probe grab smaller shank and smaller headed nails.

We used the salvage blade to strip shingles and old lap siding off a couple of projects. It has a 3½-inch-wide by 3-inch-deep footprint and beveled edges on three sides. The left corner is clipped at 45 degrees and the right corner is curved. The beveled edges and corners make it easy to plunge and slide the tool under siding and trim from any angle.

Handles and Specialty Heads

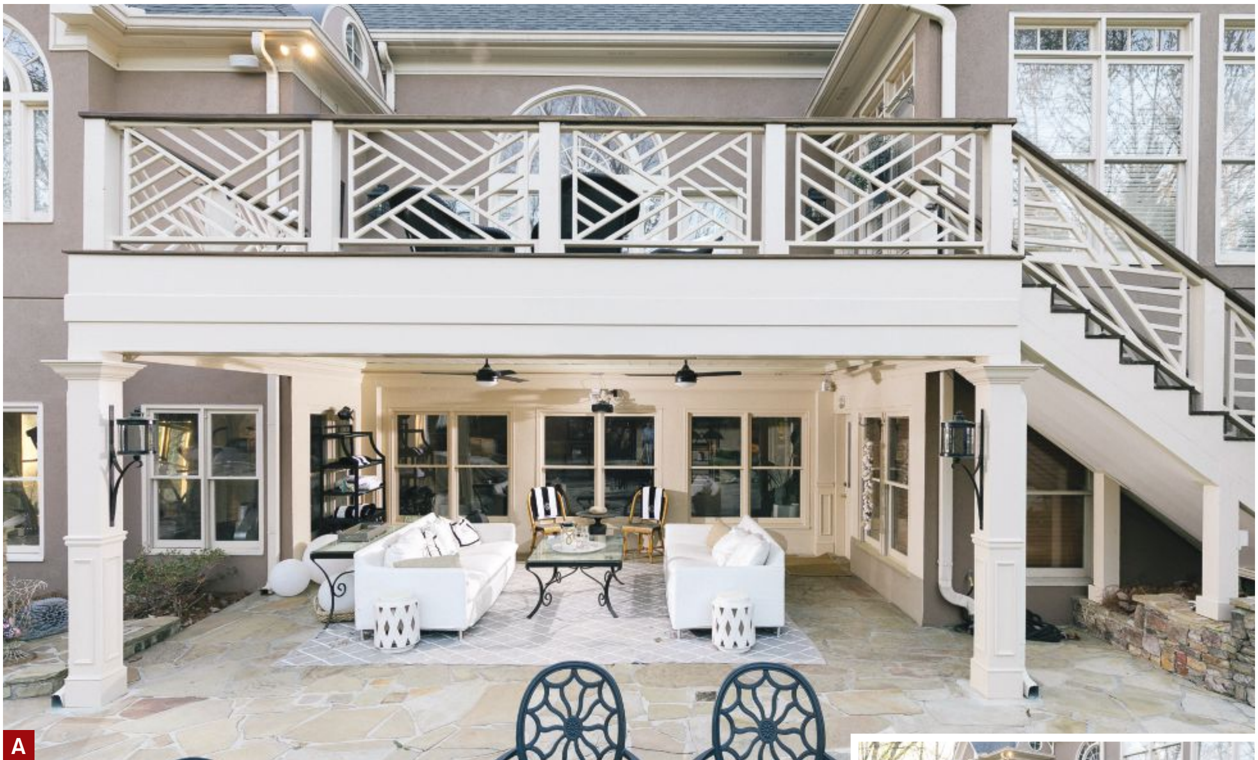
The standard steel handle is 25 inches long with a 12-inch cushioned grip. Two handle extensions—12 and 15 inches—can be used with the handle or separately for short-length tool outfitting. A lighter weight, 25-inch fiberglass handle is also available. A 2½-inch-diameter plastic ball grip can be screwed onto the steel handle and extensions to make driving the bar forcefully under roofing, siding, and flooring much more comfortable than it is with just the handle or end cap.

There are specialty heads, too. The heavy, nail-pulling cat's-paw-shaped head threads to any length handle or extension (no fulcrum needed) for more leverage than you get from most pullers. The rebar bender head handles up to #5 bar.

