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On the cover: Emanuel Silva fastens meranti decking to sleepers for a balcony floor in a Massachusetts home. See the story in the *Professional Deck Builder* section on page 17. Photo by Emanuel Silva.

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DEPARTMENTS

THE JOURNAL OF LIGHT CONSTRUCTION (ISSN 1056-828X), Volume 40, Number 7, is published monthly except combined issues in Jan/Feb, July/Aug, Sept/Oct and Nov/Dec by Zonda Media, 1152 15th St. NW, Suite 850, Washington, DC 20005. Annual subscription rate for qualified readers in the construction trades: $39.95; nonqualified annual subscription rate: $59.95. Frequency of all magazines subject to change without notice. Double issues may be published, which count as 2 issues. Publisher reserves the right to determine recipient qualification. Canada Post Registration #40612608/G.S.T. number: R-120931738. Canadian return address: IMEX, PO Box 25542, London, ON N6C 6B2. Periodicals postage paid at Washington, DC, and at additional mailing offices. POSTMASTER: Send address changes to JLC, Box 3530 Northbrook IL 60065-3530.

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JLC will occasionally write about companies in which its parent organization, Zonda Media, has an investment interest. When it does, the magazine will fully disclose that relationship.

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BY CLAYTON DEKORNE WITH RICK MILLS, JEREMY KASSEL, AND MIKE WHALEN

Project Logistics

Last month, JLC began this series with Rick Mills, Jeremy Kassel, and Mike Whalen to explore the roles and responsibilities of project managers. Each of these individuals works under a slightly different business model: Jeremy operates as a "bags on" general contractor and assumes the role of project manager on his renovation projects in and around Albany, N.Y.; Mike is a lead carpenter at DBS Remodel, a design-build residential remodeling company based in Poughkeepsie, N.Y.; and Rick is senior project manager for Jackson Andrews Building + Design, a custom-home builder based in Virginia Beach, Va.

In this second article, we pick up the discussion examining the project manager's role in keeping a project running smoothly. It's not so much about tips and tricks for organizing the site. Rather, it's an extension of the jobsite-etiquette discussion we published in the first article. Here, the main concern is managing relationships with clients, crew, and trade partners to keep the job flowing, as well as efficiently handling problems that arise.
—Clayton DeKorne

STARTING THE JOB

Rick Mills: With our new construction builds, obviously, we arrive on the site having already spent time to wrap our heads around what's on the plans. But the first steps were set in motion before we arrive. For the past few years, most of our jobs have been on the water, and to be able to build on one of those waterfront lots, we need to have a hearing with the Chesapeake Bay Preservation Area Board. But to even schedule the hearing, you've got to have all the engineering done to define what you're proposing to build. Included with that, our civil engineer does a site plan that gives us all the street protection [runoff controls] and silt-fence locations. So for our first steps, we are following that site plan and working with a trade partner who is in the business of installing those protections on the site. This then needs to be inspected, and once we get CBPA's blessing, we can bring in the job trailer we use for a jobsite office and begin to schedule the footings.

On a lot of the projects we've been doing, there was a house on the lot that was either vacant or had been torn down. On these projects, we will have the existing driveway, but all the utilities had to be disconnected for the demo, so we're setting a temp pole, getting power back, and then, usually, we'll have our plumber come out. If the water meter got pulled, we'll have to reschedule with the city to install the water meter, and then our plumber will give us a stand pipe for water.

To secure the site, we have started doing more of what you'll see on a commercial site: erecting a 6-foot temporary chain-link fence. We hang a banner with our company logo on it, and at the entrance, we also post job rules for trade partners and delivery people, clarifying start times, no loud music, that sort of thing. This is mostly for the trades, but it's also good for clients and neighbors to see. It says, "Hey, these builders actually care about how their trades conduct themselves."

Part of this sign also discourages neighbors or passersby, anyone not working on the project, from coming onto the site. This is needed for insurance reasons and to give the clients some privacy. We also have to post "no trespassing" signs elsewhere, particularly near the waterline. We keep the fence gate locked after hours, and I have a camera on it that I can monitor with my phone. Again, all this is mostly for insurance, and to discourage vandalism, but we've been lucky that we haven't had too much of that, and we haven't had any robberies after hours. Usually, it's just kids who cross the site after getting dropped off by a boat, and they're walking to their house. I am always reminding the guys to take the perspective of a teenager who might make bad decisions: "Don't leave ladders up; don't leave the keys in the machines. Let's try to prevent them from doing something dumb."

For any new trade partner coming in, we need to explain what we expect beforehand. But people tend to forget. There's always a policing part to it.

Mike Whalen: For us, it's a different process because we're a smaller outfit on smaller jobs. About two weeks before the preconstruction meeting, I get the job book, so I have a chance to review it and make notes, and am familiar with what's involved when I walk into the meeting. Where we start will vary by the type of job. If it's a second-floor bathroom on the other side of the house, like I'm on now, I'll know how much protection is required—it's dropcloths everywhere, 1-mil poly on everything we walk by, Ram Board on the floors, Masonite on the steps, a Build Clean unit running. This is very different from, say, a kitchen on the first floor that has a rear-slider entry off the deck, where we don't have to protect anything except the deck.

I am always the first one on site. As a lead carpenter/project manager, I rely heavily on trade partners for a lot of the work. My

role is to make sure everything is prepped for them when they walk on the site, and all our trade partners have been with us awhile, so they know how to carry themselves—no swearing or yelling or smoking, and such. For any new trade partner coming in, we need to explain what we expect beforehand. But people tend to forget. If they are smoking outside where the homeowner may be, we have to remind them; there's always a policing part to it.

We remind ourselves what to do constantly, too. In a meeting every month, all the lead carpenters discuss pain points we have run into on other jobs. We remind ourselves that we not only need to put planks down to protect the driveway from the rollers, but we also need to put a tarp down under the dumpster. The dumpsters can be rusty, and we don't want rust marks on a nice, new driveway. Landscaping is another big one: "That favorite rose bush that Aunt Sally gave the client two years ago got stepped on. So let's remember to put up scaffolding with plywood to protect those things." Every month, something comes up, and it's important we all recognize how important these issues are to clients, so we won't repeat the same kinds of mistakes.

Jeremy Kassel: I try to set expectations early on, even before maybe somebody has signed on the dotted line. So much of what we do is in the client's domain. I say, "I'm at your house. This is the scope of work that we're doing. For that we're going to need things like half of your garage to stage materials; we're going to bring in a dump trailer and park it here, etc." I think it's important to set those expectations way before the job has started, even before they've signed a contract, so that on the day the job begins, we aren't surprising anyone, we are only reminding them, this is where we agreed the dump trailer is going, or this is the half of the garage that we talked about.

We don't have nearly as many sub-trades on site as Rick does, so I'm relying less on infrastructure—a fence with signs and cameras and such—to remind everyone and leaning more on providing early notice and follow-up reminders to keep subcontractors aware of the client's best interests.

LOGISTICAL CHALLENGES

***JLC*:** Once the job gets underway, what are the biggest logistical challenges?

RM: The site that I'm on currently is extremely tight. It's at the end of a cul-de-sac, and the house takes up most of the lot. The neighbors on both sides are more than ready for us to be done, because managing parking, well, it's been pretty wild out there.

There have been numerous days when I can count at least 20 vehicles on site. I've resorted to painting parking lines on site. But even this doesn't always work. Yesterday, we had a new trade partner on site doing some block work for us. They just pulled in like they're the only ones working there that day, and I'm there saying, "You know, guys, we have these lines. I need you to park in them so that I can manage all the cars here." And that's just on the site. On the street, I've got to set cones that define where you can't park past, because otherwise it will create a bottleneck, and neighbors can't get in and out. I've also got cones that indicate you can't park past here because it's going to block the neighbor's mailbox, and so on. We may have to move people farther down to another street in the neighborhood. I've had to tell the neighbors: "The more cars you see here, the faster we're going to get this done and get out of your way if you can just bear with us."

JK: Very recently, we wrapped up a window-replacement job in a brick row house, which was in the middle of the block with no driveway in front or back, and no garage, just a small shed about 5 1/2 feet tall. There's no place to store anything here.

This basically leaves me to store stuff inside the home. Fortunately, this is a client who I've worked with before, and she knows what to expect. A lot of materials—dimensional lumber, windows, tools—ended up stored in the occupied living room because there's literally nowhere else to store it, and it's impractical for me to bring tools to and from the job every day. Those are the types of jobs that make me wish I just had a different career entirely. (Laughs)

We run into that a lot in row houses in some places, where there's just no access, and most people who own these homes are aware of the issue.

We also have the issue that in downtown Albany in the center square, we are required to use licensed plumbers and electricians. And I work with licensed plumbers and electricians nearby in Schenectady and Troy who will not work in downtown Albany because they can't pull into a driveway, or they have to keep their van locked during the job. That forces me to find another licensed plumber who's willing to work there, which limits the pool of available subs considerably.

RM: Delivery drivers are a constant challenge; I'm not sure what it is about them. I know it's a tough job, but they really do seem to have little regard for anything besides getting offloaded. Don't get me wrong; there are some good ones. But on my most recent project, we were at the end of a cul-de-sac, and they would back down and stop right in the middle [of the street] so that none of the neighbors could exit their driveway.

The most helpful thing that I find is I try to request a call 30 to 60 minutes ahead. That way, we can be on the lookout for their arrival and help orchestrate the offloading process. Now of course, you have the ones that don't call even though the top of the delivery tickets states to do so.

JK: A few times, we have had delivery drivers either park, drive, or set down their outriggers on a neighbor's lawn. The struggle here is that those drivers are serving me and my client, so they have an objective. However, and I hate to generalize, many drivers just simply don't care about lawns. If driving on a neighbor's lawn is a consequence of that delivery objective, so be it. It puts everyone in a bad spot—me, my client who becomes the "bad guy" in the neighborhood for having the delivery, the company and driver who are doing the damage, and the neighbor who now has a damaged lawn. When something like this happens, I immediately take photos and notify the delivering company and then also contact the neighbor.

I always ask that any driver have my cell number and that they call when they are on their way. I also ask what type of truck they

are driving when the order is placed. This can be a big deal. No driver wants to back an 18-wheeler down into a cul-de-sac. Straight trucks are better for that. Knowing and understanding what type of truck is being used for the delivery is hugely important. Also, is the driver coming alone?

I always try to be extra polite with lots of "please" and "thank you" to these guys. Most of them are treated poorly and get paid poorly. I almost always offer to help offload if there's no piggyback, or Moffet.

In the last few years, many of our regular vendors have started taking photos of the delivery after it's been dropped at the site. This protects most parties to say in effect, "Here are the materials, this is where they were left, and they're in this condition."

RM: One thing I'll add is that we have starting adding a telehandler (jobsite fork lift) to most of our projects (which we budget/charge for). Of course, in the renovation world, this may not be feasible. But this has made all the difference for expediting the offloading process, especially for LTL [less-than-truckload] freight delivery trucks that show up without a lift gate. Without that or a forklift, you are stuck breaking down pallets and offloading piece by piece. This is a sure way to tick the driver off.

MW: One thing I also try to do with deliveries is request how they build the load sometimes. If we are doing an addition, a big deck, or a porch, I want the flooring materials on top and the rafters below, etc. We also check everything when it's delivered as much as we can. Kitchen cabinets, bathtubs, fixtures, sinks, and such to make sure they're not damaged and to reconfirm with the client that it's what they have selected. We use a designated area that is clear for storage in the garage, basement, or a cleared-out living room. We have also arranged to have storage pods and or an extra job trailer on site for extra space to keep materials dry and secure.

***JLC*:** That touches on another challenge: handling and storage of materials on site. Besides asking suppliers to stack the delivery, are you able to stage materials to avoid having to move them?

RM: I run through a process for material management, asking myself, is this the most effective location for the trade using this material, and is this going to be in the next guy's way coming along? I can speak from experience there is no perfect location for any material. I call it the "constant material shuffle." No matter where you place something, it's eventually in someone else's way. I just let trades know, "Hey, if you need anything moved, let us know what, and we'll see what we can do."

JK: On material handling, sometimes less tenured folks need to be reminded to handle things with care. Seems super obvious, but at times you have to explicitly tell people to be careful, don't walk on stuff, don't stack boxes a certain way, that sort of thing.

When we do a window job, we either have the screens shipped separately or immediately take them out of the window units and store them far, far away from any work space.

LANDSCAPING AND OTHER EXCLUSIONS

MW: Landscaping can be a challenge, but it varies from job to job. We always make an effort to protect plants if we're doing, say, siding or a roof. Certainly, shrubs and other plantings near the house are part of the conversation at the preconstruction meeting. Where the clients come down on this issue can be very different.

I'm finishing up a job now for a new front porch and roof. The clients were taking out the landscaping anyway, so they said it wasn't much of a concern. We were just mindful of where we put our trailers—we kept them off the lawn—and made sure no lumber deliveries were placed on the lawn.

For other people, though, their lawn is immaculate, and they don't want us out there at all. We've been on jobs where we're vacuuming sawdust off the front lawn with a shop vacuum just because the lawn is like the fairway on a golf course. While there are others who will let us drive the truck right up to the back door. So it depends. But as a rule, we take as much precaution based on the situation as possible.

JK: I have an exclusion clause in my contracts when we are doing exterior remodeling work that reads, and I'm just paraphrasing: "Excluded from the cost of the scope of work, and excluded thereby from the scope of work, is any type of lawn repair." This means if we build a deck at your home and the deck takes a week and a half to build, and in the course of that week, we wreck your lawn, you have to pay us above and beyond the contract price if you want us to repair it. I know that sounds like I'm really putting my foot down, so to speak, but we don't know if it's going to rain for five straight days. We don't know if we're going to have a drought for two weeks. They could say, "Hey, I don't like the way the lawn looks. You have to fix it." Well, I'm not going to pay out of my own pocket to fix it.

We don't know if it's going to rain for five straight days. We don't know if we're going to have a drought for two weeks. They could say, "Hey, I don't like the way the lawn looks. You have to fix it." Well, I'm not going to pay out of my own pocket to fix it.

That is very different than, say, if you're doing a bathroom remodel: We make sure we put down floor protection between the front door and the bathroom. I can't very well exclude the flooring, and if I did, I doubt I would get the contract signed. But we don't need to exclude it, because that's something we can control.

I don't know if that seems wild to you guys or not, but the lawn exclusion protects me from having to pay out of my pocket to address something that I never have a ton of control over when somebody has hired me to work at their home.

MW: That does not seem wild at all. We also have an exclusion clause to cover the lawn, if we're doing additions or a deck. We also have one specifically excluding damage to driveways. If there's a crack in the driveway, was it there when we arrived? And in part of the contract, we identify everything we're not touching. It's a list for every job, and sometimes it seems obvious, but you do have to identify

it because, like your example with the lawn, a homeowner can just go outside if there's no boundaries. They'll just keep going and then you're on the hook for something that wasn't ever part of the scope of work. So, no, it's not crazy at all. This is protecting yourself.

JK: We insisted on another exclusion on a new house build a couple of years ago. The client had a shared driveway with his brother. I had the brother and the brother's wife sign my contract with my client to say that we were not responsible for repair work to the shared driveway: We knew we would have dump trucks with crushed stone, multiple concrete trucks, low boys coming in with a bulldozer and excavator; truck after truck on a shared driveway. I saw it coming and knew I had to get all parties concerned to exclude damage to the driveway. In essence, I was telling the client's brother, "If your brother wants to build a house, this is what has to happen."

Neighbors do take special consideration. I tell anyone who is working for me—employee, driver, sub—to not engage any neighbors. That's my job or the client's.

MANAGING NEIGHBORS

***JLC*:** You bring up neighbors, and they're different. They don't have the same motivation to "just get it done" that a client might have. I used to work jobs in Manhattan, and before one job that involved jackhammering out a bathroom slab in an apartment building, the contractor's lawyer insisted on the neighbors allowing an inspection of the finishes and structure of their property, and signing off on existing conditions. At first I felt, "Wow, are people really so litigious?" But the project manager pointed out to me that if you are next door, and someone starts jackhammering a slab, you may begin to think, "What is all that vibration doing to my place?" Suddenly, they start seeing hairline cracks in the plaster—cracks that might have been there all along and went unnoticed. Now they see them and think they were caused by the work they hear. They're not necessarily predatory; they're just protecting their interests." So I can imagine someone seeing cracks in the driveway that they didn't see before, and they make false assumptions. For sure, you shouldn't have to pay for that, and your exclusions seem right on. But I can also see their point of view.

JK: Neighbors do take special consideration. I tell anyone who is working for me (employee, driver, sub) to *not* engage any neighbors. That's my job or the client's.

