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The Journal of Light Construction

IN THIS ISSUE

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**ON THE COVER:** Todd Usher of Addison Homes nails off strap ties to reinforce the wall-to-truss connection on a gable end of the Attainable Zero project. Photo by Todd Usher. See the story on page 27.

**THE JOURNAL OF LIGHT CONSTRUCTION** (ISSN 1056-828X), Volume 43, Number 3, is published bimonthly by Zonda Media, 4000 MacArthur Blvd, Ste 400, Newport Beach, CA 92660-2543. Annual subscription rate for qualified readers in the construction trades: $39.95; nonqualified annual subscription rate: $59.95. Frequency of all magazines subject to change without notice. Double issues may be published, which count as 2 issues. Publisher reserves the right to determine recipient qualification.  Canada Post Registration #40612608/G.S.T. number: R-120931738. Canadian return address: IMEX, PO Box 25542, London, ON N6C 6B2. Periodicals postage paid at Newport Beach, CA., and at additional mailing offices. POSTMASTER: Send address changes to JLC, Box 3530 Northbrook IL 60065-3530.

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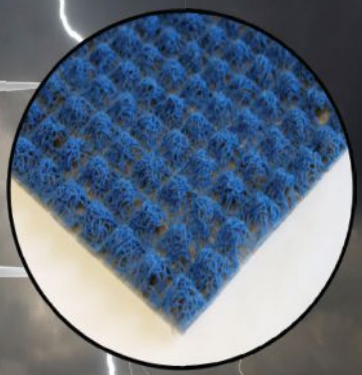

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# Chisel Sharpening Basics

*by* **MARC FORGET**

**When I was younger,** I worked in a restaurant and learned that sharp knifes were essential to being productive. It's the same with carpentry—dull edges make for poor results. In my experience a dull chisel, planer blade, or saw blade can also be dangerous. Having to force the tool to do the work can lead to an uncontrolled outcome where part of you ends up catching the misdirected tool.

The beauty of the digital world we live in is that all the knowledge of other craftsmen is available through a simple online search. A search for "how to sharpen a chisel" brings up hundreds of articles and videos, each with its own twist. The problem with all of this advice is that it can be overwhelming and often provides far more information than most of us need. So, in this article I want to keep things simple enough that people who are new to sharpening will have some easy first steps to get them started.

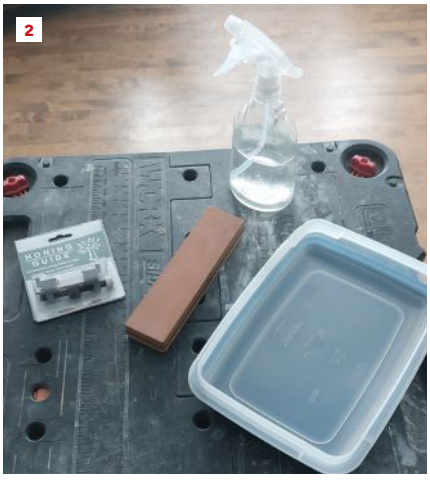
Most carpenters will need to mortise out a lock set or striker plate at some point. For this you will need a set of chisels, so let's start there.

### Types of Chisels

The two types of chisels I carry in my tool roll are bench chisels and butt chisels. A bench chisel usually has a longer, all-wooden handle. The length allows for control with two hands, but to prevent damage to the handle it should not be struck at its end with anything other than a wooden or rubber mallet. Think finer work, less brute force.

Butt chisels have shorter handles and metal or hardened plastic ends. The reduced handle length gets you into tighter spaces and the tougher end cap can take repeated blows from a hammer. Handy when you are done asking nicely and need to get through that wood grain.

Whichever type you carry, I recommend protecting the edges by storing chisels in a roll or by putting protective caps on their business ends. There is no sense in sharpening your tools and then throwing them in a bag or box where they can get dulled or chipped by bumping against each other or other tools.


Chisels are easy to damage, so use a tool roll or tip covers **(1)**. A guide, a stone, and some water are all you need to start **(2)**.

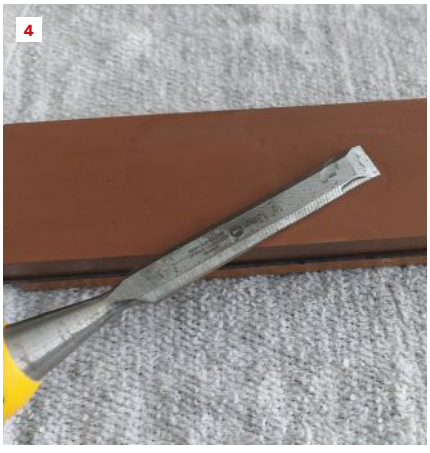
### Understanding Bevels

The bevel is the angle of the blade end. Out-of-the-package general carpenters' chisels will usually come sharpened to the most common bevel.

Bevels for woodworking chisels range from 20 to 30 degrees, with 25 degrees being the most common. This angle is a middle ground between a thinner carving or paring tip (20 degrees) and a thicker end like that used in timber-framing chisels (30 or more degrees). The thinner the end, the finer the work, but also the more prone that end is to chip or wear. A blunter end, as with the 30-degree (or more) bevel of a timber-framing chisel, makes the tip more resistant in heavy work but will not work well for detail.

We can refine this even further by

PHOTOS BY MARC FORGET



A chisel with a rough edge **(3)** has its back flattened on the damp stone **(4)**. A honing guide prevents bevel missteps in sharpening **(5)**.

adding a micro bevel to the chisel. This for me is the full "have my cake and eat it too" option. When sharpening, I set the full face of the tool to 25 degrees and then do a few passes on the finest grit stone at two to three degrees steeper, but just on the first 1/16 inch of the leading edge. The other advantage in having this micro bevel is that a quick tuneup back to sharp is easier. So as long as the blade is not too dull or chipped you do not need to work the full face of the tool at 25 degrees back to sharp; you need only work the leading edge at the steeper 30 degrees.

### Sharpening Tools Needed

This brings me to what you need for sharpening. For just starting out I would go with a combination water stone. These have two levels of grit, one on each side, which is why they are called combination stones. They use water as the lubricant and are the cheaper option of the many types available.

And oh my, are there a lot of options out there! What I said at the beginning of this article about the amount of advice you can get certainly holds true for types of sharpening systems as well. If you are turning wood on a lathe, carving, or doing joinery work, then advancing your sharpening knowledge and the equipment to do it with makes sense. This is a first-steps article, though, and for the general finish carpentry I have done, my water stone with its 1,000- and 4,000-grit surfaces has served me well. A small note of advice: If you live in a cold climate, be sure to store your water stones inside. A wet stone will crack if frozen.

The one other piece of hardware you need for getting started is a honing guide. Think of it as training wheels for sharpening. This is a jig that holds your chisel or planer blade at a constant angle as you pass the blade across the stone. By having the bevel set by this jig as you work the tool, your chances of not achieving a consistent angle are almost zero. The final advantage of doing all of this by hand as opposed to using a powered sharpening system is that you can stop before you do something to your chisel that would be difficult to reverse.

### How to Sharpen

Now for the actual sharpening. For a water stone you want the stone to be saturated with water before you start. Immersion for 10 to 15 minutes in a tray of water—I use a Tupperware container—does the trick. The container, when emptied of water, also serves as storage for the stone when not in use. I allow the stone to dry out and then wrap it in a clean dry rag and put it in the container when I am finished. This way it is somewhat protected from being banged about while sitting on the shelf. Any of these stones can be cracked or chipped if mishandled.

I set the stone on a damp cloth on the surface of a work bench or countertop. There are holders that you can buy that will keep the stone from moving as you work, but the cloth works fine for me. Before dealing with the bevel, I run the back of chisel across the stone to true it up. This ensures that the back is flat and allows for a truer bevel angle. If the back is not flat and has some amount of angle to it, then you will get some amount of compounded angle on the front face. I do this ten or twelve times across the entire stone, adding water and wiping away any metal fines and/or stone grit that appear on the stone.

Then I put the chisel into the honing guide at the bevel angle I want. For my guide that angle is set by how far the chisel protrudes from the front of the guide. The more it protrudes the shallower the angle. So for my guide 1 5/8 inches is 25 degrees and 1 3/16 inches is 30 degrees. Other guides have set screws that adjust the angle. When in doubt, follow the directions.

If the chisel is very dull then I will start by sharpening the full face of the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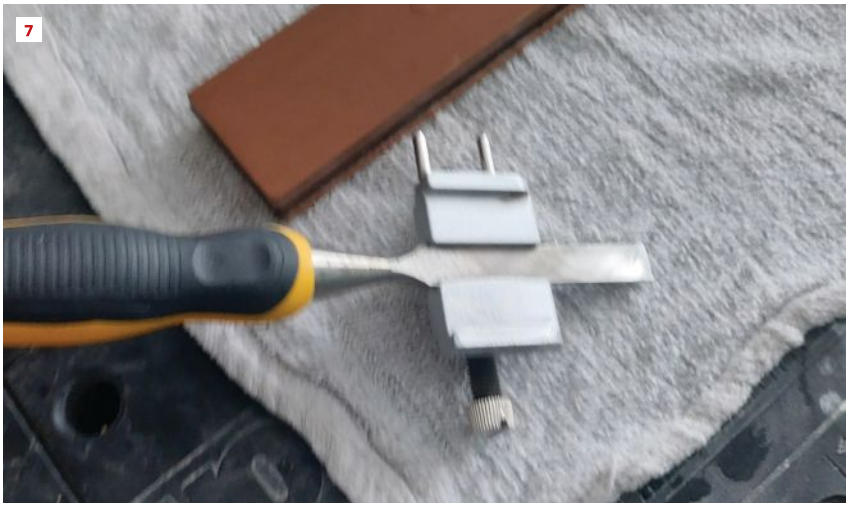



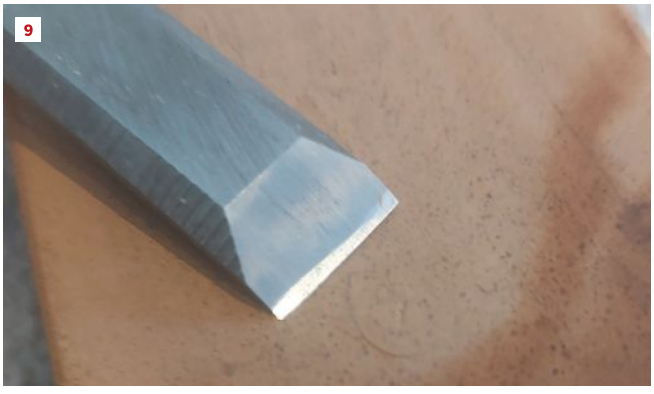


On this guide, the bevel angle is set by the amount of projection. One and five-eighths inches results in 25 degrees on the stone **(6)**. A set screw holds the chisel in place and sharpening begins **(7, 8)**. Note the even polish and the micro bevel at 30 degrees at the tip **(9)**.

bevel at 25 degrees, running it back and forth across the whole stone on the 1,000-grit face. How many times depends on how much is needed to get back to sharp. Every ten or so passes I check the edge with a piece of paper to see how sharp it is. I wet the stone as I go, and if the blade doesn't glide on the stone I add more water. When the tool is as I want it, I then flip the stone over, readjust the honing guide to 30 degrees, and make passes along the stone until I have a polished leading edge on the blade 1/16 inch back from the tip. If the chisel is not too bad or if I just want to prep it for some finer work, I will only do this last step on the 4,000 grit to reestablish the micro bevel on the leading edge.

The beauty of sharpening by hand is that you can adjust as you go. You can remove more steel if you need to or stop at any time. A powered sharpening system moves much quicker but can take away more than is needed before you have a chance to stop. When working by hand there is little chance of mucking up your angles and damaging the tool or stone. The downside is that it is slow, so if you need to sharpen a lot of chisels you will be at this for a while. I found that by making time to do short sessions frequently I spend less time overall. Frequent touch-ups are easier than waiting until the tool is very dull. When it gets to the point of very dull you are going to spend much longer getting the chisel back to what you need.

If you want to get past the basics there are a number of books that never go out of date. Two that I like are "A Sharpening Handbook" by Richard D. Wile and "The Complete Guide to Sharpening" by Leonard Lee. There is also the internet but be prepared for a flood of ads for equipment. Whether you keep things simple or get further into other techniques, a sharp tool is a joy to use and will help produce better results.

*Marc Forget is an associate editor at JLC.*

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# Deck Ledgers Done Right

*by* **TREVOR KURZ**

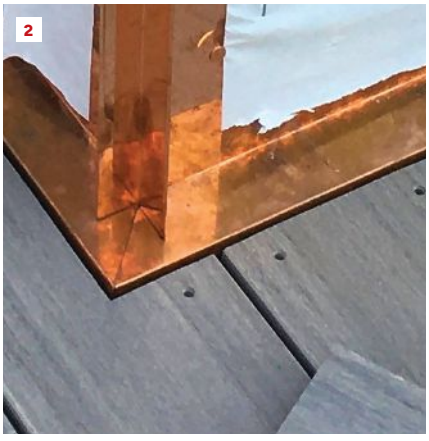
**A recent project** began as a straightforward interior renovation of a small guest house on Cape Cod. As is often the case, the scope expanded once the work got underway.

I informed the client that working drawings would be required for permitting and would serve as an invaluable tool to keep everyone aligned. We handle all drawing work in-house and begin by documenting existing conditions. While I was on site taking measurements for the as-built, I noticed several recent upgrades, including new windows and fresh siding. A pressure-treated 2x8 deck ledger had also been installed—but there was no deck.

Soon after work commenced, the homeowner asked about adding the deck, prompting a closer inspection of the existing ledger.

In this case, the ledger had been fastened directly to the wall sheathing over a strip of tar paper and secured to the rim joist with randomly placed spikes. A plastic ledger cap sat atop the board, and the first course of cedar shakes started 1 ¼ inches above it. The configuration suggested the installer intended for 2x8 joists to sit flush with the top of the ledger and for the final deck board to bridge over the flashing.

In my view, that approach traps water, dirt, and debris. In addition, fastening through the ledger cap punctures it—inviting long-term water intrusion.


The author uses a ledger board one dimension larger than the joist size **(1)** and drops the joists so the deck boards align flush to the top of the copper ledger cap **(2)**.

## Common Ledger Mistakes

Over the years, I've encountered ledger installations that were far worse, including:

- Ledgers spaced off the wall with pressure-treated blocks
- Ledgers spaced with PVC pipe

In both situations, siding and trim end up trapped behind the ledger, making future repairs nearly impossible without temporarily supporting the deck and removing the entire assembly.

## A Reliable Installation Method

On this particular job, the deck was added later as a change order. With most of the siding on the deck wall already stripped for new windows and a door, removing the remaining siding and existing ledger made sense and allowed us to reinstall a new ledger using a method that has proven reliable for more than two decades.

