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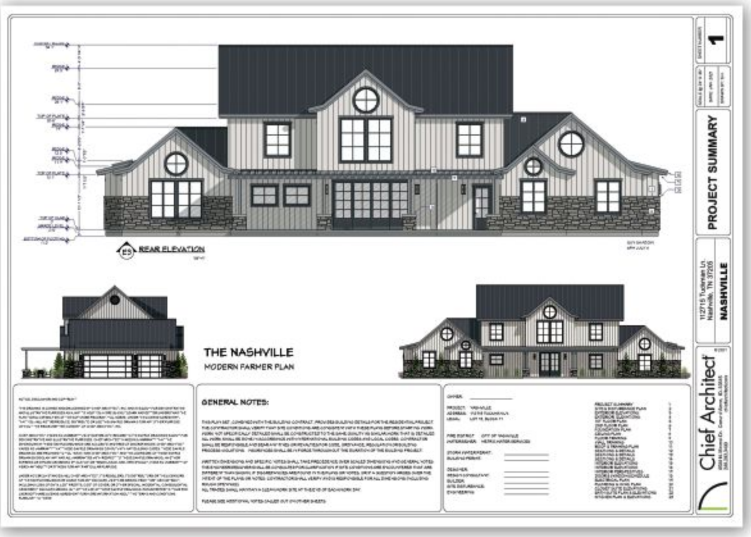

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VERSATEX BUILDING PRODUCTS

THE NEW MUST-HAVE MATERIAL FOR RENOVATORS

Renovations are surging—and PVC could make those projects easier and long-lasting.

Renovations have surged in recent years. In fact, according to the Leading Indicator of Remodeling Activity, home improvement spending jumped over 9% in just the last quarter of 2021 alone.

It's not wholly surprising: With more time spent at home amid the pandemic, millions of homeowners are now focused on improving their living environments. They're building home offices and gyms, adding more space, and updating their home's aesthetics and systems.

Skyrocketing home prices have contributed to the boom, too, forcing many move-up homebuyers to stay put and renovate their existing properties instead.

Regardless of the reasoning, though, it's led to a clamor for building supplies—particularly versatile and hardy materials like PVC, which can be used in a multitude of ways both inside and outside the home.

Here are just a few reasons PVC is high on the list for today's renovators:

IT'S VERSATILE.

PVC trim can be used on the interior and the exterior of the home. Renovators and contractors often use it to achieve the classic board-and-batten look, on popular shiplap walls, or as siding and trim. Common applications include ceilings, roofs, entryways, decks, patios, accent walls, soffits, and specialized rooms like pool rooms and sunrooms.

Visually, it's versatile, too. Available in an array of colors and even realistic wood tones, there's a PVC option for every aesthetic. VERSATEX Canvas Series trim boards, for example, come in a range of hardwood look-alike tones, including amber, driftwood, and walnut—without all the trouble and upkeep of real wood materials.

IT'S MORE DURABLE.

Because it's made from solid—not organic—material, PVC holds up notably well in exterior applications, even in coastal regions affected by salt and high humidity. It's also impervious to moisture, meaning no warping, splitting, bowing, or rotting, and it's mold-, mildew-, and insect-resistant, too, allowing it to last many years longer than traditional trim and siding. Manufacturers are often so confident in this material, they offer extended (sometimes lifetime) warranties on it.

IT'S EASY TO MAINTAIN.

One of the biggest perks of this material is the lack of maintenance it requires. PVC does not need to be repainted or re-stained as typical wood options do, and it generally retains an as-new appearance for many years.

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IT COSTS LESS IN THE LONG RUN.

In some cases, PVC could cost more up front than other trim options, but because it requires no maintenance, it's typically much more affordable in the long run. It also boasts an extended lifetime, ensuring you won't need to replace or replace the trim for years to come.

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On the cover: Nick Home and Addison Oliveira apply self-adhering ice membrane along the eaves of a home being built in East Greenwich, R.I. See a discussion of fully covering an asphalt roof with an ice membrane on page 14. Photo by Mike Guertin.

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BY JOHN CARROLL

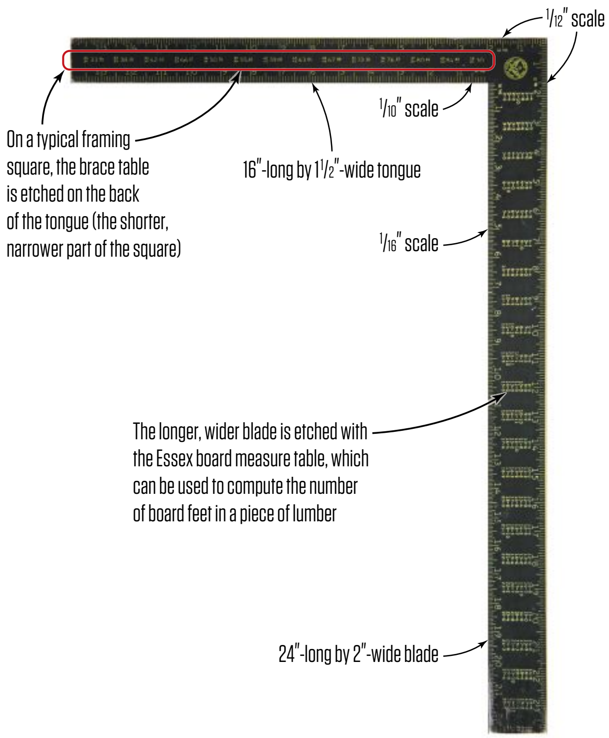
Framing Square Basics: Foundation Layout

When I first started doing carpentry in the mid-1970s, I had never seen a hand-held calculator. Like a lot of carpenters, I learned to do some layouts without using math. To do others, I figured out how to use the geometry stored on my framing square. Using the tables on the square often required multiplication and division, which I did with a pencil and paper. Using this method, I was able to lay out things like foundations and roof frames precisely, and I was usually able to do the necessary math in a few minutes because it was fairly simple.

I used geometry, to be sure, but I didn't actually do geometry. The geometric proportions were etched on the framing square, and all I had to do was expand them using the multiplication I had mastered in grammar school. To do this, of course, I had to convert from fractions to decimals. Doing this, again, required grammar-school math, and after doing it for a while, I found it as easy and natural as driving a truck with a manual transmission.

More importantly, I learned how to visualize how the geometry stored on my framing square fit the structure I was laying out. For as long as I can remember, people have overstated the difficulty of the underlying math (especially of roof framing) and assumed that, once they overcame that obstacle, they'd be able to lay out foundations and roof frames. But the math is not the main obstacle. Almost everyone I know, whether they work in the trades or not, can do the math required for these tasks. What they struggle with is visualizing how that math can be applied to the layout.

In this article—the first of a two-part series—I'll walk down memory lane in part simply to show how things were done before we had calculators and also to explain the meaning of the mysterious tables on framing squares. The main thing I want to show, however, is how geometry—whether it's compiled in manuals such as Riechers' *Full Length Roof Framer*, etched in the tables on a framing square, or stored in the electronic memory of a calculator—can be applied to a foundation; in Part 2, I'll show how a framing square applies to the roof framing process. In my own career, making that connection was key to my development as a builder.



A framing square can be used as a ruler, a straightedge, and a right angle, but it also includes a brace table and the Essex board measure table, as well as several different scales on both the front and back (shown) of the square.

Illustrations by Tim Healey; photos by John Carroll and Andrew Wormer

UNDERSTANDING THE BRACE TABLE

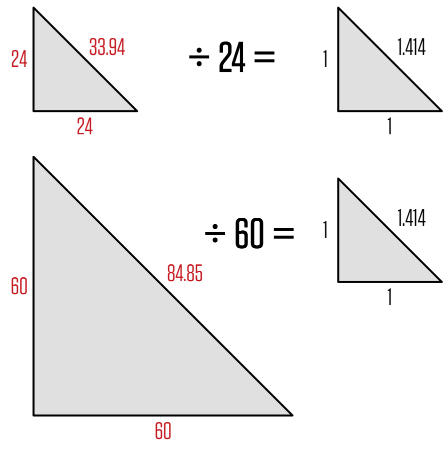
A traditional framing square includes a number of cryptic-looking tables on both the blade (the longer, 2-inch-wide portion of the square) and the tongue (the shorter, 1 1/2-inch-wide portion). The rafter table on the front of the square is easy enough to identify (if not to interpret), while the brace table on the back of the square may seem a little more obscure. These tables can look perplexing at first glance, until you realize that the numbers in both tables describe the base, the altitude, and the hypotenuse of a series of right triangles (see photo, above).

For a timber framer, the brace table—sometimes called the diagonal scale—is useful for knee or post bracing because it indicates the lengths of the diagonals of isosceles right triangles. It can also be used to cut and fit angled braces to hold things like window and door jambs, cabinets, and shelving square while you install them. Some triangles, such as the 48-48-67.88 triangle, could be doubled to lay out let-in bracing, a required skill before the advent of 4x8 sheathing. These tables have been on squares since the 1830s, when carpenters built windows and cupboards from scratch.

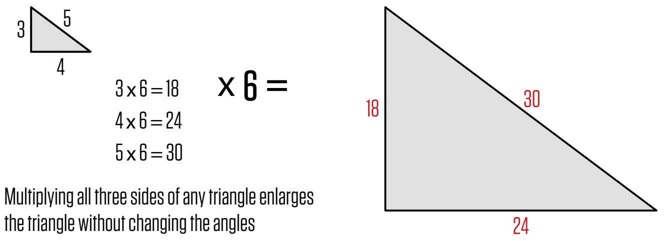
Working the triangles. The first 13 entries on the brace table are

The first entry on the far left-hand side of the brace table indicates an isosceles right triangle with two sides that measure 24 (of any unit of measure) and a hypotenuse that measures 33.94 (in the same unit of measure). Each of the following 12 entries is the same triangle but with different dimensions. The final entry on the far right-hand side of the brace table is a basic 3-4-5 right triangle, in this case with sides measuring 18 and 24 and a diagonal of 30.

Isosceles Triangle



3-4-5 Triangle



The ratio of the sides of an isosceles right triangle is 1-1-1.414 (left). Reducing the 24-24-33.94 triangle on the brace table by a factor of 24 and the 60-60-84.85 triangle by a factor of 60 produces identical 1-1-1.414 triangles. This pattern holds for all but the last 18-24-30 triangle on the brace table, which is a 3-4-5 right triangle (above). These ratios are commonly used in construction to determine that two layout lines are exactly perpendicular to each other.

actually the same triangle. All are isosceles triangles, which means they have two equal sides. They also have the same angles, which are two 45-degree angles and one 90-degree angle. On every one of the entries, you can reduce the triangle to a 1-1-1.414 triangle by dividing all three sides by the smaller number in the entry.

The last entry on the brace table is 18-24-30. This is a 3-4-5 triangle multiplied by 6. The 3-4-5 triangle is easy to remember, and it fits the rectangular shape of a lot of building elements better than the 1-1-1.414 triangle.

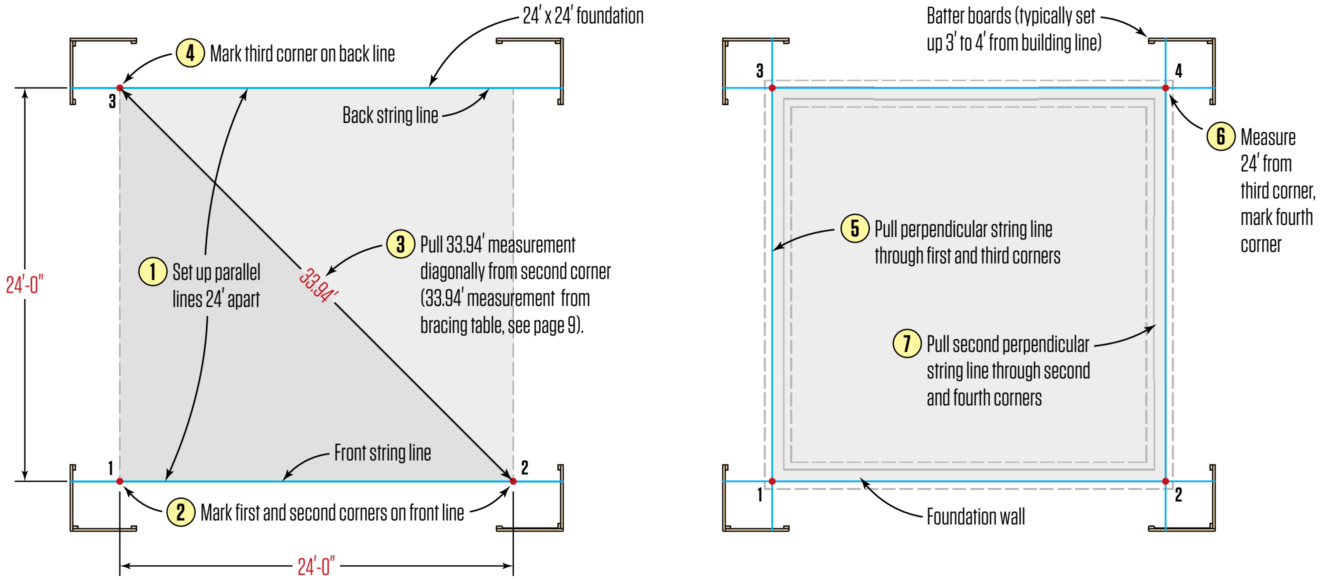
These triangles can be expanded without changing any of the angles by multiplying the lengths of all three sides by the same number. If you multiply all three sides of the familiar 3-4-5 right triangle by the number 8, for example, you end up with a right triangle with sides of 24, 32, and 40. This enlarged triangle retains the exact same angles as the 3-4-5 triangle. This process, by the way, works in reverse: You can shrink any right triangle by dividing all three sides by the same number.

What's more, you can use these numbers with any measuring unit you want. You might use a right triangle that has an altitude of 24 feet, a base of 32 feet, and a hypotenuse of 40 feet to square up the foundation of a house. Or you could use a right triangle with an altitude of 24 inches, a base of 32 inches, and a hypotenuse of 40 inches to square up a bookcase.

Dealing with fractions. If you flip the square over and look closely at the numbers in the first two lines of the rafter table, you'll see that they're in decimal form. Although it's not self-evident, the numbers in the brace table are also in decimal form. The reason these numbers are in decimals is because they are meant to be multiplied or divided.

These tables first appeared on steel squares almost two centuries ago, and for most of that time, carpenters have had to convert their fractional measurements into decimal equivalents in order to do the required math. There are many ways to make these conversions, and it wasn't too hard to do before we had calculators.

Square Foundation Layout



To lay out a perfectly square foundation with 90-degree corners, use the isosceles right triangle in the brace table that corresponds most closely to the desired dimensions, and set up batter boards and string lines as described in the steps above.

There are also a few tricks to avoid making these conversions, which I'll explain below.

FOUNDATION LAYOUT

Once you've cracked the code, you can see that the first entry in the brace table describes a triangle that has two sides of 24 and a hypotenuse of 33.94. Here's how to use this information to lay out a basic 24-by-24-foot foundation. Start by setting up two parallel strings 24 feet apart on batter boards, marking the first two corners on one line (the "front" string line in the illustration, above).

Next, use a long tape measure (I use my Crescent Lufkin HYT 100D 100-foot engineer's scale tape; see photo on page 12) to pull the 33.94-foot measurement diagonally across the layout to mark the third corner on the back string. After measuring and marking 24 feet down the back string, measure diagonally in both directions to double-check the layout. If the measurements are equal, the layout is square. Finally, preserve the layout by installing strings that represent the perpendicular walls.

Tip: When I first set string lines on batter boards, I use mason's line blocks to hold the strings. This way, I can move the lines laterally as I make fine adjustments. After I'm satisfied with the layout, I attach screws to anchor the strings and preserve the layout.

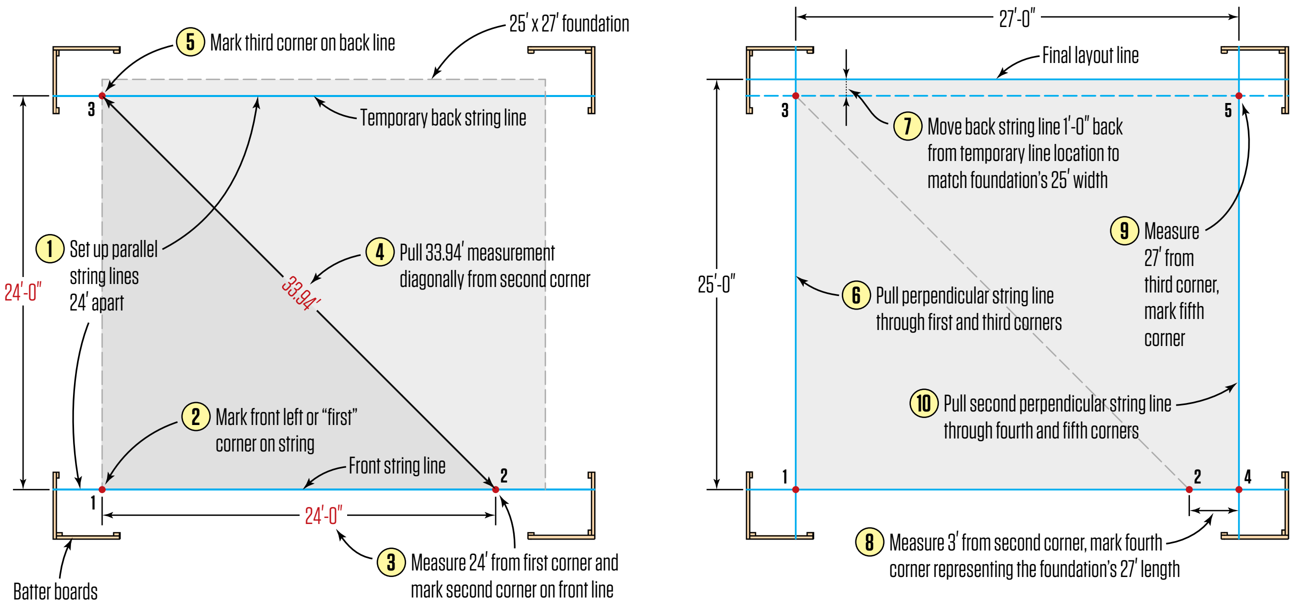
Using an engineer's scale. For the 24-foot square just described, the critical dimension is the 33.94-foot hypotenuse. You can convert the .94-foot dimension into 11 1/4 inches by multiplying .94 by 12 (this comes to 11.28 inches). But you don't need to make this conversion mathematically if you have a tape measure marked with the engineer's scale, where feet are divided into tenths and hundredths rather than inches; simply measure and mark the 33.94-foot dimension using a 100-foot engineer's tape measure.