MW: We will sometimes introduce ourselves to the neighbors and give them a gift card to Dunkin' Donuts. It can be a nice ice breaker to let them know we may be outside early making noise. It depends on the type of job it is. We'll do this on an addition, siding, roofing, or deck. If we are doing a bathroom project inside, we don't make it as much of a priority to let the neighbors know. The exception to this is in a condo complex. I have one of these coming up, and there are adjoining units connected on each side, so we have to let everyone know and also abide by the HOA [homeowner's association] rules around parking on street, no dumpsters allowed, and no job signs.

THE CHALLENGE OF NEW HIRES

RM: We have a lot of trades that we work with year after year. When we do have new trades coming on, we will email them a package that goes through our expectations. But it's not uncommon they will have a new hire who is not up to speed on what our standards are on site. That's been happening more recently. So we make a point of reviewing those standards when we have new trades that come on site.

MW: I agree, new hires for trade partners can be a challenge. One example: We had a guy who ran a one-man operation installing shower doors and glass panels in bathrooms. We've always used him, and we were always able to reach him. Over the past couple of years, he's been scaling his business. He wants to grow like many businesses do, of course. And we want him to grow so we can do more work with him. But once you start scaling, there's that training element. He's had new office staff, and maybe they're not relaying some things to him they're not used to, so he's sometimes hard to reach now. Those are natural growing pains, but it means we're feeling them, too.

Another example: We have a plumber who has a new hire, an apprentice. The apprentice is going to be doing the major work, but they're going to do some of it. What if a small leak occurs? It's happened, and then there's a ripple effect: We get some drywall damage. It's not about money for damages so much as the disruption with the homeowner.

We don't go around announcing that someone's training, or is an apprentice or a new hire. It's a touchy line to walk. As project managers, we want to constantly convey professionalism, experience, craftsmanship. The best we can do is stay on top of our trade contractors, especially the new hires, and maybe pull the senior person aside and say, "We can't have your apprentice doing this particular job because there are high expectations and not much room for error here."

It's the same for our own new hires. Of course, we are careful to not throw someone into a new situation to fend for themselves. But we're constantly asking, "At what point do you let them expand and try different things?" With that comes mistakes. With new hires we have to be willing to take that chance—take the time needed to train, be willing to fix the mistakes, and take the financial hit. It's all part of our cost of doing business. The only advice here is we need to be very intentional about it. And, of course, it goes back to what we talked about in the previous article: What matters when mistakes arise is how you handle it with the homeowner. If you do it right, that's what the home owners will remember, and they will tell others you did the right thing.

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Q We often hang and finish our own drywall on small jobs and have always used premixed joint compound straight out of the bucket. However, another subcontractor on our job was surprised we didn't add water and mix the mud before using it. Is this necessary or does it have an advantage?

A *Lydia Crowder, a drywall finisher and owner of Trinity Drywall based in Boseman, Mont., responds:* Adding water to joint compound creates a smoother compound with fewer air bubbles and helps improve workability. Having a smoother mix allows you to spread it in a thinner layer and avoid overfilling joints. When you have a thick, dry layer of joint compound on the wall, it's harder to spread out in a thin layer, and it takes more work to feather out, so you end up with heavy edges and may even create waves in the coat. Mixing in a little water is also necessary when finishing with semi-automatic or automatic tools.

Premixed joint compounds come in a variety of consistencies, depending on the brand, the factory where they were produced, and even regional formulas. The joint compound manufacturers allow users to add water to the compounds, but the formulas are designed be thinned with water only. There is no reason to add anything else to the mix.

Sometimes, you can open a bucket or box of joint compound and find it is dry and hard to work with **(1)**, and if you try to use it straight out of the box, you will not be happy with the results. On the other hand, you want to be careful to avoid adding too much water, as the compound can fail—that is, crack and flake off—when it's too thin. You may also have to apply multiple coats that you wouldn't otherwise need to do. We want to be right in the middle with the consistency—not too thick and not too thin. For any sort of "heavy" filling, I would recommend using Easy Sand or Durabond. Those are chemical-set muds and are made for prefill and heavier fill applications.

When we mix our joint compound, we typically empty a box into a 5-gallon bucket, and then add 1/2 to 1 cup of water. We then use a mixing paddle with a mud mixing drill to stir the water in until it is fully incorporated into the compound and the consistency is smooth **(2)**. Before using it, we test the mix with a knife to see if it is the right consistency and add more water as needed. If you haven't done this before, you will likely be nicely surprised with the results: smoother joints, better workability, and a nicer finish.

Photos by Lydia Crowder; @drywallshorty

The author typically empties a box of joint compound into a 5-gallon bucket. Out of the box, the material is dry and stiff **(1)**, but after mixing in about 1/2 cup of water **(2)**, she gets a nice, smooth consistency that is vastly easier to work with.

Q During plan review, we submitted a 2x6 wall with unfaced R-21 batts and 1-inch continuous polyiso foam on the exterior. This design exceeds the code's "20 + 5" insulation requirement for climate zone 6, but it was rejected because it doesn't "meet vapor retarder requirements." (Because we are using the foam, we are trying to avoid poly on the interior.) To pass, we were told we needed $1\frac{1}{2}$ inches of foam on the exterior. Can you explain why the code's vapor requirements contradict the insulation requirements?

A *Clayton DeKorne, editor of* JLC, *responds:* The building code is written to be as flexible as possible so you have options. For example, you could install a Class I vapor barrier, such as poly, on the interior and stick with "20 + 5" (R-20 cavity insulation + R-5 continuous insulation). Even though the poly and the foam are both vapor barriers, this wall system does work in cold climates.

But I understand your reluctance to add poly given the trend toward warmer climates and the increased use of air conditioning in cooler climates. I wouldn't say the requirements contradict each other, but the IRC's minimum insulation requirements are confusing. At the very least, the insulation requirements listed in Table R402.1.2 (pre-2021 IRC; in 2021, it's relabeled as Table R402.1.3) should have a footnote that specifies which vapor control option is assumed in the table and refer users to the Chapter 7 vapor retarder options.

It's worth noting that the 2021 IRC has added clarifying information to the Chapter 7 discussion of vapor retarders, including guidance on types of vapor retarders allowed in each climate zone and details on using Class II vapor retarders, such as kraft-faced batts. If you use kraft-faced batts, you should be able to use your proposed wall insulation under the new rules, which specify a minimum R-5 continuous insulation over a 2x6 wall.

Condensation Potential in Wood-Framed Walls

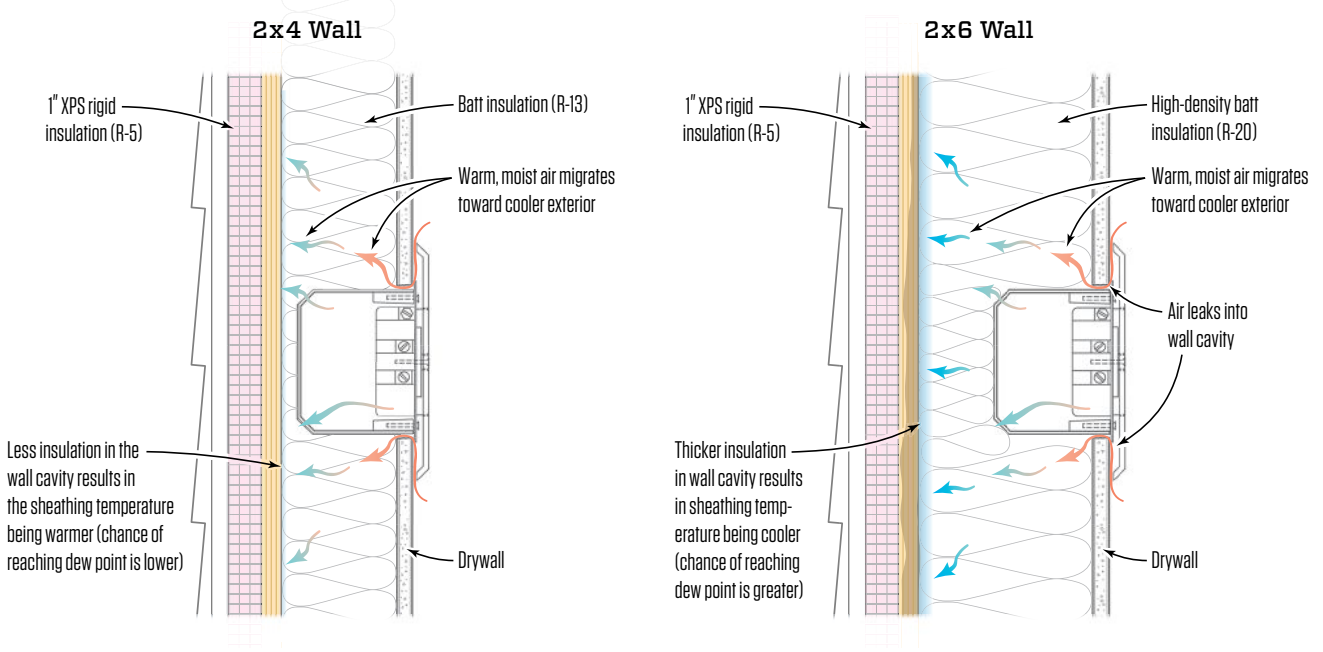

Illustration by Tim Healey

Condensation is more likely to form in the 2x6 wall (right) because, under the same temperature and humidity conditions, the thicker cavity insulation will keep the inside face of the sheathing cooler than will the thinner insulation on the 2x4 wall (left).

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Resurrecting a Sagging Roof

BY JAKE LEWANDOWSKI

On a recent job, we were called in to repair a garage that had been converted to the primary bedroom of a home near Chicago. It was visually apparent that the roof had some deficiencies. The ridge had a substantial sag, which in turn pushed the exterior wall out of plumb upward of 3 1/2 inches at its worst location.

The roof structure was insulated and had been finished with wood paneling. It also included widely spaced tie beams that were more cosmetic than structural. Cathedral ceiling areas like this one require a structural ridge beam to support the roof loads, or adequate rafter ties or ceiling joists to resist the outward thrust of the roof loads. This building lacked both.

A true ridge beam should not be confused with a ridge board, which is not a structural member and functions only to make installing rafters easier during construction. A true ridge beam must be sized appropriately to support the roof loads and have a clear load path that transfers the loads through columns to a solid foundation. On top of a poorly designed ridge and inadequate ties, the roof rafters on this building were only 2x4s, which are greatly undersized for this part of the country.

Our job was to bring this home's primary bedroom to a structurally sound state. Working with a local engineer, we determined the most cost-effective approach was reinforcing the 2x4 rafters with modified 2x6s and adding rafter ties along with intermittent collar ties.

We started the repair work by temporarily reinforcing the existing ridge board to support our shoring. We then mounted eye hooks to the top plates at the bowed wall section and, using a come-along to pull the wall inward and our shoring to lift the ridge upward, we were able to make significant improvements in the ridge sag and the wall bow.

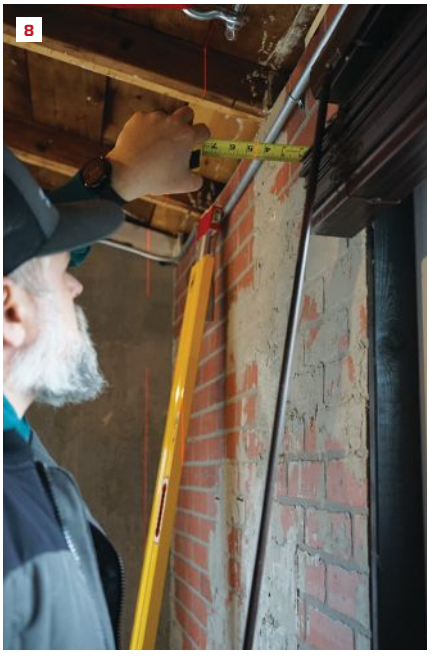
Once we had everything where we wanted it, we sistered new members to the rafters, then locked everything in with 2x6 rafter ties, using a laser to define their elevation. To maximize headroom, we set the rafter ties at the top of the lower third of the rafter elevation (the "1/3 rule"). We also installed collar ties just below the ridge board on every other rafter-and-tie assembly to help hold each structural assembly together.

Jake Lewandowski is a construction manager with his family's business, Great Lakes Builders, based in Chicago.

Photos by Jake Lewandowski

Before. The structural problems of a small primary bedroom addition were immediately apparent to the author: The ridge sagged **(1)** and the bearing walls had been pushed out of plumb, causing the top plate to bow outward **(2)**. The cathedral ceiling had only widely spaced ties that were boxed-in to look massive but were more cosmetic than structural **(3)**.

The crew begins by demolishing the ceiling **(4)**. Next, they cut the roofing nails near the ridge board flush to the underside of the sheathing **(5)**. This allows them to install blocks on both sides of the ridge board to support shoring for lifting the ridge **(6)**. Note the laser installed just below the ridge; this will provide a reference line during the lifting.



To lift the ridge and pull in the outer walls, Toby raises the shoring **(7)** while tension is kept on a come-along attached to the top plates. Measuring near the top **(8)** and bottom **(9)** of the outer wall to a laser that was set up to provide a reference plane, the author checks progress on the outer walls during the lift. (Note: The wood frames are covered with a faux-brick paneling.)

Toby installs 2x6 sisters to the existing 2x4 rafters **(10)**. To optimize headroom, the engineer allowed the crew to cut a slight taper on the underside of the sisters from the point where the rafter ties intersect to the end near the wall plates **(11)**.

Toby fastens the rafter ties with structural screws **(12)**. Note the eye hook attached to the top plate of the wall to secure the come-along. On every other rafter assembly, the crew also installed 2x4 collar ties just below the ridge board **(13)**.

After. When the job was completed, the sag in the ridge **(14)** and the bow in the outer wall were vastly improved.

Installing a Precast Shower Floor

BY RICH BALLAND

Our company not only installs trim and cabinetry but also focuses on bathroom and kitchen remodels ranging from cosmetic changes to complete renovations. Over the course of 15 years, we have installed $15,000 showers with full tile surrounds, mud floors, and copper pans, as well as $1,500, three-piece acrylic tub units. In the same time frame, a lot of new products have come onto the market.

On a recent project, we used one of those products. Instead of going with a traditional acrylic- or mud-floor tile shower, the owner opted for a cast shower floor. We selected one produced by Castico and ordered it through Home Depot.

We had several reasons for choosing this base. For starters, Castico offers multiple beautiful finishes and colors, including for the drain lid, which is provided with the unit. Bases are available with a right-side, left-side, or center drain. There are two texture options, both of which provide a slip-resistant walkable area. Budget was important on this project, and so the traditional approach using a plumber's pan, mud floor, and tile install was cost prohibitive; the Castico shower floor eliminates not only certain materials but also some labor. The caveat is that the tolerances are tight for the area where it will be installed.

We started by demoing out the entire shower area down to the framework. Here's where it got involved: Installation of a cast shower floor requires the walls to be absolutely plumb and square. On a 100-year-old house, that can be a challenge. We removed a lot of existing framing and squared up the corners of the shower area by moving and adding new wall plates. From there, we plumbed up the walls with new framing material. Next came the subfloor. The existing floor had a sag of about 5/8 inch in the center. We could have added a self-leveler to the floor but we preferred to remove the existing subfloor and sister new floor joists to the existing ones to level the floor out completely. We then installed Georgia Pacific Denshield 4x8 boards, glued and fastened to the framing using 1 1/2-inch stainless steel screws. Denshield is a waterproof substrate for tile, but the seams still need waterproof mesh and thinset.

Once that was done, we created a template using 1/4-inch lauan and hot glue and transposed it to the shower floor. Using a handheld tile saw with a water spout, we cut the shower floor to size. Cutting it was a breeze; you just have to remember to take it slow and let the saw do the work.

With the floor base cut to size, we applied waterproofing flanges (provided by the manufacturer) to the edges of the base with screws (also provided). The directions provided by Castico offer two options for installing the shower floor: Use subfloor glue, or use thinset

Photos by Rich Balland

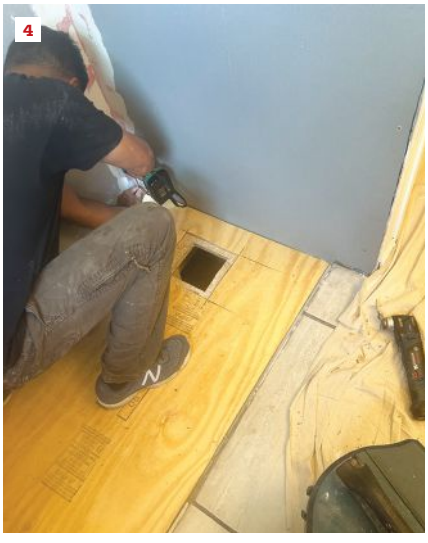
On a bathroom remodel, the author began with demolishing the existing shower **(1)**. To correct a sagging floor, he had to reframe it **(2)**. An out-of-plumb wall also needed to be reframed **(3)**.

