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THE JOURNAL OF LIGHT CONSTRUCTION

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Shingle Siding Basics

Avoiding Wet Roofs

Insulating Over a Slab

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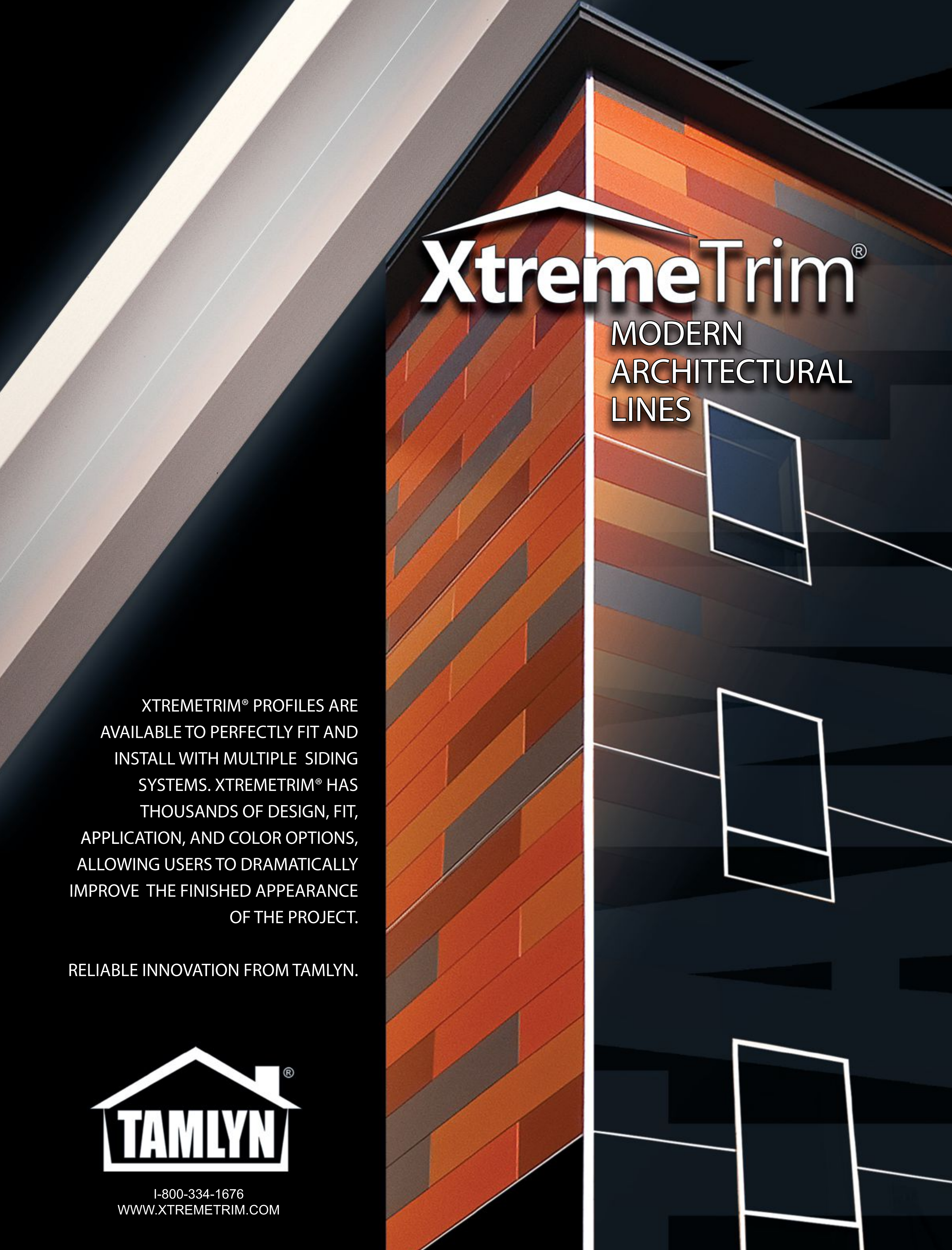
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On the cover: Estevam Castro of Cedarworks, a company that specializes in cedar roofing and siding in Brewster, Mass., fastens stained cedar shingles to a home that is being re-sided. See the story on page 11. Photo by Roe Osborn.

FEATURES

DEPARTMENTS

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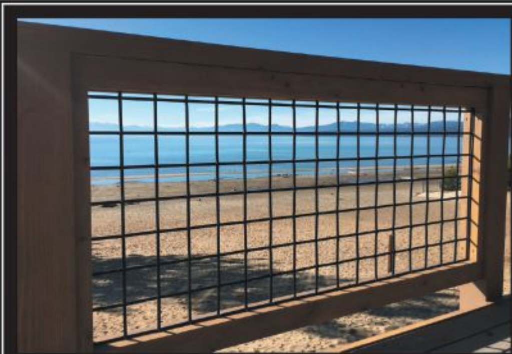

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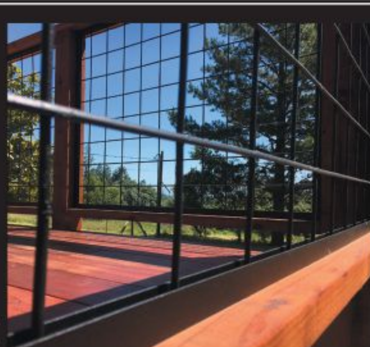

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"SOLVING BACK-PRESSURE PROBLEMS WITH DENSE-PACK CELLULOSE INSULATION," ONLINE, MARCH 29, 2018

Keith Bidwell, regional sales manager for Siga, wrote: I am hoping to clarify a few points about our typical application that seem not to have made it into the article. Everything you wrote was accurate, I just want to be sure that I have communicated clearly about our best practices. First, though I would not recommend stapling airtight membranes as a best practice for containment of blown-in, dense-pack cellulose, it can absolutely be done. Staples, by nature of their quantity, the physical impact during application, and the stress on the fastening point, yield an unpredictable result in terms of air-barrier integrity. Effectiveness of any air-barrier assembly relies on knowing and mitigating cumulative leakage variables.

Our preference at Siga is for physical strapping to help contain the cellulose and also assist in maintaining finished wall flatness. This process is outlined on page 12 of our installation guidelines, which can be found on our website. The strapping bears the weight of the cellulose and allows for the application of Majrex with a double-sided tape, which goes up very fast. And in all cases (staples or strapping), periodic exhaust ports must be cut in the material and resealed after filling the cavity.

The head of the X-Floc dry injection system uses a back-pressure relief valve that allows air to escape so that insulation can be uniformly delivered and compacted. The red filter bag contains any dust that spews out toward the installer.

There are, of course, other viable methods for achieving an airtight vapor-controlled layer with dense-pack insulation. Using mesh netting as containment with Majrex applied afterwards can be effective in terms of quality control, though it adds an extra labor step. As you can see, there are pros and cons to each method, so it's great that you are exploring these concepts.

The editor responds: The article highlights the problems of blowing insulation into high-performance walls. Unlike a leaky existing wall, an airtight wall cavity creates back-pressure that can make it difficult to uniformly place dense-pack cellulose. Securing Majrex or any other airtight membrane to the studs to avoid a blow out is possible, but you still have the back-pressure that may hamper the placement of insulation. In Mr. Bidwell's letter here, cutting and resealing "periodic exhaust ports" is the key technique to evaluate; the instructions are meager. The article pointed to other solutions, including placing the insulation before the cavity becomes airtight—as in blowing into a netted stud bay, which does require placing the air barrier afterwards (a two-step labor process, as noted). Another solution is using a cellulose injection head with built-in pressure relief, such as the German-made X-Floc head (see photo, left).

"WORKING WITH SMARTSIDE," BY TIM UHLER, MAR/18

David Mills, Red Clover Homes, Lower Hudson Valley, N.Y., wrote: After 40 years in business, I recognize the thinking [in Tim Uhler's article] on fiber-cement siding. The narrative on LP SmartSide is intriguing. Compared with InnerSeal, LP makes a better product now, which is encouraging. But how many contractors were left in the dust in the past? Same goes for Hardie board and others. Do they deserve your business? That's an individual decision. Or what about vinyl siding? It gets brittle in bold sunlight after many years.

I've found that focusing on the siding might not be the most important thing. Good flashing coupled with a good weather barrier is essential. The real trick with siding lasting a long time has to do with having a wide roof overhang. And keeping up with the occasional protruding nail head or open seam.

Everything you do requires a revisit, no matter what. I walk around my work once a year for at least six years so I know how I'm doing. A few minutes a year is certainly worth my reputation and the owner's investment.

dharriman (online, 3/29/18): Why is the author using an oil-based canned spray primer, in place of the acrylic-based primer required by LP? Using a non-acrylic-based primer will void the warranty.

The editor responds: This is not correct. First, the author is not using an oil-based primer; rather, he is using Zinsser Bulls-Eye 1-2-3 Plus, which is a water-based, interior/exterior primer. To your concern about the warranty, LP's SmartSide installation instructions specify: "Prime and paint all exposed surfaces including all drip edges or where water will hang." That's the strict requirement printed in bold in the instructions. It does not "require" an acrylic primer, but the instructions do go on to "recommend" one. Specifically, the instructions state: "High-quality acrylic latex paint, specially formulated for use on wood and engineered wood substrates, is highly recommended. Semi-gloss or satin finish oil or alkyd paints are acceptable."

Correction. In "Jack of All Saws" (*Training the Trades*, Mar/18), we incorrectly stated that "Milwaukee didn't invent the tool," referring to the recip saw. In fact, Milwaukee did invent the *portable* reciprocating saw, taking the concept of a reciprocating blade and introducing a hand-held Sawzall, the first of its kind, in 1951. This fact has been corrected in the online version of the article.

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BY JLC STAFF

Sidewall Shingling With Cedar

Shingles and shakes have been used as siding for as long we've been building houses in this country. Made mostly from western red cedar and northern white cedar, sidewall shingles are rot-resistant and long lasting if installed properly. While there are subtle differences between cedar shakes and cedar shingles, installation is essentially the same.

The Cedar Shake and Shingle Bureau (CSSB) provides the guidelines for installing red cedar, and Maibec publishes guidelines for white cedar shingles. This article covers the basic steps for a successful installation of both.

PAY ATTENTION TO DRAINAGE

The biggest enemy of sidewall shingles is water. Even with cedar's rot resistance, the shingles still need to be able to thoroughly dry out after being exposed to precipitation. A drainage plane behind the shingles allows water to drain away and lets air circulate to dry the shingles completely.

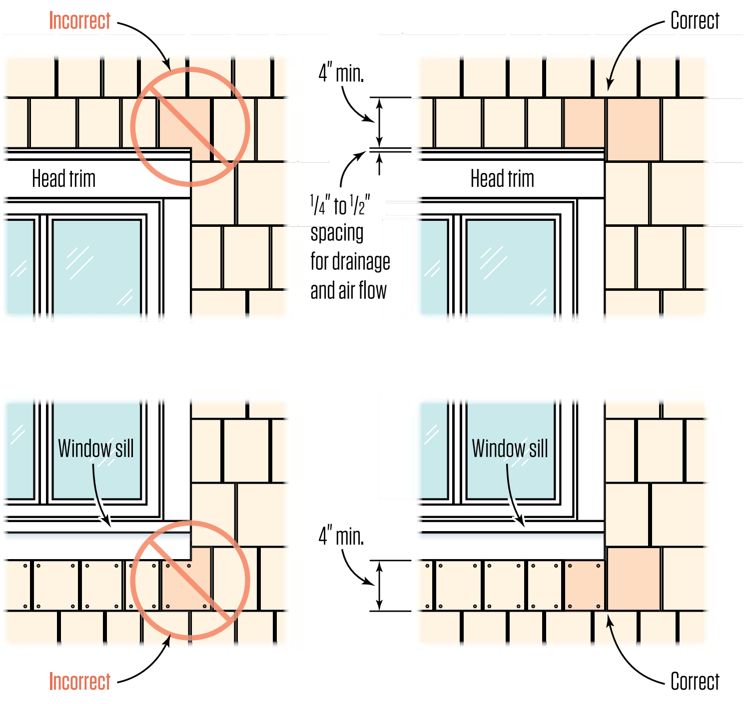
The most practical way to create a drainage plane is with a self-draining rainscreen mat that attaches to the wall over the WRB. The shingles then install over the mat. The mat creates enough space for air to circulate to dry the shingles while allowing the moisture to drain away. Another strategy is creating a grid of furring strips—vertical battens to create drainage overlaid with horizontal battens on which you attach the shingles.

CORNER STRATEGIES

One factor that determines what the finished job will look like is the corner treatment. For shingled walls, outside corners are usually done either with corner boards or as woven corners. For the purposes of this article on basics, we will stick to using corner boards. (For a more in-depth look at woven corners, see "Weaving Stained-Shingle Corners," Jun/16).

The simplest inside-corner trim is a 1x1 or 2x2 wood strip installed over a tar-paper or peel-and-stick spline that extends a few inches onto each wall. With this type

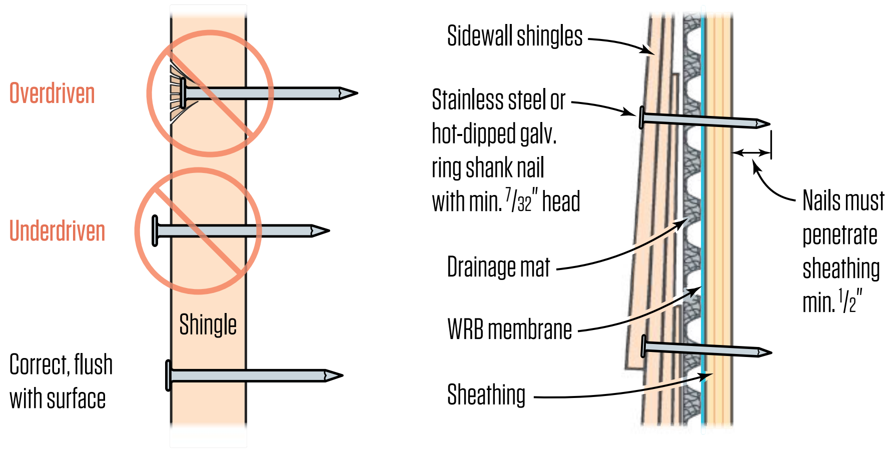
Window Finish Details



When you're shingling around windows, exposure should be no less than 4 inches for the courses above and below the windows. Be sure to leave ample clearance between the course above the window and the head flashing. For proper drainage, align the shingle gaps with the corners and avoid having shingles that wrap around the corners.

Illustrations by Tim Healey

Properly Driven Nails



Always drive nails flush to the surface of the shingle. Underdriven nails do not anchor the shingle properly and overdriven nails break the wood. Additionally, always use nails that are the proper length. Remember that nails must go through the layers of shingles, through the drainage plane, and then through the sheathing with a penetration of at least 1/2 inch. Nails for fastening shingles should be either stainless steel or hot-dipped galvanized.

of corner, the shingles butt against it, as they would with a corner board. Inside corners can also be woven like outside corners.

COURSE LAYOUT

The recommended exposure varies, depending on the size (height) of the shingles. For white cedar shingles, Maibec recommends a 5-inch exposure, but that figure can vary up to 1/4 inch to make a layout work in the space you have. Measure from the underside of the soffit or the frieze board to the bottom of the sheathing and add the overhang (see "Starter Course," below). Divide that distance by 5. This gives you the number of courses you'll need, but it is unlikely to be a whole number (you can forget the fraction). To find the exact exposure, divide the distance (including the overhang) by the number of courses.

In addition, measure the distance from the bottom starting edge to the bottom of the windows. Adjust the layout so that you are not left with a narrow strip to fill in under a window. Also measure to the top of the windows and try to make the bottom edge of a course line up with the top of the windows (including a drainage gap over the head flashing). Maibec says that you should not have less than a 4-inch course below or above a window.

Story pole. Transfer these measurements to a story pole. A story pole is a straight piece of wood, usually a 1x2 length of strapping on which you mark the layout for the courses as well as any other pertinent measurements, such as the tops and bottoms of windows. With a story pole, you can quickly mark off the heights of the courses at each corner of the house to keep the courses consistent as you work from wall to wall.

STARTER COURSE

The bottom of the wall starts with a double layer of shingles, so that the angle of the courses is consistent top to bottom. The inside layer is called the "starter course," and because it will be covered, it can be made with inexpensive, lower-grade shingles.

Overhang. Pay attention to the placement of the starter course. Maibec recommends that the bottom edge of the starter course extend down at least an inch past the top of the foundation. If the wall sheathing laps over the foundation, as it often does in new construction, the starter shingles only need to extend a small distance past the sheathing. The outer first course should then extend 1/2 inch below the bottom edge of the starter course so that water will drip off the outer edge. In addition, note that code requires at least 6 inches between the bottom edge of the first course and grade.

GUIDE STRIP

Installers typically nail a strip of wood (such as a straight length of 1x2 strapping) temporarily to the wall for installing each course. The shingles then sit on the guide strip to keep them in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a straight line for nailing. Some installers just nail the guide strip directly to the course below, but those nails can split the shingles that they nail into, and nail holes are left in the face of the shingles when the guide strip is removed. A better way is to attach pieces of thin-gauge aluminum flashing to the back of the guide strip. A single nail near the top edge of the aluminum holds the guide strip in place. After the course is all nailed in, a light tap on the strip tears the aluminum out from around the nail, and the guide strip is ready for the next course.

For the starter course, the guide strip has to be suspended below the sheathing. Starting at one end, set it at the right height for the finished first course, tack it in place, and then level it across. You can eyeball the starter course to locate it about 1/2 inch above the support strip. Then install the outer course with the shingles sitting directly on top of the strip.

