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On the cover: Carpenters Alex Strugatskiy and Ryan Bielenda, of Maine Passive House, site-assemble a heavy LVL carrying beam for a custom home in Greenwood, Maine. See the story on page 39. Photo by Ted Cushman.

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DEPARTMENTS

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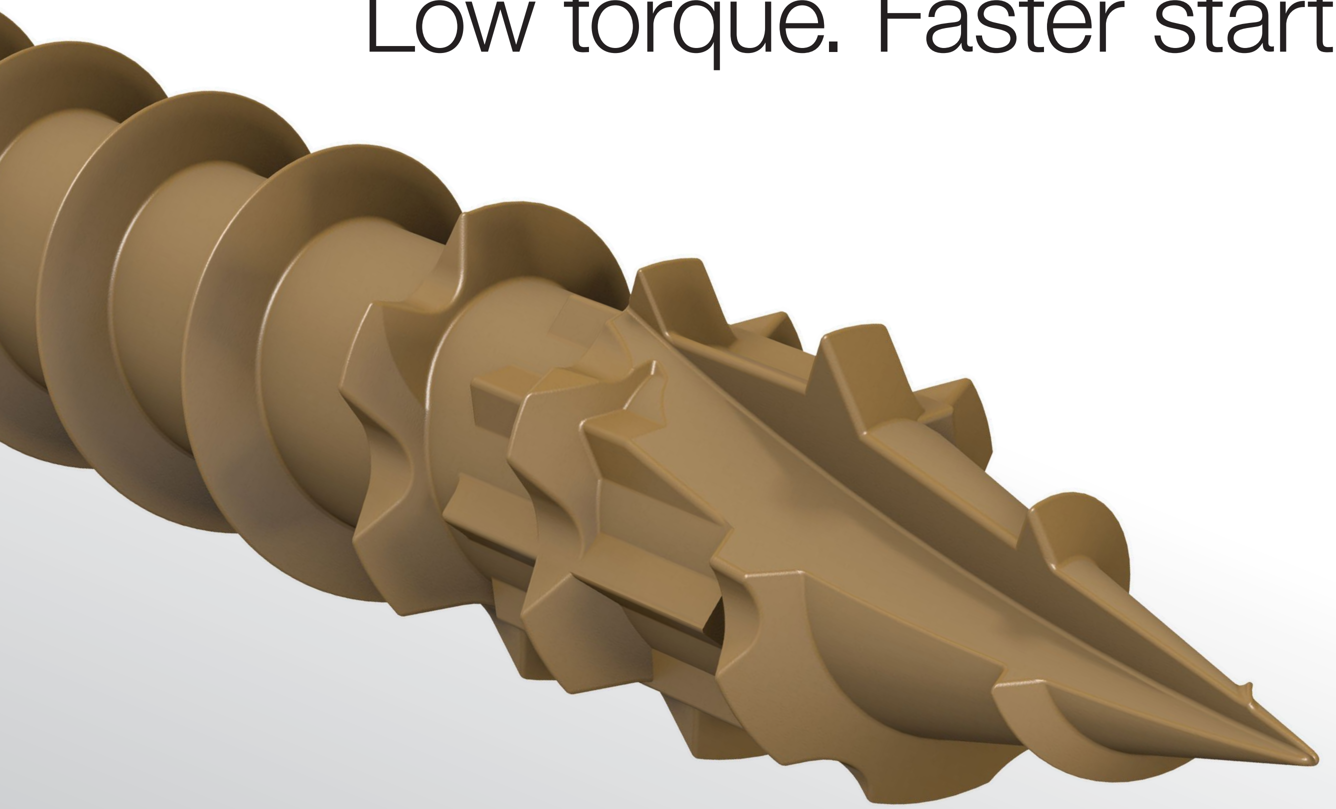

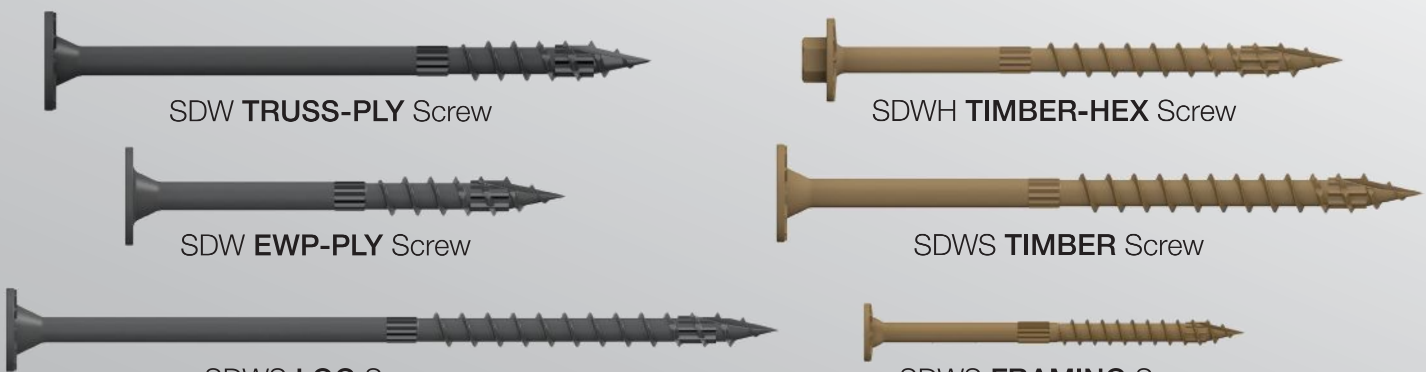

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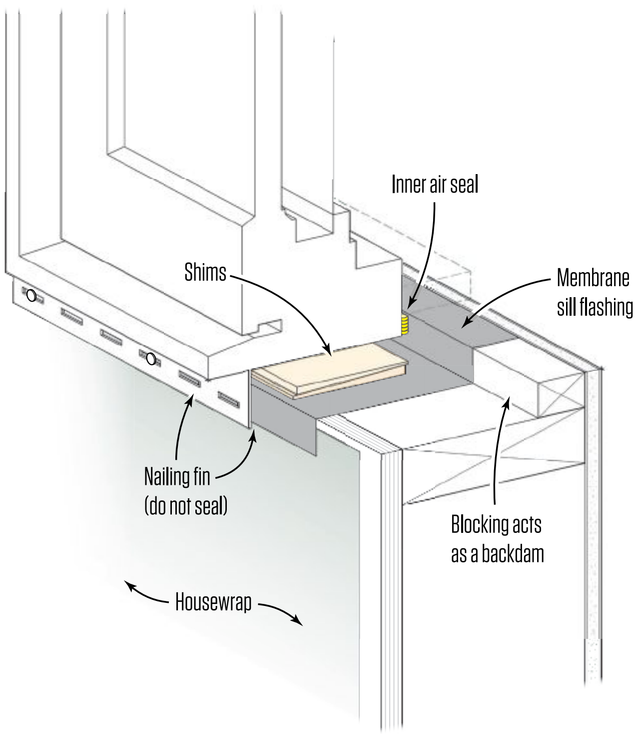
BY JLC STAFF

Air-Sealing Windows

Window Sill Detail



Air-sealing a window is distinctly different from flashing a window. Flashing is done to keep water out. It can't completely stop air because the bottom needs to be left open to allow water to drain out of the assembly. A window's air seal, on the other hand, is typically applied from the interior. The bottom of the window is sealed along the backdam, as shown in the illustration above. This bead of caulk should be applied when the window is installed. As a backup to the inner seal shown above, a fillet of caulk can also be applied in the corner between the blocking used as a backdam and the window unit, as shown in the photos on the next page.

Illustration by Tim Healey

Windows are complicated, big openings in a house that can leak both water and air. This article focuses only on air leaks around windows. Preventing water leaks gets even more complicated. (As an example, the article on page 24 shows one method that works with Zip System sheathing. The methods vary when you use a housewrap and vary further depending on whether the window has a nailing flange or not. For much more, search JLConline + window flashing).

While window flashing is often performed by an advanced installer, air-sealing windows is often a task that builders assign to novice carpenters. That should not be construed as this being a less important task. Both the air barrier and the water barrier are vital to building performance.

The goal in air-sealing windows is to seal the gap between the window rough opening and the window unit. Most *JLC* veterans know they can't do this by stuffing window gaps with fiberglass insulation. That was a seriously flawed, old-school method. These days, you're more likely to be handed a can of closed-cell foam, or a roll of backer rod and a caulk gun.

WHY WE AIR-SEAL

Like any task, air-sealing is best done when we understand why it's important. Here are some principles to keep in mind:

• **Air carries both heat and moisture.** We air-seal buildings to keep conditioned air (warm or cool, depending on the season) inside the home, and to keep unconditioned air outside. Air-sealing also stops moisture-laden air from leaking through the building and condensing onto cold surfaces inside walls.

• **Air is moved by pressure differences.** Wind blowing against a house can push or pull air out through cracks. Fans inside the home can also build up pressure that pushes air through a building enclosure.

• **No gap is too small.** When you seal the gap around a window, you need to remember that any break in the foam or caulk can allow pressurized air to escape. Don't rush the application.

SEQUENCE OF STEPS

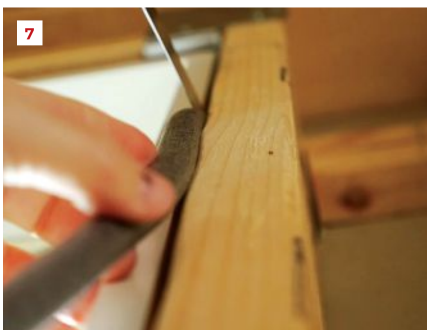
Window air-sealing typically takes place after the window is installed, but there is one exception: If a backdam is used, it's best to apply a bead of caulk along the outer face of the backdam while the window is being installed (see "Window Sill Detail," previous page).

Instead of a backdam, some builders may use a piece of beveled siding on the rough sill. The bevel slopes to the outside and helps drain away water that might leak through the window. In either case, there is not enough room to seal the inside with foam; the bottom must be caulked tight instead.

The photos that follow show the steps to sealing a window with foam sealant. As an alternative to foam, you can also use a foam backer rod and caulk, as the last couple of photos demonstrate.

Start with good tools. A professional-grade caulk gun and foam gun (not a plastic straw) provide needed control **(1)**. On this window, foam is applied on both sides and across the head. The carpenter started at the upper right corner and pulled a bead down the right side of the window **(2)**.

After completing the right side, the carpenter returns to the upper right-hand corner **(3)** and pulls a bead across the window head **(4)**. Note that jamb extensions have not yet been installed, and the carpenter has inserted the gun's tip deep into the gap, so the cavity fills from the back forward as the foam expands. Finally, the carpenter turns the corner and works down the left side **(5)**.



Complete the air seal by caulking in the corner between the backdam and the window **(6)**. Caulk can also be used to seal the wide gap at the sides and head of the window. Many builders prefer a more flexible seal, but in order to make caulk work, the gap must be filled with a foam backer rod first **(7)**. Backer rod allows you to apply a thinner bead of caulk **(8)** that will remain flexible.

Photos: 1–6, Tim Healey; 7 & 8, Matt Risinger

For a more detailed discussion on air-sealing windows, go to **www.jlconline.com/training-the-trades/airsealing-windows**.

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When does the electrical code require pigtails for connecting devices in residential wiring?

A Ben Giles, licensed electrician and owner of South Shore Electrical Contractors, in Wakefield, R.I., responds: "Pigtail" is a slang term in the electrical trades for a junction of a group of conductors, where a lead conductor is added to connect that junction to a device or fixture **(1)**. Using a pigtail allows the circuit to run continuously whether or not the device is attached; that is, the circuit won't be interrupted or affected if the device is removed. Pigtails are common in outlet and switch wiring, particularly where there are more than one or two sets of conductors in the electrical box, and the installer doesn't want to rely on the device attachment screws to carry the load of the circuit. They are also common in those instances where the code requires pigtails, such as for attaching ground conductors to a device.

NO PIGTAILS IN THE CODE

To the best of my knowledge, the term "pigtail" never appears in the code. Instead, the code approaches the situation from a reverse angle by laying out instances where using the screws on a device to continue certain conductors is not allowed. One example of this approach is section 300.13b in the code, which states: "In multiwire branch circuits, the continuity of the grounded (neutral) conductor shall not depend on device connections such as lamp holders, receptacles, and so forth, where the removal of such devices would interrupt the continuity."

In multiwire branch circuits, more than one circuit coming from the main electrical panel shares the same neutral conductor, such as when 3-wire cable runs from the panel with the black conductor and red conductor controlled by a two-pole breaker while using the same white (neutral) conductor. The code says that when you are using one neutral to serve two separate 120v circuits, you have to junction and pigtail the neutral at each device. That way, if you remove the device, you don't accidentally disconnect the neutral that is also serving the second circuit.

