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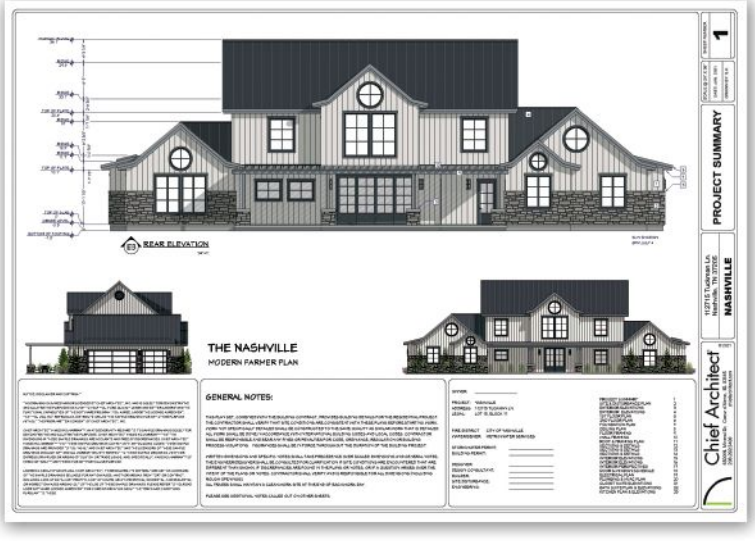

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5 MISTAKES TO AVOID WHEN INSTALLING PVC TRIM, SIDING, AND MOLDING

A material known for resilience and versatility performs even better when you follow a few rules.

There are many reasons why free foam cellular PVC (polyvinyl chloride) has assumed an ever-growing role as the go-to material for decks, trim, siding and cladding.

Durability, availability, and versatility are often cited as leading reasons, key considerations in today's tough building environment. Yet, change isn't always easy. Contractors used to working with a certain material may be reluctant to switch to something else, even if the alternative is widely accepted and is proven over many decades, like PVC.

Ask Garrett Davis, owner and operator of G.W. Davis Company, a custom homebuilder and remodeler in central Maine. Davis started out a wood guy, but his thinking has evolved in recent years.

"I love wood. In fact, my company was called G.W. Woodworking for the first few years," Davis says. Wood is still a big part of Davis' life, but it's PVC he specs first in bids because of the way the material has eliminated callbacks in his home building, remodeling, and decking projects.

What have years of field experience taught Davis about PVC molding, trim and siding? He offers five lessons:

1. **Fasten it right.** "Use Cortex fastening screws [when installing PVC trim]," Davis says. "Cortex plugs aren't obvious if you're consistent with placement, not haphazard. Depending on the board size, install every 12 inches and make sure the screws line up vertically. I do two screws, one-inch from the bottom and top. Three screws on bigger boards. Cortex eliminates movement."
2. **Fasten often.** "Every single nail holding PVC siding is into a stud, just like all my trim. I have solid attachments everywhere. I use a lot of fasteners and lots of glue. If you think you're doing enough, you're probably not. You need to do more," Davis advises. The reward? No siding movement from season to season, even in Maine (where you have big temp changes).
3. **Fasten near the edges.** Wood and cement board can splinter or crack if fastened near the edge. Free foam cellular PVC is different. You fasten PVC near the edges to prevent buckling and warping, Davis says.
4. **Keep it cool.** Keep stored PVC siding, trim, molding, or other PVC products out of the sun. Store in a garage or under a lumber tarp. Cool PVC installs truer. Davis knows all material moves, whether it's wood, fiber cement, or PVC. "If installed right, it's set-and-forget with PVC. That's the beauty of it. Just follow the manufacturer's guidelines," Davis says. "There's no expansion and contraction from water absorption. Sealing, painting, repainting, maintenance and all the things you normally face with wood go away with PVC. Just fasten properly."
5. **Butt joints and glue.** "Use butt joints as much as possible, with biscuits and lots of PVC glue. Christie's Red Hot Blue Glue is a great product," the contractor says. For longer runs on skirt boards, fascia or frieze, manufacturers recommend scarf joints, fastened on both sides near the edge with adhesive.

Davis has one last piece of advice and one he feels is too often misunderstand by contractors. "I've heard all the arguments for and against PVC," Davis explains. "A lot of people say wood is cheaper. In my experience, it's not. I don't like worrying about water seeping into end grains or wondering how much paint is enough. Do I need to biscuit this? How do I hold this joint together? With PVC, water worries and callbacks go away. Plus, it's a cinch to install. If you're used to wood, you'll like PVC."

As proof, Davis points to his own home. He relied exclusively on PVC trim, molding, and siding from his go-to PVC building material supplier, AZEK.

"I want the look of wood, not the maintenance," he says. "It's all about set-and-forget. No repainting. No color fading. No peeling, warping, rot, or having to add a rain screen."

Davis singles out AZEK for all PVC siding, trim, molding, cladding, and deck products. "They keep me a step or two ahead of my competition. I sell on quality. No one delivers like AZEK."

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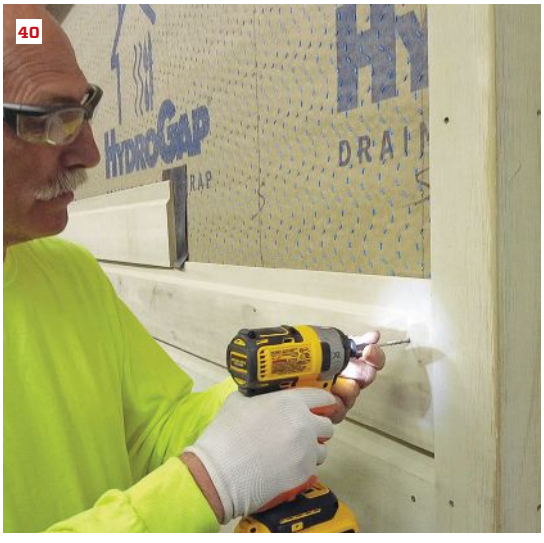

On the cover: Ernesto Bonilla of Great Lake Builders Inc. in Greater Chicago installs metal straps as part of a structural repair. Photo by Jake Lewandowski. See the story on page 35.

FEATURES

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WINTER READY

BY TIM UHLER

Working With Large Beams

When you're framing a home, working with large beams is just a fact of life. On nearly every house we frame, we install large glulams or other engineered-wood beams. With a lot of these beams, we stage the lift before the roof has been framed or the trusses have been set, and, as a result, we often need to lift the beams over walls to the roof and upper floors. We have worked out processes to do this safely and efficiently, so what used to take us an entire afternoon to lift now may take less than an hour—with good planning and the right equipment.

CUTTING LARGE BEAMS

Every framing crew needs at least one 10¼-inch circular saw. For a long time, we have been using a Big Foot (bigfootsaws.com) 10¼-inch saw to cut beams. It's one of the last corded saws we still use, though Makita recently came out with its 40-volt XGT 10¼-inch saw, which is quickly becoming our go-to choice. We have a 14-inch Big Foot Big Boy, too, but we prefer to use it only for exposed beams, where we want a very clean cut end.

Because the maximum depth of cut with 10¼-inch saws is about 3⅞ inches, we have to cut from both directions on most beams. We typically cut from one side of the beam, and then from the other, cutting vertically with the beam on edge. When you do this, make sure you keep track of what side of the line you're cutting so you don't end up with a stepped end cut.

We also keep a chain saw in the truck and use that to cut beams whose ends won't be exposed. When we use a chain saw, we first cut with a 10¼-inch saw to define cut lines, and then finish them off with the chain saw. Even with the saw cut to define the cut line, it's still faster with a chain saw, because it's a few less moves. Handling big beams is more dangerous than cutting them, so it's always best to limit how much you handle them. And when you do move them, it's often better to use a machine. While it can be a point of pride to manhandle a beam into place, it isn't safe and it isn't efficient.

HANDLING LARGE BEAMS

It's not unusual for us to work with 18- or 24-inch-deep glulam beams. Because these are often too heavy for my crew (typically just two guys) to lift, much less flip over and cut to length, we use an all-terrain forklift. We have had a forklift on site since 2002 to do our heavy lifting.

Training. There's a lot to learn about safely operating a forklift (see "Rough-Terrain Forklift Training," Sep/19). It's critical that the

Photos by Tim Uhler

The maximum cut on a 10¼-inch saw is about 3⅞ inches, so cutting through a 5½-inch glulam requires two cuts. With the beam positioned on edge and crown up on the forks of the forklift, Kyle Davis cuts vertically from one side **(1)** and then the other **(2)**.

Another way to maneuver a beam is with a "beam wrench," which can be made on site with plywood or OSB scrap **(3)**. This simple moment arm gives the author enough leverage to tip the beam on edge safely and quickly **(4)**. For beam ends that won't be exposed, Kyle makes a first pass with a circular saw and finishes the cut with a chain saw **(5)**, without moving the beam at all.

driver be certified as a "lift driver." It's not a one-time training; that person also has to maintain their certification over time. In addition, it's important that everyone else on site be trained about working around a forklift, so they know what to do or not do—like not pass under the forks. In the middle of a lift, people can get excited and forget what they're doing. Calm and concentration during the lift is important for all. Our perfect "no accident" record is no accident; it comes from not being cowboys on the jobsite.

Planning. We order all of the engineered beams at once and have them bundled together, apart from the rest of the lumber package. This makes them easy to store on site and simplifies moving them. I don't like to manually pull or lift a beam unless there is no other option. Instead, we use the forklift to pick up one end of the beam, set stickers, and lower it back down. This gives us the clearance we need to pick the beam up from the center for final placement.

Cutting. We often use the forks to tip a beam on edge (crown up or "top" stamp up), then pick it up and hold it on the forks at about knee or hip height so we can cut both sides while the beam is in a vertical position. That way, when the thickness of the beam exceeds the capacity of our saw, we don't have to flip it to cut from the other side. It also eliminates any stresses that might bind the blade.

Recently, we have been using a "beam wrench" (see photos 3 and 4, above). Made from plywood or OSB, this simple site-made tool allows us to quickly and safely tip monster beams on edge that we otherwise couldn't move.

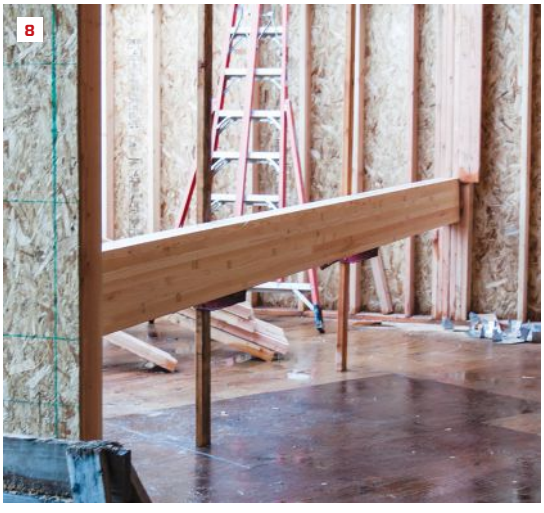
Lifting and setting. To lift a beam into place, we use two basic approaches. The first, easier method works well for most garage beams and other beams that sit on first-floor walls that we have direct access to. We center the beam on the forks and lift it into place on support columns or walls.

A variation of this technique is to attach the support columns and hardware to the beam while it's on the ground; we then lift the whole assembly into place. Often, this is the safest, most efficient way of handling the beam. We can work faster on the ground, and when we set the beam, we only need to plumb and brace it—no drilling or fastening hardware while working from a ladder.

The second approach is to carry the beam from rigging straps. This takes a little longer but gives the guys on ladders or scaffolding more maneuverability to guide the beam into a pocket. We have an assortment of rigging straps that are rated for far more weight than we'll ever lift. To locate choke points for the straps, we typically split a beam into thirds. The strap angle off the beam should be 60 degrees or greater. (Please note: Some states have specific rules about who can rig, so be sure to check what may be required locally.)

We often have to drive with the boom in the air, which can cause large beams to swing all over the place. This can be dangerous, but we have never had an accident because we take our time and always use at least one tag line so that the beam doesn't swing out of control.

Hand signals. There are standard hand signals for signaling a



One of the safest ways to lift a beam into place is to first attach the support columns and then lift from the center of the beam with the forklift **(6)**. For larger beams that require more control, the author uses rigging straps **(7)**. If the crew can't use a forklift, they use wall jacks **(8)**, making sure to brace them back to the framing to keep the jack poles straight **(9)**.

crane or forklift operator. We've modified them so that they make sense to us, and we train anyone new on our sites to use our version. What's most important is that everyone on the crew uses exactly the same signal style, and that the operator stays focused on the framer who is doing the signaling. We learn to watch the hand signals, but just as important, the driver pays attention to the signaler's facial expressions and body language.

Lifting without a machine. Sometimes we have to set a beam where we can't use a forklift. This comes up more often in remodeling situations, but occasionally on a new house, a change will occur after the trusses have been set and the building dried in, and we have to walk a beam inside and lift it with wall jacks. In one example, we had to set a 42-foot-long, 5½-by-12-inch glulam. It needed to go up 14 feet in the air—and we had just three guys on the crew. To get this done, we had the lumber company drop the material as close to a window as possible. From there, we were able to slide the beam onto a section of rolling scaffolding. This allowed us to wheel the beam into place and then use two wall jacks to lift it up, bracing the jacks to keep them straight.

However we move heavy beams, we alway take the time to come up with a good plan. We can't afford either a miscut or someone getting hurt.

Tim Uhler is lead framer for Pioneer Builders, in Port Orchard, Wash.

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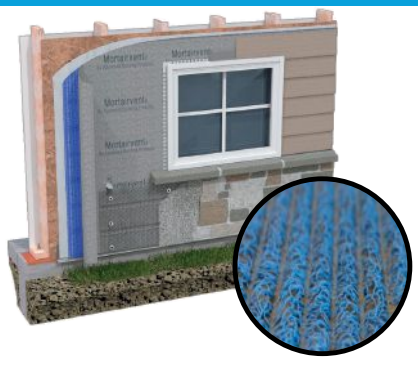

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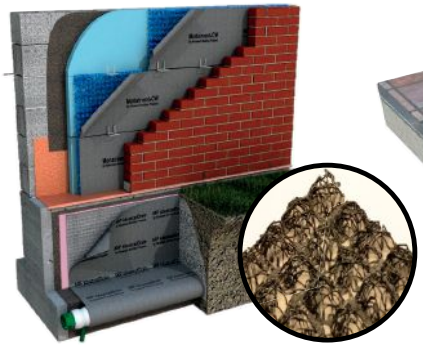

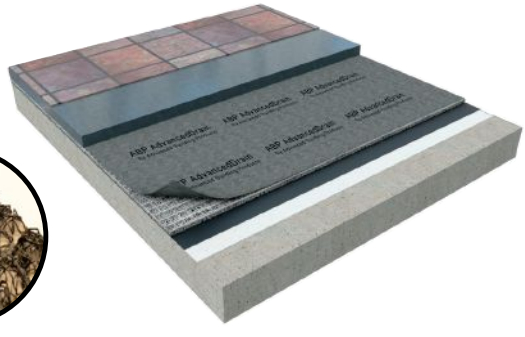

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Q My clients own a seasonal vacation home built in the 1930s that has several pairs of single-pane double casement windows. The windows, which open to the outside, are original to the house and in good shape but leak in a driving rain and are drafty. What is the best way to weatherseal these windows that will preserve their appearance and function?

A *Steve Jordan, author of* The Window Sash Bible *and* Storm Windows: A Comprehensive Guide *and owner of a window repair business in Rochester, N.Y., responds*: Out-opening casement windows are often vulnerable to air infiltration and blowing rain because there is no trim (blind stop) around the perimeter opening; paired casements without a centered mullion increase the problem by adding a gap where the two sashes join—this gap may or may not have an astragal to deter air and rain. Storm windows are an option, but exterior ones would have to be removable to allow opening the casement during warm weather. While an interior storm sash helps with energy efficiency and exterior noise reduction, it will not prevent rain from blowing around the perimeter where it may become trapped between the prime and interior storm sashes.

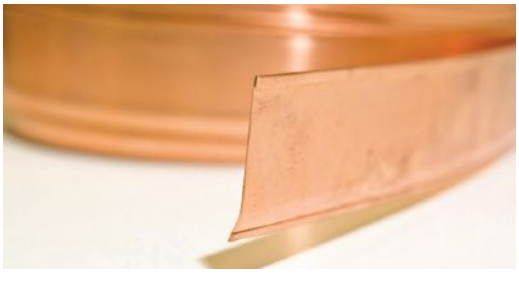

Photo by Steve Jordan

Spring bronze is installed with the flat side on the interior and the sprung side facing the exterior so that the sash compacts the bronze as it closes.

Casements are also prone to sagging that creates a gap at the latch-side head and sticking at the sill. Older casements were installed three ways: without weatherseals; with spring bronze weatherseals installed on site; or with complicated proprietary zinc or bronze seals installed at the millwork plant. There are various methods to weatherseal casements at the vertical jambs and head, but sealing at the sill/stool/bottom rail is tricky.

You didn't tell us if there were original weatherseals, so I assume there were none. We also don't know the construction details—the return edges could be a simple right angle, rabbeted, or even a convex-to-concave joint, so I'll discuss the simplest: a right-angle return. If the perimeter spaces between a sash and its frame are consistent all around and the sash is not sticking, proceed with spring bronze. But if the sash is sagging and racked, it may need to be squared up first. Square a racked sash by removing the glass or leaded panels, pulling it into square with clamps, and inserting two 1/4-inch white oak or mahogany pegs with glue through the joinery in each corner. Always measure squareness from inside the glass rabbet using a framing square, not from the outside perimeter, which may have been planed, altered, or worn over time.

Start by installing the spring bronze at the jambs and head and possibly at the bottom rail or sill. Sometimes minor planing is necessary; it's also traditional to run the bronze over the hinge leaves. As for sealing the sill, I usually remove the sash and determine what will work most efficiently—spring bronze, brush seals, or maybe a compression silicone bulb. On casements equipped with a metal sill trough, there is usually a bronze seal that diverts water into the trough where it runs out to the sill. But when there is no sill trough, there should be a wood drip mold to pitch the water to the sill and prevent it from entering at the stool. This mold includes a kerf on the underside to prevent water from running back to the inside.

There are other methods to weatherseal a casement including bulb seals and brush seals, but the traditional bronze is my go-to method. You can buy old-fashioned, high-quality 17-foot or 100-foot rolls of spring bronze from various online vendors, including Kilian Hardware, Accurate Machine Made, and Randy Surley Manufacturing Co. You can also find videos online that demonstrate installing and adjusting the spring bronze to get a tight fit.

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BY GARY STRIEGLER

Adding Hand-Hewn Beams to a Finished Ceiling

Modern engineered lumber and trusses make it easy to build massive rooms with vaulted ceilings and large volumes; these days, at least half of our projects feature a great room with a vaulted ceiling. Historically, those big, open spaces called for timber framing with large timbers to support the roof structure. Timbers are still popular today, but instead of serving a structural purpose, they are more often just large trim details.

One way we create a timber look is to build hollow box beams out of 1x12 pine. We have developed several tricks for making test cuts, fitting beam pieces, and attaching beam parts, but for the most part, we build these timbers piece by piece, in place. We always use a smooth finish, whether we stain the beams (which is typical) or not.

Occasionally, clients ask for a more rustic look, which requires solid wood beams. In Northwest Arkansas, we can order rough-sawn fir or cedar timbers and even get custom-milled air-dried oak beams from a local sawmill, but for the project shown here, the clients were looking for something with a little history. Their research led them to Heritage Restorations (heritagebarns.com), a company that finds, disassembles, and restores vintage barns, but that also has a huge inventory of reclaimed beams, siding, and other old barn parts.

Ordering the beams. To get a quote, I needed to estimate the sizes and lengths of the beams. I always plan for beams that are slightly deeper than they are wide, or at least square. In this case, I also wanted the main beam at the ceiling to be a couple of inches deeper than the hip beams butting into it. My client approved the estimate, but before we placed an order, I set up scaffolding to double-check the lengths. I ended up adding a couple of feet to the length of the main ridge beam just to be safe.

While awaiting delivery (it took about a month), I had to come up with a plan for accurately cutting the beams and securely fastening

Photos by Gary Striegler

After determining the angle where the sloped and flat sections of the ceiling converged, the author made an MDF template and used it to mark that angle on both sides of the beam **(1)**. Next, he cut to the lines with a circular saw at maximum depth **(2)** and finished the cut with a chain saw **(3)** while a helper supported the offcut. Finally, he smoothed out the cut with a handheld power planer **(4)**.

The crew cut the ridge beam long by 2 inches to allow for fine-tuning the fit, then lifted and propped it in place **(5)** to scribe both ends for the final precise fit **(6)**. Before installation, a worker drilled a hole in the middle of the beam for an electrical fixture **(7)**. The crew fastened the beam to the framing above with long structural screws **(8, 9)**. The first hip beam was cut long by 3 inches, then gradually trimmed to fit following the same procedure as for the ridge beam **(10)**.

them in place. My contact at Heritage Restorations suggested using long LedgerLok structural screws to mount the beams to the ceiling framing. I was a little concerned that the large head size of the LedgerLoks would make them too visible, but the countersink holes for the heads aren't noticeable on the rustic beams. We also decided that we could use long trim-head screws for the wood-to-wood attachments. From past jobs, I knew that having good scaffolding and lots of help would be critical.