NAILING AND GAPPING THE SHINGLES

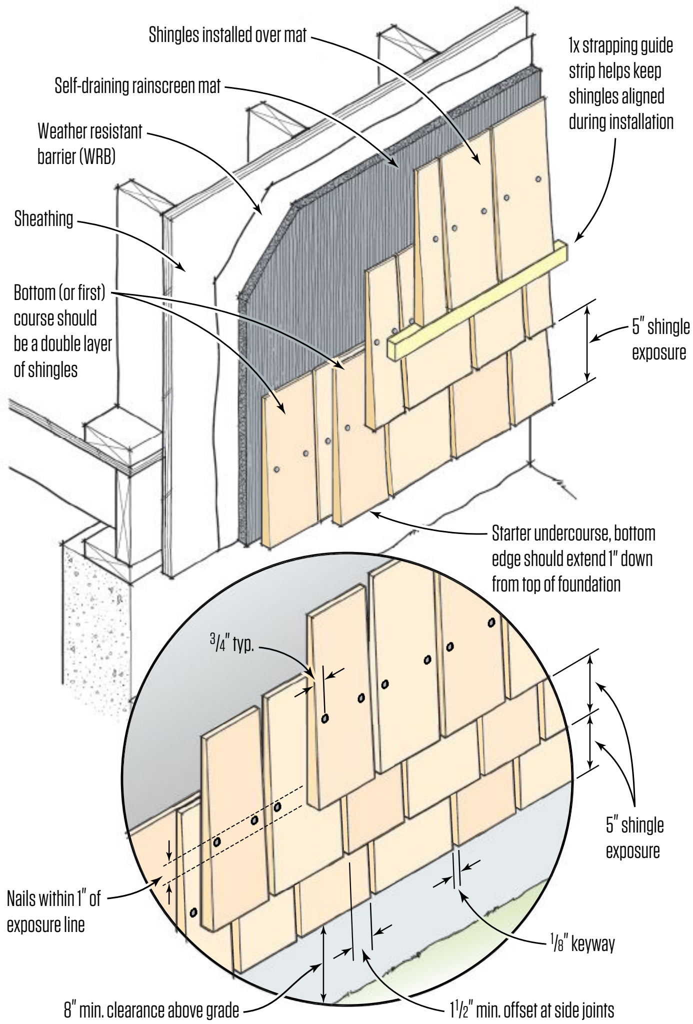
For the next courses, use your story pole to mark out the height of the courses lightly in pencil on the corner boards. Then stretch a chalk line between the corners and snap a guide line. Align the guide strip with the snapped line and tack it in place.

As you place the shingles on the guide strip, take care to offset the gaps between the shingles at least 1 1/2 inches from the gaps in the course below. Leave about 1/8 inch between the shingles to let them expand and contract as they get wet and dry out. Never install the shingles tight to one another.

Nails for attaching cedar shingles should be stainless steel or hot-dipped galvanized and have heads with a minimum 7/32-inch diameter. They also must be long enough to penetrate at least 1/2 inch into the sheathing (see Properly Driven Nails, page 12). Place nails 3/4 inch in from each edge and 1 inch above the exposure line for the next course, as shown in the illustration at right.

As you pull shingles from a box or bundle, try to use them as randomly as they were packed. A common mistake is to grab the largest shingles first to cover as much area as quickly as you can. This strategy will leave you with a bunch of smaller shingles at the end. It's much better to use the smaller shingles as you pull them out to keep the gaps random and evenly distributed over the wall. Plus, as tempting as it is to use wide shingles (10 inches or greater), they have a tendency to buckle and eventually split over time. Put the widest shingles to one side, and use these in areas such as the rakes or dormer cheeks where wider shingles work better for creating the angles (see "Wide Shingles," Oct/17).

Sidewall Shingle Installation Detail



Always establish a drainage plane using drainage mat or furring strips between the shingles and the WRB. Double the bottom course of shingles to maintain the proper angle of that course. The bottom course must be at least 1 inch below the top of the foundation. Let the outer layer of the first course hang 1/4 to 1/2 inch below the inner layer to shed water properly. Drive nails within 1 inch of the exposure line and 3/4 inch from the edges of the shingle. Be sure to leave at least 1 1/2 inches between the gaps on successive courses.

For a more detailed discussion on installing cedar shingles, go to **jlconline.com/training-the-trades/installing-cedar-shingles**.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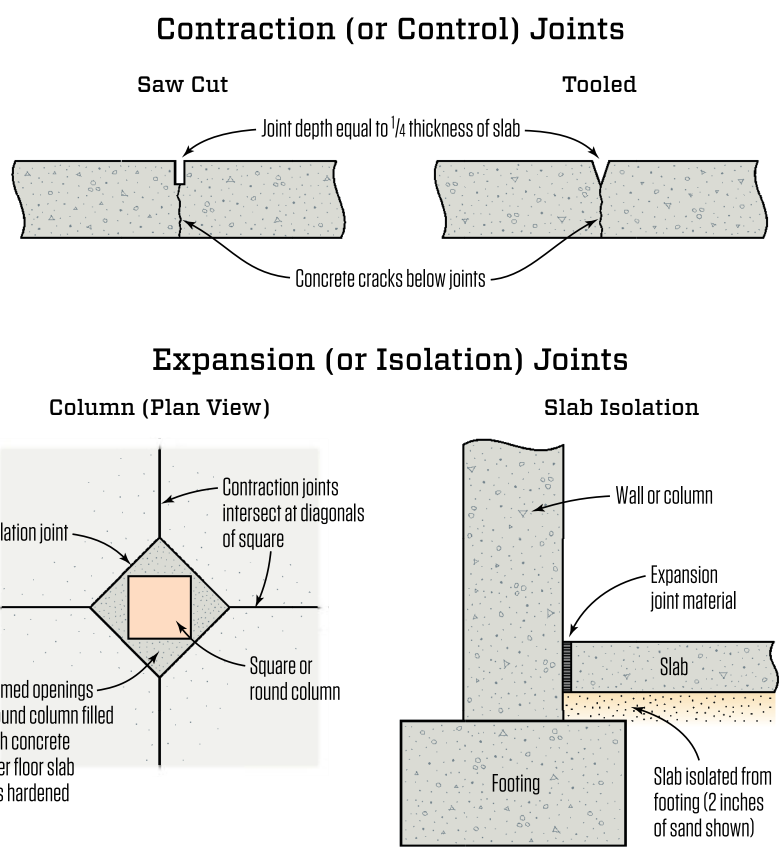
Q My clients want a finished basement in their new home, and they hope to use the concrete slab as a finished floor. How can I detail the slab to minimize cracking?

A The staff at *JLC* responds: A wise man once said that nothing is certain except death and taxes, but perhaps cracks in concrete can be added to that list. The simple truth is that concrete cracks are inevitable—especially when the concrete is spread in a relatively thin layer, as in a slab. The National Ready Mix Concrete Association (NRMCA) has published an excellent series of articles called "Concrete in Practice." One of those articles, "CIP 6—Joints in Concrete Slabs on Grade," thoroughly explains how and why concrete slabs crack, as well as how to control that cracking. Most of this answer has been sourced from that article.

Concrete moves—expands and contracts—with changes in moisture and temperature and as part of the curing process. It is weak in tension, and as it shrinks, the stresses become greater than its tensile strength, resulting in cracks. This cracking occurs even when a slab is reinforced with wire mesh, which does not prevent cracking, but works to keep cracks tightly closed. Left to its own devices, a slab will crack uncontrolled in irregular patterns, and that is precisely what your clients are trying to avoid.

We can control cracks in concrete by using two different types of joints: expansion (or isolation) joints and contraction



Having the proper joints in a slab can prevent uncontrolled cracking. Contraction joints cut into the surface give a slab a weakened point to crack as it shrinks during the curing process. Expansion joints allow a slab to move horizontally and vertically without being in contact with parts of the structure such as the foundation walls, footings, or structural columns. Strips of compressible foam or asphalt sheeting make good expansion joints, and a 2-inch layer of sand can isolate a slab from the footing.

Illustration by Tim Healey

(or control) joints (see illustration, previous page).

Expansion joints separate the slab from structures such as foundation walls, footings, and structural support columns, and allow the slab to move unrestrained both horizontally and vertically. These joints can be strips of asphalt-impregnated sheeting, compressible foam, or other materials that are put in place before the slab is poured. A layer of sand at least 2 inches thick can also serve to isolate a slab from the footing. For a column, the NRMCA recommends forming a box around its base with the joint material. It says to turn the box 45 degrees into a diamond configuration and then have the contraction joints intersect with the points of the diamond. The box stays in place during the pour and is filled afterward in a separate pour.

Contraction joints are lines cut or formed into a slab that create a weak point in the slab profile, forcing a place for the cracking to occur. In other words, when you cut a contraction joint into a slab, the cracking should happen below the joint where the slab is the weakest. Think of these joints as scoring the slab, not unlike scoring drywall to control where it breaks.

Contraction joints can be formed into a slab with a jointing tool early in the finishing process. These joints can also be cut into a slab with a circular saw equipped with a concrete-cutting blade. Saw-cut joints should be made four to 12 hours after finishing. Another option is to insert hardboard or plastic joint strips into the surface of a slab when the concrete is still wet. Contraction joints should be one-fourth the depth of the concrete, so for a 4-inch-thick slab, the contraction joint should be 1 inch deep.

For a floor in a finished basement, the goal would be to control the cracking as much as possible while making the joints as inconspicuous as possible. The expansion joints along the foundation walls will most likely be covered with whatever wall framing you install. If a slab is to be used as a finished floor, a good choice for the contraction joints would be saw-cut joints, which are probably the least visible of the choices. If your client intends to divide the finished basement into rooms, you may be able to hide some or all of the contraction joints under partition walls.

Before the concrete is delivered, locate all of the contraction joints on the finished basement plan. The NRMCA offers a few rules of thumb for positioning contraction joints. First, the joints should be spaced no more than 24 to 36 times the thickness of the slab; for a 4-inch slab, for instance, contraction joints should be 8 to 12 feet apart. The NRMCA states further that spacing should never exceed 15 feet.

Lay out the contraction-joint pattern to form panels that are close to square. The length of each panel should not be more than 1.5 times the width. If the basement is L-shaped, use a contraction joint to isolate the leg of the L. With careful, creative planning, you should be able to conceal most of the joints in the finished basement, and properly-placed joints should all but eliminate any irregular and uncontrolled cracking in the slab.

A Steel Door in a Brick Foundation

BY JOHN CARROLL

Last year, clients approached me to install a door at the rear of their walkout basement. They'd attached a workshop to their home, but access to the shop required walking outside in the elements. The only protected route involved climbing through a window, which they had been doing in the worst weather. The plan was to expand the window opening and install a door.

The location of the new door was ideal for access, except for one detail: The rear of the house faced a wooded area, and the new door would be completely hidden from the street and from neighboring houses. A recent break-in at a nearby home made the clients concerned that the secluded location of the door might be attractive to thieves. For maximum security, they wanted a heavy-duty steel door hinged to a steel frame.

At a local supply house, we found a commercial-grade steel door that would fit perfectly in the width of the brick window opening (40 1/8 inches). But at 80 inches high, the door was too tall for the opening. To make the door fit, I'd have to expand the opening up a few inches and remove the masonry below the window.

Prepping the opening. Like many foundation walls in North Carolina, these basement walls consisted of a wythe of 4-inch-thick block on the inside and a wythe of 4-inch brick on the outside for a total wall thickness of 8 inches. After removing the window, I took out the brick and block below the opening down to a few inches below the basement floor level. Above the window, I removed the steel lintels and then took out a couple of courses of brick on both the inside and the outside. (The original masons used brick instead of block to fill in the space above the inside lintel). As I took out the brick above and below the opening, I toothed out the brickwork to maintain a running-bond pattern.

After removing the masonry, I formed and poured a concrete sill precisely level and one inch above the floor to work properly with the anticipated basement floor covering. On the inside, I set a 1-by board on edge and shimmed it level for the form. On the outside, the door stepped down a few inches to a patio, so I ran the outside form board past the bricks on each side, holding the top even with the interior form. Concrete blocks held the form tight against the bricks during the pour.

The author opens up a window opening for the door **(1)** and then forms a new sill **(2)**. Bolts threaded onto the jambs form masonry anchors for the side jambs **(3)**. To anchor jambs to the sill, he drills holes **(4)** and then drives Tapcon concrete anchors into the holes with a flexible drill **(5)**.

Photos by Werner Lehenbauer

Anchoring the door frame. The biggest challenge was anchoring the metal door frame solidly to the sill and the wall. The owner wanted a door that would be a formidable barrier with the frame bonded tenaciously to the opening. I needed to position the door frame precisely. Once a steel frame is set in masonry, it can't be adjusted, and unlike a wood door, a steel door cannot be shaved to fit.

After letting the concrete sill cure for three days, I was ready to install the welded-steel frame. Each side jamb of the frame had four predrilled holes with a dimple around each one to serve as a countersink. I inserted 3-inch-long, 5/16-inch-diameter flat-head machine screws into the holes and secured them with nuts on the other side of the frame. Then, at each location, I threaded on a second nut about 2 inches from the first, followed by a fender washer and a third nut. Then I tightened everything together with wrenches. Later, when I filled the jamb channels with concrete, these assemblies would embed in the concrete to mechanically anchor the frame in the opening.

With the anchors attached to the jambs, I was ready to bolt the frame to the sill. After setting the frame in place on the concrete sill and making sure it was straight and plumb, I marked the locations of the holes in the attachment plates welded to the bottoms of the jambs. I took the frame out, drilled the holes, and then set the frame back in place. I screwed the jambs to the sill with Tapcon bolts made from steel that was hard enough to cut threads in the green concrete. Toothing the brick next to the jambs gave me plenty of room to fit my hand and the flexible shaft of a nut driver inside the channel, so I was able to use a cordless impact driver to drive the Tapcons.

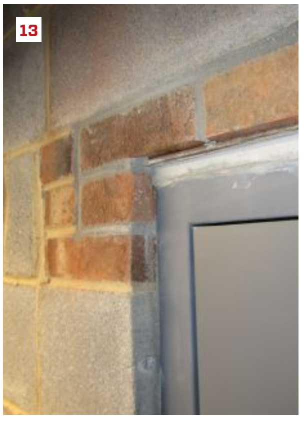
With the frame attached to the sill, I clamped on braces to hold it plumb. The basement ceiling joists provided good anchor points for the upper ends of the braces. I also notched three temporary 2x6 spreaders into the door opening to keep the sides straight while I filled in the toothed-out sections with brick and grouted the jamb channels.

Filling in around the frame At the bottom of the jambs, I laid five courses of bricks, filling in the toothed-out area over to the steel door frame. Following the recommendations of the Steel Door Institute, I filled in the steel frame channel with mortar as I laid in the courses.

At the top of the frame, I laid single bricks at each corner, which brought the masonry to a point about 1/2 inch above the top of the head jamb. These bricks would support the two steel lintels (one for the inside wythe and the other for the outside wythe) that would span across the opening. After laying these bricks, I stopped for the day to allow the mortar to set up.

The next step was grouting, or filling in, the rest of the channel with concrete. I kept the three 2x6 spreaders in place to keep the frame from bulging inward as the channel filled. I'd made the spreaders 1/16 inch longer than the width

Braces clamped to the frame and attached to the joists hold the door frame in place **(6)**. Spreaders keep the jambs from bulging inward while the brickwork and grouting is completed **(7)**. Bricks fill the toothed-out sections near the bottom of the opening **(8)**, and bricks at the top corners of the frame bring the masonry to a height 1/2 inch above the header jamb **(9)**.



The author grouts the jamb channels from the top, scraping the mix into the header channel and pushing it into the sides **(10)**. After filling the head channel about two-thirds of the way, he embeds rebar in the mix **(11)**, then finishes grouting **(12)**. Steel lintels (seen above the door) sit on top of the corner bricks and support the brickwork on both sides of the door **(13)**.

of the opening. The tight fit ensured that the door would not hit the jamb after it was installed.

I'd grouted the bottom foot or so of the channel with mortar as I filled in the brick, and now I had to grout the rest of the jamb channels from the top. Before mixing the grout, I put screws into the threaded holes for the hinges and strikes to keep them from being filled up with grout mix. I also put pieces of rigid foam insulation in the slots that would receive the door bolt and the deadbolt.

I made the grout mix out of bagged concrete enriched with Portland cement. The grout needed to be somewhat loose because it had to go more than 5 feet down the channels, flowing around and completely embedding the anchors in the frame. I added plenty of water to make sure the mix flowed readily. A rich, wet mix would also suck deep into the pores of the brickwork, ensuring a tenacious bond. To get the grout into the channels, I loaded up my hawk and used a margin trowel to push the mud onto the header section of the frame and then down into the side channels.

When both side channels were full, I stopped and let the grout cure for two days before removing the spreaders and the braces at the top of the frame. With the braces out of the way, I mixed another batch of grout and filled the (horizontal) head channel. When the channel was about two-thirds full, I placed a length of 1/2-inch rebar in the concrete, letting the ends of the rebar extend a few inches on both sides into the groove between the inside and outside wythes of brick. The rebar provided an additional mechanical connection between the frame and the masonry at the top corners.

Finishing the brickwork. I finished grouting to the top of the header channel and again gave the grout two days to set up. The final steps were setting the lintels and finishing the brickwork on the inside and outside. The steel lintels I'd taken out earlier were in excellent shape, so I was able to re-use them.

When I set the lintels on the top corner bricks, they had about 4 inches of bearing on each side of the door frame and sat about 1/2 inch above the header jamb. I spread a layer of mortar over the grouted header channel to fill in below the steel lintels. After setting the lintels in place, I laid a single course of bricks over the inside lintel, and two courses over the outside lintel. I used tuck pointers to completely fill the joint between the new bricks and the existing masonry with mortar. Although painstaking, it was necessary to fill these joints solidly because the area above the lintels was load-bearing.