A tape measure laid out in the engineer's scale is a great time-saving tool, but it is not compatible with inches—even if the inches are divided into tenths. This means that the tenths scale on the framing square should not be used to convert to the engineer's scale. Here's why. The engineer's scale is divided into tenths of a foot, which are further divided into hundredths of a foot. A standard foot, on the other hand, is divided into 12 inches. If the inches are divided into tenths, there are 120 of these increments per foot. At 1/120 foot, these increments are smaller than the 1/100-foot increments in the engineer's scale.

Once in a while, though, you might want to convert from one scale to the other. If you use math, it's a two-tiered process. To convert 5 3/4 inches to a decimal foot, for example, start by converting 5 3/4 inches to 5.75 inches, then divide 5.75 by 12 to get to the engineer's scale equivalent, which is .48 foot. To go from hundredths of a foot to inches, multiply the decimal by 12. In this case, .48 x 12 = 5.76 (5 3/4 inches).

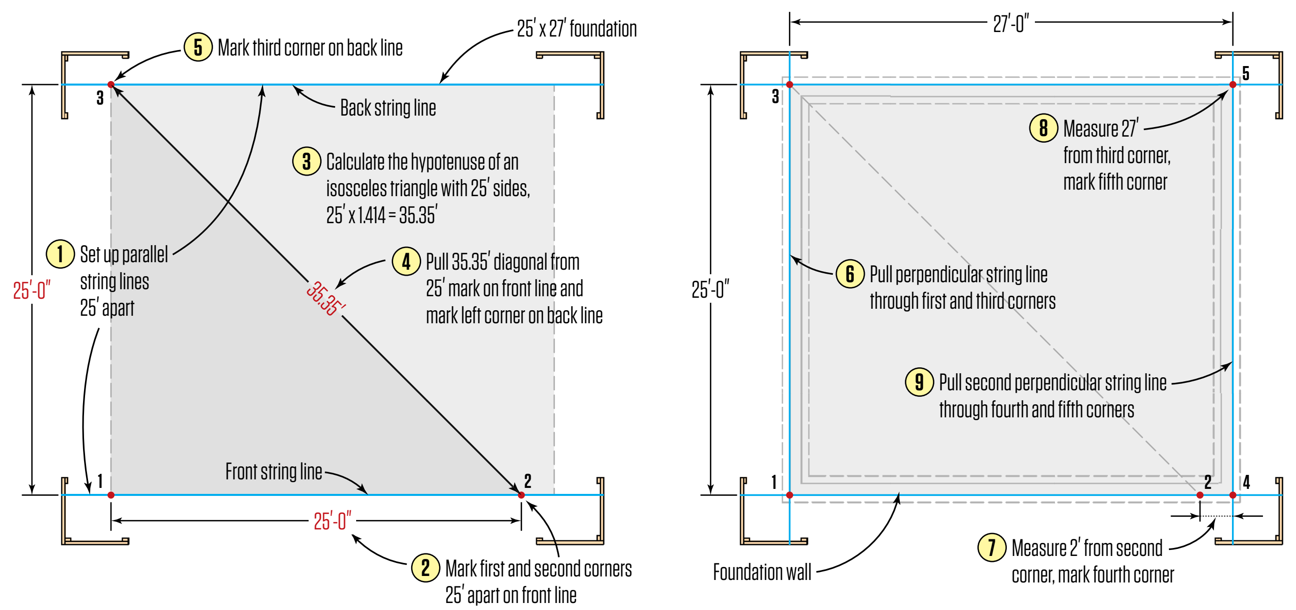
It's simpler and easier, however, to measure and mark the length of the partial foot in one scale, then remeasure that distance with the other scale. For this reason, 6-foot engineer's scale rulers have standard inches and fractions on one side and the engineer's scale on the other. And engineer's scale tape measures that are 25 to

Expanding the Rectangle



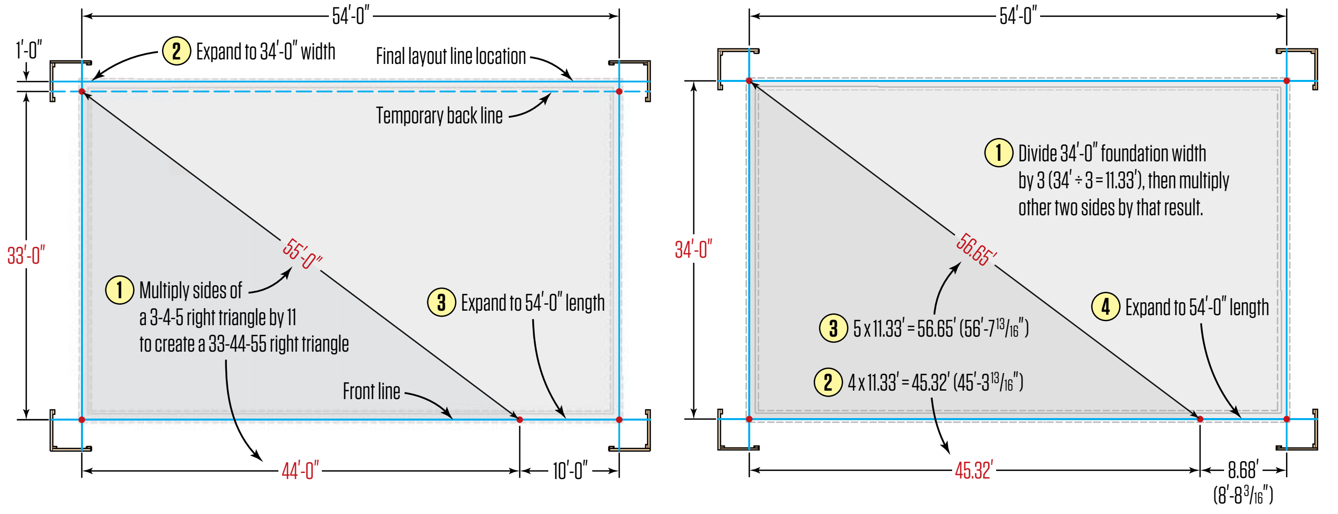
Once a square with 24-foot sides has been laid out as described above left in steps 1 through 5, it can be expanded into a 25-by-27-foot rectangle (or a rectangle of virtually any dimension) by following steps 6 through 10, above right. The key to this approach is the ability to take accurate measurements and mark them on the string lines without deflecting the strings.

Expanding the Triangle



Another way to lay out a 25-by-27-foot foundation is by setting the initial parallel string lines 25 feet apart, then using the 1-1-1.414 ratio of an isosceles right triangle to calculate the length of the diagonal, or 25 x 1.414 = 35.35 (above left). After marking a square with 25-foot sides, extend one side of the square by 2 feet to create a 25-by-27-foot rectangle, as shown above right.

3-4-5 Triangle



One way to lay out a 34-by-56-foot rectangular foundation is to multiply the sides of a 3-4-5 right triangle by 11 to create a 33-44-55 right triangle, then expand the rectangle as shown (above left). Alternatively, you can find the dimensions of a triangle with a height of 34 feet by dividing the height by 3 (34/3 = 11.33) and multiplying the other two sides by that result (above right).

30 feet long usually have standard feet and inches along one edge and the engineer's scale along the other.

Laying out a 25-by-27-foot foundation. Of course, you won't always be lucky enough to have a foundation that is exactly the same as one of the entries in the brace table. To lay out a 25-by-27-foot foundation, for example, you can take either of two approaches. In the first, you would simply lay out a 24-by-24-foot square as described above, then move two of the lines to enlarge the rectangle to 25 feet by 27 feet. This method would not require math at all (see the illustration, "Expanding the Rectangle," on previous page).

The second method would require one multiplication equation to calculate the hypotenuse of a triangle with two 25-foot sides. I would probably choose this method because the math would only take a couple of minutes (less with a calculator). This would be a good trade-off for not having to move the line.

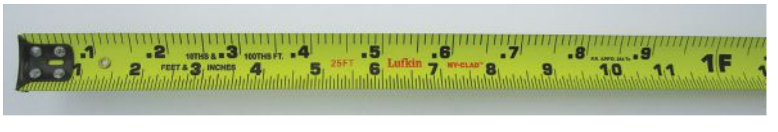
Back in 1976, a lot of carpenters knew that they could quickly find the diagonal of a square (or the hypotenuse of an isosceles right triangle) by multiplying the length of the side by 1.414. They committed this number to memory and used it often to square up their layouts. My sister, who is an avid quilter, has used the same formula to keep her quilts square for more than 40 years. To square up the 25-by-27-foot foundation mentioned above, for example, multiply 25 by 1.414 to find the hypotenuse of a triangle with two 25-foot sides, or 35.35 feet (see the illustration, "Expanding the Triangle," on previous page).

I still use this formula a lot because I can multiply 1.414 by 10 or by 100 in my head by simply moving the decimal point over one or two places. To create a 10-by-10-by-14.14-foot triangle, for example, just move the decimal over one place; to create a 100-by-100-by-141.4-foot triangle, move the decimal point two places to the right. With this triangle, you can use either inches or centimeters to create a triangle that fits a smaller layout.

The builder who laid out the foundation for my house in 1949 may have used the final 18-24-30 entry in the brace table for reference, because my house footprint is a rectangle measuring 34 feet wide and 56 feet long. To do this, he could have expanded the 3-4-5 triangle by a factor of 11, then laid out a 33-44-55 triangle. After establishing the perpendicular line, he could have moved the parallel line one foot (see illustration, above).

Or he could have divided 34 by 3 and then multiplied the result, 11.33, by 4 and 5. This would produce a 34-by-45.32-by-56.65-foot triangle. Doing it this way would have required less than five minutes of math, but he wouldn't have had to move the line after he squared up the foundation.

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



To lay out foundations, the author uses a tape measure marked with the engineer's scale, which divides a foot into increments of 100 rather than inches. This tape also has a standard scale marked along the bottom edge.

Q Can I use full coverage of ice membrane on an asphalt-shingle roof? Do I need to vent the roof?

A *Doug Horgan, vice president of best practices at BOWA in Silver Springs, Md., responds*: You can fully cover a roof with ice membrane, with some qualifications. Let's start with why we would do this. The first answer is to follow code provisions for roofs between 4/12 slope and 2/12 slope. Code permits three options for underlayment in this condition, as laid out (confusingly) in Section 905.1.1, Table 905.1.1(2), and Section 905.2.2: We can install a double layer of conventional underlayment; install fully taped sheathing seams with a conventional underlayment; or install full coverage of ice-dam membrane material.

A second answer is to follow the roofing-material manufacturer's directions. With asphalt, the typical requirement is the same as the code requirements—better underlayment is required once slope gets below 4/12. (Be careful with other materials, though; several synthetic slates require upgraded underlayment at higher pitches.)

Some builders elect to use an ice-barrier membrane over an entire roof even when not required by code. There's no question that these materials are more leak-resistant and hold up better during the construction process. Their self-sealing properties at edges and with fasteners are also a quality upgrade. Arguably, on a steep-slope roof they're overkill and an unnecessary expense. But for some projects, they may be worth the added peace of mind.

WHAT CAN GO WRONG?

Some ice-membrane materials fail quickly when left exposed to ultraviolet light. We've experienced this on large slate roof projects where it takes a month or two to get all the ice membrane covered. Hot summer days end up melting the material enough that it sticks to boots and peels into pieces. I've also heard of failures that weren't as obvious, resulting in leaky structures taken apart to reveal asphalt-based sheets that have turned brittle and leaked at fasteners. This damage was attributed to exposure to the sun. We've learned to use higher-grade membranes rated for 180-day exposure, or even to cover the ice-barrier membrane with another layer of underlayment.

A second layer on top is also the approach we use to prevent shingles from permanently sticking to granulated-face ice barriers, which become very sticky over time. We once experienced a failure on a 2/12 slope, and it took a four-person crew about a half day per square to remove the shingles, which came off in 2- to 3-inch square pieces along with the gooey ice membrane. Savvy roofers cover this type of ice-barrier membrane with a layer of synthetic or felt underlayment. Ice-barrier membrane with a plastic top layer doesn't have the same issue, though beware: At edges of the rolls, the sticky asphalt can adhere to shingles.

The biggest problems we've experienced have not been with the membrane itself but with penetrations and complications on the roof. The one we tore off had a pitch change, plumbing vents, skylights, a kitchen range-hood exhaust, and even a framed chimney on it. Most of these features were letting water into the assembly or, at least, under the shingles. The ice-barrier membrane held most of the water out until the nails rusted out a few years in—at that point, we had to redo the whole thing with much more attention to the detailing around the penetrations. A careful reading of various instructions will show that underlayment, properly layered in a watertight manner, is supposed to be carefully adhered to pipes, ductwork, and skylight frames before the caps and flashings are installed around the penetrations. It's challenging to find crews willing and able to take the time and care needed to make these work over the long term, so we now aim to avoid any penetrations or complications in roofs below 4/12 slope.

VENTED ROOF?

A vented roof is not an absolute requirement for a roof fully covered with an ice-barrier membrane, but if you don't have good ventilation, it will be generally riskier and you'll need to use special insulation or vapor control layers (or both) to manage moisture.

Vented roofs are able to recover from intermittent wetting, so the occasional overwhelming rain or ice storm that puts a bit of water through some nail holes can dry out and end up being no problem. However, unvented roofs don't have nearly the same drying capacity and are inherently more vulnerable to small leaks. It should be noted that many roof leaks are big enough that it doesn't matter; they'll damage the roof whether it's vented or not. Certainly venting is not a cure-all for leaky roofs.

Unvented roofs can accumulate moisture through various mechanisms, as explored in Peter Yost's article "Avoiding Wet Roofs, Part 1" (Jun/2018), which focuses on cold-climate issues, or in the follow-up article (Jul/2018), which discusses vapor diffusion ports—a way to manage moisture that is now enshrined in code for climate zones 1 to 3 (and a possible solution for certain cold-climate situations, as well).

In northern climate zones (north of climate zone 3), a spray-foam or rigid foam-board layer is part of most unvented assemblies, but another resource to consider is the educational material developed by 475 High Performance Building Supply (foursevenfive.com). This advocates for foam-free assemblies—which use non-foam insulation layers above the roof sheathing—or even for the use of "intelligent" vapor control membranes (plus dark-colored roofing fully exposed to the sun) to manage moisture in roofs insulated with air-permeable, fibrous insulation, even in colder climates.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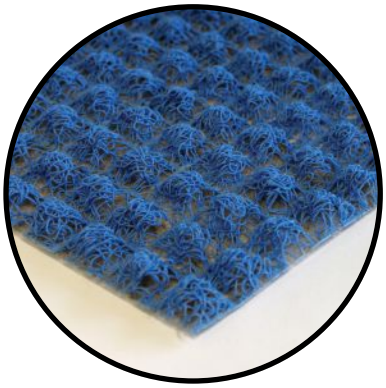

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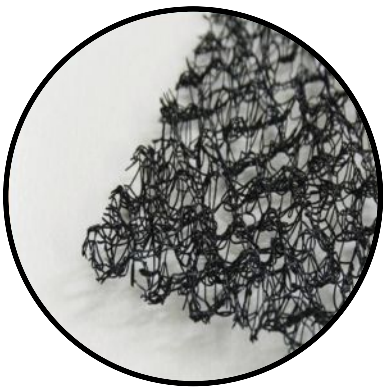

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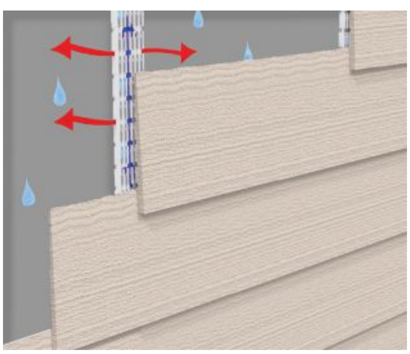

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Sealing Foundation Cracks

BY JAKE LEWANDOWSKI

While my family's company, Great Lakes Builders, specializes in structural repairs, we are often called in to fix cracks in foundations that don't present any overt structural problems but do allow water infiltration and need to be sealed up to keep the basement dry. That was the case on the job shown in this article.

For this job, we used Simpson Strong-Tie's Crack-Pac Flex-H2O, which is a lot easier to apply than some of the brands that we have sourced from concrete supply companies in our area. The Crack-Pac system uses an injection resin that reacts with moisture and expands, creating a flexible dam in cracks up to 1/4 inch wide. The installation method I'll describe here ensures that we are able to get continuous coverage in the crack to provide a good seal and a clean job.

The basic process shown in the photos on the following pages begins with grinding down the surface near the crack. On this job, we are grinding through paint, but we do this even on unpainted concrete to remove dirt and surface particles to ensure a strong bond with the dam material (epoxy paste) that we will apply to hold the injection resin in place. For this work, we use a grinder with a vacuum shroud so we can be as dust-free as possible.

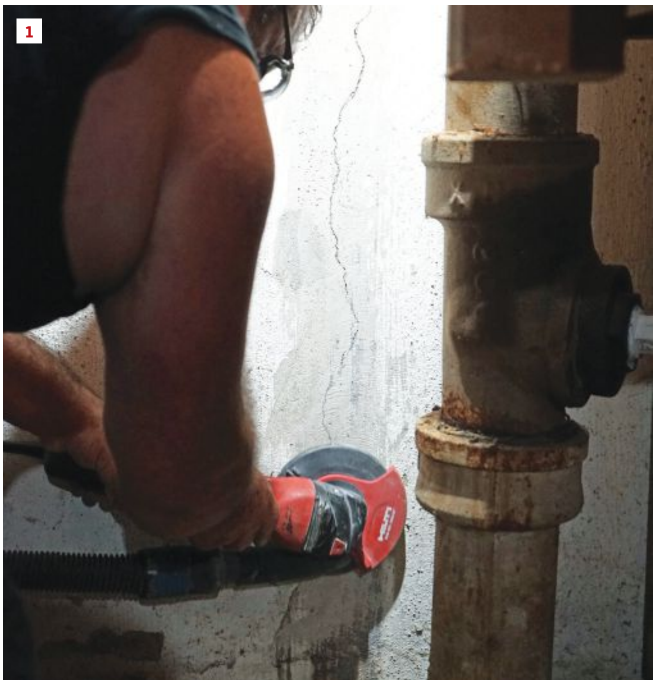
Using a rotary hammer, we drill a series of small (3/8-inch-diameter) holes a few inches deep every 8 to 10 inches along the crack. Before installing the ports over these holes, we carefully vacuum out the crack and "chase" it with a small drill bit to remove any loose material.