Cut to fit. We had enough room to store and cut the beams next to where they were to be installed. The beams had to fit tight to the drywall with no trim or scribe. Usually, when we do beam work, I use a short test piece to get the angle of my cuts right, but I couldn't

Once they were satisfied with the fit of the first hip beam, workers fastened it in place using long trim screws for the wood-to-wood connection to the ridge beam **(11)** and structural screws for the connection to the house framing **(12)**. After honing their technique on the first hip beam, they were able to install the remaining three beams quickly **(13)**, and the ceiling was soon ready for the paint crew **(14)**. When viewed from floor level, the screw heads are virtually invisible.

figure out a good mockup that would be the same size as the beam for a test cut, short of stacking a lot of pieces of framing lumber together. Instead, I marked the end cuts with a scrap of MDF cut to the angle of the sloped ceiling, allowing a couple of extra inches so that I could test the fit of the beam in place. My plan was to start the cut with a circular saw from each side of the beam, finish it with a sharp electric chain saw, and then fine-tune each cut with a hand-held planer.

The ridge beam had to go up first. To check the fit and scribe a final cut line with a 1x2 held against the ceiling, we quickly figured out that cutting temporary legs to prop the heavy beam in place worked better than four guys straining to hold it over their heads. It took about three test fittings, making slight adjustments with the planer each time, before we were ready to drill a hole for the chandelier wire. To install the beam, we drove a pair of 10-inch LedgerLoks at each end into framing and toe-screwed the beam in the middle from each side.

Hips. I was even more careful with the first of the four hip beams, cutting it long by about 3 inches to test the fit. Doing that meant several extra tries lifting it in place to check the cut, but the fit had to be perfectly tight, and I didn't want to order (and pay for) an extra beam. We focused on the top wood-to-wood joint first, using our temporary legs to prop the beam in place for each test fit. It took a lot of patience from the crew, but right before lunch, we were able to screw the beam in place.

As I became more comfortable with the process, I added only an inch and a half instead of 3 inches to the measured length for the test cuts. We also learned that removing a little drywall from the inside corner at the bottom made it easier to get a good fit at the bottom.

When we first started talking about the project, I thought it might take most of a week to install the beams; there was no margin for error. It got easier as we went along (the guys doing the lifting might not agree), though, and we finished in just under two days. I have always been proud of the pine box beams we build in place, but I have to admit, nothing looks as nice (or is more work) than these historic hand-hewn beams.

Gary Striegler, a JLC contributing editor, owns Craftsman Builders in Fayetteville, Ark., and teaches workshops at the Marc Adams School of Woodworking. Visit his website, craftsmanbuildersnwa.com, or follow him on Instagram: @craftsmanbuilders.

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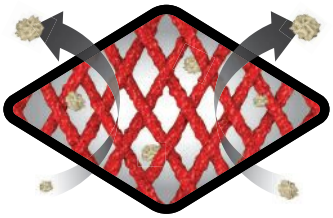

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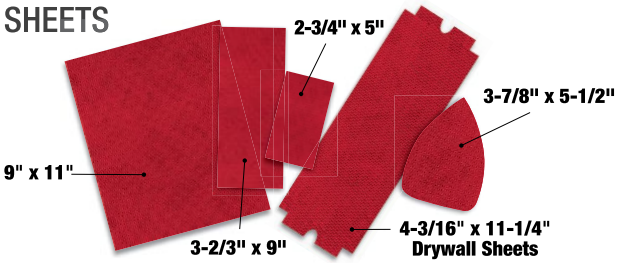

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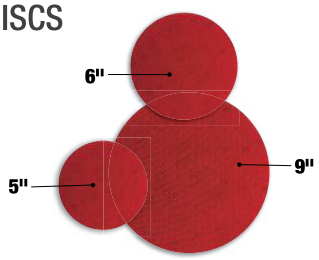

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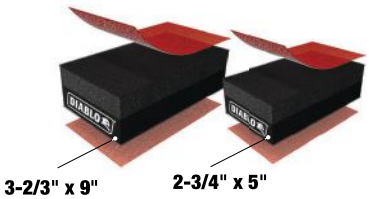

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BY ROB CORBO

Making Social Security Benefits Work

In my previous series on retirement, I discussed the need for construction business owners to save for retirement. I identified various retirement savings accounts you can establish, and I emphasized starting early, being motivated, making sacrifices, and taking advantage of tax-free saving. I did not discuss Social Security as a part of overall retirement planning, so let's dive into that now.

A HISTORY OF SOCIAL SECURITY

Social Security was signed into law in 1935 with the passage of the Social Security Act, a response to the devastation inflicted on the average American family by the Great Depression. As part of President Roosevelt's goals to provide protection from poverty in old age and from job loss, two of the benefits established under the act were retirement and unemployment insurances. Social Security benefits were meant to be combined with family savings to prepare for retirement. That is true today as well; Social Security should be combined with personal savings and tax savings retirement accounts to prepare a family for its future. In addition to retirement and unemployment benefits, the act provided assistance for work disabilities, assistance for children of retired, disabled, or deceased workers, and benefits for survivors of deceased workers. Other benefits have been added since the passage of the law.

Social Security is not an entitlement; it's insurance that you pay for. Money is deducted from your paycheck each month as a payroll tax known as FICA (Federal Insurance Contribution Act). Every year, you pay 6.2% of earnings up to $142,800; that contribution is then matched by your employer for a total of 12.4%. An additional 1.45% is deducted from your earnings for Medicare, which is also matched by your employer for a total contribution of 2.9%. If you're self-employed, you contribute the entire amount—12.4% for Social Security and 2.9% for Medicare.

There is a tremendous amount to know about the many Social Security benefits—disability benefits are especially significant for those of us in the construction trades—but for this article, I am going to focus on retirement benefits. Social Security's retirement plan is perfect for our industry. Participation is required, and you can't skip the contribution to pay a supplier, a liability insurance premium, or a truck loan. You can only complain that your paycheck looks a bit light. On the bright side, if you're an employee, your contribution is matched, and for both employees and employers, there's a good chance you or your family will get more money back from Social Security than you put in. With participation required, there is only one decision you will need to make once you qualify for drawing Social Security: at what age to start collecting.

QUALIFYING FOR SOCIAL SECURITY

To qualify for Social Security, you have to accumulate 40 credits. A credit is awarded for every $1,410 earned up to four credits a year. If you make $5,640 a year or more for 10 years and pay FICA taxes on those earnings, you qualify for benefits. The amount of your benefit, however, is based on your lifetime earnings (available for review at ssa.gov/myaccount). Your benefit is based on your 35 highest earning years, adjusted for inflation, in which you paid FICA taxes. If you work fewer than 35 years, a zero is added for each year you're short. Once you have 40 credits and 35 years of earnings, you have the choice to begin collecting Social Security benefits sometime between 62 and 70 years of age.

Social Security's retirement plan is perfect for our industry. Participation is required, and you can't skip the contribution to pay a supplier, a liability insurance premium, or a truck loan.

Before we continue, let's get the 1,000-pound gorilla out of the room. Will Social Security go bankrupt before I can collect? The Social Security Administration is projected to run out of surplus funds around 2033, but it will still collect payroll taxes and have enough funding to pay 78% of benefits. So, if Congress does nothing, Social Security recipients will take a 22% cut in 2034. However, that's not likely. Keep in mind, 76% of folks 65 to 74 vote, which is the highest percentage for any cohort. For that reason, Congress may be responsive to retirees' needs and pass legislation to maintain benefits; some possibilities include raising taxes, raising the $142,800 wage cap for paying FICA taxes, reducing benefits for the wealthy, and raising the full retirement age. What Congress does or doesn't do may mean thousands of retirement dollars for you, so keep an eye on Social Security news—and don't wait until you're

65 to vote. To maximize your benefits in case of a 22% reduction, work 35 years and delay collecting until you are 70.

WHEN TO BEGIN COLLECTING SOCIAL SECURITY

When to begin collecting benefits is a personal decision. Your decision likely will depend on factors such as family savings, retirement savings, sources of income, marital status, your health, family longevity, and future financial needs. And, let's not forget, do you like what you're doing? What's Sunday night like: Are you looking forward to Monday morning and getting back to the job, or are you anxious about returning to work? There is a lot to sort out.

The bottom line is, the longer you wait to collect, the higher your monthly benefit will be. You can start collecting retirement benefits any time between the ages of 62 and 70, though there is something called a "full retirement age" (FRA), which is based on the year you were born. For those born in 1960 or later, the FRA is 67. (If you were born earlier, visit ssa.gov to find out your FRA.) If you start collecting benefits before you reach 67, your monthly benefit will be reduced by about 0.5% for each month you're shy of 67; if you start collecting at 62, this reduction amounts to 30%. On the other hand, by waiting until after you reach 67 to collect benefits, you receive an 8% increase each year (8% on your FRA benefit, not on the compounded sum each year after). If you wait until you're 70 to collect, your monthly benefit will be 77% higher than had you started at age 62. Boiling it down, if your monthly payment starting at age 67 would be $2,000, then your monthly benefit starting at 62 would be $1,400 and at 70, $2,480 (see chart, right).

BREAK-EVEN AGE

Waiting to collect benefits means you collect more per month, but you collect this higher amount for fewer years. So, how do you figure out whether it pays long term to wait? Break-even math helps you calculate how old you'll be when the sum of a greater number of lower payments will be the same as the sum of fewer higher payments (see chart, opposite page). That's the age at which you will start to realize a higher lifetime benefit from waiting. Knowing this age may help you decide when to start collecting, especially if you have a particularly short or long life expectancy based on your health and family history.

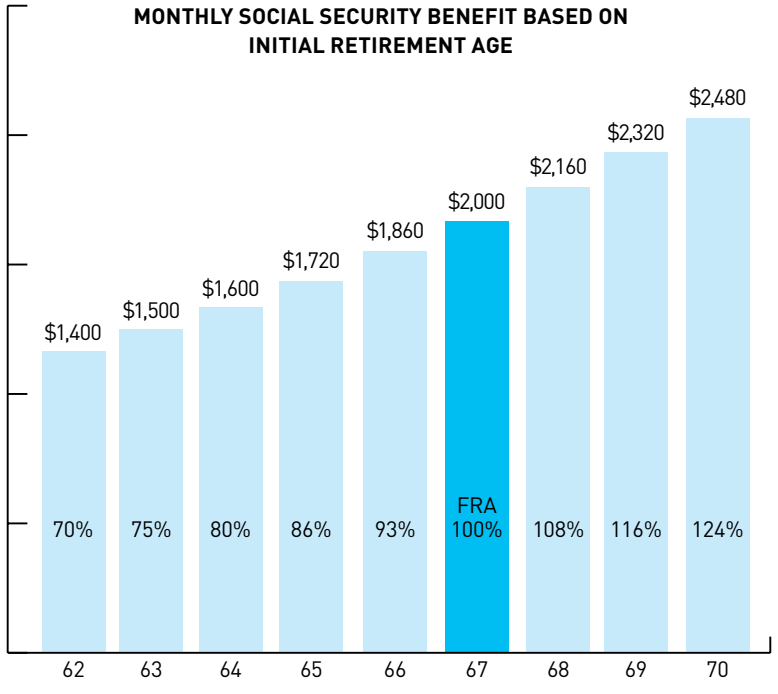
Let's use the example above and find the break-even point of starting benefits at 62 versus waiting until your FRA of 67. Starting at 62 means you will collect 60 monthly (five years) $1,400 payments, or $84,000, by the time you reach 67. If instead you start at 67 and collect $2,000 a month, it will take 11.7 years to break even—$84,000 divided by $600 (the difference in monthly benefits) divided by 12 months. That means at age 78.7, you break even and head toward the finish line with a higher monthly benefit.

What is the break-even point if you wait until 70 to collect benefits? If you start at 62, you will collect 96 $1,400 payments, or $134,400, by age 70. If you wait until you're 70, when your monthly benefit will be $2,480 ($1,080 more per month than at 62), it will take you 10.4 years to break even—$134,400 divided by $1,080 divided by 12 months. So you are walking tall at age 80.4 with maximum benefits.

If you start benefits at your FRA of 67, you will collect 36 $2,000 payments, or $72,000, by age 70. Waiting until 70 and collecting $2,480 a month ($480 more a month than at 67) will take you 12.5 years, until the age of 82.5, to be in the green—$72,000 divided by $480 divided by 12 months. Do you feel lucky?

OTHER CONSIDERATIONS

Be aware that if you want to collect Social Security at 62 and continue to work, there is an earnings limit. If you continue to work after starting to collect at 62, you are allowed to make $19,560 (beginning in 2022) before the SSA withholds $1 for every $2 earned. The withholdings are not lost, however. At full retirement,



For individuals born in 1960 or later, "full retirement age" (FRA) is 67—the age at which you are eligible for 100% of your benefit. The amount of your monthly benefit at FRA is based on the 35 highest earning years, adjusted for inflation, in which you paid FICA taxes. Individuals are eligible to start collecting benefits at age 62, but the monthly amount will be lower; waiting until age 70 results in a higher amount, as shown here for a $2,000 monthly FRA benefit.

monthly benefits are increased to reflect withholdings, and the higher monthly benefits will continue even after withholdings are paid back in full (about 12 years). Once you reach your FRA, there is no earnings limit or withholdings, and you can work and collect with no earnings penalty.

Inflation. A wonderful feature of Social Security's retirement benefit that should be considered in your decision-making process is the cost-of-living (COLA) adjustment (not guaranteed each year). You have to look long and hard to find other investments with such an inflation hedge. This year's COLA is 5.9% effective January 2022. Cost of living adjustments apply if you start at 62, but if you can wait until you're 70, you get not only the 8% a year delayed retirement credit each year after FRA but also a cost-of-living adjustment on a larger base, which has a compounding effect. This may be significant if inflation is persistent during your retirement or you or your spouse live to a ripe old age.

Life expectancy. Here are a few life expectancy estimates from the SSA: A typical 65-year-old today will live to 83, one in four 65-year-olds will live to 90, and one in 10 65-year-olds will live to 95. People are living longer, and generally, women live longer than men.

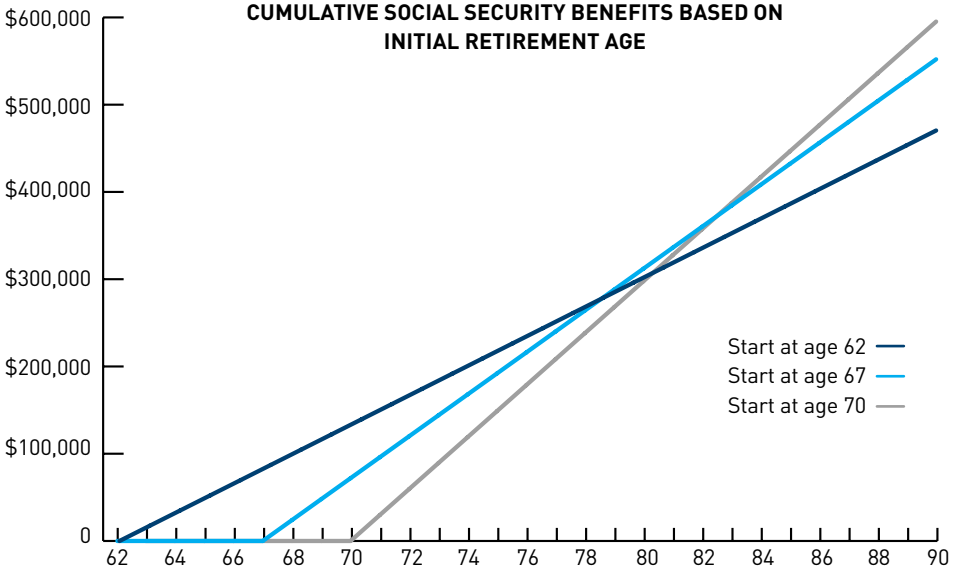
Spousal benefits. A surviving spouse with a lower benefit can collect their partner's higher benefit upon the partner's death. If at the time of your spouse's death, they are collecting $2,000 a month and you are collecting $800 and are at your FRA, you now qualify for their $2,000 a month benefit instead. So, collecting early at 62 rather than at your FRA or 70 may mean your surviving spouse will receive less money in monthly benefits and have a lower COLA base for the rest of their life. (Unfortunately, in the example above, the *household* income drops from $2,800 to $2,000.) The longer a spouse lives, the less likely family savings will last and the more likely they will need a larger Social Security benefit that adjusts for inflation. So, the proper age to start benefits may not be about how much you may collect in your lifetime, but about how much your family may collect.

There is a second spousal benefit, for a couple rather than a widow or widower, that may bring additional retirement benefits into your household. Using the $2,000/$800 example above and assuming both spouses have reached their FRA, the lower earner can collect 50% of the higher earner's benefit. So, the $800 spouse can apply to receive $1,000—while the higher wage earner continues to collect their $2,000. Collecting a spousal benefit before FRA will reduce the 50% benefit. Additional, special spousal benefits for Social Security recipients are available for retired couples with a disabled child or a child under 16.

COLLECT EARLY OR DELAY?

Reasons to collect early and receive a smaller monthly payment include the following: You dislike work, you need the money, inflation is not a concern, your health or life expectancy is an issue, you don't trust the Social Security system, and you have no family to consider. Reasons to delay, increasing your monthly benefit, are: You want to continue working, you don't need the money, you want to maximize your spouse's benefit and COLA, you don't want to run out of money, and your health and life expectancy are good.

So, when do you start to collect Social Security benefits? It's an individual's task to figure out the best scenario. Don't hesitate to seek assistance. Start with the local Social Security office. Many communities offer free retirement planning assistance with volunteer professionals. Check into AARP (American Association of Retired Persons). Pick up a book or magazine or search retirement planning online. Talk to family and friends. Do your homework and see a paid professional, if need be. And, be thankful that the voters 87 years ago, in 1935, thought it important to make your future a bit more secure. What can we do now to make the future 87 years from now—in 2109—a better place? Cue up Zager and Evans: "In the year 2525, if man is still alive, if women can survive ..."



The longer you wait to claim Social Security benefits, the more you stand to gain over the long term, provided you live past the break-even age. Above, that would be 82.5, if you are comparing starting at 67 versus 70 (based on a $2,000 monthly payment at a full retirement age of 67).

Rob Corbo is a building contractor based in Elizabeth, N.J., specializing in high-quality gut rehabs and renovations of inner-city residences.

BY DOUG HORGAN

Humidifying Homes

Why would you want to add moisture to a house? As anyone who's dealt with an expensive and challenging mold issue knows, moisture is often the *problem* in houses. Why would we deliberately add more? There are three answers I know of:

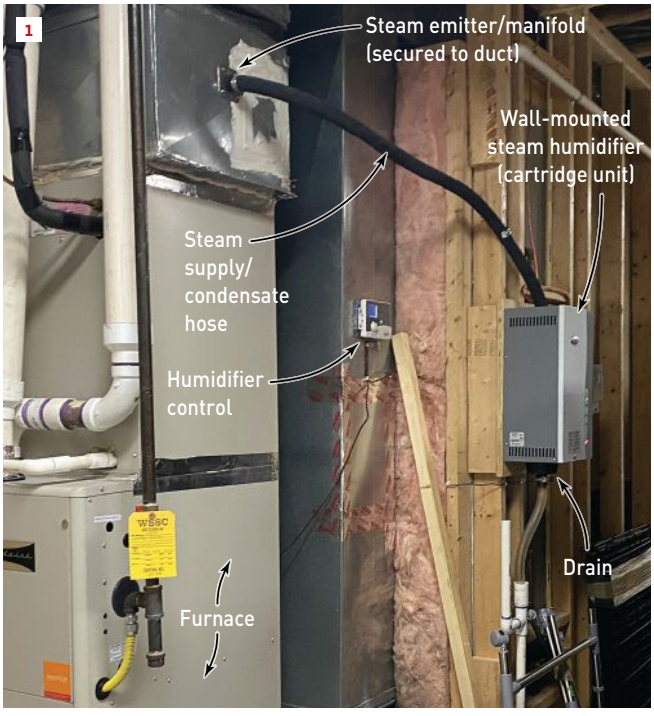
- Low humidity causes wood to shrink (when it dries out); this can cause aesthetic issues or even cause things to break.
- People are less comfortable when humidity is very low. Static shocks, dry nasal passages, and itchy skin are common issues.
- There is some evidence that low humidity allows some illnesses to transmit more effectively, so higher humidity may reduce the likelihood of these spreading—but there are important reasons to be cautious with this information.