After tooling the joints in the brickwork, I installed the hinges on the frame and the door. Then I hung the door and everyone took a deep breath. To everyone's relief, the door fit perfectly.

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

Tile-Membrane Origami

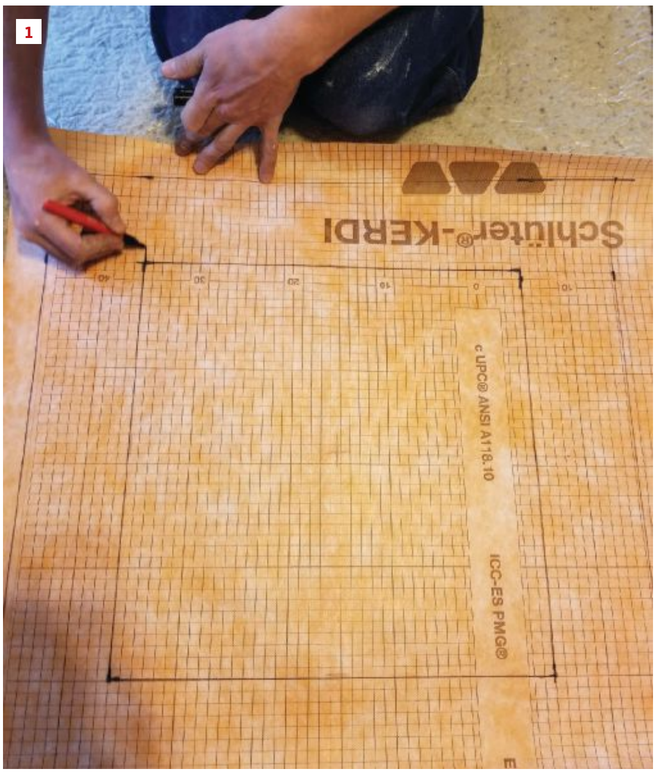
BY JAKE BRUTON

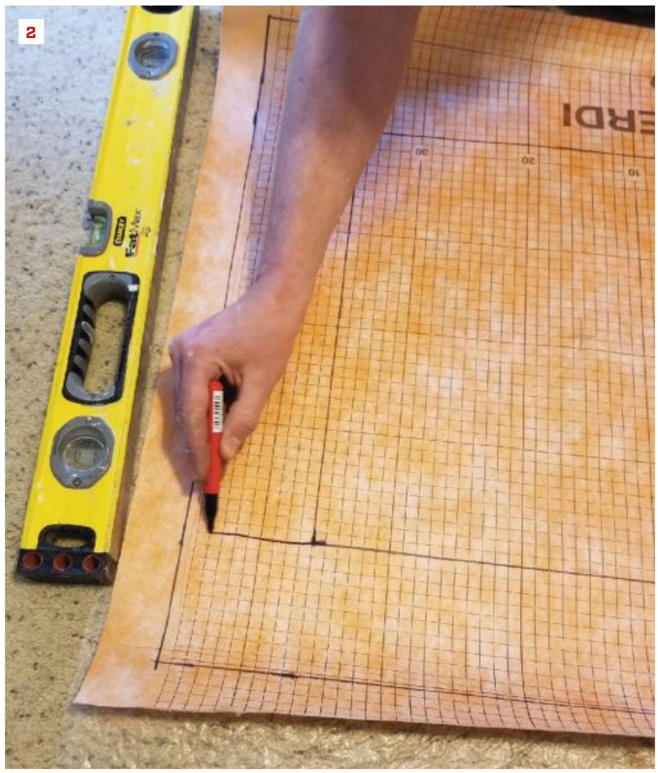
Schluter waterproofing has been our go-to product for almost every tile job for the last 10 years. The primary waterproofing product we use is the Kerdi membrane. It has a tough modified polyethylene core with non-woven polypropylene on both sides that bonds well to thinset mortar. The membrane is anchored to backerboard with thinset, and it provides a good foundation for thinset to hold the tile. Kerdi is lightweight, simple to install, and virtually idiot-proof.

We do all our own tile work in-house, and the only downside for us with the Kerdi product has occurred in situations that require multiple layers of the membrane. These can result in lumps, ridges, and generally uneven surfaces, over which setting tile is difficult. The place this occurs the most is in a shower niche or inset. With layers of Kerdi coming from top, bottom, and all sides, the inset can have multiple layers on multiple surfaces.

After working with the membrane for years, we developed a method that prevents lumps and unevenness by minimizing the number of layers and that uses only one piece of Kerdi. It's a little like origami but isn't too hard to execute once you see how it's done.

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





One sheet of Kerdi. The author starts by drawing the back wall of the inset or niche on a piece of Kerdi. He expands that box to include the depth of the inset on all sides and then adds the prescribed 2 inches of overlap as the outside dimensions of the Kerdi paper. For this example, the interior box is 15 inches square; the second box is 23 inches square (2x4 wall with 1/2-inch drywall); and the sheet size is 27 inches square **(1)**. With the perimeters defined, the author then draws a line from the corners of the interior box to the edges of the exterior box to represent either a cutting line or a folding line **(2)**.

Photos by Jake Bruton

Cut out. While Schluter doesn't prescribe a specific way seams should lap, the author adheres to a shingling method to prevent potential water leaks. To achieve this, the top, or "ceiling," of the inset is cut from the interior box outward, leaving flaps that will fold over the sides **(3)**. Similarly, the sides are cut downward (toward the knees in this photo) to create flaps that will lap onto the base, or "floor," of the inset **(4)**. The entire piece is folded and scored once; the creases provide some rigidity needed for the install **(5)**. We then apply thinset to the entire opening **(6)** and are ready to install the precut, prefolded sheet.

Installation. Starting at the bottom, the author aligns the back corner and presses the membrane into the back wall and bottom of the inset **(7)**. He adds thinset to the bottom corners so the side flaps will adhere over the base. The side walls may then be pushed into the thinset. After the side walls are secure, he adds more thinset to the top of the sides to adhere the top flaps onto the walls. He then presses the flaps and ceiling of the inset in place. All that remains is to spread thinset on the surface of the shower and press the 2-inch perimeter flaps into place **(8)**.

Two-Story Block Addition

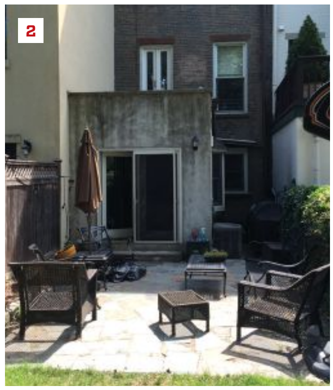
BY ROB CORBO

My company, R Corbo Improvements, specializes in remodeling inner-city row houses in Hoboken, N.J. For the last few years, our work has largely centered around rehabbing the lower two floors (of these four-story homes) into modern kitchen and living-room spaces. An important part of the renovations has been to introduce natural light into these long, narrow homes by opening up the entire back wall and installing large slider doors (see “Revitalizing an Urban Row House,” Mar/16).

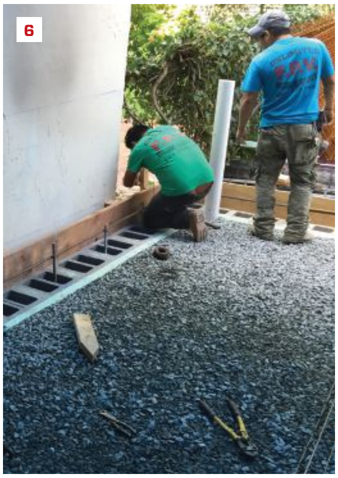
Our remodeling work is usually confined to the building’s original footprint, but we’re occasionally asked to build an addition. For this story, I’m going to focus on the steps we took to build a 15-foot-wide-by-18-foot-long two-story block addition. Though we’ve built a few row-house additions in the past with other code-compliant noncombustible materials, such as structural steel studs with exterior gypsum board, we prefer to lay up block walls.

Documenting existing conditions. When you’re working in an urban environment with tight lots and shared party walls, it’s best to foster a cooperative relationship with your client’s neighbors. Prior to construction, I have a meeting with the abutting neighbors in their homes to review what our client’s goals are. This is more than a courtesy call. It allows us to swap contact information to keep the lines of communication open, while also giving me the opportunity to check out the condition of their homes. I want to avoid being wrongfully accused of cracking a wall, or worse, so I take photos of the neighbor’s property and of the city-owned sidewalk area out front to establish a baseline of preconstruction conditions.

Case in point, on this project, we started out by demolishing an existing 8-by-10-foot block addition off the kitchen. While removing the addition’s block frost walls, we noticed the neighbor’s two-story addition was built on top of an old, undersized footing. Hoboken row houses typically had one-story additions (similar to the one we removed), which served as kitchens back in the day. Around the time the neighbor’s two-story addition was built, some 30 or 40 years ago, Hoboken was a depressed area. Row houses were haphazardly split up into multifamily homes and boarding houses, and often the work was not done under any municipal supervision. Upon discovery, we notified the project architect and photographed the neighbor’s marginal footings.



Masons apply brick veneer to the two-story block addition **(1)**. An existing 8x10 bump-out addition was removed prior to construction **(2)**. During demolition, it was discovered that an abutting neighbor’s two-story addition was built on undersized footings **(3)**. New footings had to be poured with concrete wheelbarrowed through the house from a mixer truck parked street-side **(4)**.



New 12-inch-block frost walls are spaced an inch off the neighbor's walls and placed on the outside edge of the new footings **(5)**. Workers install 2-by boards to form the slab's edge after infilling the sub-slab area with crushed stone **(6)**. A city-mandated structural design called for a heavily reinforced 6-inch-thick slab **(7)**. Walls are built with 8-inch block reinforced with continuous rebar from the footing to the top; block cores are filled with mortar at the vertical rebar locations **(8)**.

BUILDING AFTER A STORM OF REGULATIONS

The architect's initial structural design called for a crawlspace under a framed first floor supported by block frost walls, but the city's zoning administrator made us switch to slab-on-grade construction. I can only guess the reason was to avoid having mechanicals located below grade and thus susceptible to flooding. On a lot of levels, we're still dealing with the aftermath of Hurricane Sandy, which flooded 60% of Hoboken for days in 2012. Many new building regulations were passed in the wake of that event. The resulting structural redesign called for a heavily reinforced 6-inch-thick slab tied into heavily reinforced frost walls and two-story block walls—this was a beefy shell.

Buckets and wheelbarrows. All the demolition and masonry work was jointly coordinated by our project foreman, Danny DoCouto, and our masonry sub, Victor Bezama, of FPV Contracting Co. Working in the city, we don't have the benefit of using excavation equipment. Our foundation prep work is done old-school—by hand with shovels. All demoed rubble and excavated soil had to be carried out in buckets and wheelbarrows through a garden-level (basement) front window or door. Conversely, all building materials, such as block and concrete mix, had to be carried in by hand or wheelbarrow from small staging areas on the street-side sidewalk.

The foundation. We excavated down to the neighbor's footings on either side of our planned addition, then formed our new 12-inch-by-30-inch footings against them. For the footing-to-frost-wall connection, we tied vertical #5 L-shaped rebar 2 feet on-center to the footing's continuous #4 rebar. We placed 1/2-inch XPS foam against the existing walls as a bond break, then wheelbarrowed in concrete from a mixer truck parked street-side.

Our 12-inch-block frost walls were placed about an inch away from the neighbor's existing walls—they sat off-center on the outside edge of the new footings. We installed galvanized metal truss reinforcement on top of the second course to provide lateral strength. After we laid up three courses, we placed 2-inch XPS rigid foam on the block's interior face, then leveled and compacted the under-slab native soil. We infilled with crushed stone to the top of the frost wall, then installed 2-by stock to form the slab's edge.

For the under-slab insulation, we placed 2-inch XPS rigid foam over the crushed-stone base and taped the seams. The architect's structural redesign called for a robust 6-inch-thick slab reinforced with two layers of heavy-duty welded wire mesh tied into the 12-inch-thick-block frost walls, with #5 L-shaped rebar placed 12 inches on-center.

Block walls. The two-story-plus-high walls were built with 8-inch block. We ran continuous #5 rebar, placed 2 feet on-center, from the footing to the top of the wall and infilled the block cores with mortar at the vertical rebar locations. As we laid up the wall, we incorporated two W8 steel I-beams into the blockwork. The I-beams served as lintels for the addition's opened-up back wall (large slider doors provided abundant natural light into the home).

At the second-floor and roof levels, we installed bond-beam courses, which helped tie the walls together and provided solid masonry for anchoring our flush-framed floor and roof ledgers to the wall. A third bond beam was installed at the top of the wall. We ran continuous horizontal #5 rebar in the bond-beam channel (tied to vertical rebar), then grouted the channel solid with mortar.

Flush-framed joists. For the addition's parlor-level (second floor) framing, we installed 3x10 joists flush framed to 3x10 ledgers anchored to the block wall's bond beams. The architect's initial design called for the 16-inch-on-center floor framing to be left exposed to the garden-level (basement) living room below, but we ended up covering the ceiling with drywall to hide wiring and mechanicals.

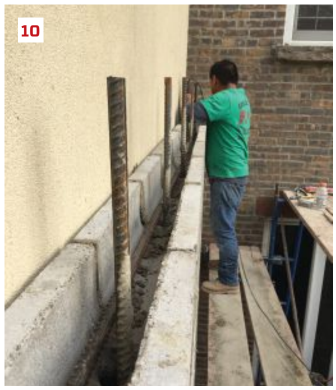
Prior to lifting and securing the 3x10 ledgers in place, DoCouto installed the joist hangers and applied peel-and-stick to the back of the ledger, then predrilled holes for the expansion bolts. Of note: We followed the structural plans and drilled the holes in-line (rather than in a staggered pattern) and later got dinged by the building inspector for the ledger fastening. The architect had to provide a letter to the city stating that the 3x10 ledgers were structurally sound and wouldn't split.

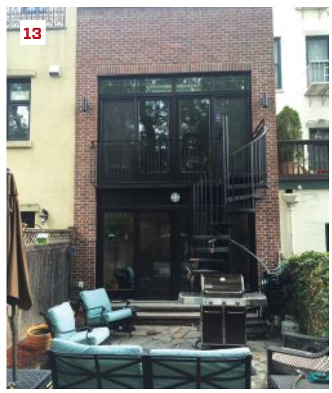
DoCouto held the ledger in place with 2x4 bracing and then injected Hilti HIT-HY 70 two-component epoxy into the holes with a Hilti HDM 500 manual dispenser gun. He then inserted the expansion bolt, tightened it down, and moved on to the next one. After a little while, the anchor connections hardened like a rock, and we were able to frame the floor.

We flushed-framed the roof similarly, but with TJIs and an LVL box-out for a skylight. Our roof system consisted of a plywood deck with tapered roof insulation (pitched toward a corner roof drain) and a TPO single-ply membrane.

Exterior cladding. We finished off the exterior with brick veneer on the rear façade, and stucco on the right-hand side. For the stucco, the neighbors allowed us access to work from their deck, which was in marginal shape. But I took lots of "before" photos to document its condition and carefully protected the deck from any damage, so we managed to finish without incident.

Rob Corbo is a building contractor based in Elizabeth, N.J.





Workers hoist a wall-to-wall steel I-beam lintel in place **(9)**; the addition's back wall is opened up to provide natural light into the home's interior. Bond beams, coordinated with floor-system ledger locations, are reinforced with continuous horizontal rebar, then grouted solid with mortar **(10)**. Two-part epoxy is injected into predrilled holes prior to inserting the ledger anchor bolts **(11)**. The flush-framed floor is installed **(12)**. The rear façade is clad with brick veneer **(13)**.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BY KYLE DIAMOND

Tracking the Cost of Labor

I'm a second-generation building and remodeling contractor in New York state, managing the company that my father started many years ago. (My dad, Dale Diamond, is still a partner in the company, working sometimes in the cabinet shop and sometimes in the field.)

In recent years, I've made the transition from working in the field to running the business full time. As part of that transition, I'm putting a lot of work into creating systems that help the company run better. The goal is to set our company apart from the competition with a distinctive process that adds value for our customers, so that we are able to charge more money.

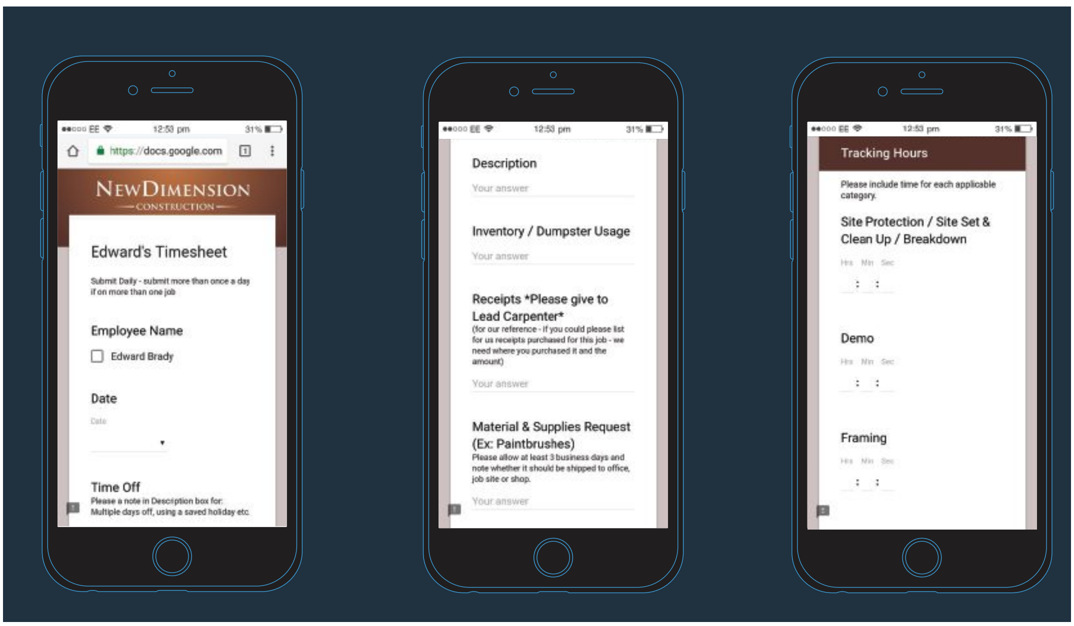
Written systems not only set us apart, but also take some pressure off me. A well-structured set of written systems lets me delegate some of the work of running the company to other people and still be confident that those tasks are getting done in an organized and consistent way. In this column, I'll describe one of the systems that we've created: a process for tracking the hours worked by our employees in the field and putting that information to good use in our company.