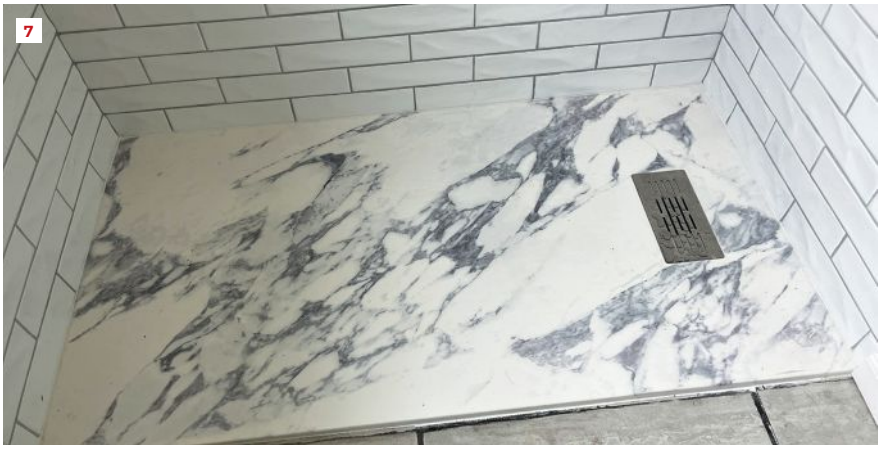
mortar. We chose thinset, feeling that option would provide total support to the base, and we opted for the flexible version to allow some separation between the Castico floor and the existing framing. We mixed up a batch, applying it directly to the subfloor. Next, we back-buttered the shower floor and carefully installed it. (It took two people.)

We gave it 24 hours to set before sealing the flange with a waterproof silicone. Again, we allowed that to cure for 24 hours before starting the tile. Deciding to allow that time to cure was our choice. The floor was installed after the waterproof substrate was installed—contrary to an acrylic shower base going in first and the substrate being applied to the walls after. That was per the manufacturer's directions. Tiling the walls was no different from usual, and once they were grouted, we applied a seal around the shower floor and the tile using a waterproof caulk.

Overall, we were impressed with the Castico shower floor. The unit cost about $650—well worth it, in my opinion. Compared with previous jobs of similar size and scope, it allowed us to save about $300 to $400 on labor and material. The installation of the shower floor did have a slight learning curve, but we will definitely use it again in the future.

Rich Balland owns Balland Construction based in Morgan, Ga. Follow him on Instagram at @ballandconstruction.





New floor sheathing and backerboard completes the rejuvenated shower area **(4)**. The new cultured-stone base was first cut to fit the new space **(5)** with a hand-held tile saw equipped with a water spout, and then set in thinset. The base requires flanges provided by the manufacturer (shown along the end and back edge). These are secured to the edge of the base with screws before the wall tile is installed **(6, 7)**.

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BY BRIAN ALTMANN

Using Feedback to Boost Your Bottom Line

In a previous article, "Becoming the Company Your Clients Want," (Jun/23), I discussed reasons that client feedback should be one of the most valuable resources for your company. That article outlined the urgency to build great value, especially during the sales process. We are constantly challenged to close the gap between the number that we must sell a project for and the number our clients want to pay—particularly now as costs continue to rise, and it becomes more and more expensive to be in the remodeling business.

Over the years, my company has managed to close that "price gap" through obtaining client feedback, taking the resulting data, and integrating it into every facet of our business operations. Simply put, properly incorporating feedback from our clients has led to improvements in our customer service. Better customer service has led to greater value, and greater value has increased our bottom line. In this article, I'll explain in more detail how to obtain feedback, how to process it, and how to use it to boost your bottom line.

Rules for obtaining feedback. I've been in the remodeling business for 37 years. I own and operate a design-build company with 23 full-time employees, running seven to 10 jobs at one time. We mostly do kitchen and bathroom remodels, finished basements, and additions. Our work volume affords us an ample database of client responses to draw from (particularly over the past 10 to 15 years as we have increasingly incorporated client feedback into our operations).

We have a few basic rules we follow when soliciting feedback from clients: Share why you want their feedback; be sincere when asking for it; write all their comments down; ask follow-up questions for clarity; and don't "yeah, but" the clients when they are giving their responses. We've trained ourselves to remember that the quality and accuracy of feedback from a client is only as good as the delivery of the question.

If you want clients to be honest with you, then you have to share why you want their feedback. You have to tell them what you're going to do with the information because that'll influence what they tell you. For instance, I'd ask, "I'd love to get some feedback from you because I'm trying to build a better company. I've been doing this for 37 years, but I don't have all the answers and I'm trying to get better." So, who better to ask than those we serve, right?

Then I'd say, "I just want to thank you again for allowing us to work with you. Are you willing to share with us three or four things that you would change if you were running this job? Are you willing to be my coach right now? I'd appreciate that. And, I promise you that I'm going to bring your comments up in our team meetings so we can learn from them." If you ask your clients like that, you'll likely get the truth from them. Also, by doing this, you're setting the table for repeat customers. Repeat work is 46% of our work, which roughly translates to $3 million dollars per year coming in from doing a great job for past clients. People like to work with people who care, who are truthful. Having soft skills and exhibiting emotional intelligence when dealing with clients matters.

"We've trained ourselves to remember that the quality and accuracy of feedback from a client is only as good as the delivery of the question. So, we need to ask great questions."

Be sincere when asking clients for their feedback. You have to know from your heart what you're looking for and not be perceived as just going through the motions. Be thoughtful, take notes, and thank them for their responses. Don't be afraid to ask follow-up questions for clarity. "You said the site wasn't neat and clean. Can I ask you, did you mean the whole job or was it just the subs? Was there dust in some other rooms? Could you elaborate? I just want to know a little bit more." And again, no yeah, buts! "Yeah, I remember the 'Fluffy' incident, but do you see those cabinets, they're dead-level, right?" Are you willing to go to the mat for the quality of your workmanship, while you let their declawed house cat out that one time, and you frequently parked your truck on their lawn? Some homeowners care way more about their pets and lawn than dead-level cabinets.

OPPORTUNITIES TO OBTAIN FEEDBACK

We try to attain feedback from our clients at every stage of a project—during lead qualifying, intro appointments, contract signing, weekly visits and calls, exit interviews, online reviews, and paper surveys (though I prefer attaining feedback via face-to-face meetings with clients rather than with mail-in surveys).

Intro appointments. When visiting somebody's home for the first time, we can get a lot of information. For example, when

visiting a homeowner who wants a kitchen remodel, we don't necessarily care about what kind of kitchen they want; first, we want to see if they're a good fit for our company, and second, we want to know what qualities they're looking for in a remodeler.

"You need to know what attracts people to your company; you can't assume it. You need the truth—why do clients hire you? I have at least three responses from everybody who has ever signed a contract with us over the last 15 years. I know why they hired us. I'm not guessing."

Instead of asking, "Hey, what do you want, maple cabinets? Do you want crown molding?," we say, "You're planning to invest a hundred thousand dollars in your kitchen; let's talk about this whole project. What kind of qualities are you looking for in a contractor?" More likely than not, they're going to think, "That's a weird question. Why would a contractor ask me that? That's not typical language from a contractor." But, it's going to be impressive, and they may think, "Maybe there is something here? They asked some pretty thoughtful questions. I could see them working on our home." This would be a great start for us.

We ask, "Have you remodeled before? If so, please describe that experience for us." If they have, the answer may unfortunately be something along the lines of, "Thank you for asking; our last remodeler made a mess and didn't show up on site consistently. We felt abandoned." A pithy response like this is loaded with good intel. It tells us how to take care of them if we get the privilege to work in their home, as well as coaches us on how to build a better business—cleanliness and fear of abandonment are top concerns with homeowners. So, when we're writing our job scope, we'll insert a pamphlet on the air scrubber-HEPA filter we use to point out that we care about cleanliness. Regarding abandonment, we tell them that we have a process, a lead carpenter system, which will ensure that won't happen. The lead carpenter is dedicated to their project and will provide great communication, oversee all trade partners, and keep the schedule on track. And be someone they can contact at any time if they have any questions or problems.

We also ask, "What's giving you the most anxiety while looking for a remodeler? You said you talked to five or six remodelers and you haven't pulled the trigger yet. What's holding you back? I know we have some scars in our industry, but don't lose faith, there are some great companies out there." And we tell them, "It's tough to buy a remodel. You can't see it. You can't test drive it. It's a leap of faith. It's probably the most money you're going to spend in your entire life, besides the purchase of your home. It's going to give you anxiety." If you could learn from everybody in your area what gives them anxiety about having you as a guest in their home and develop protocols to avoid these pitfalls, would that not make you a premiere remodeler?

"What criteria will you be using to make your decision on a remodeler?" Imagine if you asked that, and you already knew the criteria that are most important to people. They're giving you the keys to success. For some people it may be price, but we've always found there are few things above price. Cleanliness, fear of abandonment, and communication to name a few. If they select us, that's going to be the value they'll be getting; we have a reputation of keeping our jobsites impeccably clean and sticking with a project from start to finish … we've been taught well!

Contract signing. The contract signing is an excellent time to attain feedback. When a homeowner signs a contract, we say, "Mr. and Mrs. Jones, I want to thank you so much for taking this leap of faith with our company. You chose to have our company come and be a guest in your home, and thank you so much again for that trust. I know you talked to five other companies, and we were a little bit more expensive. Would you be willing to share with me maybe three reasons why we're being awarded the privilege to remodel your home? What was the motivating factor? Why DBS Remodel? They may say, "I've heard great things from my neighbor who said you guys were so clean, so friendly, so trustworthy."

You need to know what attracts people to your company; you can't assume it. You need the truth—why do clients hire you? I have at least three responses from everybody who has ever signed a contract with us over the last 15 years. I know why they hired us. I'm not guessing. As I stated in my previous article, we've used this feedback to morph into the company my clients wanted it to be rather than the company that I initially thought it would be.

So, at contract signings, don't lose out on the opportunity to learn what clients think about your company. Imagine how that would make them feel at that moment, being asked why they chose your company; wouldn't that make them feel good about you? And about their choice? Somebody who is being sincere and just wants to learn and make their company better.

Weekly visits. During weekly site visits, the first thing we're going to do is thank homeowners for giving us their business and allowing us to be a guest in their home. We ask, "How is the remodeling going at your residence so far? Are we meeting your expectations? Is there anything that you feel needs attention? Are you finding our team friendly?" We want to get a gauge on how things are going and right the ship, if necessary. We don't assume everything is going great; that's why we're asking the questions. It's not going to help us at all if they say, "Yeah, everything's good." We're not looking for praise, we're looking for their disappointment because that's where the money is—small incremental changes for the good.

Is the cleanliness up to par? Is there any area that needs improvement? Are you happy with the workmanship? You'd think that your workmanship is the most important thing, but I know from looking at 15 years of surveys that it is not. It's important and it can get you in trouble if it's not good, but it's not the most important thing to them. So, don't sell that you're the best kitchen

installer and that your workmanship is better than everyone else's. Homeowners care about friendliness. They care about trust. So, if you want to build value, and you want to get them coming your way in terms of closing the "price gap," emphasize other company traits and learn what those are by asking great questions.

Exit interviews. For us, the exit interview is the most important stage of the project to attain feedback. We get together with the homeowners one last time on site and bring them a gift. (We would never show up empty-handed; we consider gifts part of our marketing.) We thank them and lay it out to them again, why we want their feedback, why we want them to be our business coach. We ask them, "Can you please share three things you appreciated most regarding your remodeling experience? What was it that you enjoyed most about DBS Remodel? I promise you, I will share this with everyone involved with our team. We're going to try to make our company better using your remarks." They reply, "Honey, do you want to go first? OK, um, you guys were so clean and you didn't leave us hanging. We felt like we were in good hands." We just let them go through their experience and draw out more detail for clarity as needed, "When you said 'you guys were so clean', what do you mean? Do you have specifics?"

Then the hard part, we ask, "Can you please share three things that you appreciated least about this remodeling experience? What are some things that we could've done better? If you were running this company, what's the first thing you would change?" That's the way we ask, and the clients may be reticent at first, "I don't know. Honey, do you have anything?" You may have to work hard to get their feedback: "Please, we won't be offended, we know we're not perfect." We make it comfortable for them because we want to learn. "OK. You know one thing. We didn't know when your guys were coming one day, and the doors were locked, and it was a pain because my cousin had to leave work to let somebody in." We write it down and bring their responses, positive and negative, back to the office and evaluate them in our lead meetings. We then develop procedures to safeguard against these "least appreciated" items from recurring.

Last, we want to know how they feel about the money they've just spent. We ask, "Could you please share how you feel about the value you received for your investment in this project? I know on the front end, you thought this was a lot. Our budget was $85,000 and you were getting bids for $60,000. You took that leap of faith with us, but now that the project's done, and you've been living in it for a couple of weeks, how do you feel?" I want to always gauge this, learn how they feel about the project cost, and why they feel that way, so I can continue learning. I can't think of a finer response at the end of the job than for them to say it was worth investing more money because of our cleanliness, our politeness, and their trust in us.

WHAT DO WE DO WITH THIS FEEDBACK?

OK, so we've collected all this feedback from clients, what do we do with it? We compile a feedback data sheet in Excel that lists all of our clients; the job type (kitchen, bath, deck, etc.); the lead carpenter in charge of the job; the sales consultant; the contract date; the exit interview date; the "why hired" responses by client; the "most appreciated" responses; and the "least appreciated" responses. We've accumulated all this intel on how to build a better company over the past 10 to 15 years. It's living proof, and it's a front-and-center topic in our meetings. We've made (and continue to make) changes to every facet of our business operations based on everything we learned. So, if you're asking the right questions, your clients should be telling you how you're different. For us, this was pivotal; it taught us to "name our difference."

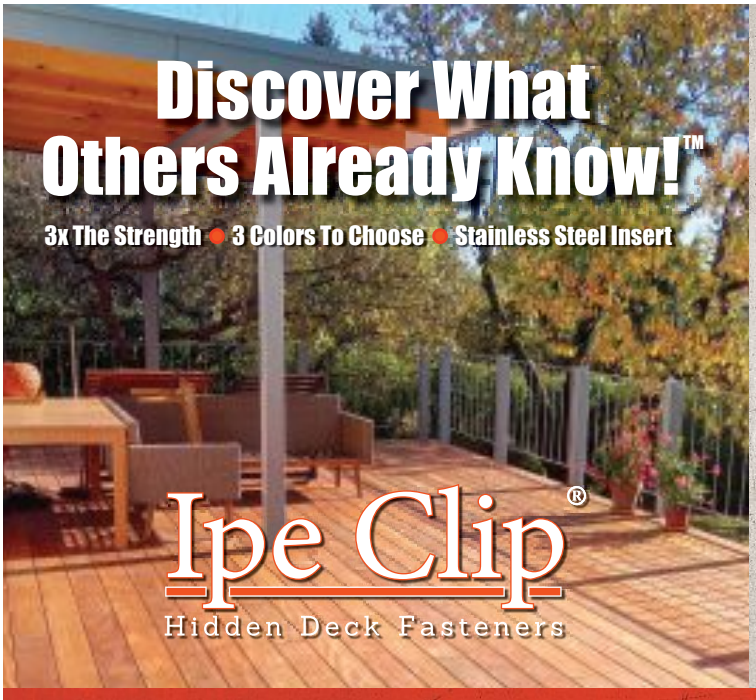
Finding your brand. "When cleanliness, politeness & trust matter" is our brand. It's on all of our trucks, on our website, our conference room wall, everywhere. Where did we come up with this? We looked at more than 2,000 surveys and said, "What's the common theme? How are we different?" We didn't come up with it as a slogan because we thought it would be cool. We looked at all these surveys and said, "Look, everybody cares about these qualities. That's who we are. That's our brand." We coined the phrase from client feedback; you can as well from your clients.

"When cleanliness, politeness & trust matter" is our brand ... We looked at more than 2,000 surveys and said, "What's the common theme? How are we different? Everybody cares about these qualities. That's who we are. That's our brand."