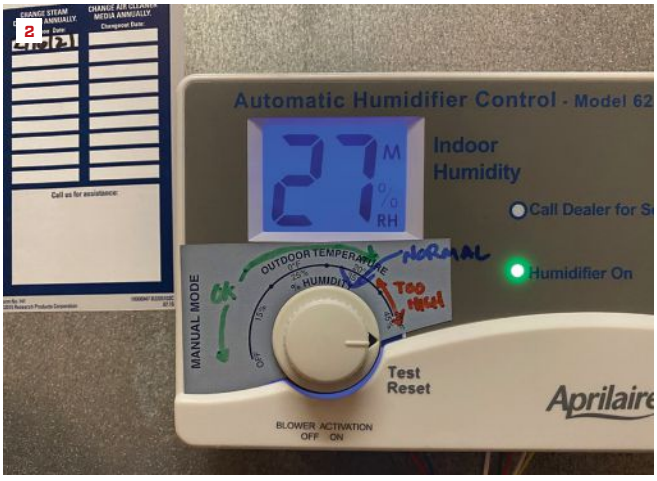
WHAT IS THE RIGHT LEVEL OF WINTER HUMIDITY?

To prevent wood from moving around too much, we want to keep humidity somewhat even, so the correct level in winter varies with climate. Where I work, the Washington, D.C., area, it's common for indoor humidity to run well above 50% for the humid half of the year. (I'll be using relative humidity (RH) at indoor temperatures in this article.) Wood will condition to this level of humidity and measure around 9% to 11% EMC (equilibrium moisture content) during the humid months.

In winter, we want to limit how much the wood shrinks from its summer level, so the closer we stay to 50% RH, the less movement. Having said that, 50% is too high for normal buildings to handle in many climates, and in my experience, problems develop only when humidity runs close to 20%, drying wood to about 4% EMC. If we can keep humidity between 30% and 40%, EMC will drop only to 6% or 7%, and wood shrinkage will be acceptable. After all, it's normal for hardwoods to have small gaps in winter; we just don't want them to be so wide they are objectionable. We find even wider baseboards and crown moldings won't shrink enough to break caulk lines as long as humidity stays above 30% most of the time.

If your summers are drier (typical of northern locations), you may not need to keep winter humidity levels as high as 30% to keep wood in good shape, whereas if your summers are wetter, your buildings may need to be humidified to more than 30% to prevent problems with wood. In other parts of the country, there may not be





Cartridge steam humidifiers emit steam into HVAC ductwork when called for by the humidistat **(1)**. In the author's climate, his company recommends clients set controls at 35% RH or lower (shown here marked up with colored pens), based on its experience that most buildings can handle 40% to 45% relative humidity in winter without moisture problems, and allowing for some inaccuracy or drift in the sensor **(2)**.

Photos by Doug Horgan; illustrations by Tim Healey

a significant difference in humidity between summer and winter, so it may not make sense to have a humidifier—at least for limiting seasonal wood movement.

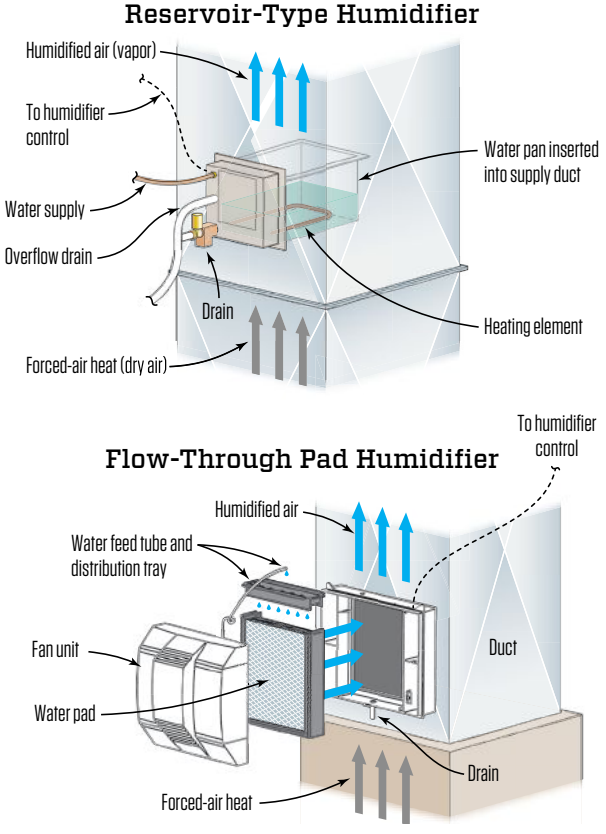
Engineered flooring seems to have the biggest problem with large seasonal humidity swings. We've seen several floors, from multiple manufacturers, rip apart at glue joints between layers in homes with low winter humidity (around 20%—so far, no issues at 30% or higher). A look at the warranties may be disheartening; some "require" that humidity be kept in small ranges like 35% to 45% RH year round, which is possible only in tight houses with closed windows, humidifiers, dehumidifiers, and perfect operation and maintenance.

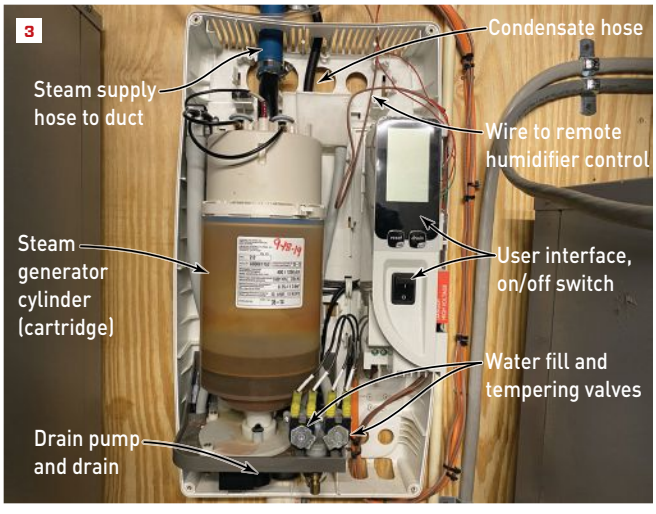
Striving for 30%. For human comfort, I have heard few complaints once humidity is maintained in the 30% range—despite what you may read. We work on many leaky houses and buildings where humidity can't be kept much above the low 30s, or even high 20s in some cases. These houses don't have super-dry static electricity issues or even many complaints about dry noses or skin; those start when houses run in the low 20s or lower for a few weeks.

In fact, John Straube, a principal at RDH Building Science, recently spoke of a client with itchy eye complaints on an ASHRAE Journal podcast (ashrae.org) with Joe Lstiburek. A doctor recommended a humidifier, but the symptoms became worse once it was in use, because the irritation was caused by mold growing in the walls, and the humidifier made the mold problem worse. This brings us to the wisdom of the internet.

If you search online for the "correct" level of humidity, you'll come across a diagram that seems to state that optimal relative humidity is between 40% and 60%. The main evidence about keeping humidity this high comes from hospital wards where influenza has been shown to spread much more effectively below 40% RH.

I would never minimize this important data point, which has been shown in multiple studies. But, it's crucially important not to overhumidify buildings in cold climates. Many houses in my area (climate zone 4) should not be operated at humidity levels above 40% or 45% in winter, or they will suffer from moisture damage, including growth of mold, bacteria, and other water-loving organisms (which themselves cause human health problems), wood rot and damage in walls and roofs, and also undesirable window condensation that can drip down walls, damage floors, and wet window shades. In colder climates than ours, the building envelope is that





Reservoir humidifiers can be high maintenance and may present an indoor air quality risk; typical designs stay wet all winter, allowing the potential for organisms to grow in them (illustration, top left). Flow-through pad humidifiers (illustration, bottom left) use disposable pads. Water trickles down from the top while air is blown through the pad. Pads are often treated to resist biological growth. Steam humidifier cartridges do accumulate minerals and debris from the water supply, but they are easily replaced—typically annually **(3)**. They are designed to fully drain in the off cycle.

much colder, and condensation and moisture accumulation can happen at even lower humidity levels.

It's easy to overhumidify ordinary buildings in cold climates. Standard windows, doors, and even walls and roofs are prone to condensation problems when indoor humidity levels are high. If you want to run a house at higher humidity, you have to build differently: more insulation, better windows, minimal air leaks, and thermal bridge protection—pretty much the recipe for a passive house—or use materials that can handle high levels of moisture and freeze-thaw conditions—the old recipe for hospitals and museums.

The respiratory pandemic we're in has increased this kind of talk, but it's not clear that higher humidity is helpful against SARS CoV-2. In fact, the one study I know of that tangentially addresses it indicated lower humidity may be helpful.

Whatever data or study one is looking at, high levels of humidity will definitely cause problems and must be avoided.

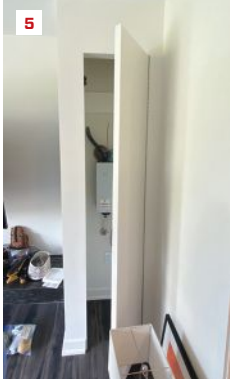
PORTABLE VS. WHOLE-HOUSE HUMIDIFIERS

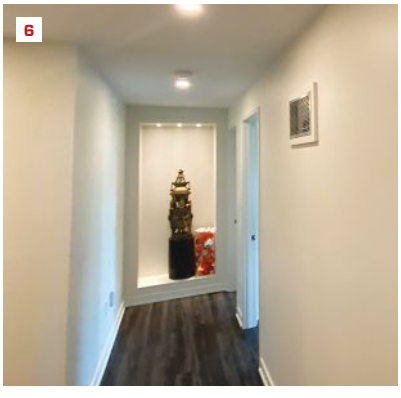
Many people use portable or plug-in humidifiers, which they refill regularly. Some scientists are concerned about using tap water in one type of portables, "ultrasonic" humidifiers, because the minerals and other junk in the water are turned into indoor air pollution. Other than that, and the inconvenience of managing them every day (including moving them to where people are), these can work.

Most of our clients install whole-house or automatic humidifiers so they don't have to spend as much time and energy managing them. It helps that most houses in our area have ductwork for air conditioning and heating, which makes it easy to install automatic equipment. There are several different types of automatic humidifiers, but we use only two: flow-through pad humidifiers, and steam cartridge humidifiers.

Flow-through pad humidifiers use a disposable pad about a foot square by 2 inches thick. Water is piped to the top of the pad and trickles down, while air is blown through the pad. The large surface area encourages evaporation. In the off cycle, the pad dries quickly so mold doesn't seem to grow on it, and some pads are treated with coatings that resist biological growth. These humidifiers are reasonably effective and are not expensive to install or maintain. They do use a lot of water, depending on how they are set. Much of the water doesn't evaporate and instead heads down the drain. When you're paying a lot for water and sewer, this adds up. Not to mention that many of these devices recommend using hot water, which obviously increases energy use.

We've seen a lot of pad humidifiers leak a bit of water, especially on startup in the fall. For this reason, we usually recommend them only for areas that can handle some splashing. Adding a pad humidifier to an upstairs system is risky, even when we're able to install the oversized drain pan we insist on for new installations. (When possible, we run HVAC closet drain pans from frame to frame, before drywall, so even splashing or spraying can land in the pan.)





Wall emitter boxes are used with steam cartridge units where ductwork is not available to distribute the humidity **(4)**. Humid supply air is hosed from a steam cartridge unit, typically housed in a nearby mechanical room or closet **(5)**, to the emitter box, which has a built-in fan to mix air with the steam. Grills can be a bit obtrusive unless hidden in a hallway or other less visible location **(6, 7)**.

Steam cartridges. The second type of humidifier we use is a steam cartridge unit. This heats water in a replaceable plastic cartridge and pipes the resulting steam into an emitter in the ductwork.

Steam humidifiers are powerful and can put out terrific amounts of moisture—so much that we have to be careful with them. We've learned to install at least one safety device when we use these, either an "airflow proving switch" that won't let the humidifier run if the HVAC fan is off, or a humidity safety switch that turns it off if levels inside the ductwork get too high. One of our HVAC subs installs both devices in case one fails. A problem with a steam humidifier is a big problem! I've seen two failures; both were discovered when water poured out of seams in the ductwork and soaked through ceilings and walls. The cleanups were big projects. Other issues I've seen with these are melted PVC drain pipes (follow installation instructions—usually the first few feet of drain should be metal) and a strange situation where all the steam went down one branch duct, overhumidifying one part of the house while leaving the rest of the house dry. (Moving the emitter solved that issue.)

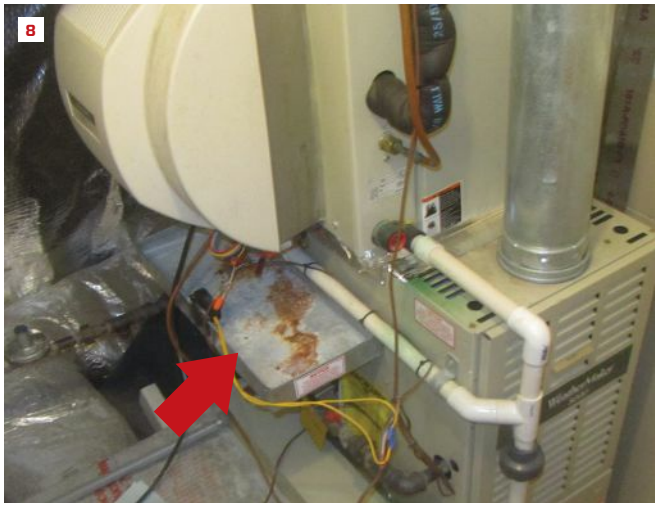
If your building doesn't have ductwork, there are options. We've installed a few steam humidifiers with a special wall emitter box that has a fan to mix air with the steam to help blow it around the home. I also recently saw a pad-type unit with its own built-in fan for a free-standing installation.

Reservoir humidifiers. Taking a cue from my indoor air quality friends, we no longer install reservoir humidifiers—whole-house units that fill a bucket with water and energize a heating element in the water. Because organisms grow in the water easily, this type of humidifier is a maintenance headache, requiring multiple thorough cleanings per heating season. An even worse version runs a wicking device (like a belt or disks) through the reservoir so water evaporates off the wick. These gunk up even quicker.

Cost comparison. Steam humidifiers are significantly more expensive than pad humidifiers. Installed cost is usually closer to $3,000, and annual replacement cartridges cost around $100, while the pad style usually installs for around $1,000, and replacement pads (also annual) are only around $20. Steam humidifiers use a small amount of cold water, which costs a lot less than the nearly constant stream of hot water that pad humidifiers use, so some of the cost is offset that way, but steam humidifiers also use a fair amount of electricity. Also, most steam units need a 240-volt dedicated circuit, while the pad units can be added to existing furnace electrical circuits.

In short, in our area we recommend flow-through pad or cartridge steam humidifiers, and we warn people not to set humidistats higher than 35% to 40% RH based on the typical buildings and typical winter around here. In colder climates, this should usually be lower, but with better construction, it can be higher.

Doug Horgan is vice president of best practices at BOWA, a design/build remodeling company in McLean and Middleburg, Va.



Pad humidifiers often drip or splash a bit of water, as on this galvanized metal pan, which has seen enough water to start rusting **(8)**. Steam humidifiers put out a tremendous amount of moisture, and if the HVAC fan doesn't circulate it throughout the house, it will turn into water in the ductwork and leak, as seen in the two photos at right **(9, 10)**. The author's company now uses a secondary safety device to ensure the fan is operating before the humidifier will run.

BY JIM BRADLEY AND CHRIS WEST

Air-Sealing Framing

In a previous article, "Tracing Air Leaks With a Blower Door" (Nov/20), we discussed locating "areas of opportunity" for air-sealing—a last chance to easily tighten up the air barrier in a new home prior to drywalling and installing the exterior cladding. We advocated that making the effort to track these down can often add up to hundreds of cfm worth of air leakage reduction as well as help avoid building-durability callbacks down the road.

Along with blower-door testing of new homes, we also conduct home performance assessments and energy audits on existing homes. This is when we often encounter the "usual suspects" with regard to air leaks, including poorly air-sealed can lights, bath fans, and top plates of partition walls in attics. In this article, we're going to focus on air-sealing the framing—specifically as it relates to complex roofing, ganged framing, and "marriage" walls (walls between an addition and the main structure).

Problems related to poor air-sealing or unintentionally missed air barriers may take years to manifest, sometimes with harmful consequences to a home's structural integrity and, in worst-case-scenarios, to the health of its occupants. In existing construction, because these locations are hidden behind drywall or buried underneath insulation, air-sealing errors can be difficult to find and expensive to fix. (For more on common air leakage pathways at critical building envelope intersections and air leaks related to mechanical, electrical, and plumbing penetrations, see "Practical Air-Sealing," Aug/2018).

COMPLICATED ROOFS

If we were to adhere to the principle "form follows function," the ideal roof would be a simple gable over an unheated attic (much like the roof of a house a child would draw). On this type of roof, it's not difficult to install an effective air barrier that is aligned with the thermal control layer, or insulation. But more often than not, roofs are complicated, with multiple valleys, dormers, and intersecting planes—more "form over function." It's not uncommon

Air-sealing homes has much improved over the past 15 to 20 years. Here, the authors test a well-built Vermont home with a complex roof for air leaks using theatrical fog **(1)**. The home's multiple dormers proved to be well sealed by the builder's conscientious crew (dormers are notoriously leaky spots). This modern take on a Cape has shed dormers front and back **(2)**. The home's thermal shell (2-inch EPS with taped seams sandwiched between the sheathing and 2x6 studs) was airtight, though some small leaks were discovered at the shed dormer framing and sealed before the wall assembly was completed **(3)**.

Photos by Jim Bradley, Chris West, Sebastian West, and Tim Healey

for homes to have conditioned space tucked under steep-sloped roofs—cathedral ceiling areas and the second-story knee walls on Cape-style homes are typical examples. When roofs are complex, they can be difficult to air-seal and insulate, difficult to ventilate, and—in a cold climate—prone to ice damming.

Framing. When it comes to design, clients are often reticent to give up their ideas in favor of a simple, well-insulated and ventilated roof. For example, their new home or addition may have a roof detail that requires built-up quintuple 2x12 valley rafters to achieve its "form." While this valley roof framing scenario may be structurally sound, it doesn't "function," because the built-up wood members can shrink, leading to unwanted air leakage pathways—small gaps between the framing members that are still large enough to allow airflow through the assembly. Under the right conditions, these small air leaks have the potential to transport warm interior air to the underside of the roof deck, where moisture can condense. This moisture, along with vapor diffusion through building materials, will rot the sheathing.

Without proper ventilation, warm interior moisture that has found its way into the thermal envelope has no way to escape or dry out. And, just because a design may have created a contiguous, aesthetically pleasing surface on the home's interior, it doesn't mean that surface is airtight. Air infiltration can occur at penetrations, framed intersections, and massed framing locations, such as at wall and ceiling corners behind the drywall. Wherever we need large built-up framing to support heavy structural loads, the design of that structure must accommodate shrinkage to avoid air leaks. It also must be thermally broken to prevent significant conductive losses and cold spots where moist air will condense and grow mold. It's commonplace to think only about the structure and to ignore the flow of air, moisture, and heat.

Bypassing the drywall air barrier. Finished and painted drywall can be an effective air barrier, but on flat ceilings, warm moist air bypasses the drywall via air-sealing misses at penetrations like


4


5


6

This circa-2006 L-shaped Cape with a bonus room above the garage had a history of ice damming, not only in the valley but also around the entire perimeter of the garage roof **(4, 5)**. Heat loss from an exposed flue located in the transitional framing area where the roofs intersect (outside the existing thermal envelope) contributed to the ice damming, along with air leaks from the heated garage below the bonus room. Working around the attic trusses, batt insulation was removed above the strapped ceiling drywall in order to air-seal ceiling penetrations, while the bonus room knee walls were air-sealed from the back with XPS foam **(6)**. Cellulose insulation will later be blown in under the bonus-room floor and between the trusses.

Spray foam was applied to the underside of the decking with no ventilation channel on this northern Vermont home built in 2008, to create a hot roof **(7)**. Here, "tea-staining" leaking from above indicates where moisture transported by warm air flowing through cracks between the foam and the framing has condensed on the roof sheathing **(8)**.

Above, the door header, jack, and king framing of an attached, unheated garage has been air-sealed with a quality sealant **(9)**. Seemingly small, unsealed gaps between framing members become significant pathways when depressurization happens in the home via appliances such as dryers and range hoods.