Task-Specific Sets

Artillery pry bars are sold individually or in sets with blades, fulcrums, and bars geared towards different user groups and general tasks. The Professional Demolition set is the entry-level kit ($265 at artillerytools.com), while the Disaster Restoration set is the top-of-the-line kit ($610). You can also buy components separately, so you can add parts to your kit or outfit a crew from one set plus a few extra fulcrums and bars. ❖

Mike Guertin is a remodeler in East Greenwich, R.I., and presents trainings at JLC Live. Follow him on Instagram: @mike_guertin.



A

B

C

PHOTOS BY GREGG WILLETT PHOTOGRAPHY

Chinese Chippendale Railing

by Frank Pologruto

Our clients' existing upper-level deck was serviceable and structurally sound, but rather humdrum. In addition to an update to the upper level, they wanted to create space under the elevated deck that would be protected from both the rain and the sun while providing unobstructed views and easy access to their nearby swimming pool. To meet their goals, our team designed a plan featuring an under-deck drainage system and a beefier carrying beam that would eliminate the need for midspan support. A custom-built Chippendale-style balustrade would give their new space a distinctive look (A, B).

The biggest structural challenge on the project was the beam replacement, which required an engineer to size a new pressure-treated beam that would clear span the 22 feet between the corner posts, and would take five or six hours to install. As we wrapped the beam, columns, and stair stringers with PVC trim and moldings, the team at Southeastern Underdeck Systems tackled the weatherproof ceiling installation, which features aluminum panels that drain to a gutter system.

For us, the highlight of the job was the railing upgrade, where we replaced clunky-looking vertical balusters (C) with Chippendale-style railing panels. Named after English furniture-maker Thomas Chippendale, who was influenced by Chinese design, the style influenced American architecture during the colonial period, particularly for porch balustrades and fences. The fretwork pattern is a geometric challenge, particularly where the balustrade angles down the stairs. But once we figured out the angles and custom-fabricated the panels on site out of #1 KDAT southern pine, installation was straightforward. Finally, we turned the project over to our painter. ❖

Frank Pologruto owns Decks & More in Smyrna, Ga.

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BY VINCENT SALANDRO

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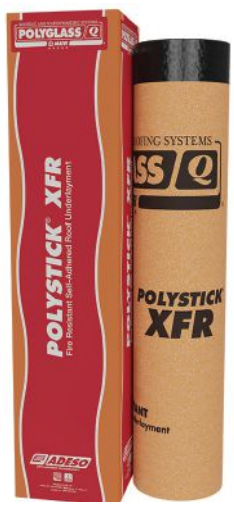

1. Metal Deck Fasteners

The Camo Edgexmetal Clip can be used for fastening any grooved deck board on metal substrates. Clips feature a drill point screw that engages in less than two seconds, according to Camo. The clip's wings fit into the groove of a deck board, securing the clip for fastening, and the product's 304 stainless steel gusset holds the boards down. According to the manufacturer, the clips work with top manufacturers' deck boards at any angle on 14- to 18-gauge metal framing. The clips are available in 90-count and 450-count pails. Pricing starts at $75. camofasteners.com

2. Mass Timber Fasteners and Connectors

The Strong-Drive SDWS Timber structural wood screw is part of Simpson Strong-Tie's line of connectors for mass-timber construction. The company says that the screw's serrated thread reduces splitting, and its saw-tooth point reduces installation torque, ensuring faster starts and eliminating the need for most predrilling. Screws are available in both interior and exterior coatings. strong-tie.com

3. High-Performance Housewrap

Benjamin Obdyke's updated Flatwrap HP is a relatively high-perm housewrap designed for rainscreen applications, or as the secondary WRB, for stucco and manufactured stone. According to the manufacturer, Flatwrap HP can be exposed for 120 days before cladding installation and features a trilaminate polypropylene substrate to protect the water hold-out layer from damage during install. The manufacturer reports a perm rating between 10 and 20 perms (perm ratings vary with ambient humidity conditions). The product is available in 3-, 5-, and 9-foot sizes. Pricing varies by distributor. benjaminobdyke.com