Other uses. We share positive feedback with our team to inspire them. For example, if we learn great things about a carpenter on a client's project, we immediately share the news about what a wonderful job they did. If you want to keep your employees, that's what you have to do. We celebrate all of these victories. But, sometimes it's the other way around—when an employee dropped the ball and we have to have a difficult conversation to teach them the error of their ways. Again, we develop procedures to safeguard against these "least appreciated" items from recurring. We don't let the negatives fester; we quickly address them and move on.

We use the feedback (both positive and negative) in our in-house training sessions and to strengthen our culture and reinforce our company's core values. It has allowed us to build tremendous value in our company. So, the gold-nugget takeaway here is that feedback leads to changes in customer service, improved customer service leads to greater value, and greater value is where you boost your bottom line. It's worked for us.

Brian Altmann, CAPS, is president of DBS Remodel, a design-build residential remodeling company based in Poughkeepsie, N.Y. He is also a private consultant for other remodeling companies related to business advice. You can reach him at brian@dbsremodel.com.



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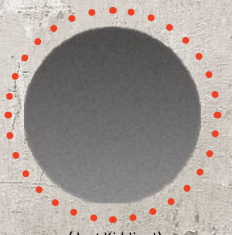

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Photos by Philip Armand

Deep Energy Retrofit
Part 3: Insulation and Thermal Decoupling

BY PHILIP ARMAND

As the Millennium Falcon is being chased by Imperial cruisers in *Star Wars Episode IV: A New Hope*, Han Solo declares, "We'll be safe enough when we make the jump to hyperspace."

"You're kidding, they're right there ... gaining!" Luke Skywalker protests.

Waiting for the ship computer to come up with coordinates, Solo explains to a frantic Skywalker, "Traveling through hyperspace ain't like dusting crops, boy! Without precise calculations we could fly right through a star or bounce too close to a supernova and that'd end your trip real quick, wouldn't it?"

Insulation has certainly jumped through hyperspace since I started in this business. Standard procedure in the 1990s—staple up some kraft-faced fluffy stuff and slap up drywall—is no longer in the playbook.

Here on Long Island where I work (climate zone 4A), we have hot, humid summers and cold, humid winters. Cooling degree days last nearly nine months with just over three months of heating degree days (measured as days above or below 65°F average temperature). Even at the most eastern point of the island, the lowest temperature rarely dips below 0°F. In the dead of winter, it's a polar bear's summer vacation. Humidity is always high, with a morning average of 70% and an afternoon average of 55%.

In this climate, overinsulating may yield no return on investment and possibly inhibit drying of building components. Allowing

The author generously dusted the compacted earth with diatomaceous earth to protect against insects, laid down a 10-mil vapor barrier, and topped it with 2-inch (R-8) Rockwool Comfortboard 110 **(1)**. A woven vapor barrier (not shown) was installed over the Comfortboard. A grid of horizontal strapping followed by vertical strapping was filled with Comfortboard 80 **(2)**. Canned foam was used to fill any small voids, reducing convection and slowing vapor movement within the assembly.

a wall assembly to remain vapor open in both directions is ideal here, though not always possible. When I see a client holding up swatches of vinyl wallpaper, large slabs of wall tile, or drawings of built-ins on exterior walls—"They're right there ... gaining!"—I know it's time for a targeted strategy. This is where the possibility of flying right through a star or bouncing too close to a supernova requires precise calculations.

UNDER-SLAB INSULATION

Let's begin at the bottom, below the slab. A sizable portion of heat is lost through an uninsulated slab. Until I removed and insulated below and around the slab on my 1950s cottage, I had consistent complaints from visitors that my house was cold; despite the warm interior air temperature, the radiant cooling effect of the floor induced an uncomfortable chill. On the 1977 hilltop renovation we've been following in this energy-retrofit series, three separate slabs needed to be vapor isolated and insulated.

In the main basement, about 800 square feet of concrete was removed and the ground compacted. A thin dusting of diatomaceous earth was cheap protection against termites that could chomp on the vapor barriers and insulation, followed by a 10-mil vapor barrier taped onto the walls, and overlaps taped with Stego Tape. The thermal control includes 2-inch XPS (all seams taped) topped by Insul-Tarp, an under-slab thermal and moisture-control blanket that has an insulation layer sandwiched between two layers of a woven Class A vapor barrier rated at .002 perms. We taped all the seams and the wall connections for a final R-value of around R-15. Once the slab was complete, we connected the under-slab barrier to the walls with closed-cell spray foam insulation at R-16.

In the mudroom and gym, we used a different strategy. This part of the home is 6 inches above grade and had tremendous termite and carpenter-ant damage. We generously dusted the compacted earth with diatomaceous earth to protect a 10-mil vapor barrier, taped at all edges and seams, and then laid down 2-inch Rockwool Comfortboard 110 at R-8. This ensures termites won't eat the insulation, and the added compressive strength (1,566 psf at 25% compression) is insurance for heavy gym equipment. The final layer is a 15-mil woven vapor barrier, all seams taped.

In the crawlspace, we painted the concrete walls and rat slab with Drylok Extreme (a liquid-applied, Class A vapor barrier that blocks up to 15 psi of water pressure). One layer of 2-inch Comfortboard 80 at R-8 was topped with CleanSpace, a 20-mil puncture-proof vapor barrier by Basement Systems. All seams were taped, and the barrier was taped onto the walls. Closed-cell spray foam at R-16 locks the vapor barrier to the walls, connecting the wall insulation to the floor insulation.

Why two vapor barriers? R-values change with temperature and humidity (R-values of insulation are measured in controlled environments; the parameters are often listed in product literature). Rockwool is quite stable; XPS, less so. A sub-insulation vapor barrier is cheap insurance to keep the insulation performing as optimally as possible. The mason on this project expressed that I was wasting time and money with the primary 10-mil vapor barrier, considering how dry the sandy soil seemed. The next morning, though, he was

Walls shared with the garage received one thermal break with horizontal strapping and one layer of Rockwool Comfortboard 80 **(3)**. In the attic above the mudroom and gym, the author created a 1-inch air gap below the roof sheathing with 1-inch XPS foam between the rafters, then applied 7 inches of closed-cell foam, for a combined R-value of around R-55 **(4)**. The foam was carried down the walls to create a cohesive insulation barrier.

amazed that puddles had formed under the plastic vapor barrier.

A vapor barrier and thermal break under a slab are fundamental parts of keeping the building envelope cohesive. After the first heating season, the client mentioned how evenly heated and comfortable those areas felt.

INTERIOR WALL INSULATION

My team spent considerable resources air-sealing prior to the insulation contractor arriving (see "Deep Energy Retrofit, Part 1," Mar/23). A standard insulation quote includes fire-caulking and basic air-sealing; however, we have a higher degree of impeccability than most insulation crews, and without the pressure of a big crew descending on the jobsite, we can closely inspect the project before everything is obscured. This allows the building inspector to easily inspect without removing batts; sometimes, the timing allows this to work out.

When possible, I work with the architect to upgrade header sizes or swap in engineered material, allowing an interior pocket for insulation. For this, we used Comfortboard 80 in 1 1/2-inch R-6 or 2-inch R-8. For the wall cavities, we used Rockwool Comfortbatt R-15 for 2x4 framing and R-23 for some areas that were upgraded to 2x6 framing. In the interior wall and floor assemblies, we used Rockwool Safe'n'Sound for sound deadening.

I am careful to strategize where I use spray foam. I always consider, "Can this assembly dry?" as I proceed. Having encountered rot and mold consistently throughout my career, I aim for assemblies that are able to release vapor in at least one direction.

INSULATION TOOLS

Spray-foam sealant gun. A pro gun allows you to buy the pro-sized cans and not worry about the product drying up by the end of the day. I recommend buying a stock of plastic gun tips; they protect the gun and allow easy access to small gaps and cracks. Foam-gun cleaner is available in the same format as the foam; keep the gun clean between uses, and it will last for several jobs.

Rubber gloves and eye protection. On two occasions—once when a spray-foam can exploded and once when cleaner shot onto my assistant's face—severe eye damage was averted by eye protection. In the case of the cleaner, the caustic material destroyed his plastic eyeglass lenses immediately. It was a good reminder to always proceed with caution.

Respirator. Rockwool and other fibrous insulation make a bit of a particulate cloud when being cut and installed. For spreading diatomaceous earth, a pro respirator is a must.

Insulation saw. You'll want a serrated knife that slices through Rockwool Comfortboard and Comfortbatt with ease. Basic versions are as simple as a bread knife.

INSULATION MATERIALS

Rockwool Comfortbatt. I prefer this over fiberglass because it will not absorb water, it's about three times more dense with a higher R-value per inch, and it has more recycled content. The high density makes installation simpler; it stays put once properly placed in a wall or ceiling cavity. I always choose the most dense and highest R-value option that fits into the wall or ceiling cavity.

Rockwool Comfortboard. It has the same characteristics as the Comfortbatt in a rigid board. Local inventory comes in 24-by-48-inch bundles; 48-by-72-inches and 48-by-96-inches can be ordered. Comfortboard comes in 1-, 1.25-, 1.5-, 2-, 2.5-, 3-, 4-, and 5-inch thicknesses. It's great for under slabs, in thin cavities like header pockets, and for exterior insulation. The most common is Comfortboard 80. The denser Comfortboard 110 is also available (often, lead times are longer for the 110 version).

Rockwool Safe'n'Sound. These mineral-wool batts offer interior sound and fire resistance. Batts come in 3- and 6-inch thicknesses. All open interior walls and ceilings were filled with one 3-inch layer for sound deadening.

Diatomaceous earth. Diatomaceous earth is made from the fossilized remains of tiny, aquatic organisms called diatoms; their skeletons are mostly silica. Spreading this is like spreading shards of glass for crawling insects. We buy large bags at farm and garden suppliers. Simply spread the product by hand, but use caution and wear a professional respirator.

Vapor barrier. Below the insulation, we use 10-mil poly sheeting. This works if you have sandy or clean soil; any rocks or hard granules may puncture a nonwoven barrier. The main barrier needs to be woven—rebar, mesh, and foot traffic may pierce a nonwoven product. Stego makes great products and its website has many options. We taped all seams using Stego Tape. For the crawlspace, we chose CleanSpace by Basement Systems, a 20-mil puncture-proof vapor barrier with an antimicrobial agent blended in to kill mold and bacteria.

XPS foam. We used a standard 2-inch XPS foam under the main basement slab due to supply and scheduling issues. My go-to option is Rockwool Comfortboard 110 or GPS foam board (graphite polystyrene). Halo has an excellent below-grade GPS foam called Subterra. Between the roof rafters, we used 1-inch Styrofoam by Dow at R-5.

Insul-Tarp. This lightweight thermal and Class A vapor barrier comes rolled like a giant blanket. It has an R-value of around R-6 and comes in four standard sizes: 6-by-25-, 12-by-25-, 6-by-50-, and 12-by-50-feet. Custom sizes can be special ordered.

DryLok Extreme. This Class A vapor barrier blocks up to 15 psi of water pressure. We coated all the interior masonry walls and the crawlspace slab prior to insulating, which is my standard practice to ensure solid, long-lasting adhesion of closed-cell spray foam.

Zip System R-Sheathing. The all-in-one moisture, air, and thermal structural panel has polyisocyanurate foam adhered to the Zip Sheathing. It's available in 4-foot-wide panels in 8-, 9-, and 10-foot lengths and in R-3, -6, -9, and -12.

Tremco Tuff-N-Dri and Warm-N-Dri. Tuff-N-Dri is a spray-applied, Class A basement waterproofing membrane. The Warm-N-Dri boards are set into the wet membrane, adding a drainage plane and an R-5 thermal break.

ROOF INSULATION

We moved insulation to the roof plane in the three attics, allowing mechanicals and ducting to remain inside the building envelope. We first created a 1-inch air gap below the roof sheathing using strips of plywood as spacers and 1-inch XPS foam between the rafters, sealing any gaps with canned foam. In the two attics above the second floor, I opted for 12 inches of open-cell foam, for a combined R-value of around R-50. Open-cell foam has one-quarter the density of closed-cell spray foam and is vapor open; in my climate, open cell needs to be used with caution. Leaving the air gap above this assembly permits some moisture to migrate through the open-cell foam into the vented space above. Moist air rises, so I expect the highest humidity level at the highest points. I designed this strategy around a dedicated dehumidification system that monitors and dehumidifies the air in the uppermost attics. ERV ventilation is always pulling and refreshing the attic air, as well.

I preferred to use open-cell foam in this application because it remains flexible and (arguably) is less toxic and better for the environment, as it uses a water blowing agent (instead of hydrofluorocarbon, or HFC). In the last few years, I have changed my strategy to

On the cathedral areas of the roof-ceiling assembly, the author added 2-inch strapping set perpendicular to the rafters and filled the voids with Rockwool 2-inch (R-8) Comfortboard 80 **(5)**. In the crawlspace **(6)**, one layer of 2-inch Comfortboard 80 was topped with CleanSpace, a 20-mil puncture-proof vapor barrier by Basement Systems. Closed-cell spray foam (R-16) locks the vapor barrier to the walls, connecting the wall insulation to the floor insulation.

using closed-cell insulation only where material movement is minimal, when vapor permeance isn't an issue, or when I have no other option to meet code requirements. In several instances, I've seen closed-cell foam separate from expanding and contracting framing components or delaminate because of water intrusion. I have also consulted with clients who have chemical sensitivities and suffer around closed-cell foam; even minimal off-gassing seemed to cause health issues. There is nuance to this topic, so I take it case by case.

In the attic above the mudroom and gym, we had less clearance; we again created a 1-inch air gap below the roof sheathing with 1-inch XPS foam between the rafters, then applied 7 inches of closed-cell foam for a combined R-value of around R-55. The foam was carried down the walls to create a cohesive insulation barrier. Within one year, we found two areas had delaminated from the framing, leaving voids. During routine maintenance, we check the attic insulation and repair any voids with canned foam.

We insulated the kitchen and rear-hall cathedral ceilings with Comfortbatt combined with the exterior Comfortboard insulation for a total of R-52. Allowing vapor to migrate through the assembly and into the vented over-roof above was the safest strategy for the high humidity potential of an active kitchen. This approach completely sound-isolated those areas; even heavy rain can't be heard on the interior.

EXTERIOR INSULATION

Much of the house was wrapped with two layers of Comfortboard 80. The original house settled, leaving walls as much as 3 inches out of plumb. We chose to install horizontal, then vertical strapping to straighten out the final sheathing and to break the thermal bridging potential of the structural framing. The front of the house receives the least amount of sunlight; there, we used 2-inch-thick strapping, allowing for two layers of 2-inch Comfortboard (R-8). The rest of the house received two layers of 1½-inch Comfortboard (R-6). In the areas that were extended or reframed, we used Zip System R-Sheathing at R-3.

Some areas—namely, the second-floor primary bath and hallway

The author moved insulation to the roof plane, allowing mechanicals and ducting to remain inside the building envelope. First, a 1-inch air gap below the roof sheathing was created using strips of plywood as spacers and 1-inch XPS foam between the rafters topped with 12 inches of open-cell foam, for a combined R-value of around R-50.

joining a laundry and two baths in a line—needed to remain vapor-open to the exterior. In the primary bath, we thickened the framing on the interior using 2x6s, increasing the R-value to R-23. The exterior WRB, Henry Blueskin VP100, has a perm rating of 33, allowing vapor to migrate through the wall assembly. For the hall laundry and baths, we did not have the interior space to increase wall thickness, so we covered the Henry Blueskin VP100 with 2-inch Comfortboard (R-8) then 2x3 framing and no sheathing, for a total of R-23.

On the cathedral areas, we added 2-inch strapping perpendicular to the rafters and filled the voids with 2-inch Comfortboard 80 (R-8). This left miniscule thermally bridged spots.

On the rear of the house, the foundation was extended for the kitchen. We took advantage of the equipment on site to excavate areas that required waterproofing. The foundation was coated with Tremco Tuff-N-Dri, and Warm-N-Dri boards were adhered into the wet membrane. This added a drainage plane and an R-5 thermal break below grade.

PRECISE CALCULATIONS

While we don't use fancy modeling software or overly complicated math, we do spend time strategizing what approach will yield the most reliable, effective, and long-lasting outcome. We read white papers and data sheets provided by product manufacturers and keep updated with new ideas in building science. The tweaks we make are rarely interfered with by building department officials, as long as we meet or exceed the code requirements.

Insulation contractors are never left alone on my jobsites. I explain myself as clearly as possible. I mark areas to be spray-foamed in brightly colored spray paint and mask off or protect critical areas in advance. Tipping the insulators prior to the work has increased care and compliance dramatically, and I point out or fix any over-compressed or missing insulation. The ideal is to have full insulation contact with the back of your wallboard.