This method is simple, logical, and—when executed correctly—virtually eliminates the chronic water issues that plague many decks. There are four main steps:

### 1. Prepare the Wall

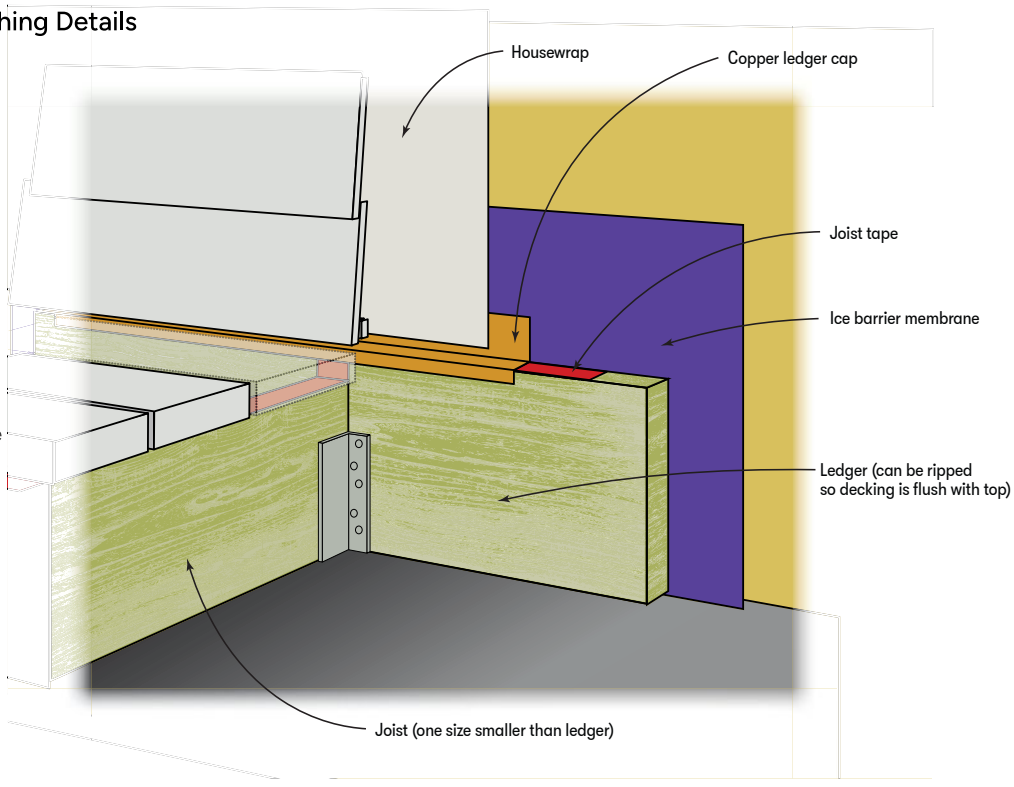
Before installation, I always clean the wall sheathing—removing old fasteners, building wrap, and leftover flashing. I then snap a horizontal line roughly 17 ½ inches up from the sheathing's bottom edge. This establishes a reference for installing an 18-inch-wide strip of ice-barrier self-adhering flashing membrane, wrinkle-free, behind the ledger. (I used Grace Ice & Water Shield on this project, and on most others, because of its adhesion characteristics and because its split-release rip cord makes it easy to remove the release liner and to install the membrane wrinkle-free.)

### 2. Establish Ledger Height

On the job at hand, I struck a level line 4 to 6 inches below the new door sill to mark the top of the ledger, which will also correspond to the top of the finished deck. The proposed deck was 10 feet wide by 12 feet deep with 5/4 composite decking as the finished surface. To limit deflection and bounce over that span, I selected 2x10 joists and paired them with a 2x12 ledger. (As a rule of thumb, I size the ledger one nominal dimension deeper than the joist). We cut the ledger to length and secured it directly over the ice barrier with two appropriately sized LedgerLok screws (fastenmaster.com) in each joist

PHOTOS BY TREVOR KURZ; ILLUSTRATION BY OLA KWIATKOWSKA

Deck Ledger Flashing Details




The author applies ice barrier membrane to the wall prior to installing the ledger board, then runs joist tape on top of the ledger and joist prior to installing the ledger cap.

bay—strategically placed to avoid the deck joist layout and related joist hangers. Some may say two screws per bay is excessive—and I agree in principle—but I stand behind this method because it helps maintain a plumb, stable ledger, especially when working with lumberyard-delivered stock or when shimming is required.

### 3. Lay Out Joists and Decking

I start the layout by marking the top of each joist on the ledger. For 5/4 composite decking, I snap a line approximately 1 1⁄16 inches down from the ledger's top edge and install joists so their top edges align with that line. This creates a flush plane between the finished decking and the top of the ledger.

For ¾-inch decking, I drop the joists ¾ inch below the ledger top. I also maintain a ⅛-inch gap between the final deck board and the ledger cap to allow for drainage. Once siding is installed, about ¾ inch of the ledger flashing remains visible.

### 4. Flash and Lap Properly

I start with joist tape, which a lot of builders today use on deck framing. When doing so, I not only run the tape along the top edges of the joist, but also run it up the ledger and then up the wall behind the ledger cap. This bridges the joist-to-ledger joint and helps direct water away from the joist end grain. I also run tape down the top edge of the ledger.

My preference for a ledger cap is copper flashing for durability and appearance. In my experience, plastic ledger cap doesn't hold up well over time. Regardless of fastening method, it tends to become brittle, and cracks or deforms over time. Galvanized metal may perform better by comparison and is serviceable in many applications, but in high-exposure areas—including coastal areas like here on the Cape or anywhere with persistently wet conditions—I view it as a long-term weak point. In addition, unlike plastic and copper, galvanized ledger cap is not an off-the-shelf offering in my area. Copper has proven to be the most durable option in wet environments, which is why it remains my go-to.

I install the ledger cap over the ice-barrier membrane and atop the ledger so it gets lapped by housewrap and siding. I leave a ¼-inch gap between the bottom of the siding and the ledger cap to prevent moisture wicking.

### Why It Matters

Deck ledgers are deceptively simple components that often determine the long-term success or failure of a deck. Poor detailing can lead to trapped moisture, hidden rot, and structural compromise. A properly installed ledger—with clean substrate, correct flashing, and precise fastening—will perform reliably for decades.

The extra time spent on proper prep and detailing is minimal, but the payoff in durability and safety is substantial.

*Trevor Kurz is president of Kurzhaus Designs in Harwich, Mass.*

# Cedar Shingle Drying Rack

*by* **EMANUEL SILVA**

**For most of the work I do,** I must be creative in finding ways to make my projects easier and more profitable. Buying specialty tools and jigs can be helpful but expensive, so sometimes constructing my own makes more sense. That was the case about 12 years ago when I wrote "Drying Rack for Staining Shingles," 6/14. For that project, I bought natural cedar shingles and stained them myself—which required a place to store them as they dried. I made that rack for that specific project only and disposed of it when the project was done.

Fast forward 12 years and I found myself once again needing a rack for drying stained shingles. This time I did a little more planning based on past experience. I built this rack so it can hold two and a half boxes of wood shingles, is lightweight, transportable by one person, and easy to fit in my box truck and store on job sites. It's also inexpensive and can be built in a few hours.

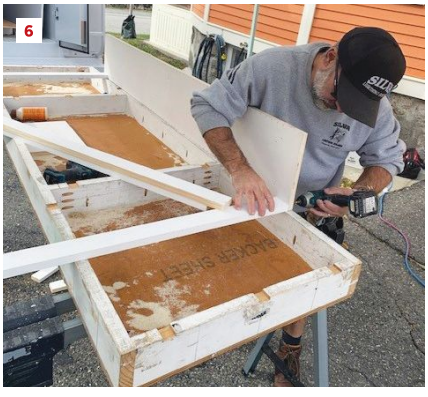
If I had purchased the materials, the rack would have cost about $100, but by using scraps from past jobs it cost me nothing but my time. I decided that 4 feet wide by 5 feet high by 9 inches deep was the size that would work for all my needs. From a few previous jobs, I was able to gather up all the materials needed: 3/4-inch primed birch plywood and 1-by primed stock. I also used fishing line supplied by the homeowner.

**Building the frame.** Starting with the side verticals, I ripped them down to 9 inches wide. To make the middle vertical, I needed to piece it together with glue and pocket screws and then





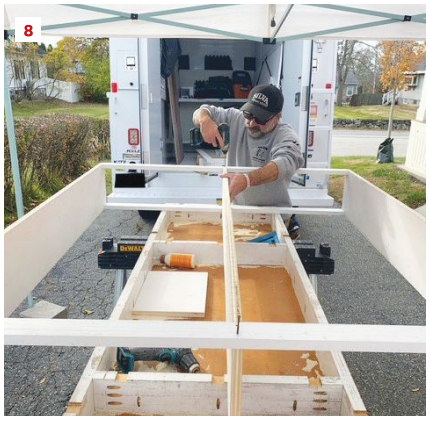
The author marks out notch spacing on all three verticals **(1)**. The middle vertical is pocket-screwed together **(2)**. All three are fastened to the work table to be held steady **(3)**. Then the 1/4-inch-deep kerfs are cut at the marks for the fishing line on both outside edges **(4)**.

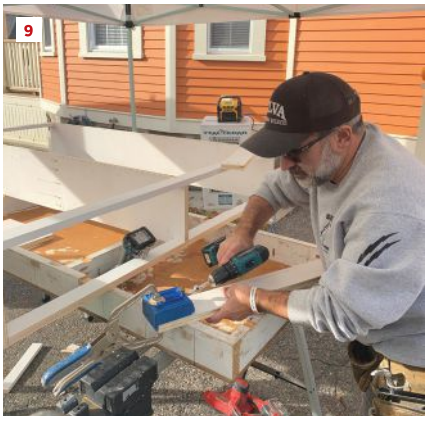





PHOTOS BY EMANUEL SILVA

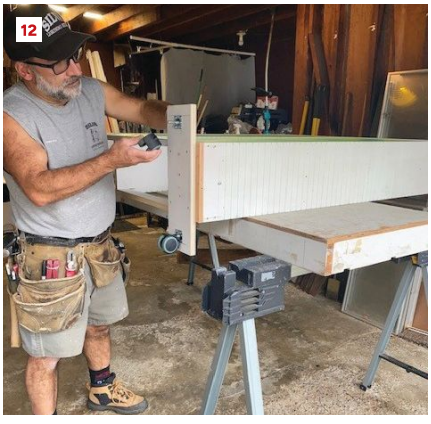
A notch is made in the middle section for the top and bottom horizontal braces **(5)** and then the outside frame assembly is started **(6, 7)**.





The middle vertical is centered and secured to the top and bottom braces **(8)**. Next, the middle braces are prepped **(9)** and squared before fastening with pocket screws to the outside and middle part of the rack. The tension of the fishing line required three in each section **(10)**.



Outriggers for stability and caster attachment are screwed to the bottom of the rack **(11, 12)**. These are removed for storage and transport. The stringing of the rack is done in 12 line sections for quicker replacement if a line breaks in use, easily the longest part of the project **(13)**.

rip it down to 9 inches. Screwing the verticals together let me cut them as one, making them the same length. While still screwed as one, I measured 2 inches from both ends and then ran my tape measure along the edge, marking 1-inch increments, giving me the proper clearance for each row.

After that, I fastened them as one to the side of my portable worktable ("Two-in-One Worktable," 1/24) with a few screws. Using my speed square and a small cordless trim saw I made 1/4-inch-deep saw kerfs at every mark across the edge of all the boards and did the same on the opposite edge. These saw kerfs are where the fishing line sits to make each row. To keep all the verticals in order, I labeled each piece. Then I ripped and crosscut four horizontals at 2 inches wide by 46 1/2 inches long and screwed them with 2-inch trim screws to both side verticals, creating the boxed frame. For the middle vertical, I notched both ends, top and bottom, and screwed it to the top and bottom horizontals.

In order to keep the frame from bowing due to the fishing line tension, I needed to add two horizontal pieces to the middle of the frame between the verticals. After ripping them to 3 inches wide and crosscutting them to the length needed between the verticals I pocket-screwed both ends and secured them between the verticals.

**Making it mobile.** Next, I needed to make the rack mobile enough to move to and around job sites. It also needed to be stable enough to keep from tipping over because of its narrow depth. Attaching outrigger boards to the bottom of the rack, cut from scraps to the size of 6 inches wide by 16 inches long, made the rack very stable. Before attaching the outriggers, I added a scrap piece of 3/4-inch plywood (9 inches by 9 inches) to the

bottom corners of the rack to help give more fastening surface. I screwed the outrigger boards to the bottom of the rack through the plywood boards with 1 1/2-inch construction screws.

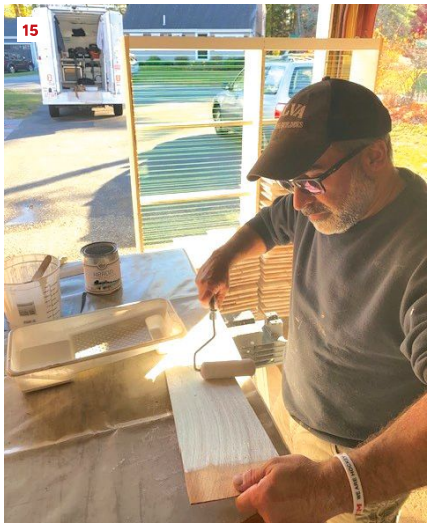
**Fishing line shelves.** The toughest and longest part of the job was running fishing line around the rack for "shelves." I used a 50-pound solar green (neon green) fishing line that is easier to see than clear line when placing the shingles in the rack. It took about an hour to feed the line into the kerf cuts and then wrap it around the ends and back. I attached a stainless-steel screw along the outside of the rack every 12 inches, leaving them proud enough to tie off the fishing line. Having a screw set at every 12 inches makes it easier to install and, most of all, easier to replace if a string breaks—you can replace that one section only, not the whole rack.

Starting with the top screw, I then tied off the fishing line and ran it around the rack with just enough tension to not snap it. After tying off the first line to the next screw I repeated the process until I reached the bottom. About halfway through the process I noticed there was some minor bowing along the top section. This required more horizontal bracing between the verticals. I cut and installed two braces to the top section and to the bottom sections. Once the installation of the fishing line was complete, I stood back to see that the frame was still straight.

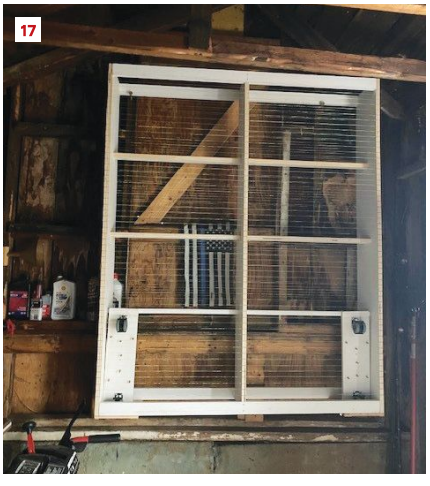
The last thing to do was install the four rubber caster wheels, which were also left over from a previous job. I secured the metal base plates to the outriggers and snapped in the wheels. For the weight and what this rack is used for, these wheels have worked great.