In another example, section 250.148b in the code states: "The arrangement of grounding connections (the bare ground wires) shall be such that the disconnection or removal of a receptacle, luminaire, or other device fed from the box does not interfere with or interrupt the grounding continuity." This means that ground conductors should always be pigtailed so that removing a receptacle or switch does not disconnect the ground to the rest of the circuit. When pigtailing the grounds in new construction, I twist all of them together with several turns and then cut off all but one for each device in the box **(2)**. I then secure the ground junction with a copper crimping sleeve **(3)**.

If you want to use the screws on a device to continue a regular two-wire, 120v circuit, nothing in the code prohibits it as long as the circuit you are continuing falls within the UL-listed pass-through ampacity rating of the device you are using. In other words, the device—such as a receptacle—would have to be heavy-duty enough to handle the load of the entire circuit downstream from the device.

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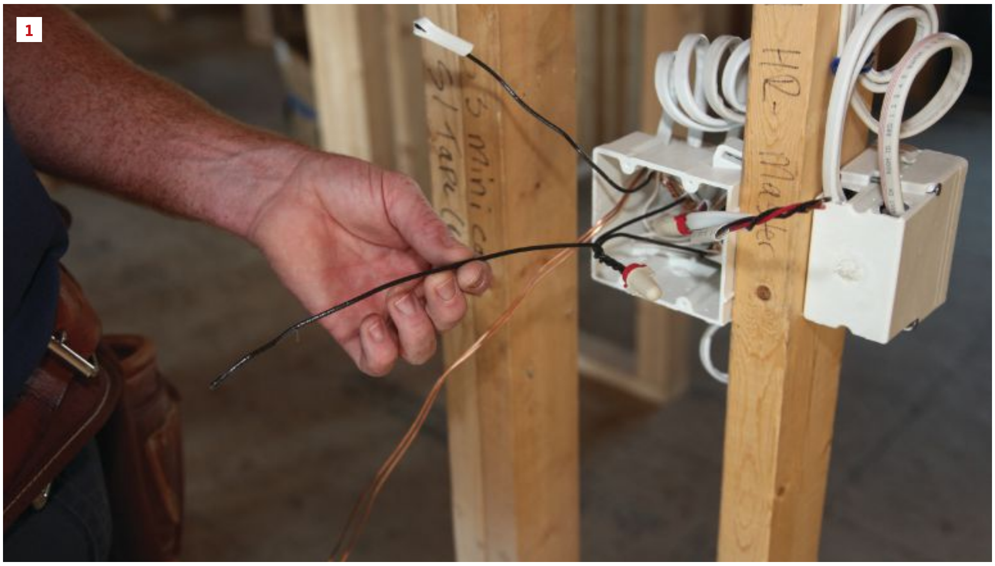

A pigtail is a short length of conductor that is added to a junction to connect to a device (such as a switch or receptacle). The alternative would be to attach the conductors directly to the device. With the pigtail connection, the circuit would not be interrupted if the device failed or was removed.

Photos by Roe Osborn

Some local jurisdictions require pigtails for connecting devices. And in fact, some states have amendments to the code requiring that all devices having more than one set of conductors be connected to the circuit with pigtails rather than via the screws on the device. The other part of this equation follows common sense. If you have three or four sets of conductors but only two screws on a device, you probably wouldn't want to use both screws and both sets of backstabs to continue a circuit.

PIGTAILS IN EVERYDAY WIRING

In my everyday work as an electrician, I use pigtails for connecting devices whenever there are more than two sets of conductors passing through a device in a residential application. I would never attach conductors to all the screws and then add another conductor to the backstabs on a device as well. I try to wire the switches and receptacles in every house in a consistent manner ("Wiring Receptacles and Switches," Sep/17), so I've never had an issue troubleshooting a circuit or felt that it made any tangible difference to pigtail instead of using device screws. I also use pigtails on circuits where I don't want to rely on the devices to carry what may potentially be a higher load, such as in a kitchen or on a garage workbench.

As a matter of course, I pigtail the devices in all commercial and industrial work. Troubleshooting an electrical problem in a busy office or shop can be difficult enough while people are working, and I don't want to have to tell employees to take a break while I remove a device. If the outlets are all pigtailed, I can remove one and leave the rest of the circuit hot and usable while I inspect or replace the faulty device. Also, the load applied to any circuit is likely to be higher in a commercial application. Whether the business is a hair salon, a bakery, a restaurant, or other establishment, people tend to overuse the power provided, and I trust the junctions and pigtails that I make more than I trust the devices themselves to handle excessive loads.

I know that this reply is likely to run contrary to what some electricians believe: that it's required by code to pigtail the conductors at every outlet. I think that belief is probably just an example of people mistaking how they were initially trained with the actual code requirements. That said, be sure to follow any state or local code amendments in your area that may have added a requirement for using pigtails at every device. Pigtailing devices is certainly a good practice that I can't argue with, but from a business standpoint, I can't justify the extra time spent on the practice in situations where I know the loads will be lower or where troubleshooting will be relatively easy, such as in residential bedrooms.

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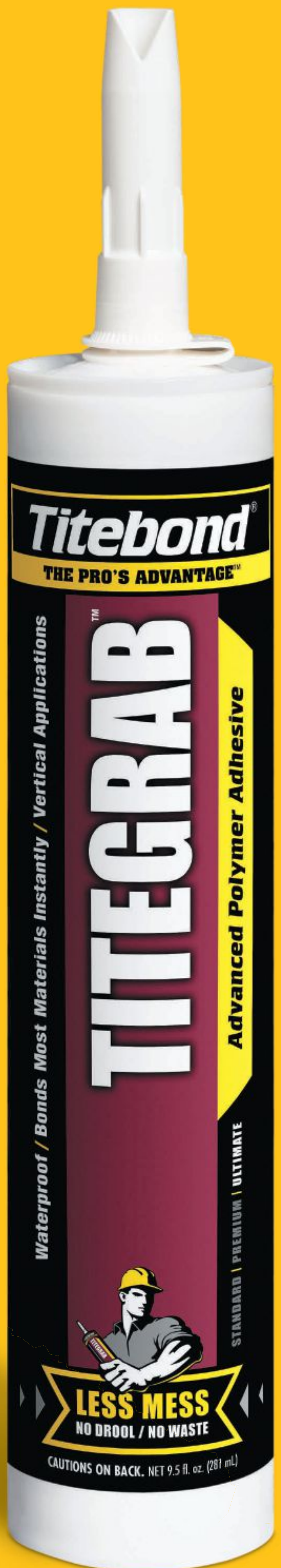
The code requires that all ground conductors be connected so that the continuity of the ground is not interrupted if the device is removed. This requires a pigtail, but making a pigtail for ground conductors requires a specific approach: First, twist the bare ground conductors together for several turns, and then cut off all but one for each device in the electrical box **(2)**. To secure the junction, slide a copper sleeve onto the twisted conductors and crimp the junction with pliers **(3)**.



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Photos by Tim Healey

Installing Lift-and-Slide Doors

BY TED CUSHMAN

High-performance windows and doors are an essential feature of an advanced energy-efficient home. And when the house is a high-end custom project sited on a property with sweeping water views, architects these days are likely to call for European-style lift-and-slide glass doors.

With triple or quadruple glazing, thermally broken frames, and beefy hardware, those Euro units get heavy fast. So while they offer superb insulating qualities, airtight seals, and easy operation, they are not easy to install.

This winter, Hayward Design Build (hayward designbuild.com) installed two lift-and-slide units in a custom home on the shore of Lake Champlain in Vermont. *JLC* editor Tim Healey was on site to see Jim Bradley, along with framing contractor Mike Lovejoy and a crew of carpenters, set the massive units into a foot-thick, double-stud wall. Even with extra hands on site, Bradley said, just moving the doors around was a challenge **(1)**: “They weighed about 750 pounds apiece without the slider, and more like 950 pounds with it.”

Lift-and-slide doors need stiff headers; typically, manufacturers specify deflection no greater than 1/16 inch at mid-span. That usually requires a steel header, and this case was no exception—structural designer Chris Hill (engineeringventures.com) called for a steel I-beam skeleton outlining the door openings and supporting the overhanging roof above.

Heavy steel in a wall always complicates the energy calculations, because of steel’s thermal conductivity. In this design, the steel lies outboard of the insulated wall assembly, bearing on its own foundation footings.

The interior floor is an exposed polished-concrete slab, and that mass also had to be thermally broken from the exterior-exposed concrete footing. “We used 6 inches of rigid insulation board to separate the slab from the stem wall,” Bradley noted. “I told the foundation crew to run the foam proud and then pour the slab. Before we set the door, we cut the foam off flush with the top of the slab **(2)**. Then we injected one-component expanding foam to fill the gaps between the rigid insulation and the concrete stem wall **(3)**.”

PREPPING THE OPENING

After the foam was trimmed flush at the door opening, Mike Lovejoy prepared the door sills by screwing down a strip of treated plywood to span from the outer 2x6 mudsill in over the 6 inches of rigid foam **(4)**. The plywood protected the foam insulation and provided a solid, continuous substrate for wide Siga Fentrim self-adhering weather barrier membrane **(5)**.

The low-expansion gun foam that had just been injected below the plywood continued to expand slightly to seal the plywood into place, Bradley said, adding a redundant layer of air-sealing as a failsafe for the adhesive-backed Fentrim.

"Later, we are going to come back with a riftsawn oak threshold that will bridge from the plywood to the polished concrete floor," Bradley explained. "And the nice thing about the wide Fentrim fabric is that it has a split back. We left the paper backing on the inside part of the piece. Then once the threshold goes in, we are going to bend the Fentrim upwards, perpendicular with the floor, and stick it to the threshold to get an air seal there as well."

On top of the Fentrim, the crew ran a bead of silicone adhesive caulking to seal the door sill down to the fabric **(6)**. Around the sides of the doors, they sealed the sheathing to the jack studs with Siga flashing tape **(7)**. "We're also going to slide rigid insulation by the sides of the doors, inject foam into the gap, and seal on both sides with Siga or ProClima tape," said Bradley.

MANHANDLING THE DOORS

With the openings prepared, the next order of business was to get the massive door frames set into place and correctly plumbed, leveled, aligned, and fastened. For this step, the crew had help from consultant John Mokas, an expert in Euro-style doors and windows who spent years learning the craft in Germany and Greece.

"These are baby doors," Mokas told *JLC*. "If you want to see big doors, I'll show you some pictures." On some other jobs, he said, doors were too heavy for muscle power. Mokas has gone as far as to install an electric hoist on the roof of an apartment building and cut holes in the floors below for a steel lifting cable.

Still, a half ton is no small door—especially since the home's roof overhang on this site made a crane impractical. To roll the doors around the concrete floor, the crew relied on heavy-duty floor dollies, along with a site-built wooden cradle on casters devised by carpenter Richard Coffin **(8)**. "Those worked great," said Mokas. "They were a big help."

Mokas was also a big help, said Bradley, especially with advice on the fine points of aligning the door components and adjusting the mechanisms. "They have to


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be spot on, and they're not like ordinary doors," Bradley said. "You have to use lasers. If they're not completely plumb and square, then they're going to whistle when that wind comes in off the lake."

A level base is critical, Mokas told *JLC*; if the track slopes even $\frac{1}{8}$ inch, the door may be easy to open but hard to close (or vice versa). Beyond that, he said, maintaining square and plumb may be less critical than making sure that the doors align and meet up as intended, and that all the hardware is properly installed. "The point is to get it where it works perfectly," he said.

At this jobsite, Bradley said, the door supplier recommended Mokas on the day the doors were delivered to the site. But because mix-ups can be costly and disruptive, Mokas told *JLC* that he prefers to get involved earlier in the job. That way, he said, he can verify the measurements and specifications before the doors are custom-built, first by double-checking the plans, and then later by measuring on site after the rough framing is complete.

ATTACHMENT POINTS

To set and align the doors, the crew used the supplied strap connectors, which screw into the jambs from the back **(9)**, then muscled the doors into position **(10)**. Then, for a permanent structural connection, they set structural screws through the jambs into the framing through the predrilled holes in the jambs before placing the sliding doors onto their tracks **(11)**. "Once you've got them dialed in," said Bradley, "they open and close really nicely. I have to admit they're pretty slick."

Ted Cushman is a senior editor at JLC*.*


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Setting Precast Footings

BY JIM WOLFFER AND STEVE BACZEK

They say the shortest distance between two points is a straight line. That seems easy enough, but things get a bit more complex when the straight line is 78 feet long and there are 11 points along the line that have to be lined up perfectly. That was the challenge that Shoreline Builders, of Scituate, Mass., faced recently when building a new, custom, high-performance residence on Cape Cod. The home was to have a 1,100-square-foot covered porch that measured 78 feet along one side and wrapped around one corner of the house, and many of the standard construction details required an exceptionally high level of precision.

The porch and its roof framing system had to be supported by 20 footings total—16 perimeter footings plus four inside footings to support the wider porch section at the end of the house; the long side of the porch had 11 footings. Because the roof was to be a prefabricated truss system that was ordered about the same time as the footing installation, there was little margin for error or for misalignment of the footings. In addition, the project was located in one of Cape Cod's high-wind zones, so the alignment of all the support and framing components was a critical structural detail specified by the engineer to resist the uplift potential of the large porch roof.