If your head hurts, I understand; to most pros and homeowners, all this may seem extreme, so why bother? It isn't this or that hole, or that bit of over-compressed or missing insulation that will ruin a project. It is cumulative shortcomings that make for a mediocre outcome. My secret to impeccable outcomes is simple: Make everything just a little bit better than standard practice. Improve each task by 15% (I know, this is hard to quantify, but let's play with 15%), then the final product is noticeably better than standard-issue. All these extra steps cost time and money and may seem erroneous, slow, and expensive; working with a client who is well informed and has the same intention as I do is critical.

Shortly after moving in, my client received an energy audit from his power supplier. His energy usage was the lowest of comparable homes in the area.

We know what happened to Luke Skywalker and his rag-tag cohorts. They managed to jump to hyperspace and eventually beat the Imperial empire. It wasn't easy, or direct, or without loss, and the Empire does strike back. But they worked with what they had and prevailed. May the deep energy retrofit be with you.

Philip Armand is a craftsman, designer, and general contractor serving eastern Long Island, N.Y.

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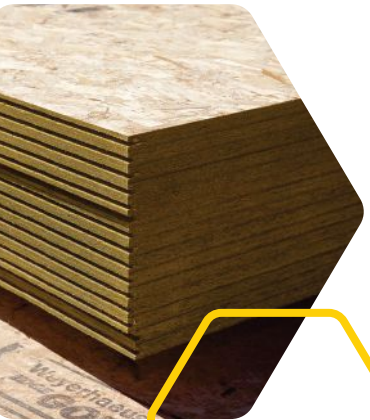

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Practical Ventilation for a Warm, Humid Climate

Lessons learned from building in a coastal region

BY THOMAS DUGAN

Soon after building my first hurricane- and disaster-resistant home in coastal North Carolina in 2010, I realized that making the house structurally able to withstand storm conditions had also improved its building performance. Tightening up the house to prevent water intrusion, using better windows to seal out wind-driven water, and using closed-cell spray foam under the roof deck to seal it and increase resistance to uplift forces from high winds had all contributed to the house being more energy efficient. This made me eager to learn more about building science and provide my homes with better HVAC installations.

I became particularly interested in air infiltration/exfiltration issues and how tightening up the exterior envelope may affect indoor air quality (IAQ). For the homes that I built over the following years, I explored various techniques and technologies as they became available.

This article is a summary of what I've learned, along with a case study detailing specific practices and equipment I've used to improve energy efficiency and IAQ in the homes I've built in my humid coastal environment. My hope is to help both the general contractor and the client make better decisions about the efficiency, comfort, and costs that factor into the structural design as well as the design of the HVAC system.

Photos by Thomas Dugan

REQUIRED VENTILATION RATES

For a stand-alone, continuous whole-house ventilation system, the 2012/2015/2018/2021 International Residential Code offers two methods to determine the required airflow in cubic feet per minute (cfm):

Prescriptive table. The simplest way to determine the baseline airflow rate is to use the prescriptive table (below).

Calculation. Another method is to calculate the required airflow using the following equation:

Ventilation rate in cfm = [floor area / 100] + [(number of bedrooms + 1) x 7.5]

MINIMUM CONTINUOUS WHOLE-HOUSE VENTILATION (CFM)

Floor Area (sq ft)	Number of Bedrooms				
	0 to 1	2 to 3	4 to 5	6 to 7	> 7
< 1,500	30	45	60	75	90
1,501 to 3,000	45	60	75	90	105
3,001 to 4,500	60	75	90	105	120
4,501 to 6,000	75	90	105	120	135
6,001 to 7,500	90	105	120	135	150
> 7,500	105	120	135	150	165

Table M1507.3.3(1) of the International Mechanical Code.

The ventilation rates derived using either the equation or the table are specific to continuously running ventilation systems. The IRC does allow whole-house ventilation systems to operate intermittently, provided the ventilation rates from either the equation or the table are increased by a "rate factor" defined in Table M1507.3.3(2). However, continuous ventilation will offer the best performance for both the building and the health of the occupants.

Keep in mind that these are minimum rates. You can provide more, although this is a topic of great debate: The more conditioned air you exhaust from the building, the more energy you use to condition that air. The latest ASHRAE 62.2 (2013 and later) provides guidance for a higher ventilation rate. It has yet to be widely adopted but may make sense for homes equipped with energy recovery ventilation, which reduces the energy penalty associated with exhausting conditioned air.

EXAMPLE VENTILATION RATES

Method	cfm	cfm/person	ACH
IRC	60	15	0.13
ASHRAE 62.2	120	30	0.27

This table compares the IRC requirements—based on ASHRAE-2010—and ASHRAE 62.2-2013 for a 3,000-square-foot, three-bedroom house with a 9-foot ceiling height.

WHOLE-HOUSE VENTILATION

Prior to the introduction of air conditioning in the early 1950s, fresh, outside air entered coastal homes through double-hung windows that created some airflow when the top sash was dropped down and the bottom sash raised up. Many homes also had operable transom windows above exterior doors to move hot air that had risen into their 12-foot ceilings, which were designed for that purpose. Moisture control was not a consideration as there was little that could be done about it.

The widespread adoption of air conditioning and the building boom for WWII veterans needing homes changed all that. Transom windows went away as 12-foot ceilings became 8-foot ceilings, and whole-house air conditioning allowed homes to be completely closed up yet still be comfortable. But the perception that houses needed to "breathe"—either through open windows or through inadvertent openings in the building envelope—in order to provide fresh air to its occupants and allow stale, moist air to escape into the outside atmosphere persisted in building practices for several decades, primarily to encourage drying.

A typical home built during this period relied on air pressure differentials from a simple breeze to push air in (infiltration) and negative pressure on the opposite side of the house to pull air out (exfiltration). Air was simply passing through. As it turns out, this kind of uncontrolled ventilation is not good practice, especially in a hot, humid climate. Fresh air can introduce not only humidity but also pollen, carbon monoxide from a garage, and other contaminants. And as energy costs rise and energy efficiency becomes more important, losing conditioned air becomes more and more costly.

Dew point. Of course, as hot, moist outside air is drawn inside and comes into contact with cool, conditioned air, the moisture in the air can condense and change to liquid form, making whatever surfaces are close by wet. The most common dew point temperature (at which condensation occurs) in our area on an 85°F to 90°F day with normal relative humidity is around 74°F. Meanwhile, the most common temperature setting for air conditioning systems is 72°F to 74°F. These conditions can lead to moisture problems and black mold.

To avoid uncontrolled ventilation, building scientists have told us to build tighter building envelopes and use blower door testing to

find and fix air leaks. This is what led to my interest in the topics of controlled mechanical ventilation and dehumidification.

Mechanical ventilation. In northern climates where humidity and air conditioning do not typically pose problems, some building codes allow for the use of an exhaust fan, such as in a bathroom, running continuously to slightly depressurize the house. As a result, air infiltration becomes a source of fresh air, diluting the existing air inside the building. But bringing in fresh air this way to dilute the existing air is like adding a couple of drops of food coloring to a bucket of water. You can stir it around, but you will never completely change the color to what was added.

In small, confined spaces, like bathrooms, where the moist or smelly air is exhausted out of the house by a fan and replaced with air from the main house, the fan has to run for a length of time to pull air in from under the door. A range hood is another example. As it exhausts air with cooking contaminants, that air is replaced by air from other parts of the house. In both cases, uncontrolled air infiltration—air leaking through the cracks and openings in the building envelope—is typically the source of that replacement air, which is not a good thing. A better option is to provide an inlet—such as a vent through the wall—near the exhaust so that the exhaust air is replenished with fresh air.

In my area, fresh air is often provided for by simply running a duct from a soffit outside to the return air supply on the HVAC air handler. This approach is certainly better than doing nothing but addresses only part of the problem. It is effective for diluting poor indoor air only when the HVAC air handler is running (so not in spring and fall shoulder months) and does nothing about removing contaminants year-round or addressing concentrations of contaminants.

A well-designed whole-house ventilation system should provide a controlled path for needed fresh air. We want to control where, when, and how that air enters the building envelope. It will need to be filtered and conditioned to match the indoor temperature and humidity level as close as is reasonable.

Ventilation rate. Currently, the IRC requires at least 1 cfm of fresh air for each 100 square feet of conditioned floor area, plus 7.5 cfm per person (see "Required Ventilation Rates," opposite page). For a 3,000-square-foot house with three bedrooms and a 9-foot ceiling height, this would be 0.13 ACH50. This is good general guidance but isn't always effective for all the various conditions found in specific buildings. Without accurate measurements in any given building, this can be both wasteful and insufficient. This is why I recommend including an air-quality measurement device in any HVAC system design.

The simplest way to remove contaminants such as CO_2, VOCs, and particulates from a home is to remove the bad air and replace it with better air. However, there is no practical way to completely remove and replace the conditioned air within a building all at once. Bringing in fresh outdoor air introduces measured amounts of air and mixes it with existing stale air. To what degree we want to dilute the indoor air is based upon how many cubic feet per minute of new air we can bring in and our ability to remove that same volume from the building. The farther the input air opening is from the removal opening, the better the dilution.

Makeup air. It is best to remove pollutants as close to the source as physically possible to prevent them from dispersing into the air in the rest of the house. The most common concentrated source of pollutants is the cooktop or stove, which is typically equipped with a hood that has a blower; the hood captures some portion of the moisture and contaminants, and the blower exhausts them to the exterior before they can disperse into other areas of the home. A range hood's blower can be quite powerful, up to 1,000 cfm or more, which can overpower most general ventilation systems and create a negative pressure differential in the house, something we never want to happen where naturally drafted combustion appliances, such as a furnace or water heater, are present.

The best solution is to provide makeup air as close as possible to source of contaminants to replenish the contaminant-laden air exhausted from the hood with fresh air. In homes with naturally drafted combustion appliances, building codes mandate that a demand-driven makeup air system consisting of a fresh air inlet near the exhaust must be included in the system design for any exhaust fan rated 400 cfm or more.

DEHUMIDIFICATION

While IAQ is important to inhabitants, excess humidity is a structure's enemy. Along with being uncomfortable, it can condense into its liquid state almost anywhere the air is cooled below the dew point. Black mold loves to find moisture in dark, remote places where it can thrive undetected.

Up-sizing the HVAC air handler can help by increasing the air volume passing through the coils while dropping the air velocity. Some air handlers have a setting for dehumidification that slows the airflow, allowing more time for condensation to occur on the coils. It will drop the coil temperature a few degrees as well. This water is then collected and drained to the outside. While this helps in most situations, it is usually limited to a 3°F drop in temperature as a greater drop may make the inside air feel moist and clammy.

This is where a dedicated dehumidifier can help. It will kick in to help the air conditioning system when it is needed during peak summer months. Dropping the relative humidity to 45% to 50% often makes it possible for inhabitants to set the thermostat several degrees higher and still feel comfortable.

In addition, in our area, there are several months during the year when the HVAC system seldom runs for either air conditioning or heating. The swing, or shoulder, months in spring and fall are when a dedicated dehumidifier that can maintain 45% to 50% relative humidity is most important. And sometimes, it will kick on during rainy winter weather, even with the heat on.

Balancing return airflow. An air handler can deliver only the amount of air it can pull in from the return trunks. Returns that are restricted or undersized put a load on the blower fan that reduces the amount of air that is put out to the supported spaces. Depending upon the layout of the rooms, more than one return trunk may be required. This is where system design comes into play, and it is

Built with concrete panels, this wind-resistant North Carolina house measured less than 1 air change per hour in blower door testing **(1)**. To bring the attic and HVAC system within the home's conditioned space, the author specced closed-cell foam insulation to be sprayed on the underside of the roof system **(2)**. Here the ductwork has been installed, and the electrical has been roughed in **(3)**.

important that the HVAC designer understands the requirements: Will there be multiple zones? Is controlling humidity an issue? Does the system need to be really quiet?

The preferred solution is to provide return air ducts sized to handle the necessary flow. Additional return ducts can require some changes to the framing of the building along with some additional cost for the system, but the improved performance of the system and comfort to inhabitants will make it worthwhile. The goal is to limit both positive and negative air pressures within the whole house envelope, though being slightly positive—with the help of a mechanical makeup air device, for example—is preferred.

Tightening up a house reduces the number of places air gets in, but wind against a building will always cause some infiltration on one side and exfiltration on the other. We can't guarantee a house will never have negative pressure, but we can recognize what causes it and mitigate what we can with makeup air techniques.

CASE STUDY

Here is an example of a house that I built in 2020 that addresses these issues using some of the techniques and technologies that I have found effective in my hot, humid climate. Located in Southport, N.C., it is a single-story home built with Superior Walls concrete panels, with 2,260 square feet of habitable space, and rated for winds up to a low Category 5 hurricane. In a blower door test, it measured less than 1 ACH50, which included the conditioned attic space along with the habitable space **(1)**.

Before the ductwork was installed or any other trades went in, the spray-foam subs started with a completely empty building shell. All that stood were the exterior walls and the roof system, which resulted in a uniform foam application with no overspray on the ductwork **(2)**. Along the top of the walls, we used a gray mastic to seal the double top plates to the concrete panels. The foam insulation, concrete walls, and mastic are the keys to achieving blower door test results that are less than 1 ACH50.

We always include the crawlspace and attic within the air-sealed building envelope. This allows us to locate various components such as HVAC equipment and ducting in these conditioned spaces for better efficiency **(3)**. Also, when makeup air is introduced into the building, these spaces can be helpful in blending and conditioning outside air prior to it being introduced into the living spaces. Conditioned air is also ducted into these spaces, as shown here.

An additional benefit is that the owner gains a great deal of safe storage space. You may notice the OSB curbing around the perimeter of the walkable areas to prevent stored objects from falling onto the ceiling below **(4)**.

Dehumidifier installation. Shown in the sidebar "Whole-House Dehumidification Study" (see opposite page) are three options for installation of a "DHU" (dedicated dehumidifier), from a research study

WHOLE-HOUSE DEHUMIDIFICATION STUDY

In 2018, the Florida Solar Energy Center (FSEC) set out to answer some basic questions about ducted dehumidification systems, including:

- Does ducting a dehumidifer unit (DHU) though a central cooling system diminish the performance of the cooling system or the dehumidifier?
- Is it better to run a stand-alone dehumidifier that runs independently from the cooling system, so the DHU pulls air from and delivers dehumidified air to the living space?
- Does the location of the DHU and DHU ductwork affect heat loss or heat gain in the conditioned areas of the home?

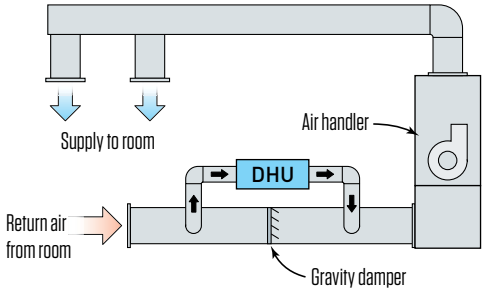
Three systems tested. To answer those questions, the FSEC studied three configurations:

1. A DHU ducted from and to the central cooling system's air return.
2. A DHU ducted from and to the central cooling system's air supply.
3. A stand-alone DHU ducted directly from and to the living space.

Results. Findings and recommendations of FSEC include:

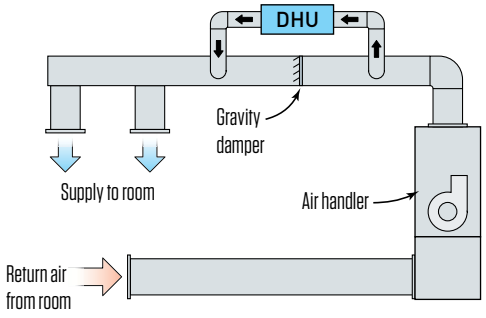
- Pulling air from the return side of the cooling system and dumping dehumidified air back into the return upstream of the cooling coil is the worst-performing scenario. In fact, FSEC advised it should not be permitted by code. Even if you use a gravity damper to prevent short-circuiting the DHU, there is an enormous energy penalty to the central cooling system. In essence, if the dehumidifier runs after the air conditioning turns off, you'll have to run the air-handler fan to move the dry air into your home. As the fan moves that air across the wet cooling coil, moisture evaporates back into the airstream, degrading the performance of the system.
- Pulling air for the DHU from the supply side of the cooling system and dumping it back into the supply resulted in the most efficient dehumidification, since you're pulling cooler air, which is already drier than house air, into the DHU. The conditioned (cooled) air also tempers the dehumidified air. However, this configuration is more complex because you need to wire the system so the air handler runs when the DHU runs, and dampers need to be installed to prevent backflow into the DHU.
- The independently ducted system provides optimal performance, and FSEC proposed this as the "base case" for the performance path of the energy code.