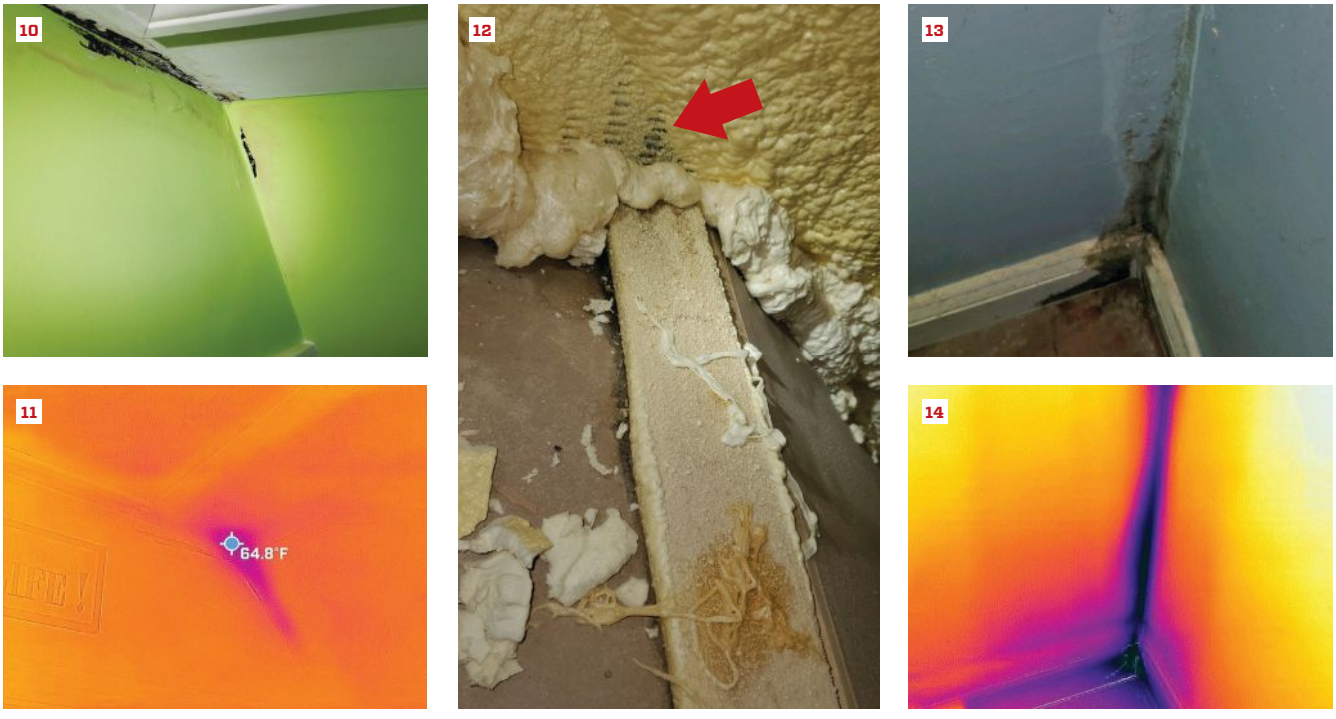
bath fans and can lights, leaky attic hatches, and chimney chases. With cathedral ceilings, warm, moist air gets into rafter bays typically through light fixtures, fire alarms, and other penetrations. Often, we find cathedral ceilings that are clad with shiplap or tongue-and-groove paneling without any air barrier. Areas where the ceiling material joins other building surfaces serve as potential leakage pathways, as well. Diffusion through building materials also occurs, usually a small amount, but enough to add moisture to the roof assembly.

The spray foam "solution." One way builders often try to create effective thermal and air control layers on a complex roof is with closed-cell spray foam in the rafter bays. But we've found in our area of Vermont (climate zones 5 and 6, with 60-pound snow loads) that this solution doesn't work well. Even when the foam is properly mixed and applied, the framing members shrink, especially in attics where the installers are not spraying over the edges of the rafters or encapsulating the truss chords. In these cases, gaps between the spray foam and the wood framing can leak air. The problem isn't with the foam itself, and applying a thicker layer of foam (filling deeper cavities with more) won't alleviate the problem in colder climate zones. And once warm indoor air meets up with the layers of roof sheathing and nonpermeable roofing underlayment, it becomes trapped in a "vapor sandwich." In our opinion, the solution is to install a roof ventilation channel in each rafter bay before spraying the bays with foam. When properly connected to soffit and ridge vents, this ventilation channel will allow any assembly moisture that escapes through small cracks in the framing to safely vent outside.

Because of discovered issues—including ice damming, black mold, and rot—that we've seen with foam-insulated hot roofs in our climate, we've become firm believers in proper roof ventilation.

AIR-SEALING WALL FRAMING

Problems with insufficient air-sealing occur not only with roof framing, but also with wall framing, especially when multiple members are sistered together. Built-up jack studs to king studs, headers, and corners are all common culprits. When assessing existing construction with a thermal camera, we often find corners where the framing has separated and allowed a stream of cold air to infiltrate the space. That's why we emphasize using a proper sealant to air-seal built-up framing. Pay close attention to inside



Mold appeared on the ceiling of a marriage wall between the addition (circa 2012, insulated with spray foam) and the main home **(10)**. An infrared image **(11)** zeroed in on the foaming "miss" of a exposed truss plate abutting the unheated attic space of the old house **(12)**. Lower on the same marriage wall of this otherwise fairly tight house, a gap in the framing occurred because of shrinkage of the framing member. The airflow led to condensation and mold **(13, 14)**. Initially, closed-cell spray foam was thought to solve most air-sealing problems, but the authors believe that sealants (such as caulking, membranes, and air-sealing tapes) and a better understanding of ventilation are needed to avoid condensation problems in cold climates.

and outside corners, ganged jack studs and king studs, multiple-ply headers, and double top plates in new construction. These measures are mostly done for durability reasons (to prevent streams of air that can condense on cold surfaces and begin to rot the structure).

Knee walls. On Cape-style homes and in bonus rooms over garages, fixing poor insulation and air-sealing in tight spaces behind second-floor knee walls can be a challenge. Often we find poorly installed fiberglass batts on top of ceiling drywall with a poorly defined air barrier and air gaps everywhere, even on relatively recently built homes. In a cold climate, warm, moist air passing through these gaps inevitably finds its way into the attic.

Marriage walls. When an addition has been built onto an existing house, we often see problems where the framing for the addition is fastened to the existing sidewall. The problem isn't with the framing cavity, which typically is well-insulated; it's with the joint itself, which seems insignificant until air flowing through that joint and up into the attic space of the existing house starts to create moisture problems. Typically, the attic is above the home's thermal boundary, and any indoor air that leaks into this space is likely to condense on any cool surfaces, creating big problems.

Appliances. Clothes dryers, bath fans, and range hoods can exhaust a considerable amount of air from a house. For example, a typical clothes dryer runs at 300 cfm, while a bath fan runs as high as 130 cfm. If there's a fireplace, that can draw 500 cfm or more if there isn't a makeup air supply. The exhaust fan over a kitchen range can run at 600 to 900 cfm or even more. All these "exfiltration loads" can put the house under negative pressure.

When a home is depressurized, air will be pulled through any unsealed gaps or seams between adjoining framing members, intensifying these leakage pathways and increasing the potential for problems. It's critically important to get the air-sealing details correct, even on the most granular level.

Jim Bradley is a BPI-certified home-performance contractor, builder, and remodeler based in Vermont. He is currently a project developer and manager for Hayward Design Build in Colchester.

Chris West is PHIUS/PHI Certified Passive House consultant/trainer and owner of Eco Houses of Vermont, a building science consultancy specializing in Passive House design for single family, multifamily, and commercial projects.

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Photos by Jake Lewandowski

Repairing a Buckled Ceiling

How poor framing and a meager insulation job led to failure

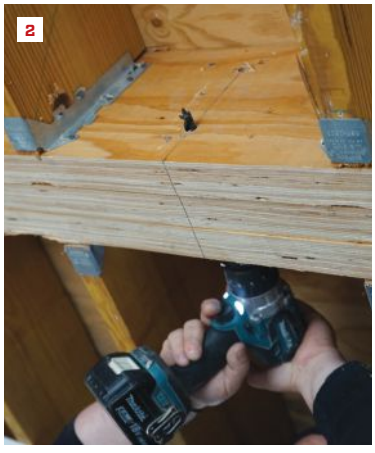
BY JAKE LEWANDOWSKI

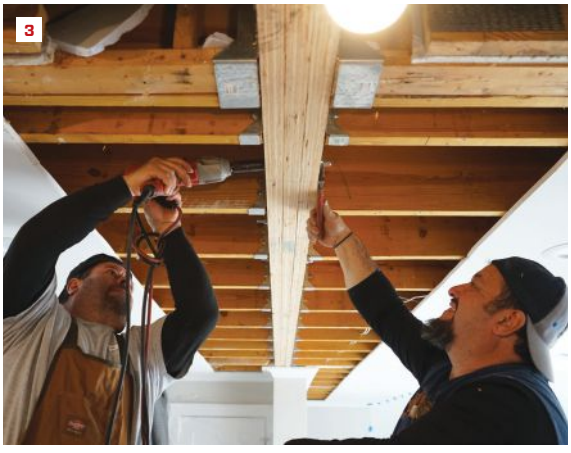
On a recent job completed by my family's company, Great Lakes Builders, we were called out to look at an unusual condition: The ceiling drywall had buckled along random panel seams near the middle of an open living area (see photo, above). Similar failures were found in other areas on the first floor, which we also corrected, but in this article I will focus on the repairs in the main living room.

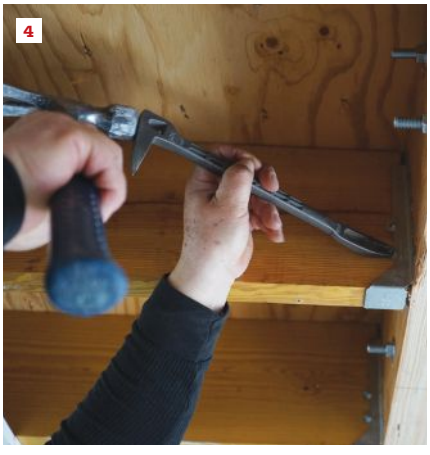
The homeowner told us that the building, which is situated a few blocks from Lake Michigan, had originally been a modest ranch house. A large dormer had been added to open up a second floor and capture a lake view, and interior walls had been removed to open up the first floor. The first signs of trouble the homeowner reported were cracks in the ceiling drywall. She called the drywallers back to repair the cracks, and everyone chocked it up to the framing drying. That is, until the repaired ceiling buckled along joints between panels. The drywallers had never seen anything like this and recommended the owner call a structural engineer.

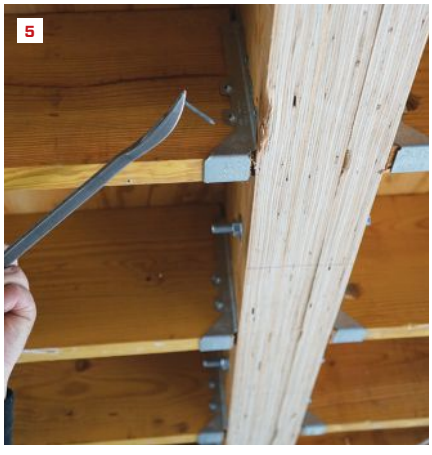
INVESTIGATION

We began our investigation for the engineer by opening a hole in the ceiling. The engineer needed to verify the type and size of the concealed, flush-framed beam that had been installed during the prior renovation. It checked out to be what had been specified on









Overcut joists. Gaps at joists ranged from 1/4 to 1/2 inch wide **(1)**. **Repair work** began with drilling for 1/2-inch threaded rod on 16-inch centers **(2)**. Ernesto and Toby Bonilla of Great Lake Builders worked together to tighten the nuts, drawing the beam plies together **(3)**. All the undersized nails had to be pulled from the joist hangers **(4, 5)** and replaced with structural screws **(6)**.

the plans by engineers for the prior work—three 1 3/4-by-9 1/4-inch LVL plies. New 2x10 floor joists, which replaced the home's original 2x8 joists, terminated into the flush-framed LVL beam.

While the framing checked out, we did noticed some irregularities: Nails were missing from the face-mounted joist hangers, and many of the nails that were there had backed out. These proved to be only 1 1/2 inches long, not the 3-inch joist-hanger nails that we would have expected. On closer inspection, we noticed large gaps—from 1/4 to 1/2 inch wide—between the ends of the joists and the LVL beam (see photo 1, above). This is much wider than the 1/8-inch maximum allowed for code-accepted standards on face-mounted joist hangers. We speculated that the framers might have originally built the new floor expecting an undermount beam, and then switched direction when they noticed it was a flush beam. There were clear signs on the underside of the floor sheathing that the joists had been cut off with a recip saw—not what you'd expect for installing new joists.

We also noticed that one side of the LVL beam was plumb while the other side was out of plumb, suggesting to the engineer that the LVL plies had separated. And as it turned out, the LVL plies had been secured on each face only with two rows of small (3/16-inch-diameter instead of 5/16-inch) structural screws on 32-inch centers, with the rows staggered at 16 inches. That was not nearly enough fasteners for this beam, in the engineer's estimation, accounting for one of the plies rotating out of plumb.

CAUSES

Ultimately, the engineer concluded that the buckling was caused by a combination of forces:

Lateral loads from the winds coming off the lake pushed and pulled at the floor framing, and the gaps between the joist ends and the LVL beam, along with inadequate nailing of the joist hangers, allowed the joists to move.

Tight quarters. Every hole had to be filled with a fastener—a feat that can be challenging in narrow bays. Here Toby used an angle drive **(7)** to get the job done **(8)**. **Tension ties.** Ernesto screwed off 20-gauge steel straps to the bottom edge of the joists **(9)**. Each pair of joists abutting the LVL beam was tied together with these straps **(10)**.

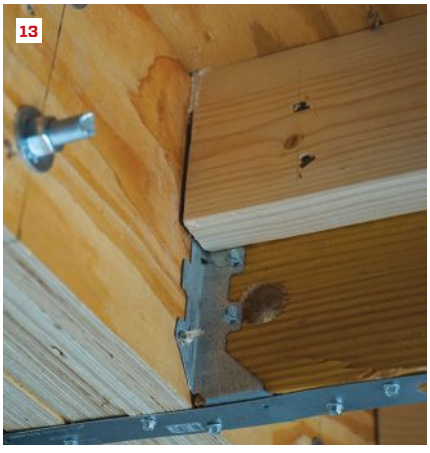
Side loading of the joists on the LVL would ordinarily not cause any shift in the structure if a beam is sized adequately and the LVL plies are tied together securely so the beam acts as a single unit. In this case, without adequate fasteners, the plies pulled apart.

Seasonal humidity swings. In addition, changes in seasonal humidity caused excessive movement in the framing. These seasonal changes were higher than normal, the engineer reasoned, because of the absence of vapor, air, and thermal controls in critical areas of the building. Inspection holes along the side of the house revealed rusty nails and black joists and floor sheathing, caused by air and moisture intrusion. In this region of the country, cold winters with very dry air, springtime inversions that create a lot of fog over the lake, and very humid summers all result in huge swings in outdoor relative humidity. These conditions accentuate the need for vapor and air barriers to keep interior wood framing near equilibrium moisture content, as well as good insulation to combat condensation. To overcome these challenges, part of the engineer's repair plan included spray foam insulation installed along the rim joist and in critical wall sections of the dormer that was funneling air into the floor structure. Our scope of work involved only the structural repairs, so this insulation work happened after we had left the job.

REPAIRS

We began by stripping the drywall off the ceiling to expose the full length of the flush beam, opening the ceiling on both sides of the beam beyond the panel joints that had buckled.

Through-bolts. With the beam and joist ends fully exposed, we set to work first on installing ½-inch-diameter threaded rod with nuts and bolts on each side to draw the beam laminations back to plumb. Working to the engineer's spec, we placed these 16 inches on-center. When drawing the LVL plies together, we expected a lot



Compression blocks. Toby nailed off 18-inch-long 2x6 blocks at the top edge of the joists **(11)**. These blocks hit the joist hangers and screws, so the crew eased the corners **(12)** and in places used shims **(13)** to get a tight wood-to-wood connection. The result of all the repairs **(14)** is a single assembly rather than a collection of disconnected parts.

of resistance from nails through the sheathing in the upstairs floor. But to our surprise, there were no nails, and the plies snugged up tight and plumb as soon as the nuts were tight.

Secure hangers. Next, we backed out all the 1½-inch joist-hanger nails and replaced these with 2½-inch-long connector screws made by Simpson Strong-Tie. As required for all metal framing hardware, we filled every hole in the hangers.

Strap ties. The engineer specified Simpson LSTA24 20-gauge, 1.25-by-24-inch straps at each pair of joists along the beam, centered on the beam and secured with structural screws.

Compression blocks. To prevent the movement of the 2x10 joists, the engineer called for 18-inch-long 2x6 blocks nailed off with 16d nails at the top of the joists butting the beam. These blocks ran into the joist hangers and screw heads, so we had to work at getting a tight connection between the end of the block and the beam.

Joist-wall connection. The repair wouldn't have been complete if we hadn't also verified the connections at the other ends of the joists, checking that these were securely fastened and fully bearing on the exterior wall plates. This proved to require little work, but it was important to do.

Through our work, we had taken a lot of disconnected pieces of a floor frame and created a single structural system. This frame still had the gaps between the joists ends and an LVL beam—an unfortunate condition. But the repairs compensated with blocks to resist compression at the top of the joists, and straps to resist tension on the bottom edge. And with the multiple LVLs securely bolted and the hangers fully fastened, we had, in essence, one beam connected to floor joists functioning as a single assembly.

JLC contributing editor Jake Lewandowski is a construction manager with his family's business, Great Lakes Builders Inc., which specializes in structural repairs in Greater Chicago (greatlakesbuildersinc.com).

Working With TruExterior

The material doesn't absorb water, simplifying finish details

BY MIKE SLOGGATT

Three years ago, Tim Uhler wrote an article describing how he switched from using fiber-cement siding to LP SmartSide (see "Working With SmartSide," Mar/18). I'll use a similar format in this article to describe how I work with another type of engineered siding—TruExterior, which has grown to be my go-to siding for exterior projects.

Unlike Tim Uhler, who builds homes on spec, I work primarily on renovation jobs and the siding choice is not always mine; most of the time, we install what the homeowner demands. SmartSide is popular in other parts of the country but isn't as popular on Long Island where I do most of my work, though I have occasionally installed it by customer request, and it is a nice product. Fiber cement is probably the most common siding product used here; I've installed it on many projects and will likely continue to in the future. But lately, TruExterior siding and trim has been getting a lot of attention.

WHAT IS TRUEXTERIOR?

TruExterior is a composite blend of 70% fly ash and 30% polymer (generically dubbed "poly-ash," though Westlake Royal Building Products is currently the only company making it for the building trades). It is an extruded material made using a process similar to the one used for making cellular-PVC boards, but the material itself is different. Poly-ash stands apart from just about any other exterior product. While it looks like fiber cement, it doesn't have any cement. It's extruded like PVC, but it doesn't perform like PVC. And it has a texture a bit like MDF; however, there is no wood in it.

Photos by Mike Sloggatt

TruExterior needs to be fastened to studs, so the author marks them out beforehand **(1)**. It cuts easily with a 32-tooth carbide blade **(2)**. Since the material doesn't swell with water, he prefers to miter outside corners, securing them with ring-shank nails and a compatible exterior glue **(3, 4)**.

Fly ash is the byproduct of burning coal. Years ago, this ash went into the atmosphere—not good if you lived downwind of a coal-burning power plant. Technology was developed to remove the ash and store it for use in other products, notably as an additive to concrete. You can't store fly ash outside in the open air or the wind will pick it up and redistribute it to the neighbors, so some facilities store it in containment ponds as a slurry or bury it as waste in landfills. Boral Industries found ways to store, clean, and process fly ash for use in building materials, such as brick and cementitious products. The company also developed a process to combine it with a polymer to produce trim and siding boards. Currently, this product is branded as TruExterior and made by Westlake Royal Building Products.

What makes this material different? If "TruEx" (as we have come to refer to it on the job) is properly stored and installed, it does not move much from temperature or moisture. This makes it unique among exterior trim and siding products. You can install it with tight-fitting joints because you don't need to accommodate expansion and contraction caused by absorbing water and drying (a process we call "water cycling"). You don't have to maintain wide clearances above roofing, windows, doors, and hardscaping, and the manufacturer does not require back priming the boards or end priming cuts. You only need to paint what you can see after the material has been installed. And I don't know of any termite in the world that would choose to munch on poly-ash, so ground contact is fine. However, as with any siding, water can still get behind it, so you do need to provide water drainage to help protect the rest of the structure.

Product line. TruEx comes as trim boards and a few siding profiles. The trim and siding lengths are 16 feet long, which is great for minimizing seams. Trim comes in most nominal sizes from 5/8x4 to 5/8x12, 1x3 to 1x12, 5/4x4 to 5/4x12, and 2x2 to 2x12. Because it mills so easily, I regularly use it to make window trim, corner boards, and panels. If you can do it in wood, you can likely duplicate it in TruEx.

Most of the time we install horizontal siding, but one nice advantage of TruEx is the varied siding profiles available. Aside from the more traditional channel bevel and cove/Dutch lap horizontal panels, TruEx also comes in V-rustic, shiplap, nickel-gap, and channel

When the author does use corner boards, he preassembles them from 5/4-inch TruExterior trim boards. He glues the miter with Dap's RapidFuse adhesive **(5, 6)**, then clamps and nails off the joint **(7)**.

siding profiles that can be installed vertically or horizontally.