**How it performs.** So what do I think of this drying rack? There are so many good points, but I'll just mention a few. The rack helps keep all the shingles contained in one area, rather than scattered all around the job site. Keeping the rack closer to the worktable where I'm applying stain or paint saves me from moving around so much (time is money). With all those rows of line I'm able to place hundreds of shingles on very thin surfaces, which helps dry an entire shingle without marring up the surface. One thing that I will change in the future is this: Instead of using screws to attach and detach the outriggers when transporting, I will replace them with bolts and wing nuts. This will help prevent damage to the wood and make it faster and easier to change over. I look forward to using this rack for years to come—I just wish I'd built it earlier.

*Emanuel Silva, a JLC contributing editor, owns Silva Lightning Builder in North Andover, Mass. Reach him at silvalightningbuilders@gmail.com*






With the rack strung it is ready for its intended use **(14)**. The spacing of the lines could be adapted for other paint/stain projects. Treating each shingle before installation is a time-consuming and space-hungry task, but the author found the rack a real help for both of those problems **(15, 16)**. When not in use the light and compact construction of the rack makes for easy storage **(17)**.

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# Cost to Complete: An Essential Monthly Metric

*by* **IAN SCHWANDT**

**Most contractors I talk to** fall into one of two groups. Either they don't know what to provide their bookkeeper at month end, or worse, their bookkeeper produces a Work in Progress report (WIP), and they don't know what it means. In both cases, the problem isn't accounting. The problem is ownership of information.

If production doesn't own cost to complete, accounting can't produce a meaningful WIP. And if the WIP isn't meaningful, your month-end close—the process of finalizing the books so the financial statements reflect what actually happened that month—is little more than a guess.

Over the past few years, as I've stepped into what I think of as the CFO of Production role at our company, I've come to see month-end close and the WIP very differently. They are not simply bookkeeping artifacts. Viewed correctly, they can be management tools. And like all good tools, their usefulness depends entirely on the quality of the inputs, especially cost to complete.

### Month-End Close

Before talking about the WIP or cost to complete, it's worth clarifying why we close the month at all. The purpose of month-end close is not compliance and it's not to satisfy your CPA. It's to answer three questions with confidence:

- How much revenue did we earn this month?
- How much gross profit did that revenue generate?
- What decisions can we safely make next month?

If you don't trust the answers, you're running the business on last month's weather report. That's how companies drift into cash flow surprises, over-hire labor, or green-light projects they can't support.

For companies with long-duration projects, the accuracy of month-end accounting lives and dies by the WIP. And the accuracy of the WIP lives and dies by cost to complete.

### WIP: Fundamentally an Accounting Tool

A WIP is a monthly financial snapshot that shows how much revenue and profit a contractor has truly earned on each active job, based on actual costs and progress. For instance, it might show that the contractor has incurred and billed for $60,000 in costs on a kitchen remodel with an estimated job cost of $80,000. Assuming the job is performing to its estimate, the cost to complete is $20,000.

There's a tendency among production leaders to want the WIP to provide forecasting, schedule validation, and labor analysis. In my experience, that insight already exists upstream in accurate job costing and cost to complete tracking.

The WIP's job is narrower and that's a good thing. Its primary purpose is to present an accurate picture of earned revenue and over- or under-billings at a point in time. In the above example, if the contractor has billed the client $70,000 the project is $10,000 overbilled while $50,000 in billings would result in a $10,000 underbilling. When cost to complete is solid, the WIP does that job extremely well. When it isn't, producing the WIP becomes accounting gymnastics. (For more on generating accurate WIP reports, see Melanie Hodgdon's "Recognizing Earned Income," 5/23, and "Process vs. Purpose: The Key to Accurate WIP Adjustments," 7/25.)

### Cost to Complete: Where Reality Enters Accounting

Cost to complete, or CTC, is the single most important input to an accurate WIP. Again, in my view, WIP is fundamentally an accounting tool designed to reconcile earned revenue and identify over- or under-billings. But the quality of that reconciliation depends entirely on whether CTC reflects reality in the field.

At our company, CTC is owned by the Project Manager. When a PM marks a line item "complete" in our job costing system, they are making a very specific judgment: no additional meaningful costs—only those less than $1000—remain on that scope. That judgment isn't based on a formula. It's based on the PM using their knowledge of scope, labor performance, and trade partner invoicing to record costs against an estimate set up with job costing in mind.

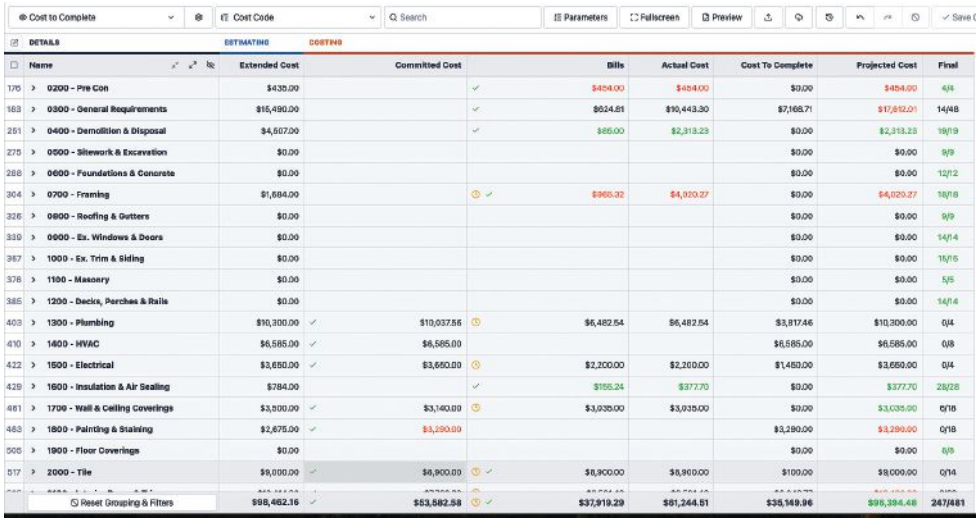
Some job costing programs or spreadsheets allow you to give a line item a specific completion percentage, but JobTread, the program we use at TDS, only allows a done/not done input. At first this limited our CTC effectiveness until we devised a system of using internal change orders to add cost to the project estimate. CTC is not about being right at bid time; it's about being honest as reality unfolds.

### Effect of Change Orders

When we become aware of additional costs we add them to the job immediately. Sometimes there's margin attached. Sometimes there isn't. Either way, the job's cost structure reflects what we now know to be true today, not on the day the project was sold.

I believe that this is where many companies go wrong. They delay acknowledging cost changes in the hope that labor will make it up later. All that does is distort CTC, which then distorts the WIP, which then distorts revenue recognition on the P&L. By the time the job finishes, the financials tell a story no one recognizes.

That's why internal change orders are important. They keep CTC honest, which keeps the WIP accurate.



| | Name | Extended Cost | Committed Cost | | Bills | Actual Cost | Cost To Complete | Projected Cost | Final |
|---|---|---|---|---|---|---|---|---|---|
| 175 | 0200 - Pre Con | $435.00 | | ✓ | $454.00 | $454.00 | $0.00 | $454.00 | 4/4 |
| 183 | 0300 - General Requirements | $15,490.00 | | ✓ | $624.61 | $10,443.30 | $7,166.71 | $17,612.01 | 14/48 |
| 251 | 0400 - Demolition & Disposal | $4,607.00 | | ✓ | $85.00 | $2,313.23 | $0.00 | $2,313.23 | 19/19 |
| 275 | 0500 - Sitework & Excavation | $0.00 | | | | | $0.00 | $0.00 | 9/9 |
| 288 | 0600 - Foundations & Concrete | $0.00 | | | | | $0.00 | $0.00 | 12/12 |
| 304 | 0700 - Framing | $1,684.00 | | ✓ | $965.32 | $4,920.27 | $0.00 | $4,920.27 | 18/18 |
| 326 | 0800 - Roofing & Gutters | $0.00 | | | | | $0.00 | $0.00 | 9/9 |
| 339 | 0900 - Ex. Windows & Doors | $0.00 | | | | | $0.00 | $0.00 | 14/14 |
| 367 | 1000 - Ex. Trim & Siding | $0.00 | | | | | $0.00 | $0.00 | 15/15 |
| 378 | 1100 - Masonry | $0.00 | | | | | $0.00 | $0.00 | 5/5 |
| 385 | 1200 - Decks, Porches & Rails | $0.00 | | | | | $0.00 | $0.00 | 14/14 |
| 403 | 1300 - Plumbing | $10,300.00 | $10,037.56 | | $6,482.54 | $6,482.54 | $3,817.46 | $10,300.00 | 0/4 |
| 410 | 1400 - HVAC | $6,585.00 | $6,585.00 | | | | $6,585.00 | $6,585.00 | 0/8 |
| 422 | 1500 - Electrical | $3,650.00 | $3,650.00 | | $2,200.00 | $2,200.00 | $1,450.00 | $3,650.00 | 0/4 |
| 429 | 1600 - Insulation & Air Sealing | $784.00 | | ✓ | $155.24 | $377.70 | $0.00 | $377.70 | 28/28 |
| 461 | 1700 - Wall & Ceiling Coverings | $3,500.00 | $3,140.00 | | $3,035.00 | $3,035.00 | $0.00 | $3,035.00 | 6/16 |
| 483 | 1800 - Painting & Staining | $2,675.00 | $3,290.00 | | | | $3,290.00 | $3,290.00 | 0/16 |
| 505 | 1900 - Floor Coverings | $0.00 | | | | | $0.00 | $0.00 | 8/8 |
| 517 | 2000 - Tile | $9,000.00 | $8,900.00 | | $8,900.00 | $8,900.00 | $100.00 | $9,000.00 | 0/14 |
| | Reset Grouping & Filters | $98,462.16 | $53,582.58 | | $37,919.29 | $81,244.51 | $35,149.96 | $96,394.48 | 247/481 |

The JobTread cost to complete budget view provides the cost to complete adjustment for the WIP by subtracting the bills in real time from the estimated project cost. All change orders, including internal ones, are accounted for in the extended cost.

### Early Warning System

One advantage of accurate cost to complete is that it acts as an early warning system. In our work, when both demolition and framing start trending over cost, often by the one-third mark of the job, it's a signal that something deeper is off.

Sometimes it's an estimating error. Sometimes it's poor scope definition. Occasionally it's a macro trend, such as an unexpected increase in material costs, that needs to feed back into future estimates.

Production leadership cannot rely on accounting to discover these trends. Accounting's role is to use the data provided by production to report on the consequences of company performance.

### Before Closing Out the Month

At our company, we won't close the month until three things happen:

1. All bills and invoices have been processed through job costing.
2. Cost to complete has been updated.
3. Production leadership agrees that the numbers reflect reality.

Without this discipline the damage shows up immediately: incorrect over- or under-billings, revenue pulled forward or delayed, and a P&L that doesn't match what's happening in the field.

### GP/Day and VPW Live Inside WIP

Although WIP doesn't explicitly reference metrics like Gross Profit per Day (GP/Day) or Volume per Week (VPW), they're embedded in it. Each month's WIP shows total earned gross profit and revenue.

Using the spreadsheet to calculate the monthly differences allows you to track other performance metrics. Divide earned gross profit by the days in the month and you have GP/Day. Earned revenue divided by the number of weeks gives you VPW.

In that sense, WIP doesn't replace operational metrics; it validates them. It proves whether your assumptions about duration, throughput, and labor efficiency were right.

### A Production Leader's Read

When I review the WIP, I'm not hunting for accounting errors. I'm asking production questions. If we're over-billed, did we receive a large deposit this month? If we're under-billed, who owes us money and why? Every answer ties back to billing timing, production progress, and cost to complete confidence.

WIP doesn't fix problems. It reflects how well production and leadership are aligned. If your WIP is confusing, the problem isn't accounting. It's that production hasn't finished telling the story yet or doesn't know how to tell it. CTC is where reality enters the financial system. When production and accounting own their inputs then month-end close becomes a management exercise instead of a mystery.

*Ian Schwandt is the operations manager at TDS Design Build in Madison, Wis., and the author of* Nails to Numbers *(nailstonumbers.substack.com).*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# Using Wood Grain With Intention

*by* **BRIAN CAMPBELL**



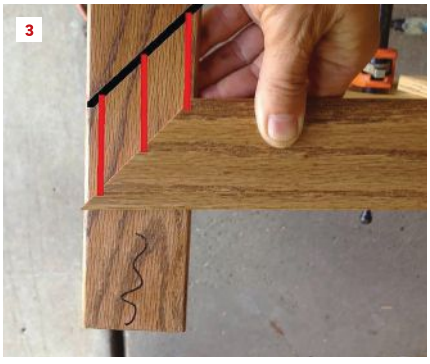
The author typically aligns the grain on miters for stain-grade work (1). He spends a little time sorting boards into pairs by grain type (2) to make it easier to match the grain prior to cutting the miters.

PHOTOS BY BRIAN CAMPBELL

**Wood grain** is often the main attraction of stain-grade and clear-finished woodwork, yet I'm surprised how often I see new trim that has been installed without any consideration for the grain patterns in the wood. A little time and attention paid to wood grain can vastly improve the look. For example, I always take a little time to align grain patterns when mitering casing around a window or door opening (1). It helps to spend some extra time sorting boards by grain style in matched pairs for casing (2). Working with matched grain, it only takes a few minutes more to slide the boards past each other to find the best match, as shown in photos 3 and 4. It's even faster if you are cutting the head and the side casing from the same board. Matching the grain at a miter means you end up with a little more waste. But the difference, once you see it, is immense. When the grain is aligned, a miter all but disappears; you see the grain turn direction but you aren't necessarily aware of the joint. Whereas, when the grain doesn't align, the miter disrupts the grain patterns and the board's cut ends stand out.

**Earlywood vs latewood.** The pronounced grain patterns on a board are typically formed by the combination of light-colored earlywood (formed early in the tree's annual growing season) and darker-colored latewood (formed in late summer and autumn). Each pair of early and late wood represents one year of a tree's growth and forms the "annual rings" in a log. When that log gets sliced up at a mill, what we see as rings at the end of a log turn into grain patterns that vary by how a board is cut.

**Plainsawn patterns.** Most of the time, boards will be "plain sawn," which produces "flat grain" with distinctive cathedral or flame patterns on the face of most boards. These patterns vary widely and yield an inconsistent pattern, particularly on boards cut closer to the outside of the log where the growth rings of the tree run parallel, or close to parallel, to the face of the boards. Plainsawing is





The author cuts one side of a miter **(3)** and slides it across the face of the joining board to find where the latewood grain lines match the best. The result is shown above at right **(4)**.


While it creates a little more waste when casing a window, centering the grain figure over the window **(5)** yields a balanced composition in the grain of this stain-grade oak trim.

the most common method of milling lumber because it produces the least waste. But because the grain runs parallel to the face of most boards, those boards are more likely to cup or warp.

While the flamelike patterns on plainsawn boards vary widely and are inconsistent, the shapes can be positioned to create some sense of visual harmony. With stain-grade casing, for example, I center shapes in the grain pattern on the headers of windows and doors whenever possible (5,6).

**Quartersawn and riftsawn** boards tend to have "vertical grain" that runs parallel to the edges of the board and the grain pattern on the face of boards appears as alternating stripes of earlywood and latewood. Vertical grain tends to warp much less because the bands of early and later wood, which absorb moisture at different rates, are consistent, so a board tends to shrink and swell evenly.