DHU Ducted From/To Return Side



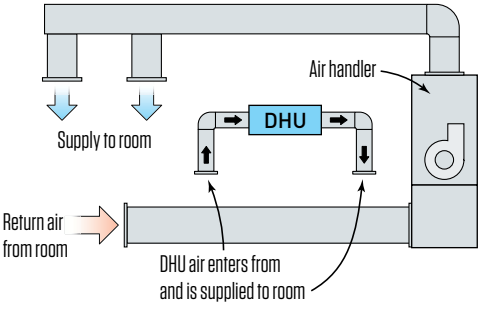
A DHU that pulls air from and delivers drier air back to a central cooling system's return is the least effective, according to the FSEC study.

DHU Ducted From/To Supply Side



Pulling air from and delivering it back to the supply side is marginally better, but you still have higher static pressures from the two different blowers.

Stand-Alone: DHU Air Ducted Directly From/To Living Space



An independently ducted DHU proves the simplest and most effective since you have only one blower influencing the air pressure in the ductwork.

Illustrations by Tim Healey

The supply duct in the attic allows new air to be mixed with conditioned attic air before being drawn into the living space. The OSB around the perimeter of the walkable attic area prevents stored items from falling onto the ceiling below **(4)**. The Air King QFAMD makeup air unit brings outside air directly into the attic buffer space via a 6-inch-diameter flex line from a grille in the front porch ceiling. There is a replaceable filter in the unit, but it seldom gets dirty. Power usage is only 26 watts **(5)**. Also installed in the attic is an Aprilaire E070 dehumidifier, shown here with an open duct that draws in attic air for dehumidification. The unit's condensation line is connected to the home's DWV plumbing **(6)**. Here, the author is shown adjusting the relative humidity setting to his preferred setting of 45% **(7)**.

by the Florida Solar Energy Center. One option is to duct the DHU from and to the central cooling system's air return. The second is to duct the DHU to the main central supply duct, and the third is to provide a stand-alone DHU ducted directly from and to the living space.

Running dehumidified air through the air handler works fine but has some downsides due to possible additional static load on the handler and recycling moisture back into the living space from coils in the handler. The key is that the dehumidifier should be able to run without running the air handler. If you have the space for a separate supply and return, I prefer the third option.

To provide a metered supply of fresh outside air for overall air quality in the house, I installed a QFAMD makeup air unit, made by Air King, which brings outside air directly into the attic buffer space through a 6-inch-diameter flex line from a grille in the front porch ceiling. The unit has a replaceable filter, but it seldom gets dirty. The new air is mixed with attic-space air so it can be conditioned before entering the living space. Power usage is only 26 watts **(5)**.

This unit allows me to select how many cfm I want, up to

To fine-tune the operation of the home's ventilation system, the author uses an Awair Element indoor air quality monitor **(8)**. Sensor data can be viewed on the device and shared wirelessly through the free Awair app, which allows the user to track the metrics over time **(9)**. The unit can track temperature, humidity, CO_2 levels, total VOCs, and particulates **(10)**.

130 cfm. It also allows me to select temperature range and humidity range. We want to avoid bringing in 95°F, heavily saturated air.

This new air is mixed with the already conditioned air before being brought into the living spaces. Reducing the cfm to 60 to 100 puts it well within a range that a 1 ACH50 house can handle using moderate exfiltration. Also if possible, I prefer to have the house slightly positive to reduce air infiltration from other sources. At this low level of air being brought in, I feel that an ERV is unnecessary for this environment.

The Aprilaire 70-pint dedicated dehumidifier that we installed can handle homes of up to 2,800 square feet **(6)**. It has its own filter, but with the return duct being placed high in a 14-foot wall in the common area space, it can go a long time before cleaning. The panel on the front is for setting the desired relative humidity **(7)**. I always select 45%, as that is supposed to be best for limiting viruses. The unit has a condensation line that goes into the plumbing waste pipe using its own trap. The open duct pipe shown in front of the unit is for drawing in attic air to be dehumidified along with the return air from the living space below.

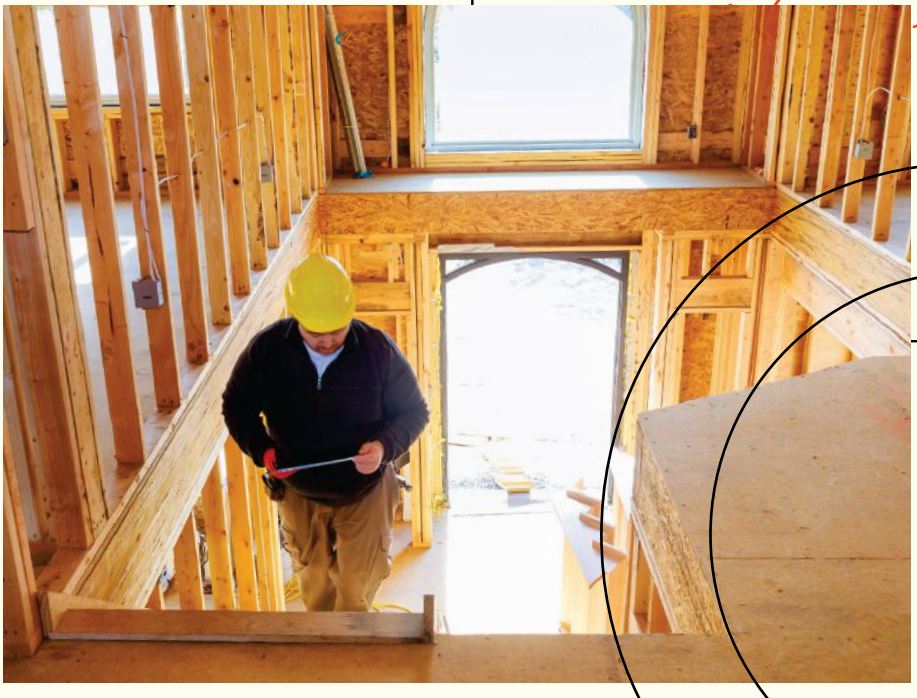
Note that the makeup air introduced by the QFAMD unit is part of the air being dehumidified. The Aprilaire and the QFAMD are spaced as far apart as reasonable to provide air volume for the makeup air to be mixed in with the air from the living space. Like the QFAMD, this unit uses only 26 watts maximum, which is the equivalent of two LED light bulbs.

There are many recommendations as to how much fresh air should be brought into a house to provide a healthy environment. Rather than picking makeup air numbers from various sources, I combine mechanical makeup air with a measurement device that monitors the IAQ. The Awair Element air quality monitor **(8)** maintains a continuous readout that is displayed on the monitor, as well as a Wi-Fi connection to an app on a cellphone. The app gives you a total quality score and specific numbers for each category, along with graphs, historical data, and export capability **(9, 10)**. Using these scores, we can "tune" the house as needed by raising the cfm setting on the QFAMD makeup air unit. We can also make changes to the dehumidifier setting to maintain the RH percentage. As a builder who is using closed-cell spray foam under all roof decks, I am sensitive to owners' concerns regarding chemical off-gassing. As such, I include an Awair unit in every home.

The ability to collect and track this data and manually adjust the volume of air being brought in by the QFAMD allows the home to be fine-tuned to fit the air quality needs of its occupants. One or two people living in the home may not need a lot of makeup air, so the cfm setting could be quite low for daily living. If visiting family members increase the number of occupants, the cfm setting can be increased to accommodate them.

Thomas Dugan is a retired general contractor in coastal North Carolina who specialized in building hurricane-resistant homes.

JLC



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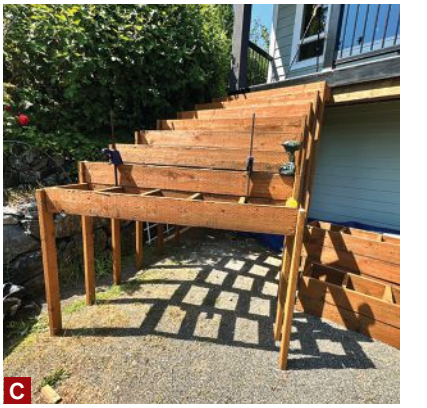
Box-Framed Curved Deck Stairs

by Jason Russell


A


B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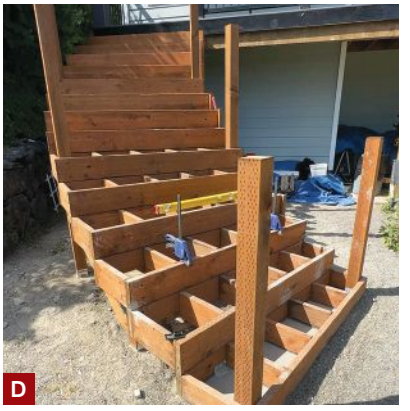
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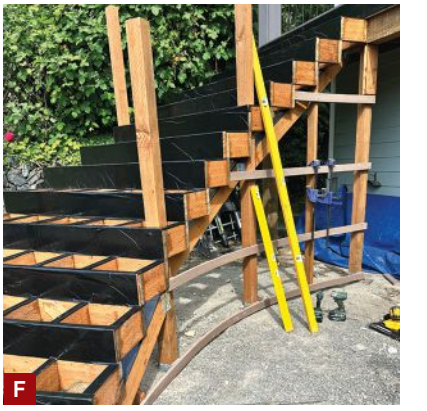

F

PHOTOS BY JASON RUSSELL

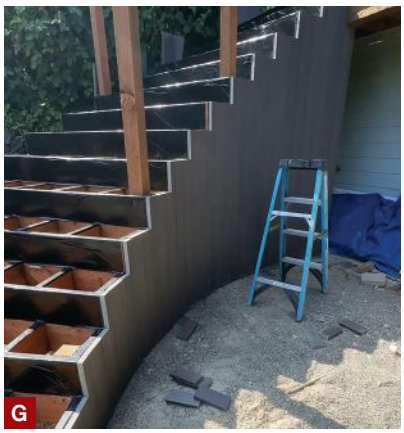
A fun and challenging project that I've been working on lately is a new elevated deck, which features the set of curved stairs shown here. Instead of framing the stairs with cut stringers, I built a series of tapered boxes out of incised pressure-treated hemlock, standard exterior framing lumber here on the West Coast. The boxes are all 6 feet long and taper 5 1/2 inches in width from one side to other. Stacked on top of each other, the boxes form the framework for the stair's treads and risers **(A)**.

Tread boxes. I started framing the stairs from the top and worked my way down, one box at a time **(B)**. At this stage of the project, I was working solo, so I supported the cumbersome boxes on stepladders as I roughed in the stairs, screwing the first box to the deck framing, and subsequent boxes to each other. After each box was in place, I screwed a pair of temporary 2x4 support posts to either side that extended all the way to the ground **(C)**.

I waited to pour the concrete landing pad until all of the tread boxes had been installed, and I knew exactly where the pad should be located. To compact the mix and remove air bubbles, I used a concrete vibrator before applying a smooth finish to the surface, then waited three days before installing Simpson Strong-Tie ML24Z angle brackets to fasten the tread box to the pad. I added a 1/2-inch-thick PVC shim to the base of the tread box so that it wouldn't wick moisture, then fastened the angle brackets through the PVC and into the concrete pad with SST Titen HD screw anchors **(D)**.

Support. The pair of guard posts at the bottom of the stairs were fastened to the tread box with structural screws reinforced with blocking. All of the stair's intermediate 4x4 guard posts were installed on metal post bases bolted to concrete footings, which I located and poured after the stairs were framed.

Between those posts, I installed 4x6 beams to support the tread boxes, first cutting them to length and fastening them to the posts with structural screws, then installing SST LS50 skewable brackets to reinforce the post-to-beam connections.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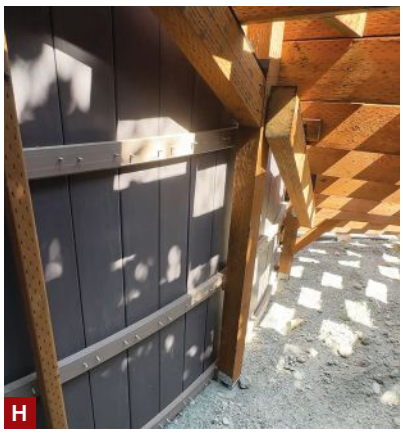
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I


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K


L

Then I locked each box to the beam with 4-inch FastenMaster TimberLok screws and flashed the tops of the beams with self-adhering flashing tape **(E)**.

Along the inside radius of the stairs in the center sections, I had to set the beams inside the posts instead of between them. Otherwise, the beams would have stuck out too far and disrupted the skirting detail. While the lowest beam section fit between the posts, I had to notch out the skirt rail to fit around the beam and bracket. The cuts for all the beams that support the tread boxes were complex, so I started with a template to find the angles for the cuts and help me find the finish lengths for the beams.

Skirting. I used a Stabila LAX 600 G multi-line laser to identify elevations on the reverse curve for the skirting framing, then used them for reference when bending in the horizontal rails that support the skirting **(F)**. I used TimberTech deck boards for the skirt rails, shimming them as needed to match the plane of the tread boxes and adding an extra vertical post for additional support **(G)**. Then I installed TimberTech dark hickory decking as the skirting, covering both the inside and outside faces of the stairs but not the back so that I would have access to install the riser lights **(H)**.

I was able to cold-bend the fascia boards in place **(I)**. While the inside fascia measured less than 20 feet and thus could be done with a single board, the outside fascia measured more than 20 feet and required a splice joint. This reflects the unequal pitch of the inside—33 degrees—and outside—26 degrees—stringers, which had to be accounted for when fabricating the railing.

Treads. Neither the left nor the right sides of the 6-foot-wide treads are square, but had to be custom cut to different angles to fit the curved fascia. I used a cutoff as a template to make the cut on one end, then find the length and mark the cut on the other end. After installing the two full-width treads, I used a track saw to cut the inner pie-shaped tread.

Before installing the first tread, I had to install the riser first in order to have access to the back of the riser for wiring the riser light.

Railings. Finally, I enlisted the homeowner's help to fabricate the custom-curved TimberTech Radiance railings. I heated the rails with heat blankets, then clamped them to a form that I had set up on a work table that matched the curve of each section of stair **(J)**. After checking the individual rails for fit **(K)**, I assembled the balustrade for each section and installed the railing as a unit **(L)**. ❖

Jason Russell owns Dr. Decks (drdecks.com), in Tacoma, Wash. Follow him on Instagram and on YouTube at @drdecks.