Also, several aftermarket companies sell custom trim and profiles, as well as millwork for historic restoration work. Duration Moulding & Millwork (durationmillwork.com) has provided me with a number of custom applications, including windowsills and surrounds as well as classical exterior moldings. (For more on using Duration millwork, see "Restoring a Gothic Porch," Jul/19).

PRODUCT QUESTIONS

There have been no glaring questions about TruExterior. Poly-ash seems to be extremely stable under the most demanding environmental conditions, and no special tools other than carbide-tipped saw blades are required to cut it. The only issues that could be raised are with the dust created from milling and cutting it, but these seem to be minor. It's a heavy nuisance type of dust; it settles quickly. For personal and crew safety, dust must be managed with engineering controls and personal protective equipment (PPE). Outdoors, an N95 mask is recommended when cutting and milling it. But the MSDS for TruExterior does not specify the same safety controls that are required under OSHA's silica rules for fiber-cement products.

INSTALLATION

If you can install wood, you can install TruExterior. The process is almost the same. The big difference is that most of today's exterior siding products have less tolerance for water and move more with seasonal changes, so you need to provide gaps at butt joints and intersections and fully prime and seal boards on all sides. Not having to do these last two steps at every intersection and every cut with TruEx saves an enormous amount of time.

TruEx siding is typically face-nailed with 8d (2 1/2-inch-long) hot-dipped galvanized or stainless steel ring-shank nails, following the on-center spacing of studs so nails are driven into framing, not just through sheathing. Two nails in each stud works for siding exposures up to 8 inches; wider boards require three nails. We occasionally screw boards in place, particularly for homes along the coast where we want the greater withdrawal resistance to high winds. When we do, we follow the same schedule the manufacturer requires for nails.

Though TruExterior is hydrophobic (naturally water repellent), water will still leak behind it or be drawn through gaps by capillary action, as with any siding. Therefore, it is important to establish a drainage plane behind the siding before installing it. I don't think flat housewrap or black paper cuts it as a water-resistive barrier (WRB), as water tends to get held by surface tension between the back of the siding and the WRB and is slow to dry. The water can't hurt the siding, but there has long been evidence that with a pressure differential, water can seep through most housewraps into a framed wall, mostly through nail holes (see "Water-Managed Wall Systems," Mar/03). I recommend a drainable housewrap or a rainscreen. I typically use Benjamin Obdyke's Hydrogap housewrap, which leaves a 1mm (about 1/16 inch) drainage space behind the siding to allow water to drain down the wall. Remember to look for where the water will escape at the bottom and plan for drainage with drip caps and flashing at head trim, transition boards, and skirt boards. Drainage gaps should not be caulked; the water must be able to drain freely away.

Field joints on siding runs can be butted; no gap is required. I like to install flashing strips behind field joints to minimize water intrusion, but it's not required by the manufacturer. (Bearskin makes 6-by-12-inch joint flashing strips; I cut my own from a roll of Benjamin Obdyke InvisiWrap housewrap, which is UV stable, using a saw.)

Where siding butts corner boards and door and window casings, a tight fit is also acceptable. A good miter saw will give a perfect "factory-look" finish to cuts. (I use the stock 32-tooth blade that came with my saw.)

At roof-wall intersections and above door and window heads, the only requirement is to leave a small drainage gap. Generally, 1/4 inch

TruExterior mills well, so corner boards can also be made with a lock miter **(8, 9)**, but because the material doesn't move much, this is largely overkill. The author countersinks nails and fills the holes with epoxy filler **(10)**. Because long siding boards are heavy, longer runs are easier to install with two people **(11)**.

is sufficient, but at roof intersections and above exterior decks, the manufacturer calls for 1/2 inch to limit fine debris collecting. This gap is still much smaller than the 1 inch or more needed for wood and fiber cement. It's also important to install kickout flashings at the end of roof-wall intersections (see "Kickout Flashing: Required by Code, Yet Often Overlooked," Oct/19). This is not for the siding's sake; it's needed for keeping the volume of water that gathers here from leaking into the structure.

Corners. TruExterior currently does not make corner boards. We rarely use them; instead, we miter the siding boards, gluing and clamping the miter before nailing it off. (We have used a polyurethane glue, such as Gorilla Glue, and recently have been using Dap RapidFuse Wood Adhesive—a hybrid glue that creates a strong bond on poly-ash and sets up fast.)

When we do use corner boards, we preassemble them using a miter at the outside edge. I have also joined corner boards with lock miters, cut with carbide bits on a 2-hp router on a table, as shown above. But to be honest, a lock miter is overkill; a mitered corner looks just as good, and because the material doesn't move around, it works as well too. You could also use a lap joint, as you would with a wood corner; it works well to apply a bead of compatible glue and nail the corner off with hot-dipped galvanized or stainless steel nails. However, I prefer the clean look of the mitered edge, and miters have never opened on us.

Mounting blocks. For outlets and fixtures, you can go one of two ways: Using 5/4 TruEx stock, you can make your own mounting blocks, or you can purchase premade poly-ash blocks from Sturdi-Mount (sturdimount.com). These are easy to flash using peel-and-stick flashing tape.

Finish. Before installing material, I typically apply a coat of finish paint (I use Sherwin-Williams Emerald Rain Refresh). This is especially important with a nickel-gap profile—you do not want to paint those nickel-size gaps later. Remember, though, that with TruEx, there is no need to paint anything that is not exposed, and paint will last a lot longer on TruEx than on wood since there is no water cycling.

The author typically preassembles window trim using a Kreg jig **(12)** and finishes it before installing it **(13)**. Pieces of blue tape protect from marring the finished trim when it is nailed into place **(14)**. Note the peel-and-stick flashing for the mounting blocks (made from 5/4 stock). The author prefinishes both siding and trim before installation using a Graco 390PC airless sprayer **(15)**.

One piece of advice: If you spray finish the siding, finish it off with a roller as per the manufacturer's recommendations. The spray finish develops air bubbles that need to be knocked down with the roller for a smoother finish.

WHAT WE DON'T LIKE

There's not a lot we don't like, but there are a few things we miss that we're accustomed to with fiber cement. We can blind-nail fiber-cement siding, and when we use prepainted material, we walk away with almost no painting. With TruEx, we need to follow the face-nailing pattern. Not a big deal; traditional clapboard is always face-nailed. But it does mean we have to fill nail holes and have considerable touch-up painting, as most clients prefer a classic look without the nails showing prominently.

If you insist your siding be blind-nailed, Duration does offer a clapboard profile that can be blind-nailed, and the company can prefinish it for you, as well.

One drawback of TruEx is the weight of 16-foot boards. One person can carry them if the wind isn't blowing too hard, but it's a lot easier with two people, and they need be carried on edge or they snap under their own weight.

While standard wood cutting tools work fine, the dust is gritty and hard. If you don't keep your tools clean, it will get into motors and bearings and diminish tool life. I know guys who don't like to clean their tools regularly and buy cheap throw-away tools for TruEx. That's not my style, so I make it a habit to frequently clear the dust off tools and blow out the motors with compressed air. Also, once I use a carbide tool on poly-ash, I dedicate it to that use. The material dulls the razor edge of the carbide, and while it will cut the poly-ash just fine, it will start a fire on a piece of pine. I mark all of the tooling I use with blue paint, so I don't mix it up. I have run thousands of feet through a half-inch-collet, classical-profile router bit, and it still cuts TruExterior just fine.

Mike Sloggatt has been remodeling old homes on Long Island for 42 years and is a member of the JLC Live construction demonstration team.

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Better Deck Post Sizing

by Glenn Mathewson

For years, 4x4 posts had been used to support decks with little thought to how much load the posts were carrying or how tall the deck was. That changed in 2015, when Section R507.8, a prescriptive method for sizing deck posts, was included in the 2015 International Residential Code. Prescriptive design is a cookbook for construction that eliminates the need for a design professional. However, like a cookbook compared with a chef, it's limited in what it offers. The design tables for deck-post height included in both the 2015 and 2018 editions of the IRC were indeed limiting, as Table R507.8 was a one-size-fits-all prescription, with the maximum heights of 4x4 to 6x6 posts based on the greatest possible area of deck that could be generated with IRC joist-span and deck-beam design tables. This resulted in every deck having an 8-foot height limit when supported by 4x4 posts, based on loads coming from a two-ply 2x12 beam with 2x12 joists 12 inches on-center and cantilevering past the beam more than 4 feet. It was a good start to deck code, but desperately needed to be expanded and made more flexible (**Figure 1**).

The 2021 edition of the IRC does just that. Three different categories of wood species with similar specific gravities are included, allowing southern pine posts to extend taller than redwood or cedar posts, for example. The previous tables were based on only a 40-lb. live load, but the new one includes three snow loads: 50, 60, and 70 lb. In regions where a 60-lb. live load is required by the local code, the 70-lb. snow load column is an equivalent (**Figure 2**).

In 2018, 8x8 posts were added to the table and are included in the 2021 version as well, but they are limited to 14 feet in height. In no cases does the table allow a height of greater than 14 feet for either 8x8 or 6x6 posts, but this is not because of

The new deck-post sizing table in the 2021 IRC offers more flexibility in deck-post design than earlier 2015 and 2018 versions of the table, as shown below.

TABLE R507.8
DECK POST HEIGHT[a]

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

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

TABLE R507.4
DECK POST HEIGHT[a]

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

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

Figure 1. In both the 2015 (above) and 2018 (right) versions of the IRC's deck-post sizing table, the maximum height of a 4x4 post is limited to 8 feet, regardless of loads.

PHOTO BY MICHAEL WALTER

TABLE R507.4
DECK POST HEIGHT

LOADS (psf)[b]	POST SPECIES[c]	POST SIZE[d]	TRIBUTARY AREA (ft^2)[g, h]							
			20	40	60	80	100	120	140	160
			MAXIMUM DECK POST HEIGHT[a] (feet-inches)							
40 live load	Southern pine	4 × 4	14-0	13-8	11-0	9-5	8-4	7-5	6-9	6-2
		4× 6	14-0	14-0	13-11	12-0	10-8	9-8	8-10	8-2
		6 × 6	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
		8 × 8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
	Douglas fir[e] Hem-fir[e] Spruce-pine-fir[e]	4 × 4	14-0	13-6	10-10	9-3	8-0	7-0	6-2	5-3
		4 × 6	14-0	14-0	13-10	11-10	10-6	9-5	8-7	7-10
		6 × 6	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
		8 × 8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
	Redwood[f] Western cedars[f] Ponderosa pine[f] Red pine[f]	4 × 4	14-0	13-2	10-3	8-1	5-8	NP	NP	NP
		4 × 6	14-0	14-0	13-6	11-4	9-9	8-4	6-9	4-7
		6 × 6	14-0	14-0	14-0	14-0	14-0	14-0	13-7	9-7
		8 × 8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
50 ground snow load	Southern pine	4 × 4	14-0	12-2	9-10	8-5	7-5	6-7	5-11	5-4
		4 × 6	14-0	14-0	12-6	10-9	9-6	8-7	7-10	7-3
		6 × 6	14-0	14-0	14-0	14-0	14-0	14-0	14-0	13-4
		8 × 8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
	Douglas fir[e] Hem-fir[e] Spruce-pine-fir[e]	4 × 4	14-0	12-1	9-8	8-2	7-1	6-2	5-3	4-2
		4 × 6	14-0	14-0	12-4	10-7	9-4	8-4	7-7	6-11
		6 × 6	14-0	14-0	14-0	14-0	14-0	14-0	14-0	12-10
		8 × 8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
	Redwood[f] Western cedars[f] Ponderosa pine[f] Red pine[f]	4 × 4	14-0	11-8	9-0	6-10	3-7	NP	NP	NP
		4 × 6	14-0	14-0	12-0	10-0	8-6	7-0	5-3	NP
		6 × 6	14-0	14-0	14-0	14-0	14-0	14-0	10-8	2-4
		8 × 8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
60 ground snow load	Southern pine	4 × 4	14-0	11-1	8-11	7-7	6-7	5-10	5-2	4-6
		4 × 6	14-0	14-0	11-4	9-9	8-7	7-9	7-1	6-6
		6 × 6	14-0	14-0	14-0	14-0	14-0	14-0	12-9	11-2
		8 × 8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
	Douglas fir[e] Hem-fir[e] Spruce-pine-fir[e]	4 × 4	14-0	10-11	8-8	7-3	6-2	5-0	3-7	NP
		4 × 6	14-0	13-11	11-2	9-7	8-4	7-5	6-8	5-11
		6 × 6	14-0	14-0	14-0	14-0	14-0	14-0	12-2	10-2
		8 × 8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
	Redwood[f] Western cedars[f] Ponderosa pine[f] Red pine[f]	4 × 4	14-0	10-6	7-9	4-7	NP	NP	NP	NP
		4 × 6	14-0	13-7	10-9	8-9	7-0	4-9	NP	NP
		6 × 6	14-0	14-0	14-0	14-0	14-0	9-9	NP	NP
		8 × 8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
70 ground snow load	Southern pine	4 × 4	14-0	10-2	8-2	6-11	5-11	5-2	4-4	3-4
		4 × 6	14-0	12-11	10-5	8-11	7-10	7-1	6-5	5-10
		6 × 6	14-0	14-0	14-0	14-0	14-0	12-9	10-11	8-7
		8 × 8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
	Douglas fir[e] Hem-fir[e] Spruce-pine-fir[e]	4 × 4	14-0	10-1	7-11	6-6	5-3	3-7	NP	NP
		4 × 6	14-0	12-10	10-3	8-9	7-7	6-8	5-10	4-11
		6 × 6	14-0	14-0	14-0	14-0	14-0	12-2	9-9	5-9
		8 × 8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
	Redwood[f] Western cedars[f] Ponderosa pine[f] Red pine[f]	4 × 4	14-0	9-5	6-5	NP	NP	NP	NP	NP
		4 × 6	14-0	12-6	9-8	7-7	5-3	NP	NP	NP
		6 × 6	14-0	14-0	14-0	14-0	10-8	NP	NP	NP
		8 × 8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.
NP = Not Permitted.
a. Measured from the underside of the beam to the top of footing or pier.
b. 10 psf dead load. Snow load not assumed to be concurrent with live load.
c. No. 2 grade, wet service factor included.
d. Notched deck posts shall be sized to accommodate beam size in accordance with Section R507.5.2.
e. Includes incising factor.
f. Incising factor not included.
g. Area, in square feet, of deck surface supported by post and footings.
h. Interpolation permitted. Extrapolation not permitted.

Figure 2. The deck-post sizing table in the 2021 IRC allows posts to be sized according to species and the design loads on the deck. For accurate sizing, builders will need to determine the tributary area supported by the post.

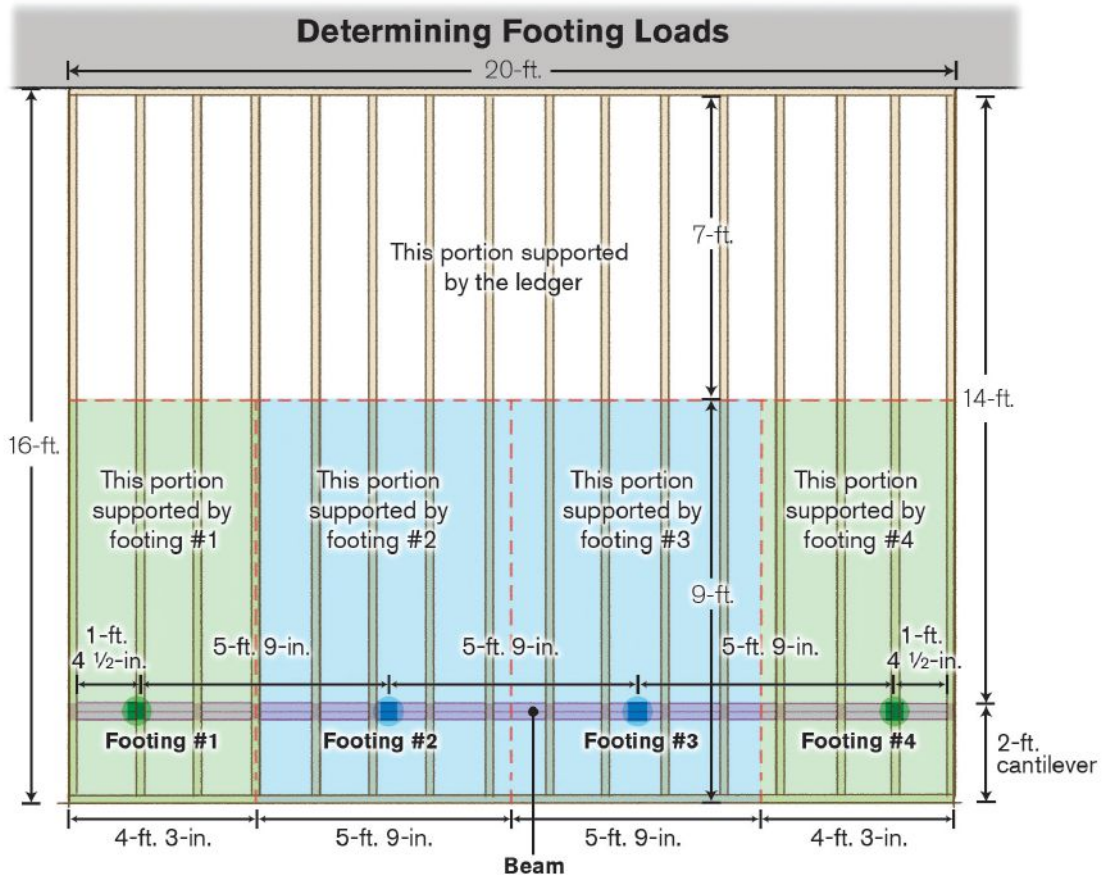

Figure 3. The tributary area supported by a post is half the length of the beam on either side of the post multiplied by half the joist length to the next support, such as the ledger on the house or another beam, plus the entire distance the joists cantilever past the beam. Above, each footing represents the location of a support post.

limitations in the post. Rather, it has to do with the greater risk of lateral loads at that height and the general limitations of prescriptive design.

The best parts of the new table are the rows for various tributary areas, allowing each post to be sized on the actual loads it supports and not a worse case. Tributary area is the area of deck supported by a post, and, for rectangular decks, it's simply half the joist span distance plus the length of the joist cantilever (if applicable), multiplied by half the beam span (**Figure 3**). For a center post, you sum the half beam spans on each side before multiplying. If the joists are of differing lengths, simply connect a line across the mid-span of each joist and practice some geometry to find the area over the post: (base x height)/2.

The smallest area provided in the table is 20 square feet, but in every condition the posts are limited to the ultimate 14-foot limit, so a smaller area is unnecessary. Columns continue in 20-square-foot increments up to 160 square feet. However, footnote h of the table allows for interpolation, which means an exact area between column values can yield an exact maximum height (search "interpolation between columns" for a formula). Another benefit of this table is that while joist and beam design from the IRC design tables can generate only about 120 square feet of area, the additional columns up to 160 square feet in this table allow for prescriptively designed posts to support engineered lumber beams and joists that can span farther than the three-ply 2x12 the IRC offers. Section R301.1.3 makes it clear that engineered design can be used with prescriptive design.

The 2021 IRC is the latest edition and many building authorities have not yet adopted it. However, even if you're working under the 2015 or 2018 editions, there is no reason the prescriptive methods in the 2021 IRC could not be approved as an alternative. If you find your posts limited in height by the older editions, talk with your building authority and ask them to approve the latest IRC. ❖

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

DRAWING BY CHUCK LOCKHART

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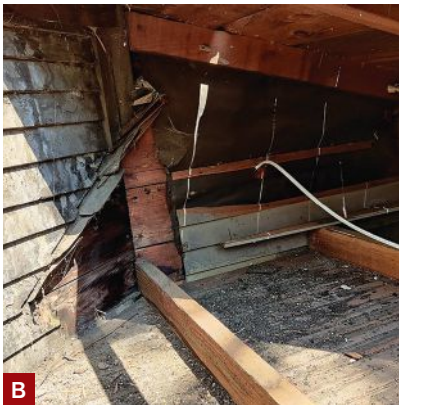
New Life for an Old Porch

by Alex Bartlett


A


B


C


D

After shoring up the porch roof with temporary supports (A), workers removed the old porch. In addition to inadequate footings, the porch's roof system had been simply toenailed to the wall sheathing and was pulling away (B). After digging and pouring new footings (C), the crew installed new porch framing, with the joists oriented parallel to the house (D).

PHOTOS: ELLIOT SAMUEL-LAMM

In the Third Lake Ridge Historic District in Madison, Wisc., front porches are a prominent architectural feature of many of the homes, which were built between the 1850s and the 1920s. This particular Victorian-style home dates to 1899, and the porch (like many in this neighborhood) suffered from shallow footings, rotten floor boards, and roof leaks. My employer, TDS Custom Construction, a 30+ year-old design/build firm located a few blocks away from the district, was hired to restore the porch as well as design and build a single-car garage for the property that would stylistically complement the original house.