4. Dual-Purpose Underlayment

Polyglass Polystick XFR is a dual-purpose fire-resistant and self-adhered waterproofing underlayment. The roof underlayment achieves a UL Class-A fire rating for combustible decks and is designed to withstand temperatures up to 265°F. The product features an SBS-modified-bitumen upper compound and a self-adhesive compound on the bottom with fiberglass reinforcement for strength and stability. Pricing varies by region. polyglass.us

5. WUI-Approved Decking
MoistureShield's Vision capped composite decking line has been approved for the Wildland Urban Interface (WUI) Building Materials listing in California. WUI zones are severe fire hazard areas where potentially flammable vegetation meets or overlaps with developed areas. The manufacturer says that Vision composite decking resists scratches, stains, and other damage, and absorbs less heat so it stays cooler than traditional capped composite boards. Pricing varies by region. moistureshield.com


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6. Deck Stair Safety Treads
Wooster Products' Stairmaster safety renovation treads are now available in coordinating and contrasting colors to enhance front edge visibility and safety. According to the manufacturer, the anti-slip stair treads, which are made to adhere to steps and landings, meet the 2015 IRC and are suited for interior or exterior retrofit applications. The safety treads start at $25.70 per lineal foot, are available in 9- or 11-inch widths, and include a mill finish extruded aluminum base, with a beveled edge and countersunk holes. woosterproducts.com


6

7. Structural Countertop Support
Federal Brace designed its Metal Stud Cantilever Plate to solve issues with weight-bearing cantilevers (such as a heavy solid-surface or stone countertop) common with brackets installed on steel studs. The plate can reportedly be installed much quicker than wood blocking, to carry countertops, residential and commercial vanities, and wall-mounted workstations. The 24-inch plate has four 0.26-inch slots and is available in a raw steel finish. Pricing starts at $22.50. federalbrace.com

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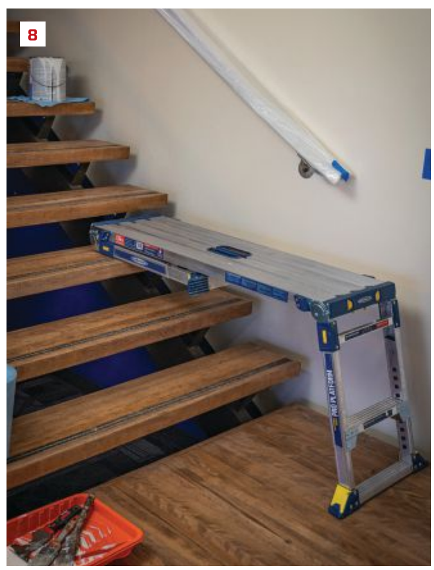
8. Compact, Adjustable Workstation
Werner's Aluminum Adjustable Pro Work Platform provides up to a 9-foot reach and 10 inches of height adjustability on both sides for workers. The platform, with a load capacity up to 300 pounds, provides users with a 45-inch-by-14-inch work surface that can be maneuvered easily on a jobsite. The platform can be configured to 10 different height positions with one-handed adjustment and locking. A protective bumper shields contact surfaces from damage. Available for about $110, the Pro Work Platform features a handle with wide openings to enable a comfortable grip and easy transport. wernerco.com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9. New Low-Profile Ridge Vent

Atlas Roofing has introduced TruRidge and High-Point Roof Ventilation—the company's first vent systems. Both systems are manufactured with a polymer that reportedly withstands severe freeze-thaw and other extreme weather conditions. The manufacturer claims the products are backed by a full-system warranty against high-wind damage, streaks, and manufacturing defects. The company's goal was to offer a range of 18- and 12-NFA (net free area) products at a range of prices. Pricing varies by region. atlasroofing.com


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10. Impact-Rated Sliding Patio Door