Once the crack is prepped, we mix up the epoxy paste on a small piece of Lexan and carefully trowel it onto the base of the ports, being careful not to block them. We install these over each hole and then work the paste along the entire length of the crack, literally connecting the dots with paste applied about 3/16 inch thick in a 1-inch-wide swath. The working time for Flex-H2O is a few minutes (that can vary due to environmental conditions), so we mix it in small batches. This short working time is one of the advantages. Other products can take much longer to set up, and we have had to hot-glue the ports in place so they would stick to the wall while the paste set up. The epoxy paste acts as a dam to hold the resin in. The soil holds the resin in on the other side of the foundation, but on above-grade sections, we have had to dam the crack (you can use hydraulic cement as a dam material, too), or even excavate the backfill to gain access to the crack and adequately contain the injected resin. We typically use plenty of paste on the crack, sometimes more than is recommended, to be sure we don't have a blowout. The resin is not fun to clean up, to say the least.

Starting with the bottom port, we inject the resin until it begins to come out the port above, and then work our way up to the last port, filling it until resin leaks out the top. We use Simpson Strong-Tie's flush-mount ports, which have an O-ring that engages when the nozzle of the resin cartridge is pushed in, creating a good mechanical seal so there is no squeeze-out. The port also gets sealed off when you pull the nozzle out, which limits the dribble of resin. At the start, all the ports have to be pushed in to their open position.

The process for injecting a crack-sealing resin is almost identical to what we sometimes do to make structural repairs using injection epoxies. The difficulty with structural repairs, however, is that the epoxy usually holds, but stresses on the wall may cause another crack right alongside the epoxy repair. So structural jobs often include soil stabilization work to eliminate the stresses, and may also require steel plates or other methods to reinforce the wall.

1

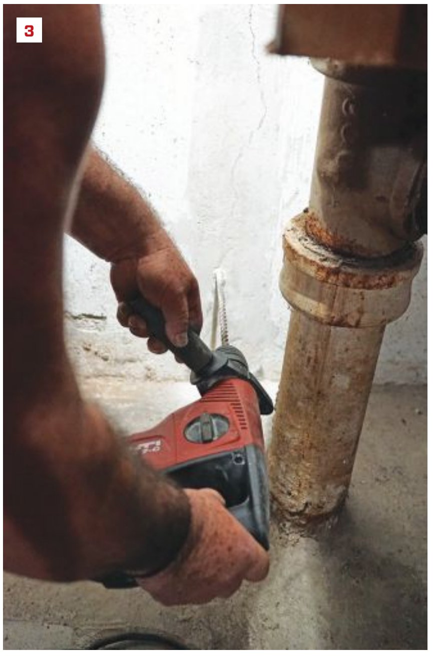


Photos by Jake Lewandowski

Toby Bonilla of Great Lakes Builders grinds the surface of the foundation wall to ensure a strong bond with an epoxy dam material.

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

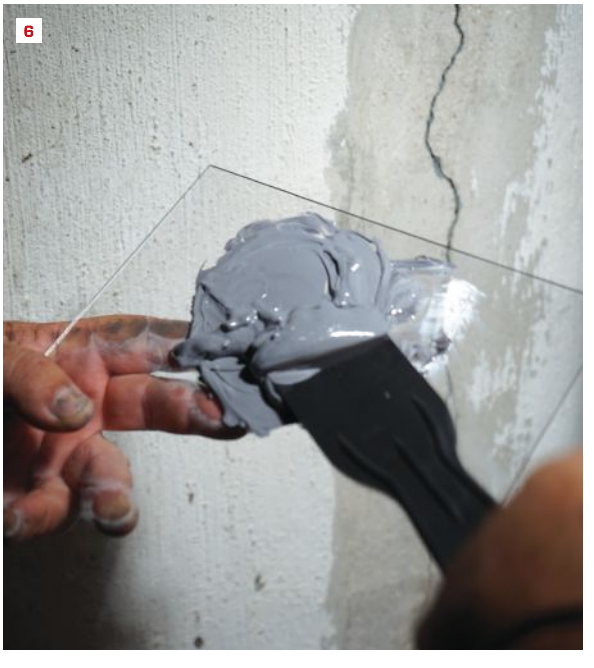
2


3


4


With the foundation wall surface free of paint and dirt **(2)**, Toby starts at the bottom **(3)** and works his way up the crack **(4)**, drilling a series of $^3/_8$-inch-diameter holes every 8 to 10 inches. The injection ports will be placed over each of these holes.

5


6


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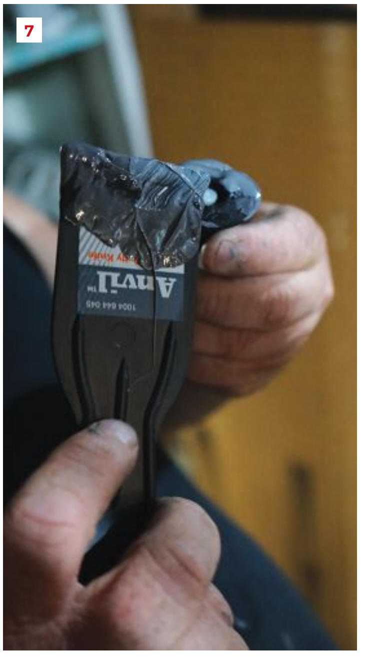
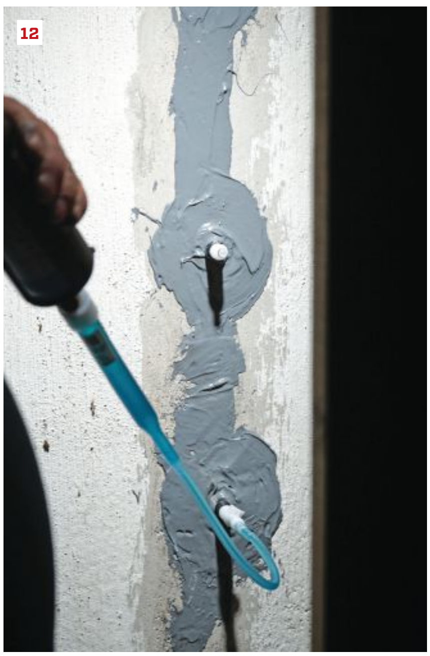


After drilling, Toby cleans out dust and loose debris from the holes and the crack **(5)**. Working in small batches, he mixes a two-part epoxy paste **(6)** and carefully applies this to the perimeter of an injection port **(7)**. He is careful here to spread the paste only on the flange of each port, so it doesn't clog the opening.

Toby sticks a port over each drilled hole **(8, 9)** and then begins spreading the paste around the port to seal it in **(10)**. Epoxy paste has a short working time, which helps stick the ports in place.



Connecting the dots, Toby spreads the epoxy paste along the length of the crack **(11)**. The paste acts as a dam material to hold the resin in the crack **(12)**. Toby starts at the bottom and works upward, injecting the resin until it begins to ooze out the port above. The top of the crack is left open so the resin can overflow, indicating the crack is filled **(13)**.

An Evolution in Laying Out Stair Stringers

BY BRIAN CAMPBELL

Most carpenters are familiar with laying out stair stringers by stepping them out with a framing square equipped with stair gauges. (For those who are not, or who want a refresher, see "Stair Stringers: Calculation and Layout," Apr/17.) A common source of errors with this method is failing to accurately line up the framing square at the edge of the board as you move from one step to the next. The rounded edges of most boards make it hard to align the layout lines from one step to the next. Minor shifts can compound errors. Savvy carpenters will make a tick mark when laying out each step to accurately define the exact points where the gauges meet the board edge, but it's still easy to wander off, and the result is a set of stringers that don't perfectly match. Sometimes, boards with waney edges throw off the square and you end up having to guess at the position—an issue that seems increasingly common with some pressure-treated lumber.

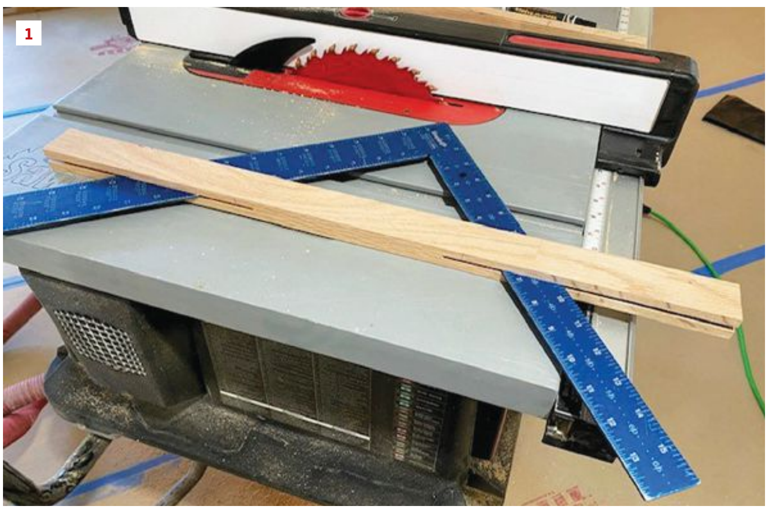
To avoid these problems, I stopped using stair gauges and made a sliding jig that I use with the framing square instead (see photo, below). It's simple to make on a table saw. The square slides in a kerf cut on each end of a 1x2, and I clamp the sides together with small C-clamps when stepping off a stringer. (Eventually, I'd like to add threaded inserts and small knobs.)

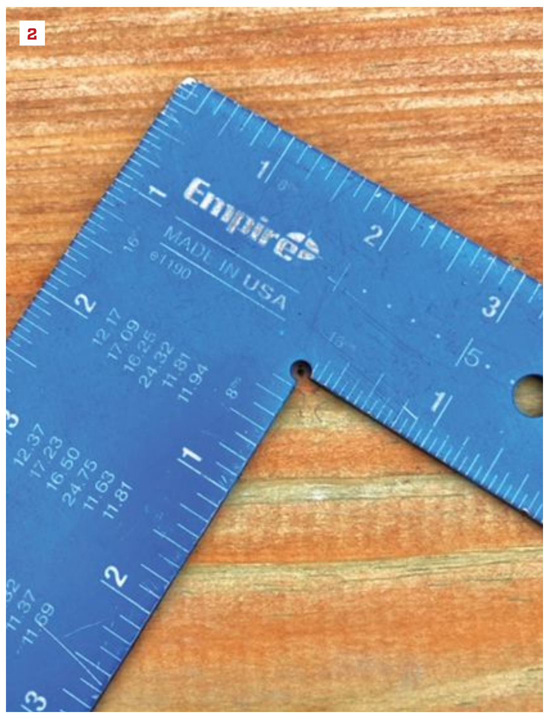
To improve accuracy, I moved to stepping off the stringer with trammel points. I set up my trammel points on a board the length of the hypotenuse of the stair's rise and run, and at first used this trammel set to step off the distance along the edge of the board.

I eventually evolved this process further by avoiding the edge of the board entirely. Instead, I work along a chalk line I snap down the length of the stringer. This line passes through the inside corner of each stair step. The step distance is exactly the same as the step distance at the edge, but using a straight line down the middle of the stringer helps to keep things more consistent.

Empire's framing square has a cut-out milled at the inside corner that makes it easy to line up a trammel point at the exact inside corner of the square. I use this point to define where to snap my line, and after stepping off the inside corners of the stair with the trammel set, I line the square up on the points I have inscribed with the trammel points to draw cut lines for each step. This method adds a few movements, but it eliminates minor errors, allowing for a perfect set of stringers, even when the lumber is a little rough.

Brian Campbell is a finish carpenter and foreman with Solid, based in St. Paul, Minn.

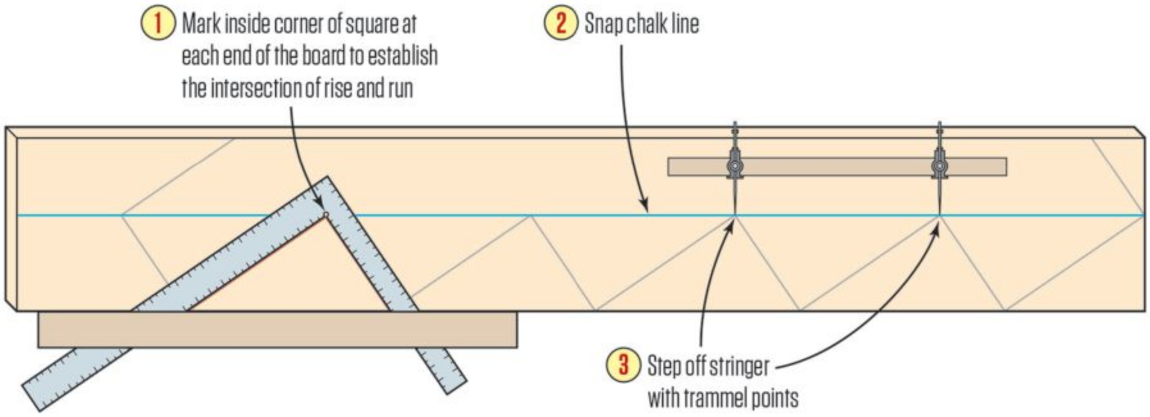




Instead of using stair gauges, the author makes a jig **(1)** by ripping a kerf from each end of a 1x2. This can be lined up with the rise and run distances on the square, and the sides of the jig clamped with small C-clamps to hold the square in position while he steps off the stringer. Empire's framing square includes a cut-out at the intersection of the tongue and blade, which allows precise placement of a trammel point **(2)**.

Photos by Brian Campbell

Stepping Off With Trammel Points



Instead of working from the edge of a board, which can lead to errors, the author steps off a stair stringer with a trammel set, working off a chalk line snapped near the middle of the board.

Illustration by Tim Healey

The trammel set is two trammel points spaced the distance of the hypotenuse of the rise and run of the stair **(3)**. The result of working to precision is a perfectly matched set of stringers **(4)**.

BY MELANIE HODGDON

Getting Labor Burden Right

Labor burden refers to the costs above and beyond wages that a company incurs as a result of having employees. Most companies are only concerned with burdens as they are linked to production employees, since knowing these costs contributes to appropriate pricing and accurate job costing.

For most remodeling companies, burden consists of some or all of the following:

- Payroll taxes
- Worker's comp insurance
- Liability insurance
- Benefits such as retirement, health, and dental contributions
- Other costs related to field workers including vehicle and communications
- Paid time off

The impact of these burdens on financial and job-costing reports can be significant. Basically, the more generous and numerous the burdens, the larger the gap between the base hourly wage and the burdened cost per hour. When working through labor burden calculations with clients, I often see examples such as $28.50/hour for wages and $42.75/hour for burdened figures. This translates to a 50% cost increase due to burdens.

There are multiple implications associated with not knowing your fully burdened costs, which I will cover in this article.

ESTIMATING WITHOUT BURDENS

	Hourly Cost	Hours	Estimated Cost
Labor	$28.50	400	$11,400
Materials			$15,875
Subs			$12,725
Total cost			$40,000
Markup	65.66%		$26,264
Sale price			**$66,264**

ESTIMATING WITH BURDENS

	Hourly Cost	Hours	Estimated Cost
Labor	$42.75	400	$17,100
Materials			$15,875
Subs			$12,725
Total cost			$45,700
Markup	45.00%		$20,565
Sale price			**$66,264**

If you estimate without a fully burdened labor cost (top), you may be able to make up for it with a higher markup to price the job accurately. Note the difference in estimated costs (bottom).

ESTIMATING

If you estimate using a partially burdened cost for your labor, you risk underpricing the job. It's that simple.

Some companies address this risk by putting only wages above the line and putting all burdens in overhead. This inflates overhead, and provided that they base their markup on a formula consisting of overhead and achieved margin (see charts "Estimating Without Burdens" and "Estimating With Burdens," left), they may succeed in pricing the job correctly. Their markup will simply be higher than that of a company putting burdens above the line, but based on a lower estimated cost. The job price can be the same, but there will still be issues when it comes time to job cost and calculate work-in-progress (WIP) adjustments.

JOB COSTING

Let's say that you have decided to estimate using burdened labor costs, but your software doesn't allow for burden. It may pick up wages and payroll taxes and possibly worker's comp and assign those to individual tasks and jobs successfully, but other burdens may be missed. So, you may be estimating at a fully burdened rate but job costing at a partially burdened rate. This is what you'll need to watch out for.

Focusing on a single task, "Task00," let's see how this plays out: Say you have calculated your burdened hourly rate at $60. Your estimate allows 10 hours to complete this task. Therefore, the estimated cost to complete Task00 is $600 (below).

Estimate			
Task	**Hours**	**Burdened Cost/Hr.**	**Cost for Task**
Task00	10	$60	$600

However, if your software includes only partial burden, it may display an hourly cost of $50, not $60. When you review your job cost report, you note that Task00 "cost" $550. Since the estimated amount was $600, it appears that you are $50 under budget.

Accounting Software			
Task	Hours	Partially Burdened Cost/Hr.	Cost for Task
Task00	11	$50	$550

But wait! Task00 actually took 11, not 10, hours. Because the software applied only a partially burdened labor cost, it calculated a deceptively low cost of $550 (11 x $50) for the task (above). At the fully burdened cost of $60/hour, however, the actual cost for the task was $660 (11 x $60) and you're *over* budget by $60 (below).

Numbers Should Be			
Task	Hours	Burdened Cost/Hr.	Cost for Task
Task00	11	$60	$660

Obviously, this discrepancy will inflate as the size of the job or proportion of labor within the job increases.

Such reporting errors can lead to unfortunate results, such as bonusing or profit-sharing on a job that is less profitable than it appears. It can also cause estimators to think they are overestimating the length of time it takes for a task to be completed, which can lead to underestimating and underpricing the next job.

WORK IN PROGRESS ADJUSTMENTS

Sophisticated companies know that it's important to differentiate between dollars that you have received and dollars you have earned. In this case, "earned" refers to the calculated amount of incoming dollars that correspond proportionally to actual costs incurred on a job-by-job basis. In other words, if you have taken a $50,000 "deposit" from a customer to hold their place in your schedule but have incurred no costs for their job yet, then you have not earned those dollars and they should not be included when showing ordinary income on your profit and loss statement (P&L).

One way around this is to use WIP (work in progress) adjustments to your income in order to correct a P&L to show earned income rather than income.

Note: The term "income" properly refers to your "bottom line" profit at the bottom of a P&L, while "revenue" refers to dollars that come in as a result of your conducting ordinary business. However, many popular accounting software packages use the term "income" in place of "revenue," or mix and match them. For the sake of clarity I will use the term "actual revenue" to refer to all dollars coming in from customers and "earned income" to denote the results of applying WIP adjustments to this revenue.

The WIP process has three steps:

- Calculate percent complete by dividing actual costs to date by total estimated costs.
- Apply this percentage to the job price to establish earned income.
- Adjust the income figure on your P&L with a WIP adjustment to display earned income. This adjustment may be done on a job-by-job basis, or all jobs may be put into the calculation and a single adjustment applied to reflect the net of all jobs.