One important detail to think about if you're installing a backband around window and door casings: A lot of the time, we create the look of a traditional backband with a corner molding. One leg of the corner molding will have flat grain and one leg will have vertical grain (7). Most importantly, pay attention to this difference and be consistent in where you place the vertical or flat grain on the face casing. You probably don't want the flat-grain face of a corner molding meeting a vertical grain face at the miter. Consistency rules.

Also, because the side with vertical grain will move evenly with changes in moisture content, it's better to cut the miter on this face of the corner molding. With something as small as a corner molding this doesn't tend to make a huge difference. But it's worth noting and getting into the habit of thinking about how the grain will move, remembering that miters in flat grain are more likely to open than miters in vertical-grain wood.

**Sapwood and heartwood.** Tree logs also have sapwood made of living cells that grow closer to the outer circumference of the tree. Sapwood cells convey water from the roots up the tree. As the tree grows, these sapwood cells die, turning to heartwood that forms the dense, structural core of a tree. The variation in color between lighter sapwood and darker heartwood is also visible when the log gets sliced up.

This difference can also be exploited for visual interest. One example is the casing I installed for some custom interior doors and windows (8). The doors and casing are made of yellow



Another example showing a variation in how the grain of a head casing can be centered over the window **(6)**. One leg of any corner molding will have flat grain (in this example, it's the horizontal leg on top), and the other leg will have vertical grain **(7)**.



To case around custom birch doors, the author used yellow birch with a mix of sapwood and heartwood, going for a "wild" look as requested by the client **(8)**. The ray fleck visible in quartersawn oak (most prominent on the casing and door on the right) is often called "tiger stripes." **(9)**.

birch. Hardwood suppliers will sell either "yellow birch" or "red birch" or "white birch," but it's all the same species. But while red birch is mostly heartwood and white birch is mostly sapwood, yellow birch (what we have here) is a mix of sapwood and heartwood. We were going for a wild look that in many ways is the opposite of grain matching, but it was done with intention. The high contrast between the sapwood and heartwood of yellow birch was fun to play with on this job.

**Figure in wood.** Along with variations in early and latewood, and in sapwood and heartwood, different cell configurations in different wood species along with the growing stresses that change the shape and configuration of wood cells produce all kinds of variation in wood grain patterns. A common one is the ray fleck in quartersawn oak, which is formed when radial cell bands that transport nutrients through the tree are exposed on the surface of a quatersawn board. Sometimes called "tiger stripes," ray fleck appears as wavy ribbons that reflect the light differently than the rest of the board's surface. The ray fleck in photo 9 is especially noticeable in the casing near the hinges and on the door.

Variations such as these in the appearance of wood grain are often called "figure" in wood. Paying attention to wood grain and intentionally selecting and positioning boards to highlight wood figure becomes one of the more fun aspects of finish carpentry, I think. I always make a point to show clients how I have intentionally aligned the grain and positioned the figure. Those who already have a feel for figure in wood appreciate the work more, and those who learn about it for the first time suddenly take a keen interest in it throughout their home; it becomes a topic of conversation and another point of pride they feel for their new or newly renovated home.

*Brian Campbell is a finish carpenter in the Twin Cities of Minn.*

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PHOTOS BY TODD USHER

# Fortifying Attainable Zero

## This above-code project reaches for new standard of resilience

*by* **TODD USHER**

In our area of Greenville, South Carolina, high wind resilience isn't just "a nice to have" home feature—it's a baseline for building a durable home. That made our decision to aim for Fortified Gold—the highest level in the Institute of Business and Home Safety (IBHS) Fortified Home standard—feel right for our Attainable Zero project.

**Attainable Zero.** We embarked on this project—a three-bedroom, two-bath, 1,300-square-foot home that when complete will be a certified DOE Efficient New Home / formerly DOE Zero Energy Ready Home—to showcase what my company, Addison Homes, does best: build high-performance homes at an attainable price for middle-class families in our market. This home will include on-site power generation through solar roof shingles, battery storage, and ducted heating and cooling with an air source heat pump, at a price around $400,000 for design and construction costs.

Building above-code homes that deliver maximum value to our clients has been the defining principle for Addison Homes for over 20 years. I feel strongly that doing the right thing for the environment doesn't have to be at odds with doing right by the customer. The opposite is true. The more I learned about quality sustainable construction practices, the more I connected the benefits of these practices to my customers, employees, community, and business.

One of the appeals of the Efficient New Home program is that it combines the requirements for a comfortable, healthy, duruable and energy-efficient home under a single standard. DOE requires new homes to meet the latest energy codes as well as to achieve Energy Star and EPA Indoor AirPlus certifications. The program also includes requirements that ensure water savings, HVAC and water-heating efficiencies, and third party-verified air sealing.




Fortified Gold requires first meeting Fortified Roof specifications, including a tight nailing schedule for roof sheathing **(1)**, using a minimum 7/16-inch sheathing panel **(2)**, and a sealed deck, which the author accomplished with continuous peel-and-stick membrane **(3)**.

The DOE program promotes the IBHS Fortified Home standard, though it's not a requirement. Building in S.C., however, we feel it's crucial to build to a robust high-wind standard. While we are not in a wind zone, per se, typical design wind speeds for our upstate counties fall in the 85- to 100-mph range. And while we are inland, hurricanes that hit the state still wreak havoc. In 1989, Hurricane Hugo brought 90-mph winds that snapped off trees and power lines, triggered inland tornadoes, and left most of Greenville county without power. During Hurricane Helene in 2024—the deadliest hurricane in state history—over 600 properties in Greenville suffered major damage, 55 were destroyed, and more than 80% of the county lost power, with outages in some neighborhoods lasting more than two weeks. Living through such events made a strong impression on many of my clients, and that has been the reason we adopted Fortified Roof for the majority of our builds as a baseline protection that few clients ever question.

## Fortified Home Levels

The Fortified Home standards are divided into three levels: Fortified Roof, Fortified Silver, and Fortified Gold. The levels are successively more stringent.

**Roof.** Fortified Roof, as the name says, focuses on keeping the home's roof intact during a storm event. It requires nailing off the roof deck every 4 inches along panel edges and 6 inches in the field with 8d ring-shank nails, as well as "locking down" roof edges by nailing down a minimum 26-gauge drip edge over the underlayment. This must be paired with a fully adhered starter strip or 8-inch-wide bed of mastic on eaves and rakes. The roof deck must be sealed with tape or with a continuous peel-and-stick underlayment. (For details on achieving Fortified Roof, see "Toughening Up the Roof, 2/19).

**Silver.** Fortified Silver adds reinforcement of other critical elements. At this level, we must meet all Roof requirements, brace gable-ends and chimneys, add impact- and pressure-rated garage doors, and anchor any structures attached to the house, such as porches and carports. (In hurricane zones this level also requires impact-protected windows and doors.)

**Gold.** The Fortified Gold designation includes all the requirements of the Roof and Silver standards, and also requires an engineered continuous load path. All roof-to-wall and wall-to-roof connections must be designed by a structural engineer, and like all the Fortified standards must be verified by a third-party inspector.

## Finding The Right Engineer

The Attainable Zero project was the first time we have pursued Fortified Gold, and based on my experience with Roof and Silver, I thought achieving Gold would be straightforward. However, getting the right engineer involved wasn't as easy as I assumed it would be.

We first engaged our truss designer, who's a licensed engineer, but he said he didn't understand what was being asked to complete the formwork. I reached out to the Fortified field engineering services, who referred me to an evaluation service based in Missouri, which covers our area. They referred me to an engineering firm in North Carolina. I waited two weeks, calling them daily, but was told repeatedly



Visible in the center of a door opening **(4)**, the 2-in. perimeter slab insulation left just a sliver of the slab under the wall plates for securing the plates with two Titan anchors **(5)**.

Gable-end trusses were tied to the gable-end walls with metal straps. To meet Fortified Gold, the size, frequency, and nailing needed to be specified by an engineer.

that their team was still reviewing our case. I learned later that this firm had never done engineering for a project at the Gold level and they were trying to figure out what was required before calling me back. Concerned about the extended delay, I reached out to a local engineer we had used in the past. I wished I had done so earlier. He came out to the site, looked at the standards, and within a few days came back to us with compliant details for our project.

The big lesson here, of course, is to "start early." I should have begun the planning and gotten everyone—engineer, third-party evaluator, and local code officials—on board much sooner.

## Marrying Framing with Performance

Most of the lessons we learned on this project centered around framing, but they weren't isolated structural details. They had to be integrated with advanced insulation and air sealing details, and overall building performance.

**Foundation to wall.** A good example of this integration occurred early on. When we designed the slab foundation, we planned on using our typical perimeter insulation detail: We use an 8-inch concrete block (CMU) for the stem wall with a 4-inch CMU for the top course, set to the outside to create a step that supports the slab ledge. Our subslab insulation comes across the bottom of this step and turns up on the inside of the 4-inch CMU. When we build our 2x6 walls, we set them back 1½ inches from the outside of the stem wall so the wall ends flush to the outside of the foundation after they are sheathed and continuous wall insulation is installed on the walls. That puts our bottom wall plate over the insulation that turns up the 4-inch CMU along the perimeter.

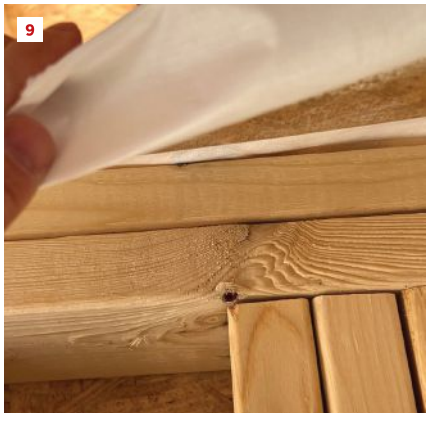
Typically, we use 1-inch XPS foam for our subslab insulation, but because we were aiming at a higher level of thermal performance on this job I switched to 2 inches of perimeter insulation. But that reduced the concrete area we had to anchor into. For a bit I thought we might not be able to anchor the plates properly to the foundation. Fortunately, we were able to use two screw-in Titan anchors, one on the CMU wall and one into the slab, to get a solid uplift connection.

We were able to use Titan anchors for anchoring the plates around the entire house. This was nothing new. We have been using Titans for a while. They are so much easier to place than anchor straps because we're able to install them as we attach our sill plates, rather than before the foundation pour.

The difference with the anchors for meeting Gold is that we had to get these and all the other uplift connections and nailing schedules inspected before we started installing the continuous insulation and the housewrap that served as our primary air barrier. We did schedule the inspections with the evaluator, but then our start date got pushed back due to supply chain issues and pricing uncertainty last summer. This set up a chain reaction of delays. In the future we will know to build in extra time to accommodate such uncertainties.

**Wall to roof.** For the top plate to truss connection we relied on FastenMaster's FrameFAST screws instead of metal hurricane clips. In most parts of the house, we were able to screw these up through the wall plates from below. Where we had LVL headers we needed to come in from above, but, overall, these screws are much easier and faster to install than metal hurricane ties. The material cost is higher for the screws than for ties, but the labor savings is considerable. Also, for our primary air barrier we ran the Tyvek over the top plate, leaving a flap on the inside that we attached to the ceiling drywall with wide-spray foam sealant. This detail would have been nearly impossible with hurricane ties. In theory, you can install ties over the housewrap, but the number of penetrations would seriously compromise the air barrier.

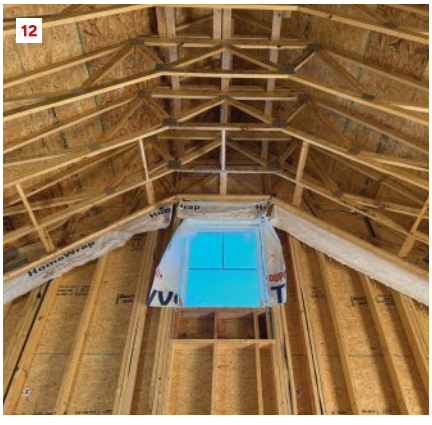
**Trusses.** The main living room and kitchen area of the house has a vaulted ceiling so we used raised heel scissors

Top plate to plate connections were made with FrameFAST screws.


Scissors trusses over the great room (to the right) bear on 10-foot walls. The bonus trusses (on the left) sit on 9-foot walls.


The "bonus" trusses have a parallel-chord floor structure where mechanicals will run.




Horizontal bracing ties the gable-end truss to the next two scissors trusses.

trusses. The raised heel gave us the vertical space we need to get full insulation thickness over the exterior wall plates. Without that space, insulation can get compressed at the eaves and lose its effectiveness, something we were absolutely trying to avoid, especially since this project is aligned with net-zero performance goals.

The truss system over the unvaulted portion of the house included a built-in floor system—what I refer to as a "bonus truss." In this section, the bottom of the trusses is formed with parallel chords that create a floor structure integrated into the attic truss above it. This floor structure provides more room to run our mechanicals—ductwork, plumbing, electrical—without having to cut any holes or drill into structural members, which, of course, is especially problematic with trusses.

Using a bonus truss for the upstairs living area provided one simplification in meeting Gold: The structure acts like a one-story home. If we had stick-framed a more typical story-and-half to gain the upstairs living area, we would have had to install a lot more mid-floor connections (metal straps) to tie the two stories together.

**Attached structures.** On this project we have two porches facing south and east that provide critical shading to reduce summer cooling loads. To meet Gold, the connections of the porch posts to the porch slab were included in the engineering design. These were easily done with metal post anchors. The trickier details involved the porch trusses, which tied back to the main house truss system.

In the vaulted ceiling area, the walls are 10 feet tall, and in the area we have the bonus trusses the walls are 9 feet tall. The porch spans both wall heights but the porch roof ceiling remains level across this distance. To get all these areas to align, the porch trusses that bear on the 10-foot wall had to drop down one foot on the exterior side to maintain the level porch ceiling. This drop-down portion of the truss also had to bump out an inch and a half so that we could slide our wall sheathing and continuous insulation up onto that 10-foot wall behind that drop down of the truss. It was a bit of a booger of a detail that required close communication with the framers.

## Better Communication

A big advantage of using engineered trusses is clarity. The whole system—roof, attic floor, load paths—is designed by the truss manufacturer, eliminating the need to interpret prescriptive framing tables or spans. On this project, our manufacturer used MiTek design software, which allowed them to generate a 3D model of the entire truss system. Before we placed an order, we reviewed that model to make sure everything would fit exactly as intended.