Our system has several components: There's a smartphone app (see below) that our workers use to report their hours each day, broken out by job task; there's a back-end interface (see page 32) that lets Kristen Detheridge, our office manager, tabulate and organize the information our field crews send in; and there's a simple set of spreadsheets Kristen can use to generate weekly labor tracking reports that she and I review together every Monday (see page 34).

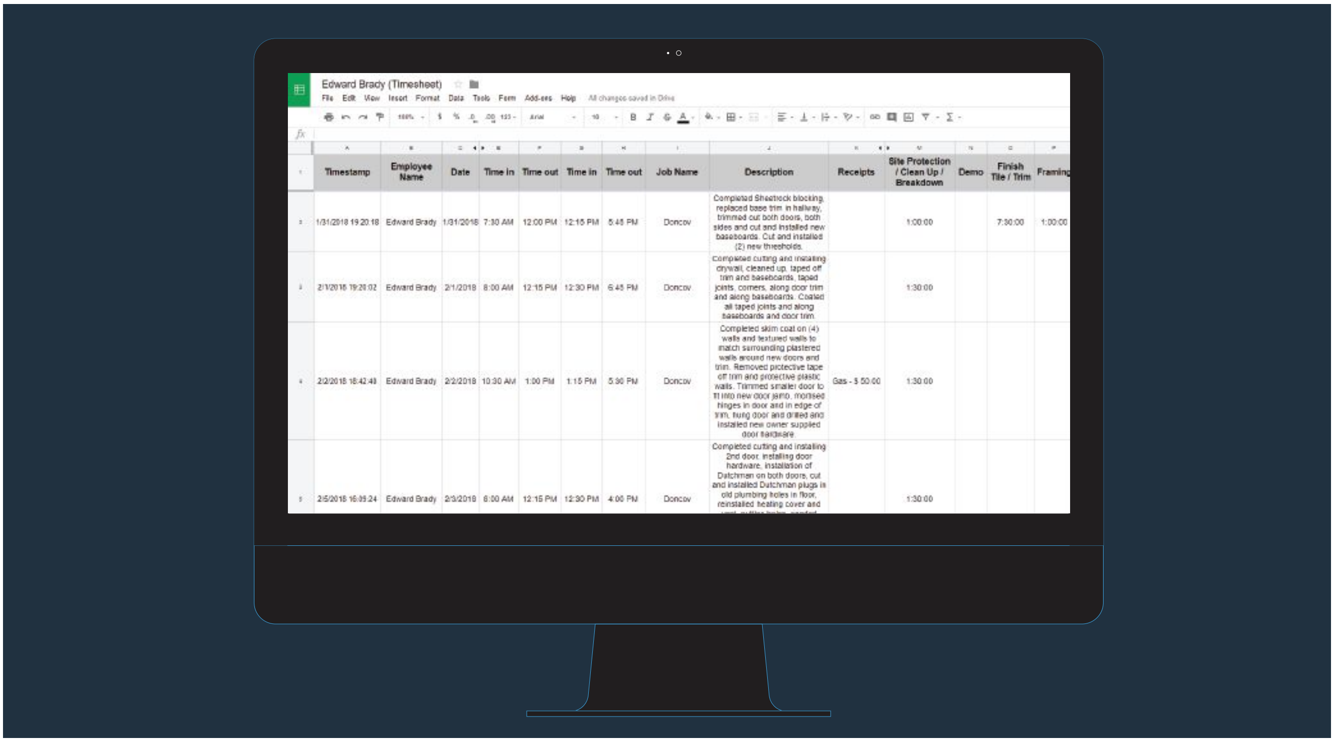
Then, at the end of each job, Kristen plugs the labor and materials information for that job into a final gross-profit report (see page 36) that I can use to evaluate the profitability of that particular job. This job-by-job postmortem helps me set our company's strategic course.

COLLECTING THE DATA: GOOGLE FORMS

There are many apps on the market for reporting labor hours; one popular example is Tsheets (tsheets.com), which is owned by Intuit, the maker of QuickBooks. But we chose to use a Google-based method because it's free and it works. The field interface of our labor



Smart reporting. Google Drive lets the author create a customized smartphone form that his field crews can use to report their labor hours each day, breaking their time down by task.



Labor reporting "back end." Daily hours reported by the author's employees on site dump directly to a Google Sheet in the cloud, which the company's office manager can view on her desktop computer. Total hours for each employee, hours spent on specific tasks, and descriptions or comments from the employees all appear in an organized format, in a continually updated permanent record. The office manager then copies and pastes the information into Excel for processing and analysis.

tracking system—the part we use to collect information from our crew members—is based on Google Drive. Google provides a variety of customizable interactive forms that integrate with the online spreadsheet functionality of Google Sheets. Google's customizable survey response form offers various ways for people to respond: drop-down lists, check boxes, multiple choice questions, text boxes—you can even take a snapshot with a phone camera and upload it to the drive.

Kristen has modified Google's simple template with questions and response options appropriate to the work our people do. Using that form, our workers can punch in their total hours worked each day, along with a simple breakdown of the time spent on particular tasks. (They can also let the office know about any materials and supplies they need—an added capability that often comes in handy.)

Kristen updates the form as necessary with a current list of jobs in progress and the various tasks that might be happening on those jobs. She emails each worker a link to a version of the updated form that is personalized for that individual; when workers click on the link, the form opens up on their smartphone. They can pin the form to their phone's screen so it's available any time. Then, at the end of every day, our workers on each job take out their smartphones and fill out their forms.

The customization helps. As a business manager, I've come to understand that too much information is worthless. With labor tracking, there's a risk that you can get lost in the details and give yourself so much granular information that it's confusing instead of clarifying. So it's nice that Kristen can tailor the Google forms to suit our information needs. Even on a large project, I prefer to use big, broad categories: "site protection," "demo," "framing," "tile," "cleanup," and so forth. You could get bogged down wondering, "Was that cleanup after demo, or cleanup after framing?" Or, "Was that wall layout, or building headers, or what?" But my system doesn't ask my workers to split hairs.

I also let my people know that I'm not asking them to track their time spent on any of those broad categories to the minute; recording time on a task to the nearest half hour is fine. When I use the information later—to estimate future jobs, for example, or to assess whether the current job is on track and predict when it will be completed—I think in terms of "worker days," not worker hours.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Date	Site Protection	Demo		Framing		Management	Roof / Plywood		Siding		Plumbing / Electric	
Friday Close	Labor	Labor	Materials	Labor	Materials	Labor	Labor	Materials	Labor	Materials	Labor	Materials
01/05/18	8	20.5	$300.78	46.75	$5,525.71	2	2			$441.47		
01/12/18	10.5	1.5	$122.25	105.5	$523.28	1	31.75	$603.71	14.5	$2,627.12		
01/19/18	2.25	7.25							79.25			$1,670.33
01/26/18	6.75					5			62		60.75	
02/02/18	1.25					1			63.25	$59.46	38	
02/09/18	1			16					58		7	$3,190.69
02/16/18	0.75			5.5					6.5			$1,495.12
02/23/18	6										2	
03/02/18	5.25									$492.95	8.5	
03/09/18	2										22.5	
Budgeted	45	30	$750.00	170	$5,500.00	20	20	$680.00	250	$3,700.00	160	$6,300.00
Remaining	1.25	0.75	$326.97	-3.75	-$548.99	11.00	-13.75	$76.29	-33.50	$79.00	21.25	-$56.14
Total	43.75	29.25	$423.03	173.75	$6,048.99	9	33.75	$603.71	283.5	$3,621.00	138.75	$6,356.14

Labor tracker. The customized Excel spreadsheet form shown above helps the author review his ongoing labor and materials cost for each job on a weekly basis. In the example shown, framing labor and materials exceeded the author's estimate, as did labor in the "Roof / Plywood" category. Noticing this kind of pattern in his weekly review of the job numbers helps the author catch problems early and make adjustments.

I'm certainly not thinking about worker minutes. When my people are reporting to me, the nearest half hour is close enough.

Google Forms automatically dumps to a Google Sheet, the spreadsheet capability of Google Drive. That's the "back end" of our information-gathering system. Every day, all the reports from all our workers show up on one Google Sheet that Kristen can view on her desktop computer. Every Monday morning, she starts her week by opening up the Google Sheet to work with the labor data from the previous week.

PROCESSING THE DATA: EXCEL

The next step is to organize our data and structure it into a compact form that I, as the business owner, can use efficiently for decision making, planning, sales, estimating, financial reporting, and so forth. Google Sheets could be used to massage the data like that, but Microsoft Excel is much more powerful for that sort of work. So every Monday, Kristen manually copies and pastes our incoming labor information from Google Sheets into our customized Excel spreadsheet.

We typically have anywhere from two to five jobs going at any given time. Kristen's Excel "sort sheet" lets her take each worker's individual reported hours and allocate them to the different jobs that person worked on that week. Then, she can assemble a report for each job, listing all the work performed on that job by all our crew members that week. She goes on to break down that labor time based on categories of work: demolition, framing, tile, finish, cleanup, and so forth.

APPLYING THE DATA: REPORTS

From the point of view of our workers in the field, the reason for reporting labor hours is so that they can get paid (including tracking time-and-a-half for overtime, if they've earned that); and of course, that's the reason the state requires us to keep good records of everyone's hours worked. We archive a record of each worker's daily time sheet for that purpose. We also transfer our total cost of labor into QuickBooks so that we can generate accurate tax reports.

But our labor-tracking system does much more than just help us pay our people and pay our taxes. Taken together, our simple communication and organizing tools give us a reliable and efficient

Date Completed:	1/30/2017
Customer Name:	
Division/Type:	Bathroom
Zip Code:	12545
Estimator:	Kyle
Crew Leader:	Kyle
Job Leader:	Ryan

Contracted Price:		
Labor (in-house)		84,131.31
Materials		6,765.80
Subcontractors		41,933.10
Other		
Contracted Revenue	$	132,830.21
Add'l Work Order(s):		
TOTAL REVENUE	**$**	**132,830.21**

Job Costs:			
Direct Labor Gross Wages	$	14,995.50	11%
Direct Labor Burden + Ins	$	5,125.46	4%
Job Materials:**	$	6,765.80	5%
Subcontractors	$	41,933.10	32%
Add'l Material/Expense			0%
TOTAL REVENUE	**$**	**68,819.86**	52%

Employee		Hours	Adj Rate	Adj Rate	Rate
Ryan		200.00	100%	200.00	27.00
James		100.00	100%	100.00	27.00
Ed		70.00	92%	64.40	23.00
Steve		71.00	62%	44.02	15.50
Isaiah		50.00	68%	34.00	17.00
Ben		145.00	92%	133.40	23.00

Estimated Hours:	1202
AWO Hours:	0
PUSH BACK HOURS:	0
HOURS (Over)/Under:	626.1
Productivity %:	209%
Grade:	A+

Sales Rate:	110.52
AWO Sales Rate:	-
Total Sales Rate:	$110.52

Actual Average Wage	$	23.58
Budgeted Actual	$	25.00

Gross Profit		**48.2%**
Actual Gross Profit	$	64,010
Revenue Per Man Day	$	1,671
(TOTAL) Actual Rev Per/Hr	$	208.85
Labor Only Rev/Hr	$	132.28

Gross profit tracker. The author uses a standard Excel form that compiles and aggregates all the cost information from each job his company completes, packaged as a concise statement of gross profit. At the end of each job, this form presents a comparison of the estimated labor and materials cost in the job contract with the actual labor and materials cost. In this example, the company's gross profit was 48%, making the job a success—and perhaps a clue to help guide strategy.

way to keep jobs on track. They provide me with information I need to create good estimates. They give me an objective way to evaluate how productive each of my employees is. By keeping me aware week by week of how our jobs are progressing, they let me know how soon I need to have the next job teed up to keep our people busy, and how soon I can promise the next client that we will show up and get started. And they help me identify the kinds of jobs that are most profitable for our company, so I can target that kind of work with my marketing and sales operation.

As I mentioned earlier, too much data is worthless. But well-organized data is priceless. So, after assembling and sorting the information, Kristen prints out a one-page "Labor Tracker" report on each job. Then the two of us meet to go over the data for all the jobs we have in progress that week.

Every Monday morning at that routine meeting, I familiarize myself with the progress on each job. I can compare the actual labor time so far for each phase of the job with the hours I had allowed for that work. If we're 10 hours over budget on framing, I'll know it. When there's a discrepancy, I'll ask the crew—what happened here? Did I get something wrong? If I see that we're falling behind on a job, maybe I can make an adjustment to catch us back up.

Many times, a difference in the numbers reflects an "extra." On one recent job, we were building a mahogany deck, and in the middle of the job, the client decided that she also wanted a mahogany walkway. The next week, those extra hours showed up on the Labor Tracker, and it reminded me to separate out the hours for that portion of the job so that Kristen could bill for the work separately under the appropriate change order.

Periodically, I look back and analyze our labor numbers, looking for patterns that help me understand the big picture and evolve our company's strategy. At the bitter end of every job, after we've completed all the work and received our final payment, Kristen creates a "Gross Profit Tracker" report for that job. This one-page graphic report displays final labor and materials costs for each job, including estimated and actual costs for employee labor. It breaks out the employee labor totals by individual employee.

The Gross Profit Tracker helps me develop important insights. I want to know job by job how we are doing in terms of gross profit; but more importantly, I want to look for trends. What is our sweet spot? Is there anything we are doing exceptionally well? Are there

things we are exceptionally bad at? Is it a certain job size that we do well, or poorly? Are my estimates accurate? Am I making a suitable profit, or should I adjust my pricing? I don't want to make that kind of decision based on gut feelings—I want to base those decisions on the real numbers.

> "TOO MUCH INFORMATION IS WORTHLESS. BUT WELL-ORGANIZED INFORMATION IS PRICELESS."

We're still early in our process of developing this big-picture view. But now that we're starting to accumulate an organized record of our labor productivity and profitability, I'm already seeing some interesting things. For example, I've learned from various sources that the category of site protection, setup, and cleanup usually amounts to about 12% of total job cost, industry-wide. Looking at our own data, I see that we're pretty close to that number: For us, that category is typically about 13% of our job cost.

It's also useful to compare that sort of average number with specific cases where the number was higher or lower. We work on a lot of second homes and vacation homes. On some jobs, we're working on a house where the owners are going to be gone for weeks, leaving us alone to get the job done. On other jobs, the owners will be back every weekend, and they expect the place to be spotless when they arrive. Obviously, if we're leaving the house pristine every Friday, we're going to spend more labor hours cleaning up and moving our equipment out of sight than if we're allowed to leave a stack of drywall and spackle buckets in the living room.

By the same token, if I have to carry materials around to the back of the property by hand, it's going to use more hours than if I have easy access from the driveway. So when I'm doing a detailed estimate, naturally I'll adjust particular categories of work up or down to reflect the particular case.

In addition, having a general baseline of historic labor data to work from is a huge help to me when it comes to screening client calls and selling jobs. For us, as for a lot of people in the industry, the phone is ringing a lot these days, and it's important to efficiently qualify each lead to see if the caller is a serious prospect. If I have good ballpark numbers, I can say, "Your deck will probably cost X dollars," or "We can do a bathroom this size typically for about Y dollars." That way, I can find out quickly whether a customer's budget makes them a suitable client for us.

Kyle Diamond co-owns New Dimension Construction, in Millbrook, N.Y., with his father, Dale Diamond. Kristen Detheridge, office manager for New Dimension Construction, also contributed to this story.

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Photo: Mark Partee

Avoiding Wet Roofs

A building-science guide to insulating attics and roofs

BY PETER YOST

The performance of attics and roofs covers a big subject area, so this is the first of two articles addressing this topic. In this first article, we get everyone on the same page, explaining the science and options available to builders and remodelers.

In the second article, we will look at the even thornier issues of the evolving building code, real-world roof performance, and exciting new research in residential roof performance.

Vented, unfinished attics usually work great as built-in moisture buffers. By the word "buffer," we mean the space allows indoor moisture to be whisked away on air currents or to condense on the underside of the roof sheathing where it harmlessly evaporates away ("dries") or is absorbed into the sheathing and framing before it eventually dissipates (again, "dries"). The unfinished attic makes it easy to inspect your roof from the interior.

But it's just so tempting to take back that attic space; you can use it for mechanicals, for storage, or even as a place to banish teenagers to. We routinely configure walls without such a buffer space. So why do we run into roof moisture problems way more often than we run into wall moisture problems? To answer this first question, we need to work our way through a pretty long list of questions about attics and roofs.

WHAT ARE THE OPTIONS?

The wide variety of attic and roof configurations is one way that roofs differ markedly from walls. I number them here in order of preference from a moisture-control perspective. As Steven Baczek is fond of saying, "You vent until you can't."

1. Vented attic. The most moisture-forgiving attic-roof assembly is a vented attic. Properly built, a vented attic requires continuous air and thermal control layers at the top-floor ceiling with soffit-to-ridge or gable-to-gable venting.

In terms of driving forces, you gain a big advantage with soffit-to-ridge vents, or high-low venting (supported by stack effect).