PRECAST FOOTINGS

In reviewing the project with the site contractor, George Botelho, we considered a couple of options for the porch footings: the typical poured-in-place tube footings vs. precast concrete footings. Poured concrete footings pose a number of challenges. The first factor is that they are difficult to install with precise alignment, which was critical to this project. And backfilling tube footings almost inevitably causes the tubes to move a little (and sometimes a lot), which results in a ragged layout. Another consideration when using site-poured tube footings is that they have to be inspected prior to filling, which can often mean a day or more between the placement of the forms and getting them filled. If the soil is at all moist, the tube material can absorb moisture and deform before they can be filled. For these reasons, Botelho suggested that we go with precast footings.

When Botelho started using precast footings a few years back, they were typically made with square tops. But setting a straight line of footings presented a big enough challenge in itself; trying to align the square edges was an additional task that could be eliminated if the footings were cylindrical. So Botelho asked the precast manufacturer to start casting the footings in the round. In the casting process, the manufacturer embedded a fitting in the top of the footing that could accept a threaded eyebolt for lifting and placing the footings. Eventually, these threaded fittings would be the attachment points for the post-base connectors, a critical link in the framing sequence.

The perimeter of the porch required 11 footings along the long section and five additional footings where the porch returned around the corner of the house. Each footing was 5 feet tall and 1 foot in diameter at the top and tapered slightly down to a wide supporting base that was about 30 inches wide and a foot high. When the footings were delivered on site, we were ready to begin installation.

SETTING THE FOOTINGS AT THE SAME HEIGHT

To set the footings, we had to maintain two critical parameters: The 11 footings all had to be set at exactly the same elevation, and they all had to be in a perfectly straight line. With the extremely

1

2

Photos by Jim Wolffer

The site crew dug the hole for each precast footing individually, compacting the base of the hole and using a laser level to set the elevation **(1)**. Each footing has an integral fitting for an eyebolt that was used to lift and place the footing **(2)**. After the footings were placed, the crew used the fittings to attach the post connectors.

Backfilling in lifts and compacting between each layer locks the footings in place **(3)**. As the crew compacted the final grade, they sloped it away gradually from the foundation **(4)**. The grade drops just beyond the footings, for the ground gutter **(5)**. Filter fabric covers the grade **(6)** and then wraps back over the crushed stone and drainage pipe **(7)**.

sandy Cape Cod soil, it made sense to excavate each footing separately. The frost depth for this location was 4 feet, so we excavated to exactly that depth below rough grade. Because the precast footings are 5 feet tall, that left 12 inches of vertical play for the drainage layer under the porch that we would install later.

Botelho's crew compacted the base soil in each excavation by hand, setting the depth of each hole with a laser and a measuring stick, which gave the holes the vertical accuracy that we needed **(1)**. The crew used an excavator equipped with a chain for the actual placement of the footings. A hook on the end of the chain grabbed an eyebolt threaded into the fitting on the top of the footing. The excavator easily lifted the footings into place, setting each one on the compacted, undisturbed soil of the hole excavation **(2)**.

GETTING THE FOOTINGS IN A STRAIGHT LINE

Making sure that the footings were in line with each other was as critical as their all being at the same height. We did a quick check of the foundation wall along the edge of the house adjacent to the porch to confirm that it was perfectly straight. We also verified that the outside corner—where the porch returned along the end of the house—was a true 90 degrees. Having the foundation as a reliable reference helped immensely, as it allowed the crew to pull accurate measurements from the face of the foundation wall to place the footings in a straight line.

As the crew placed each footing, they measured off the foundation as well as off the center point of the previous footing. The footings were 8 feet on-center. The crew set up a 100-foot string parallel to the foundation and a second laser as a secondary check of the footing alignment. The string provided a true sight line to work from and the laser provided a continuous line along the tops of the footings.

After setting each footing, the site crew backfilled about 2 feet and compacted the fill, which helped to lock the footings in place **(3)**. After the initial compaction, they quickly checked that the footings were still in perfect alignment. The crew completed the backfilling in two more lifts, compacting each layer and checking after each compaction to make sure the footings stayed in perfect position.

PERIMETER DRAINAGE

Because this home has no roof gutters, it would rely on a perimeter ground-gutter system (see "A Primer on Water Management," Jun/17). The ground gutter is designed to carry groundwater and roof runoff to an area of reclamation on the other side of the site. The porch was to be open to the weather, so we had to tie

Crushed stone filled the area under the porch up to the tops of the footings **(8)**. The crew checked the alignment of the footings at every step, and a taut string confirmed that both the height and the placement of all 11 footings along the 78-foot length of the porch were within 1/8 inch **(9)**. The high degree of accuracy meant that the treated beams supporting the porch were installed without a hitch **(10)**. The precision was critical for engineering the roof frame to withstand severe uplift in this high-wind area **(11)**.

the area below the porch into the ground-gutter system. After the site crew finished backfilling around the footings, they compacted the top layer of soil, sloping the grade away from the foundation slightly toward the outer edge of the porch **(4)**.

Just beyond the line of the footings, the grade dropped sharply about 18 inches to form one side of the ground gutter **(5)**. The crew covered the sloped ground with heavy-duty filter fabric and then added an 8- to 10-inch layer of crushed stone on top of the fabric **(6)**. The crushed stone would drain any water that filtered through the porch floor above. The filter fabric continued beyond the footings to line the ground gutter, and it was intentionally left long so that it could roll back over the stone to fully encapsulate the drain pipe and the stone around it. We centered the drain pipe side-to-side in the ground gutter so that it sat directly below the "drip line" of the porch roof above **(7)**.

PRECISION PAYS OFF

Before the porch framing could begin, we quickly checked the footings again to make sure that they were all still perfectly in line **(8)**. When all was said and done, Botelho and his site crew had placed all of the footings within 1/8 inch on-center of each other **(9)**, a level of accuracy and consistency that would have been difficult or nearly impossible to duplicate with poured-in-place footings.

When the framers arrived, they were pleasantly surprised to find such an accurate layout. The precision of the footing placement allowed them to quickly install the treated frame, columns, and beams for the porch **(10)**. And this precision continued throughout the frame; from the straight and level lines of the footings, the crew efficiently placed the grade beams, posts, roof beams, and roof trusses in perfect alignment **(11)**.

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Practical Window Flashing

BY EMANUEL SILVA

As I drive to work each day, I can't help but notice construction sites on the way, and it amazes me to see the huge number of windows that are flashed incorrectly. I see some windows installed with only sill flashing and no side flashing, some with no sill flashing and only housewrap as side flashing, and then others with only housewrap and no flashing at all. But the scenario that bothers me the most is a window installed over the housewrap and then flashed on all four sides—a sure recipe for disaster.

There are many ways to flash windows correctly. You don't have to use proprietary systems; you just need to know that there are no chemical incompatibilities and follow basic principles. For the project in this article, I used material left over from another job: 6-inch 3M All Weather tape for the rough opening (RO) flashing, 6-inch Typar Flex Flashing for the sill pan, and 6-inch Grace Vycor Pro tape everywhere else. I'm aware that combining different products can void their warranties (such as the Zip System warranty). But knowing that there were no compatibility issues, I was willing to chance it because I felt confident that my window installation would outlast any warranty.

PREPPING THE OPENING

Before installing the windows, I precut the flashing tape needed for each window and set the pieces next to each opening. Except for the pan flashing, I make all the lengths out of two pieces of tape. I often work alone, and I find that two shorter lengths of tape are easier to handle and install than a single long length.

Next, I make layout marks on the sheathing to guide placement of the flashing. On the sides, I measure out 3 inches (half the width of the 6-inch tape) and draw a plumb line with a level. At the top and bottom of the opening, the flashing will extend 6 inches beyond the opening, so I measure this distance on both sides and draw these plumb lines, as well.

SILL FLASHING

The first place I apply flashing tape is directly below the opening **(1)**, which I consider to be cheap insurance. I trust the flexible sill pan flashing to adhere to the flashing tape more than to the sheathing. (The alternative, of course, is to use Zip System Stretch tape, but I was using stock I had on hand. As builders, we sometimes have to make practical choices.) I install

Window installation begins with properly flashing the opening. The first piece of flashing to be installed is the sill flashing below the rough opening **(1)**. It extends 6 inches beyond the opening on either side. A length of beveled siding pitches the sill for drainage **(2)**. Flexible flashing tape creates a one-piece sill pan that seals the bottom of the opening from moisture **(3)**.

Photos by Emanuel Silva

the tape in two pieces, working from my marks at each end and overlapping the pieces about 6 inches in the center. Next, I nail a piece of beveled siding to the bottom of the opening **(2)**. The bevel provides positive drainage on the sill.

I find it's faster and more reliable to use flexible flashing to create a seamless, watertight pan than trying to turn corners with multiple pieces of straight flashing. To install the pan, I first mark both the center of the RO and the center of the flashing. I also draw a guideline on the beveled sill 4 inches from the edge of the RO. I peel off the backing, line up both center lines, and let the tape down onto the sill following the 4-inch line. I press the tape firmly into place by hand, working from the center to both corners and then smoothing the ends of the tape up the side jambs. When the sill portion is adhered, I press the remaining 2 inches onto the vertical wall surface, again working from the center toward the ends. When I reach the corners, I pull the tape outward to create a smooth and tight seal **(3)**.

SIDE AND HEAD FLASHING

To keep water from entering between the sheathing and the framing, I flash the sides of the opening next. On the lower section of my two-piece side flashing, I cut out the bottom corner where it wraps over the sill pan. Some folks prefer just to slit the flashing at the corner, but in my experience, cutting that corner out helps to keep the tape from accidentally sticking to itself.

Before I peel off the backing from the tape, I hold it in place and mark the top edge on the wall sheathing. Using this mark as a starting point and using the plumb line I'd drawn earlier, I peel off the backing and apply the jamb flashing to the sheathing, working from top to bottom. Again, I create a wrinkle-free surface with pressure from my hand. With the bottom corners cut out, I wrap the flashing tape into the opening, stretching it slightly as I smooth it out and adhere it in place **(4)**.

The upper piece of side flashing goes on next, extending over the lower piece in shingle fashion **(5)**. Starting a few inches above the top of the opening, I adhere the top piece to the sheathing, again using the plumb line as a guide. I've found that cutting out the corner is not as helpful for the top jamb flashing, so instead, when the tape is adhered to the sheathing, I slit the tape along the top edge of the opening and then wrap it onto the jamb.

At the head, I apply my two pieces of flashing tape, starting on the 6-inch plumb line and making sure it completely covers the top end of the side flashings. As I apply each side, I peel only half of the backing at a time to help keep the flashing from sticking to itself **(6)**. As before, the two pieces overlap by about 6 inches.

4


5


6


7


The sides of the opening are flashed in two pieces. The bottom piece laps over the sill flashing **(4)**. The top piece of flashing starts a few inches above the opening and laps over the piece below **(5)**. Then the head flashing laps over the side flashing **(6)**. Sealant is applied to the opening before the window goes in **(7)**.


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After pressing the window into the wet sealant, the author levels the frame and nails the bottom corners **(8)**. Diagonal measurements ensure that the frame is square **(9)** before the top flange is secured **(10)**. He flashes the flange on the sides and top, with all the lengths done in two pieces. The side pieces extend past the top of the window **(11)**, and the top pieces cover the sides **(12)**.

INSTALLING THE WINDOW

I usually remove the sash from the window frame so that installation requires just one person. First, I center the window frame in the opening and trace the outer edge of the nailing flange. I then remove it from the opening and run a bead of OSI Quad sealant along the top and sides of the opening, keeping the caulk inside the traced lines **(7)**. The bottom edge of the opening should never be sealed, so that any moisture can drain from the opening.

Using the lines I traced as a guide, I press the frame into the wet caulk. I make sure the window is level in the opening **(8)**, and then nail both bottom corners using 2-inch galvanized roofing nails. To ensure that the window is square, I measure across the frame diagonally and tack the center to hold the frame in place **(9)**. After double-checking the diagonal measurements, I drive additional nails at the top corners **(10)**. Before nailing the side flanges of the window, I measure across the opening in three spots to make sure the sides are straight. Finally, I secure the sides of the frame and nail off the bottom flange and any remaining holes in the flange.

FLASHING THE FLANGE

Before going any further, I re-install the sashes and make sure they operate properly. Once the window is set, I begin flashing the window flanges, using two pieces for each section of flashing. As before, I mark the starting point for top edge of the lower side flashing. After peeling half of the backing, I align the top edge with my mark and the inside edge with the corner where the flange meets the window frame. Then I press the tape into place, using my hand to smooth it out as I work my way down to the sill.

I start the top piece of side flashing a few inches above the top flange **(11)**. Peeling off half the backing at a time, I press the tape into place, overlapping the lower piece by 6 inches. The final step is applying the head flashing. I install that in two pieces as well, using the outer plumb lines as starting points and overlapping the pieces by at least 6 inches where they meet **(12)**.