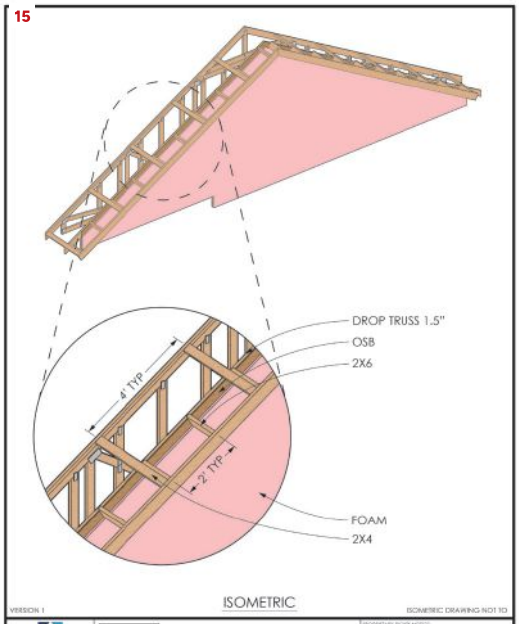
In addition, we have begun to build a library of isometric details that better show complex or unusual details that are a departure from how the framers normally do things. An example is the isometric (see facing page) of the rake overhang detail. Since we're not in a hurricane zone we don't need engineering on the reinforced soffits. But we have devised a rugged detail that involves more than just toenailing 2x6 blocks to the gable end to support the rake overhang. Our detail relies on a gable-end truss that's held down 1½ inches so we can slide a flat 2-by member over the truss and tie back to the first full truss. We print the isometrics on waterproof paper and collect them in a binder that we can hand to subcontractors. The isometric drawings help ex-

plain details much better than a page or two of section views buried in the plans.

Early coordination with our trade partners is a huge part of our process. Almost every home we build is unique, at least in some way, but we effectively build each home six or seven times at the computer before it ever goes up in the field. That includes reviewing drawings, the estimate. mechanical layouts, and, in this case, the 3D truss model. This helps reduce the unknowns, prevents field conflicts, and gives everyone—framers, HVAC contractors, plumbers, electricians—a head start on understanding the job. We review the 3D truss models both internally and with our subcontractors. When we know a project is coming up, we'll walk them through the model so they can see exactly how the structure is going to come together. This transparency helps everyone prepare for the complexity of the job. It's also part of our pricing discussions with trade partners, which is particularly important when we are trying something different, as we were on this project. Rather than telling them, "Trust us, it's easy," we can show them exactly what they'll be working with.

It's not just the production team who benefits from the 3D model and isometric drawings. We use them with our customers as well. Architectural plans can be hard for homeowners to interpret. When we can show them the actual truss layout as a 3D "box" that represents their attic and bonus space, they immediately understand things like clearances, knee wall heights, and the amount of flat ceiling area they'll have. It's much more intuitive than trying to read lines on a plan.

An additional communication step and quality control process we have devised involves "tagging" and marking out critical framing connections with fluorescent orange spray paint and a Sharpie. We tag anything that needs special attention by the framers and write on it what needs to be addressed. We also mark out the rough opening sizes at doors and windows. We start tagging and marking up the frame before the framers are done, and we tell them not to freak out about all the orange. It's not meant to be anything punitive; we're just being clear and asking them to address each issue when they're working in that area. Once an item is addressed, we paint it white. This strategy proved especially important on this project to ensure we had all the engineered connections properly resolved before inspection.




The author relies on isometric drawings, such as this one of the rake overhang detail, to better communicate plan details to installers.



To keep the porch ceiling level, the porch trusses bearing on the 10-foot walls in the great room drop down 12 inches and include a 1½-inch space between the drop-down and the wall to fit continuous insulation.

## Practical Lessons

Pursuing Fortified Gold involved more inspections, coordination, and careful planning than for a typical build. But at the end of the day, the result is a stronger, more resilient home.

Our process highlights how much easier everything becomes when you prioritize design and communications on the front end—modeling, aligning with the truss designer, and making sure every trade partner understands the plan. The work that happens before framing ever starts is what makes the rest of the build more predictable. And for us, that planning is what allows the home to perform—not just structurally, but thermally, mechanically, and as a complete system.

The lessons we're learning will help us serve clients with limited budgets—a key demographic for our company. The combination of Fortified Gold, DOE certification, and a disciplined building process shows that durability, resilience, and energy efficiency need not be luxury upgrades. That's great news: My goal as a builder has always been to deliver real performance to many people, not just a few, and this project is showing us some new ways of making that happen.

*Todd Usher owns Addison Homes based in Greenville, S.C.*

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# Electric Floor Heat: Lessons Learned

## Guidance to help contractors avoid problems

*by* **DOUG HORGAN**

PHOTOS BY DOUG HORGAN

In theory electric floor heat is not too hard to install, but we've found a number of ways to do it wrong. Here are some mistakes we've made, along with advice for doing the job right.

### Read the Fantastic Manual

This is one task where the instruction manual is critical. One of our earliest failures was with an older type of system that required both ends of the wire to terminate in the control box. When the electricians showed up to install the control in the box, only one end of the wire was there, and we had already completed a beautiful, tiled bathroom with cabinets and fixtures sitting on the tile. That client chose a full refund of the cost of the floor heat rather than starting over with the floor.

Each system has its own particular installation details, and those details can change now and again too. It's always worth a close look at the latest instructions. You can make the college intern do it if you don't have the time!

**Understand the proper coverage.** Floor heat wires come in precut lengths that cover a certain amount of floor area. The actual square footage that needs to be warmed is smaller than the total floor area: manufacturers point out that there are areas that don't need heat, such as within 8 inches of most walls and behind toilets and bathtubs. These are areas no one normally steps on. We can calculate the heated area without these spaces and order the next size up kit.

Wire Placement Recommendations in Two Sample Bathrooms


The extra square feet of wire can be placed in these "optional" areas.

A persistent problem for us on remodeling jobs is ordering wire based on the square footage on the plans. Things change when we open up walls and floors, and the actual floor area may increase or shrink compared with what's on the blueprints. For this reason we always measure the actual square footage of the room before ordering the heat kit.

We also have seen many problems with "mat"-type kits where the wires are pre-attached to a mesh. In theory, the mats are no more difficult to install, but in reality, people seem to frequently make basic errors like leaving cold gaps between sections or overlapping the wires where mats meet (a big no-no). I have seen lots of well-done mat installations, but running loose wire seems to result in fewer problems for us.

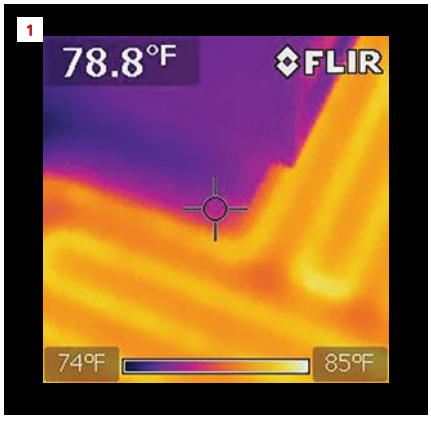
One of our biggest mistakes has been not adequately covering all the places where people actually put their feet. It turns out that people stand with their toes under the toekick space under a sink, almost touching the trim in front of the sink. We have found we need to mark out the exact toekick location and run wires as close to it as the manufacturer permits so there are no cold spots where people will stand.

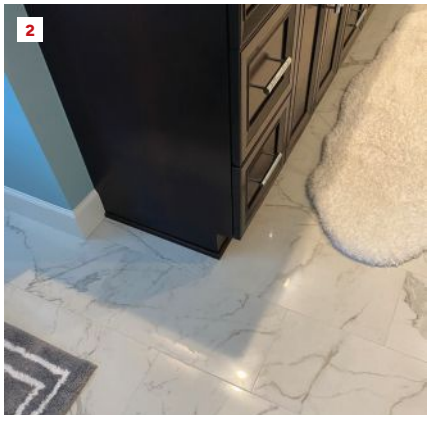
Doorways are another place where tile crews seem to want to omit the wire, creating a cold spot that clients notice later. Yet another is the "make-up desk" space in a cabinet run. The overhead plan view will show a straight line of countertop, and it's easy to forget that below the desk area there is exposed floor that needs to be heated. We take extra time to lay out the cabinet location precisely and cover the whole exposed area to avoid complaints.

Finally, keeping the wire close to bathtubs and the fronts of toilets takes some extra effort. We usually make a template we can place on the floor so the wires can be run close and the clients don't end up with any cold spots. A heads up: The "cut sheets" we get for tubs and toilets often don't show the exact size of the base; they just show the dimensions of the upper parts. So we try to ensure these fixtures are on site so we can get the actual base sizes.

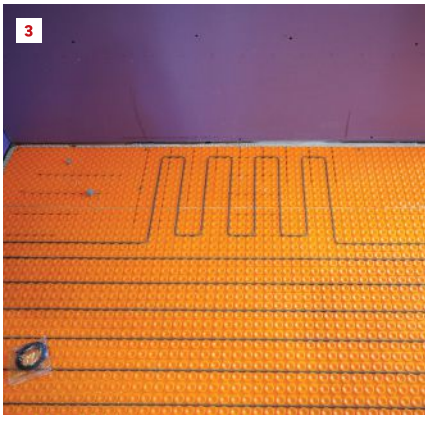
## Make Showers and Benches a Separate Zone

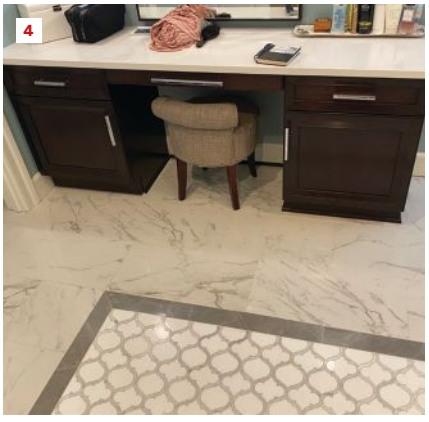
Wet areas need their own consideration. It's certainly true that most people start a shower by running the hot water, so it doesn't necessarily seem clear that the shower floor needs

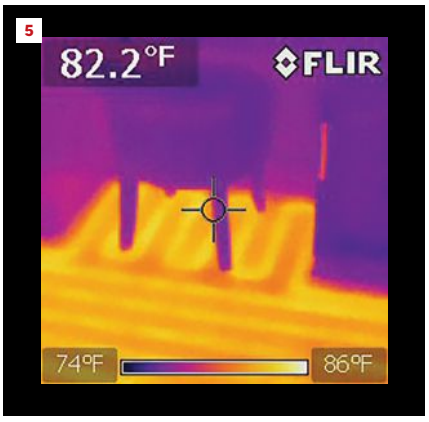



Floor heating manufacturers don't want heating wire below built-ins, but they do need to go under the toe-kick of cabinets; otherwise, clients may complain.








Layout markings on the orange mat **(3)** show the exact cabinet footprint, so the tile crew was able to place wires close on all sides, including below the makeup desk **(4)** where the floor would be exposed. The client experiences the same warm floor **(5)** while sitting.

another heat source. But a warm floor will radiate onto the walls and glass and make the whole shower warmer and more comfortable, which is a noticeable improvement—especially in the very large showers people are choosing these days. Plus, heating the shower will help dry it out.

In recent years, our product reps have been suggesting we use a second, separate wire for the shower floor, since apparently the heating in this area experiences more problems and failures over time. Making this a separate zone means the shower floor heat could be abandoned down the road, if necessary, without affecting the heating in the rest of the bathroom. The reps have even suggested using a separate controller so it can be turned off most of the day and turned on when drying is desired (though sometimes I think they are getting paid by the number of thermostats they sell). Shower benches can be warmed too, and even the wall behind the bench, for the diehard heat lovers.

A couple of things to note: When crossing a curb, the wire needs to run right under the tile, rather than through a hole in the curb. It's wise to meet the glass people ahead of time so this wire can be run somewhere they aren't planning to drill for anchors. Also, the shower waterproofing has to go on top of the heat wire, so the wire goes in first. We usually use a single-layer-type waterproofing, rather than a bilevel drain with a thick mortar bed that takes a long time to heat up.

## Correctly Locate Electrical Elements

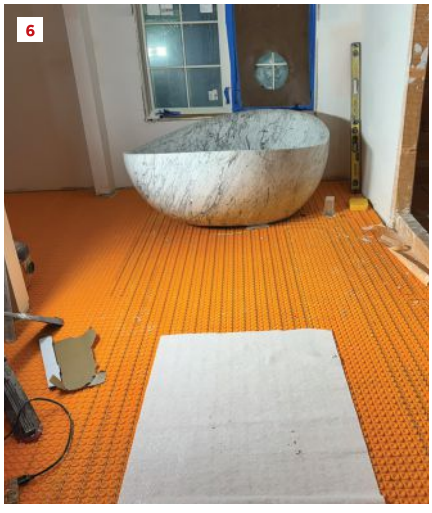
Improperly placed controls, sensors, and connections can lead to customer frustration. Here are the main ones to pay attention to.

**Thermostats** typically mount close to eye level on a wall. In some designs, we try to hide them behind a door or in a closet, but remember that people do need to look at the display and press buttons, so don't go crazy with concealing the location.

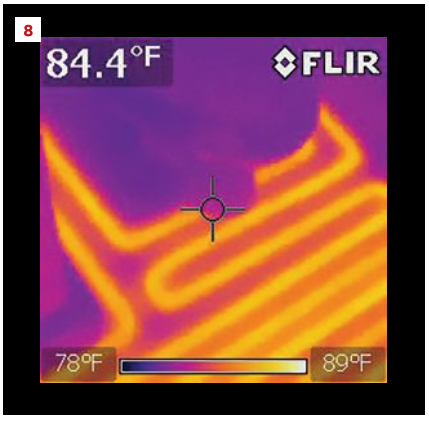
**Sensors.** All the systems we've used have hardwired temperature sensors that run from the floor up to the thermostat location. The sensor end needs to be buried halfway between two heat wires out in the floor, and this control wire can't cross over any of the heat wires, so make sure you plan for this carefully. Some systems come with a second sensor that can be used in the future as a replacement: The sensors have a limited lifespan and replacing one that is buried in tile can be challenging (to say the least).

We have created problems by putting sensors where air conditioning blows on them or in locations where thick rugs or bathmats go. Long story short, the wire layout should ensure that sensors are located so they won't be compromised by other systems or customer behavior.

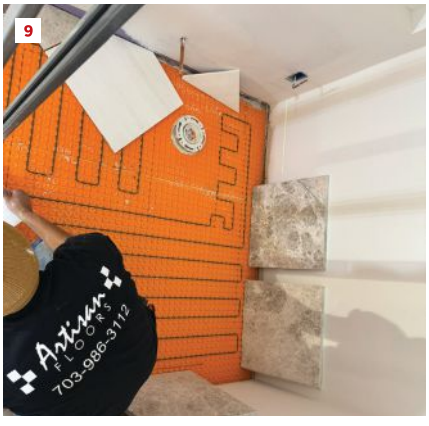
**Relays** are needed when square footage gets large enough that one thermostat can't handle the electrical power needed for the whole space. Typically, the thermostat is used to energize the relay, which then lets electricity flow into the wire (or wires) for the whole room. Although relays



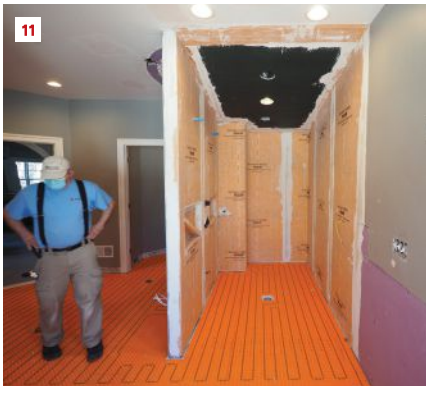
It's best to have fixtures, such as this tub, on site when determining where to place heat wires. It can be difficult to determine the base size from the literature alone.