Let's apply this to two example jobs:

Clark job. Estimated costs for the Clark job are $100,000. The job was sold at a 50% markup for $150,000. The job costs to date are $39,750, and the invoices to date total $65,000.

Hernandez job. Estimated costs for the Hernandez job are $80,000. This job was sold at a 50% markup for $120,000. The job costs to date are $15,365, and the invoices to date are $20,000.

As of the first reporting period, the chart below shows the relevant figures for each job.

In the case of the Clark job, the customer has been overinvoiced (revenue—what has been invoiced—in excess of earned income) and the WIP adjustment is a negative number. In the Hernandez job, the customer has been underinvoiced (earned income in excess of revenue) and the WIP adjustment is a positive number.

Note that any time your actual invoices are lower than your earned income, you are no longer paying for job costs using the customer's money. You are providing them with an interest-free loan. It should be obvious, then, that the "Actual Cost" amount should be as accurate as possible.

So what happens if you aren't using a burdened figure? If your actual labor cost is understated (without burdens, as shown in the top chart, facing page), then "% Complete" will be inaccurate. Since your earned income figure is based on that percentage, your earned income figure will be incorrect. Since your WIP adjustment is based on the discrepancy between reported income on the P&L and earned income from your WIP calculator, your WIP adjustment will be wrong.

In a perfect world, you would be able to assign a 100% accurate burdened cost to each employee. This will never be possible down to the penny. However, it makes sense to either commit to calculating and then estimating, job costing, and performing WIP adjustments that take into account labor burden to the best of your ability or, at the very least, recognize the potential pitfalls of not doing so.

Melanie Hodgdon owns Business Systems Management, which provides management consulting and coaching for contractors.

RELEVANT NUMBERS FOR SAMPLE JOBS

	Estimated Cost	Actual Cost	% Complete (Actual Cost / Estimated Cost)	Estimated Revenue (Job Price)	Actual Revenue	Earned Income (% Complete x Est. Rev.)	WIP Adjustment
Clark job	$100,000	$39,750	39.75%	$150,000	$65,000	$59,625	($5,375)
Hernandez job	$80,000	$15,365	19.21%	$120,000	$20,000	$23,052	$3,048

CLARK JOB AT SALE PRICE OF $150,000

Labor estimated at full burden

	Estimated Cost	Actual Cost	% Complete	Actual Revenue	Earned Income	WIP Adjustment
Labor	$28,900	$15,000	52%			
Materials	$30,750	$8,000	26%			
Subs	$40,350	$12,000	30%			
Total	$100,000	$35,000	35%	$58,000	$52,500	($5,500)

Labor job-costed at partial burden

	Estimated Cost	Actual Cost	% Complete	Actual Revenue	Earned Income	WIP Adjustment
Labor	$28,900	$19,500	67%			
Materials	$30,750	$8,000	26%			
Subs	$40,350	$12,000	30%			
Total	$100,000	$39,500	40%	$58,000	$59,250	$1,250

Labor job-costed at full burden

Labor estimated at full burden

The “Estimated Cost” of labor in both charts above includes full burden. In the top chart, however, labor is job costed with partial burden (apples to oranges), which throws off “Earned Income” and results in a negative WIP adjustment. In the lower chart, labor is job costed with full burden (apples to apples), resulting in a higher amount of earned income and a positive WIP adjustment.

BY RANDY WILLIAMS

Setting Up a Home for a Blower Door Test

When setting up a house for a blower door test, should you seal off the bath fans? How do you address that 6-inch combustion air vent in the mechanical room? Should the overhead garage door in the attached garage be open or closed?

The primary reason to conduct a blower door test is to evaluate the continuity and integrity of the air barrier, or what we prefer to call the "air control layer." We can't create a 100% perfect barrier, but we can control air leakage, bringing it down to a measured amount. The blower door allows us to find out how much air is moving through the building's envelope when a house is either pressurized or depressurized. Opening, closing, or sealing the "planned openings" such as doors, windows, ducts, and vents in the air control layer will have an effect on the blower door test results. We look to standards to tell us what is allowed to be opened, closed, or sealed.

THE STANDARDS

There are a few blower door testing standards. Which standard is used will depend on the country the home is in, local codes, and whether you are trying to achieve a certification, such as a HERS score or Passive House. Three common standards in the U.S. are ANSI/RESNET/ICC 380, ASTM E779, and ASTM E1827. All three meet the ICC R402.4.1.2 code requirement for conducting a blower door test. A Canadian option is the Canadian General Standards Board (CGSB), and in Europe, you might use EN 13829 or ISO 9972. These last two are also the standards that would be used to certify a project as Passive House. To keep this article from becoming a book, I'm going to go over in detail the ANSI/RESNET/ICC 380 section on how to prepare a home for either a positive or negative blower door test and discuss a few of the differences with the other standards later.

HEALTH AND SAFETY

Before performing a blower door test, we want to make sure we don't create a hazardous condition that may affect the health or safety of the occupants. I first try to confirm that there is no vermiculite insulation or other asbestos fibers that can become airborne during the test. I avoid blower door testing if I feel there is any chance of the air movement through the building envelope disturbing asbestos fibers. This is usually not an issue for new buildings, but often blower door tests are conducted on older structures. If vermiculite or asbestos duct insulation is present, you may have to alter the way you test, such as by conducting a positive pressure test, or it may be best not to test at all.

All fireplaces and wood or pellet stoves must be cold. An active fire or even hot coals from a recent fire can become a fire risk during testing. A homeowner needs to be made aware that there can be no fires the day before the test, and, if possible, all ashes should be removed from the fireplace or woodstove.

Blower door testing a home requires much more than simply setting up the equipment and running it.

Any combustion appliances need to be turned off or set to "pilot" so they cannot start during the test. This includes space heaters and water heaters. A negative-pressure blower door test can easily pull carbon monoxide into the home. Fan-assisted combustion appliances may also influence the home's pressure during the test. Tip: I place my car keys next to an appliance that I have turned off; this way, I cannot leave the home without turning it back on. I also suggest checking any pilot lights after testing. I have yet to have one extinguished during testing, but I'm sure a homeowner wouldn't appreciate not having hot water or heat.

All plumbing traps need to be sealed or filled with water. I often find open plumbing waste and vent piping, especially during new-home testing; a custom shower or bathtub may not have water in the traps. The smell of sewage is the giveaway. Duct tape can make an effective seal when plumbing traps have yet to be installed.

Testing at certain times of the year can influence comfort. Living in a cold climate, sometimes I have to test in very cold temperatures. I run the test as quickly as possible to reduce the amount of time I'm drawing very cold air into the home or pushing the warm air out.

Photos by Randy Williams

Natural drafting appliances, such as this vented water heater **(2)**, are not allowed to be sealed. Fireplace and stove dampers need to be closed during blower door testing. Any doors should also be closed **(3)**. Plumbing drains should be sealed; if the trap is present, filling the trap with water will stop air moving through the waste and drain system. Duct tape can create an effective seal **(4)**.

Lastly, I speak with the occupants or any workers present during the test. Make sure they are aware that if they need to leave the building during testing, they should let the person performing the test know so they can pause or stop the testing. I've had homeowners worry about how the test may affect them or their home—one even asked if they would be able to breathe while the test was being performed. A quick conversation of what to expect is often helpful.

DOORS AND WINDOWS

All exterior doors and windows should be closed and locked. Be sure to check them all; one window left open just a little can result in an inaccurate test. I like to lock doors not only to ensure they are tightly closed but also to keep people from opening a door during a test. On a couple of occasions, an exterior door opened while I was testing and produced such a large change in pressure that it pulled the blower door frame along with the fan out of the door.

All interior doors need to be opened with a few exceptions. This is where the 380 standard can be confusing. The standard lists four areas of a home: conditioned space volume, unconditioned space volume, conditioned floor area, and infiltration volume. Inclusion in these different spaces has different requirements that often have little to do with performing the test. For instance, a space may not fall into the definition of conditioned space volume but still be included in infiltration volume and be connected to the rest of the home during blower door testing. In my opinion, this area of the 380 standard could be simplified. To make this section easier to understand, I've listed below if a space should be open or closed during testing:

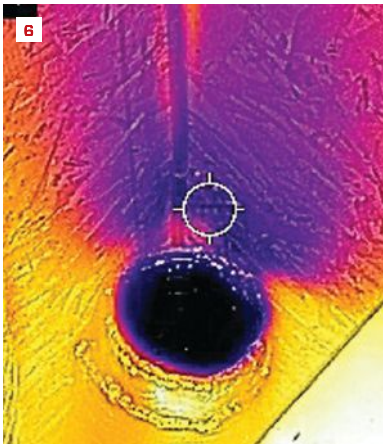
If a space is outside the air barrier, vented, or unconditioned, it is considered unconditioned space volume and needs to be sealed from the rest of the home with a closed door or hatch. This would include all vented attics, attic knee walls, crawlspaces, and basements where the basement ceiling is both air-sealed and insulated.

If a space is insulated and air-sealed, a door or hatch will be open to the space during testing. This would include sealed attics and attic knee walls, crawlspaces, and basements that do not have insulation and air-sealing at the basement ceiling. Many basements may not be insulated (or have poor air-sealing) at the walls and rim joist, but if there is no insulation and air-sealing at the basement ceiling, a door will be open and the space included in the test.

If any of these spaces are open during testing, they are included in the infiltration volume calculations.

Attached garages are always outside the conditioned space of the home. If there is an attached garage, whether conditioned or not, a door leading to the garage from inside the home needs to be closed. If you are using the door to the garage to perform the test, at least one garage door must be opened.

Other attached structures that are thermally broken from the main home, such as a sunroom or porch, shall be sealed from the rest of the home during testing.



Ducts like this non-dampered combustion-air supply to a mechanical room **(5)** cannot be sealed during a blower door test. A thermal image of the same vent taken during a final blower door test shows leakage that will increase test results **(6)**. All equipment capable of moving air into, out of, or around a home needs to be turned off before testing begins **(7)**.

EXHAUST AND VENTILATION FANS

All fans should be turned off. This includes dryers, bath fans, kitchen exhaust fans, whole-house ventilation fans, HRV and ERV systems, and any ventilation fan providing either supply or exhaust ventilation. All heating and cooling equipment fans should also be off. In the case of a whole-house ventilation fan, one that is located either in the attic or crawlspace, the shutters for the fan should be closed, and if there is a seasonal cover, the cover should be installed.

DAMPERS AND VENTS

Many dampers and vents that perform different tasks can be present in a home. Let's start with chimneys and supply air for solid-fuel (wood) burning appliances. Both the chimney and supply-air dampers should be closed. This will hopefully limit any ash or soot from entering the home during a negative pressure test.

The flue vents for natural drafting combustion appliances shall be in their "as found" position. In other words, you are not allowed to seal off the vent hood of a natural venting gas or oil water heater or natural drafting gas or oil furnace, though I have had inspectors in my area allow builders to seal these vents off during code-compliant blower door tests. They are normally open holes to the exterior and according to the 380 standard, should remain unsealed.

Non-motorized dampers that lead outside the air control layer will be left as found. This would include things like the exterior dryer damper, kitchen exhaust damper, and bath fan damper. You cannot seal these vents off from the exterior.

Motorized dampers can be moved to their closed position. No additional sealing is allowed.

Any supply and return vents for a forced-air heating system need to remain in their "as found" position.

The last area is non-dampered openings. Most are not allowed to be sealed. For example, a combustion air vent for natural drafting combustion appliances must remain unsealed. This often results in a 6-inch, non-dampered opening (hole) directly to the exterior that will remain open during the blower door test. (This should influence the decision to install all sealed combustion appliances.) There are two exceptions to the non-dampered rules where non-dampered openings can be sealed. These include continuously operating local exhaust ventilation systems, like bathroom or kitchen exhaust, and continuously operating dwelling unit ventilation systems, such as HRVs or ERVs, that connect to the exterior. Both can be sealed. If either of these ventilation systems operates intermittently, it must be left open. (If either of these ventilation systems is intermittent, the exterior vent will most likely be dampered and will be left as found.)

The thinking behind what is turned off, left open, closed, or sealed is for the home to be in as close as possible to a natural state, or how it operates normally. This gets us the most accurate blower door test that best represents the actual conditions of the home.

OTHER STANDARDS

That covers the high points of how to set up a home for a blower door test using ANSI/RESNET/ICC 380. The ASTM E779, which is designed to be an international standard, is much less detailed on how a home should be set up. There are three paragraphs; the first is to open all doors that connect the space. Second, the HVAC dampers and registers shall be left as found. Fireplace and other dampers can be closed unless they are designed to pressurize or depressurize the building. The last paragraph requires the inspection and recording of the building's condition, including windows, doors, opaque walls, roof, and floor.

The last standard I'll discuss is the European EN 13829 and the requirements for Passive House. I had a discussion with Enrico Bonilauri from Emu Systems, an organization that conducts Passive House training. Here's what he had to say:

"Passive House certification requires the building to be tested in its final stage (below 'final test'), to be executed per the planned use of the building and its components. However, it is often recommended to execute a preliminary blower door test in order to achieve the very low ACH50 required for Passive House certification (ACH50 ≤ 0.6).

"The preliminary blower door test is executed at a time when the air barrier is still accessible (that is pre-drywall). This is addressed by EN 13829 method 'B.' The main purpose of the test is to detect air leaks at the air barrier, meaning all other sources of leaks should be sealed off. These include, for example, unfinished penetrations such as incomplete drains, and ducts to the outside and so on.

"If some elements show leakage during the preliminary test, these can be temporarily sealed off to see how the building would perform without those leaks. This is often the windows and doors, where some leakier units may need some adjusting to seal properly.

"For PH, the final [blower door test] is executed according to EN 13829 method 'A,' or ISO 9972. The goal of this final test is to determine the air leakage of the building as complete and occupied. The building is required to be set up per the planned use—no taping at windows, ducts, drains. The only ducts to the exterior to be sealed off are the intake and exhaust ducts of the ERV/HRV system.

"Passive House requires the test to be executed at positive as well as negative pressure. The reason for that is that some building elements seal better at positive pressure (for example, an in-swing door), while others seal better at negative pressure (an outswing window). For both positive and negative tests, the building is pressurized at incremental intervals (typically 10 or so) of higher/lower pressure, with the average being 50 Pa. For example, the positive pressure test would start at 25 Pa pressure difference, then step up to 30, 35, 40, 45, 50, 55, 60, 65, and 70 Pa. The results are averaged, and that becomes the ACH50 value for the positive pressure test. The same procedure is repeated for the negative pressure test, yielding the negative pressure ACH50. The final ACH50 result used for Passive House is the average of the positive and negative pressure tests."

How a home is set up for a blower door test can have a big effect on the final blower door number. The recipient of the final numbers will often specify which standard is used or may have requirements for the way the home is set up. The person doing the testing may also have their own standard or procedure for testing. As long as it's approved by an authority having jurisdiction and follows any required codes, this may be acceptable. The way a home is set up should be documented so that a test at a later date can duplicate the earlier one. Being consistent in the setup will help in the test's accuracy and will ensure a test is repeatable.

Randy Williams is a builder and energy auditor in northern Minnesota. Follow him on Instagram @northernbuiltpro and his blog at northernbuilt.pro.

A Custom Newel Post Retrofit

Tapered sleeves update the original square posts

BY DAVE HOLBROOK

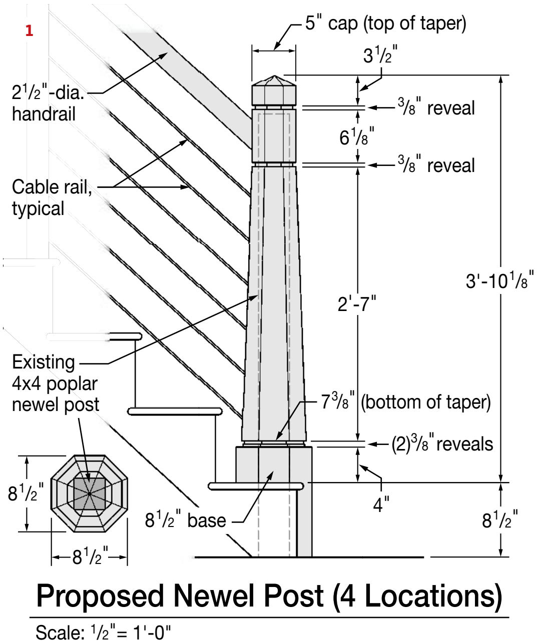
Late last year, a friend texted me a drawing of a custom newel post for a remodeling project he'd taken on, wondering if I'd be interested in making four of them. I was. The drawing **(1)** showed a tapered octagonal column between base and cap elements, resembling a lighthouse in form. Construction details were up to me. We determined that, since the existing 4x4 newels **(2)** were decently plumb and seemed secure, it made sense to leave them in place and sleeve the new newels over them. Further, the newels would be paint-grade, so I chose to work with poplar.

The base was to be fitted over the starting tread, so I decided it would be kindest to the installer if I made it as a separate element, to simplify scribing, fitting, and installation. That was one of my better decisions, because I ended up being that installer.

Solving the octagon. Having basically zero experience with the octagonal realm, I looked up how to find the dimension of the facets of an octagon of a given diameter. As I feared, the answer involved some fascinating math that went right over my head. Given the diameters at the top and bottom of the taper and at the base (5, 7 3/8, and 8 1/2 inches in diameter, respectfully), I figured that I could simply rip scrap lengths of 1/4-inch plywood at half of each diameter, then cut individual isosceles triangle segments at 22 1/2 degrees on a miter saw, flipping the board edge-for-edge to produce each piece **(3)**. For example, with the 5-inch cap, I took a 2 1/2-inch-wide board and cut across that at 22 1/2 degrees (360 degrees divided by 8 is

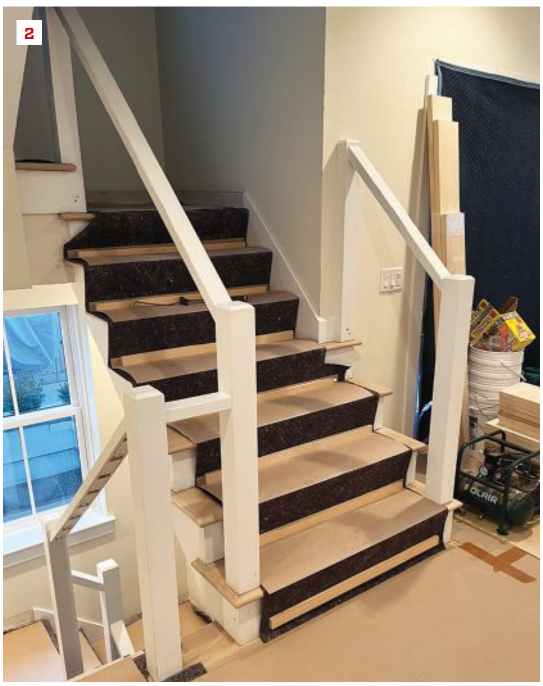
Photos by Dave Holbrook and Eve Aspinwall

1



The designer's plan provided the basic elements without construction details **(1)**.