A contributing editor to JLC*, Emanuel Silva owns Silva Lightning Builders, in North Andover, Mass.*


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BY LESLIE SHINER AND MELANIE HODGDON

Pricing Risk Into Your Estimates

The longer you've been in business, the more war stories you accumulate about how a project fell apart due to inclement weather, power losses, forest fires, loss of your most responsible carpenter, or the homeowners who morphed into the customers from hell as soon as the contract's ink was dry. You can't predict the nature and timing of the next disaster, but you can draw on your experience to smooth out some of the inevitable ups and downs of your business.

There are three categories of risk—financial, contractual, and operational—that you can assess about a job.

Financial factors include the amount of cash reserves, the timing of your billing, and the likelihood that the customer will pay you on time.

Contractual factors include the clarity of the scope of work and change-order process, and how accurate and current your legal documents are.

Operational factors include how familiar the work to be performed is, the quality of the crew and project manager, availability of the appropriate equipment, insured status of subcontractors, and the likelihood that required materials will be available on time.

Once you've considered a prospective job's risk factors, how can you quantify this in a useful way? Obviously, if a job looks *too* risky, you should walk away from it. But let's say it doesn't.

If you price a risky job accurately enough, you are more likely to make a profit—or scare the prospects off.

First, come up with an estimate for the job, unadjusted for risk. Let's say $100,000. Next, come up with "perfect world" and "catastrophic" estimates for the same job. This is where your gut and years of experience come in and where you can consider the likelihood of bad weather, crew loss, sour customers, and so on. Assign a probability for each scenario. For example, you may feel that there's a 40% chance that the job will run as usual, 25% that conditions will be perfect, and 35% that the job will be a disaster (note that the probabilities must add up to 100%).

While you can't see the future, you can provide a cushion against the inevitable.

Create a table like the one below. Complete the "weighted average" column for each of the three conditions by multiplying its estimated cost by its probability. The total of the weighted averages reflects the estimated job cost *including risk*. In this example, 4.4% was added to the estimated cost to account for risk.

While you can't see the future, you can provide a cushion against the inevitable. The final step will be to add a markup suitable for your company's overhead and its target profit, based on the total estimated cost adjusted for risk.

Leslie Shiner, owner of The ShinerGroup, and Melanie Hodgdon, president of Business Systems Management, co-authored A Simple Guide to Turning a Profit as a Contractor *and provide management consulting for contractors. A version of this article appeared in* Remodeling *magazine.*

Estimated Cost Adjusted for Risk

	Estimate	Probability	Weighted Average
Perfect World	$84,000	25%	$21,000
Unadjusted for Risk	$100,000	40%	$40,000
Catastrophic	$124,000	35%	$43,400
Total Weighted-Average Estimate		**100%**	**$104,400**

Weighted averages can help you account for risk. Estimate your costs for best, normal, and worst cases, and assign each a probability. Multiply each estimate by its probability, then add up the three results to find your estimated cost adjusted for risk.

BY TED CUSHMAN

A One-Way Vapor Barrier?

Vapor barriers are a complex subject, and often a confusing one for contractors and tradespeople. In recent years, as new materials have entered the industry, the topic has only gotten more complicated.

A few years ago, *JLC* took a look at the new crop of "smart" vapor retarders, represented by products such as ProClima's Intello and CertainTeed's MemBrain (see "Understanding 'Smart' Vapor Retarders," Dec/15). This year, there's yet another entry in the market, and it's a distinctly different category of product: Majrex, introduced by the Swiss firm Siga, is an advanced vapor control membrane that not only adjusts to variable humidity like Intello and MemBrain, but actually has a greater moisture permeability in one direction than in the other. The material is intended for use in cold climates, where its purpose is to protect insulated wall and roof assemblies from indoor-generated moisture during winter, but still allow the insulated cavities to dry out towards the occupied space during summer.

Based on "dry-cup" and "wet-cup" ASTM testing, the less-permeable face of Majrex is rated at just 0.16 ("dry") to 1.3 perms ("wet"); that's the side you install facing the conditioned space. The more permeable face opens up from 0.17 ("dry") to as much as 3.8 perms ("wet"); that side is placed facing into the fiber-insulated wall or roof assembly. So all else being equal, moisture can move out of the wall or roof into the conditioned space three times faster than it can move in the opposite direction, into the walls or roof. Siga rep Keith Bidwell showed *JLC* a simple demonstration (left): If you seal wet wood into two envelopes made of Majrex, one with the vapor-open side in, and one with the vapor-open side out, only one piece of wood will dry out.

And like Intello and MemBrain, Majrex also responds to moisture conditions. In winter, when the indoor space tends to be dry, the material becomes more vapor-closed to help keep the structure dry. If the sun drives vapor inward during summer, the membrane opens up. So the effective difference between the two faces is more than triple: Depending on conditions, the variation from winter to summer could be a factor of 10 or more. The idea is that over time, insulated walls and roofs, even if they're built wet, will dry out during summer, and then stay dry year round.

Siga sales manager Keith Bidwell conducts a training for contractors at Performance Building Supply, in Portland, Maine **(1)**. At a meeting with *JLC* **(2)**, Bidwell explains Siga's kitchen-table demonstration of the Majrex membrane's directional drying properties.

Photos: Ted Cushman (1, 2); Collective Carpentry (3); Kim Weaver (4); Nate Dorr (5)

How does it work? The science behind Majrex is similar to the principles that make Intello and MemBrain work. All the products rely on the moisture-sensitive properties of polyamide, a relative of nylon that has the special characteristic of opening up more to the rapid passage of moisture as more water vapor contacts and penetrates it. In humid conditions, Majrex, like Intello and MemBrain, transports moisture faster through its polyamide layer.

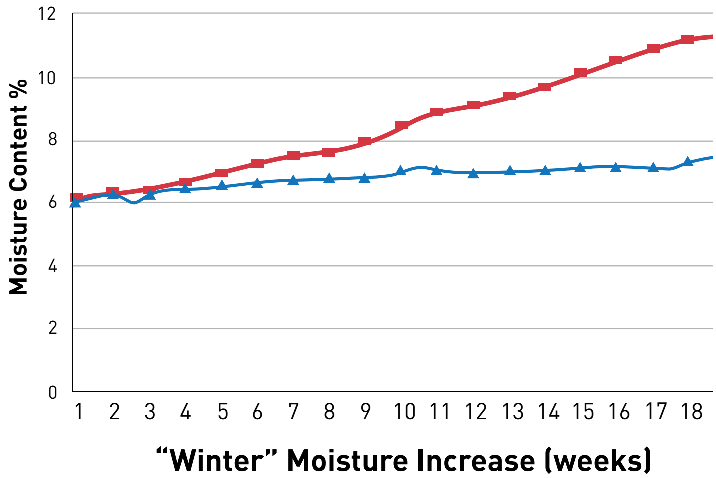
But unlike the others, Majrex has a relatively impermeable control layer laminated to its indoor-facing side; the perforations in this surface lamination let moisture pass out of the polyamide into the room air faster than it can pass from the air into the polyamide.

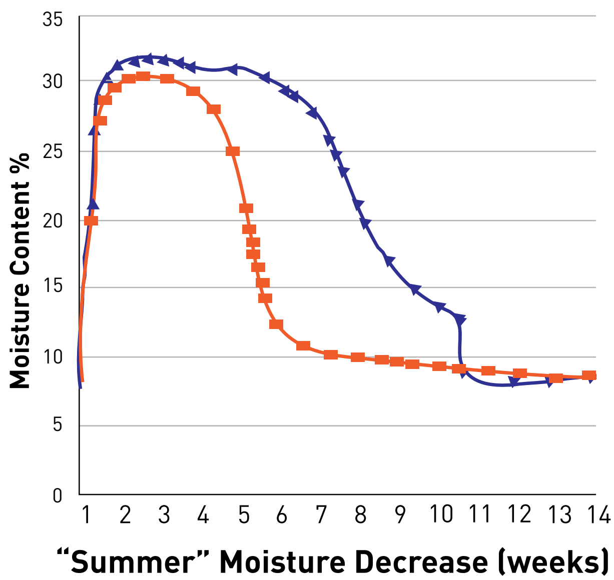
But there's a price to be paid for designing this indoor-facing face with a more vapor-closed baseline: At its most vapor-open, even the open side of Majrex is still quite a bit less permeable than either MemBrain or Intello in their most vapor-open states. Whether that fact matters is an open question, and it could influence a builder's thinking about which type of membrane—if any—to use.

Science first. Understanding the behavior of moisture in buildings is a science. And in the case of smart vapor barriers, it turns out, theory came before practice. According to the website of the Fraunhofer Society, a technical think tank based in Germany, Fraunhofer researcher Hartwig Kunzel used WUFI, the sophisticated simulation program developed by Fraunhofer to analyze building moisture problems, to determine the characteristics of a vapor-control layer that would strike the best balance between cold-climate wintertime performance, when the vapor drive is from the inside out, and summertime performance, when warm outdoor temperatures and sunshine tend to drive moisture inward towards the conditioned space.

Kunzel's simulations led him to look for a material that would be vapor-closed when indoor relative humidity was low during the winter, but 10 times more vapor-open when vapor inside the wall or roof cavity was being forced toward the room. The search led investigators to the food-packaging industry, where polyamide's properties were already known, and then on to the development of reinforced polyamide fabrics that would have the variable permeability qualities desired while also being strong enough to be stapled to studs and rafters. Today's commercial products, MemBrain and Intello, both draw on Fraunhofer's patented technology.

The development of Siga Majrex seems to have followed a similar path. Researchers first identified a concern that even a variable-permeability fabric might expose structures to excessive vapor exposure in winter (especially flat roofs with a vapor-closed top surface). Then they tried to imagine a material that would be more vapor-tight on the indoor-facing side than on the side that faces the insulated





Controlled conditions. European building-science researchers studied variable-permeability membranes in the lab, using mock-ups of an insulated roof with a vapor-closed roofing material. During simulated "winter" conditions (top), the mock-up with the directional permeability membrane (blue) gained less moisture than the one with a two-way humidity-responsive membrane (red). But the less vapor-open directional-permeability mock-up also took several weeks longer to dry out during simulated "summer" (bottom).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assembly, even when the indoor space was humid. Then they developed a material that they hoped would better achieve the required compromise. In the case of the new "directional" vapor barrier technology, the conceptual work originates with researchers at the Technical University of Dresden in Germany, and the mathematical simulations have been accomplished, not with WUFI, but with that university's DELPHIN building physics software.

Nick Holbus, a manager in Siga's tech support department for the U.S. market, emphasizes "air-barrier continuity at the lid." He recommends Majrex for flat roofs with impermeable roofing—the very problem that inspired the product. Architect Jay Woodworth, who works with Siga in New York, agrees: "In my territory in Brooklyn, where you have a lot of flat roofs with mod bit or EPDM, pretty much 100% vapor-closed, Majrex at those ceiling assemblies on the inside really saves the day. Now you're not worrying about vapor."

Siga's Keith Bidwell emphasizes the value of Majrex's one-sided protective power for buildings under construction, where moisture evaporating out of concrete or drywall compound can stress a building early in its life. In that situation, he points out, other variable-permeability membranes may open up and expose the structure to indoor moisture.

But Floris Keverling Buisman, a principal with 475 High Performance Building Supply in New York, is quick to counter that Pro-Clima's Intello fabric will also allow the cavities to dry out when the seasons change.

Early adopters are starting to try out Siga Majrex in projects such as these cathedral ceilings, constructed for high-performance homes in British Columbia **(3)** and Maine **(4)**.

The ideal use for Siga Majrex, the company claims, is the underside of a flat roof in a cold climate with vapor-tight roofing above—the same application where New York architect James Wagman specified Intello variable-permeability membrane **(5)**.

Early adopters. Siga's existing line of weather-resistive barriers and sealing tapes has a strong presence in North America, but Majrex has a long way to go to build a track record. Still, the technology already has a toe-hold. Collective Carpentry, a Passive House panelizer and custom builder in British Columbia, recently tried the product out on one of the company's rare truss roof projects **(3)**. Homeowners Kirt and Kim Weaver chose Siga Majrex for a custom home project in Topsham, Maine **(4)**.

But at this early stage, building-science experts in the United States remain skeptical. "Four perms isn't very impressive when you compare it to all the other products that are designed to open up," said Kohta Ueno of Building Science Corporation. Ueno recommends variable-permeability vapor control layers for structures in cold climates, but he's reserving judgment on materials like Majrex—in part because the wet-cup and dry-cup boundary values in Majrex marketing sheets don't tell us about the material's behavior in controlled mid-range humidity laboratory conditions, much less describe its behavior in more chaotic real-world situations.

Canadian researcher Aaron Grin, a principal at RDH Building Science, in Waterloo, Ontario, says that modeling should be validated by real-world measurements. If you want to use a program like WUFI to predict a building's performance, it's wise to fill in the information gaps with a more detailed and complete set of data.

Ted Cushman is a senior editor at JLC.