Heat wires should not be so close to the drain that they melt the wax ring, but close enough to the front of the toilet to warm the tile where a person sitting on or standing at the toilet will place their feet. The thermograh **(8)** shows wires that are too close.




Initially, the heat wire was placed too far back from the front of the toilet **(9)**. In this case, we checked prior to installing the tile and were able to rearrange the heat wire closer to the front of the fixture **(10)**.



This curbless shower features in-floor heating **(11)**. This photo **(12)** shows how to arrange the black sensor wires between the heat wires, but the tips should have been centered between the heat wires; this photo was taken to remind the crew to do that.

now come in relatively small and quiet versions, a regular relay is noisy and typically requires a large metal electrical enclosure, which we place in a nearby closet, basement, or utility space. A planning meeting with the tile and electrical contractors, and with someone who has read the manual (you, probably), will help sort it all out ahead of time.

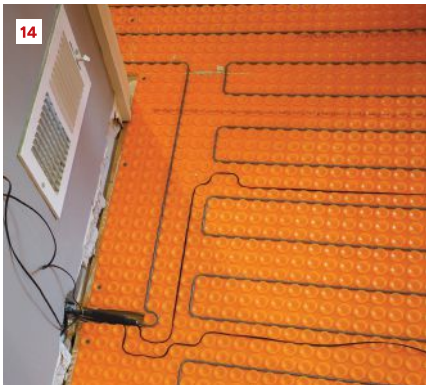
**Cold lead.** Most heat wire is allowed to be run only under flooring, not under cabinets, fixtures, and so forth, and not within walls. There is a transition from the heat wire to the "cold lead"—an unheated wire section that runs up inside the wall to the thermostat or relay. The connection between the heat wire and the cold lead is usually a large, thick device and the subfloor has to be chiseled out to make room for it. It's tempting to try to hide this device within the wall—we've had several tile guys try to do that—but the correct location is out under the floor.

## Confirm the Tile Layout

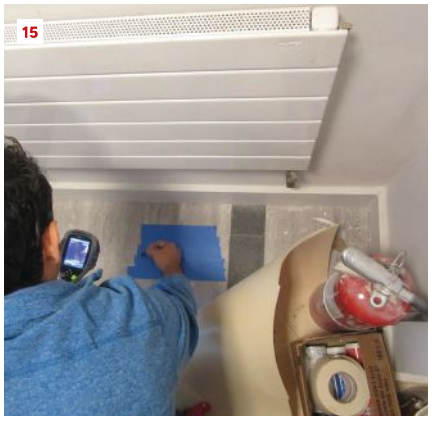
We destroyed a floor once by trying to swap out a few pieces of limestone that the clients decided were the wrong shade. In the process of getting the limestone out the wire was cut in several places, and even the factory repair kit couldn't fix it. Repairs void the warranty anyway. The takeaway—it's best to have a 100% confirmed layout of the tile before setting it.

## Prevent Random Drilling

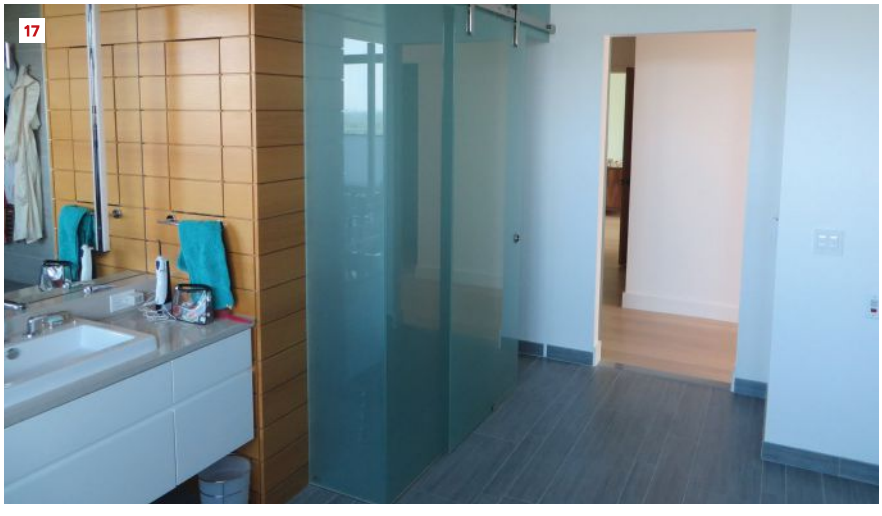
Over the years we've accidentally cut a number of wires while drilling for screws for shower glass or door bumpers. But since we bought an infrared camera, we now can very easily see where the wires run under the tile. We just have to let everyone know to not randomly drill into the heated floor. We started making signs that we post on heated floor projects, and at least one heat wire company now sends stickers with each kit that can be put on the door. I'm sure we haven't seen the end of this problem, but we've gotten a lot better. If you can just keep the


To diagnose temperature control problems, a Schluter rep tested the heat wire, sensors, and wire insulation with a megohmmeter **(13)**. The problem turned out to be the air vent **(14)**, which was warming the sensors all winter and cooling them all summer. This was fixed by changing the register to one that blows upwards.








To locate a floor-mounted door stop, a crew member uses an infrared camera to pinpoint a safe place to drill, marking it on the blue tape **(15)**. Here **(16)**, the same technique is used to mark safe places to drill for the glass partition shown above **(17)**.

glass company from drilling without first checking the wire location, you're probably good.

## Check for Wire Nicks

It's a little too easy to nick the insulation on the heat wire, which can lead to ground-fault-circuit-breaker trips down the road. The best prevention is to test the wire with a megohmmeter before, during, and after the wire and tile installation. I also recommend testing the wire continuity and resistance to make sure no one snipped it off by accident and then hid it. (Ask me how I know.)

Some manufacturers make an alarm device that clamps to the wire end and goes off if serious damage occurs. The alarm can't hurt, but such catastrophic damage is unusual, so manual testing is also recommended. Most wires also come with an info label that should be saved, ideally taped to the end of the wire in the thermostat junction box. It lists the manufacturer and key electrical info, including the resistance of the uncut wire, which is useful for future troubleshooting.

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


If any trouble comes up, having this label will help with diagnostic testing, finding support from the manufacturer, or checking for recalls.

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PHOTOS BY DALE HULST

# Comprehensive Net-Zero

## An in-depth approach to addressing energy, carbon, and climate resilience

*by* **DALE HULST**

The evolution of high-performance homebuilding demonstrates an important truth that is not apparent to many homeowners: The building enclosure—not the mechanical system—does most of the work when it comes to making a home livable. With our first "MiNet0" house in Grand Rapids, Mich., I pushed this idea, building a 16½-inch-thick, double-stud enclosure that all but eliminates thermal bridging, shrugs off extended power outages, and allows the home to be heated and cooled with a single one-ton mini-split.

This home is the first certified Phius Zero house in the Grand Rapids area but it's more than just super-efficient. It's a case study in how a well-thought-out thermal envelope affects everything else. Besides only needing a small mechanical system, the house can support days, if not weeks, of livability during grid outages and is more resilient to wind and long-term wear.

The project also reflects how I think about carbon in residential construction. My goal wasn't just to reduce operational energy, but to drive down the home's carbon footprint across its entire life cycle. In this article, I explain how the enclosure made that possible and where the approach added complexity. And I offer some thoughts on how to cut carbon without sacrificing comfort, durability, or buildability.

I've written one article about this project that focused on the foundation system ("High-Performance Foundation without Concrete," 1/26); this one looks in detail at the rest of the home.

### First Some Definitions

I refer to this home as offering resilience and comprehensive net zero performance. Since people understand



In his first project building a double-wall assembly, the author and crew framed the inner wall first. Some sheathing on the gable-end walls **(2)** adds shear strength to an otherwise sheathingless assembly.



The assymetrical gable trusses bear on the inner wall of the double-wall assembly and were installed before building the outer wall.

those terms differently, I need to clarify how I define them.

By "resilience" I mean the house can operate normally during a grid-down event for one to two cloudy days and indefinitely on sunny days thanks to its large solar PV array. Even if all mechanical systems failed, the house is so well insulated and airtight that it could stay livable for several days and above freezing for at least a week during winter conditions. This is thanks in part to the home's extra thermal mass. With 11 tons of TimberHP wood fiber insulation, 5/8-inch drywall on the ceilings, and 50 tons of pea stone under the main floor slab, the house has a lot of thermal stability.

By "comprehensive net zero," I mean that, when designing this home, I took a broader view of net zero than simply "the house produces as much power as it uses on an annual basis." My comprehensive approach also slashes the carbon footprint of the site more broadly. This home zeroes out the owner's carbon footprint for their local transportation. Its PV panels can charge two EVs that are driven 33 miles/day each (assuming they can be driven 3 miles per kWh used). And we focus on reducing up-front, or embodied, carbon by 60% compared to conventional construction by eliminating concrete and foam, and by using wood-fiber insulation. We also chose low-carbon finishes like Dekton countertops, MILEstone Net Zero tile, hardwood floors, and site-harvested walnut for the window sills. My approach to building this home was also to make it more durable. I estimate that the materials we used will last roughly twice as long as the materials used in a typical home. For example, the standing-seam metal roof has a 60-year expected life vs. 30 years at best for asphalt. In addition, plywood was used rather than OSB throughout the project (1/2-inch CDX for sheathing, 3/4-inch T&G SYP for subfloors, and 5/8-inch CDX for the roof deck), and the Pro Clima membranes are tested for a 100-year lifespan. The vented rain screen behind the siding and under the roof deck enables drying, further extending the life of the envelope. Because less material will need to be replaced over time and the house itself will last longer, the whole project's life-cycle carbon footprint is reduced. The structure's enhanced wind resistance also reduces repairs needed after high-wind events.

## Double-Stud Complexity

The house is narrow with a footprint measuring 20 feet wide by 52 feet long. The long walls face north and south, and the short walls east and west. We framed the walls using a double-stud system that consists of two 2x4 walls spaced 9 ½ inches apart for a total enclosure thickness of 16 ½ inches that achieves R59. This creates a deep cavity with very little thermal bridging but also introduces a lot of complexity and adds a good deal of time to the framing process. (More on that below.)

I based the wall design on 475 Building Supply's Tier-3 double-wall assembly (475.supply/pages/double-stud), which aims to eliminate the structural sheathing (a high-risk condensing surface) and instead relies on diagonal strapping for shear resistance. However, we ran this by a structural engineer to ensure the house could handle the wind loads in our area. Here in West Michigan, we've seen an increase in straight-line winds, particularly during summer thunderstorms. These winds can exceed 60 to 80 mph and cause structural damage similar to what a tornado can bring. The engineer wasn't comfortable relying on strapping alone and recommended we add plywood sheathing to the shorter east- and west-facing walls. Those walls have large window and door openings so to stiffen them we added ½-inch CDX plywood to the exterior face of the inner wall. In addition, we framed the front wall on the first floor as a portal frame.

To improve the wind resistance of the structure, we applied a 1/4-inch bead

of Climate Non-Slump (NS) Adhesive (climateadhesive.com) between the sheathing and studs, between the double top plates, below the sole plate of the walls, and between the furring strips and the roof sheathing in our ventilated roof assembly. NS is a remarkable new structural adhesive that is 100% solids, has no VOCs, and is completely nontoxic for workers and occupants alike.

According to the manufacturer's testing, this moisture-curing polyether acts as a shock absorber for light-frame wood, distributing the forces of violent wind and seismic events across the frame rather than concentrating those forces at metal fasteners. It's relatively affordable—on par for cost with PL Premium—but is available in 20-ounce sausage packs. Most importantly, Climate Adhesive has managed to solve the embrittlement problem: the manufacturer claims that, unlike conventional construction adhesives, NS will not dry out, become stiff, or fracture, but will remain flexible over time.

## A Unique Roof Frame

The need for solar power led us to design an asymmetrical gable roof. While each roof plane has the same pitch (12/12), the surface area of the south-facing roof is much larger and, as noted above, supports enough photovoltaic capacity (32 panels with a total peak output of 12.48 kWp DC) to power not just the house, but also two electric vehicles. The only exception would be during a grid-down event in extreme weather, when electric vehicles might need to be charged off site to preserve battery power to operate the home. In an extended grid-down event with little PV production, compatible EVs could charge elsewhere and deliver power to the house indefinitely.

Designing the roof trusses and the attic frame were among the project's biggest challenges. The trusses had to bear on a 16 ½-inch-wide wall, which isn't something truss manufacturers see every day. There was a lot of back-and-forth. The initial design was not configured as a parallel-chord truss, but we needed the continuous depth for the roof insulation (resulting in a conditioned attic). Also, we needed to include the floor structure for the attic, but with only one side of that floor bearing directly on an exterior wall the forces were a bit tricky for the designer.

In the end, we did manage to arrive at a workable design. The roof trusses have parallel chords spaced 25 inches apart, which left plenty of room for dense-packed wood-fiber insulation that achieves R93. For the span across the second-floor ceiling, we had the truss built with 9 ¼-inch LVLs. One end of each LVL is supported by the bottom chord of the truss mid-span on the south-facing side, while the opposite end bears on the north-facing exterior wall. I also specified blocking trusses—small rectangular truss frames—which we installed between the tall truss heels above the inner (bearing) 2x4 walls. They provide a more secure connection to the top plate, helped keep the truss stable while we set them (making for a safer, easier process), and provide additional wind shear resistance to the (more or less) sheathing-less design.

We completed the roof and dried-in the house before building the outer double wall, which meant there was no wall to support the last rafters of the rake overhang. To manage that, we added diagonal 2×4 bracing on the gable ends. These braces would later end up inside the wall assembly once the outer wall was framed.


5


6


7

A Mento weather barrier covers the trusses **(5)** and Intello X covers the outside of the inner wall in the double-stud wall assembly **(6)**. Note the diagonal braces supporting the rake overhang. The outer wall was framed after the building was weathered in **(7)**.

## Details to Keep Framing Cavities Dry

Super-insulated building assemblies have the potential for big moisture problems because all that insulation in the extra-deep wall and roof cavities



The exterior of the outer wall is covered with Mento Plus—a vapor-open weather barrier that provides a drainage plane for the rainscreen.



Over the Mento Plus, the crew installed 2x2 battens and $^{5}/_{8}$-inch plywood to create a ventilated roof **(10)** before installing standing-seam metal roofing **(11)**.



Over 11 tons of wood-fiber insulation was blown into the double-wall assembly **(12)**. On the underside of the trusses, the Intello needed to be cut into flaps, taped, and then reinforced with 2x2 blocking to withstand the pressure of dense-packing the insulation **(13)**.

reduces heat flow, which in turn slows drying. We solved part of the problem by leaving off the exterior sheathing, which eliminated a potentially high-risk condensing surface—a vulnerability for many fat-wall assemblies ("Major Surgery for a Failing Fat Wall," 11/15). However, even without this condensing surface, the reduced drying potential of the assembly meant we had to take steps to ensure the insulation stayed dry. We would need to keep humid air from inside and outside the home out of the wall cavity and prevent wind-driven rain and snow from penetrating the eaves and siding.