2



Existing newels were basic 4x4 painted poplar, left in place as the new posts' structural core **(2)**.

3

4

To determine octagonal facet, or "stave," dimensions, the author made segmented patterns from ¼-inch plywood **(3)**. A calibrated digital angle gauge ensures precise beveling **(4)**.

45 degrees, half of which is 22½ degrees). I then flipped the board, edge-for-edge, and started my next 22½-degree cut at the peak of the angle that I just cut, leaving a nice isosceles pie wedge of the octagon—a simple, "no-math" solution.

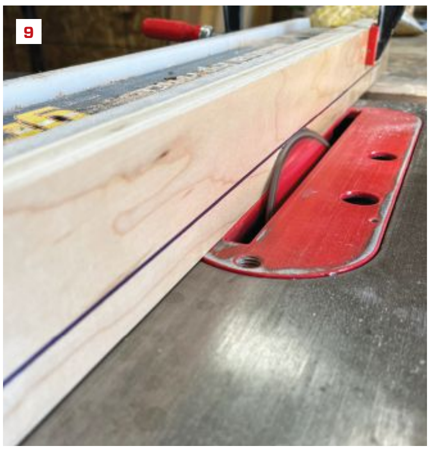
With eight triangles accurately cut, I glued them together into a regular octagonal pattern. I made three patterns, at 5 , 7⅜, and 8½ inches in diameter, to create a proof-of-concept mock-up for reference, helping me to cut everything to accurate width and to lay out the taper. Now, to determine the respective facets of the workpieces—I'll call them staves—all I had to do was measure the base of the appropriate triangle. With the blade tilted to 22½ degrees, the base and cap pieces only called for straight rips on a table saw **(4)**.

Before proceeding further, I processed all my poplar stock, first to rough width, then to length using a stop on the miter saw for repeat accuracy. Each newel consists of three separate components (cap, tapered column, and base), each with eight sides. So, for four retrofit posts (two per floor), I needed to make 96 staves.

Tapered rips. For cutting all the tapered column sides, I made a simple tapering jig **(5, 6)**. With those 32 staves ripped on one edge, I marked them for reference to avoid accidentally recutting the same edge **(7)**. Adding a tapered waste piece to the jig **(8)**, essentially restoring parallel sides, let me cut the opposite edge to the mirror profile. With the previously cut and marked edge toward the saw fence, I completed the tapering operation.

Edge bevels. I'd thought I could then simply bevel all the edges for the tapered pieces on a router table, using a 22½-degree bit, with the fence and top bearing limiting the cut. However, I immediately had trouble regulating the feed, with the bit eating beyond the desired edge. Instead of resolving the issue, I decided I could move faster on a table saw. I clamped a waste piece of smooth plywood to cover the right side of the table saw fence. With the blade tilted to 22½ degrees, I raised it spinning into the face of the plywood, burying the teeth at the height of the ¾-inch stock thickness **(9)**. This way, I beveled all the edges on the table saw, error-free.

To cut the tapered column facets, the author uses a disposable jig on a table saw **(5)**. Self-adhering sandpaper pads add friction **(6)**. The first edge of all 32 pieces is cut, and the pieces stacked and marked to avoid accidental recutting **(7)**. A tapered waste piece is added to the jig, establishing the second ripped edge **(8)**.



To bevel the tapered edges, the author raises the table-saw blade at 22 1/2 degrees into a sacrificial fence face, at the thickness of the stock **(9)**. Decorative grooves are cut using a router table for tapered stock **(10)** and a dado blade in the table saw for parallel pieces **(11)**.

Grooving. The posts featured two 3/8-inch-wide decorative grooves running around the cap and a double-height groove atop the base. On the router table, I rabbeted the top and bottom ends of the tapered mid-section pieces **(10)** to create the groove effect. I used a miter gauge to compensate for the taper and cut squarely across the ends. I cut the cap and base grooves using a dado blade in the table saw **(11)**.

Slick clamping trick. I wasn't particularly nervous at the prospect of clamping the pieces together, despite the faceted configuration. I knew I could use the same technique a friend (the one who asked me to do this job) demonstrated a few years earlier, simply taping multisided pieces together at their mitered edges, adding glue, and folding them up **(12–16)**. I've always used plain blue masking tape; this time, for added strength, I used duct tape. I'd seen prior perfect results with four-corner pieces, so eight-sided pieces could only be twice as successful—happily, this proved to be more or less the case. Once I'd rolled up a column, cap, or base, I taped it closed then wrapped it with ratcheting tie-down

Tapered staves are aligned face down and edge-to-edge, taped together with duct tape **(12)**, then flipped **(13)**. Wood glue is applied to the open joints **(14)**, and then the assembly is rolled up and band-clamped **(15)**.

Before the glue sets, misalignments are tapped out with a rubber mallet **(16)**. For the column caps, back-beveled post segments create a dished surface to cradle and control cap pieces during glue-up **(17)**. After the glue sets **(18)**, caps are pressed and bonded into place in a bed of two-part epoxy filler, then sanded true. To make the newel caps, the author rips slope and bed angles in a rough length of laminated poplar, then cuts segmented elements at 22 $^1/_2$ degrees on a miter saw **(19)**.

To align sleeve components around the existing 4x4 post, U-shaped plywood is glued together to form a 4x4 cutout **(20)**, the corners chamfered and fine-tuned on a sander **(21)** to fit inside post and base ends **(22)**.

The base section, fitted over the old post, is plumbed **(23)** and traced onto the existing starter tread **(24)**, to be let in. The outline is cut from the tread **(25)**, and the riser lines traced onto the base (viewed looking up under the starter tread) **(26)**.

The base is cut out to drop onto the floor **(27)**. After the author scribe-tunes the fit, he glues the base in place with heavy-duty construction adhesive **(28)**. Squeeze-out is cut away after curing. To fit the post inside the tapered sleeves, the author power-planes the old post corners until the sleeves drop into place without resistance **(29)**.

straps and cranked all the joints tightly together at once. To true the ends, I tapped out slight misalignments with a rubber mallet. Regular Titebond glue leaves enough open time to work at a relaxed pace, provided you have all your ducks in a row at the outset.

Column caps. The newel design included a peaked octagonal top, with a 1-inch edge-to-center rise. I couldn't come up with a simple way to clamp these elements together; paint-grade wood, however, has the saving grace of not requiring "invisible" joints. I decided that I could "dish" the top end of the post by back-beveling the ends before assembly **(17, 18)** and use a reciprocal, fitted bevel on the underside of the top segments **(19)**, nesting the individual pieces together in place with a generous dollop of glue and hand pressure. The nesting angle was arbitrary, so I stuck with 22 1/2 degrees. Coincidentally, the same 22 1/2-degree angle suited the cap's required slope.

I ripped 1-by poplar to 2 1/2 inches (half the width of the cap's 5-inch octagon) and laminated three lengths to obtain the necessary thickness. I beveled opposing faces at 22 1/2 degrees. Then, using the same approach as for the octagonal patterns, I used a miter saw to cut the eight identical little wedges needed for each post cap, swiveling the saw back and forth to cut the 22 1/2-degree left and right angle cuts. Nesting worked even better than I expected, with the pieces self-aligning along the facets. Once the glue dried, I hand-pressed the preassembled tops into place in a bed of two-part Minwax epoxy wood filler, sanding away the squeeze-out after it hardened.

Three-piece assembly. To mate and align the base and taper sections on the original posts, I inserted internal guide plates, at the bottom of the tapered segment and the top of base, that would fit around the 4x4 posts **(20–22)** with enough room to tweak the alignment as needed. (The top of the tapered column was close enough to the existing 4x4 post that it fit snugly after I later planed it to the eight-sided shape, as shown in photo 29). I cut U-shaped pieces from 3/4-inch plywood, glued them together, and trimmed the corners at 45 degrees. Then I fine-tuned them to a press-fit using an oscillating belt sander and glued them in with Titebond.

Six inches of old post projects above the main sleeve, enough to glue on the cap piece **(30, 31)**, which is pinned plumb and stable using trim-head screws before the glue sets.

The oversized handrail had to be let in to the post. The author made a router jig and used a bearing-over straight router bit to make the recess **(32)**. A slightly oversized recess accommodated the angled insertion, later filled with two-part epoxy wood filler and sanded to a seamless fit **(33)**. The retrofit glued-in bases provide a stiff newel–rail assembly **(34)**.

Installation. At the jobsite, I began by sliding a base section over the old post, plumbing it, and tracing its profile onto the tread surface **(23–27)**. I then cut away the tread material within the outline and dropped the base into the recess, transferred the riser line, and cut away the waste material. With a little additional scribing and shaving, I achieved a plumb and level fit. I used “heavy-duty” construction adhesive to bond the base to all contact surfaces and let everything harden overnight **(28)**.

Due to the tapered interior of my newel sleeves, they weren’t going to slide right down onto the bases. First, I had to taper the old posts, which was easily done using a power plane and about 20 passes per corner **(29)**. I slathered the post with adhesive and dropped the sleeve into place on the base. This left about 6 inches of old post projecting, enough to capture the cap pieces with more adhesive **(30, 31)**. I used trim-head screws to hold everything plumb while the glue cured.

Railing attachment. In what was perhaps a design oversight, the top railing, a 2 1/2-inch-diameter, full-round custom oak profile, was about 1/2 inch wider than its corresponding facet on the cap, making for an awkward union. We decided to let the railing into the post, requiring a 1/4-inch-deep recess. I made a simple router template **(32)**, tracing the end of a railing sample cut at the proper angle. I clamped it to the post and used a top-bearing straight bit in a trim router to make the recess. As planned, it was a little oversized to allow for adjustment. I eliminated the voids with Minwax epoxy wood filler **(33)**. I fastened the rail with TimberLok screws, installed from the front of the post, and then bunged the holes.

With the original handrail removed, the old posts had some movement, but the new glued-in bases did a remarkable job of stiffening the entire assembly **(34)**. The final railing system includes cable rail, to follow painting—still a couple of months out as of this writing. I charged $625 per newel, plus installation.

Dave Holbrook is a freelance carpenter in South Orleans, Mass., and a JLC *contributing editor.*

Photo: Liz Roll/FEMA

Flood-Resilient Buildings

Managing the increased incidence of coastal and inland floods

BY JLC STAFF

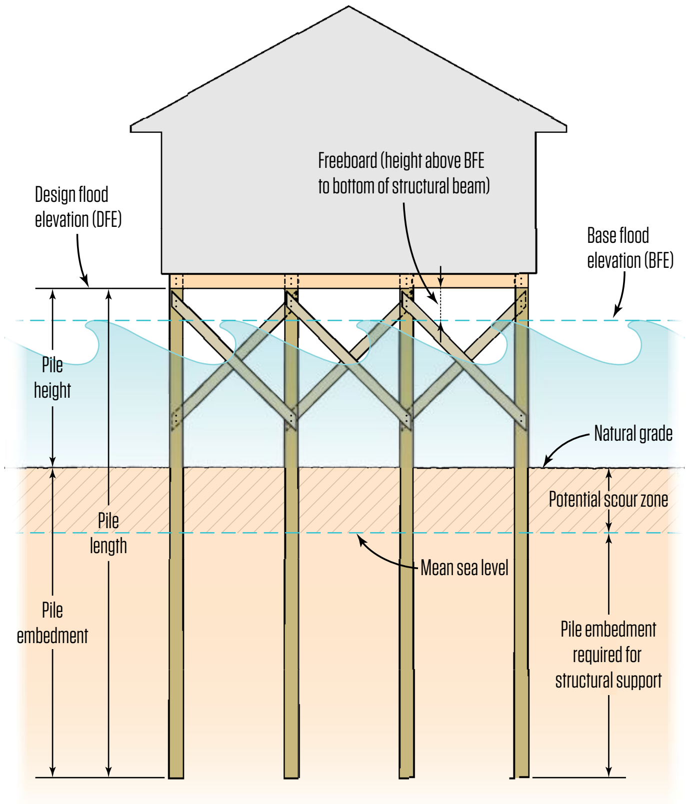
Strategies for rendering homes resilient to floods vary by whether the site is subject to coastal wave action or (in the case of most inland flooding) at risk of immersion in still or slow-moving high water.

COASTAL CONDITIONS

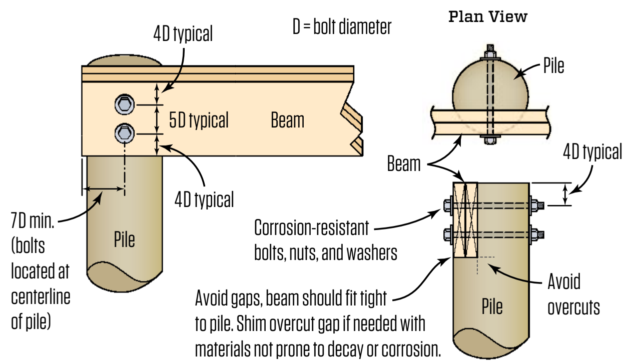
Waves can exert enormous loads on buildings. While winds wield pressures in the tens of pounds per square foot, a 2- to 3-foot wave can exert pressures in the hundreds or even thousands of pounds per square foot. Waves that break at a structure create the most intense impacts; wave outflow and ocean currents running diagonally to the shoreline mean structures get hit from all sides. No ordinary wall can resist such a combination of forces. But despite the magnitude, protection proves relatively straightforward: elevating structures above the wave action and allowing the water to wash harmlessly under the building. In storm after storm, inspectors assessing damages report that homes elevated on pilings survive relatively unscathed compared with older homes supported by solid foundations.

In V zones ("V" stands for "velocity wave action"—think ocean-front sites that can be overrun by waves 3 feet and higher) and Coastal-A zones (further back from the coastline but still subject to waves up to 3 feet high), the lowest portion of the first-floor framing must be elevated above the base flood elevation, or BFE. The height of the BFE is determined by a statistical analysis of the last 100 years of measured stillwater elevations and calculated heights for waves

V-Zone Flood Elevations



Note: pile layout, bracing, and pile-to-beam connections must be designed by an engineer



MAXIMUM PILING HEIGHTS (8-IN. ROUND PILES IN SAND)

One Story		MAX. UNBRACED HEIGHT (FT.)		MAX. BRACED HEIGHT (FT.)	
Building Dimension	Pile Spacing	Dense Sand	Loose Sand	Dense Sand	Loose Sand
20'	10'-0"	8	9	12	13
24'	12'-0"	8	9	12	13
28'	9'-4"	8	10	12	14
30'	10'-0"	8	10	12	14
34'	11'-4"	8	10	12	14
34'	8'-6"	9	10	13	14
36'	12'-0"	8	10	12	14
36'	9'-0"	9	10	13	14
40'	10'-0"	9	10	13	14
40'	8'-0"	9	10	13	14

Two Story		MAX. UNBRACED HEIGHT (FT.)		MAX. BRACED HEIGHT (FT.)	
Building Dimension	Pile Spacing	Dense Sand	Loose Sand	Dense Sand	Loose Sand
20'	10'-0"	6	8	10	12
24'	12'-0"	6	8	10	12
28'	9'-4"	7	9	11	13
30'	10'-0"	7	9	11	13
34'	11'-4"	7	9	11	13
34'	8'-6"	7	9	11	13
36'	12'-0"	7	9	11	13
36'	9'-0"	7	9	11	13
40'	10'-0"	7	9	11	13
40'	8'-0"	8	10	12	14

"V-Zone Elevation" and piling connection details adapted from FEMA P-499 (Dec. 2010): "Home Builder's Guide to Coastal Construction"; example piling heights based on Texas Dept. of Insurance Building Code for Windstorm Resistant Construction

and wave runup (the rush of water up a slope or structure caused by breaking waves). In V and Coastal-A zones, no permanent enclosures are allowed below the first floor. Some community building codes may go beyond this by identifying a design flood elevation (DFE) above the BFE. The height exceeding the BFE is called a "freeboard" (see illustration, above).

The height of the foundation (see chart, above right, for examples) is only one factor in coastal-storm resilience. A building's structural integrity also depends on the depth of piling embedment and the quality of connections between the piling and the framing.

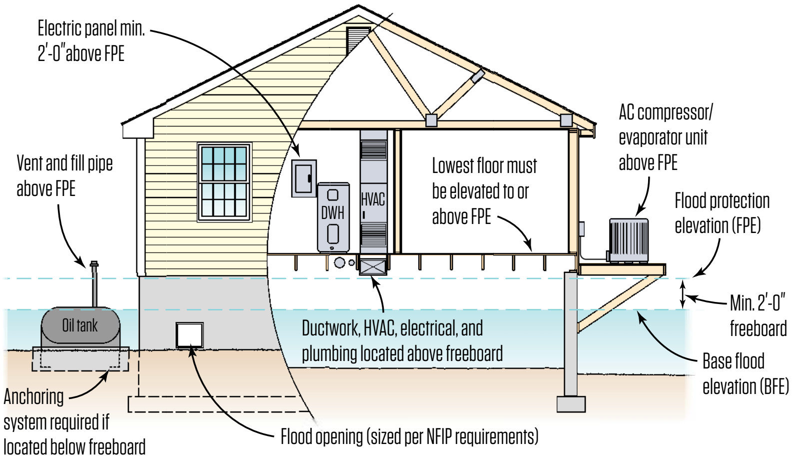
Embedment. Unlike a foundation that rests on a footing, most driven piles support loads by friction along the length of their sides. The embedment depth depends on the soil characteristics, and most jurisdictions require an engineer's soil analysis. A typical pile length for residential homes is between 20 and 60 feet.

The piling embedment specified by the engineer must account for predicted scour, the erosion around a fixed object. If the soil erodes around piles in a storm, the remaining embedment must be sufficient to resist uplift and provide lateral support.