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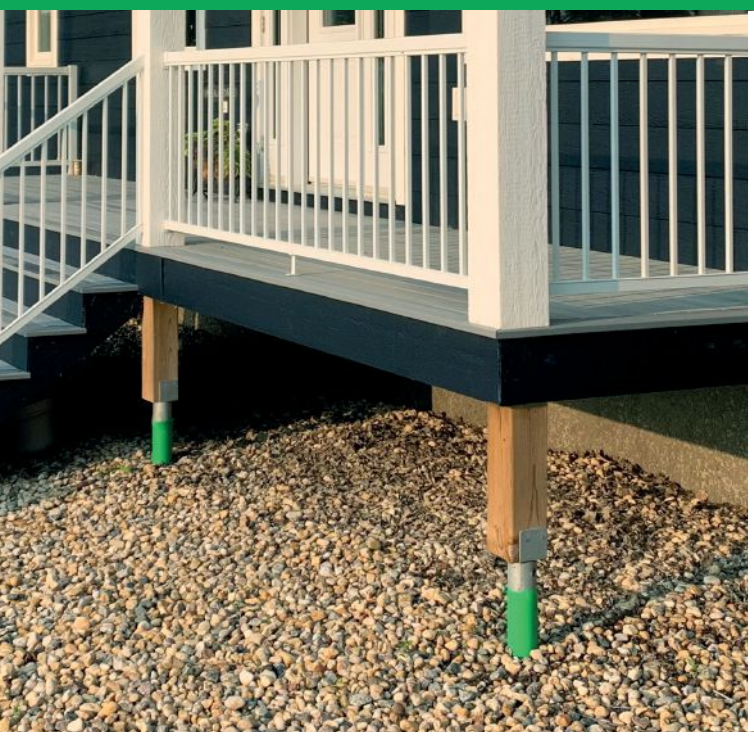

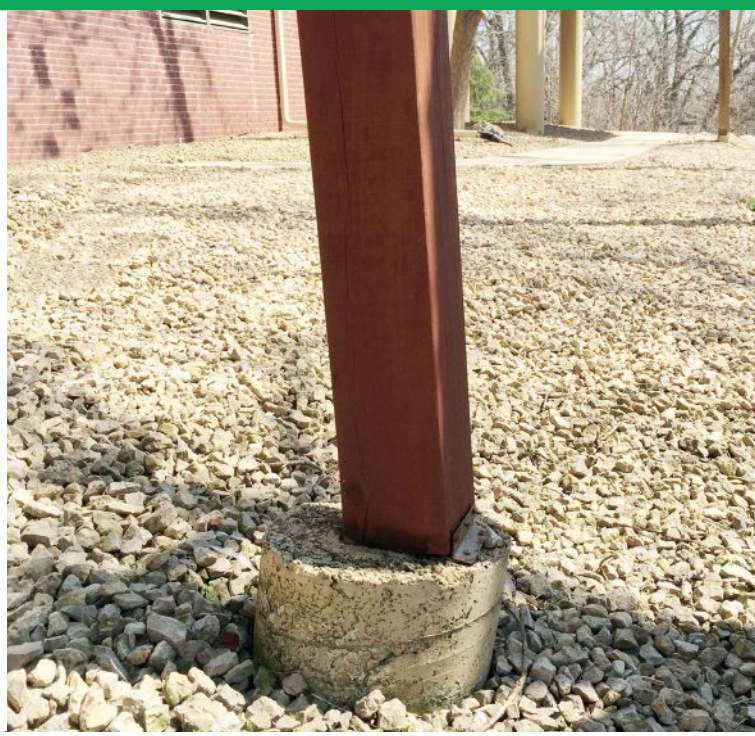

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Right-Sizing Deck Beams

New code tables and adjustments for cantilevered joists dial in beam spans

by Mike Guertin

If you're using the beam sizing tables in older versions of the International Residential Code (IRC), you're probably oversizing your deck beams. In this article, I'll focus on how to read the new maximum deck beam span tables in the 2021 IRC, and explain how to use the code's new "joist span factors" table to determine the "effective deck joist span length" so you can get the greatest span out of a beam (don't worry, it'll all make sense shortly). I'll refer to my previous article, "Right-Size Your Deck Joists" (*JLC*, Mar/23), which contains information about measuring joist span. That article also explains the differences between dead, live, and snow loads, which are the different loads the code tables are adapted for.

A Work in Progress

The 2015 IRC simplified sizing deck beams with the introduction of Table R507.6 "Deck Beam Span Length." That table presented the maximum spans for a series of multi-ply, built-up-dimensional-lumber beams from a double 2x6 through a triple 2x12, with beam spans based on the span of the deck joists from the ledger to the beam. Joist span is a proxy for the tributary area of deck that is supported by a beam and—in turn—the load on the beam.

In the 2018 edition of the IRC, more beam options were added to the southern pine species group: single-ply 2x6, 2x8, 2x10, and 2x12 beams. While most deck builders don't think of a single two-by as a "beam," singles can indeed act as beams and may be a good option, especially for small decks and landings (see "Single-Ply Beam Solution," jlconline.com, February 11, 2019).

Limitations. One of the problems with the 2015 and 2018 IRC beam tables is that they can be applied only to decks with up to 10-psf dead loads and 40-psf live loads. Anyone building decks in areas with a snow load greater than 40 psf can't use the tables to accurately size beams.

Navigating the Maximum Deck Beam Span Table in the 2021 IRC

Maximum beam span lengths are controlled by three factors: species of wood; size of beam (depth and number of plies); and span of deck joists

Span tables for decks with live loads greater than 40 psf (tables R507.5(2) for 50 psf, R507.5(3) for 60 psf, and R507.5(4) for 70 psf snow loads) not shown in this article

TABLE R507.5(1)
MAXIMUM DECK BEAM SPAN—40 PSF LIVE LOAD[c]

BEAM SPECIES[d]	BEAM SIZE[e]	EFFECTIVE DECK JOIST SPAN LENGTH[a, i, j] (feet)						
		6	8	10	12	14	16	18
		MAXIMUM DECK BEAM SPAN LENGTH (feet-inches)[a, b, f]						
Southern pine	1 – 2 × 6	4-7	4-0	3-7	3-3	3-0	2-10	2-8
	1 – 2 × 8	5-11	5-1	4-7	4-2	3-10	3-7	3-5
	1 – 2 × 10	7-0	6-0	5-5	4-11	4-7	4-3	4-0
	1 – 2 × 12	8-3	7-1	6-4	5-10	5-5	5-0	4-9
	2 – 2 × 6	6-11	5-11	5-4	4-10	4-6	4-3	4-0
	2 – 2 × 8	8-9	7-7	6-9	6-2	5-9	5-4	5-0
	2 – 2 × 10	10-4	9-0	8-0	7-4	6-9	6-4	
	2 – 2 × 12	12-2	10-7	9-5	8-7	8-0	7-5	
	3 – 2 × 6	8-6	7-5	6-8	6-1	5-8	5-3	
	3 – 2 × 8	10-11	9-6	8-6	7-9	7-2	6-8	
	3 – 2 × 10	13-0	11-2	10-0	9-2	8-6	7-11	
	3 – 2 × 12	15-3	13-3	11-10	10-9	10-0	9-4	
Douglas fir-larch[g] Hem-fir[g] Spruce-pine-fir	1 – 2 × 6	4-1	3-6	3-0	2-8	2-5	2-3	
	1 – 2 × 8	5-6	4-8	4-0	3-6	3-2	2-11	2-9
	1 – 2 × 10	6-8	5-10	5-1	4-6	4-1	3-9	3-6
	1 – 2 × 12	7-9	6-9	6-0	5-6	5-0	3-9	3-6
	1 – 2 × 8	5-4	4-7	4-1	3-7	3-3	3-0	2-10
	1 – 2 × 10	6-6	5-7	5-0	4-7	4-2	3-10	3-7
	1 – 2 × 12	7-6	6-6	5-10	5-4	4-11	4-7	4-4
	2 – 2 × 6	6-2	5-4	4-10	4-5	4-0	3-8	3-4
Redwood[h] Western cedars[h] Ponderosa pine[h] Red pine[h]	2 – 2 × 8	7-10	6-10	6-1	5-7	5-2	4-10	
	2 – 2 × 10	9-7	8-4	7-5	6-9	6-3	5-10	
	2 – 2 × 12	11-1	9-8	8-7	7-10	7-3	6-10	
	3 – 2 × 6	7-8	6-9	6-0	5-6	5-1	4-9	
	3 – 2 × 8	9-10						
	3 – 2 × 10	12-0						
	3 – 2 × 12	13-11						

Columns under "Effective Deck Joist Span Length" heading are spans in 2-foot increments from 6'-0" to 18'-0". Measurements listed in field are the "Maximum Deck Beam Span Length" for a given joist span and its corresponding beam size.

Three beam species groups instead of two. Single-ply beam options added to each group, not just Southern pine.

Rows omitted for space considerations

The new tables explicitly permit interpolation of beam spans based on joist spans that fall between the "Effective Deck Joist Span Length" columns.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 pound = 0.454 kg.

a. Interpolation permitted. Extrapolation not permitted.
b. Beams supporting a single span of joists with or without cantilever.
c. Dead load = 10 psf, $L/\Delta = 360$ at main span, $L/\Delta = 180$ at cantilever. Snow load is not assumed to be concurrent with live loa
d. No. 2 grade, wet service factor included.
e. Beam depth shall be equal to or greater than the depth of intersecting joist for a flush beam connection.
f. Beam cantilevers are limited to the adjacent beam's span divided by 4.
g. Includes incising factor.
h. Incising factor not included.
i. Deck joist span as shown in Figure R507.5.
j. For calculation of effective deck joist span, the actual joist span length shall be multiplied by the joist span factor in accordance with Table R507.5(5).

Beam span lengths listed in field of table are based on joist span plus maximum cantilever listed in joist span table (Table R507.6 "Maximum Deck Joist Spans"). If deck design has a flush rim beam without any cantilever (or if cantilever is less than the maximum cantilever allowed), then new Table R507.5(5) "Joist Span Factors for Calculating Effective Deck Joist Span" (see page 9) can be used to right-size beams and span greater distances between posts. See examples 1, 2, and 3 on pages 14 and 15 showing how the cantilever distance influences the beam span.

Figure 1. The 2021 version of the IRC's deck-beam-sizing table (R507.5) incorporates a number of changes to the 2015 and 2018 versions, including having values for three species groups—the 2015 and 2018 IRC beam tables grouped all species other than southern pine into a single category. It also adds tables for 50-psf, 60-psf, and 70-psf snow loads. But perhaps the biggest change is the addition of the term "Effective" to qualify "Deck Joist Span Length" (see "Solving Effective Deck Joist Span Length Problem" on page 12 for an explanation of its impact). Along with the changes highlighted above, the new tables explicitly permit interpolation of beam spans based on joist spans that fall between the lengths provided in the "Effective Deck Joist Span Length" columns.

Another issue is that interpolation isn't explicitly permitted between field values in the 2015 and 2018 tables. That means that when the actual joist span falls between two joist-span columns, you have to round up to the next longest joist span, resulting in a shorter beam span than is structurally necessary for a given size beam.

In addition, those beam tables address only two species groups: southern pine in one group and everything else in the other. Grouping pressure-treated Doug-fir, hem-fir, and SPF; redwood; western cedars; ponderosa pine; and red pine all in the same category penalizes the stronger species in the group by limiting the beam spans to those of the weaker species.

Finally, the beam tables in both the 2015 and 2018 IRC presume that the deck is designed with a dropped beam and the maximum joist cantilever allowed. This results in oversizing beams, sometimes substantially, when a deck design has a shorter cantilever or no cantilever at all, as when you're framing a deck with a flush rim beam.

Expanded 2021 IRC beam tables. Some of the shortcomings that are outlined above are addressed in the beam tables in the 2021 IRC, making it possible to size beams more precisely to use lumber efficiently and to minimize the number of footings. The improvements include:

- Three new beam span tables for snow loads greater than 40 psf.
- Three beam species groups instead of just two.
- A series of rows for single-ply beams added to each species group (not just for southern pine).
- Interpolation is explicitly permitted and can be used to refine the beam span when a joist span length falls between the columns listed on the beam table.
- A new adjustment table alleviates oversizing beams on decks that don't have the maximum joist cantilever.

TABLE R507.5(5)
JOIST SPAN FACTORS FOR CALCULATING EFFECTIVE DECK JOIST SPAN
[for use with Note j in Tables R507.5(1), R507.5(2), R507.5(3), and R507.5(4)]

C/J[a]	JOIST SPAN FACTOR
0 (no cantilever)	0.66
1/12 (0.083)	0.72
1/10 (0.10)	0.80
1/8 (0.125)	0.84
1/6 (0.167)	0.90
1/4 (0.250)	1.00

For SI: 1 foot = 304.8 mm

a. C = actual joist cantilever length (feet): J = actual joist span length (length)

Multiply actual joist span by "Joist Span Factor" to determine the "Effective Deck Joist Span Length". See table on page 8.

Figure 2. A new addition to the 2021 IRC Table R507.5(5) can be used to fine-tune beam size when there is a flush rim beam or when the cantilever is less than allowed.

Navigating the Maximum Deck Beam Span Table

Table R507.5(1) "Maximum Deck Beam Span - 40 PSF Live Load" in the 2021 IRC applies to decks built for 40-psf live loads and is similar to the tables in the previous codes (**Figure 1**). Now, with new tables for 50-psf, 60-psf, and 70-psf snow loads, deck builders in high snowfall regions around the Great Lakes, northern New England, and mountain areas can size beams without consulting an engineer or working through the engineering calculations themselves. The tables are numbered and titled successively: Table R507.5(2) "Maximum Deck Beam Span - 50 PSF Snow Load," and so on for 60-psf and 70-psf snow loads. As logic would reason, the increase in snow load results in shorter maximum deck beam spans in the corresponding table.

In this article, I'll use the 40-psf table for beam-sizing examples, but the same process would apply using the other three tables.

Maximum beam span. The maximum beam span lengths listed in the field of the beam table are controlled by three factors: the species of wood, the size of the beam (depth and number of plies), and the span of the deck joists. Though it may seem odd to factor in the joist span for deck beams, the joist span is a simple proxy for the tributary load that is borne by the beam. These factors become the rows and columns that feed into the field of the table where the beam span lengths are listed.

Effective joist span length. The major column, "Deck Joist Span," in the previous versions of the beam table was retitled "Effective Deck Joist Span Length" in the 2021 IRC. The change may seem minor, but the new title corresponds to a new table, R507.5(5) "Joist Span Factors for Calculating Effective Deck Joist Span" (**Figure 2**).

As in previous code versions, the beam span lengths listed in the field of the table are based on the joist span plus the maximum cantilever listed in Table R507.6 "Maximum Deck Joist Spans," which was the focus of my article, mentioned earlier, in the March issue.

When you size a beam directly from the joist spans listed on the table, the beam will support the maximum span of a given joist depth and the maximum joist cantilever allowed. But if your deck design has a flush rim beam without any cantilever, or if the cantilever is less

than the maximum allowed, then you can employ the new "joist span factors for calculating effective deck joist span" to right-size the beam for your deck design and span greater distances between posts.

Shown on pages 14 and 15 are three examples to demonstrate how the cantilever distance influences the beam span. To keep things simple, snow loads for these examples are less than 40 psf, so I'll use Table R507.5(1).

Navigating Table R507.5(5) "Joist Span Factors for Calculating Effective Deck Joist Span"

Table R507.5(5) (see again Figure 2) is the engine behind the effective deck joist span length. It's a workaround used in conjunction with the beam tables that adjusts for the lighter load a beam has on it when there is no joist cantilever or when a joist cantilever is shorter than the maximum allowed.

The left column of Table R507.5(5) is a series of fractions. The column is labeled "C/J," with C being the actual joist cantilever length and J being the actual joist span length.

The right-hand column lists joist span factors. These are the numbers you multiply the *actual* joist span by to determine the *effective* deck joist span length on the beam table. You'll notice that most of the joist span factors are numbers less than 1. So when you multiply the actual joist span length by a number less than 1, the resulting effective deck joist span length measurement will be shorter. When that measurement is applied to the beam table, it will result in a greater beam span than you get when you use the actual joist span length.

It'll make your head spin the first few times you use it. I found the trick is to avoid confusing the decimal values in the left and right columns.

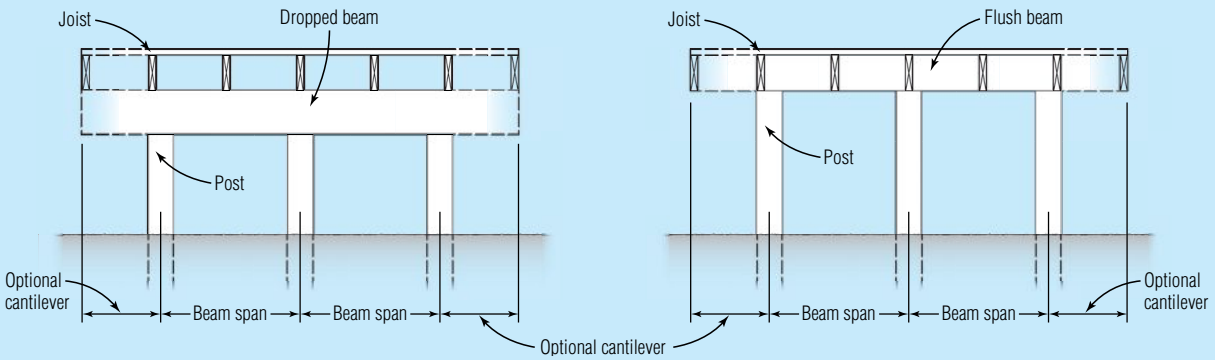
On page 12, you'll find an example of the steps involved in solving an "Effective Deck Joist Span Length" problem. The deck will be built with 2x10 SYP deck joists with a 14-foot span between the beam and ledger, and a 1-foot-1 1/2-inch cantilever (the fact that the joists are 2x10 SYP is irrelevant to the calculation) (**Figure 3**).

After determining the joist span factor and calculating the effective deck joist span length following step 1, refer to the beam span table to find the maximum beam span allowed. In this example, the effective joist span length is 10 feet 15/16 inches, which I rounded up to 10 feet 1 inch.

Unless you're lucky, the effective joist span calculated won't match one of the column lengths listed, in which case you have a few options. The simplest is to round up to the column with the next longer length, in this case from 10 feet 1 inch to 12 feet, then read the maximum deck beam span length associated with the beam size you're planning. For double 2x10 southern pine beams in this example, that measurement is 7 feet 4 inches, as shown (Option A in Figure 3).