I was the lead carpenter on the project, which still had a variety of unknowns when we started our work. For example, we knew that we would need to pour new footings and rebuild the floor system, but we didn't know the extent to which the roof system had been damaged as a result of the old footings' sinking. Because the existing finished ceiling of the porch was in good shape, we wanted to save it and the roof framing, if possible. But it was obvious that something was going on with the roof framing based on a soft spot and obvious mid-roof sag.

We started by temporarily posting under each corner of the sagging roof using screw jacks to try and level it **(A)**. The porch was nearly 2 inches out of level from left to right, and one of our biggest concerns was the connection to the house as we began to jack the corner up to level the roofline. To help with any stress or settling that might occur because of this, we built a temporary shoring wall under the roof right against the house. Next, we removed a few sections of skip sheathing near the peak of the porch roof to see how it was fastened to the


E


F

The crew installed blocking around the new pressure treated posts supporting the roof, then reinstalled the porch's original columns and colorful balustrade (E). The project included a new garage, designed and finished to fit with the character of the house (F).

house and discovered that the roof rafters and ceiling joists were only toenailed to the existing siding with 10d nails (the porch wasn't original to the house). As the porch framing settled, the rafters had pulled away from the house **(B)**.

We corrected this by adding a ledger screwed directly into the stud wall, and then refastening the rafters to this ledger after we jacked the roof up. The ceiling joists were still well-fastened to the rafters, so we simply added a few 4-inch-long structural screws to reinforce those connections. Then we posted the rafters to the ceiling joists, which were supported by our temporary wall below.

We had to cut back the rafters so they were no longer nailed to the house and wouldn't pinch as we jacked the roof up. With the roof system shored up and everything cut back, we were able to easily use the screw jacks to lift the roof to level. We then cut the rafters back further so we could slide a 2x6 ledger in. We screwed the ledger into the studs and screwed the rafters to it.

Removing the railings was straightforward. We blocked under them so they wouldn't fall or pinch as we began cutting them free. We went slow and used a ton of sharp multitool blades to cut all the caulk and nails free. We brought the railings to our shop to sand and wood-epoxy the tops and any cracks or flaws.

While our painting contractor worked on the railings in our shop, we went about building the new porch floor system and adding the posts that would support the repaired roof system. This part of the project followed standard deck framing practices, though we framed the joists parallel with the front of the house to allow for easy installation of the tongue-and-groove Douglas fir porch flooring running perpendicular to—and sloped slightly away from—the house **(C, D)**.

When we reinstalled the columns after completing the porch flooring, we added a lot of blocking so that when we reinstalled the railings, we would have plenty of meat to grab **(E)**. We tried to predrill and use screws in inconspicuous locations (the undersides of the top and bottoms, toe screws through the sides facing the house, and so on). We then filled the holes with wood epoxy, sanded once more, and primed everything.

After completing the porch restoration, we started on the garage build. The garage, designed by TDS Custom Construction director of design Christi Weber, is a single-car garage with a workspace area in the back and an attic for storage. The foundation of poured concrete frost walls and the standard wood-stud framing with attic trusses are typical of current construction methods. The exterior finishes—2¾-inch exposure cedar siding, trim details to match the house, and carriage house–style door—are what tie the garage to the historic district **(F)**.

Working on homes in historic districts presents both challenges and opportunities for interesting, creative problem-solving work. Matching and preserving the historic details possessed by these homes while repairing failing parts of the structure are key to making a project like this successful. Adding in a new-construction build component like a garage gave us carpenters in the field and our associated building trades a well-rounded project to execute. ❖

Alex Bartlett is lead carpenter with TDS Custom Construction in Madison, Wisc.

PHOTOS: E, ELLIOT SAMUEL-LAMM; F, BETH SKOGAN

PHOTOS BY JEREMY KASSEL

Building a Budget-Conscious Deck

Add value to pressure-treated decking with smart details and good craftsmanship

by Jeremy Kassel

During the planning stages for a custom home we recently completed, I had encouraged the customer to upgrade some choices originally made by the architect and adopt some products and practices that I believed would add value to the home. For example, we decided to insulate with mineral wool instead of fiberglass, sheathe the house with Zip System sheathing and tape rather than commodity sheathing and housewrap, and upgrade the siding from channel-rustic to a vertically oriented Brazilian hardwood rainscreen siding.

As the cost of the upgrades started to escalate, however, we had to pull back the budget in some other areas. On this project, one place to carve out some savings was to install a less expensive alternative to composite decking on the home's large wrap-around deck. In our area, the deck market is dominated by composite and PVC decking products. However, at a cost of about $8 to $10 per square foot (for the decking only), composite decks are not for every budget, nor do they satisfy everyone's taste, so I presented a few other options to my clients.

We considered hardwood decking, but quickly ruled it out as prohibitively expensive, and due to COVID-19 supply-and-demand issues, the price of cedar was also too high. So, at first reluctantly, then more enthusiastically once we had calculated the potential cost savings, the client agreed that pressure treated decking would provide the best value. For additional cost savings, we would also install a pressure treated railing system.

Framing

My co-worker Ed Backus and I installed the deck ledger during the framing stage of the house to make sure that the ledger flashing would be properly counter-flashed with the door sills and sill flashing and that all the layers of flashing tapes were properly lapped from the

Figure 1. Precast concrete piers were installed to support the deck (A). Prior to installing the 6x6 support posts, Ed Backus applied liquid flashing membrane to the post bases (B, C) and the notches for a 2-ply dropped beam (D). Backus assembled a quick jig fitted with a couple of utility blades (E) to slice Vycor flashing tape to cover the tops of joists (F).

start of the project. Flashing the ledger under doors can be difficult as an afterthought if the doors are already installed with taped sills (**Figure 1**).

The footprint of the deck is a large "L" shape that hugs two sides of the house. The dimensions of the "L" are 63 feet by 10 feet along the front of the house and 28 feet by 10 feet along the side, for a total area of approximately 910 square feet.

TechnoPost steel helical piles are typically our go-to deck footing. But on this project, our installer—who understands the soil conditions at our jobsites—talked us out of installing his product for a few reasons: The soil was too disturbed from excavating for the foundation of the house; the soil type didn't have the lateral stability to support steel posts; and the bedrock is very high at the house site, and securing a helical pile to the ledge would be difficult. Rather than dig the 11 footings by hand and pour concrete into cardboard tube forms, we chose to install precast concrete deck piers. The piers have a wide base, a tapered body, and a female threaded fitting cast into the top that accepts a ½-inch-diameter bolt to secure the bottom of a post-base connector.

The excavation contractor already had equipment on site, so he dug a long trench and we worked with him to lay out and place the piers exactly where we wanted them. Because of the bedrock at the house site, some of the piers needed to be trimmed with a gas-powered cutoff saw so they wouldn't sit too high above grade.

The 2x8 joists are spaced 16 inches

Figure 2. To ensure that the visible fastener heads would be aligned, the author snapped chalk lines on top of the pressure treated decking to mark the joist layout (A). The width of the deck was planned so that there would be no ripped deck boards; decking was installed from the ledger out toward the rim joist. All the end cuts on the decking were eased with a router (B).

on-center and bear on a two-ply 2x10 dropped beam at the outer edge of the deck. We made a point of laying out the joist framing to ensure there would be a full-width deck board at the house as well as at the perimeter of the deck.

The 2x10 beam bears on 6x6 pressure treated posts connected to the precast concrete piers with metal hardware that provides a 1-inch standoff. We treated all end cuts of the beam and posts, including the shoulders that nest the beam, with Huber's Zip Liquid Flash to prevent the end grain from wicking in water and shortening the life of the framing.

We covered the top faces of all the deck framing with Vycor self-adhered flashing membrane, which we ripped to width using a site-made slitting jig.

Decking

In our area, both standard and premium 5/4x6 pressure treated deck boards are available, and we felt the upgrade to the premium grade (from about $2.35 to about $2.53 per square foot) was worth the extra cost: The premium ACQ-treated southern yellow pine decking stocked by our local lumberyard has fewer knots and an overall nicer grain appearance.

During installation, we opted to create a random pattern for the decking—similar to a hardwood floor—rather than a racked look where each subsequent course has a repeated break in board length. Working from the ledger out, we started every course of decking with the offcut from the previous course, then infilled with full 16-foot boards (**Figure 2**).

We face-screwed the decking to the joists with PamFast coated fasteners. To keep the screw heads aligned, we marked the joist locations by snapping baby-powder chalk lines, then eyeballed the spacing off the edge of each board.

We eased over all the end cuts with a 1/4-inch roundover bit on a cordless router to match the long edges of the boards from the mill. For now, the client has chosen to leave the decking unfinished.

Cable Railing

The home sits on a heavily wooded private lot on the Helderberg Escarpment in upstate New York. The scenery from the deck is beautiful, and the client didn't want to interrupt the view with the railing system that was suggested by the architect: a wood railing built with a 2x4 top rail fastened to 4x4 posts with typical 2x2 balusters. Instead of balusters, I suggested using a steel "hog fence" balustrade, but the client instead suggested cable rail.

To keep the deck budget to a minimum, I agreed to install customer-provided cable-rail components that the client had sourced online rather than a name-brand cable-rail system stocked by our local lumberyard. While my standard policy is not to provide a warranty on customer-provided materials, my customer would be able to save a few thousand dollars by installing a generic product.

Posts. Before installing the posts, we set up a drill press and spacing jig and predrilled all of the holes for the cables. We wanted to make sure the holes for the coarse-thread fittings in the 6x6 corner posts and the stainless steel grommets through the 4x4 intermediate posts would be seated squarely. Then we dry-set the posts to the frame with a few Irwin Quick-Grip clamps, shimmed them plumb, then fastened them with plenty of solid 2x8 blocking and structural screws.

Top rail. The top rail (some people call this a "drink rail") of our railing system is a pressure treated 2x6 on the flat, running over the tops of the 6x6 corner posts and the intermediary 4x4 posts. A 2x4 rail runs post-to-post under the 2x6 creating a "T." We fastened the 2x4 to the 2x6 from the underside using 4-inch-long GRK Multi-Purpose Screws, countersunk 1/2 inch into the 2x4 (**Figure 3**).

Corner detail. At the two outside corners of the deck, a carpenter might typically miter the top rail, but I find that inevitably this miter will open up as the pressure treated lumber dries out. Instead, I suggested creating a half-lap joint. Ed quickly agreed, and with a stout corded router and a little bit of layout work, he executed the plan flawlessly.


A


B


C


D

Figure 3. HeadLok structural screws were used to fasten the 2x6 top rail to the posts; to create a slight recess for the broad-headed screws, the author predrilled the screw holes with a Forstner bit (A). Instead of miters at the corners, Ed Backus cut half-lap joints using a router (B, C). A 2x4 subrail that runs between the posts is fastened to the top "drink" rail with structural screws from below, reinforcing the assembly for the tension created by the cable rail system (D).

We fastened the 2x6 top rail into the tops of the posts with 2 7/8-inch-long FastenMaster HeadLok structural screws, carefully laying out their positions because they would be exposed. Before driving the screws, I predrilled a slight recess for the screw heads with a 5/8-inch Forstner bit, which helped eliminate any mushrooming or flattening of the wood grain. The customer loves the intentional look of the black fastener heads.

Cable installation. The cable rail fittings came in left-hand and right-hand versions, with a course thread on the side that is screwed into the post, and an open end on the other side where the cable is inserted. After each section of cable is precisely cut to length per the manufacturer's installation instructions, the cable ends are inserted into the fitting and a hydraulic crimping tool is used to swage the fittings. In this system, the cable is then tensioned by simultaneously screwing the left-hand and right-hand fittings at the end of each length of cable into the end posts (for more on cable railing installation, see "Foolproof Cable Railings," by Tom Salas, *PDB*, Jun/15).

Final Touches

Before wrapping up, we dressed the posts with a 1/8-inch roundover bit to break the sharp edge from the mill, similar to the treatment we gave the end cuts of the decking. Finally, we sanded all the posts and top rails with a random orbit sander and 120-grit paper.

Pressure treated wood can be a good-looking alternative to pricier materials on the market. Many of the upgrades we made to spruce up the deck were not time consuming, nor were they expensive, thereby giving our client a pretty decent bang for his buck. ❖

Jeremy Kassel is the owner and operator of Kassel Construction in Glenmont, N.Y. He can be found on Instagram at @kasselconstruction.

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Connecting Guard Posts to Deck Frames

How to make strong guard post installations with screws and blocking to meet the new requirements in the 2021 IRC

by Mike Guertin

I can't count the number of different ways I've fastened guard posts to deck framing. But I started paying a lot more attention to this important detail in 2005, when Virginia Tech researchers Frank Woeste and Joe Loferski and their team tested common post connection details used by deck builders (see "Strong Rail-Post Connections for Wooden Decks," *JLC*, Feb/05). What they found is that most commonly used post connection details would not pass the minimum code requirement of a 200-pound load (plus a 2.5x safety factor to account for variations in field installation and degradation of the connections due to time and exposure to the elements). To strengthen this joint, the team devised and tested guard-post-to-frame connections using metal hardware that transferred outward force on the posts to the joists. After reading their article, I started using their tested connections right away.

My decision to adopt tested assemblies using hardware instead of going with my carpenter's notion of a strong connection was reinforced a few years later when I visited a deck we had built before that guard-post article was published. The owner asked me to look at the railing on his deck, which had been hit by a falling tree. Aside from the damage caused by the tree's impact, I noticed that most of the 17 guard posts that we had carefully installed only seven years earlier now wobbled and deflected several inches with just a moderate push. Yikes!

Still, other than the 200-lb. load requirement, the 2000 through 2018 versions of the International Residential Code didn't offer any guidance on guard-rail-post fastening. Construction details

PHOTOS BY MIKE GUERTIN; ILLUSTRATIONS BY TIM HEALEY

were left to deck builders to design and assemble, and to code officials to approve or disapprove. That has changed in the 2021 IRC, which has a new section, "R507.10 Exterior guards," that provides more guidance on the guard-post-to-frame attachment (see "Guards, Handrails, and the 2021 IRC," by Glenn Mathewson, *JLC*, Nov/Dec/21).

In this article, I'll explain two basic approaches to fastening posts to the deck framing and dive deeper into the "structural screw and block" approach that will satisfy the new code requirements. Most jurisdictions haven't adopted the 2021 IRC yet, so now is a good time to prepare, by trying out different approaches for guardrail post connections that will comply with the new code section and seeing which construction details work best for you and your crew.


A


B

Figure 1. The author used a hand cable winch fitted with a 1,500-lb. digital crane scale to informally test the strength of different guard-post-to-frame connections made with structural screws and blocking (A). His goal was to see how these connections would fare under the 500-lb. test load requirement of ASTM D7032, the standard that wood-plastic composite (WPC) guardrail systems have to meet to comply with code (B).

Know the Code

Section R507.10.1 in the 2021 IRC states, "Where guards are supported on deck framing, guard loads shall be transferred to the deck framing with a continuous load path to the deck joists." Subsection R507.10.1.1 provides further detail: "Where guards are connected to the interior or exterior side of a deck joist or beam, the joist or beam shall be connected to the adjacent joists to prevent rotation of the joist or beam. Connections relying only on fasteners in end grain withdrawal are not permitted."

In any guardrail system, the posts are the critical part of the load path that transfers loads applied to the guard system down to the deck frame. For either a site-built wood guardrail assembly or a manufactured guardrail system, where a post is fastened to a deck joist, the term "joist" in the code would apply to the joists at the ends of a deck, joists in the middle of the deck frame, and the rim joist (band joist) that fastens to the ends of joists along the front of a deck.

Note that the joist itself must be "connected to the adjacent joists to prevent rotation of the joist." Essentially, that means that the joist to which a guard post is fastened must be reinforced to prevent that joist from twisting when someone pushes against the post. Think of the post as a lever. When a moderate force is applied against the top of the post, that force is amplified at the connection with the joist, potentially causing the joist to twist or rotate (**Figure 1**).

The code doesn't specify *how* to make the connection to prevent joist rotation. But it does prohibit connections that rely only on fasteners (nails and screws) driven into end grain, because it recognizes that they do not hold connections tight and are relatively easy to pull out. This is especially the case for deck frames, where the elements will take their toll over time and weaken connections that may initially feel solid.

So if you fasten posts to the rim joist, you also have to connect the rim joist to the adjacent joists (the deck joists that the rim joist is fastened to) in a manner other than driving screws or nails into the ends of those joists. The same would be the case for perpendicular blocking between the end joist and the next inboard floor joist. Fasteners that are driven through the joists and into the end grain of the blocks are subject to withdrawal; that's why the code doesn't allow us to rely solely on those fasteners.

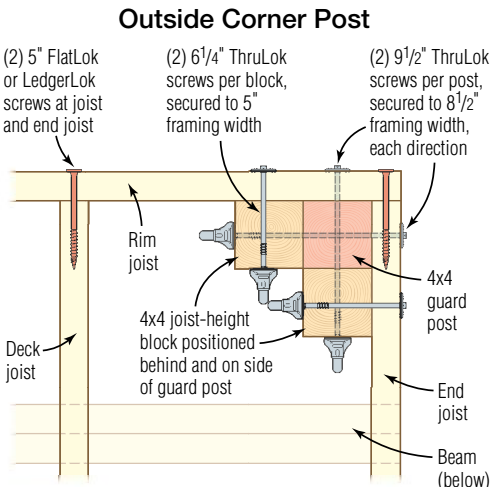

Figure 2. FastenMaster's corner post detail is made with ThruLok and either LedgerLok or FlatLok structural screws and a pair of full-height 4x4 blocks. Where pairs of screws are required, the screws are located 1¾ inches from the top and bottom edge of the joists. Note: ThruLok screws are not recommended for saltwater locations; LedgerLok screws require 5/32-inch-diameter pilot holes.

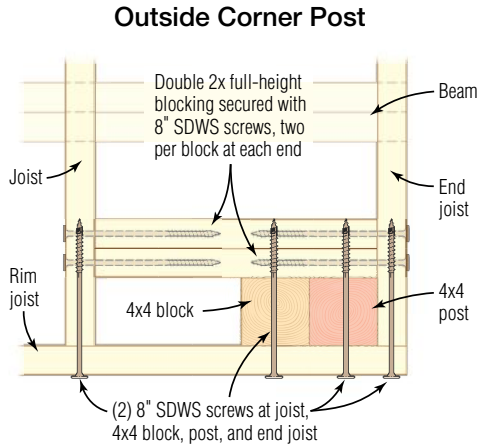

Figure 3. Simpson Strong-Tie's corner post detail is made with SDWS timber screws, a single 4x4 block, and a pair of full-height 2-by blocks between joists. Pairs of screws driven through the rim and end joist into the joists and blocking are located 1½ inches from the top and bottom edges. The two screws driven into the corner post are located 2 inches from the top and bottom edges of the rim joist.

Two Approaches to Code-Compliant Connections

How to design and construct the connections between joists to prevent rotation can be puzzling. The code doesn't want to limit our options, so it offers no prescriptive solutions, but on the other hand, how do we know that the connections we devise will meet the code? Ultimately, the decision is up to your local code official. I expect there will be a wide variation in how code officials apply this new section.

One way to be confident that your post-to-frame connection detail will meet code is to look to construction details that have had independent testing to demonstrate that they comply with code-required minimum load and safety factors. For example, the first set of tested post-to-frame connections that were developed by Virginia Tech researchers and published in *JLC* resulted in a detail that can now be found in the American Wood Council's DCA6, Prescriptive Wood Deck Construction Guide. In addition, manufacturers of metal connectors and structural screws have researched post-to-frame connection designs and tested them to verify that those designs using their products will meet the same test requirements that manufacturers of wood-plastic composite (WPC) guardrail systems have to meet—a 500-lb. test load. That test load is based on a 200-lb. concentrated guard load plus a 2.5 safety factor for tested assemblies and complies with the ASTM D7032 requirements noted in another section of the deck portion of the IRC.

Metal hardware. The original Virginia Tech post-to-frame connections relied on metal hardware to transfer loads on guard posts to the deck frame. By design, those details reinforce the joist that the guardrail posts are connected to and prevent the joist from rotating. I've used these details for years, but there were only a few basic connections. So I extrapolated additional connection details based on the principles Virginia Tech used in its designs (see "Code-Complaint Guardrail Posts," *PDB*, May/11, and *JLC*, July/19).

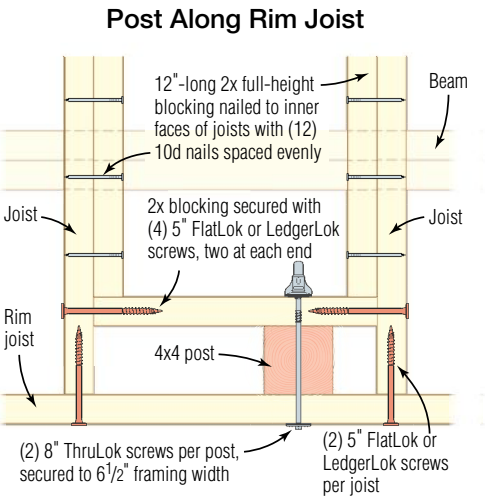

Figure 4. When fastening a post to a rim joist with ThruLoks, reinforce the connection with blocking as shown in the photo and drawing at left. ThruLoks should be located 2¼ inches from the top and bottom edges of the rim joist, while FlatLok or LedgerLok screws should be located 1¾ inches from the framing edges.