For air and vapor control, we leaned heavily on vapor-open and vapor-variable membranes. Namely, we installed Pro Clima's Intello X—a vapor-variable membrane available from 475 Building Supply—on the underside of the roof trusses and on the outside surface of the 2x4 inner wall. It's an upgraded version of Pro Clima's Intello product that offers enhanced durability in extreme weather conditions.

As the air barrier, Intello X's primary job is to block airflow created by pressure differences between the indoors and outdoors (caused by wind pushing or pulling on the envelope or from mechanical pressure generated indoors). As a vapor-variable membrane, it also keeps indoor humidity inside the house in the winter, and outdoor humidity outside in the summer. Only if or when relative humidity (RH) rises to 80% does it open up to allow humidity through it. (Vapor diffusion resistance decreases as RH increases.) In the summer, if RH in the wall rose to 80%, it would allow the wall to dry into the mechanically cooled and dehumidified interior of the house.

We installed Solitex Mento Plus from 475 Building Supply on the exterior of the trusses and over the outer wall of the double-stud assembly. This product serves as an air block to prevent wind from blowing through the insulation. It also functions as a weather-resistive barrier, helping to keep the walls and roof dry by serving as a drainage plane for our vented rainscreen behind the siding and under the roofing.

We put a lot of time into sealing wall-to-foundation, membrane-to-membrane, and wall-to-roof transitions, relying on careful taping with Tescon Vana tape (also from 475 Building Supply). We also used liberal amounts of Contega HF sealant on difficult membrane connections and Climate NS Adhesive on framing and plywood joints. The Intello X transitions from the walls to the underside of the trusses were particularly tricky, as was working up through the attic floor on the underside of the trusses.

Note the details at the top of Photo 13 where the Intello is cut into flaps and taped, sealed, and reinforced with 2x2 blocking to withstand dense-packed insulation pressure. Also note that the 2x2s under the Intello create a service cavity for wiring and protect the membrane over the life of the house.

On the roof, we created a ventilated roof assembly by installing 2x2 furring strips over the Mento Plus membrane and then placing $^{5}/_{8}$-inch plywood sheathing on top of that. The ventilated cavity improves drying potential and therefore durability. A

specialist roofing contractor installed the double-hemmed standing-seam metal roof over a heavy, continuous, stick-on underlayment applied over the plywood. The steep 12/12 slope made installation challenging, but improves winter PV performance by facing the winter sun more squarely and improving the ability for snow to slide off. The goal was to get closer to meeting the high winter electrical needs due to the heating load on the heat pump.

Snow management was another consideration. On the south side, I set the eavestrough (or gutter) low enough so snow can slide right over it and into the rain garden below. On the north side, we used snowguard rails to prevent slide-offs from falling onto the walking path there.

Once the roof was done, we built the outer wall. The interior and exterior walls are connected only by small plywood gussets, placed wherever there wasn't a plywood window or door buck. When everything is open, you can literally see all the way down the wall cavity from one end of the house to the other.

The open cavity minimizes thermal bridging, but it also made construction more labor-intensive than I expected. I initially thought, "How hard can it be to build two walls?" In practice, it was more than double the work. There was a lot of fussing—straightening studs, aligning planes, and sometimes taking things apart and redoing them.

## Insulation and Windows

Dense-pack TimberHP wood-fiber insulation (timberhp.com) fills the main wall and roof cavities. TimberHP batts were used in the interior 2x4 wall frames, which also function as service cavities for electrical and plumbing. The dense-pack installation turned into a major learning curve (for more on the challenges of blowing wood-fiber insulation ("On Site with TimberHP," 5/25). Our installers had never worked with wood-fiber insulation before, and the large, open cavities made it difficult to achieve proper density. They were on site for weeks, and I'm not sure they made any money on the job, but in the end, we got it filled correctly.

The windows are quad-pane Alpen windows (thinkalpen.com). I started with triple-pane in my WUFI energy model, but the U-value wasn't low enough to meet the annual heating demand target so quad-pane became necessary. The windows are Phius-certified.

Around the windows, over the plywood bucks, we used a structural polyurethane foam board from Thermal Bridging Solutions (thermalbridgingsolutions.com), layering it to over-insulate the frames. While it performed well thermally, I did fire testing with a propane torch and didn't like how it behaved. It produced a lot of black smoke and continued burning after the flame was removed, so it's not a product I plan to use again. (Next time, I'll look into BOSIG; bosig.de/en.)



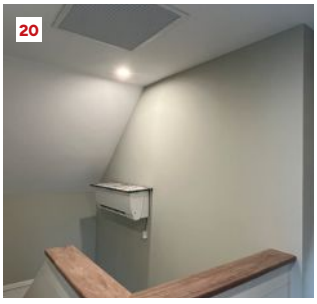
Structural foam board from Thermal Bridging Solutions insulates the window wells **(14)**. LP Smartside and passive-solar-control overhangs on the south side dress up the exterior **(15)**.

## HVAC: Small by Design

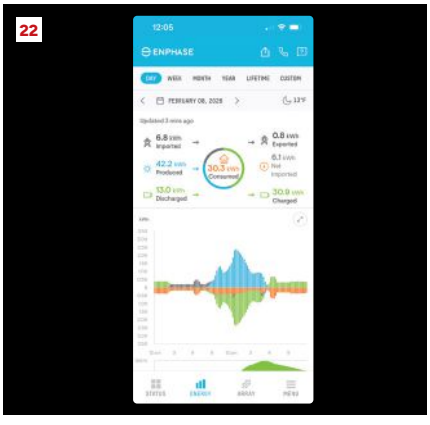
With our dual-membrane wall system, triple-gasketed, Phius-certified, quad-pane windows, and attention to detail, we obtained 0.0285 CFM50 of air leakage—less than half of the Phius requirement of 0.06 CFM50. With 5,546 square feet of envelope and 15,786 cubic feet of volume, we achieved 0.60 ACH50. Because the envelope is so robust, the mechanical systems are intentionally small. The house is heated and




A single one-ton Mitsubishi mini-split is sufficient to heat and cool the home **(16)**, while a SanCO$_2$ heat-pump water heater handles domestic hot water **(17)**. Ventilation is provided by a dedicated Zehnder ERV installed in the attic **(18)**.


To solve an unexpected stratification problem, the author installed three inline fans in the attic. These pull from a square plenum **(19)**; the grille is at the top of the stairwell **(20)**.


With a steep 12/12 roof, snow easily slides off the PV panels **(21)**. The Enphase app shows that the house produced more than it consumed on a sunny day in early February **(22)**.

cooled with a one-ton Mitsubishi mini-split. Domestic hot water is provided by a SanCO₂ heat- pump water heater, which I chose so I wouldn't be adding a space-heating load during winter.

Ventilation is handled by a Zehnder ERV, distributing air through multiple 3-inch supply and extract tubes. We insulated both the intake and exhaust heavily to avoid condensation and heat loss, especially since those pipes are in conditioned space.

One assumption that didn't hold up was that the ERV would distribute the mini-split heat through the house. In practice, this didn't work at all. I ended up with a serious temperature stratification problem—so serious that the inspector noticed it immediately and wouldn't approve the system.

To fix it, I added three Ruck inline fans (made by Ruck Air Movement out of Germany; I sourced them through HVACQuick.com) that pull air from a stairwell plenum and distribute it to the living spaces. Each fan has a speed control, which allows some adjustment room by room. It works very well in heating mode—I'm seeing only less than a two-degree difference between floors—but I haven't yet proven how it will perform during the cooling season.

This was not how I would design the system from scratch next time. It was a fix, not an ideal solution, and I'm still unsure how homeowners will perceive it. Some may appreciate the control; others may find it complicated. Next time, I will design a zoned mini-split system to avoid the stratification issue.

## Actual Performance

We had an extreme test of the heating performance on some sub-zero days in January. The one-ton heat pump was designed to maintain a 65-degree F setpoint down to 5 degrees F ambient. It did so until 0 degrees F with no occupants or activity in the house over a weekend, but slipped a few degrees when the temperature plunged to -10 degrees F. When occupied, we expect that this home will maintain setpoint even below zero due to heat generated by occupants, lights, and appliances. Summer cooling performance is easier; the one-ton heat pump has double the capacity needed to meet the calculated load on a design cooling day. The only question that remains is how well our Ruck circulating fans will move cool air around the house next summer.

The PV array performance has been good; Snow slides off much sooner than it does on the east/west facing arrays on my own home's 8/12 shingled roof. After some cloudy, snow-covered, zero-performance days in January, the sunnier days in February have produced the power needed to run the house. We anticipate that the array will overproduce consistently in the April through September months. With the underproduction in dreary December and January months, we expect the owner to be operationally net zero on balance, with a small residual bill (because in Michigan, we sell extra power to the utility at half price in the summer and buy at full price in winter).

## Enhanced Envelope

If there's one clear takeaway from this project, it's that the building envelope enables everything else. The level of performance in the walls and roof allowed me to use very small mechanical systems and create a very comfortable house free of any cold spots or condensation. At the same time, every decision—framing, air-sealing, insulation, and mechanical layout—had more implications than I initially expected. The next one will be easier!

*Dale Hulst owns Michigan Net Zero Homes LLC, a design-build firm based in Wyoming, Mich.*

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# Products

*by* **VINCENT SALANDRO**

### 1. Efficient Heat and Moisture Vent

GAF's Master Flow Bath & Dryer Rooftop Appliance Vent will exhaust heat and moisture from bathroom and kitchen exhaust fans, clothes dryers, and other household appliances. According to the manufacturer, it passes 110 mile-per-hour wind-driven rain testing, ensuring continuous operation in severe weather, and meets building codes that require a minimum of 12 ½ square inches of net-free ventilation area for rooftop bath, dryer, and appliance vents. It's compatible with 4-inch and 3-inch round ducts. *gaf.com*


### 2. Fast-Installing Collated Fastener

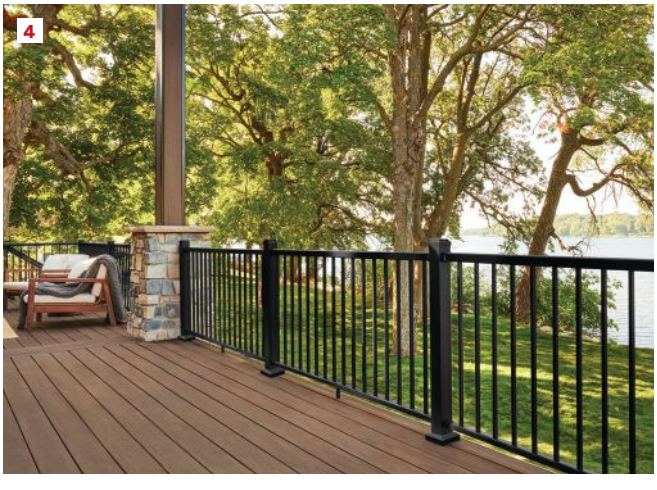
Grip-Rite SpeedSpikes are 4 ½-inch collated fasteners for installing high R-value insulated exterior sheathing. The manufacturer says that they can be driven through the sheathing and rigid foam layers in a single shot with full 2-inch stud embedment, and that they reduce installation time to one-fifth that of hand-driven fasteners. The ring shank design ensures secure grip in wood studs. The SpeedSpike is designed for use with 21-degree heavy-duty timber framing nailers. *grip-rite.com*


### 3. Louvered Exhaust Vents

PlyGem says that its 4-inch and 6-inch Exvent and Exvent6 louvered exhaust vents have an improved design for easier installation. These products are able to accommodate ⅛-inch airflow adjustments and feature optional, removable screens to protect against insects and pests. The vents come in molded colors, but they can also be custom painted to color-match the siding. *plygem.com*


### 4. Non-Combustible Steel Railing

Fulton Rail from TimberTech is a line of steel deck railings with a sleek, minimalist profile that blends seamlessly with contemporary deck and outdoor architecture. The squared balusters and clean lines are less bulky than traditional wood railings, giving decks a polished, professional look. The product is made from galvanized steel, and can be washed with soap and water. It's a panelized system that's designed to install quickly. *timbertech.com*



### 5. Bluetooth Ventilation Fan

For those who like music in the shower, the Energy Star-certified WhisperFit DC fan with Bluetooth speakers from Panasonic comes with dual integrated speakers mounted inside the housing. The fan also features LED dimmable lighting, cost-saving DC motor technology, and a sone rating of 0.4 at 80 cubic feet per minute. The product installs using Flex-Z Fast brackets, fits 2x6 joist bays, and supports 3-inch and 4-inch ducts. *iaq.na.panasonic.com*

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### 6. Dual-Fuel Air-to-Water Heat Pump

The Eco Hybrid Dual Fuel Hydronic System integrates Weil-McLain's Eco HP air-to-water heat pump with a high-efficiency boiler. It automatically switches between the heat pump and boiler based on outdoor temperatures to maximize energy efficiency and comfort. The system achieves efficiencies up to 5.37 COP and uses R32 refrigerant. It can be used with radiant heating and domestic hot water. *weil-mclain.com*

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### 7. Whole-Home Dehumidifier

The Honeywell Whole Home Dehumidifier from Resideo Technologies is an indoor air quality system with a tri-directional outlet. According to Honeywell, flexible installation options enable the unit to fit into a variety of spaces and allow easy access for filter changes. In addition to dehumidification, the 90- and 120-pints-per-day models combine ventilation control for timed ventilation, damper management, and smart compressor activation based on outdoor air conditions. Built-in water-leak detection and temperature, humidity, and differential pressure sensors should improve performance and extend the life of the unit. *honeywellhome.com*

7


### 8. Fire-Resistant Composite Decking

Altitude FR Decking is Deckorators' first fire-resistant composite decking line. Designed with a Class B flame spread rating for use in the Wildland-Urban Interface, the decking is launching in Colorado and California. The boards are made with a blend of 95% recycled plastic and sawdust and are capped on three sides, including through the groove, for moisture protection. According to Deckorators, third-party testing found Altitude Decking slows the advance of flames more effectively than wood or composite decking. *deckorators.com*

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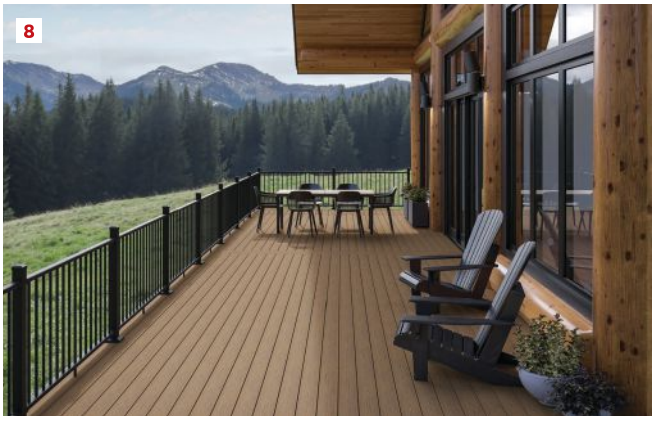


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### 9. Easy Install Recessed Lighting Hoods