The Rehau System 2150 sliding patio door has a structural NAFS rating up to LC-PG45 and is designed to achieve an impact rating up to DP50 at 96 inches by 96 inches. The door allows for the creation of X-O, O-X, O-X-O, and O-XX-O configurations; an optional integral J-channel frame is available for new construction. Accessory grooves on the frame accept profiles such as jamb extensions and drywall returns. According to the maker, units with an overall U-value down to 0.20 are available. Contact distributors for pricing. na.rehau.com


10

11. Pressure-Treated LVL

Pacific Woodtech and Kop-Coat created a commercially available, fully treated laminated veneer lumber (LVL), using a proprietary treatment system and process to fully penetrate each veneer layer and add an envelope finish. The PWT Treated LVL can withstand damage caused by fungal rot, decay, and wood-destroying insects, with a life expectancy of 50 years, and will not bow or twist, according to the makers. The product is ideal for above-ground interior or exterior use, such as deck beams, joists, columns, and treated sill plates. Pricing varies by region. pacificwoodtech.com

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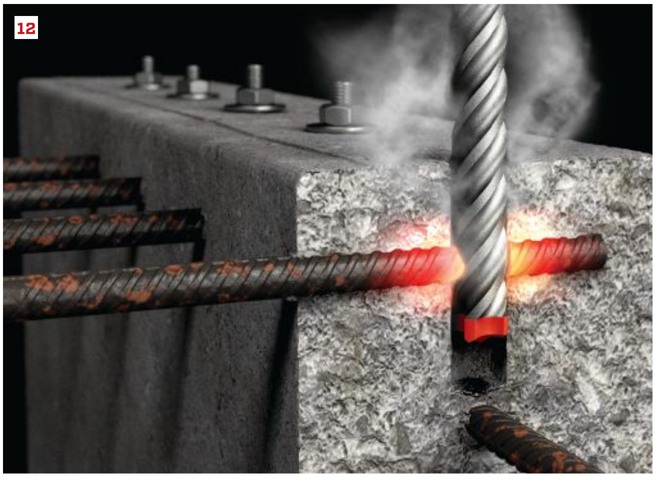
12. Precision Drilling Hammer Bits

Diablo's SDS-Plus and SDS-Max Rebar Demon 4-cutter full-carbide-head hammer bits for concrete with rebar applications provide a solution for drilling precise holes without the need for changing to a rebar cutter. The ultra-hardened bits are designed to withstand the stress of high-powered hammer drills and heat, and the impact of rebar cutting. Diablo's Rebar Demon line includes 74 hammer bits, covering a range of 5/32 inch to 1 1/8 inches for the SDS-Plus and 3/8 inch to 2 inches for the SDS-Max. Pricing ranges from $4 to $190. diablotools.com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Both chain saws have the power to slice through framing lumber (top). The DeWalt gets it from one 60-volt battery; the Makita, from two 18-volt batteries.

Cordless, Brushless Chain Saws

BY TIM UHLER

As a framer, I often rely on specialty tools that help me save time without sacrificing quality. Chain saws are one such tool. You may not think of a chain saw as a typical framing tool, but since I was a teenager, we have had a gas-powered chain saw on site. We used it—and continue to use it—to cut large beams or gang-cut materials like joists and rafters.

Last year, DeWalt and Makita introduced battery-powered brushless chain saws. I liked the idea of a cordless chain saw; for me, having a lighter-weight tool and not having to deal with fuel mix and the stink of gas balanced any potential power loss. Plus, cordless tools tend to be quieter, and, for safety reasons, I liked that I could set the saw down between cuts without its running continuously.

The big questions for me were whether these saws would have enough power for what we do and whether the runtime would be good enough to maintain our productivity. I knew they wouldn't compare with our big Stihl gas-powered saws, but we don't usually need a lot of power from a chain saw on a framing site.

MAKITA XCU03PT1 18V X2 (36V) LXT 14-INCH CHAIN SAW

I reviewed—and fell in love with—the Makita in-line cordless saw last year. Makita's cordless chain saw has a similar design approach in that it uses two 5-Ah batteries to provide 36 volts to power the chain. It also has a brushless motor, which is said to improve runtime, efficiency, and longevity of the tool.