2. Cavity-vented insulated pitched roof. If you can't give up the attic space to moisture management, then the least expensive way to vent and protect the roof sheathing is to vent within the roof framing space, but that takes up valuable real estate within the cavity that could otherwise be filled with insulation.

This configuration requires continuous air and thermal control layers at the roof line with soffit-to-ridge venting within the roof framing cavities.

3. Top-vented insulated pitched roof. If you can't give up either the attic space or the framing cavity spaces to venting, then you can add venting on top of your roof sheathing, but that comes at a significant added cost.

This configuration requires continuous air and thermal control layers at the roof line with soffit-to-ridge venting topside of the roof structural sheathing.

4. Unvented insulated roof. If you make your roof geometrically complex enough that you can't achieve soffit-to-ridge venting—or you make your roof a low enough pitch that there is no driving force from soffit-to-ridge—you will be forced to give up on venting and go unvented, as your last resort.

An unvented insulated roof still must have continuous air and thermal control layers at the roof line with no venting (for any roof pitch or slope).

Note: Our industry, particularly in cold regions, likes to call unvented roofs "hot" and vented roofs "cold." The logic is that vented roofs move cold, dry air up the vent chutes, while unvented roofs get hot without the vented air. Obviously, the terminology belies climate, weather, time of day, and the direction the roof slope faces. (Just venting here ...)

A vented attic with gable end vents is the most forgiving type of roof. This photo **(1)** shows part of the author's gabled-gambrel home with a vent in each gable. Note also the gapped roof-sheathing boards, which support a slate roof. There is quite a bit of drying potential for the entire space and assembly.

Vented cavity. An inexpensive option to vent a cathedralized space is to use continuous vent chutes **(2)**.

Photos: 1&4, Peter Yost; 2, J&R Products; 3, Steve Shirber

Top venting. This roof assembly **(3)** has an "over-roof"—the 2x4 furring supports nailbase sheathing for the roof cladding and creates soffit-to-ridge venting on top of the unvented roof assembly below.

Unvented roof assembly. This is a SIPs roof on the kitchen addition of the author's home **(4)**. The insulated roof panels have no venting, and the standing-seam-metal roof will be attached directly to the panels.

WHY CONTINUOUS CONTROL LAYERS?

In every description of the typical roof options I listed on the previous page, I used the terms "continuous" and "control layers." The goal is to create an unbroken line of defense against water penetration, thermal losses, air leaks, and vapor transmission—with an emphasis on unbroken, or "continuous."

The essential "control layers" include (prioritized in this order):

1. A continuous bulk-water control layer. The roof cladding or underlayment must be properly weather-lapped and connected to flashings at all penetrations.

2. A continuous air control layer. An air-impermeable insulation or sheet good must be properly sealed or connected to all air-sealing at penetrations and connections to the exterior-wall air control layer.

3. Dedicated, directional drying potential (vapor profile). All layers of the roof assembly are selected based on vapor permeance such that drying in one or both directions is possible, encouraged, and achieved.

4. A continuous thermal control layer. Continuous insulation eliminates or significantly reduces thermal bridging. (Thermal bridges in roof assemblies include structural through-members, such as rafters that extend from the inside ceiling plane to the exterior sheathing plane. But they also include timber-frame rafters that extend from inside the building to outside for eaves overhangs.)

The problems actually arise when we do not honor their prioritization.

A bulk-water leak spells major trouble no matter how airtight the roof assembly, how well it is designed to dry, or how continuous the insulation is.

Condensation caused by air leakage in a roof assembly cannot be overcome by drying by diffusion or—in many cases—even by roof ventilation. And elimination of thermal bridges must include thermal bypasses involving leaking air. Essentially, you can't vent your way out of an air-leakage problem, especially for north-facing roofs that see so much less solar energy than the other three cardinal directions (for examples of this, see photos on page 46).

Drying potential is more important to design in than a thermal control layer because a thermal bridge not involving air leakage may not involve condensation or, if it does, it can be managed or corrected from the interior. An assembly that lacks drying potential cannot be "redesigned;" the assembly is more likely to stay wet if it gets wet.

HOW MANY WAYS CAN THE ROOF DRY ONCE IT GETS WET?

1. Weather-lapped drainage is how we move bulk water—our biggest threat—off the roof. Drainage relief is immediate and complete; it's the best! Once water soaks an assembly, we can't drain it to dry it, at least not as a performance strategy (although we might drain a flooded building cavity as an emergency measure).

2. Convective drying is what happens when dry (or drier) air moves past wet materials in a building assembly. Roof assemblies with air flowing from soffit to ridge are often said to be ventilated (not just vented) because there is actual air flow (rather than just diffusive air movement). Active air movement by convection is many times more powerful as a drying force than diffusion. Convective drying by ventilation is powerful and fast, but its speed and effectiveness is based on how much energy is driving the airflow.

3. Diffusive drying. If an assembly gets wet, our last line of defense is to rely upon diffusive drying. If building materials get wet, they can slowly dry by giving up their moisture content as vapor. Here we have two pathways:

- Vapor moving through materials that allow drying to the exterior, where the world at large takes away that moisture without notice
- Vapor moving through materials that allow drying to the interior, where space-conditioning systems work as the primary way to manage the moisture.

Building scientists call designing and selecting materials for drying "doing a vapor profile" (see sidebar, facing page). Diffusive drying is slow and may not be fast enough to keep a moisture problem from becoming a mold, mildew, or even a rot problem. Moving from a moisture problem to a mold problem is often determined by how wet an assembly gets and how long it stays wet.

Bottom line. Focus on the continuity of your bulk-water and air control layers so you don't have to rely on your last resort: directional drying by diffusion.

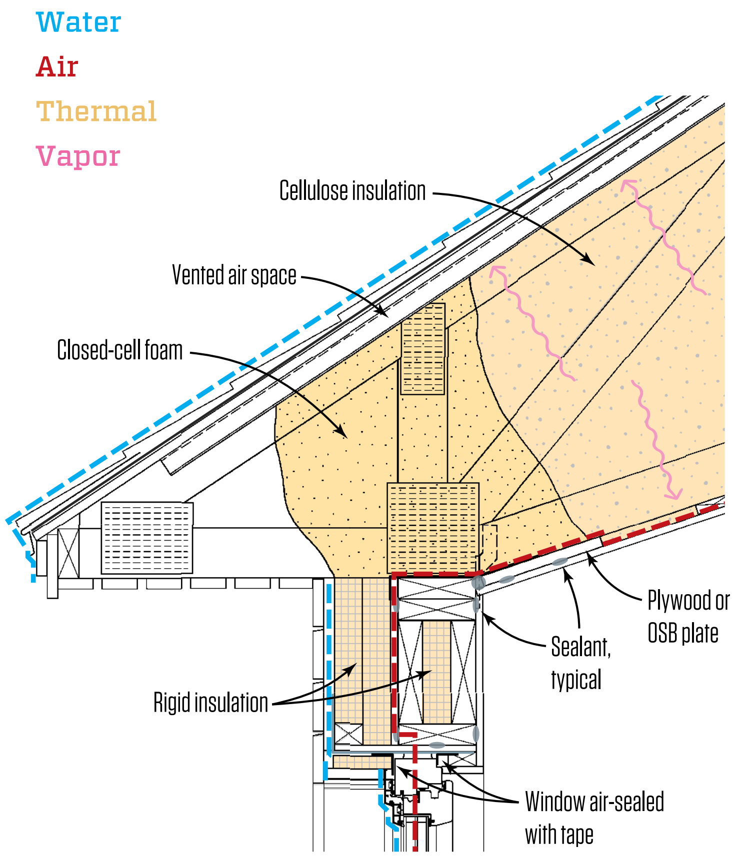
WHAT ABOUT LOW-SLOPE OR COMPACT FLAT ROOFS?

There really is no such thing as passive ventilation in low-slope or compact flat roofs, since there is no soffit-to-ridge configuration to drive any pressure difference that would support airflow. William Rose, in his book, *Moisture in Buildings* (Chapter 7 "Attics," page 189, Wiley, 2005), is unequivocal on this front: "Tobiasson (1986) showed that low-slope roof system[s] should not be constructed as vented cavity assemblies, as the difficulties in actually getting flow through a horizontal cavity by natural means are considerable."

IS POWER VENTING EFFECTIVE OR NEEDED?

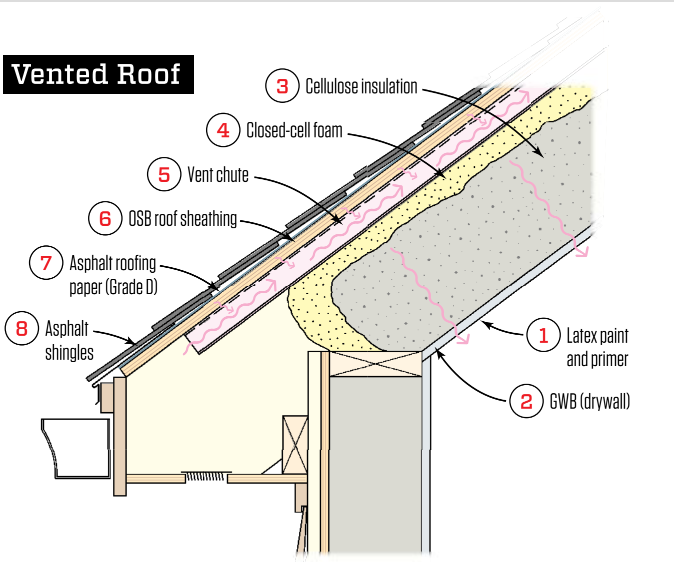
Powered attic ventilators often create more moisture problems than they solve, particularly with air-perme-

Essential Control "Layers"

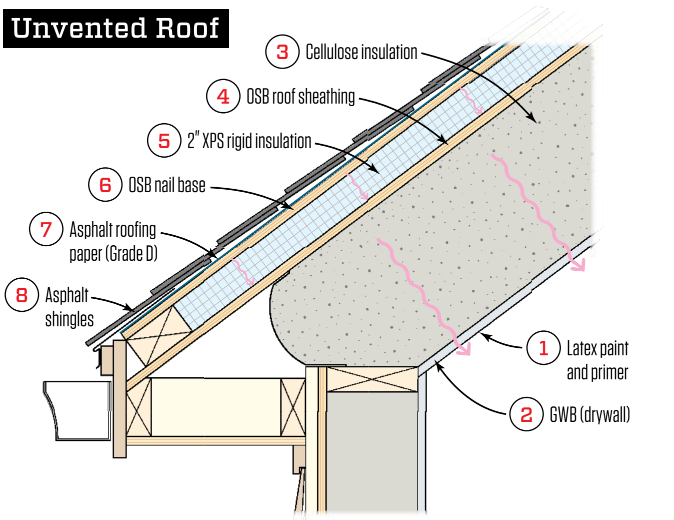


Control "layers." Each colored line in the illustration above shows the continuous water, air, and thermal control layers, while the wavy arrows indicate directional drying of the vapor profile. This architectural detail is based on a design by Steven Baczek. In this design, the drywall serves as the air barrier for most of the ceiling. At the edges, it transitions to plates that are installed in plane with ceiling strapping. These plates provide a surface for wide peel-and-stick flashing that laps over the wall top plates and adheres to Zip System sheathing—the air barrier for the walls. For more on this air-sealing technique, see the article by Steve Baczek and Jake Bruton, "Air Sealing That Works," Apr/18.

Illustrations: Tim Healey / Steven Baczek



1	Latex paint and primer	5 perms	Class III retarder
2	GWB (drywall)	40 perms	Vapor open
3	Cellulose insulation	75 perms	Vapor open
4	Closed-cell spray foam	1 perm	Class II retarder
5	Vent chute	300 perms	Vapor open
6	OSB roof sheathing	2 perms	Class III retarder
7	Asphalt roofing paper	30 perms	Vapor open
8	Asphalt roofing shingles	.65 perm	Class II retarder



1	Latex paint and primer	5 perms	Class III retarder
2	GWB (drywall)	40 perms	Vapor open
3	Cellulose insulation	75 perms	Vapor open
4	OSB roof sheathing	2 perms	Class III retarder
5	2" XPS rigid insulation	.5 perm	Class II retarder
6	OSB nail base	2 perms	Class III retarder
7	Asphalt roofing paper	30 perms	Vapor open
8	Asphalt roofing shingles	.65 perm	Class II retarder

CONDUCTING A VAPOR PROFILE

A vapor profile is a qualitative method to determine what sort of drying potential a building assembly has, based on the vapor permeance of each layer of the assembly. There are four steps:

1. Determine the vapor permeance of each component or layer of the assembly. You can determine vapor permeance by using Building Science Corporation's Building Materials Property Table [https://buildingscience.com/documents/information-sheets/building-materials-property-table] or by obtaining the information from individual product manufacturers and standardized test results for ASTM E96.

2. Assign a class to each layer, based on this information.
a. > 10 perms – vapor open: little to no restriction to drying
b. 1 – 10 perms – Class III retarder: very limited restriction to drying
c. 0.1 – 1.0 perms – Class II retarder: substantial resistance to drying but still some drying potential
d. < 0.1 perms – Class I retarder: little to no drying

3. Assess the extent and direction of prevailing vapor drive. This means taking into account the vapor drive associated with the climate, and moisture levels associated with the type of building and number of occupants. A home for a retired couple living in Hawaii in a 5,000-square-foot masonry-based home experiences very little vapor drive or pressure while a 1,200-square-foot multifamily, wood-framed dwelling unit with six occupants in Ottawa, Canada, experiences extreme vapor drive or pressure.

4. Identify the least vapor-permeable component(s) and determine if that component or those components restrict drying of moisture-sensitive components. Concern should or will be high if the restricting component is a Class I retarder and still of some concern if the restricting component is Class II.

There are a lot of variables that heighten or reduce the need for drying potential of assemblies. The goal is to determine the directional drying potential based on a vapor profile. However, having limited drying potential does not translate to assembly failure should the assembly get wet. A lot depends on how much moisture the assembly sees, how much sun it sees, and how bombproof your water and air control layers are.

In Part 2 of this article, we will return to the two vapor profiles shown in these illustrations and examine how well each roof would dry in a given direction. In the meantime: How well do you think they would dry?

able roof cavity insulation or with the lack of a continuous air control layer at the top-floor ceiling or roof framing assembly.

DOES THE TYPE OF ROOF CLADDING MATTER?

You bet. Some roof claddings are made and installed in such a way that there is little to no air or vapor movement that encourages drying. Roof membranes certainly don't allow any air movement through them and many have very low vapor permeance (Class 1 retarder). You would think that the lapped installation of asphalt roofing shingles would permit at least some drying by way of either air or vapor movement, but they don't. Asphalt roofing shingles constitute a Class 1 vapor retarder. Standing-seam-metal roofs are made of Class 1 vapor-retarding metal, and when they're installed in direct contact with the roof assembly below, there is little to no air or vapor movement.

Roof claddings that are made or installed to allow air and vapor movement include barrel tiles, slate, corrugated metal roofing, and wood shakes and shingles. While there is no dedicated soffit-to-ridge channel in these materials and installations, there can be enough air moving through the installation and enough vapor permeance in the materials themselves to provide varying levels of drying potential to the exterior.

MORE TO COME

So far, we have laid the groundwork for understanding the basic building science that governs how roofs get wet. It's becoming clear from this Q&A that roofs aren't just walls turned sideways. The venting options, configurations, materials and even the forces at work differ markedly from walls, making roofs more complex assemblies to keep dry. It gets even more interesting when we start considering all the different ways you can insulate the assembly, something we will tackle in Part 2. Also in the next part, we will dive into the code requirements that address the issues we have laid out here, and look at some emerging practices that can further help you avoid problems.

Peter Yost is Vice President of Building Performance for BuildingGreen in Brattleboro, Vt. He and Steven Baczek present Home Building Crossroads *and other traveling building-science symposiums throughout the U.S. Look for them in a city near you to answer your building-science questions and clarify home performance issues related to the latest energy codes.*

Poor air control. Each of these show vent channels that are supposed to be directing outside cold, dry air from the soffit to the ridge, but because there is no continuous air control layer in the ceiling plane, the vents are directing leaking warm, moist air up against the cold underside of the roof sheathing.