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STRUCTURE

Framing Problems and Solutions

Skilled carpenters tackle the challenge of a complex structure

BY TED CUSHMAN

Photos by Ted Cushman and Jesper Kruse

When architect Eric Sokol (Winkelmann Architecture, Portland, Maine) took on the task of squeezing a high-end custom home into the pie-shaped buildable outline of a lakeside lot in the Maine woods, he solved the problem using every trick in the book.

Stairs from a split-level entry on the road lead down to a wide-open living and entertainment space with exposed wood ceiling beams. Upstairs, a pair of shed-roofed spaces set at a 10-degree angle to one another, and connected by a flat-roofed passageway, form the shell for a master bedroom suite at one end of the house and an open-plan living, dining, and kitchen area at the other end.

To frame the custom forms, architect Sokol and engineer Albert Putnam specified a smorgasbord of structural components tailored to manage the long spans and point loads involved: steel I-beams, heavy glue-laminated timbers, built-up laminated veneer lumber (LVL) girders, custom angled steel connectors, trimmable-end web-truss floor joists, and wood I-joist roof rafters.

Sokol and Putnam's complex assembly posed a construction challenge to Maine builder Jesper Kruse, owner of Maine Passive House, and his crew of skilled carpenters. Over the winter, *JLC* spent several days on the jobsite with the Maine Passive House team to see how they put the puzzle together.

Warmth of wood, stiffness of steel. Timber framer Rusty Partridge **(1)** supplied precut timbers, routed out for wiring chases and electrical boxes. A stiff mid-span steel beam **(2)** helped achieve the required span **(3)**. After nailing down tongue-and-groove ceiling boards topped by AdvanTech subflooring, the crew locked the joists in from below with pan-head screws **(4)**.

STEEL AND TIMBERS

The basement room will get a polished concrete floor. Overhead, its ceiling is exposed wood: tongue-and-groove 1x6 pine boards laid over sawn 3x8 pine joists, supported by a flush steel beam. It's Sokol's trademark style, and Kruse has built it before.

Sokol likes the rugged look of the exposed steel beam and sawn rafters. Beyond that, building height restrictions constrained the head height in the lower-floor room, and the exposed beams add a feeling of greater height to the ceiling.

Regardless of the aesthetic considerations, said engineer Putnam, the stiffness of steel made the I-beam the only practical choice to support the ends of the sawn joists and allow a clear span across the room. Engineered lumber could have carried the load but would have required too deep a member. "The stiffness of steel (its modulus of elasticity) is 29," said Putnam. "The stiffness of LVL is 2. An LVL that would carry the load would have had to be 16 inches deep or more, not 8. You couldn't make it flush to the ceiling."

Sokol's plans included light fixtures routed into the sides of the pine ceiling beams and supplied by wiring running in grooves routed into the tops of the beams. Sokol made the framing task easier for Kruse's team by providing detailed drawings. Kruse turned to Rusty Partridge (blackdogtimberworks.com), a local timber framer, to supply the sawn floor joists.

"Rusty routed out the wiring chases in the tops of the beams and the holes for the electrical boxes to sit inside the beams," said Kruse. Sokol had also specified exact locations for screw holes in the lower flange of the steel member for fastening the sawn joists, said Kruse. "So they drilled those holes at the steel shop, and then Rusty went down to the shop and cleaned up the steel beams and coated them with beeswax. And he brought them up to the site,




Hidden wiring. Working in a light snowstorm, the crew glued and nailed tongue-and-groove pine boards to the sawn beam framing **(5)**, taking care to leave space for wiring that serves light fixtures in the room below **(6)**. They capped the wiring chases with steel to protect the wires **(7)**, then covered the whole layer of boards with a top course of AdvanTech subflooring **(8)**.

and he brought his Bobcat with a boom to set the steel beams."

The sawn joists rest on a ledger of 3/4-inch pine set on the lower flange of the I-beam. Kruse's crew pinned that ledger in place with short temporary screws, then set the sawn beams in place by hand based on Sokol's layout. Then, after the pine ceiling and upper-story subfloor were in place, the crew backed out the small screws and replaced them with long pan-head screws extending into the sawn timbers. "We wanted the screws to look good with the steel beam, so we took a torch and burned the coating off the heads to expose the metal," said Kruse.

WHEN THE CEILING IS THE FLOOR

The design called for building the lower story's ceiling into the upper story's subfloor. This required Kruse's crew to glue and nail the pine boards to the wood timbers. At the same time, the crew had to install and protect the rough wiring for the lower room's ceiling lighting fixtures. Working from both sides of the steel beam, the carpenters laid out their starting courses for the tongue-and-groove pine so that the edges of the final courses would fall short of the center of the steel beam, leaving access to wiring runs on top of the steel. To protect runs of wiring set into the channels along the tops of the sawn joists, the crew laid strips of steel into the grooves before nailing down the pine boards.

After all the boards were in place, the crew glued and nailed 7/8-inch AdvanTech subflooring panels over the pine, taking care to nail only into the beams. They snapped chalk lines on the subflooring to mark the edges of all the beams that housed wiring runs, and used screws to fasten down the AdvanTech at those locations, to remove the risk of a nail near the edge going astray and either hitting a wire or shining out on the ceiling below.

A load-bearing window wall. Carpenters Alex Strugatskiy and Will Kessler framed in the window opening between two large glulam carrying beams with 2x6 lumber. Strugatskiy laid out stud locations **(9)**, boxed out the window opening **(10)**, and then nailed plywood sheathing onto the face of the wall to stiffen the structure **(11)**.

GLULAM HEADERS

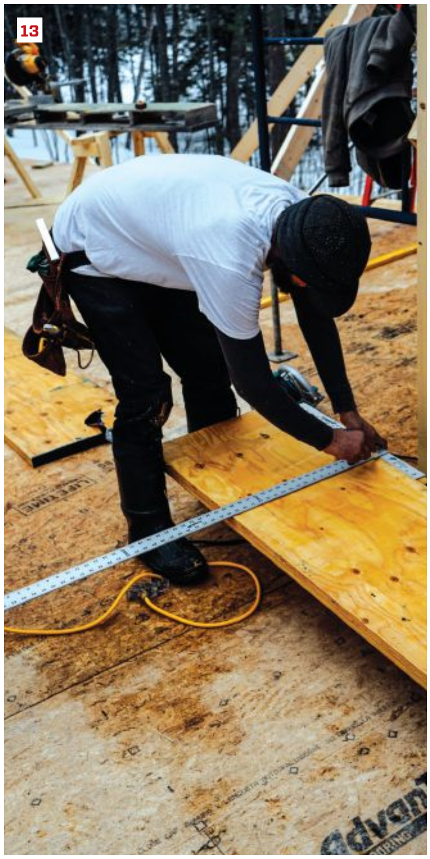
At the front of the house, a flat-roofed entry greets the street, with wide windows looking out onto the road. A structural header across the uppermost window has to do more than just hold up the entry roof, however. It also receives the end of a huge, triple-LVL built-up beam that extends through the width of the house from front to back (see photo, page 39), supporting one end of the long living-room roof—and also helping to hold up the flat-roofed center section of the building.

We see the crew assembling that massive LVL in place in the next two pages. But first, they had to build the front wall to support its end. "The engineer gave us a choice for the header," said Jesper Kruse: "A glulam or a built-up LVL."

"It varies by contractor," said Putnam. "Some folks like to use individual plies, at an inch and 3/4, because they can more easily handle it. But in that particular connection, there's a lot of load that needs to move through that heavy-duty Simpson girder hanger. It's a side-loaded flush connection. And if you are connecting a huge side load through three plies of LVL, 33% of that load needs to get to the furthest ply away from the hanger. So if you use LVL, you need to add a bunch of bolts to the connection."

"So we said, 'Let's go with the solid piece,'" said Kruse. "If it had been up high like the other beam, we might have had to use LVLs and bolt it together. But with that lower one, it wasn't too hard to lift the glulam up. We lifted one end up onto the scaffolding, and then the other end, very carefully. We were seven guys doing it, and it was manageable."

The front wall actually has two glulams: one above the window to support the flat roof of the center of the house, and one below the window to support an entryway and garage roof. Before attaching



One piece at a time. Engineered LVL material lets carpenters assemble high-capacity beams on site, using manageable pieces with uniform strength characteristics. Carpenter Matt Friel helped carry 28-foot pieces onto the home's floor deck **(12)**, then marked cut lines with a 4-foot square **(13)** before cutting the pieces to length at the architect-specified 10-degree angle **(14)**.

the huge Simpson hanger to the face of the top glulam, the crew framed in the window opening between the two glulams and sheathed the wall to stiffen it (see photos, facing page).

A BUILT-UP LVL BEAM

With the glulam header wall in place, the crew set about cutting and assembling the big LVL beam that would tie into it. Although the LVL plies were 28 feet long and 20 inches wide, two carpenters could wrestle the pieces off the lumber pile and move them around to the deck for cutting to length.

At just 1¾ inches thick, the LVL plies were a convenient size for cutting and fastening with ordinary framing tools. To cut the beams to length, lead carpenter Matt Friel took his measurements from Sokol's plans and checked them against the actual measurement from the post he had just set at the back of the house that would hold up the far end of the beam. Then he measured and marked each ply, using a 4-foot drywall square to mark his lines.

Making things even more interesting, Sokol's design oriented the home's two wings at a 10-degree angle to each other (part of fitting the building to the property's tightly constrained buildable area). So the site-built LVL beam, which would help carry roof loads for one shed-roofed wing and the flat-roofed center section, would need to join its supporting glulam at the same 10-degree angle.

For $450, Simpson Strong-Tie supplied an EGQ high-capacity beam hanger fabricated at the required angle (the EGQ can be sloped and skewed as much as 45 degrees, according to Simpson). It was up to the carpenters, though, to make the correct angle on the beam end. Friel had to start with the longest angle cut, then subtract a fraction for each cut on the next two pieces of LVL.

That's not all. The flat roof of the center section of the building was

Building a beam in place. Matt Friel attached the Simpson beam hanger in position with Simpson SDS screws **(15)**. He laid out and cut a notch on the end of the beam to match the framing of the flat-roofed section at the front of the house **(16)**. Then the crew muscled the LVL pieces into place one by one **(17)**. Ryan Bielenda fastened the beam into the angled hanger **(18)**.

to be framed with 16-inch wood I-joists, and Sokol's design originally called for the big LVL girder to also be 16 inches deep—which would match up perfectly with the flat-roof rafters. When engineer Putnam checked the plans, though, he found that a three-banger 16-inch LVL would deflect too much in the center where it crossed the open kitchen. So Putnam bumped the beam size up to 20 inches.

But at 20 inches deep, the LVL would be too high for the flat-roofed portion near the road—the beam would stick up above the roof. So Friel had to notch the end of the beam down to 16 inches.

You have to be careful when you notch a beam, Putnam said. Engineers commonly check beams for three qualities: strength in bending, deflection, and shear. Bending strength and deflection are the main concerns at the center of the beam, but shear sometimes becomes important at beam ends. In this case, Putnam found that the 20-inch depth was necessary at the center of the span, where deflection controlled the analysis, but not at the ends. So a 16-inch depth would suffice for the short section where the flat roof would join the beam. That's only because the notch was at the top of the beam, Putnam pointed out; if the carpenters had needed to thin out the bottom of the beam instead, they would have introduced a risk of splitting at the notch.

Friel set the big Simpson hanger in position using the supplied Strong-Drive SDS structural screws, taking care to put a screw in each hole. Next, he cut down the end of each LVL beam ply to 16 inches deep. Then it was time to assemble the beam; the crew lifted the long pieces into place one by one, screwing them together along their length with structural screws, and finally screwing the completed beam into its hanger with the Simpson-supplied fasteners.

Carpenters know that wood can be an inconsistent material that warps, shrinks, and twists. Engineered lumber is more consistent,

Prepping wood I-joist rafters. Jesper Kruse and carpenter Anna Heath made rafter plumb cuts using a site-built jig **(19)**. Carpenter Ryan Bielenda packed out each rafter web with plywood stiffeners **(20, 21)** and then pre-applied Simpson adjustable wood I-joist hangers **(22)**, which can be adjusted in the field to the necessary angle for a sloped or skewed connection.

but even LVLs aren't perfect. In this case, one piece of LVL showed a noticeable cup across its width. The crew had to screw the plies together in the center first, then persuade the cupped ply to lie flat at the edges using clamps and more screws.

A WOOD I-JOIST SHED ROOF

The upper-story living-dining-kitchen area is designed as a single open-plan space with a high ceiling. Eventually, this room will get the same ceiling treatment as downstairs, with sawn wood rafters and a center-span steel beam. The sawn rafters won't be structural (they're for looks only), but the steel beam at mid-span will be real; it will help support the wood I-joist shed roof.

Without the mid-span steel beam, engineer Putnam told *JLC*, the 16-inch-deep wood I-joists might struggle to make the room's 28-foot span. "The snow load at that location is about 70 pounds per square foot," Putnam remarked. "You can expect 3 feet of snow in winter." With the steel beam cutting the span in half, however, the wood I-joists are comfortably oversized. "The rafter depth is just there for insulation thickness," said Putnam.