The trigger is variable speed, just like on every chain saw I've ever used, and the saw has a toolless chain adjustment that works well. On top of the tool is a large LED on/off switch that you must press before you squeeze the trigger and start the saw, which is a safety feature. As with any chain saw, this saw has a front hand guard that locks the blade or that will protect your hand and act as a chain brake if the saw kicks back while in use.

As I put this saw together, it didn't feel cheap, and it is compact and lightweight. In use, it is easy to control, and since it is battery operated, it never floods or takes multiple pulls to start. As long as the batteries are charged and seated properly, it starts right up.

The saw has an electric brake, and though the chain doesn't stop immediately after use, it does decelerate quickly to a full stop. This is a great safety feature; with a gas-powered saw, I have to leave the motor running with the chain locked between cuts, which wastes fuel and is noisy and potentially dangerous.

It is easy to check the level of bar oil using the "view window." Under the top handle is a battery meter showing the battery charge.

Photos by Tim Uhler

The batteries take about 45 minutes to charge on the dual charger. The kit sells for $390 and includes a charger, two batteries, the chain saw, and, as a promotion, either another pair of batteries or a grinder as well. A similar version of the chain saw with a 16-inch bar is also available. makitatools.com

DEWALT DCCS670 FLEXVOLT 60V MAX BRUSHLESS CHAIN SAW

The DeWalt saw is longer tip-to-tail than the Makita, in part because it uses a 16-inch Oregon bar. The chain tensioner is also tool-free and seems to work well. The hand guard functions like that on the Makita and other chain saws.

This saw functions just like a regular chain saw; there is no safety switch, as on the Makita, that you need to press before you can turn the saw on, which I prefer. A great safety feature on this saw is that nearly as soon as you let go of the trigger, the chain stops; I love saw brakes and chain brakes for the safety they provide.

I received the review model as a tool-only, and then received a 6-Ah and a 9-Ah battery separately; both had plenty of runtime for the way we use these saws. I mention this only because the current kits sell with a 3-Ah battery, which I was not able to test. (As an aside, we also tried using both chain saws for cutting firewood, and found that none of the batteries lasted very long. That's fine with me because I don't want to cut firewood for too long anyway.)

There is a level indicator on the front of the saw for the bar oil, which makes it easy to see. The kit comes with the saw, one 3-Ah battery, and a charger, and it costs about $350. dewalt.com

WHICH TO BUY?

This is a tough call. Based solely on the chain saws themselves, I would buy the DeWalt as long as I could purchase it with a 9-Ah battery. Three of us used this saw, and we all found it cut faster (just a little) and straighter than the Makita. One of the reviewers grew up in a logging town and worked in a chain-saw repair shop. He found the DeWalt easier to control but loved both saws.

Chain saw makers like Husqvarna and Stihl make a cordless chain saw too, and our local saw shop sells both. Interestingly, their product info shows someone using the saw to cut lumber. The shop mechanic told me he put away his old Skil worm drive and now uses a cordless chain saw for cutting lumber.

While I feel the DeWalt slightly edges out the Makita, we didn't care which saw we grabbed when we were on a jobsite. Being able to go out to the lumber stack and cut glulams without dragging a cord around is so convenient. We don't use our beam saws as often now; we reserve them for exposed beam work that requires a cleaner finish cut. We cut all headers, timbers, and beams with a chain saw. With a sharp chain and good technique, the cuts are square and clean—completely acceptable for framing work. Both saws do their job well and have plenty of power and runtime for what we do on a framing site.

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The Makita XCU03PT1 18V X2 LXT 14-inch chain saw (above left) and DeWalt DCCS670 60V Max 16-inch chain saw (above right) both feature chain tensioning and bar tightening knobs for toolless chain adjustment. The Makita saw weighs 11.5 pounds (with two 18-volt batteries), while the DeWalt saw weighs 9.4 pounds (with a single 60-volt battery).