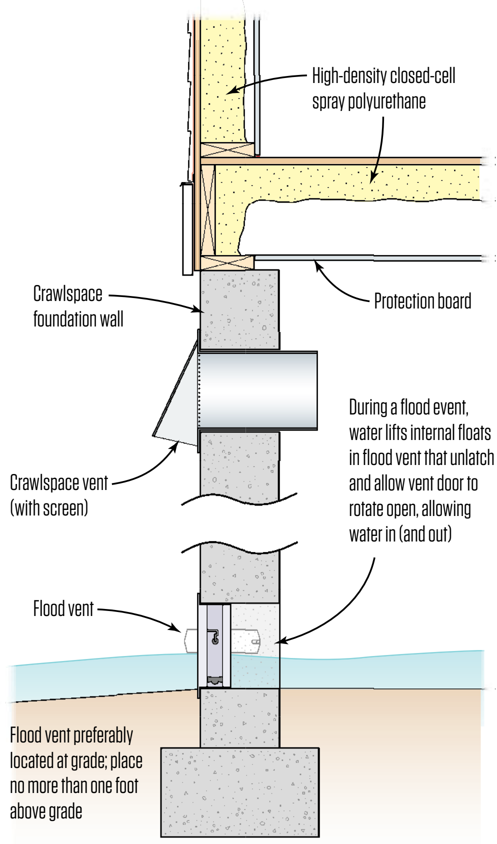
Girders and joists. Ultimately, all loads must resolve to the pilings by way of girders, blocking, and often cross-bracing. Because of the complex load paths involved and the likelihood that the home will be tested by high winds, water, and impact from waterborne debris, most jurisdictions require that the entire structure be engineered.

Because of the difficulty of driving pilings perfectly plumb, the outer pilings of a foundation array are usually placed 6 to 10 inches

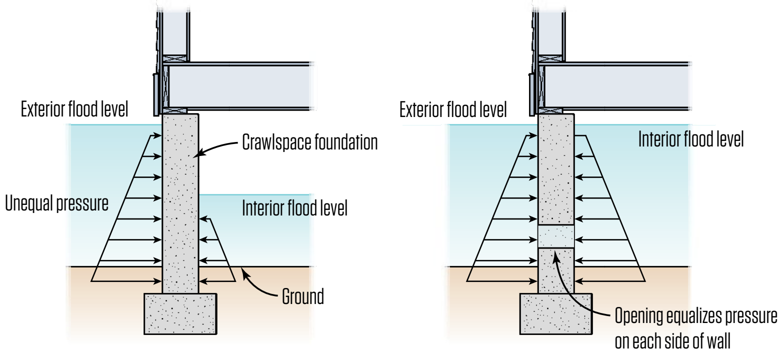
Flood Protection for Utilities (A-Zone)



A-Zone Vented Crawlspace



Controlling Hydrostatic Pressure



"Flood Protection for Utilities" adapted from Accomack County (Virginia) Flood Program; "Controlling Hydrostatic Pressure" and "A-Zone Vented Crawlspace" adapted from Building Science Corp. BSI-128

in from the building line. This means the joists will cantilever a short distance beyond the girders. As a rule of thumb, the cantilever distance should never exceed the girder or joist depth.

Girder connections. When a piling foundation fails in a storm, it's usually because the connection at the top of the piling fails, which causes the house to wash off the foundation. A strong connection between piling and girder requires a notch in the piling and several galvanized 3/4- or 7/8-inch-diameter steel bolts. Although it might seem easier to simply cut the tops of the pilings flat and use metal straps to secure the girders, that is more complicated to do well and ultimately takes more time.

The notch for a piling-to-girder connection should not be deeper than half the cross section of the pile. As with the overall structural design, the connections must be specified by an engineer for V-zone foundations.

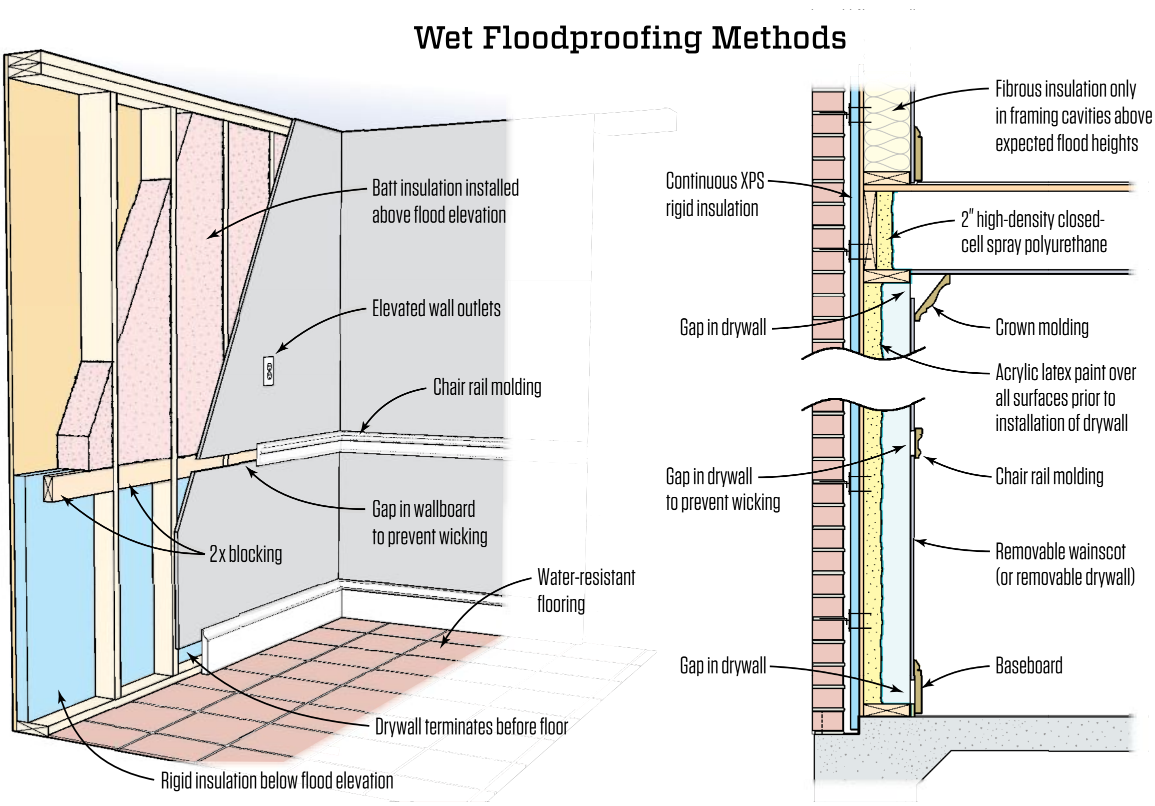
Bracing. Cross-bracing at the pilings may be necessary to resist lateral loads from wind or water. However, the cross-bracing may also catch debris and impede the flow of water, increasing the load on the foundation. As an alternative to an extensive amount of cross-bracing, a larger pile and closer spacing will allow for an increase in unbraced piling height. If cross-bracing is used, it's best to install it perpendicular to the shoreline, so the bracing does not become a barrier to incoming waves.

INLAND FLOOD RESILIENCE

Riverine flood areas are defined by the National Flood Insurance Program (NFIP) by a range of zones on flood maps, and terms have changed. BFE is defined locally by likely flood elevations without wave crests or runup. Zone A is the designated area for a 100-year flood (a 1% chance of such a flood each year); it is the only inland zone with a defined BFE. Zones B and X are shaded areas on a flood map at moderate risk of flooding. Zone X can also be unshaded; along with zone C, this area is at low risk.

Solid foundations are the norm in most inland flood areas, and while they may not see the intense force of waves, they can see lateral hydrostatic loads from standing or slowly moving floodwaters. If the water level on one side of a foundation wall is much higher than on the other, the wall must resist an immense load. The answer for many crawlspace walls in flood-prone areas is to install flood vents, which are designed to open under hydrostatic pressure. The flow of

Wet Floodproofing Methods



"Wet Floodproofing Methods" adapted from LSU AgCenter and Building Science Corp.

water inside equalizes the pressure on each side of the wall, providing relief (see "Controlling Hydrostatic Pressure," previous page).

For vented crawlspaces, most building codes require air vents sized at least 1 square foot of net free area for each 150 square feet of crawlspace area. NFIP prescriptive requirements for flood vents call for at least 1 square inch of net free area for every square foot of crawlspace area, with two vents per enclosed area on different exterior walls. The required flood vent sizing is slightly more than the air-ventilation requirement—a detail to note when non-engineered flood vents double as air vents in a short crawlspace.

For tall crawlspaces in areas with a high BFE, the best solution we have seen is to provide flood vents lower down (codes specify placing all flood vents not more than 1 foot above grade) and position required air vents high on the wall for increased circulation. (For more on building a tall crawlspace, see "Rebuilding a Flooded House," by Dave Yelovich, Nov/18.)

Sealed crawlspaces are generally seen as ineffective in flood-prone areas, and most building scientists recommend you focus efforts on air-sealing and insulating the first floor. However, two companies—Smart Vent (smartvent.com) and Flood Flaps (floodflaps.com)—make engineered flood vents for use in sealed crawlspaces and conditioned enclosures on slabs.

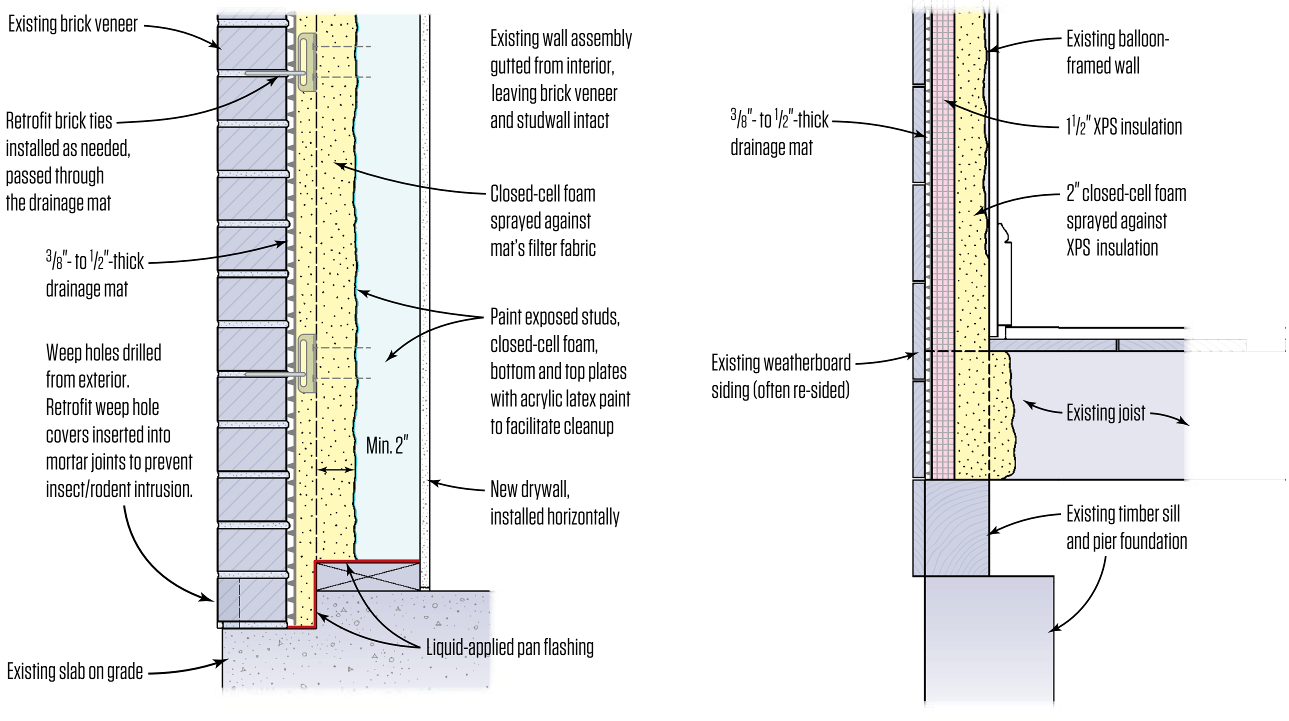
Utilities, including heating and cooling equipment, water heaters, fuel tanks, electrical panels and well heads, are all at risk of damage from floods, and the primary approach to protecting them is elevating them to the "flood protection elevation," or FPE, with a freeboard typically defined by local jurisdictions. With HVAC, it's not only the equipment but also combustion air, fresh air intakes, and ductwork that must be placed above the FPE. This holds true for all vents, including those on fuel tanks.

Wells can be drilled in flood-prone areas, but building codes usually require a watertight sanitary well seal and a steel sleeve extending above the flood protection height and at least 24 inches below grade.

FLOOD-HARDY CONSTRUCTION

Ideally, all homes in flood plains should be built above the anticipated flood level. But even for new construction, that's an expensive proposition. And the cost of raising existing homes above the flood line is usually prohibitive, especially if the house is built on a slab foundation. The alternative is what FEMA calls "wet floodproofing" (commonly dubbed "flood hardy" or "wash and wear" construction). Many of these strategies were pioneered by Joe Lstiburek of Building Science Corp. and championed by Claudette Reichel at the LaHouse demonstration home built by the LSU AgCenter (lsuagcenter.com). The initial design (see illustration, above left) was developed for rebuilding flood-damaged homes to make cleanup from future flooding events easier. The strategy was further developed by Lstiburek for new construction (above right).

Flood-Tolerant Wall Reconstruction



Left-hand design based on information from Joe Lstiburek, Building Science Corp.; right-hand retrofit based on information from Paul LaGrange. All illustrations in this article by Tim Healey.

The goal in both cases is drainable and dryable building assemblies, using building materials that don't fall apart when they get soaked and that can be easily cleaned and dried after a flood. For example, ordinary drywall is replaced with painted wood or cementitious panels, and fiberglass batts or cellulose cavity insulation is replaced with closed-cell spray foam and rigid insulation boards. Electrical fixtures and wiring also get destroyed when immersed in water, and the paper insulation in Romex wicks water far up the lines. To reduce the chances of this happening in a flood, outlets need to be placed higher on the wall.

Floodwaters tend to be filthy, so the interior side of the wall should be designed to be opened up, scrubbed, rinsed, and disinfected. In any flood, the extent of the damage and the demolition required will vary depending on how deep the floodwater is, how dirty it is, and how long this water sits in the house. In some cases, the interior wallboard may have to be completely stripped out. In others, only the lower wall may need gutting. In a best-case scenario, homeowners might be able to just remove strips of material and flush out and dry the walls.

Reconstruction after a flood will vary depending on the type of construction. For example, the solution shown above left was developed by Lstiburek to help rebuilding efforts following Hurricane Harvey in Houston, where brick veneer exteriors and slab foundations are common. This assembly creates a drainage and drying gap behind the brick, outboard of the insulated wall, using an open-weave or dimpled drainage mat against the brick. The base of the wall is coated with fluid-applied flashing to create a drain pan at the bottom of the wall. Weep holes in the bottom course of brick allow water to exit the cavity.

Paul LaGrange, a Louisiana-based building-science consultant, and *JLC* contributor Bill Robinson adapted the Lstiburek techniques to retrofit homes flooded during Hurricane Katrina in 2005, and in the Baton Rouge floods in 2016, where rebuilding efforts are still taking place. Some of the New Orleans homes were listed as historic properties, and on these balloon-framed homes, it often wasn't feasible for crews to remove the existing "weatherboard" siding, so, as with the brick-clad Houston homes, crews worked from the inside to create robust air and thermal barriers and a drainage plane.

As shown above right, LaGrange took a cue from Lstiburek's Houston design: He placed a drainage mat against the board siding, cut and fit sheets of XPS foam board, then applied closed-cell spray foam to air-seal the wall and lock the components together.

In both the Houston and Louisiana designs, the approach is the same: Building details employ materials that are not sensitive to water to reduce damage and make cleanup and repair easier the next time the building is hit by a flood. The centermost insulation layer is watertight and impermeable, while materials toward the inside and outside faces of the wall allow for drying.

Preserving an 1870 Tiny Home

A temporary roof bought time to save the building from collapse

BY DARREN TRACY

In October 2017, I received an email from Adirondack Architectural Heritage (AARCH) notifying its membership of the possible demolition of a building listed on the National Register of Historic Places. That caught my attention because it is uncommon to see National Register buildings demolished. (My wife and I are long-time members of AARCH, which provided assistance to us in the 1990s when we rehabbed Hubbard Hall, then a condemned building located in Elizabethtown, N.Y., and placed it on the National Register.) Locally known as Dr. Ferguson's Office, this building was significant not only because it was on the National Register but because of its Second Empire style, interesting construction details, small scale, and overall charm. Unfortunately, it was near collapse.

There was broad community support to save the building, including a local Facebook campaign, but the hour was late and no one had stepped forward. The City of Glens Falls, which had taken possession of the property in 2014 due to unpaid taxes, had solicited and received bids for demolition because of safety concerns. If my wife, Lisa, and I were going to act, we needed to move quickly.

I learned of the building's plight on a Thursday, looked at it on Friday, and reached out to the town's mayor about purchasing the property on the following Monday. He suggested I attend the next City Council meeting and make my pitch for purchasing. It was at that point that I started to second-guess myself, inspecting the building over and over again while trying to decide about moving

Photos by Darren Tracy

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3

The existing roof was funneling water into the building **(1)**, so the author covered it with a temporary roof framed with 2x10s, sheathed, and topped with a heavy tarp **(2)**. Temporary 2-by bracing around the perimeter helped the roof support snow loads over the winter months **(3)**.

forward with the purchase. On the one hand, it was in poor condition and needed a ton of work; on the other, it was on the National Register, small in scale, and within walking distance to downtown.

We decided to jump off the cliff and make our pitch to the council, which agreed to sell it to us for $1. This might sound like a good deal, but it was a negative asset because of its condition. Three days after our meeting, the city transferred title to us.

STABILIZING THE STRUCTURE

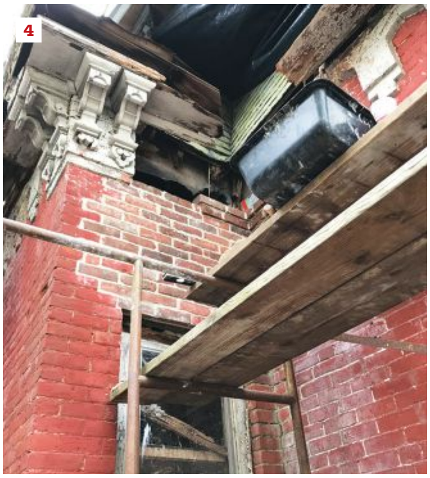
With winter fast approaching, the first order of business was to tackle the mansard roof to prevent it from collapsing and blowing out the walls. The original flat-seam metal roofing had failed, along with the built-up roofing over that, so the roof deck boards had rotted and created a funnel diverting water inside.