Photos: 5, Rick Roberts; 6&7, Peter Yost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Insulating Over a Structural Slab

Skip the sleepers and float the subfloor over the insulation

BY STEVEN BACZEK AND JIM WOLFFER

Photos courtesy Shoreline Builders

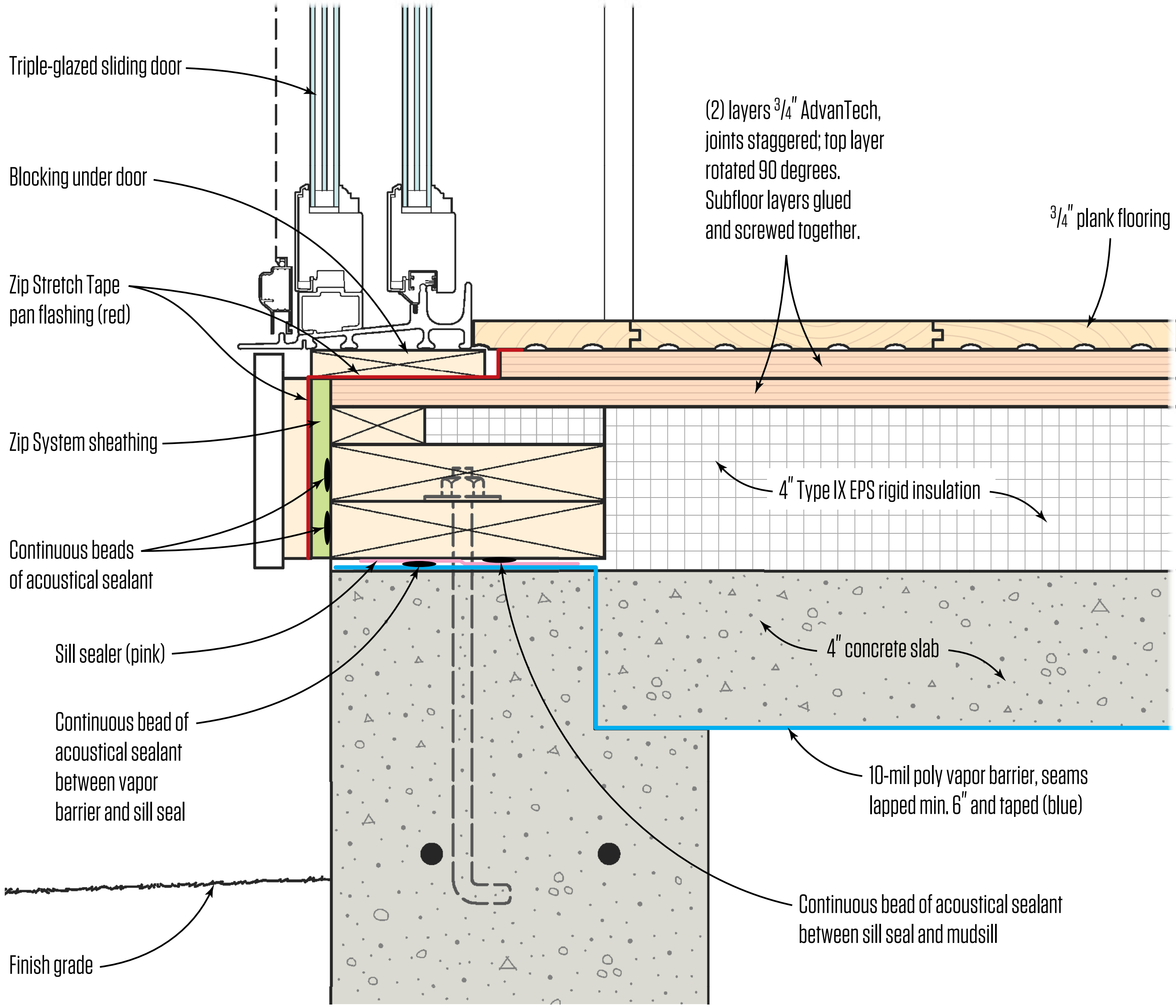
Sometimes, asking routine questions can lead to a less-than-typical solution. On a recent project, we simply asked, "How should we insulate the slab?" The foundation system for this high-performance home was to be slab-on-grade, and we were aiming to achieve R-15 to R-20 of slab insulation in our zone 5 climate. Additionally, the homeowner wanted 10-inch-wide plank flooring throughout most of the house, so the subfloor had to be solid and sealed from any moisture from below. A plus was that the 2x8 exterior walls supported a wooden roof-truss system, which meant that the floor area would not be obstructed by interior bearing partitions.

THINKING OUTSIDE THE SLAB

One solution would have been installing rigid insulation under the slab, turning it up on the perimeter (to form a giant pan), and then casting the concrete slab inside the pan. A second solution would have been placing the slab and then building a sleeper system on top of it to support the floor. These strategies both seemed reasonable and were approaches that we'd used on previous projects. But when we looked at all the factors for this particular project, we wondered if there was a better way.

We knew that 4 inches of Type IX EPS would yield R-16.5, well within our target R-value for the slab. But to get the maximum

Insulated Slab Air-Sealing Detail



Instead of a conventional sleeper system to support the subflooring, an uninterrupted layer of foam sits directly on top of the concrete slab. Two layers of 3/4-inch OSB subflooring then float unattached on top of the foam to provide a solid and stable underpinning for the wide board wood floors. The foam butts against the mudsills for a complete thermal break. The polyethylene sheet becomes part of a continuous air barrier for the home. The top layer of subfloor steps back and gets a layer of peel-and-stick flashing tape to form pan flashing under the sliding doors.

Illustrations by Tim Healey

As this was a slab-on-grade system, all of the utilities and services had to be in place before the slab was poured **(1)**. The next step was laying down and compacting a layer of crushed stone **(2)**. To help control moisture, the crew put down a layer of 10-mil polyethylene sheeting—which also acted as part of the air barrier—over the crushed stone **(3)**. The slab was placed in the usual fashion over the poly **(4)**, and the framing crew built and raised the exterior walls to support the truss roof **(5)**.

performance from this insulation, we would need to install it in a continuous fashion, which meant that we needed to build the subfloor system above the surface of the rigid insulation. On previous projects, we had built what is called "a subfloor raft": two layers of subfloor sheathing installed perpendicular to each other that simply floated on top of the insulation. The lack of interior partitions would make building this "raft" relatively easy. Another positive aspect of this plan was that the 4-inch edge of the insulation would butt against the two bottom plates of the exterior wall, providing a good thermal break between the wall plates and the floor assembly (see "Insulated Slab Air-Sealing Detail," facing page).

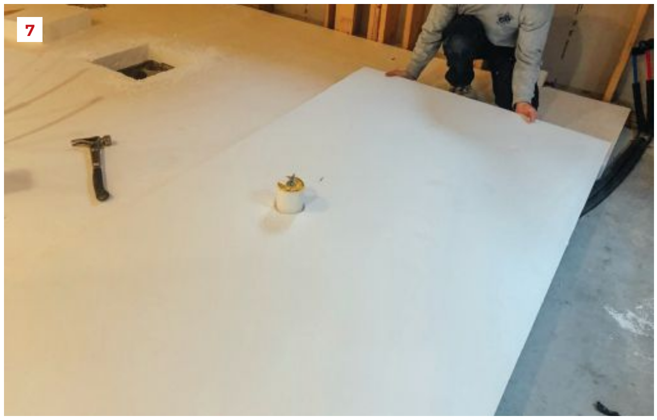
FROST WALL AND PREP

With the slab-on-grade for this home, we started with a typical frost-wall foundation. This meant that we needed to properly position all the services coming up from below before placing the concrete. After the plumbing and utilities were set, the crew put down a layer of crushed stone and compacted it.

To control moisture migration into the slab, we installed 10-mil polyethylene sheeting on top of the crushed stone. Joints in the sheeting were properly lapped and taped to let the polyethylene also act as part of our air-barrier system. At the edges, we let the poly extend over the top of the frost wall.

INSULATION NEXT

Placing the 4-inch concrete slab was routine, and after the concrete had cured, framing the exterior walls could begin. It didn't take long for the framers to build and raise the exterior walls. About the only out-of-the-ordinary thing for the framers was temporarily raising the threshold of the front entry with two 2-by



After the building had been dried in, the crew put down sheets of 4-inch EPS rigid foam insulation over the slab **(6)**. The insulation had to be cut out around all plumbing stub-ups through the slab **(7)**. In a few places, the crew notched out the insulation to reposition some of the services **(8)**. They also cut out around structural columns that supported a space between sections of the house **(9)**. Clear-span trusses allowed the entire floor to be done without dealing with interior partitions **(10)**.

layers. The raised threshold accommodated a temporary entry door that we used until the actual front door arrived. (For the entry door along with the other doors (large sliders) in the house, we used a different approach for sealing the opening that we will explain later).

The roof truss system spanned the entire first floor, and once we sheathed and taped the roof, we'd created a nice working environment below for laying down the 4-inch EPS rigid insulation. The insulation came in 4x8 sheets that were easy to handle, so the installation progressed quickly and efficiently. As the crew installed the insulation across the floor, they had to cut out for the utilities—including tub drains, toilet waste lines, and the electrical service—protruding through the slab.

EPS cuts easily, so working around the utilities was pretty straightforward. In a couple of places, we needed to reposition the utilities from where they emerged from the slab. With the 4-inch depth of the rigid insulation, we simply carved out a small channel in the bottom surface of the insulation.

The house was built in two sections separated by a flat-roof area that would be supported by structural columns. The columns sat on raised bases on the concrete slab, and the crew had to cut and fit around them. There were also shear-wall sections built on foundations that were poured with the perimeter walls. The crew fit the insulation around these walls as well. We completed the insulation layer over the entire floor before starting the subfloor.

SUBFLOOR RAFT

The flooring "raft" consisted of two layers of 3/4-inch AdvanTech subfloor sheathing that we screwed and laminated together and "floated" on top of the insulation. We considered using a single

The first layer of subflooring was installed perpendicular to the foam, with the OSB and foam seams staggered **(11)**. To keep the subfloor from sliding around on the foam, the crew squirted on some adhesive **(12)**—just enough to aid in positioning; this wasn't required for strength. Where services came up through the slab, the crew left ample space around the pipes to be filled in with expanding foam later **(13)**. While there were no full partitions, the crew did have to fit around a couple of interior shear walls **(14)**.

layer of thicker AdvanTech, but after a conversation with Huber's engineers, we felt confident that two layers of the 3/4-inch thickness would give us a strong and stiff floor without our having to special order any material.

We put down the first subfloor layer running perpendicular to the sheets of EPS with the joints staggered between the layers. Applying adhesive between the EPS and the first layer of subfloor was not required, but the installation crew soon realized that a little adhesive on the EPS helped keep the subfloor sheets from moving around during the installation. As they tapped the sheets together, they paid close attention to leaving a 1/8-inch gap between the sheets on all sides, as Huber recommends.

The crew also made sure to leave some space around conduits and pipes when they installed the subfloor around the services that came up through the floor slab. This space made it easy to air-seal around the pipes with expanding foam later. In those places where we had built shear walls, the crew fit the subflooring around them, leaving the appropriate gap for movement.

The second layer of subflooring went down perpendicular to the first layer, again with the joints staggered in both directions between layers. The crew applied construction adhesive to the top face of the first layer before dropping each second-layer sheet. They tacked the second layer in place with a few screws, and then one crew member followed, screwing the two layers together on a 6-inch grid with an auto-feed screw gun equipped with an extension handle. In the end, he drove more than 12,000 screws in the floor.

As with the EPS installation, having no interior partitions allowed the installation of the subfloor sheathing to go quickly and efficiently. The sealed truss roof also meant that the subflooring was never exposed to weather-based degradation.

15

16

17

The crew installed the second layer of subflooring perpendicular to the first with joints staggered in both directions **(15)**. They made sure to maintain 1/8-inch clearance between the sheets on all sides. After tacking the sheets in place, one crew member screwed the subfloor layers together with an auto-feed screw gun **(16)**. At the doorways, they held the top layer of sheathing back 5 inches. Flexible flashing tape laps onto the second layer of subfloor, forming a sill pan for each door **(17)**.

SHEATHING SILL PAN FOR SLIDERS

At the doorways to the house, we were able to use the double-layer floor assembly to our advantage. This house was located next to a pond, so the beautiful views warranted the installation of five 7-foot sliding glass doors facing that direction. We extended the bottom subfloor layer through each door opening to the outside of the framing, then held back the second layer of subfloor 5 inches. We ran flashing tape up the exterior wall sheathing below each opening and up over the bottom subfloor layer. Finally, the flashing tape turns up and onto the second subfloor layer to create a flashed sill pan under all of the sliding glass doors. At the front entry, we removed the temporary threshold and repeated the sill-pan detail for the new front door when it arrived. This integral sill pan gave us a durable detail for all of the door sills.

We ultimately chose to insulate the slab the way we did because it gave us the flexibility to accommodate all of the situations particular to this project. Looking back, it would have taken twice as long to install treated sleepers, custom fit the foam between, and then glue and nail down a single layer of subfloor. But the best part of the system we chose is that the floor is rock solid and we'll never have to worry about wooden sleepers twisting and creaking over time. Once the subfloor was installed, the interior wall partitions were attached directly to it and the floor was ready for wide-plank finished flooring.

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BY TED CUSHMAN

Grid-Optimized Solar-and-Battery Systems

In the past few years, the solar panel industry in the United States has been in a running battle with the nation's electric utility lobby over solar's proper place in the power resource mix (see "Solar at the Crossroads," Feb/16).

The controversy centers around the policy called "net metering." When a power company bills its customers based on net metering, utility customers with solar panels on their roofs get paid their retail electric rate for every extra kilowatt-hour (kWh) their panels push out into the grid. Then, any time the house needs more power than the panels can make (at night, for example, or on a cloudy day, or when the hot tub is operating), the customer pays to draw power from the pole on the street. Over a month or a year, the dollars balance out, and over time, many solar-equipped homeowners pay almost no electric bill—even though every day, whenever they need it, they are free to pull a lot of juice out of the grid.

With a "grid-tied" setup like this, the house doesn't need batteries. As solar-panel providers like to say, "The grid is your battery." That's great for homeowners: They have ready power whenever they need it, and they can sell extra power back if they don't need it. It's also great for the solar-panel industry, which can offer its customers reliable power and a quick payback for their investment.

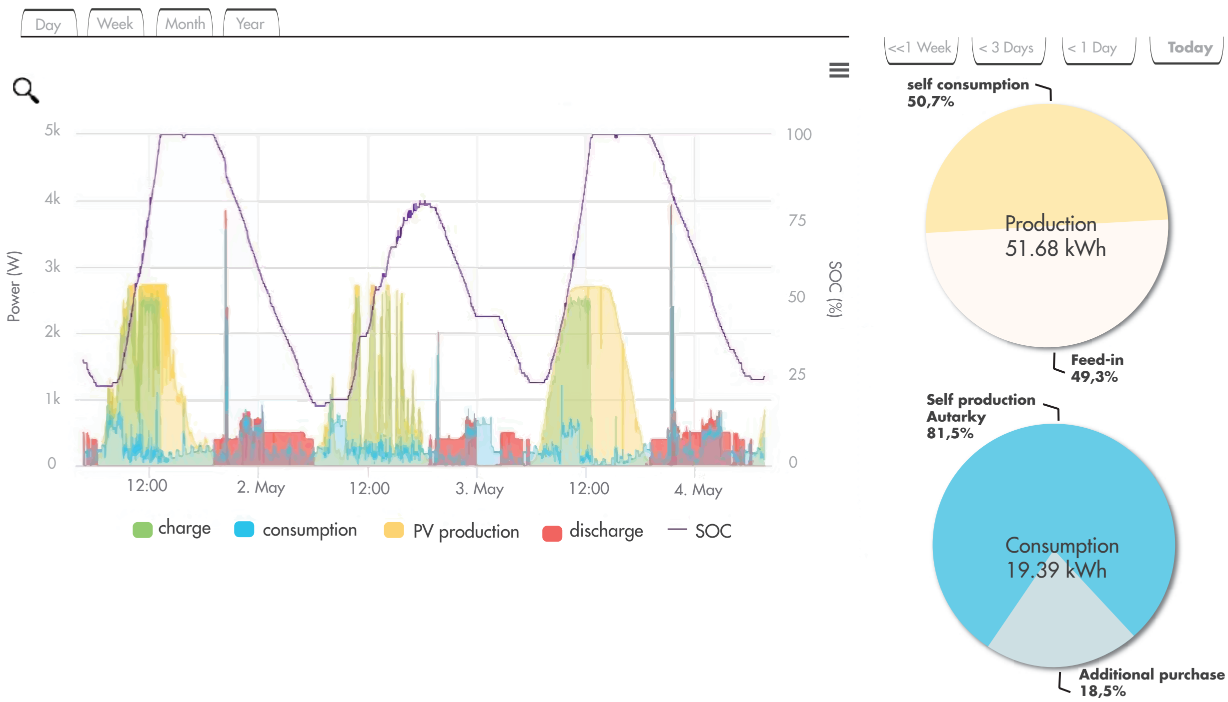
But net metering is not so great for the power company, and here's why. In reality, the grid is not a battery; that phrase is just a metaphor. In fact, the grid is a real-time network conducting power from generators to loads. The grid has almost no electrical storage capacity at all. So in order to keep their customers happy, grid operators are constantly finagling to match their various power sources to the changing power draws of homes and industry. That happens moment by moment, 24 hours a day. When you push extra power from your solar panels out to the street, the power company immediately sends it to another user; if no other user needs it, the power company needs to get rid of it, even if that means dumping it into the earth. But then when you need power at seven o'clock that night, the power company has to find you some. It's a tricky problem—and solar panels make it trickier.

Sometimes, of course, there's another user who needs your extra power right now. When your panels are powering the house next door, your production doesn't go to waste. But it does cost the power company money to manage that power. And if you get paid a full retail price for that power at your own personal meter, then the power company has no financial margin to work with.

Monthly service fees could make up the difference. And the infrastructure to bring power from your house to the house next door might be cheaper than the high-tension lines and transformers needed to bring current to your whole town from a power plant many miles away. So in theory, over the long run, utilities could either make money or lose money out of net metering, depending on the details. But even the

Photos courtesy Mandalay Homes

Power in reserve. Above left, Mandalay Homes' prototype for its grid-optimized houses actually has more panels than the production models will require to run the house independently between 3 and 8 p.m. every day. The secret is in the home's Sonnen battery compartment (above right); here, power stored up on sunny mornings will supply the houses all afternoon.



Knowledge is power. The user interface for Sonnen's battery bank and grid-tie control system supplies an up-to-the-minute display of the home's energy use, energy production, battery charge, and battery discharge. This example, taken from a grid-tied house with grandfathered net metering, shows how the home's battery charges up in the day and discharges at night.

solar-power industry, which absolutely benefits from the arrangement, doesn't claim that net metering is perfect. And in some states, net metering in its present form is a losing proposition for the power company. That's one reason that power companies have been fighting the practice all over the U.S., and it's the reason Arizona, for example, has given up on net metering.

Arizona has perhaps the worst case in the nation of the famous "duck curve"—the situation where there's too much solar power flowing into the grid all day long, but then just as the sun starts to go down, people come home from work, turn on their air conditioning, and start to cook or watch television. In Arizona, peak power needs ramp up just as the solar power fades out in the evening, leaving the utility company in the lurch. Solar power is not just variable in Arizona; it's variable in a predictable way that is the opposite of what the grid requires. So starting in 2016, new rooftop solar installations in Arizona won't qualify for net metering. New solar homeowners might or might not get paid for their surplus power; but if they do get paid, it won't be at the full retail rate.