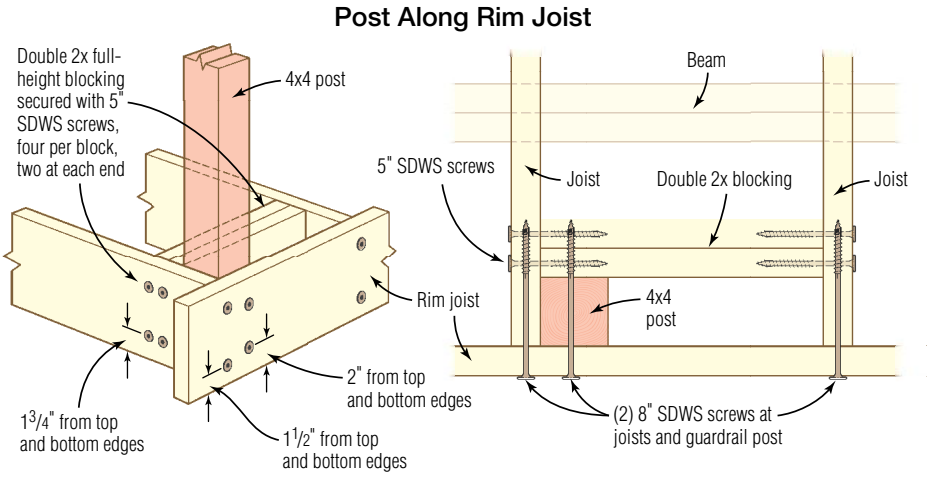

Figure 5. A post fastened to a rim joist with Simpson Strong-Tie SDWS screws can be located anywhere within the joist bay, as long as the connection is reinforced with blocking as shown in the drawings at right. This detail requires 10 5-inch SDWS screws and six 8-inch SDWS screws, along with two lengths of full-height blocking between joists.

Though not independently tested, I believe that those designs meet the intent of the code: provide a continuous load path and prevent the rotation of the joist a guardrail post is fastened to.

Blocking and screws. Another approach to securing guardrail posts to joists and securing the joists to adjacent ones to prevent rotation is using blocking and screws or bolts. Deck builders have been using blocking to reinforce guardrail posts for years.

But as the Virginia Tech research showed, common blocked post-to-frame connections weren't solid enough. In some cases, the blocking or joists split out when a force was applied to the guard post, because fasteners were driven close to the ends of the wood, and in other cases, the fasteners driven into end grain pulled out. After seeing those failures, I didn't think any arrangement of blocking and screws or bolts would be able to meet a 500-lb. test load, until a meeting with the FastenMaster tech team in 2013, where they demonstrated four post-to-deck-frame details using the company's proprietary ThruLok structural screws that would meet a 500-lb. test load.

I started using the FastenMaster blocking details when installing guard posts on my deck builds right away. We were already installing blocking around posts to support notched deck boards and border boards, so it was easy to modify our approach to include these details.

What I learned from FastenMaster's approach is that where the blocking is positioned and where the screws are installed make a big difference in how strong the connection is and how well it prevents the blocking and joists from splitting. And sometimes the blocking needs blocking. The elegant (though some may say awkward looking) feature of a couple of connection details is the use of a joist-height 4x4 block positioned behind the guardrail post. I'd always used 2-by blocking, but a single 2-by block can split when a force is applied and the fasteners are driven into the ends. The vertical 4x4 block works better—the screws penetrate side grain and the blocks are 3½ inches rather than 1½ inches wide.

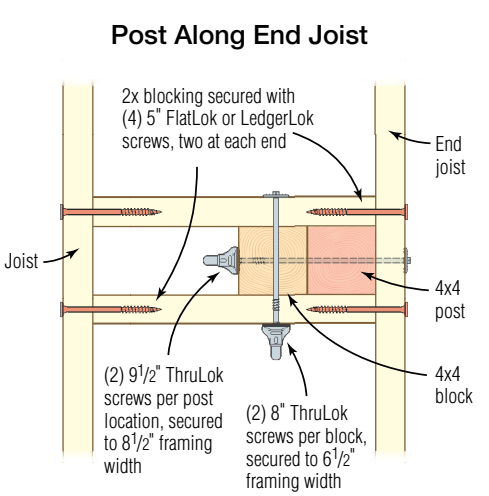

Figure 6. When fastening a post to an end joist with ThruLok screws, reinforce the connection with additional blocking as shown in the photo and drawing at left. The ThruLoks are located 2 1/4 inches from the top and bottom edges of the end joist, and 1 3/4 inches from the top and bottom edges of the blocking.

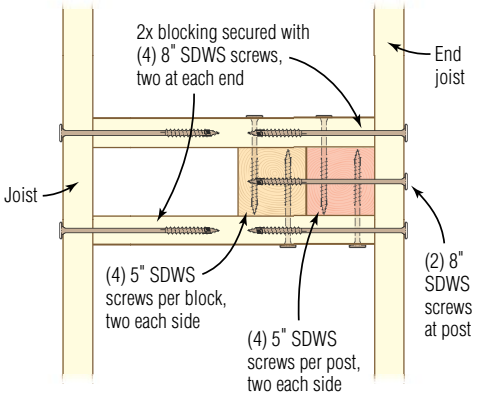

Figure 7. When fastening a post to an end joist with with 8-inch SDWS screws, locate the post screws 2 inches from the top and bottom edges of the end joist, and the screws through the end joist into the blocking 1 1/2 inches from the top and bottom edges of the joist. Pairs of 5-inch SDWS screws on both sides are also driven through the 2-by blocking into both the post and the 4x4 blocking.

A few years after FastenMaster demonstrated its block and screw details, Simpson Strong-Tie developed a series of tested block and screw connections using its SDWS structural screws that also exceed the 500-lb. test load. And I know of at least one other screw manufacturer that is doing block-and-screw connection design and testing of its own.

The new IRC requirements for exterior guardrail post connections don't require that we use the details engineered by these screw manufacturers. You can devise your own connections as long as your local building inspector judges that you are preventing rotation of the joists that your posts are fastened to and that the connections aren't relying solely on fasteners driven into end grain. But if your local official is looking for verification that the connections you use are in some way qualified by independent testing or designed by an engineer, then the designs that use proprietary screws and the manufacturers' details should be acceptable.

Manufacturers don't offer details for every guardrail-post-to-frame connection scenario you will encounter, however. For example, there are no designs for angled corners, inside corners, or the intersection of an end joist and the ledger. When you encounter a post location that doesn't have a tested solution, you can follow the principles these companies use—moving the main reinforcing blocking behind the post, reinforcing primary blocking with secondary blocking that is side-fastened to the deck joists, and doubling up blocks—to design a custom detail.

Details You Can Use

Each manufacturer has its own variations on guardrail-post-to-frame connections. If you are counting on the strength capacity that the manufacturers achieved in their testing, then it's important to carefully follow the installation guide published by the maker of the fasteners you're using. Install the blocking as each detail in the instructions depicts, install the fasteners in the locations shown, and use the model and length of the fasteners called for at each location.

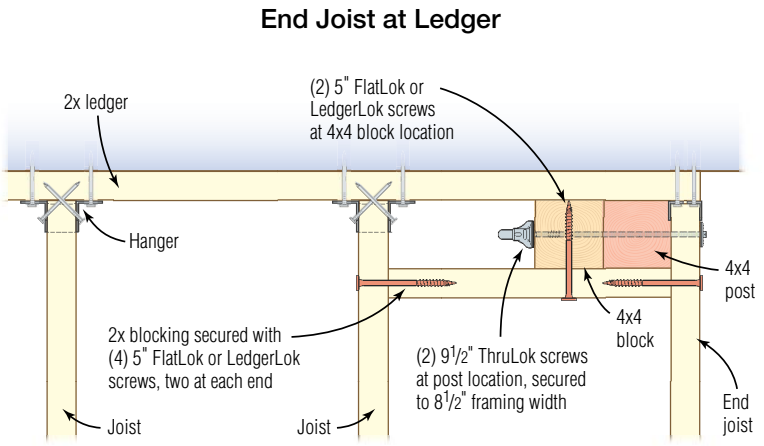

Figure 8. Where a corner post at the ledger can't be screwed through the sheathing into wall framing, the author reinforces the connection of the end joist to the deck framing with blocking as shown, then fastens the post to the end joist and 4x4 blocking with a pair of ThruLok screws.

Outside corner post. It would seem that the simplest and strongest connection of a guardrail post to a deck frame would be fastening the post to the inside face of an outside corner. Screws or bolts driven in through the post from the rim joist on one face and the end joist on the other would seem bulletproof. But the Virginia Tech testing showed that because the bolts or screws are so close to the ends of the joists, the wood split.

One solution offered by FastenMaster is to screw short 4x4 blocks on each side behind the guardrail post (**Figure 2**). This moves the screws helping to transfer the load into the joists away from the ends of the joists, so there's less chance of splitting when a force is applied.

Alternatively, Simpson Strong-Tie's corner detail uses a combination of double blocks behind the post between the end joist and the first inboard floor joist, and a 4x4 block between the double blocking and the rim joist to achieve the same result—moving the fasteners that resist the load farther back from the ends of the joists (**Figure 3**).

Post along rim joist. Rim joists are commonly fastened to the ends of the deck joists with nails or screws. Because those fasteners are driven into end grain, the 2021 IRC specifically prohibits relying on them solely to prevent the rim joist from rotating and pulling away from the joists. The rim joist needs to be reinforced or the guardrail posts connected to the deck framing in a way that doesn't rely on the rim joist (or both). Both designs use joist-depth blocking behind the guardrail post and between the joists.

FastenMaster reinforces a single 2-by block with blocks sistered alongside the joists (**Figure 4**). The guard post is fastened between the rim joist and the perpendicular block.

Simpson Strong-Tie uses double 2-by blocking behind the guardrail post and between the deck joists (**Figure 5**). In both details, the rim joist is fastened to the joists on either side of the post with structural screws. The guardrail post can be installed anywhere within the joist bay.

Post along end joist. End joists rotate easily without reinforcement. Both FastenMaster and Simpson use the same blocking arrangement: joist-depth 2-by blocks on either side of the guardrail post and between the end joist and the first inboard floor joist, along with a 4x4 vertical block behind the guardrail post and between the 2-by blocks. Screws fasten through the end joist, through the guardrail post, and into the 4x4 block, which is screwed through the 2-by blocks (**Figure 6, 7**).

End joist at ledger. Neither FastenMaster nor Simpson Strong-Tie offers a detail for fastening a guardrail post where the end joist meets the ledger. One approach to secure the post is to drive screws through the side of the post and into the framing in the wall. But if there isn't a stud or blocking in the wall, then you're out of luck. I made up my own detail, mimicking the detail used farther along the end joist. The ledger takes the place of one of the perpendicular blocks between the end joist and first inboard floor joist. The short 4x4 block is screwed through from the block and into the ledger. While it's not an independently tested detail, I believe that it meets the intent of the code (**Figure 8**). ❖

Mike Guertin is a builder and remodeler in East Greenwich, R.I., and a frequent presenter at JLC Live and DeckExpo. You can follow him on Instagram: @mike_guertin.


A


B

Lighting Effects

by Jason Russell

Located on Lake Tapps near Tacoma, Wash., this multilevel deck required all of the skills I've acquired over my 35-year career as a builder to complete. My co-worker and I worked on the project for more than four months, spending at least 40 man-hours alone heat-bending all the custom parts needed to complete the design.

It rains a lot in the Pacific Northwest, so after we framed the structure, we installed EPDM pond liner–membrane drainage systems on top of the joists on both the upper and lower levels to make the structure watertight. The lower deck is completely skirted to match the TimberTech decking, providing the homeowner with dry, secure storage accessed through custom-made doors hung from barn door hardware **(A)**.

Curved shapes and features figure prominently in the design, including the spiral staircase that provides access to the lower yard. We installed a curved glass guardrail on the stairs and around the entire perimeter of both levels of the deck, mounting the curved tempered-glass panels in Regal ideas CrystalRail brackets **(B)**. These brackets have built-in LED lamps connected to the deck's low-voltage lighting system (for more on low-voltage lighting, see "Lighting Up Outdoor Living Spaces," *PDB*, Jul/20). The lamps illuminate the edges of the glass panels, providing a dramatic nighttime lighting accent to the entire project. For safety and better visibility while ascending or descending the stairs, we installed in-lite Fusion 22 RVS Dark puck lights in the stair risers **(C)**.

To create a bit of separation from the neighboring house, we installed Hideaway laser-cut powder-coated aluminum privacy screen panels on both the upper and lower levels of the deck **(D)**. ❖

Jason Russell specializes in custom heat modification of PVC decking and railing products, automation, and custom audio installation, and owns Dr. Decks (drdecks.com), in Tacoma, Wash. Follow him on Instagram and on YouTube @drdecks.


C


D

PHOTOS: A, B, C, CALVIN RUSSELL; D, JASON RUSSELL

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BY VINCENT SALANDRO

1. Sturdy Rafter Hangers

Simpson Strong-Tie's three new models of its LSSR rafter hanger come in 2-by lumber sizes and can be installed with both miter-cut and square-cut joists for plated trusses. Like other LSSR hangers, these have a ZMAX finish for corrosion protection, are field-adjustable for skews up to 45 degrees, and can be installed after all of the rafters have been tacked into place, boosting contractor productivity and efficiency, according to the manufacturer. All LSSR models are tested and code listed in IAPMO ER-280. Pricing starts around $15. strongtie.com

2. Graspable Aluminum Handrails

Deckorators' ADA-compliant Aluminum Secondary Handrail, now available in a bronze finish, can be used to help comply with building codes for safety and livability. Compatible with 2 1/2-inch aluminum posts, the heavy-gauge-aluminum graspable handrail articulates with a variety of elbows and styles of returns to meet different installation situations, according to Deckorators. Contact the manufacturer for pricing information. deckorators.com

3. Smart Airflow Control

Panasonic's Intelli-Balance 200 Energy Recovery Ventilator (ERV) provides a stand-alone (doesn't require connection to central HVAC) balanced ventilation option with a standard MERV 13 filter. The unit, which can be floor, wall, or ceiling mounted, features a multi-speed selector that allows airflow adjustments from 60 to 200 cfm, as well as a boost function that allows occupants to increase ventilation on demand. This unit also features two electronically commutated brushless motors whose speed adjusts based on static pressure. panasonic.com

4. Tech-Savvy Plumbing Valves

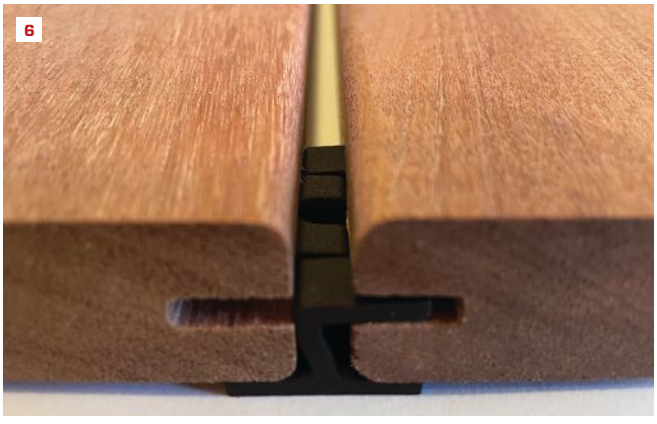
Compatible with leading smart hubs, such as Amazon Alexa and Google Home, the connectivity of the app-driven Rusco Smart Ball Valve allows for program automation, simplifying sediment flushing and flow shut-off. The unit can serve as a stand-alone shut-off valve, or it can be paired with Rusco's filters and sediment trappers, or similar products. Pricing starts at about $230 and varies depending on pipe size. rusco.com

5. Stone-Look Laminate Countertops
Wilsonart's High Pressure Laminate (HPL) stone collection includes 16 natural design options. A new Fieldstone textured finish is less reflective than other stone finishes and has authentic characteristics and veining details, according to Wilsonart. The low-maintenance surfaces resist scratches and moisture and feature low chemical emissions. Contact distributors for pricing. wilsonart.com

6. Hidden Deck Clip
Nova USA Wood Products' new ExoDek QuickClip hidden fasteners are designed for use with the manufacturer's grooved-edge hardwood decking products as well as other grooved wood, PVC, and composite deck boards. The maker says the spring clips compress with the natural swelling of wood deck boards, and then as the wood dries out and shrinks, the clips expand to keep the boards in place. Made with glass fiber–reinforced nylon, the fastener system can secure up to five rows of decking at a time. A box of 175 clips, 175 screws, and two 1/4-inch decking spacers costs between $120 and $130. novausawood.com

7. Three-in-One Temporary Door Kit
The ZipDoor Magnetic Door Kit can be used for sealing a doorway up to 46 inches by 86 inches or creating a self-close entry in a plastic barrier. The flame retardant and reusable system can be set up with ZipWall double-sided tape and is designed not to damage the door frame. The kit features one self-closing magnetic door panel, three 1-inch-by-24-foot rolls of double-sided tape, and a ZipWall plastic-sheeting cutter. The magnetic door panel is made of high-tech fabric impervious to dust. The kit retails for $100. zipwall.com

8. Anti-Glare, Radiant-Barrier Underlayment
Sol-R-Skin Blue from Boral is a UV-resistant, anti-glare coated roofing underlayment. According to the manufacturer, the product combines an aluminum radiant barrier surface with a fire-resistant mat that provides a Class-A fire rating under stone-coated steel and tile roofing. The blue coating on the underlayment helps reduce glare, making it easier to install than other radiant barrier underlayments. Offered in 54-inch-by-100-foot rolls with a thickness of 3/8 inch, the underlayment can be quickly nailed into place, with an adhesive strip at the head lap. boralroof.com



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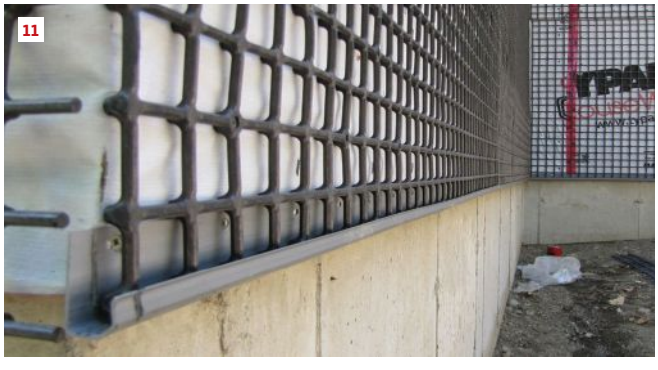

9. Wood- and Steel-Compatible Deck Clips
Aegis Clips from MoistureShield can be used to attach decking to either wood or steel joist systems. They're made from glass-reinforced polypropylene and come with pre-inserted screws for faster installation. The clips insert into grooved deck boards—providing consistent 3/16-inch spacing while their beveled edges and toothed surface help control lateral movement—and screw to the joists. Available in buckets with 90 or 450 fasteners (including pre-inserted screws), Aegis Clips cost $0.50 per square foot. Optional Starter Clips and Finishing Clips are sold separately. All clips are also available with stainless steel screws. moistureshield.com

10. Hidden Trimboard Fastening System
The VZClip is designed to keep Versatex's Canvas Series and reversible WP4/Nickel Gap Trimboards in place at wind loads in excess of 125 mph. The one-piece hidden clip and fastener system speeds installation and preserves the smooth finish of unmarred PVC, according to Versatex. The manufacturer recommends installing the clips 16 inches on-center with #8 1 5/8-inch galvanized or stainless steel screws. One box of 315 clips, for 180 square feet of coverage, costs $68.25. versatex.com

11. Easy-Install Rainscreen System
With a vertical load capacity of more than 8,000 pounds per square foot and an open grid format, Ventgrid12 can be used to create a rainscreen system behind wall cladding and beneath wood roofing, according to the manufacturer. Almost entirely made from post-consumer recycled plastic that's resistant to deterioration and degradation, each sheet covers 32 square feet and has convenient preformed fastener holes for easy installation. ventgrid.com

12. Nailable Solar Roofing Shingle
GAF Energy's Timberline Solar shingles install like a regular roof and have UL 7103 certification to serve as both solar panels and construction materials. GAF says the nailable shingles shed water, can stand up to hail, and are warranted to withstand winds up to 130 mph. The shingles are less dense than a traditional shingle at the same thickness. An average-size 6-kilowatt array includes 130 solar shingles and covers between 350 and 450 square feet on a roof. Contact GAF for pricing information. gaf.energy

Solution to the puzzle on page 58

1 E	N	2 E	R	3 G	Y	4 M	5 O	I	6 S	T	7 U	R	8 E
F	X		A		V				A		P		N
9 F	U	T	I	L	E	10 D	E	A	D	L	O	A	D
E		E		L			R				N		G
11 C	O	N	D	E	N	12 S	A	T	13 I	O	14 N		R
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34 A	I	R	S	35 P	A	C	E		36 O	U	T	G	A	S
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37 E	N	G	I	N	E	E	R		38 T	E	C	T	U	M

Makita XGT 40-Volt Rear-Handle Saw

BY JOSH BLYE AND RYAN O'MALLEY

Our carpentry crew uses a variety of tools in Makita's LXT 18-volt and CXT 12-volt battery platforms. Recently, our company hired a new carpenter, who brought with him—along with a wide range of experience, talent, and knowledge—Makita's new XGT 40-volt 7¼-inch rear-handle circular saw. Since we are big fans of the older, LXT 36-volt (two 18-volt batteries) version of the saw, we were eager to see how new hire Ryan O'Malley's saw compared.