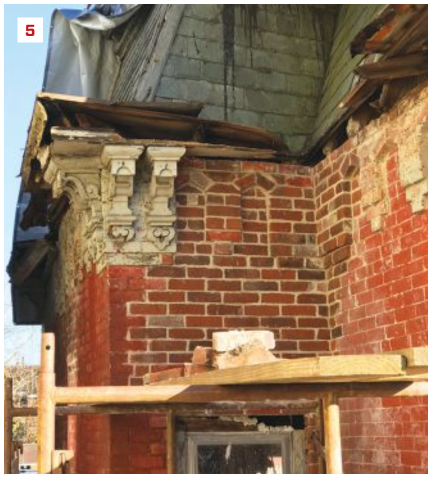
Temporary roof. Because repair work was needed on the exterior brick masonry walls before we could do anything about the existing roof framing, which was in worse shape than anticipated, I decided to install a temporary roof over the failing one. Even though the middle of the roof was badly deteriorated, I was able to install new temporary plates around the perimeter on top of the existing roof, then new 2x10 rafters on top of the plates. On top of the new framing and plywood roof deck, I installed a heavy-duty 16-mil tarp held in place with furring cleats secured to the fascia to keep the roof watertight over the winter. This detail worked well and was inexpensive, especially as we were able to reuse the framing materials in the permanent rebuild.

Brick masonry repairs. Then we rebuilt the exterior brick masonry walls that had caved in, salvaging and reusing existing brick as much as possible. This work needed to be completed before the roof work the following spring because the roof framing rested on the brick masonry.

The existing bricks measured a nonstandard average length of $7\frac{3}{4}$ inches (older bricks—called common bricks—are often a full 8 inches long; most new bricks—called modular bricks—are $7\frac{5}{8}$ inches long, a convenient length because with a $\frac{3}{8}$-inch mortar joint, the combined length of one brick and one mortar joint is 8 inches).

We matched the existing light mortar color by using white Portland cement instead of regular Portland cement, which is typically gray. Our recipe was 1 part white Portland, 1 part lime, and 6 parts washed sand, which is classified as a Type N mix. This relatively low compressive strength (750 psi) mortar flexes more than a higher compressive strength mortar, such as the commonly used Type S (1,800 psi), allowing for some movement and typically failing before the brick. Mortar is the sacrificial lamb.





A combination of salvaged and new modular brick was used to rebuild the portions of the walls that had collapsed **(4, 5)**. In places, the tops of the walls supporting the roof were single wythe **(6)**, while the remainder of the walls were double wythe **(7)**.

The stone foundation walls were in good shape and a full 8 feet high, but the basement's poured concrete floor needed to be replaced **(8)**. Virtually none of the existing framing could be salvaged, so most of it was rebuilt from the first floor up **(9)**. Tension ties screwed to the second-floor joists **(10)** and through-bolted to the masonry walls **(11)** help reinforce the brickwork.

After we completed the needed exterior masonry work, we installed temporary vertical roof supports on top of the newly repaired masonry walls to stabilize the edges of the temporary roof. We anticipated a snowy winter and windy spring before we could tackle the roof repair work. As it turned out, we had above-average snowfall, but there were warm periods between the storms that melted the snow, and I only had to shovel off the roof once.

WALL FRAMING

Meanwhile, our interior work continued over the dark and cold winter months, with weeks spent removing debris, old mechanicals and finishes, and damaged framing. In many ways, it is exponentially more difficult and time consuming to restore an old building that is in tough shape than to demolish and build new. And this building was in real tough shape, partially collapsed. I liken our work to a frame-off antique car restoration.

Original construction was wood lathe and plaster over brick. Interestingly, some walls were double wythe and some were single wythe, with wood framing backup. Nails driven into the exterior of the studs and left proud served as brick ties, but these ties had corroded and weren't effective—in some cases, they had completely disintegrated. Some wood framing was rotted and had become compost. As a result, the masonry walls were bowing and looked like they were ready to come down with a strong wind gust.

We installed new interior wood framing to help stabilize the brick and provide a cavity for insulation and electrical. While framing the walls, we glued the backs of the studs to the brick masonry walls with thin beads of canned urethane foam. This detail served to stabilize the brick exterior with no negative impact on the brick itself. We left the remainder of the brick between the studs as is, resulting in remarkably sturdy walls.

Second-floor deck framing. After installing a new beam to



The author used spray foam to insulate and reinforce the single-wythe brick walls **(12)**, and rigid foam to insulate the double-wythe walls. Studs were glued to the brickwork to reinforce the walls, while an air space between the rigid foam and the brick allows for ventilation **(13)**. Joints between the foam sheets and framing were sealed with spray foam **(14)**.

support the rear mansard roof rafters, we finished framing the second-story floor system with new joists bearing on top of the new interior walls. To prevent the masonry walls from spreading any further, we installed threaded rod and turnbuckle assemblies parallel to the floor joists. These consisted of Simpson Strong-Tie DTT2Z tension ties screwed to the ends of the floor joists and fitted with threaded rods that extend out to the exterior of the wall through holes drilled through the brick. Large plates acting as washers with nuts help distribute loads across the face of the brick wall.

Insulation. We insulated the exterior-wall stud cavities with rigid polyiso foam, setting the board insulation in a bead of spray foam, then sealing the entire perimeter of the board to make an airtight seal. This helps to minimize water vapor transmission from the interior to the exterior during winter months. Vapor drive is always a concern with brick in our cold climate because the water vapor can condense, freeze, and damage the brick face.

We left an air space between the brick and the new rigid insulation, in part because the brick wall bowed out but also to create a ventilation channel between the brick and the foam. We sprayed foam insulation directly on the single-wythe wall, a unique detail that worked well to stabilize the wall.

REPAIRING THE ROOF

As the weather warmed up, we needed to make a decision to either remove and rebuild the mansard roof, or repair it. We chose to repair it because we thought it might be easier and less expensive, particularly because we would have to deal with walls that were neither plumb, level, nor square. So we dismantled our temporary roof and got to work repairing the existing one.

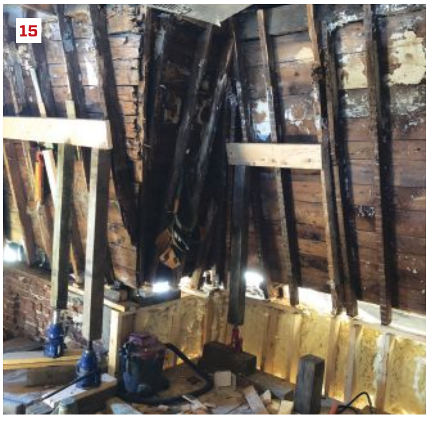
Framing fix. We shot reference elevations with a laser level and determined that portions of the roof had dropped as much as 7 inches. To correct this problem, we completely cut free the mansard roof framing from the wall top plate and jacked up the roof. We've jacked several structures over the years, including a boathouse that required diving and a three-story Victorian (which we moved one-third of a mile), but we had never separated a roof from a structure and jacked it independently. It was fun but a little nerve-wracking because the existing framing was in poor condition. We couldn't trust it, so we reinforced the roof framing as best we could while still allowing the members to move back into their original positions.

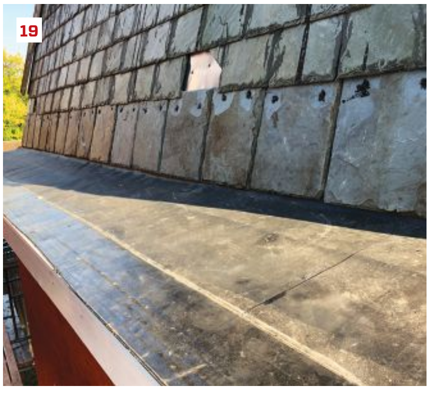
An old structure moans when it is jacked. With every sound, our heads turned and eyes darted, looking for problems. Eventually, we made most of the roof structure level and settled on gaining back $5\frac{1}{2}$ inches out of the 7 inches in the worst area, deciding that jacking that area any more might be pushing our luck. (It's wise to know when to stop, no matter what task.) This strategy saved us money and preserved functional historic materials.

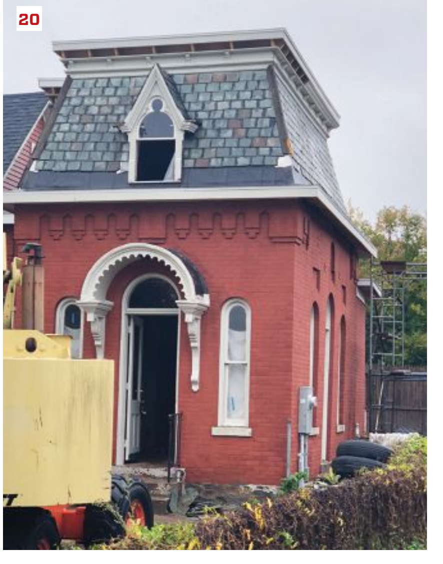
Then we fastened new plates to the tops of the brick walls as needed using Tapcons. In some places, we had to cut new rafters to completely replace damaged framing, while in other places, we were able to sister on new framing to reinforce the existing rafters. Where the board sheathing was too far gone, we replaced it with plywood sheathing.

After the roof was sheathed, we covered the flat portion with a .060 EPDM membrane. On the interior, we fit three layers of 2-inch polyisocyanurate rigid foam in the second-floor ceiling, sealed tightly to provide R-36, working as best we could with the space we had. Although current new-construction code for attics is R-49 in our climate zone, building rehabs are not necessarily required to comply with new-construction code. However, it is critically important to make the rehab of a historic building as energy efficient as possible. Care was taken to provide unobtrusive but adequate ventilation above the ceiling insulation, minimally affecting the building aesthetic. Holes were cored in the cornice and round, screened vents installed to provide ventilation above the rigid insulation.

Slate. Because of the proximity to nearby slate quarries in Granville and neighboring Vermont, many old homes in the Glens Falls area were built with slate roofs. On this roof, the old slate on the







The author detached the rafters from the plates, then jacked the existing roof framing back close to level **(15)**. After repairing the mansard roof framing, stripping the old roofing **(16)**, and rebuilding the roof deck, the author installed a new EPDM roof membrane on the flat roof **(17)** and intersection at the eaves **(18)**. Here it was necessary to remove and replace the lowest course of slate **(19, 20)**.

steeply-pitched portion of the roof was thin and many of the joints had been tarred, making it difficult to repair the shingles in the traditional manner without breaking the remaining slate. Fortunately, we were able to source replacement slates from a local quarry that closely matched the originals.

Typically, to repair broken or missing slate, a special tool—called a slate ripper—is slid under the old slate to hook the old nails. The ripper is then yanked or hammered downward, removing both the nails and the slate. After a new slate is slid in place, it's attached with slate hooks or by directly nailing through it in the space between the existing slates that cover the new piece. The exposed copper nail heads are subsequently flashed over, typically with small pieces (about 2 inches by 5 inches) of copper referred to by some old-timers as copper "babies." The baby is twisted slightly out of plane and shoved with the head of the ripper under the top slates and over the nail, held in place by friction. Slate work is a specialty trade and can be fun, but this job wasn't.

Because of our work to level and repair the roof framing, it was necessary to replace the bottom course of slate, which we surface-nailed. Then we caulked the nail heads with silicone and covered them with a copper flashing strip. This was a simple repair solution, effective and efficient.

EXTERIOR FINISHES

We only had to purchase two new windows, to replace two that had disintegrated. Otherwise, we were able to restore and refinish the remaining windows and doors. To maintain National Register designation and qualify for a 40% tax break, plans and proposed materials needed to be submitted and approved before work began.

We used select cedar for all of the exterior replacement trim. Before installation, we primed all six sides with a coat of oil-based primer, followed by two finish coats of 100% acrylic latex paint. We treated end cuts on the fly with a brush.

Exterior brick coating. The brick exterior needed attention because the existing coating was failing, mortar joints were soft, and the brick repairs were aesthetically unpleasing. After much research, I decided to use a silicate mineral paint—called Silacote—to coat the brick and the mortar joints. The previous coating appeared to be mineral paint, so incompatibility was not an issue; we simply pressure washed and applied.

Mineral paint is fundamentally different from latex and oil-based paint. It creates a chemical bond with masonry surfaces and has the added benefit of high vapor permeability (80 to 85 perms, compared with "permeable" latex paints that can range from 1 to 15 perms). That matters because when water vapor exits a brick building in winter, as it is prone to do according to the second law of thermodynamics (high pressure travels to low pressure in an effort to balance), it can condense as it approaches the brick exterior surface and freeze, popping off the brick face. You may have seen this happening on brick buildings that have been painted, particularly near the top of the building or on the exterior of bathroom walls where there is a high concentration of moisture inside the building.

The mineral paint coating, along with the drying channels between the foam insulation and the back face of the brick, allows water vapor to escape to the atmosphere instead of being trapped within the masonry. It's a low-VOC, noncombustible coating that can fill gaps up to 3mm wide and pass the ASTM E514 wind-driven rain test. We also applied Prosoco Siloxane WB, a water-based water-repellent penetrating sealer, to all masonry surfaces.

Basement. After spending weeks early in the project removing debris, we were pleasantly surprised to find a concrete basement floor and tall, massive stone foundation walls in incredibly good shape. We hit the jackpot with these 8-foot-tall walls.

We decided to demo the existing concrete floor because it wasn't level and was in poor condition. By doing so, we were able to add a 6-mil vapor barrier underneath the new slab, a critically important measure for controlling moisture in the building. Once we had the building envelope restored and weathertight, finishing up the project proceeded more or less conventionally.

HISTORIC PRESERVATION

Why undertake a project like this if it's more difficult than to tear down and build back? Natural resources can be conserved because of embodied energy in the existing materials. Preservation can be cost effective because of the initial low purchase price and use of sweat equity to create value, and historic tax credits can reduce project cost by 20% for residential and 40% for commercial rehabs.

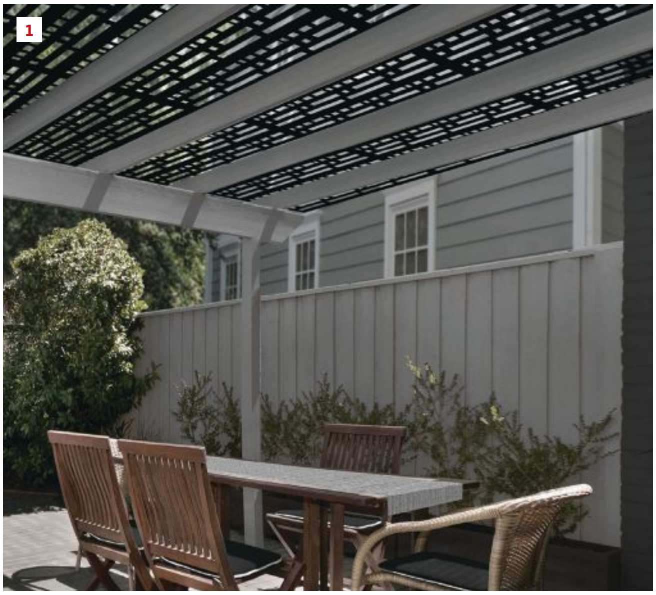
A project like this also has social value. Old buildings are part of the community fabric and provide a bridge from the past to the present and on to future generations. Unlike many other material objects in our lives, they are used regularly and can last a very long time if maintained. They provide a sense of time and place, reminding us of our mortality and fleeting time on this planet.

Darren Tracy, P.E., owns West Branch Engineering, a consulting firm, and West Branch Inc., a construction firm, in Saratoga Springs, N.Y.

Select cedar prefinished with an oil-based primer and two coats of latex paint was used to replace rotted exterior trim **(21)**. The repaired brick walls were coated with Silacote mineral paint **(22)**. Now restored from its former dire condition **(23)**, Dr. Ferguson's Office has been transformed into an attractive rental property **(24)**.

Products

BY VINCENT SALANDRO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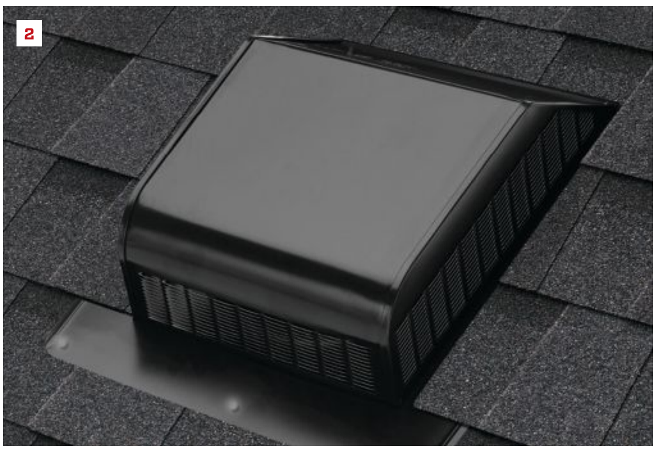
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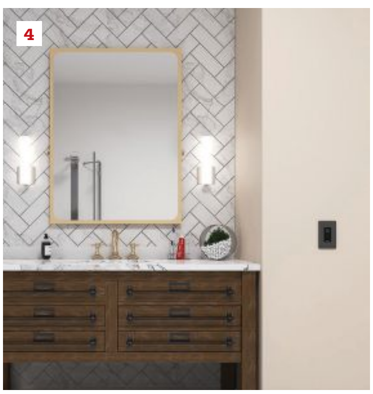
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1. Versatile Paintable Panels
Barrette Outdoor Living's Decorative Screen Panels can be used as under-deck coverage or be applied in numerous interior and exterior applications. The impact- and scratch-resistant panels are available in two sizes—2 feet by 4 feet and 3 feet by 6 feet—and in numerous patterns. Made from polypropylene, the panels can be painted or trimmed, and they remain stable in extreme weather and temperature changes with minimal expansion or contraction, Barrette says. barretteoutdoorliving.com

2. Roof Ventilation Solutions
TruRidge Pro 25, HighPoint AL 50 Slant Back, and HighPoint GL 50 Slant Back (pictured) from Atlas Roofing may help to reduce excessive attic heat and moisture for roof pitches 3/12 through 8/12. TruRidge Pro 25 provides the rigidity of a sectional ridge vent with a lightweight roll; HighPoint AL 50 and GL 50 vents have a durable, one-piece weathertight base and throat made from aluminum (AL 50) and galvanized steel (GL 50). atlasroofing.com

3. Dual Fuel Heating System
The intelli-Heat Dual Fuel System from Mitsubishi Electric Trane HVAC US connects with any thermostatically controlled furnace. During periods of extreme cold, intelli-Heat may switch to a home's gas furnace as needed using its intelligent switchover function. The unit connects to single-zone P-Series cooling-only or heat-pump units and multizone MXZ heat-pump units and is available in 18-, 24-, 30-, 36-, and 42-kBtu/h capacities. Hyper-Heating Inverter models provide 100% heating capacity down to 5°F outdoor ambient temperature and guaranteed operation to -13°F. mitsubishicomfort.com

4. Hands-Free Light Switch
Legrand's Wave Switch offers homeowners cleaner lighting control. Touchless technology allows users to turn lights on or off with a wave anywhere from 1 inch to 6 inches away from the switch. The Radiant-series Wave Switch is available in 15-amp and 20-amp versions; both feature screwless wall plates and come in metallic and standard color finishes. Pricing starts at $70. legrand.us