Kruse planned to insert the steel beam later. For now, the crew just needed to set the long wood I-joist rafters. They started by cutting the pieces to length, using a site-built jig that guides the circular saw at the correct angle and allows the saw to ride across the rafter's web without falling in. "It makes it easy," said Kruse. "You just line the jig up in the right place, and it's one nice cut across."

Then the crew packed each rafter out with plywood web stiffeners. These help transfer loads from the top flange of the member down through the web, and they also provide nailing for metal connectors. Before passing the rafters up to carpenters at the wall plates, the crew on the deck attached metal connectors to the rafter ends.

Framing the roof. The roof assembly includes load-bearing LVL rim joists that span over windows in the end walls. Matt Friel measured from the edge of the beveled bottom plate to allow room for the LVL **(23)**, then nailed the rafters in place **(24)**, while Alex Strugatskiy fastened the skewed connectors to the LVL at the top **(25)**, and the building began to take shape **(26)**.

SETTING RAFTERS

The crew had angled the top cuts on the studs for the wall that supports the lower end of this long roof span, creating a beveled top plate for the wall, so that the wood I-joists could sit flat on the plate. At the top, where the rafters dead-end into the LVL rim joist (which is also the window header), the wood I-joists were fastened using angled Simpson LSSUI joist hangers.

"I like the way Eric used the LVL band joists to do the work of the window header in a bunch of places," said Kruse. The crew did have to take care that rafter ends falling above window openings were attached with load-bearing metal connectors. But the method saved labor and reduced the amount of thermal bridging in the wall. "When we use engineered wood band joists at the floor perimeter in a two-story wall," Kruse said, "we like to hold the wood back from the edge of the plate and put some rigid foam in there for a thermal break. You just have to make sure your sheathing spans across the foam from the lower wall to the upper wall. But at the top of the roof like this, we would rather have solid lumber behind the plywood for attaching eave overhangs and trim."

Complex as this unique custom job was, Kruse and his crew made good time. "I have a really good group of carpenters right now," Kruse said—and he also gives architect Eric Sokol part of the credit. "Sometimes you get plans from an architect, and they didn't think about this and they didn't think about that," said Kruse. "That happens just about never with Eric. At first, it's hard to see how it's all going to come together. You get the plans and for a long time, you're just looking at it and trying to figure out what the heck it is. But then eventually it clicks."

Ted Cushman is a senior editor at JLC.

Photos by Jake Bruton

Air-Sealing That Works

An extremely tight shell proves affordable with "universal," repeatable details

BY JAKE BRUTON AND STEVE BACZEK

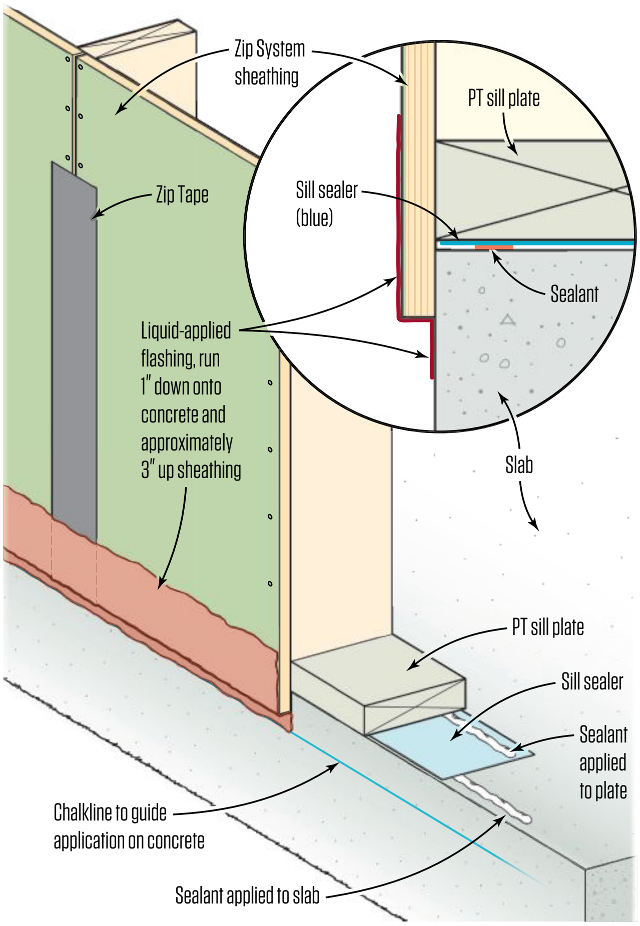
In recent years, airtightness has become an increasingly important area of focus in residential construction. As of the 2012 International Energy Conservation Code (the "energy code" that underpins Chapter 4 of the IRC), builders must attain a minimum blower-door reading of 3 ACH50. However, our company's goal is to meet or exceed the Passive House level of airtightness, which is 0.60 ACH50.

Many builders think that achieving an airtightness number this low requires a significant increase in budget due to costly materials and increased labor. But on the 1,100-square-foot home shown here, we were able to reach our initial goals with an extremely tight budget of $155 per square foot—which, for our typical practices and our market, is very low. We accomplished it by properly managing our materials and their installation.

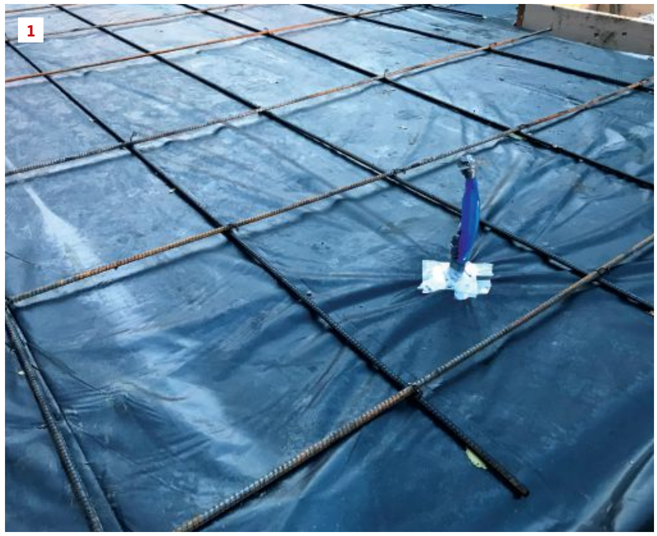
CONSULTING BUILDER PROGRAM

When our clients initially approached us about building a responsibly sized and durable home for their small family, they had concerns about meeting their tight budget and building a high-performance home. In cases like this, my firm institutes our consulting builder program, where I consult with the clients or the project's architect (or both) during the design phase to make meeting the

Air Seal at Base of Wall



Sealing down low. Stack effect—the movement of heated air from the bottom to the top of a house on a cold day—tends to draw air into a home at the base, making air leaks low on the house among the most important to seal. The author's crew accomplishes this in multiple ways. Before the slab is poured, all penetrations are sealed to the sub-slab poly **(1)**, and the author keeps stub-ups separate so they can be sealed effectively (multiple stubs are nearly impossible to seal well). His wall-to-foundation seal (see illustration, left) is applied over and under the "sill seal" (which mostly functions as capillary break) as well as at the base of the wall sheathing.



performance and durability goals easier. The clients pay a consulting fee only if they decide to go with another construction firm. Otherwise, if the clients decide to hire my company, I simply absorb the fee into the construction price for the home. This process lets me build a relationship with clients before they have chosen a builder. More importantly, I no longer have to try to retrofit details like air-sealing into an existing design.

The architects with whom we work are open to designing more-energy-efficient homes and to having a builder involved in the design process. I can't emphasize this enough: The one, simple step of being involved at the start of the design process is the single most important factor in our ability to remain profitable building high-performance homes. It has advanced both my firm's budget management process and our ability to hit energy goals.

Our basic airtightness protocol is founded on our ability to develop air-sealing details that can be repeated easily and become part of our "universal" building toolbox. They have to be simple and cost-effective, and they must rely on methods that can be performed by any of our carpenters with materials from a well-stocked lumber supplier.

AIR-SEALING STARTS AT THE SLAB

The air barrier starts below ground level, under the building. Our first line of defense is 10-mil poly, which we apply directly over the under-slab insulation. We've found that the 10-mil thickness withstands traffic better than the code-required 6-mil and prevents damage that would require us to go back and make repairs. During the installation of the 10-mil poly, all the seams are lapped and taped to ensure an airtight installation. When it's available, we prefer to use one continuous piece of poly.

The Aarow Building crew leaves window and door openings **(2)** sheathed for the duration of the framing. When the frame is complete, they'll come back, fill in doors they left open for access **(3)**, and run their initial blower-door test. Note the white spray paint above the door. All temporary nailers are painted white for easy identification so they can be filled prior to the test.

While it's not too likely that we will develop air leaks through the slab penetrations, we instruct our subs that each individual stub through the slab be taped to the 10-mil poly below the slab. This means each line that penetrates the slab does so alone and is not mated with a handful of other pipes—clusters of pipes are nearly impossible to air seal. By separating the stubs by just a couple of inches, however, we are able to properly seal them.

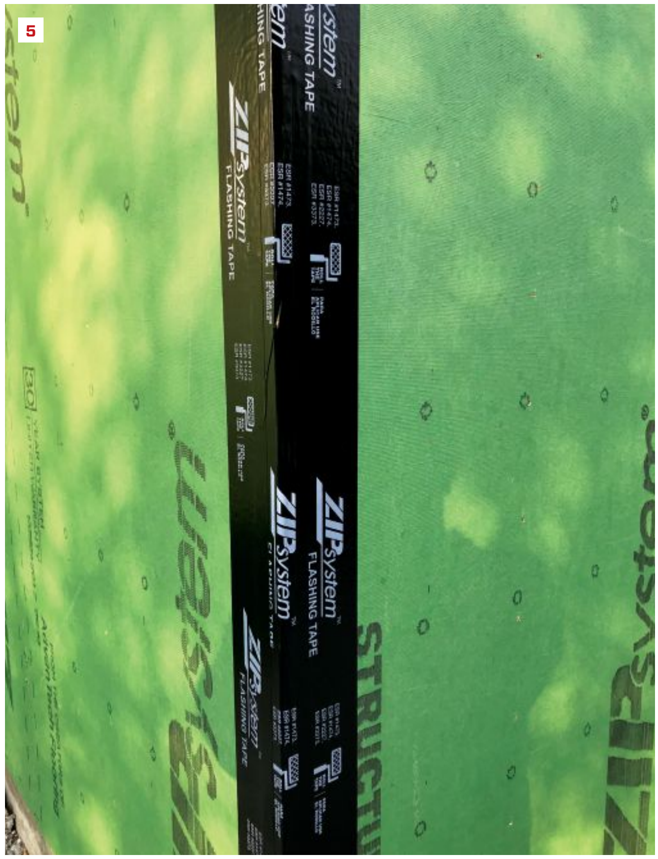
On this home, code required a 3-inch PVC line from below the slab to the roof for a passive radon vent. This radon line ended up being the only roof penetration. In general, we try to avoid roof penetrations, by using approved air-admittance valves for plumbing vents.

FRAMING PROCESS

Once we are ready to frame a home, we have a crew meeting about our goals for the next steps of the project and the methods we will use, and we ask for objections or ideas. We do this on every project; it brings every crew member, no matter how green or seasoned, fully into the process. At this time, we assign one crew member to be in charge of all air-sealing, which will take place over multiple days and include various materials. This ensures we never run into "I thought that was someone else's job."

When it comes to sealing the sill plate to the slab, we not only use the standard foam sill sealer required by code as a capillary break below the pressure-treated sill, but we also add two beads of sealant. In the past, we have used Tremco's acoustical, but on this home, we used Geocel from Proflex. Both products are supposed to have a long service life without curing to a hard finish. This is important, because when things become rigid, they tend to crack, creating leaks.

This home was our first attempt using Geocel. The decision to use it was driven by budget; the Geocel is about half the price of



Corners are areas where Aarow Building ramps up the taping detail. On inside **(4)** and outside **(5)** corners, the crew uses three pieces of tape: first, a single piece that bridges the joint between the meeting panels, and then, a strip on each side of the first piece. Huber makes a 6-inch tape that could work, but it is a special-order item for the author.

Tremco. Also, Geocel is readily available at our supply house. For the majority of homes we build, though, we prefer to use Tremco because we know that its service life can be more than half a century.

We apply the two beads of sealant before we stand the walls. We apply one bead to the pressure-treated plate near what will be the interior, and then staple the sill sealer on like normal. The second bead of sealant is applied to the concrete slab near the outer edge. Placing the beads on opposing sides of the sill sealer creates a non-direct, "Z"-shaped pathway for air movement.

Each joint in the plates is detailed with enough sealant that it squishes out once pushed into place. If it doesn't squish, we pull things apart and add more. Each of the foundation bolts also receives a large glob of the sealant, just in case. I have found that stressing the idea that the sealant is continuous is important to achieving our goals.