Similar design. The baseplates, bevel adjustments, blade housings, blade guards, and main handles on Makita's 40-volt (model GSR01Z) and 36-volt (model XSR01Z) rear-handle circular saws are nearly identical. With a 7¼-inch blade, the cutting capacity of both saws is 2 9/16 inches, deep enough to gang-cut 2x3s on edge.

However, the single battery approach of the XGT 40-volt saw allowed Makita to redesign it, changing the ergonomics and balance enough to make it "feel better" during use—as well as slightly lighter—than the LXT with its two 18-volt batteries. The design of the 40-volt battery makes checking the charge level easy even when it's secured in the tool, and it can be easily swapped out with a single hand. In contrast, the level indicator lights on Makita's 18-volt batteries are difficult to see on many LXT tools, and removing the two batteries from the 36-volt saw is awkward and difficult—even more so with gloves. Also, the XGT saw comes with an on-board wrench for changing the blade; the LXT saw doesn't.

Performance. To compare power, we ran both saws through the same obstacle course of LVLs and ply rips, using fully charged 4-Ah batteries and 24-tooth framing blades. The saws performed similarly when cutting through a 14-inch LVL 10 times in rapid succession, but the 40-volt saw felt more comfortable with better balance.

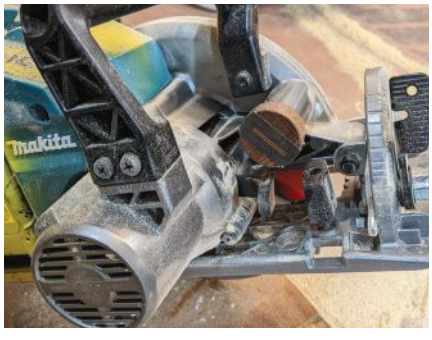
In our second test, we made five full rips through a three-layer stack of 5/8-inch Zip System sheathing, or 40 lineal feet of near-continuous cutting through almost 2 inches of OSB. Presumably because the battery's indicator lights are not visible, the 36-volt saw has a top-mounted LED battery-level indicator, a great feature that also shows when the motor is working too hard or being overtorqued, alerting the user to slow down. Both saws ripped through the sheathing at similar speeds and nearly drained their batteries by the end of the test.

To test the saws' potential under extreme (albeit somewhat unrealistic) conditions, we swapped the framing blades with Avanti 140-tooth plywood blades and attempted to rip the sheathing. Unloaded, the 40-volt saw can reach a blade speed of 6,400 rpm, roughly 25% faster than the 36-volt saw, at nearly the same decibel rating. In this test, the XGT saw outperformed the LXT—the latter bogged down after a foot of cutting, while the XGT cut about 4 to 5 feet before bogging down.

The only downside we could find to the XGT, aside from price (about $400 vs. $350 for the LXT), is the dust port. When not connected to a vacuum hose, though, the port is easily corked to prevent it from depositing dust directly onto the workpiece and obscuring any marks or lines or contributing to unsafe walking surfaces.

The 40V XGT saw is an upgrade from the older, two-battery 36V LXT saw, though it would mean investing in a completely new battery platform and set of cordless tools. makitatools.com

Josh Blye and Ryan O'Malley are carpenters with Kolbert Building in Portland, Maine.



Photos by Josh Blye

To test the new Makita XGT 40-volt rear-handle saw against its 36-volt predecessor, the authors made multiple crosscuts in a 14-inch LVL **(1)** and rips in a triple layer of 5/8-inch OSB **(2)** and compared results. Corking the dust port when it's not connected to dust extraction keeps sawdust from being deposited in a pile on the work surface **(3)**.

DeWalt DCLE34030G 20V Max 3 x 360 Line Laser

BY JOHN CARROLL

DeWalt's 20-volt 3 x 360-degree line laser emits three laser beams that appear on solid surfaces as lines but are, in effect, laser planes because those lines radiate from the instrument in all directions (360 degrees). It shoots a horizontal level plane, a vertical plane that runs perpendicular to the level plane, and a second vertical plane that runs perpendicular to the first vertical plane and also runs perpendicular to the horizontal plane.

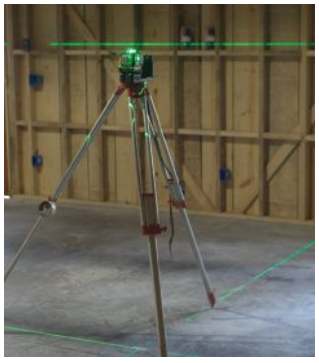
When I tested this instrument for accuracy, I found that it exceeded DeWalt's listed specification of 1/8 inch over 30 feet for level. One particularly helpful feature is an adjustment knob that fine-tunes the position of the plumb plane, which is visible on the floor, up the wall, and back over the ceiling. It can be used for many tasks, among them setting a door jamb plumb, marking stud and ceiling joist locations for attaching drywall, and laying out tile on floors and walls.

After confirming that the level and plumb planes were dead on, I used a bit of geometry that I learned in the 1970s to confirm that these planes ran at true right angles to one another (see sidebar, right).

Seeing the lines. Lasers don't operate much better than your average vampire when subjected to direct sunlight. Even with the best green lasers, the visibility of the line fades rapidly in sunlight. When I tested the DeWalt 3 x 360 for level inside my house, the green laser line was crisp and bright 50 feet from the instrument. Even when I tested it at 130 feet inside, I could clearly see the line, though admittedly the day was gray and overcast with little sun coming through the windows, and the interior lighting was fairly low. At that distance, the line measured about 7/16 inch wide, but it was easy to see.

When I tested the laser outside, though, the beam faded quickly. In direct sunlight, I could barely see the beam 6 feet from the instrument. By shading the area where the laser line struck, I could make out the line 35 feet away, but it was very faint. In a tree-shaded area, with additional shade over the surface where the laser line struck, I could discern an extremely pale line at 85 feet. At that distance, the laser line was not only faint; it was also only about 5/16 inch thick.

There is a solution if you need to use this instrument outdoors. DeWalt offers a Laser Line Detector (DW0892G) that detects the laser



Under normal interior lighting conditions, the green horizontal line and two vertical lines of DeWalt's 20V Max 3 x 360 green beam laser are clearly visible for up to 50 feet.

TESTING A LASER FOR ACCURACY

To test for level, I used a time-tested method of checking the accuracy of any leveling instrument. I began by setting the laser on a side table in my living room. I marked at the laser line a few feet away on the front wall of my house, then I walked down the hall and through the door to my bedroom and marked at the laser line on the back wall of my house, which is 56 feet from the front wall. Then, I switched the location of the laser to the top of a dresser in my bedroom, which is a few feet away from the back wall. When I switched the laser on, the horizontal line was exactly 7/8 inch above the marks on the walls in both the living room and the bedroom, indicating that the level planes were exactly parallel and right on the money over 50 feet. This test exceeded DeWalt's specification for accuracy, which is 1/8 inch over 30 feet.

To test for plumb, I set up a 32-ounce brass plumb bob in my basement and waited until it was completely still. In this position, the string holding the plumb bob was, as they say, dead plumb. I set the laser on a short wall about 8 feet away and rotated the instrument until the vertical laser plane hit the string of the plumb bob. The string line lit up like a green neon sign from top to bottom, indicating that the plane projected by the laser was perfectly plumb.

To check for square, remember that the hypotenuse of an isosceles right triangle—a right triangle with two equal sides—is always 1.4142 times the length of the sides. To check the intersecting lines on the floor for true perpendicularity, I simply measured and marked 100 inches out from the point of intersection on each line. Then I multiplied 1.4142 by 100 in my head by moving the decimal point over two places. The result, of course, was 141.42. I converted the .42 decimal to 7/16 (again, in my head). Then, I measured that amount, 141 7/16 inches, diagonally from mark to mark to see if the laser lines were perpendicular to each other. This measurement was, indeed,

Photos by Matthew Narvey

165 feet from the instrument. It's easy to use and very accurate. This detector, which costs $118, must be purchased separately.

The bottom line. This laser has it all. It's self-leveling. It can be set up on a tripod, but it works fine when set on any flat surface that's roughly level. It's very accurate in level, plumb, and the horizontal and vertical right angles it makes. It has a long run time of up to 10 hours; it's debris and water resistant; and its fine-adjustment knob is handy. The DCLE34030G kit comes with a 20-volt battery, a charger, a bracket for attaching the laser just below ceiling height (for running ceiling grid for commercial work), and a nice hard plastic case with compartments that hold all the components snugly in place. It's well worth the price of $580. If you do a lot of outdoor work, plan on investing another $118 for the detector. dewalt.com

John Carroll, author of Working Alone*, is a builder who lives and works in Durham, N.C.*

141 7/16 inches, proving that the two vertical laser lines were perfectly square to one another.

To check the intersecting lines on the walls, I didn't have the same luxury of space as on the floor. I had to use a smaller triangle to measure for perpendicularity, so I decided on 100 cm sides. After measuring and marking out 100 cm from the point of intersection on both lines, I measured across from point to point. Finding that distance to be 141.4 cm, I knew the laser lines of the DeWalt once again agreed with the geometry of Pythagoras. —*J.C.*

To test that the laser lines were perpendicular to each other, the author measured the diagonals between two equal sides, both on a floor (above) and on a wall (left).

Power Trac PT425 Articulated Compact Tractor

BY MARK CLEMENT

The first powered machine I ever operated was a skid steer I found on a jobsite with the key left in it. This was 1980-something, and I was 13 years old. Over the years since, I've operated a variety of subcompact loaders, skid steers, and mini-excavators on my jobsites, and while I'm hardly an expert operator, these experiences dosed my plasma with at least a little hydraulic fluid. These days, deck building comprises the majority of my remodeling business' work, and with the demands of moving material, digging holes, and landscaping associated with it, I decided that owning a machine was an investment in my future. In my search for the unit that would serve me best, I discovered the Power Trac PT425. It turns out that a "tool" I bought to dig holes has opened up heretofore closed business doors for me.

I bought my PT425 used and cheap with 1,700 hours on it. My rental company said its units in the same category, mainly Toro Dingoes—in daily use—had in excess of 3,000 hours. For something that I thought I might use a few hours out of a few days each month, the hours were worth the risk, so I bit down hard and forked over a bunch of cash to a guy behind his garage.

With 4-wheel hydrostatic drive and independent wheel-motors, not to mention some seriously fat "turf tires," this 1,327-pound unit with a 25-hp Kohler gasoline engine has zero—zero—impact on my customer's yards. This is not the case with other units in the subcompact loader category. Tracks and zero-turn equipment are murder on a landscape.

All the Power Trac's wheels move to make wide, sweeping turns—which I can take at full speed over and over again—and its articulating center-pivot frame is fantastic to operate. It's also nimble. I can snug that puppy in tight places and move around. It takes practice because when you turn the wheel, the whole machine moves in opposing directions, but getting the hang of it isn't learning how to paint the *Mona Lisa* either.

Output. One of the 40-plus attachments available from Power Trac is an 18-inch auger, which I use to dig my post holes. Where I build, in metro Philadelphia, the clay might as well already be brick (laced with tree roots and schist), so the ability to penetrate that layer is impressive.

Power Trac lists the lift capacity at 800 pounds, which seems a bit high. Nine bags of concrete and a pallet was a no-fly with the forks I purchased for it, but it handles 600 pounds with no problem. I tossed a few bags off the pallet and moved those bad boys from lumber drop to backyard in no time. I also use it to move lumber, paver stones, and small boulders.

Versatility. While my sweet spot is decks, my insurance agent calls me when trees are down after a storm. The last downed tree I cut up and hauled away was larger in diameter at the butt than

The Power Trac PT425 can be equipped with more than 40 different accessories, including a bucket loader **(1)**, various sized augers **(2)**, and forks **(3)**. The author finds that his Power Trac is ideal for snow removal in driveways and parking lots **(4)**.

my chain saw bar is long, but with the Power Trac fitted with a dirt bucket, I was able to easily lift the cut-up logs into my dump trailer. With its 5-foot-high lift (make sure to tip the bucket forward a little as you near the top of the lift arc to keep the opening 100% pointed away from you with an unstable load like logs), the Power Trac can lay its bucket flat on the back of the tailgate. While I'm not dumping the logs out, rolling them out of the bucket and into a trailer is easy.

The bucket is ideal for hauling 3/4-inch clean stone from my dump trailer to a backyard, where I put it over landscape fabric under some of my decks to retain or de-mud. It's great for spreading mulch, too.

Snow. Last year was a big snow season in my area, and I discovered that the Power Trac was the perfect companion to the dump truck and 9-foot blade I use to plow commercially. It's hard to overstate the power, capacity, and efficiency of clearing driveways with this thing. First, I work during the storm with the plow, but after it stops snowing, the calls come for driveway work. I leave the heavy iron at home and take the digger and bucket. Scoop-run-dump. Scoop-run-dump. The treadle pedal for forward/reverse is in constant motion for hours and awesome to operate in rapid, repetitive work.

The Power Trac gobbles up town-plow snowbanks and moves them aside, and can clear mailboxes with 4 feet of packed snow in front of them in minutes. The bucket is too wide, at about 48 inches, for some sidewalks and walks, but it is perfectly sized for driveways big and small, which otherwise would require detail work with a shovel and snow thrower after plowing. With a plow, I have to worry about damaging driveway cobbles or edging, or getting stuck by driving onto the lawn, or damaging the plow itself (I bent two rams in one storm) ... no wonder a large number of my driveway clients told me their plow guy quit.

Downsides? There is a portion of the steel frame between the seat and the controls that seems to be a weak point. I had to have mine plated and welded twice. I caught it in time, and it is a design element that's easy to reinforce before there's a real problem.

The machine doesn't have fancy ergonomics, but it's too good in too many other aspects of the work I do to complain about a lever or switch. Clean it off with a blower or hose after serious work. Grease the Zerks every 10 hours. Make sure the oil isn't black. Use a fuel treatment. Power Trac doesn't have a nationwide maintenance fleet, so unless you're ASE certified, you need a good mechanic. That said, when you call Power Trac maintenance, you get Power Trac maintenance.

Bottom of the hole. The thing I bought to only dig holes has found itself at the center of my business. List price for a new PT425 is $15,900 without attachments. power-trac.com

Mark Clement is a member of the JLC Live Demonstration team, author of The Carpenter's Notebook, A Novel, *and a deck builder/remodeler in Ambler, Pa.*

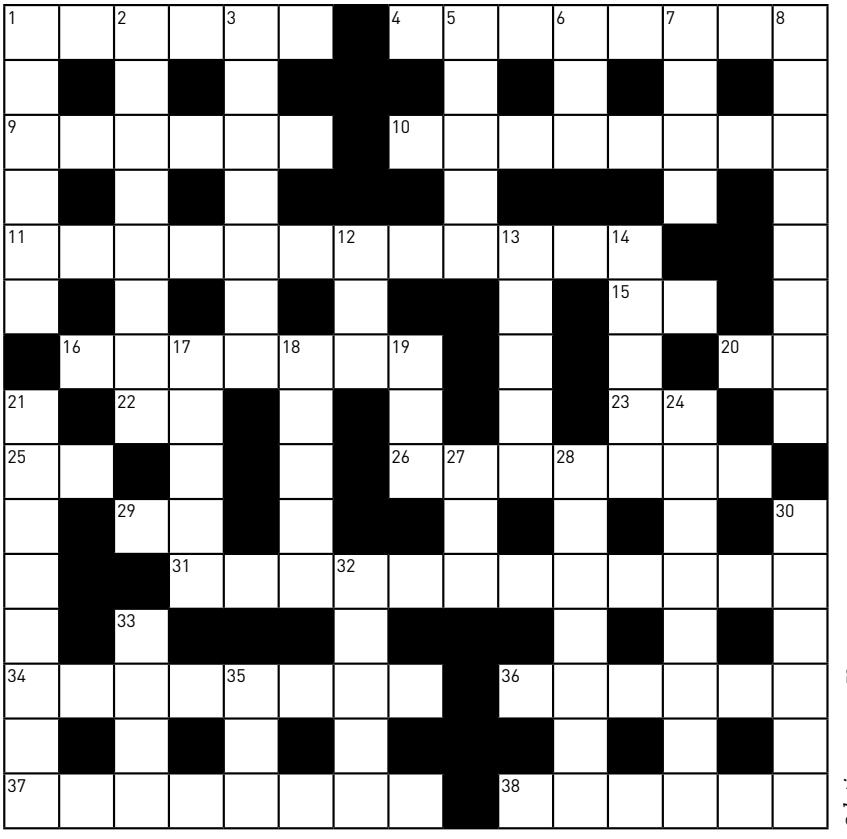
Photos by Mark Clement

Advertising Index

Classifieds

BY CLAYTON DEKORNE

Beguiled by Buildings



Solution on page 52

ACROSS

1. The capacity to do work; often expressed in Btu or joules
4. Common term for water vapor
9. Describes efforts to stop water leaks through siding with caulk or stop air leaks with fiberglass insulation
10. Design load accounting for the weight of the materials in a building
11. Forms on surfaces that drop below dew point temperature
15. 1/36 of a yard (abbrev.)
16. Things learned by observing buildings in service; often modified by "hard" when they result in a callback, loss of profit, or litigation
20. The ratio of the circumference of a circle to its diameter
22. Abbreviation for 10 Across
23. A_ _ ; describes a moment of sudden realization, like when a client realizes that new windows won't save as much energy as your recommendation to insulate the attic
25. Initial response to a client asking you to fix the leaks causing water droplets on the inside of window panes; sometimes better not to say this out loud before explaining the real cause of those droplets
26. A general type of material used for insulation that excites great controversy for some around its health and environmental impacts
29. Approx. 0.4 inch (abbrev.)
31. The field of engineering concerned with the properties of moist air
34. What is required in front of the reflective surface of a radiant barrier
36. Emit vapors from certain compounds with high vapor pressure and low water solubility
37. A building professional who focuses on performance; those in the forensic branch of the profession are often tasked with explaining why a building has failed and coming up with a solution for fixing it

DOWN

1. Frequently modified by "stack" (when referring to the air movement caused by warm air rising and cold air falling) or "throttling" (when referring to the inward drive of water vapor)
2. Describes periods of time, such as service life and warranty duration
3. Small "pinning stones" (made of sandstone, flint, or oyster shells) pushed into the mortar of some stone and brick buildings during the 17th and 18th centuries; the technique using these is purported to shield the mortar from weather
5. Apparent, not hidden or subtle; Armin Rudd used this to describe the type of objections that occupants may have to low-quality indoor air
6. How many of us feel because we missed the last two years of Building Science Summer Camp
7. Preposition commonly used with "completion" in construction contracts to define when a buyer may take possession of a property and when to release final payment to the contractor
8. The exposed pores on a cut piece of wood, which are more prone to capillary suction than other parts of the board
12. Moisture that has soaked into masonry or stucco cladding may be driven through the wall as a vapor when this comes out
13. Prefix applied to a color at the end of the light spectrum with longer wave lengths; radiation emitted from this part of the spectrum can be used to detect differences in the temperatures of materials in building assemblies
14. Period of time when earth temperatures are coolest in any given climate zone (when 12 Down is not visible)
17. A measure of the consistency of fresh concrete before it sets; used as a test of the workability of a concrete mix
18. A branch of knowledge; has yet to be applied to building knowledge
19. The upward flow of this liquid in trees is often cited as evidence that capillary action can lift water hundreds of feet
21. Action taken to limit conductive heat losses
24. Preferable state for an energy-efficient house, provided there are sealed-combustion or power-vented appliances (or no combustion appliances) and the home has effective controlled ventilation
27. Lumber (abbrev.)
28. After great debate on the value of inset stapling vs. face stapling when installing paper-faced fiberglass batts, it turns out inset stapling has ____ ___ after all—namely, when installing drywall with adhesive (two words)
30. A soft mineral that forms within layers of sedimentary rock; the U.S.—the largest consumer of it worldwide—uses it mostly for drywall, about 30 billion square feet worth
32. A recurring loop; often applied to "freeze-thaw" and "wetting-drying"
33. Math for finding sun angles, analyzing electrical circuits, and developing hip-valley rafter ratios (shortened form)
35. Critical beneath window sills and door thresholds for managing water

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