5. Indian Black Palm Cladding
PalmShell from Smith & Fong is derived from Indian black palm, a hard, dense wood with a fibrous grain. The manufacturer says the cladding is sustainable and durable and uses an easy-to-install groove/lap system that reportedly works well for rainscreen applications. Black palm's weather resistance allows PalmShell to be installed and finished using standard exterior-grade clear finishes. Cladding boards are milled in 96-inch lengths with a $3\frac{1}{4}$-inch width and $\frac{3}{4}$-inch thickness. durapalm.com

6. Self-Adhered Waterproofing Underlayment
Zip System peel-and-stick waterproofing roofing underlayment from Huber Engineered Woods provides an additional layer of protection against water intrusion due to ice dams or wind-driven rain. The self-adhered underlayment is applied to roof sheathing and can be used in valleys, eaves, transitions, or the entire roof. It has an embedded pull cord to split the liner, requires no fasteners, covers up to 200 square feet per roll, and is slip resistant. Its rubberized asphalt composition seals around roof-covering nails. huberwood.com

7. Smart Control Switch
Part of a smart home–enabled product line developed by Panasonic and Swidget, the 20/40/60 Control Switch has a port that accepts a variety of Swidget inserts, such as a Wi-Fi control and an air-quality sensor, for remote or automatic operation of ventilation devices. A 4-wire interface allows for simple installation in single-pole or dry-contact applications. The switch has three timer settings—20, 40, and 60 minutes—that can be used without an insert. With a sensor insert, it can automatically turn a bathroom fan or an ERV on and off based on occupancy, air quality, or humidity. swidget.com

8. Thermoformed Countertops
Cambria's 6mm surface thickness allows for weight-sensitive applications, as well as for backlighting, thermoforming, and wall cladding. For use in curved applications, such as the reception desk pictured at right or kitchen islands, the quartz slabs are milled down by fabricators to 4mm before being thermoformed to the desired shape, according to the manufacturer. Available in 10 designs, Cambria's 6mm surfaces have the durable, low-maintenance, and nonabsorptive qualities of quartz. cambriausa.com

9. Window-First Installation Solution
DuPont's Tyvek IntegrationWrap is designed to integrate DuPont self-adhered window flashings with Tyvek weather-resistive barriers when the window has been installed first. Made from a coated, woven polypropylene material, the membrane incorporates additives to provide ultraviolet light resistance, though DuPont requires IntegrationWrap be covered within four months of installation. Maximum in-service temperature, according to the manufacturer, is 180°F. dupont.com

10. Dual-Layered Insulated Sheathing
LP NovaCore Thermal Insulated Sheathing combines sheathing and insulation, allowing for one-step installation. One-inch XPS foam and $^{7}/_{16}$-inch OSB are bonded together to create an R-5 insulated wall panel that can be handled, cut, and drilled like OSB. Panels may be installed vertically and horizontally, provided that all edges are blocked or otherwise supported. NovaCore is available in nominal lengths of 8, 9, and 10 feet, and panels are reportedly backed by a 20-year warranty. lpcorp.com

11. Deck-Board Cladding
MoistureShield Vision and Meridian capped wood-composite decking lines are approved for use as both horizontal and vertical cladding, offering what the manufacturer says are durable, low-maintenance finishes that resemble natural hardwoods. Made with 95% recycled content, the solid, 1-inch-thick boards are protected against moisture absorption, warping, rotting, and damage from insects on all four sides. The cladding is available in 12-, 16-, and 20-foot lengths in 6-inch widths and nine color options. moistureshield.com/products/cladding

12. Architectural Siding and Trim Collection
The Hardie Architectural Collection comprises five Hardie Architectural Panels in nature-inspired textures and 14 metal Hardie Architectural trims. The manufacturer says that the fiber-cement panels are low maintenance, noncombustible, and weather resilient, and that they install more efficiently than traditional building materials. The collection is James Hardie's most significant expansion beyond wood-look exteriors. Textures include sea grass (shown), fine sand (with and without grooves), mounded sand, and sculpted clay. jameshardie.com

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Advertising Index

Filter-free Air Scrubber

BY TOM O'BRIEN

I learned ages ago that clients wouldn't appreciate my flawless miters if they came home to find their living spaces covered in sawdust. Over the years, I've amassed a sizable collection of vacuum-attached power tools and dust containment products, but I'd never found an affordable—or portable—option for filtering breathable air within a workspace until I discovered the Dust One, a 25-pound air scrubber on wheels from Vortex Dust Control Solutions **(1)**.

Cyclonic design. At first glance, all I could think about was the robot in the classic TV series *Lost in Space*, but the manufacturer of the Dust One assured me that its distinct, robot-like appearance is purely functional. Instead of trapping airborne contaminants in filtration material, it sucks particles into a cyclone that spins them out via centrifugal force and drops them into a collection bin at the bottom **(2)**. Essentially this is a compact, portable variation on the technology that many woodworking shops use to capture sawdust.

A significant advantage of cyclonic design is that it eliminates the need for expensive filters that clog up and frequently have to be replaced. The maker claims that the Dust One removes over 99% of airborne contaminants and meets OSHA standards. For emptying the collection bin when it fills up, Vortex suggests using a HEPA vac.

Double duty. As with other air scrubbers, this device can be set up in one place and run continuously to make air safer to breathe and prevent dust from escaping the work zone. To create negative air pressure, the 4-inch round exhaust port is easily connected to flex duct and vented outside.

A unique feature of the Dust One is its extendable intake port **(3)**, which enables users to capture dust at the source, before it spreads throughout the work zone. Lockable wheels and handles on both sides of the top-mounted motor make wheeling the unit from place to place effortless. Its noise level (55 dB according to the specs) was noticeable but not bothersome, even when it was running continuously.

Performance. Over a matter of months, I put the Dust One to use on every dirty job that came along: mostly drywall sanding and woodworking but also a bit of concrete grinding and some demolition work. I did not have the ability to perform dust sampling, so I can't provide quantitative evidence, but qualitatively speaking, I think the difference in the air between when the machine was running and when it was off is like comparing the air in Aspen to the air in Mexico City.

After pole-sanding a roomful of drywall on a hot summer day, I was particularly impressed that the visible dust accumulation on horizontal surfaces was negligible, and what stuck to my face

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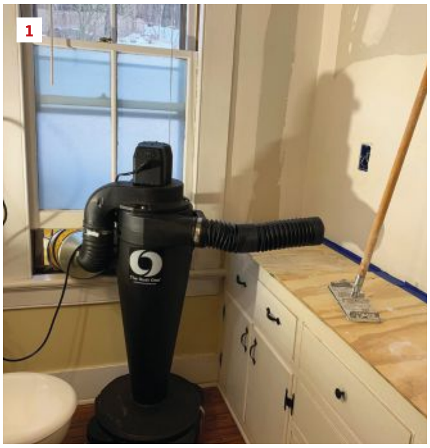

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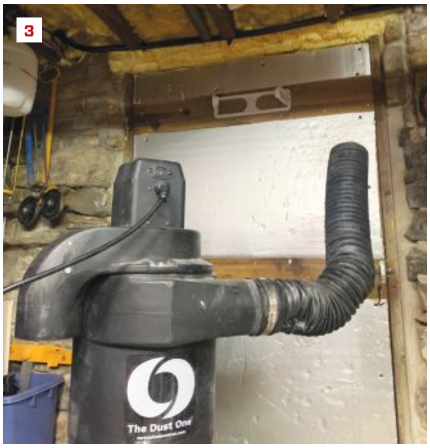


Photos: Tom O'Brien

The Dust One air scrubber uses cyclonic technology, rather than filters, to separate contaminants from breathable air **(1)**. Centrifugal force drives airborne particles away from the vortex and drops them into a collection bin at the bottom, which can be emptied by a HEPA vac when it fills up **(2)**. In order to capture dust at the source, the flexible inlet extends almost 3 feet, bends in any direction, and stays where it's put **(3)**.

did not make me look like a mime. I want to believe that if this air scrubber was used alongside a vacuum-operated sanding system, one could possibly dispense with dust curtains altogether; I should test out that hypothesis on my own house first. Happily, a few weeks after I started using it in my home workshop, which shares a basement with our washer and dryer, I noticed that my wife was no longer asking me if I could "please cut those damn things outside."

According to Vortex, the Dust One is particularly well suited for demolition work. On a recent project, it did a splendid job of tamping down the mess generated from tearing out drywall, fiberglass insulation, and other modern building materials. The next time I have to gut out a roomful of 100-year-old lath and plaster, I will be more than happy to be able to put it to use.

On the jobsite, the Dust One was nimble as well as effective. Getting it to the job was not quite so effortless. It's half the weight of my benchtop power tools but twice as bulky. The top-mounted handles are useful for wheeling it around but not so much for carrying. On those occasions, what worked best was to grab it around the middle, tip it so it was horizontal, and carry it under one arm as if it were a rug. The unit and the box containing the manufacturer's 6-inch-by-25-foot exhaust duct wanted the bed of my compact pickup almost all to themselves. But that serves me right for downsizing.

The Dust One is made entirely in the USA, assembled in a small shop, and not subject to supply chain issues. It's available directly from the manufacturer for $1,035. A starter kit that includes exhaust duct costs $1,154. vortexdustcontrol.com

Tom O'Brien is a carpenter and freelance writer in New Milford, Conn.

Skil Jobsite Table Saw

BY MARK CLEMENT

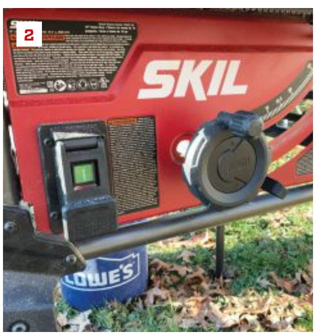
I work alone, so I sign the contract, do the design, carry the tools, and pick up the trash. I also store the tools in my tool truck. Carrying and storing were the weak spots in my game, though, especially my table saw. It was too big and too heavy for what I needed it to do, and its folding stand served no purpose other than to waste space in the truck.

In my quest to find a truly portable saw that sets up quickly and doesn't take up more acreage in my truck than necessary, I zeroed in on the Skil TS6307-00 10-inch jobsite table saw. In short, the saw is awesome. Compact. Powerful. Smartly designed. Not only does it solve the specific suite of problems I had with previous table saws, but its well-executed design features generalize into a whammer slammer of a table saw for just about anybody who has to carry one from here to there, then rip a mile of lumber with it.

Out of the box. Unlike table saws that ship with stands that require assembly, this one has folding legs that lock and unlock with a push of a bottom. The legs are rock-solid, and the splay keeps the saw stable for ripping long stock. There's no outfeed support, but that's not an issue for me since most supports I've seen don't work very well anyway. The saw is very light (Skil says it weighs 51.2 pounds) and has nice, overmold grips to carry it like a tray. On its right side is a handle for carrying it like a satchel; I use that to tie the saw to a bar in my truck so I can store it vertically and free up floor space.

On my saw, the tall, rack-and-pinion fence was parallel to the blade right out of the box, and the blade height adjustment is as smooth as on any tool I have ever used. The bevel is light, easy to adjust, and doesn't fall to a default 30-degree angle upon disengaging the quick-release lever.

The power switch is a push-button-on/paddle-off setup. The problem is, you have to reach through the paddle switch to turn it



Photos: Mark Clement

Skil's TS6307-00 10-inch table saw has sturdy fold-out legs **(1)**. The author found that the paddle-off switch sometimes interfered with the smaller, push-button power-on switch **(2)**. The plastic throat plate locks securely into place **(3)**, and the saw is light enough for easy one-handed transport **(4)**.

on. In doing so, it's way too easy to immediately turn the tool off if your finger taps the paddle. A simple fix would be to make the "on" opening wider. I think many users may remove the paddle in real life; instead, I lift the paddle a little to hit the on button. It works, and I won't be tempted to modify the tool.

The unit has—and I love this—an electric brake that works at least 50% to 75% of the time. This may be a function of the fact that I got an early model, but that it works at all is awesome: 50% of electric brake is 100% better than no electric brake at all.

The plastic throat plate locks into the table and releases with the push of a button, so it stays put instead of ending up on the floor of my truck. The included push stick has dedicated storage, so when I carry the table saw like a tray, or store it in the truck, the push stick doesn't wiggle loose or fall out.

Power and performance. Despite its light weight, the saw hits like a heavyweight and can suck all the amps out of a 15-amp breaker (ask me how I know). It has a maximum cutting depth of 3 1/2 inches, which enables me to plow through 4-by stock, and has the power to do it if it has enough juice. I've used it to bevel 2x6 stock for barn sash windowsills at a full-depth 12-degree bevel and to rip 5/4 pressure treated stock to width for a deck renovation. On that project, it easily handled the extra 2x8s that needed to be ripped to 2x4s. Even maple 1-by stock for a kitchen remodel was no match for this tool.

Dust collection. The blade is housed, so sawdust and shavings go down and out instead of flying all over the place. A 22.5-degree elbow directs the dust down; on a shed for which I did a good bit of ripping, I shot the dust into a 5-gallon bucket and, by volume, captured 10 gallons of dust. The chute can clog up, especially with long rips in wet treated deck boards, but not that often.

Storage. Because the legs fold into the saw frame, storing it is what I call "cubular." There's no handle or rail or wheels, as would be required to move a larger table saw. So while it still has a blade-right rip capacity of 25 1/2 inches (something I have nearly zero use for), it folds up tight and sits like a box on the truck floor.

Currently available for less than $300 (at Lowe's), this is a value-priced jobsite saw that more than holds its own against the higher-priced competition. skil.com

Mark Clement is a small-town carpenter in Pennsylvania and author of The Carpenter's Notebook, A Novel*. Follow him at @MyFixitUpLife.*

Kapro Ledge-It Square

BY TOMMIE MULLANEY

All carpenters have a vital set of tools in their toolbelts, and one of those tools is guaranteed to be some sort of square. Over the last few months, my toolbelt has included Kapro's 353 Ledge-It square, sort of a try square on steroids with some interesting innovations. The Ledge-It, which comes in 8-, 10-, 12-, and 16-inch versions—I tested the 12-inch square—has a cast aluminum handle and a stainless steel ruler with conveniently placed etchings and holes every 1/2 inch (every centimeter for metric) for fluid pencil marking at common angles.

Ledge support. The square has a retractable metal ledge support inside the handle, a small feature with a large impact on how the tool can be used. Without a ledge support, you often have to balance the square on the edge of the wood, and it can be tricky to hold the square still while you're marking the workpiece. This retractable ledge takes that instability out of the equation, allowing you to make marks along the ruler with confidence. And if you don't want to use it, the ledge support tucks away inside the handle.

Common angles. As on most squares, common angles are etched on the ruler to make workflow easier and more efficient. In addition to the etchings at 10, 15, 22.5, 30, 45, 50, and 60 degrees, there are holes for pencil marking. I'm a fan of stainless steel rulers on a jobsite for their durability and accuracy, and these etchings offer great clarity and should stand up to everyday jobsite use.

Accuracy. Kapro says that the 90-degree angle on its square is certified. When I checked the square's accuracy (by marking a line, then flipping the square over on the same edge and marking a second line), I found it to be about 1/64 inch out of square; that's more than accurate enough for most carpenters. For more accuracy, I would need to spend a lot more money for a square with smaller tolerances. As it is, the 12-inch Ledge-It is priced at $25, a great value for most general carpenters and hobbyist woodworkers. kapro.com

Photo: Tommie Mullaney

The Kapro Ledge-It square gets its name from a small but handy retractable support that folds back into the handle.

Tommie Mullaney owns Mullaney Woodworks in Naples, Fla. You can visit his web page at mullaneywoodworks.com or follow him on Instagram at @Mullaneywoodworks.

BY JIM BENNETTE

A New Copper Top

On Google Maps, this landmark is called Holbrook Tower Windmill, though most locals call it the Hyannisport Lighthouse, or even the "Salt Shaker." But it's actually a former water tower, built in 1907 to supply water to the nearby Holbrook Cottage, a private home perched on the village waterfront. When the sunlight reflects off its new copper roof, it's easy to understand why visitors to Cape Cod's Hyannisport, Mass., might misidentify this structure.

We installed that roof last year as part of a major renovation of the tower itself. Once, the tower was equipped with a 14,000-gallon cypress water tank on the top level and an area for coal storage in the base, but it had been converted to an artist's studio in the 1980s. When the current owners purchased the property in 2012, they had plans to renovate the tower along with the house and carriage barn, a project that picked up steam in 2020. I became involved after the general contractor—E.B. Norris—removed the tapered octagonal roof and trucked it off-site to rebuild the roof framing and install new sheathing **(1)**.

We were fortunate to be able to do most of the copper work off-site too, starting by covering the new sheathing with Carlisle WIP 300HT, a high-temperature, self-adhering roofing underlayment suitable for use under metal roofs. Next, we installed a copper drip edge that we had fabricated around the perimeter of the roof, sealing the drip edge to the underlayment with Zip System flashing tape applied over the drip-edge flange **(2)**.

We fabricated the drip edge from cold-rolled 20-ounce sheet copper from Revere Copper Products, the same material we used for the tapered roof panels. Following the project architect's specifications, we joined the panels together and to the drip edge and hips with flat-lock seams, using as few soldered joints as possible **(3)**.

Because the octagonal roof needed to be lifted back into place on top of the tower with a crane, the carpenters omitted sheathing from the very top of the roof so that the riggers could attach the crane's cable directly to the rafters. They also fabricated a separate bell-shaped finial to match the original out of solid pressure-treated lumber that we clad with soldered copper panels. The finial has a hole bored through the center for a solid copper lightning rod, which is attached to a braided copper wire that extends all the way down through the structure to a rod driven into the ground **(4)**.

After the riggers lifted the roof into place and carpenters reattached it to the 60-foot tower, we installed the final course of sheathing, membrane, and copper roofing, working from an aerial lift **(5)**. Finally, we installed the finial, carefully soldering it in place so that the new roof would withstand another 100 years of getting hammered by coastal wind, rain, and sun **(6)**.

Jim Bennette owns and operates J Bennette Roofing Inc., in Sagamore Beach, Mass.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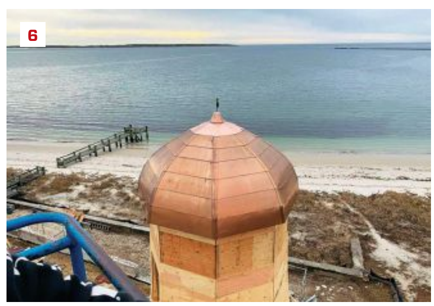
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Photos by Jim Bennette and Tim O'Neill

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