ZIP-TAPE SEALING

Now that the walls are standing, we start installing the sheathing. Our homes receive full sheathing using Huber's Zip System. The seams are then taped according to the manufacturer specs. As with the liquid sealants, one crew member is responsible for all taping and rolling, which means everyone else can move on to other tasks. First, we tape all of the horizontal seams of the sheathing on the project and then all the verticals. This creates a shingled effect on all tape joints that will help to shed water from the tape and down the wall, without making a penetration into the envelope.

The only aspect of the Huber instructions from which we deviate is the inside and outside corner taping—we use three pieces of tape instead of the recommended one. We install one piece on the corner, bridging both sides, and roll it. Then we install a strip on each edge of the first piece, as insurance. Make sure to roll the first piece before in-

Continuous air barrier. Air leaks at the top of the wall are sealed with a combination of Zip Tape and Grace Vycor Plus. First, the sheathing is taped to the top plate **(6)**. Strips of 9-inch Vycor Plus lap over this tape **(7, 8)** and extend inside **(9)**. There, they will be taped to strips of OSB that will be installed at the perimeter of the ceiling, forming the air barrier for the lid.

stalling the others; otherwise, air can easily become trapped behind all three layers. We started using this practice because it was difficult to run tape in a straight line in corners, and the three pieces ensure full coverage. Huber makes a 6-inch tape that would work perfectly for this; however, our supply house doesn't stock it and we find it easier to have a method that doesn't require special-order items that can delay the schedule or be overlooked because they're not on site.

For this home, we didn't remove the window or door sheathing during framing, so we could test the envelope before installing the windows. We taped and rolled those openings as if they didn't exist at this stage.

After all the walls are up, we return to the slab-to-wall connection. On this project, we used FastFlash, a liquid flashing product from Prosoco; I also think the fluid-applied sealer from Huber is a superb product. We chalk a line 1 inch down from the top of the slab as a guide, to avoid applying the product too far down for the siding to properly conceal it. Then we apply the Prosoco FastFlash, bridging from the Zip sheathing down to the foundation (see "Air Seal at Base of Wall," page 50).

Flashing the base of the wall requires more attention to detail than anything else discussed so far. It's messy, you're often in the mud, and the area is low and hard to see. But it is an important spot. Of all the air leaks, those low and high on the wall draw in the most air due to stack pressure. If you're going to invest your time on air-sealing, those are the areas to concentrate on.

The wall-to-slab connection is also difficult to detail because the slab concrete is never completely flat or straight. Hence, it requires a lot of added effort to create a solid seal. Keep in mind that leaks here will be impossible to repair after construction is complete, so getting them right the first time is critical.

10


11


Ceiling strapping helps flatten the ceiling **(10)**—a particularly important detail on this sloped ceiling, which will be raked by daylight from clearstory windows. At the perimeter of the ceiling, the crew installed strips of OSB **(11)**. The Vycor installed across the top plates adheres to the top of this OSB and drywall is secured to the bottom to complete the air barrier across the lid.

12


13


To avoid subs randomly cutting holes through the envelope, the author asks subcontractors to mark hole locations with spray paint. This AC line-set has been marked yellow by the installer and marked as "approved" with white paint by the author **(12)**. Blower-door testing before insulation allows the crew to easily identify leaks in the shell before they get buried **(13)**.

SEALING THE LID

On this home, the ceiling drywall is part of the air barrier, so we needed to make the transition from the Zip System sheathing to the drywall at the top of the wall. For this transition, we use two different tapes: Zip seam tape and 9-inch Grace Vycor Plus with a split backing. We first tape from the wall sheathing onto the top plate. Depending on the wall height, this may take two runs of the Zip tape.

Then we install the Grace Vycor. We leave half of the backing on the tape and let it hang into the building so we can connect to it after we've installed the ceiling joists or rafters.

After completing the taping, we finish framing the structure and even install the roof sheathing. We strap the interior ceiling with 1x3 pine to create a channel for wiring. This strapping also helps flatten the ceilings.

Around the exterior walls, we stop the strapping short, and we fill in with ripped 8-inch-by-8-foot strips of AdvanTech subflooring. We now take the Grace tape that we had left hanging, and we roll it onto the top side of the AdvanTech and nail it to the bottom of the rafters, providing continuity in the transition from wall to roof. The combination of the AdvanTech and the strapping gives us an even plane on which to install drywall. It also allows the drywall ceiling to be fastened 16 inches on-center when we are framing 24 inches on-center. The tighter fastening schedule helps to prevent sag in the drywall over time.

At ceiling penetrations, we install blocks of AdvanTech in plane with the strapping. We drill through the blocks for any lines that pass through the ceiling, giving us a good surface to seal to.

We attempt to keep as much plumbing, electrical, and HVAC inside the air barrier at all times; however, there are always some things that must penetrate the envelope. To preserve the air barrier, we have developed a system for our subs: They are given spray paint (blue for plumbing, yellow for HVAC, and red for electrical) and are required to mark with their paint any hole they wish to drill.

Once all of the subs have marked holes, we return with white paint and approve their openings. If a sub drills a hole that we did not approve, they cover the cost of repair—which could be substantial depending on where they drill. We also tell them that each penetration can hold only one item. So on this home, the mini-split units used for conditioning each have four penetrations (two coolant lines, power, and a drain). That may seem like a lot, but air-sealing two pipes in one hole is nearly impossible.

Before the ceiling can be installed, any trades that will need to be above it must perform their work. Again, all holes must be marked and approved and there must be only one item per hole. To keep the trades moving efficiently, we mark all future wall locations on the floor as well as provide laser levels to transfer marks to the ceiling. Many items like gas lines and home electrical runs still have to find their way into the ceiling assembly and any mismarking at this stage will cost a lot to fix.

Because we are using the drywall ceiling as an air barrier, we prefer to install the ceiling in one mass without wall penetrations. The building is engineered to not need interior partition walls; therefore, we can frame the entire envelope and drywall the ceiling before any interior partition walls are installed. This process is key to keeping the system simple and envelope leakage manageable.

VERIFYING FRAMING TIGHTNESS

As a standard practice, our company executes multiple blower-door tests during the sequence of construction, to progressively identify air leaks as we proceed. We own a blower door, and as a builder of high-performance homes, we believe the blower door is just as important a tool as any of our saws.

We performed the first blower-door test on this home once we were done with the sheathing and had installed drywall on the ceiling. This test was done before the door and window rough openings had been cut. We filled in the doors we needed for access, as well as the attic hatch, with Zip System sheathing, taping it in place. This allowed us to test the integrity of the primary air barrier—the taped sheathing and drywall lid. The result was 0.31 ACH50 Pa, roughly one-tenth of the allowable leakage by code in our market. It is equivalent to a cumulative hole less than the size of a business card across the entire envelope. Not a bad start.

SYSTEMATIC AIR BARRIER

We now have a system that is continuous from foundation to ceiling and back. We can visually inspect almost any part of the 4,700 square feet of envelope—almost the entire air barrier; only the top plate assembly is inaccessible.

The way we find errors in the air barrier is with the blower-door testing. If the numbers on the blower-door test seem off, we can inspect with the blower door running. Every member of the crew and all of our subtrades have the opportunity to go back and correct a seal along any section of the wall or any penetration. This first test also gives us the ability to compare numbers with the next blower-door test that we perform, after the window installation. That gives us a metric for judging how well we installed the windows and an indication of any possible problems that we should correct.

Set procedures like approving penetrations by trades and assigning one crew member to take responsibility for all air-sealing have made the process of achieving a tight envelope as simple and cost effective as possible, while setting us on the path towards an extremely energy-efficient home.

The next blower-door numbers, after the doors and windows were installed, tested out at 0.9. This number was a bit higher, but that's to be expected after cutting in all the openings. We expect this number to improve slightly before we are completely done, because there are no more holes to be cut, only finishes.

Jake Bruton is the owner of Aarow Building, in Columbia, Mo. Follow Aarow Building on youtube, and Jake on Instagram @jakebrutonlive.

Steve Baczek, of Reading, Mass., is an architect specializing in energy-efficient design and certified passive homes. Follow him on Instagram @stevenbaczekarchitect.

Products

BY KATHLEEN BROWN

1. A Folding Panelized Window System

NanaWall Systems' Kitchen Transition panelized windows for indoor-outdoor kitchens now offer the RemoteStack feature, which makes it possible to remove panels from the opening and stack them to the side. Kitchen Transition is available in two configurations: a Folding System window-door combination and a Single-Track Sliding system with a zero-floor-track option. Any combination can be created for virtually any kitchen facing a backyard, courtyard, or deck, NanaWall says. RemoteStack pricing varies by selection. nanawall.com

2. A Sleek Composite

Created from concrete and recycled glass, Formica Corp.'s new Quartz Composite is inspired by the look of traditional quartz. Its pattern features medium- to fine-fill background particulates and a blue-gray vein. Formica's Artisan finish adds a smooth, slightly glossy surface that brings out the details of the pattern, according to the manufacturer. The Formica Brand Quartz Composite design starts at approximately $28 per square foot, fabricated and installed. formica.com

3. Touchless Faucet

Moen has added its MotionSense Wave feature to its Arbor faucet collection, a one-handle high-arc pull-down kitchen faucet. The fixture's touchless motion-activated sensor, located on the side opposite the handle, allows users to turn water on and off with a wave of a hand. Moen says the feature provides ease of use, energy and water savings, and increased control over the spread of germs. The faucet is available in polished-chrome, spot-resistant-stainless, and oil-rubbed-bronze finishes. Prices range from $495 to $710. moen.com

4. Exterior-Use MDF

Accsys Group's Tricoya MDF is made from wood fibers that have undergone acetylation, which Accsys says alters cell structure to make wood more durable and dimensionally stable. Insect- and fungal-resistant, the MDF can be used in exterior applications—such as facades, cladding, fascia and soffit panels, and window components—and in wet interior applications, such as indoor pools and bathrooms. Tricoya MDF doesn't require sanding and is water-resistant after being cut into, Accsys says. Pricing varies by region and distributor. tricoya.com

5. A Universal Swing Door Locking System

Universal Multipoint Series hardware from Inox is designed to fit the multipoint locking systems of most major door manufacturers, eliminating the need to void a door's warranty by drilling new holes to fit new hardware. The trim includes a hidden framework with an adjustable thru-bolt distance that can be configured by up to 1 1/2 inches on the top and 2 inches on the bottom. Its triple-spring support reduces lever sag over time, Inox says. Twenty-six modern- and transitional-style handle designs and four metallic finishes are available. Prices range from $200 to $290. inoxproducts.com

6. High-Strength Fasteners

MiTek has debuted its new Pro Series line of fasteners, which includes washer-head, bugle-head, and hex-head structural wood screws. Available in an exterior or yellow zinc finish, the MiTek washer-head screw is suitable for deck ledger attachments, multi-ply EWP, and dimensional wood connections. MiTek's hex-head and general-purpose bugle-head screws offer a high-strength alternative to traditional lag screws. All fasteners have a "cut point" to eliminate the need for predrilling and reduce installation torque and splitting. Pricing varies by fastener grade and length. uspconnectors.com

7. Touch-Control Showerheads

American Standard's Spectra+ Touch and eTouch showerheads allow users to change spray patterns with a touch control on the fixture's outside ring. The Spectra+ eTouch includes a remote that can be wall-mounted anywhere in the shower for easy access. Spray patterns include drench, jet, massage, and gentle. The 7-inch heads are available with a 2.5-gpm standard flow rate or a 1.8-gpm rate that is WaterSense certified and CalGreen compliant. Depending on finish, the Spectra+ Touch ranges from $140 to $190 and the Spectra+ eTouch ranges from $180 to $240. americanstandard-us.com

8. One-Hour Exterior Sealant

Dap says its Dynaflex Ultra Advanced Exterior Sealant provides UV protection as well as dirt, water, mold, mildew, and algae resistance. Paint- and rain-ready one hour after application, the sealant will not wash out or undergo rain damage, the company says, and paint that's applied to the sealant after one hour will not crack, gloss, or dull. Dynaflex Ultra is available in five colors, and costs between $6.50 and $8. dap.com

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9. Engineered 'Cedar' Siding

LP SmartSide has added Cedar Texture Vertical Siding to its line of engineered-wood siding and trim. The siding's 16-foot length allows for one-piece installation and eliminates horizontal joints. For a board-and-batten look, it can be used with LP SmartSide Cedar Texture or Reversible Trim. LP also suggests this new line can be installed across an entire building or as an accent panel. Check with your local distributor for pricing. lpcorp.com

10. Balcony Waterproofing

Tamko's line of Balcony/Breezeway waterproofing products is specifically designed to help prevent water intrusion at exposed balcony and breezeway areas, the company says. The line includes TWP-2 Water-Based Primer and TWP-1 Quick-Dry Primer for prepping OSB decks, as well as TW-60 Sheet Waterproofing Membrane (for application over the deck), TW-105 Flashing, and TWM-1 Mastic. The membrane is made with a quick-release film for easy roll-out. Tamko says it designed the system to cut down on installation time by eliminating the need for corner metal flashings. Pricing varies by market. tamko.com

11. Wood-Look Beam Accessories

Fypon has added beam end caps and tops to its collection of rustic Woodgrain Beams and accessories. The company says the end caps can be used with any Fypon Woodgrain Beam size and style, while beam tops fit 6-inch-by-8-inch and 8-inch-by-10-inch beams. Fypon beams, tops, and caps are made from polyurethane, which the company says does not split, crack, warp, mold, or dry out like real wood. The new end and top caps are ideal for creating mantels, shelves, or door frames, Fypon says. An 8-inch-by-10-inch-by-12-foot beam with end caps costs $360. fypon.com

12. A Low-NOx Gas Furnace

Lennox's SL280NV Ultra Low NOx gas furnace is the first product on the market that meets new California low-emission regulations. The furnace produces 65% lower NOx emissions than standard low NOx furnaces, Lennox says, burning more NOx emissions at a higher temperature. The SL280NV has a heating efficiency rating of 80% AFUE and includes a variable-speed blower and two-stage gas valve for quiet adjustment of airflow and heating output. Pricing varies by distributor. lennox.com

Hitachi Cordless Framing Nailer

BY TIM UHLER

Editor's note: Hitachi recently announced that it will change its name to Metabo HPT beginning September 2018. Only the name will change; all warranties, model numbers, battery compatibilities, and so on will remain the same. See JLConline.com for more information.