Thermahood says that its downlight hoods and lids help reduce the amount of heat lost during use by creating an airtight seal around the lamp. The seal also minimizes condensation risk and reduces sound transmission to the floor above. Made from flame retardant materials, the TH125 hoods require little to no maintenance after installation and are available online in packs of ten priced at $99. *thermahooddirect.com*


### 10. Smart Tech Entry Door

Doma Intelligent Doors by Kolbe Windows & Doors are custom-crafted, wooden entry doors with automated technology. The Doma WelcomeDrive is a motorized opener and closer that, according to the company, authenticates the homeowner and automatically opens the door as they approach. It does this via advanced radar, motion, and facial recognition sensors that detect movement and identity for secure access with no batteries, bridges, or external components required. Kolbe's spectrum of wood species and glass options make it possible to match doors to just about any architectural design. *domahome.com*


### 11. Small Profile Garage Opener

The Side Mount Garage Door Opener (SMO) from Skylink features a DC motor, soft start and stop technology, and built-in LED lighting to illuminate the garage without additional fixtures. The unit connects to the home's Wi-Fi and is compatible with Amazon Alexa, allowing users to remotely control their garage door. As with all garage doors, the automatic safety reversal system stops and reverses the door when obstructions are detected. The SMO comes with a backup battery that keeps it functional during power outages. *skylinkhome.com*


### 12. Easy-Release Flashing Tape

Typar's FlangeFlash is a double-sided flashing tape for flashing non-flanged doors and windows. Typar says the tape creates a self-adhered flange and forms a permanent mechanical bond between the frame and the exterior wall, providing an effective air and water barrier. The tape provides 12 months of UV resistance and has a temperature application range from 0°F to 180°F. An easy-release liner speeds up installation, and a clear adhesive cuts messy residue. *typar.com*

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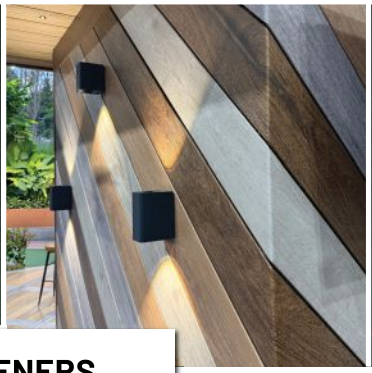

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# Makita GSL02Z 8½-Inch Cordless Miter Saw

*by* **NATHANIEL CARLSEN**

**Smaller, more compact** battery-powered miter saws have become quite popular over the last few years, offering greater portability than their beefier siblings while delivering most of the benefits. I'm generally a fan of smaller, more portable tools but I wanted a miter saw with greater capabilities and precision than most of the smaller 7 ¼-inch saws had to offer. I've spent the last few months using Makita's 40-volt 8 ½-inch miter saw in a broad range of settings and can confidently say this saw doesn't just offer a more portable alternative to a larger saw, but offers an array of features and capabilities that enables it to function as one's primary saw.

These capabilities start with the saw's cut capacity: The saw can cut through 2 ¾ inches of material 12 ¼ inches wide at 90 degrees, with a proportionally impressive capacity when cutting a miter. The 8 ½-inch blade might seem an unusual choice, but it finds the middle ground between the 10-inch and 7 ¼-inch blade sizes, stealing the best qualities of each. When trimming, I can just barely cut 1x4 trim vertically, taking advantage of a slight divot in the saw's frame. The combination of this vertical and horizontal capacity means I rarely wish for a larger blade. Were I to need to cut through 4x4 or nested crown, I would need a larger secondary saw. But I struggle to envision other situations this saw couldn't handle.


The GSL02Z has a rail-forward system so the saw can be used close to a wall. Note the multi-function front controls (above).

The cut capacity is only part of the capability equation because it's complemented by a front-bevel lock. While most small-bladed saws are single-bevel the GSL02Z is dual-bevel. The bevel angles are controlled by a multi-function front-control knob. The lever for switching directions is also positioned at the front of the saw, but the lever to allow the bevel to progress beyond 45 degrees is positioned at the back of the saw. When using a smaller-bladed saw, one inevitably ends up cutting more material on the flat, which means more bevel cuts than with a larger saw. By centralizing both miter and bevel controls in one place, adjustments to the bevel can be made with ease, virtually eliminating any hassle associated with this change in process.

This saw miters to 60 degrees and bevels to 48 degrees in both directions. The smaller blade is also stiffer and less prone to deflection. I can't sing the praises of this design enough; being able to make a quick bevel adjustment without the reach-around action that most saws have resigned themselves to is a revolution for precision work.

With the cut capacity and smooth-angled controls, Makita had already created a saw able to keep up with its much larger cousins, but they weren't done adding features. It was a fraught decision for me to add another battery platform, but with its 40-volt battery this saw has plenty of power for whatever you throw at it, and one 40-volt battery tends to last through a full day of moderate cutting—and can be rapidly recharged over lunch. Moreover, the power delivery is smooth, enabling one to cut precisely without the saw trying to buck at the beginning or end of the cut. Dust collection is pretty good, definitely better than most miter saws I've used. I haven't had the opportunity to use Makita's bluetooth dust collection system but I imagine it would be a handy add-on. Makita also added an LED cutline to the saw, allowing for quick and easy gauging of where the cut will fall, which, in

PHOTOS BY NATHANIEL CARLSEN


The author can control miter and bevel without having to reach to the back of the saw. The built-in LED light also illuminates the cut area while working (left). Weighing in at a compact 48 1/2 pounds the saw is comfortable to move around the job site (right).

my opinion, should be a standard feature given its advantages. However, the cutline is my only gripe with the saw because it requires one to push a button to engage the light rather than turning itself on automatically. Some of my coworkers found this motion more awkward than others, but at this point I've gotten used to it.

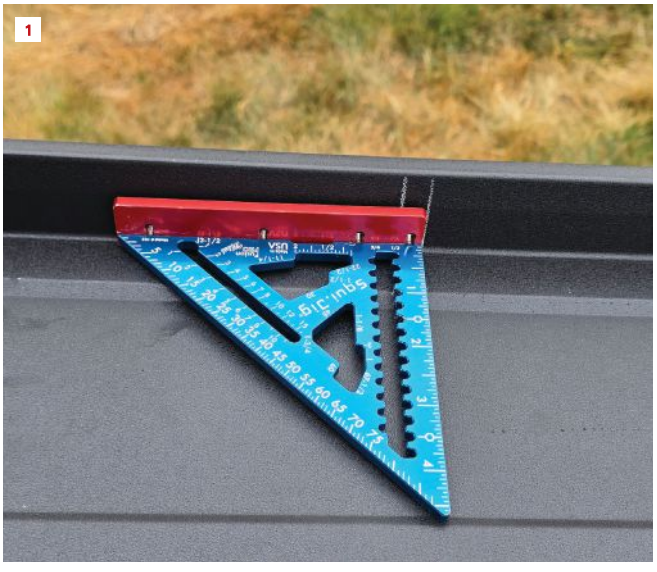
The best part about the saw is that all these features are included in a very compact package. The saw weighs 48 1/2 pounds, which isn't light but is easily manageable when paired with the saw's small footprint. This small footprint stems largely from the saw's rail-forward design, allowing the saw to feel better balanced when carried. The rail forward-design is the chef's kiss on this saw: It's easier to move around and it can be more flexibly located than most other saws. This really shone through for me when I was using the saw to dial in the head casing on a series of doors; I tucked the Makita into the hall closet, allowing me to have my saw two steps away whilst enabling myself and a host of subcontractors to also pass through the space. When space is at a premium, those last few inches of clearance are a big advantage. The combination of a small size and a large cut capacity means that the saw is well-suited to standing alone when working on smaller parts, or set up as a full cut station.

All these features do come at a hefty price tag—the Makita currently retails for $850 bare tool (GSL02Z) or $1100 (GSL02M1) as a kit. This was a hard price to pay but the capabilities of the saw make it well worth it. The small size and wide array of features means I end up using my miter saw more, encouraging a safer, cleaner, and more precise job site. Whereas I might have previously eschewed a miter saw in favor of a circular saw when framing, it's now a no-brainer to set up the Makita when a touch more precision and repeatability is needed. Need to make a quick cut for a punchlist task? The Makita is there, no cord or back-breaking lift needed. But when the chips are down and the most demanding of detailed work is necessitated, the Makita is also ready to handle the work with more power, precision, and operability than many larger saws. It's the true Goldilocks saw: Everything is just right. Find it at *makitausa.com*.

*Nathaniel Carlsen is a carpenter with TDS Custom Construction, in Madison, Wis. Follow his projects at @nvcarlsen on Instagram.*

# Squi.Jig 4 1/2-Inch Mini Pro Rafter Square

*by* **ARON JONES**






The Squi.Jig 4 1/2-Inch Mini Pro has all the features of a larger model **(1)**. Set screws in the heel allow easy offset adjustment to four options **(2)**. The flush heel allows for a steady scribe line on an inside corner **(3)**.

**At first glance,** the Squi.Jig 4 ½-Inch Mini Pro looks like many other micro or mini rafter squares on the market. It has all the hallmarks of quality manufacturing: clean machining, crisp and easy to read markings, accurate scribe points, and a 3/16-inch heel that's handy for decking, siding, and general layout work.

But anyone with a keen eye will immediately notice what truly sets it apart—the adjustable heel.

If you work with steel or aluminum trim and flashing, you already know a standard 7 ½-inch square isn't always the most efficient tool. It simply doesn't fit into many of the profiles we deal with day to day. This is where the Mini Pro's small size earns its keep.

The heel can be adjusted in several ways:

- Centered or removed entirely
- Offset ¼ inch on one side and ½ inch on the other
- Offset ⅛ inch and ⅝ inch—a most useful combination

That ⅛-inch offset is the real gem. It allows the square to sit almost perfectly flat, which improves layout accuracy by helping to prevent your pencil from wandering underneath the blade. At the same time, the ⅛-inch heel still registers cleanly against a hemmed metal edge, giving you a positive reference point even on thin stock.

If you're looking to add a versatile 4 ½-inch square to your kit, this carpenter can confirm it's a solid choice. From drawer faces to J trim to custom flashings (where I have really seen a difference), the Squi.Jig Mini Pro adapts to whatever situation you throw at it. It costs $70 standalone and with a built-in spirit level is $80. This tool and their other products are available in a range of colors and are available at *Squijig.com*.

*Aron Jones is co-founder and site supervisor of Big Dog Construction on Grand Manan Island, New Brunswick. Follow him on Instagram: @bigdogconstruction.gm*

PHOTOS BY ARON JONES

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# The Little Things

*by* **MARC FORGET**

At left you can just see the strapping just touching the water line. On the right the small groove in the middle is the result, enough to leak.

**A little while ago** a friend called me about a plumbing leak in her basement. The main line from the hot water tank had sprung a leak in the ceiling. Water had sprayed across the floor and onto part of one wall, luckily not for too long before she noticed it. She had already turned off the main water supply valve and was wondering if I could fix the leak or knew someone who could. I told her I would come by that afternoon with my plumbing tools and see what could be done.

When I got there, I removed the foam pipe wrap on the hot water line where the leak was coming from and saw that a small groove had been worn in the copper pipe by the metal plumbing strapping that was supporting the ABS drainpipe. This strapping had been installed up to the framing and was just touching the copper pipe next to it. Over many years the movement of the house or pipes or both had been enough to make the water line and strapping rub one another.

The fix ended up being straightforward enough that even a carpenter like me could handle it. I took down the strapping, cut out the section of copper with the hole, and put in a new coupling to connect the pipe ends. Leak solved. I then installed new strapping to support the 4-inch ABS, but I made sure it was in a spot that would have no chance of touching the water line again.

A happy ending all around. The fix was easy, the affected basement area was unfinished, and the small leak was caught before any damage could be done. We can all run the film in our heads of how much worse this could have been if any of those previous factors of time, volume, or location had been different. I have no doubt that when the plumber ran the pipes and put up that strapping so close to the water line they looked at it and said, "That will be fine." And it was—for years, until that day.

It got me thinking about all the details we address when we build anything, and how a small miss can turn into a big problem later on. I am sure all of you have a catalogue of these edge cases where an element of the build was done "okay," but over time caused a failure. Most of the time the worker who created the detail never sees the problem.

An experienced carpenter will take extra care to prevent these problems: Like installing some extra blocking for trim or for hanging cabinets. Or taking some time to think about how wires or pipes are run to reduce the chance of being damaged by a nail, rather than running them in a way that's most convenient. When we take that extra care we build in redundancy that is not seen but is important. It comes from thinking, "I can do it this way and it will be fine, but if I add this or do it a different way it will be better. And better will last longer."

The point here is that a pro will stop and ask why something is done a certain way, and will search out different ways of doing the work. If you are reading this magazine, you probably already do that bit of extra. This plumbing incident reminded me that a little extra thought does make an outsized difference over the life of a house. The occupants of the house may never see those extra details, but they will see the consequences if the details are not there. So this is a reminder to keep doing the extra, looking for the better way, and thinking through the next step. The care taken may be hidden but all those little things really do matter.

*Marc Forget is an associate editor at JLC.*

PHOTOS BY ELAINE FOSTER AND MARC FORGET


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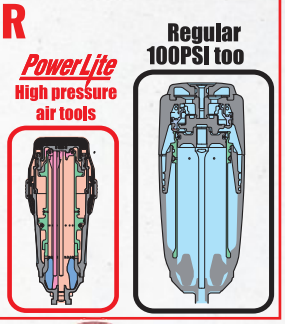


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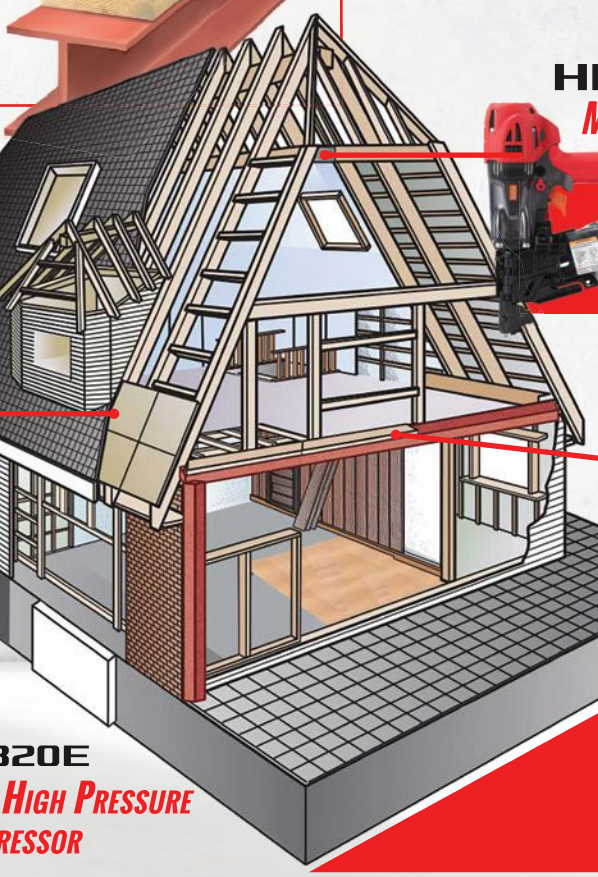

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