MANAGING DEMAND WITH POWER STORAGE

One production builder in Arizona has come up with a workaround that looks like a win for all sides, including builders, homeowners, power companies—and the environment. Prescott, Ariz., builder Mandalay Homes, in partnership with German battery supplier Sonnen, has broken ground on Mountain View, a 323-home development where each house will have a solar array on the roof and a power-storage battery bank in the garage. And rather than be either a threat or a burden to the local utilities, the community's "solar plus storage" setup will help the power company solve its own difficulties with managing Arizona's sharp daily swings in energy supply and demand.

The homes in Mountain View will generate about 80% of the power they need, on an annual basis, says Mandalay chief technology officer Geoff Ferrell, and they will qualify for a federal tax credit to offset part of the cost of the solar and battery investment. But unlike solar-equipped homes that don't have batteries, these battery-equipped homes won't pump excess power production into the grid during sunny periods when the roof is making electricity, but nobody is home to use it—times when the utility already has more electricity than it can easily handle. Instead, each home's panels will charge up its own batteries every day, using the home's own extra solar power. Later in the day, when the utility is struggling to meet its daily peak service demand, the house will stop pulling power from the grid and instead supply its needs from the battery bank. Rather than being part of the problem, these solar-powered houses will be part of the solution.

In return, Arizona Public Service (APS) has agreed to give homeowners a reduced electric rate—as long as the house keeps its side of the bargain by "going dark" (from the utility's point of view) from 3 to 8 p.m., the crucial peak-demand period. That reduced rate more than pays for the cost to finance the solar-plus-battery system that makes the whole strategy work.

"A money-making machine." Geoff Ferrell explained the solution to *JLC* in a series of interviews this year. Mandalay owner Dave Everson toyed with the idea of building net-zero homes, or even an off-grid house, Ferrell said; but given the company's position as a mid-market production homebuilder, neither strategy seemed practical.

"As you get closer to zero energy," said Ferrell, "your cost for each additional HERS [Home Energy Rating System] point goes up. So you are asking your potential buyer to invest in a higher cost with a much longer return on investment." And as for off-grid, said Ferrell, "As a production builder, it's a terrible idea for us, because nobody would buy into it. Nobody buys a production home and says, 'I want to be off grid.' Those are million-dollar homes, or people who want to convert an old missile silo—things like that. It's a very specific niche. And solar alone wouldn't accomplish it anyway—you'd still need a $15,000 generator to get you through weeks of cloudy days, even though that equipment would rarely run."

Instead, Ferrell said, Mandalay decided to build a "grid-optimized" house—and that, he explained, has proven to be an easy sell. "As a production builder, you look at the bell curve," he said, "and you want to be at the very top of it. You want to offer the greatest savings for the lowest investment price possible. The added cost for our grid-optimized homes, compared with our competition, is $20 to $25 a month on the homeowner's monthly payment for a 30-year mortgage. But we're saving our homeowners $75 to $80 a month on their electric bills. I can offer our customers close to a 4 to 1 in terms of cash flow: If you give me 20 bucks, I give you back 80 bucks a month in utility savings. You're clearing 60 bucks a month. I'm giving you back 3 bucks for every dollar you put in my hand. People buy that all day. It's a money-making machine."

To hit that sweet spot, Mandalay Homes constructs a high-performance building envelope that can earn a HERS score of about 50 (meaning that the home uses about 50% of the power of a comparable home that meets the energy code, but doesn't exceed it).

That's without any site energy or battery storage. Then Mandalay takes it a step further. "First we look at the energy load," said Ferrell. "How much power is that home going to use on the hottest day in summer, or on the coldest day in winter? And we have some pretty good equations for that." Next, the company installs a solar array to supply 80% of that peak load. "We do still pull some energy from the grid," said Ferrell. "It's about 5 or 6 kWh on any given day. But we pull that energy when the utility wants us to—in the middle of the night, or a little bit in the morning. Then when the sun comes up, the solar panels start collecting, and when we're collecting enough solar power to run the house, any excess solar power begins charging the battery."

Sonnen software controls the system: "The software looks at the battery and says, 'I need to get back to 100% charged by 3 p.m. Am I getting enough power from the solar panels?' And if not, it starts to trickle-charge off the grid as well. Which is good for the grid, because that's when the grid already has a ton of energy and they're looking for places for it to go."

"We have 15 different floor plans in Mountain Gate that go from 1,400 square feet up to about 3,000," said Ferrell. "They offer between three and four bedrooms standard, but some plans have options that allow them to go up to five and six bedrooms." The solar arrays are relatively modest, Ferrell said: six panels on the smallest homes, and eight for the larger models. But the battery packs are larger: All the homes, even the smallest ones, get a 10-kWh battery pack—"which is more than any of them need," Ferrell said. "But I need that much battery power to match the 8-kW inverter that we put in every house. And we need that powerful inverter because between 3 p.m. and 8 p.m., I have to ensure that we do not use grid power, no matter what. So I need that power at my disposal for an oven turning on, or the washing machine starting up, or whatever—so that I can handle those peak loads."

FUTURE PROMISE

So far, the strategy is a hit, said Ferrell. By April, the company had pre-sold 10 homes in Mountain View and was selling homes as fast as it could build them. Mandalay Homes plans to pursue the same grid-optimized strategy in other neighborhoods. Eventually, said Ferrell, the plan is to put thousands of battery packs in thousands of houses in Prescott and vicinity.

Once the company reaches a critical mass of installed battery power, said Ferrell, the scene will be set for another step forward: using the battery cabinets and their Sonnen controllers to create an entire "virtual power plant" that the utility company can charge up whenever it wants to, and discharge whenever it needs the power. That's exactly what battery supplier Sonnen does in Germany, Ferrell said, and there's no reason the same thing couldn't work in Arizona.

"In Germany," said Ferrell, "the majority of their power is a mixture of wind, solar, and biogas. Over there, Sonnen is a grid operator: When you get a Sonnen battery and you are part of the Sonnen Community, your utility becomes Sonnen. It has a team of engineers that manage the whole system, just like a utility would, and they work behind the scenes to make sure there is enough power in the grid to run everybody's lights. Then they actively manage all the batteries within the community to charge and discharge, to supply the grid."

"That's what we call Phase Three," said Ferrell. "The cabinets that we are installing have storage space for up to 20 kWh of energy. Our homes only need between 6 and 8 kWh of storage to weather that 3 p.m. to 8 p.m. dark time, and give my customers the maximum benefit that they are ever going to get out of the battery. But I've got room for 12 kWh more storage in every home I build, that the customer doesn't need. So we could go to the utility and say 'Hey! I've got 12 kWh times 1,000, storage just sitting out there. If you have excess during the day, push it to these meters. We can store it in our battery, and when we go into the evening and you start to hit peak load, when you need a rapid discharge to offset something, call on our batteries to do whatever you need to do. Don't charge my customer for that energy, but use it.' And there is an interesting business plan behind that, which we are starting to talk through."

Ted Cushman is a senior editor at JLC*.*

1. New Shelving Configurations

To provide more storage options in closets, pantries, and other spaces, ClosetMaid has added new hardware to its ExpressShelf prefinished shelf-and-rod system. Straight H-Channels join two cut shelves for longer shelf runs, while Corner H-Channels join two shelves at a right angle. Corner Rounder Hanger Bars enable clothes hangers to slide around corners, and Shelf End Caps provide a clean, finished look for open edges. ClosetMaid says ExpressShelf is easier and quicker to install than traditional pole and plank shelving. The system costs about $15 to $20 per foot. closetmaid.com

2. Smart Technology for the Bathroom

The new Kohler Konnect platform brings voice control to the bath. Homeowners can control features of an intelligent toilet, adjust the lighting in a mirror or under cabinets, run a shower, and automatically fill a bath by using voice commands through Amazon Alexa, Google Home, or Apple HomeKit, or through an app on their smartphone. The Verdera Voice Lighted Mirror incorporates a microphone for voice control and can connect to other Kohler products in the bath. Pricing unavailable. us.kohler.com

3. Ceramic-Coated Door Hardware

Inox says that CeraMax, its new line of ceramic-coated door hardware, lasts many times longer than stainless steel. According to the company, the finish resists most solvents and chemicals, as well as deterioration caused by salt spray or oxidation, and the hardware can endure high humidity and ultraviolet light for up to 5,750 hours without yellowing or losing luster. The hardware is hand-finished and available in glacier white, graphite black, or flat black. Pricing varies by hardware type, size, and color. inoxproducts.com

4. Repositionable Flashing Tape

For easy application around windows, doors, and decks, Nichigo G-Tape's 3040BK acrylic flashing tape tears from the roll without sticking to itself. The tape can be repositioned in the first 30 to 40 minutes and fully adheres after a few hours. When tested for 50-year aging, the flashing retained more than 60% of original adhesion and 100% of tensile strength, according to the maker. Rolls are 65 feet long and are available in 2-, 4-, 6-, 9-, and 12-inch widths, costing $18 to $89, by size. gtapeonline.com

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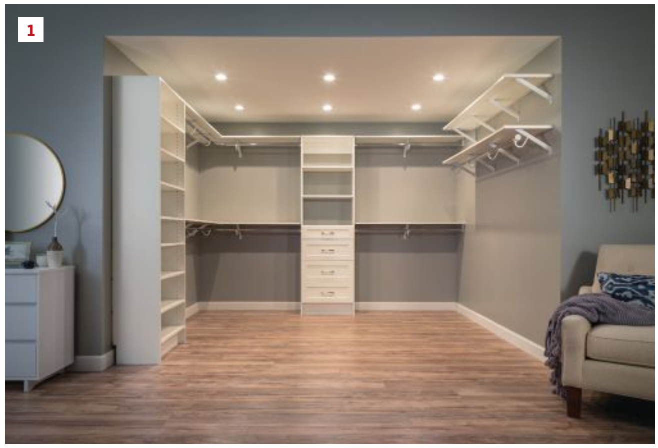

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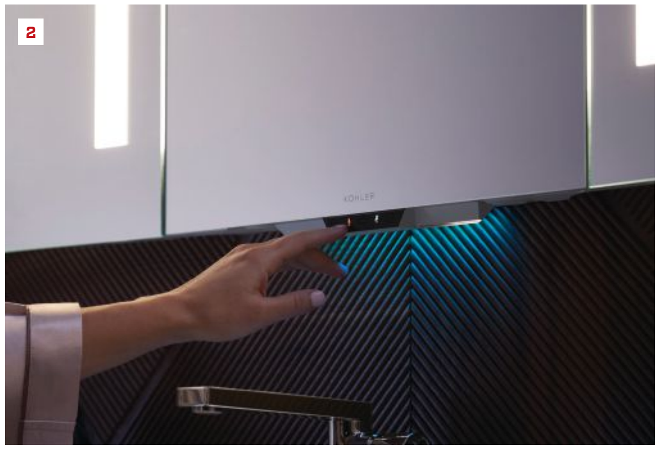

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Products

BY KATHLEEN BROWN


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5. Bold-Look Vinyl Flooring
Revive from Mannington is a resilient vinyl collection of seven patterns that offers a more budget-friendly way to achieve bold tile looks. Deco is a large-format pattern of symmetrical intertwined florals; Lattice sports a small basketweave pattern; and modern Hive (shown) resembles limestone in an updated take on a honeycomb pattern. In all Revive patterns, the flooring's wear layer incorporates aluminum oxide to help provide scratch resistance. Check with dealers for pricing. mannington.com

6. Transitional Faucet Styles
Delta's new Woodhurst bath collection combines transitional and classic styles for broad appeal. The line includes two-handle centerset and widespread lavatory faucets, three- and four-hole Roman tubs, and 14-series tub and showers. According to Delta, the spray holes in the showers facilitate cleanup of mineral residue, and valves in the tub and shower faucets provide consistent water pressure and temperatures from one visit to the next. The collection comes in three finishes: chrome, stainless steel, and Venetian bronze (pictured). Pricing varies by local distributor. deltafaucet.com

7. Time-Saving Dust Barrier
ZipWall recently added the SideBridge wall mount to its Dust Barrier system, a time-saving alternative to taping. The SideBridge snaps onto the FoamRail Span and holds it to the ZipWall pole closest to a wall for a tight seal of up to 8 feet. A longer size is available for additional clearance room around obstructions like baseboard radiators and crown molding. ZipWall says the system can be set up in minutes with plastic sheeting or reusable ZipFast panels. A four-pack of the standard SideBridge costs $36. zipwall.com

8. A Lightweight Jobsite Cleaning Solution
The Bosch GAS18V-02N 18V Cordless Handheld Vacuum Cleaner weighs only 2.9 pounds without its battery and holds up to 61 cubic inches of debris. The vacuum provides up to 21.2 cfm of airflow for up to seven minutes per battery amp hour. Two-stage rotational airflow keeps the washable HEPA filter clean for longer, Bosch says. A floor nozzle, crevice nozzle, short hose, and extension pipes are included. The GAS18V-02N costs $100. boschtools.com

9. A Decorative Exterior Trim Profile

New to CertainTeed's line of Restoration Millwork cellular PVC trim is the WP4 Nickel Gap trim style. The reversible panels are precut with a WP4 groove on one side and a 1/4-inch gap on the other to create two design options on one board. Panels also have a "TightLap" design to provide a larger nailing area for easy installation. The company says the material is low maintenance, durable, and UV-and-moisture resistant, and won't rot or warp like wood. The trim comes in white and can be painted to match any exterior. Check with your local dealer for pricing. certainteed.com

9

10. A Smart Ceiling Fan

The Hydra 120 Smart Fan from Modern Forms is a 120-inch, wet-rated indoor-outdoor fan that can be controlled by either a hard-wired wall unit or through the Modern Forms mobile app. The fan is powered by a DC motor, which is more efficient than an AC motor. The Hydra 120 includes an LED luminaire at the center and is available in white or black. The fan can integrate with leading smart-home devices such as smart thermostats. Suggested retail price is $1,200. modernforms.com

10

11. Induction Cooking at Accessible Price

In an effort to bring down the cost of induction cooking, Frigidaire added an induction range to its Gallery collection that starts at $1,200. Induction technology heats up any ferrous-metal pan; Frigidaire claims this heats food and water 50% faster than a traditional electric cooktop. The new stovetop has a low-heat feature for melting and simmering, is easy to clean, and cools quickly for a safer surface, according to the company. The oven includes a convection option for faster cooking. The range comes in a smudge-proof black stainless steel or stainless steel finish. frigidaire.com

11

12. An Automated Ventilation Fan

Broan's Fresh In supply fan ventilation system brings fresh air in from the outside—but only when it makes sense to do so. The fan monitors outdoor temperature and humidity levels and estimates the best time of day to run the fan. An ultra-efficient, variable-speed motor allows for constant airflow. The unit can easily be installed between ceiling joists with its flush-to-ceiling mount design using Broan's decorative finish ring, and filters can be replaced in less than 30 seconds, the company says. The basic model costs $290 and the premium model costs $380. broan.com

12

Cordless 10-Inch Sliding Miter Saw

BY KEN HOSKINS

I still use a Makita power planer that was as old as dirt when it was handed down to me 20 years ago. And I've been using the same 12-inch Makita chop saw for more years than I care to admit. Both tools still work great today, so when I started testing the Makita 10-inch cordless compound miter saw, I hoped to find another well-designed, durable tool. I was not disappointed.

My editor asked if I would be interested in testing out a new 10-inch saw from Makita (model XSL06PT). Although my 12-inch chop saw was in fine working condition, I was looking for a slide saw with versatile cut capacity, so the timing was perfect. This saw works off two 18V batteries for a total of 36V. As a start, I like the fact that this saw can be put flush against the wall without losing any slide range. And I was curious to test out the cordless aspect—being, I admit, skeptical of a cordless miter saw with this level of cut capacity.

EASY TO ADJUST AND ACCURATE

The first thing that jumped out at me on this saw was the upfront bevel control, located just to the left of the blade housing at the end of the slides. It was so obvious, I managed to whack my head on it a few times when I went in to take a closer look while making a cut (I'm not always a quick study). Like me, most of the guys I polled on the jobsite who tried it out appreciated not having to grope around behind the saw for the old familiar levers. The head isn't counterweighted as on a Kapex, so you do have to manually move the bevel to your desired angle. A few light twists of the knob and it holds fast, though, and if you leave it a little loose, you can get a nice ratcheting resistance, allowing you to easily dial in your angle.

Out of the box, the bevel angle was about 2 degrees off but was easily corrected; the miter angle was not quite as far off and was easily corrected as well. The bevel release button to bevel right as well as the "releasing levers" that allow you to go beyond 45 degrees are also conveniently located and easy to reach at the base of the carriage. There is a latch lever on the right that allows you to lock in standard bevel stops of 22.5 degrees and 33.9 degrees—convenient if you remember it's there. If you don't, and the little lever gets flipped down by accident, the bevel will inexplicably lock, causing you to call customer service and sound like an idiot. (That said, I found Makita's customer service easy to get through to and excellent at figuring out my issue—and they didn't treat me like I was, well, an idiot.)

Aside from the guide rail placement, the big innovation for this saw is, of course, its lack of a cord, which I have to admit is an important feature lost on me. But I'm old-school: I still have a tote of extension cords that stays in my trailer for every job I go to. My attitude is that although this saw is free from the leash, the double battery charger isn't, so no matter what, you need to plug something in somewhere.

I used the saw mostly in the field on the fly, and without the cord, I wasn't able to use my switch-activated vac to set up for automatic dust collection in finished areas. That was not a big deal—I can manually switch on a vac or use the dust bag. However, I recently learned that there is a Bluetooth-enabled model just like this one (XSL04ZU) that works with a Bluetooth-enabled cordless vac. If I still worked regularly in finished houses, I might consider it. I found dust collection to be adequate when the saw was hooked up to a dust extractor or vacuum; the dust bag clogged a lot and was less useful.