October Advertising Index

*Advertising appears in regional editions

BY JLC STAFF

Dawn of the Duplex Receptacle

On a long list of small house details we take for granted, the electrical outlet stands out as one for which we owe much gratitude. While the tale of Ben Franklin flying a kite in a thunderstorm suggests that electricity was part of American life from the outset, it wasn't until late into the 1800s that electricity found its way into most homes, and then, mostly just for lighting. (It came well after Thomas Edison's 1879 light bulb, which was initially powered by small kerosene generators, and required companies like Siemens, Westinghouse, Oerlikon, and General Electric to first perfect three-phase AC power generation, which came in the 1890s.) Wires were most often run directly to fixtures, placed where previously there had been a gas lamp—hanging in the center of the room or placed high on a wall—without a switch.

Enter Harvey Hubbell, an avid inventor who had already filed numerous patents, including one for a switch for the Edison bulb in 1891 and ones for improving the production of screw threads and for slotting screw heads. His first runaway success, however, was an 1896 patent for the "pull socket" (essentially the same pull-chain switch used today), which soon became the most common electrical control device in homes **(1)**. Others were inventing a range of ways to connect a vast number of newly invented household appliances, such as electric fans, vacuum cleaners, and clothing irons. But there were no standards, and many early appliances initially needed to be hard-wired or had a variety of plug configurations to fit known proprietary receptacles. Without any standards, though, it soon became apparent to most appliance manufacturers that these early plug options vastly limited market share, and many appliance makers settled on providing screw plugs at the end of the cords that would fit the ubiquitous light socket.

With the market headed this direction, Hubbell saw an opportunity for "separable plugs"—a base that could screw into a light socket and a mating plug on the appliance cord. Hubbell resisted working with the fledgling National Electric Code (first formed in 1897) to set a standard for the plug type. Instead, he set his own standard by the sheer force of controlling market share, aiming first at products that offered practical convenience, and then streamlining production to make them as quickly and inexpensively as possible.

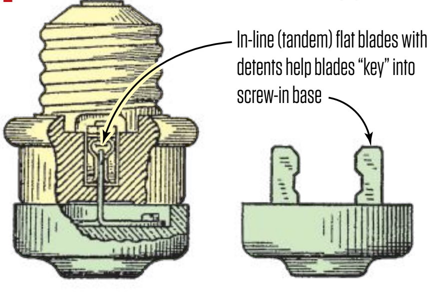
First, he adapted the round-pin plugs common in Europe at the time (as now), patenting one with annular detents on it, similar to a modern headphone jack, so it would stay plugged in to an overhead socket. To win the market, he drove to make more units: He simplified the manufacturing of the pins by making them flat blades with detents on the edges to help them "key" into the screw-in base. The first versions had in-line (tandem) blades **(2)**. In 1912, he submitted a patent for a separable plug with flat blades rotated 90 degrees, which helped streamline production **(3)**.

To ensure he could accommodate all plugs (most of which he had by then sold), he patented a T-slot base to accept both tandem and parallel blades. He patented this as a single plug in 1915, and in 1916, he patented it as a "duplex" (for two plugs), followed by a polarized version the same year. By then, his company had sold more than 15 million separable plugs. When a National Electrical Manufacturing Association (NEMA) eventually formed in 1926, it adopted Hubbell's parallel blade design as the U.S. general service electrical plug standard.

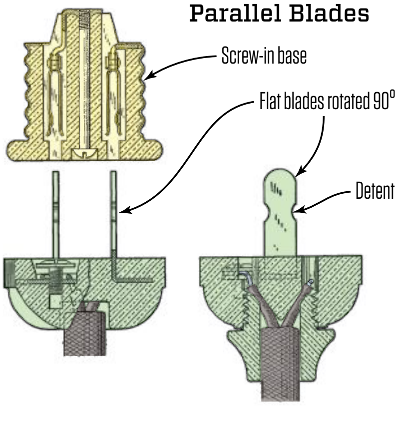
1 Hubbell's Pull-Chain Switch

Hubbell's "pull socket" (patented 1896) was the first common electrical switch **(1)**.

2 In-line Blades



3 Parallel Blades



Hubbell first made "separable plugs" with tandem blades **(2)**. His parallel-blade **(3)** version was less expensive to make.

(1) Hubbell Electrical Catalogue, 1906; (2, 3) adapted from US Patent Office, US774251 (1904) and US1064833 (1912)

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