We have pretty much gone cordless with power tools, but we haven't been able to with nailers. That being the case, is it worth owning a cordless nailer? I have previously reviewed gas-powered nailers from Bostitch and Paslode and battery-powered nailers from DeWalt. For the last few months, we've been using the new Hitachi brushless cordless framing nailer.

HOW DOES IT WORK?

Unlike the Paslode, which has an internal combustion engine, and the DeWalt, which has a flywheel design, the Hitachi uses an "Air Spring Drive System." Air that is permanently sealed in the chamber is used to drive two to three nails per second, according to Hitachi. The recoil feels like that of a pneumatic Hitachi gun—minimal on my wrist.

There is no ramp-up time, and you can use the gun sequentially or in bump-fire mode. This gun is not what you'd want for nailing off sheathing or decking, but for most framing tasks, there's hardly any difference between this and most pneumatics.

The depth of drive (a dial-type tool-free design) works very well. The magazine holds only one full strip and has a dry-fire lockout. (You can fit one and a half sticks if you break sticks in half. I don't usually.)

The soft grip has a lock switch for safety, and the power switch shows the battery charge level and the selection for bump or sequential firing. The gun also comes with the world's largest rafter hook; it will actually hold the gun on a 3 1/2-inch wall or beam. This hook does swivel out of the way, but we think it's totally ridiculous. More on that below.

THE BEST TOENAILING AROUND

This gun shoots quickly and consistently. It has little recoil, and it's probably the best gun I've ever used when it comes to toenailing. It isn't light—the Paslode is better balanced and lighter—but it isn't super heavy, either.

A cordless nailer with the power of a pneumatic. The brushless 18V nailer comes in two versions: One uses a 21° plastic strip (model NR1890DR) and the other, a 30° paper strip (NR189DC). The paper-strip model accepts clipped or offset round head nails. When equipped with a 3.0-Ah battery (shown), each model weighs a little over 10 pounds. Both nailers sell for around $400 each. Kits include a charger, one 3.0-Ah battery, and a carrying case.

Photos by Tim Uhler

Weigh In!
Want to test a new tool or share a tool-related testimonial, gripe, or technique? Contact us at JLCTools@hanleywood.com

Good nose for toenailing. The nose design makes this nailer an excellent option for toenailing. The depth-of-drive dial is easily accessible, functions well, and is easy to follow while you're making adjustments.

All-inclusive power panel. Along with a safety switch (not shown) on the gun's handle, the tool also features an on/off power button. The onboard fuel gauge provides battery-charge status, and switching from bump-fire to sequential mode happens at the push of a button.

I like, too, that the 3.0-Ah battery charges pretty quickly—in less than 30 minutes—and that the batteries are cheap (normally around $40, and cheaper if you watch for deals). You definitely need two batteries. Hitachi claims that the gun will shoot "up to 400 nails," which works out to be 14 strips, on a charge. That isn't a lot. After about an hour of pickup framing, the battery was dead. We've had no trouble with two batteries, however. So far, batteries charge faster than we can typically drain one.

The gun has plenty of power and had no trouble driving framing nails into engineered wood. Often, on second floors, we toenail through LSL; this was no trouble. It has become my go-to gun when we are framing floors or ceilings. I also use it for blocking, because walking walls without a cord is safer and more convenient.

What I don't like. The gun is a little bulky. This isn't a deal breaker for me, but if you do a lot of overhead work, it'll give your shoulders a workout. Also, the right side of the gun where the motor is can block the line of sight.

Those things don't bother me too much but are worth noting. What does bother me and almost made this gun useless for me is the rafter hook. It is massive, and when I hooked the gun on my belt, it would swivel out when I didn't want it to. Hitachi then sent me the hook for its finish guns; that is the hook that should ship with it.

Affected by weather? Our climate is moderate but wet. I've used this gun soaked, with no trouble, in pouring rain. I did have some issues shooting hot-dipped galvanized nails, because they were thicker; I switched to Hitachi nails, and they work fine. I have seen on Instagram that the gun doesn't work well below 25°F. I asked Hitachi about this, and it said that the tool is equipped with thermal protection and is designed to shut off at 23°F. According to Hitachi, anything below 23°F can cause damage to the tool and shorten the life of the internal components.

THE BOTTOM LINE

This gun isn't intended for high-volume work, but it is perfect for nailing joists, blocking, pickup framing, ladder work, and the like. It would also be great for a remodeler who doesn't need to frame walls all day. It isn't a perfect gun, but Hitachi has advanced the cordless framing nailer to the point where I think every crew could benefit by having one.

Tim Uhler is a lead carpenter with Pioneer Builders in Port Orchard, Wash. Follow him on Instagram @awesomeframers.

Two Double-Duty Ladders

BY CHRIS ERMIDES

First revealed at STAFDA about a year and a half ago, Werner's new 2-in-1 Dual Purpose Ladder became commercially available late summer 2017. This ladder converts from a stepladder to an extension ladder thanks to a special hinge and clips that lock it in position. It's available in 6-, 7-, and 8-foot stepladder versions that convert to 11-, 13-, and 15-foot extension ladders, respectively. Additional features include 3-inch-deep steps from bottom to top, oversized feet for added footing, and a padded V-rung when extended for working on things like wall corners, poles, or trees.

The Dual Purpose Ladder has a Type IA 300-pound duty rating, is made of fiberglass, and is ANSI A14.2 and OSHA certified. Once extended, the top rung of the stepladder meets with the bottom rung of the extension to create a 6-inch-deep platform. This ladder is not meant to be used as a double stepladder, though; it's not designed for you to climb both sides, or for two people to use at once.

OSHA regulations specifically state that because traditional stepladders are designed to be self-supporting, they should not be leaned directly against a vertical surface. In its closed position, the Dual Purpose ladder is not designed to be leaned up against a wall. However, Werner's Leansafe Ladder is a newly designed stepladder that can be leaned against flat wall surfaces, wall corners, poles, and wall studs.

The Leansafe has a Type 1A duty rating and a load capacity of up to 300 pounds. It has large, non-marring rubber pads that Werner says maximize contact with the ground both in a standard setup and in leaning mode. The rear ladder rails, which are attached and hinged below the top platform, lock in place when closed and allow you to be closer to the vertical work surface. It also features rubber bumper pads, a magnet for holding metal tools or bits, and holes on the top to secure various tools.

The Dual Purpose ladder sells for $192 (6 foot), $219 (7 foot), and $254 (8 foot). The Leansafe is available in 4-, 6-, 8-, 10-, and 12-foot options. Prices range from $115 to $370.

The ladders are available through various online retailers, including Home Depot (though as of now, not available in stores), as well as certain local distributors. Check Werner's site for availability. Expect a three-week lead time when ordering online.

Chris Ermides is the editor of Tools of the Trade*. Follow him on Instagram @toolmagazine.*

Stepladder and extension ladder all in one. The Dual Purpose ladder can be safely used in either position. When extended, it features a 6-inch work platform on which you can firmly stand.

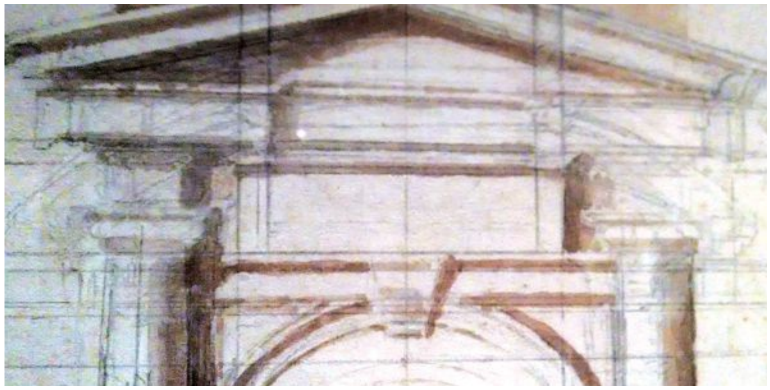
Lean safe. You likely use a stand ladder in this position all the time, though it is not OSHA-approved. Here, Werner has created a safer option—with wider feet and a dropped back rail for better contact to the wall.

Ladder photos courtesy of Werner

April Advertising Index

*Advertising appears in regional editions

BY MARK LUZIO



Above left is Michelangelo's sketch for the facade of Palazzo Farnesse in Rome. At right is a detail for a gate in the Aurelian walls; according to Vasari, Michelangelo provided five drawings for the job, and the client, Pope Pius IV, chose the least expensive option.

Photos: Clayton DeKorne, with permission of Metropolitan Museum of Art

Il Divino General Contractor

Most know Michelangelo as a master of the sculpture's chisel and mallet and as an incredible painter. But as a recent show at the Metropolitan Museum of Art, in New York City, confirmed, he was also a brilliant draftsman. Working out architectural details—including doorway columns, entablatures, window trim, stairways, balustrades, and even whole structures—was essential to his work. These elements were the backdrop for his sculptures and ground for his paintings. The Met show revealed how much time and energy he spent on the design of structures, and for this, he is often remembered as an architect, too. But the show revealed to me that he was more than this; he was also the general contractor.

Sculptors and painters in Michelangelo's day received a lump-sum deposit and progress payments from their wealthy patrons. In surviving letters, we hear the artist pleading with one of his most important clients, Pope Julius II, for long overdue payments. The needed cash was not just for himself; he also had commitments to his subs.

The contract for the painting of the Sistine Chapel ceiling included language that made him responsible for the design of an elaborate suspended scaffold, which would allow Mass to be held during the years 1508 to 1512. And in the daily work of painting one of the most famous frescoes in the history of art, he was responsible for defining each day's work, or "giornata"—the amount of painting a master (GC) thought he could complete in one day. Total dry time for the plaster would be about 12 hours. The plasterers would take roughly three hours to skim coat an area, leaving him just eight hours to paint before the plaster cured and would no longer absorb pigment. If he and his assistants could not complete the entire area that had been set out for the day, the remaining plaster had be scraped off and reapplied the next day. It's amazing to think there was a day when Michelangelo had just eight hours to complete one entire figure from the central scene, "The Creation of Adam"!

I heard about the exhibition from a GC with whom I'd worked for some 25 years, and so he was top of mind as I walked the show. Many of the drawings were sketches of moldings, and I imagined they were probably made to help other tradesmen understand his vision of the finished work. It reminded me of the hours I have spent sketching ideas and possible solutions to trim details. I do this frequently with my neighbor, Jed Dixon, who many *JLC* readers know as a stair builder and contributor to *JLC* and JLC Live. None of our drawings ever included a muscular Christ-figure in a classical door opening; that part is way beyond our artistic abilities. But there were many sketches in the show that reminded me of jobs I've worked on.

Many of the drawings at the Met can be seen in *Michelangelo, Drawing, and the Invention of Architecture*, by Cammy Brothers. And if you like to read, I highly recommend Ross King's *Michelangelo and the Pope's Ceiling*. Two other books by Ross King, one on Brunelleschi's dome and the other on Leonardo da Vinci, are also great reads for building contractors. You'll appreciate how far and not so far we've all come.

Walking out of the show, I couldn't help but imagine Michelangelo rolling up to a jobsite in a 1972 short-bed Chevy C-10, on his cellphone pleading with a sub who is making a lame excuse for not showing up. For Brunelleschi? Probably a 1949 Ford F3 with a flat-head V-8. And for Leonardo, I am thinking 1970 El Camino SS. Why not? Frank Lloyd Wright, who owned 85 cars and trucks from 1900 to 1959, said "an idea is salvation through imagination." The idea becomes a drawing that we build.

Mark Luzio owns Post Pattern Woodworking, in Brooklyn, Conn.

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