CORDED POWER, IMPRESSIVE RUNTIME

The dual 18V batteries have impressive power and longevity; the saw performed in power and cut quality no differently than corded saws I've used. A co-worker and I used the saw constantly for nearly two days trimming a house, and the batteries almost made it through the second day without a charge. I did annoy myself once by not charging the batteries the night before. I had not looked at the fuel gauge on the saw, so I take full blame.

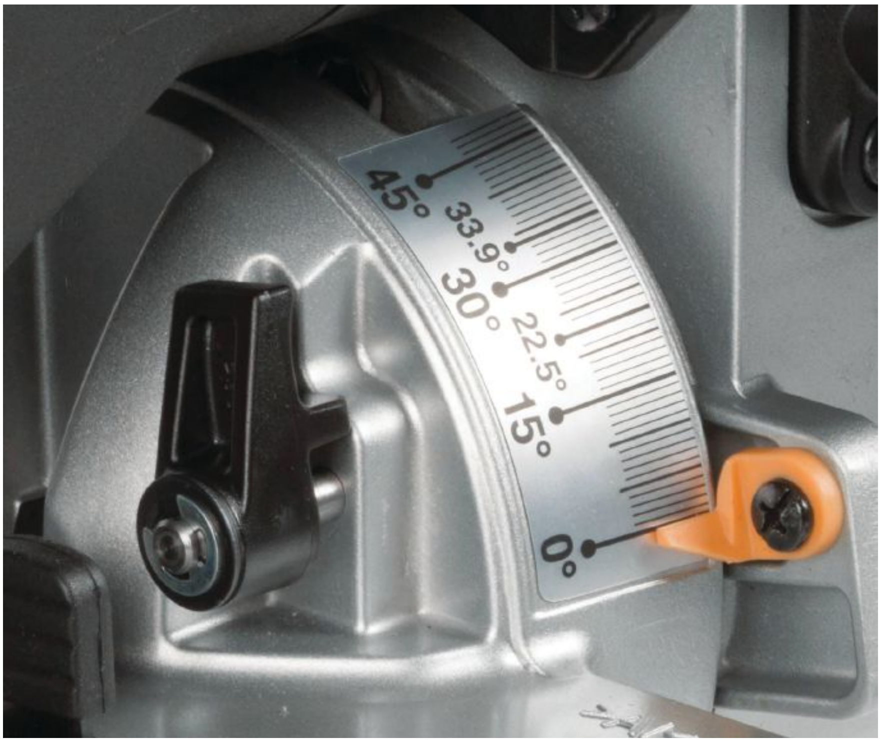
After using the saw for about six months, I found the 5Ah batteries would recharge to full in about an hour but were sufficiently charged to use in about 45 minutes. If you have multiple Makita tools going so you can swap batteries, you are all set. However, the batteries add a good bit of weight, which you can feel if you move the saw with them installed. I found this 10-inch saw to be as heavy as my older 12-inch corded one, which also has the added weight of the attached stand-mounting brackets.

This brings me to a related problem: It is awkward to carry. All the miter saws, including Makitas, I have owned in the past allow you to lock the blade carriage towards the front or back of the slides as desired. Even before reaching a certain age, when the lower back came into play, I would always lock the carriage forward and lock the miter all the way to the right to bring the saw's center of gravity as close to me as possible so I could comfortably pick the saw up. This saw only locks to the back of the slides; I find myself scooting around behind it or spinning the saw around, and even then I find it awkward to get my arms around the body of the saw. Perhaps I haven't yet found the sweet spot for grabbing it, but if the idea of a cordless miter saw is to make it more portable, I would recommend buying a good rolling stand for this one.

The saw settles in nicely in a crowded shop or tight jobsite with its compact footprint—thanks to the combined 10-inch blade and double slides—while still giving you a long cut of 12 inches. I appreciate the big work deck, the easy-to-use controls, and the laser precision (which you can dial into either side of the kerf). It has an elaborate dust-collection setup, with various boots and hoses to channel the dust, that easily ties into a shop dust collector or portable dust extractor. Of note: This tool is free of some of the manufacturing defects I have seen on past Makita saws—specifically, cast-aluminum fences not lining up.

Kitted with two batteries and a charger, the XSL06PT sells for $650 (the Bluetooth-enabled XSL04ZU is $550 bare-tool only). You may ask: Do I need a battery-powered saw in the shop? Probably not. Do I need a battery-powered saw in the field? It would be nice at times. If your answer is no to both questions, though, there is a corded version of this saw (LS1019L) that I would recommend instead; it sells for $550. I wish the cordless version came with a power cord adapter, as the DeWalt saw does, because I'd have a hard time coughing up $650 without having a plug-in option. Still, if you are looking for a cordless 10-inch slider, this is an excellent saw; just save up for that stand and don't forget to charge your batteries the night before!

Ken Hoskins is a remodeling contractor and facilities manager at Animax Designs, in Nashville, Tenn.



A convenient lever that can be tricky. There's a bevel angle gauge that's easy to see located at each side of the blade. A lever to the right of the blade allows you to lock in 22.5° and 33.9° bevel angles to the right or left. The lever is so inconspicuous that it's seemingly unimportant, until you accidentally lock it. It is spring-loaded, so you must pull it out in order to adjust it.

Safety-Toed Athletic Shoes

BY TIM UHLER

I used to wear skate shoes for summertime framing, but they don't provide ankle support or a safety toe. Last summer, I saw the Vismo M67 basketball-style work shoe and asked the company to send me a sample.

This shoe looks a lot like a pair of Under Armour basketball shoes I own. Vismo has added a composite safety toe and Kevlar puncture-resistant plate to protect from sharp objects on the jobsite. The M67 is electrical-shock resistant and slip resistant as well.

As a framer, I love how lightweight they are and that they are grippy on the roof. But this shoe won't work for me in the winter months, dealing with rain and mud. This is a perfect shoe for inside trades like drywall, taping, finish work, hardwood, and so on. If you are looking for a beefed-up athletic shoe, I highly recommend Vismo. The added safety features to a super lightweight shoe make this a good choice. Vismo recently came out with a hiker-style shoe that may be better for framing in the dry months.

The M67 costs $120 and held up all summer. I think I can easily get two seasons out of these shoes.

Tim Uhler is a lead carpenter for Pioneer Builders in Port Orchard, Wash. He is a contributing editor to JLC *and* Tools of the Trade. *Follow him on Instagram @awesomeframers.*

Bluetooth-Enabled Hearing Protection

BY CHRIS ERMIDES

The 3M WorkTunes Connect Wireless Hearing Protectors are an audio headset similar to the 3M Peltor Tekk ear muffs I've been wearing for nearly 10 years. The WorkTunes headphones feature an integrated rechargeable battery, have a lower profile than the Peltor Tekk ear muffs, and feel nearly identical in weight. They have Bluetooth technology, which allows you to stream music from any Bluetooth-enabled device. When the headphones are paired with a phone, you can make and answer calls without taking them off your head.

I like that I can comfortably listen to music in my shop (which is small) while running a table saw, router, or miter saw. With an NRR rating of 24dB, the WorkTunes protect my ears similarly to the Peltor Tekk muffs (which have an NRR of 30dB). Audio input level on the headphones is limited to 82dB, so you can't crank up the volume too loud. A single button pairs a device and provides power, audio, and phone control. The headphones charge via a micro-USB port and hold a charge for an impressive amount of time, aided by an auto-off mode triggered after five minutes of non-use.

Though I do recommend them, it's not without some caveats. The working range isn't amazing (25 feet; 3M recommends keeping your paired device within arm's length). I have noticed that during long periods of use, the headphones will stop picking up music. (I've read reports that people think the WorkTunes are dropping the Bluetooth connection—but this has not been my experience.) When this happens, I simply restart the song or skip it, and I'm back in business without having to re-pair. The phone functionality works well. People on the other end of the call can hear me clearly and it's easy to answer or end a call. There's a tinny sound on my end, though—and some echo. It's not the best talking experience, but it is adequate for answering or making a quick call when working.

Finally, there's a socket on the ear that houses a headphone jack and micro-USB port. I wish there were a cap for it to keep dust and debris out, but tape has been an adequate stand-in. At $60, these are a reasonably-priced addition to my hearing-protection arsenal.

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

June Advertising Index

*Advertising appears in regional editions

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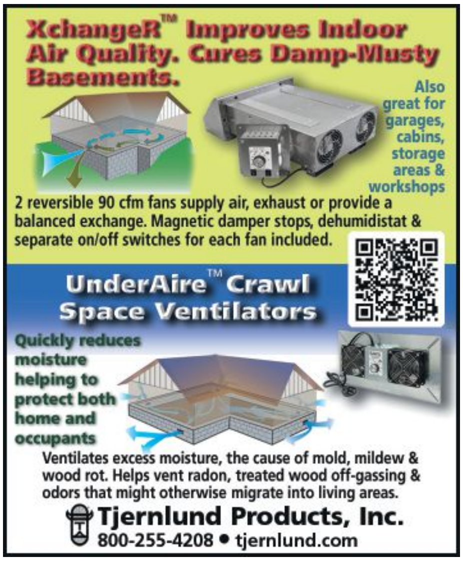
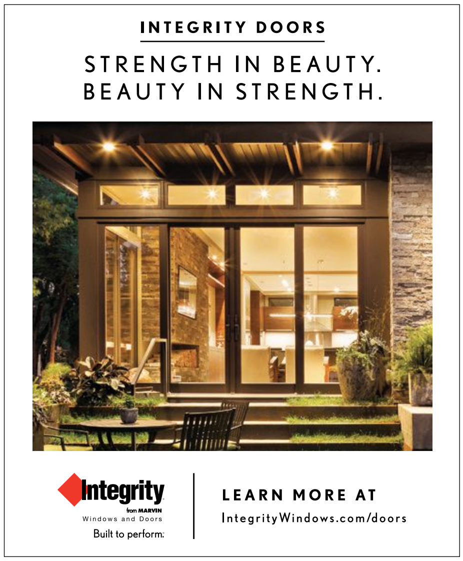
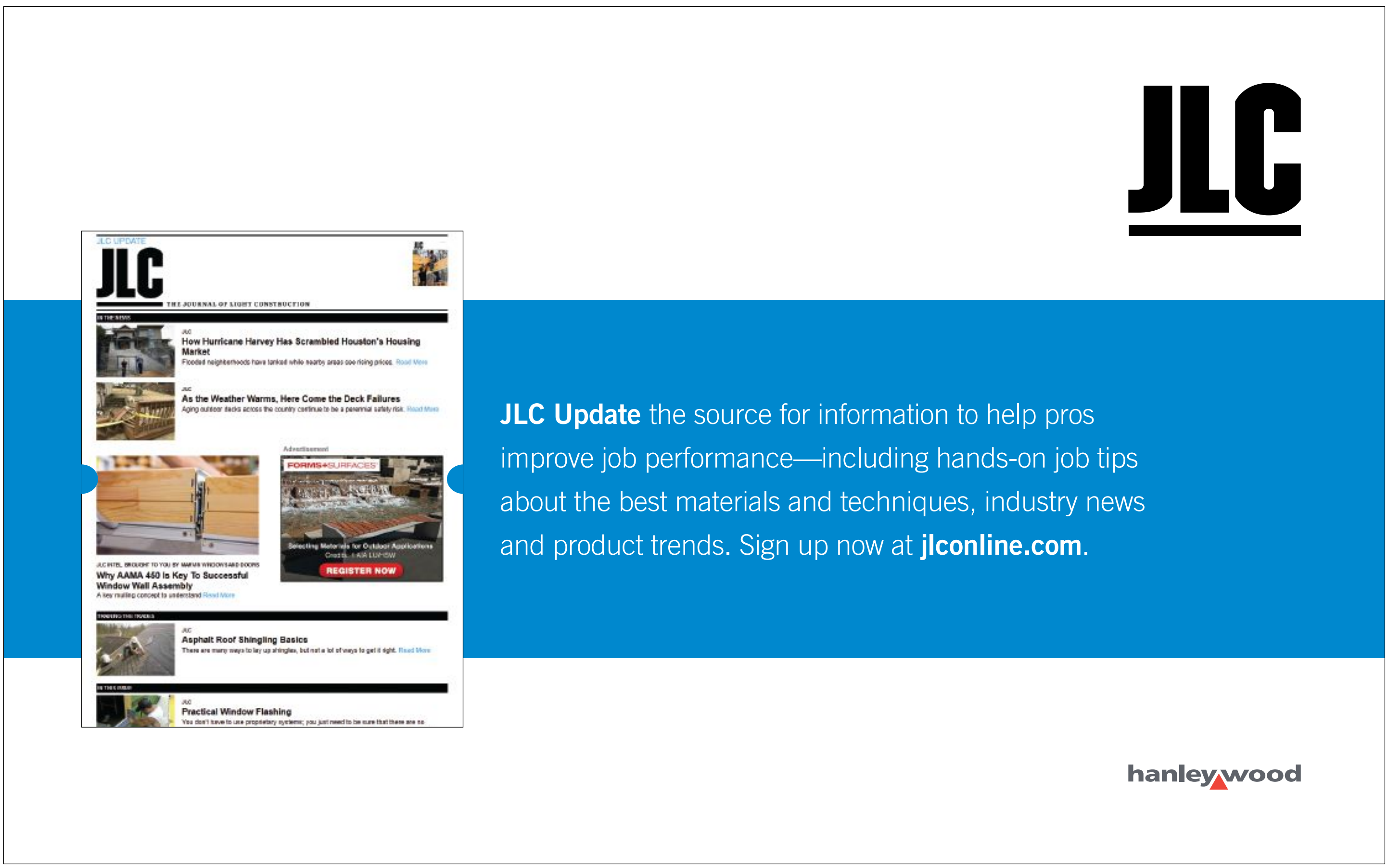






BY CLAYTON DEKORNE

Review: *From the Top Plates Up*

Will Holladay has produced a new book that falls squarely into the "must-read" pile for every carpenter. *JLC* readers may know Will as an early contributor to the magazine and author of *A Roof Cutter's Secrets to Framing the Custom House* or perhaps as a presenter at the earliest JLC Live shows.

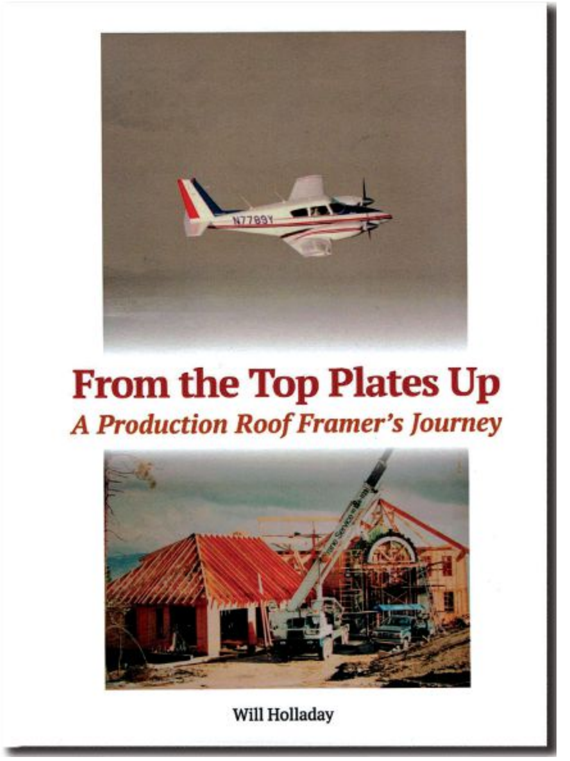
Will grew up working in the Los Angeles housing tracts—literally grew up there; he was working as a full carpenter by age 14. He came in on the tail-end of an era of "roof cutters" who had spent their careers trying to compete with trusses throughout the building booms of the late 1950s and 60s.

In his first book, Will codified much of the technical thinking those early production framers worked out. Their methods depended on supreme efficiency in calculating and cutting roof members, which took place on the ground before the entire roof package was forklifted to the plates and the pieces were stacked with precision. Efficiency frequently won out over safety; it was a brutal process carried out with jigged-up tools. But this era spun out a body of forward thinking on jobsite efficiency and tool invention, much of which Will has captured in this latest book. He does so specifically as history in the chapter "Roof Cutters - a flash in time" (which is so readable, it's hard to put down). But he gives us the insight of a true "roof cutter" throughout his new book.

If *A Roof Cutter's Secrets* captured all his technical knowledge, Will says, *From the Top Plates Up* captures all his practical knowledge. With chapter headings like "Framing is a Street Fight (treating and avoiding jobsite injuries)" and "Train to Survive (physical training ideas for a framer)," the book contains concrete guidance for staying in the game for the long term. Other chapters take on practical framing knowledge, like "One Swing, One Hammer," "My Two Best Friends—a Skil 77 and a Homelite chainsaw," and "Where Was Adam When We Need Him—names matter (a treatise on rough carpentry lingo)."

But the knowledge in this book is not for framers alone. Every carpenter, every building professional can benefit from Will's experience and insights. Chapters like "The Making of a Framing Crew," "Smiles and Frowns (job successes and failures)," and "A Man and His Truck" (one of my personal favorites) are based on personal stories, but Will has very little ego in telling them. He lives to teach, and embedded in his stories, full of joys and real-life pain, the author has captured a unique era in building and passes along the wisdom of a true working hero.

Clayton DeKorne is editor of JLC*.*



"There is some unexplainable mathematical equation that occurs when guys 'click' and somehow become a team that is greater than the sum of their individual parts. I first experienced this anomaly in my crew rowing days at Orange Coast College." (Will is third from the left; this year, 1975, the team broke the heavy-weight record).

Rowing photo courtesy Orange Coast College

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