Interpolation. If you want a more

Don't Forget About the Allowable Beam Cantilever



Many deck builders don't realize that beams can cantilever beyond the end posts. The maximum cantilever distance is one-quarter of the beam span between the end post and its neighbor post. Beam span is measured between the centers of support columns or posts. For example, the maximum cantilever of a beam with an adjacent span of 8 feet 7 inches would be 8 feet 7 inches ÷ 4 = 2 feet 1 ¾ inches. The cantilever span is measured from the center of the post to the outside end. Sometimes, cantilevering the beam at the ends of a deck will allow you to eliminate a footing and post compared with installing footings at the ends of a beam.

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Solving Effective Deck Joist Span Length Problem

Deck design calls for a deck with a 40 psf live load, 2x10 southern pine joists with an actual joist span length (J) of 14'-0" and a joist cantilever of 1'-1 1/2" (which is less than the maximum allowable.)

1a. Span factor. Determine joist span factor by dividing 1'-1 1/2" (C) by 14'-0" (J), which results in a value of 0.0804. In this case, the result doesn't match a value in column C/J, so round up to the next higher value, 1/12 (0.083), and read across the row to the joist span factor of 0.72.

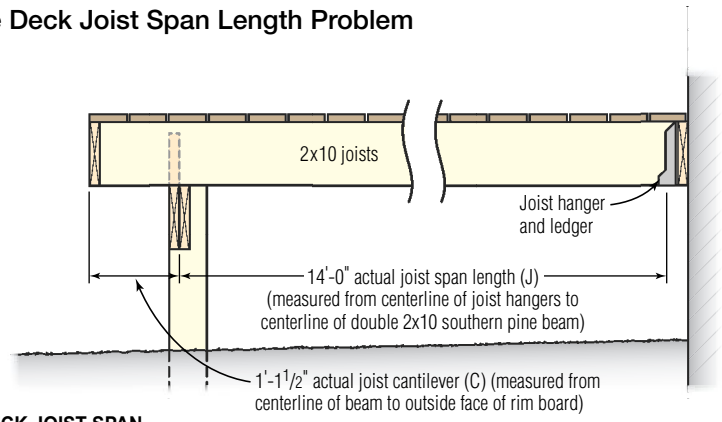

TABLE R507.5(5)
JOIST SPAN FACTORS FOR CALCULATING EFFECTIVE DECK JOIST SPAN

C/J[a]	JOIST SPAN FACTOR
0 (no cantilever)	0.66
1/12 (0.083)	0.72
1/10 (0.10)	0.80
1/8 (0.125)	0.84
1/6 (0.167)	0.90
1/4 (0.250)	1.00

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1b. Span factor. Multiply the actual joist span (14'-0") by the joist span factor (0.72) and the result is the effective deck joist span length (10'-1").

2. Option A: Rounding up. The effective joist span 10'-1" falls between the 10' and 12' joist length columns on Table R507.5(1). Round the effective joist span (10'-1") up to the next longer joist span column (12') and beam span listed for a double 2x10 (7'-4").

TABLE R507.5(1)
MAXIMUM DECK BEAM SPAN—40 PSF LIVE LOAD[c]

BEAM SPECIES[d]	BEAM SIZE[e]	EFFECTIVE DECK JOIST SPAN LENGTH[a,i,j] (feet)					
		6	8	10	12	14	16
		MAXIMUM DECK BEAM SPAN LENGTH (feet-inches)[a,b,f]					
Southern pine	1 – 2 × 6	4-7	4-0	3-7	3-3	3-0	2-10
	1 – 2 × 8	5-11	5-1	4-7	4-2	3-10	3-7
	1 – 2 × 10	7-0	6-0	5-5	4-11	4-7	4-3
	1 – 2 × 12	8-3	7-1	6-4	5-10	5-5	5-0
	2 – 2 × 6	6-11	5-11	5-4	4-10	4-6	4-3
	2 – 2 × 8	8-9	7-7	6-9	6-2	5-9	5-4
	2 – 2 × 10	10-4	9-0	8-0	7-4	6-9	6-4
	2 – 2 × 12	12-2	10-7	9-5	8-7	8-0	7-5
	3 – 2 × 6	8-6	7-5	6-8	6-1	5-8	5-3

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2. Option B: Analog interpolation is a quick way to refine the beam span closer to what is needed for the effective joist span. Round the effective joist span (10'-1") up to the next foot length (11') which is halfway between the 10' and 12' joist span columns. Then split the beam length halfway between the spans listed (8'-0" and 7'-4"). The result is a beam span of 7'-8".

2. Option C: Calculated interpolation refines the beam span precisely to what is required for an effective joist span of 10'-1". In this case, the maximum beam span is 7'-11 11/16". See "Interpolation Formula," right.

Interpolation Formula

$$\text{Interpolated maximum beam span} = \text{Max. beam span, 12-foot column (7'-4")} + \left(\text{Next longer joist span column (12'-0")} - \text{Effective joist span (10'-1")}\right) \times \frac{\left(\text{Max. beam span, 10-foot column (8'-0")} - \text{Max. beam span, 12-foot column (7'-4")}\right)}{\left(\text{Next longer joist span column (12'-0")} - \text{Next shorter joist span column (10'-0")}\right)}$$

$$\text{Interpolated max. beam span} = 7'\text{-}4" + (12'\text{-}0" - 10'\text{-}1") \times \frac{(8'\text{-}0" - 7'\text{-}4")}{(12'\text{-}0" - 10'\text{-}0")}$$

$$7'\text{-}4" + (1'\text{-}11") \times \frac{(8")}{(24")} = 7'\text{-}4" + (1'\text{-}11") \times (.3333") = 7'\text{-}4" + 7\,11/16" = 7'\text{-}11\,11/16" \text{ interpolated max. beam span}$$

Figure 3. Sizing beams for a given length of deck joist is a multistep process. First, you must determine the effective joist span length following steps 1A and 1B above, and then refer to the appropriate section of Table R507.5 to round up (Option A), perform a quick analog interpolation (Option B), or mathematically calculate the interpolation (Option C) to find the maximum deck beam span.

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precise measurement of the beam span, you can interpolate between deck-beam-span values that fall between the next lower and next higher columns associated with the effective deck joist span length you came up with. In this example, again, you would be using the 10- and 12-foot joist-span columns.

In cases where the effective joist span falls less than halfway between the 10-foot and 12-foot joist-span columns, you can perform an analog interpolation (Option B in Figure 3). This is a bit like rounding up, but rounding up to a column that could be in the table if it were graduated in 1-foot increments instead of 2-foot increments. An analog interpolation could even divide the values between the two joist-span columns by quarters rather than halves pretty easily.

In this example, the effective joist span (10 feet 1 inch) is rounded up to the next foot length (11 feet), which is halfway between the 10- and 12-foot joist-span columns. Then split the beam length halfway between the spans listed (8 feet 0 inches and 7 feet 4 inches). The result is a beam span of 7 feet 8 inches.

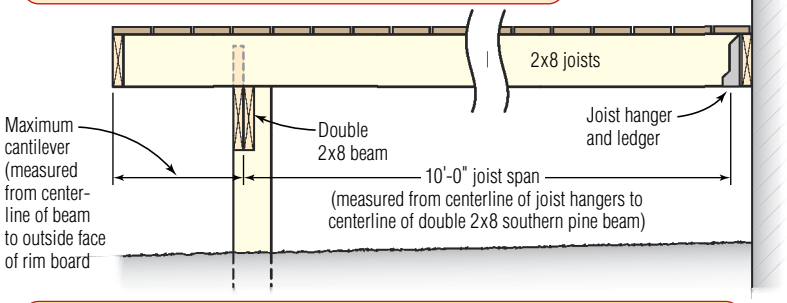
For the mathematically inclined, you can actually calculate the interpolated value following the formula in the example shown here (Option C in Figure 3). In this case, the calculated maximum beam span is 7 feet 11 $^{11}/_{16}$ inches.

As you can see, the difference between the estimated maximum beam span (7 feet 4 inches), the analog interpolation of the beam span (7 feet 8 inches), and the calculated interpolation of the beam span (7 feet 11 $^{11}/_{16}$ inches) isn't huge. But the ability to eke out a few extra inches of span (and to be able to explain to your inspector how you did it) could make a difference in your next project. ❖

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

Example 1: Sizing Beam Spans For Decks With Maximum Joist Cantilevers

Deck design calls for a deck with a 40 psf live load, 2x8 southern pine joists spanning 10'-0", and the maximum cantilever allowed



1. Maximum joist cantilever. Locate on Table R507.6. Under 40 psf live load and southern pine, follow the 2x8 joist size row to the 10' column to find a 2'-6" cantilever.

TABLE R507.6 MAXIMUM DECK JOIST SPANS

LOAD[a] (psf)	JOIST SPECIES[b]	JOIST SIZE	ALLOWABLE JOIST SPAN[b, c] (feet-inches)			MAXIMUM CANTILEVER[d,f] (feet-inches)							
			Joist spacing (inches)			Joist back span[g] (feet)							
			12	16	24	4	6	8	10	12	14	16	18
40 live load	Southern pine	2 × 6	9-11	9-0	7-7	1-0	1-6	1-5	NP	NP	NP	NP	NP
		2 × 8	13-1	11-10	9-8	1-0	1-6	2-0	2-6	2-3	NP	NP	NP
		2 × 10	16-2	14-0	11-5	1-0	1-6	2-0	2-6	3-0	3-4	3-4	NP
		2 × 12	18-0	16-6	13-6	1-0	1-6	2-0	2-6	3-0	3-6	4-0	4-1
	Douglas fir-larch[e]	2 × 6	9-6	8-4	6-10	1-0	1-6	1-4	NP	NP	NP	NP	NP
		2 × 8	12-6	11-1	9-1	1-0	1-6	2-0	2-3	2-0	NP	NP	NP

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2. Maximum beam span. Locate the maximum deck beam span length on Table R507.5(1). Under southern pine, follow the double 2x8 beam row to the 10' column to find the maximum span for the beam between posts is 6'-9".

TABLE R507.5(1)
MAXIMUM DECK BEAM SPAN—40 PSF LIVE LOAD[c]

BEAM SPECIES[d]	BEAM SIZE[e]	EFFECTIVE DECK JOIST SPAN LENGTH[a, f] (feet)						
		6	8	10	12	14	16	18
		MAXIMUM DECK BEAM SPAN LENGTH (feet-inches)[a, b, f]						
Southern pine	1 – 2 × 6	4-7	4-0	3-7	3-3	3-0	2-10	2-8
	1 – 2 × 8	5-11	5-1	4-7	4-2	3-10	3-7	3-5
	1 – 2 × 10	7-0	6-0	5-5	4-11	4-7	4-3	4-0
	1 – 2 × 12	8-3	7-1	6-4	5-10	5-5	5-0	4-9
	2 – 2 × 6	6-11	5-11	5-4	4-10	4-6	4-3	4-0
	2 – 2 × 8	8-9	7-7	6-9	6-2	5-9	5-4	5-0
	2 – 2 × 10	10-4	9-0	8-0	7-4	6-9	6-4	6-0
	2 – 2 × 12	12-2	10-7	9-5	8-7	8-0	7-5	7-0
	3 – 2 × 6	8-6	7-5	6-8	6-1	5-8	5-3	4-11

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Figure 4. When taking advantage of the maximum allowed cantilever for a given joist size, you can size the beam directly from the beam-sizing table without any adjustment. First, refer to Table R507.6 to find the maximum cantilever for your beam. Then look across the appropriate beam row to the "Effective Deck Joist Span Length" column to find the maximum beam span for your chosen joist span. In the example above, 2x8 joists spanning 10 feet with an additional 2-foot-6-inch cantilever would require a double 2x8 beam with a maximum span of 6 feet 9 inches between posts.

Example 2: Sizing Beam Spans for Decks Without Joist Cantilevers

Deck design calls for a deck with a 40 psf live load, 2x8 southern pine joists with an actual joist span length (J) of 10'-0", and no cantilever

1. Span factor. On Table R507.5(5), see that "0 (no cantilever)" has a joist span factor of 0.66. Multiply the actual joist span length (10'-0") by the joist span factor (0.66) to find the effective deck joist span length: 10'-0" x 0.66 = 6'-7 3/16".

2. Rounding up. The effective joist span 6'-7 3/16" falls between the 6' and 8' joist span length columns on Table R507.5(1). Round the effective joist span (6'-7 3/16") up to the next longer joist span column (8') and beam span listed for a double 2x8 (7'-7"). To fine-tune effective deck joist span length further, analog interpolate or do a full interpolation calculation as shown on page 12.

TABLE R507.5(5)
JOIST SPAN FACTORS FOR CALCULATING EFFECTIVE DECK JOIST SPAN

C/J[a]	JOIST SPAN FACTOR
0 (no cantilever)	0.66
1/12 (0.083)	0.72
1/10 (0.10)	0.80
1/8 (0.125)	0.84
1/6 (0.167)	0.90
1/4 (0.250)	1.00

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TABLE R507.5(1)
MAXIMUM DECK BEAM SPAN—40 PSF LIVE LOAD[c]

BEAM SPECIES[d]	BEAM SIZE[e]	EFFECTIVE DECK JOIST SPAN LENGTH[a,i,j] (feet)					
		6	8	10	12	14	16
		MAXIMUM DECK BEAM SPAN LENGTH (feet-inches)[a,b,f]					
Southern pine	1 – 2 × 6	4-7	4-0	3-7	3-3	3-0	2-10
	1 – 2 × 8	5-11	5-1	4-7	4-2	3-10	3-7
	1 – 2 × 10	7-0	6-0	5-5	4-11	4-7	4-3
	1 – 2 × 12	8-3	7-1	6-4	5-10	5-5	5-0
	2 – 2 × 6	6-11	5-11	5-4	4-10	4-6	4-3
	2 – 2 × 8	8-9	7-7	6-9	6-2	5-9	5-4
	2 – 2 × 10	10-4	9-0	8-0	7-4	6-9	6-4
	2 – 2 × 12	12-2	10-7	9-5	8-7	8-0	7-5
	3 – 2 × 6	8-6	7-5	6-8	6-1	5-8	5-3

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Example 3: Sizing Beam Spans for Decks With Shorter Than Maximum Joist Cantilevers

Deck design calls for a deck with a 40 psf live load, 2x8 southern pine joists with an actual joist span length (J) of 10'-0", and an actual joist cantilever shorter than the allowable maximum (9")

1. Span factor. Determine joist span factor by dividing 9" (C) by 10'-0" (J), which results in a factor of 0.075 (9" ÷ 10'-0" = 0.075). In this case, the result doesn't match a value in column C/J in Table R507.5(5), so round up to the next higher value, "1/12 (0.083)" row and read across to the joist span factor of 0.72. Multiply the actual joist span (10'-0") by the joist span factor (0.72) and the result is the effective deck joist span length (10'-0" x 0.72 = 7'-2 3/8").

2. Rounding up. The effective joist span 7'-2 3/8" falls between the 6' and 8' joist span length columns on Table R507.5(1). Round the effective joist span (7'-2 3/8") up to the next longer joist span column (8') and beam span listed for a double 2x8 (7'-7"). To finetune effective deck joist span length further, analog interpolate or do a full interpolation calculation as shown on page 12.

TABLE R507.5(5)
JOIST SPAN FACTORS FOR CALCULATING EFFECTIVE DECK JOIST SPAN

C/J[a]	JOIST SPAN FACTOR
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1/10 (0.10)	0.80
1/8 (0.125)	0.84
1/6 (0.167)	0.90
1/4 (0.250)	1.00

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TABLE R507.5(1)
MAXIMUM DECK BEAM SPAN—40 PSF LIVE LOAD[c]

BEAM SPECIES[d]	BEAM SIZE[e]	EFFECTIVE DECK JOIST SPAN LENGTH[a,i,j] (feet)					
		6	8	10	12	14	16
		MAXIMUM DECK BEAM SPAN LENGTH (feet-inches)[a,b,f]					
Southern pine	1 – 2 × 6	4-7	4-0	3-7	3-3	3-0	2-10
	1 – 2 × 8	5-11	5-1	4-7	4-2	3-10	3-7
	1 – 2 × 10	7-0	6-0	5-5	4-11	4-7	4-3
	1 – 2 × 12	8-3	7-1	6-4	5-10	5-5	5-0
	2 – 2 × 6	6-11	5-11	5-4	4-10	4-6	4-3
	2 – 2 × 8	8-9	7-7	6-9	6-2	5-9	5-4
	2 – 2 × 10	10-4	9-0	8-0	7-4	6-9	6-4
	2 – 2 × 12	12-2	10-7	9-5	8-7	8-0	7-5
	3 – 2 × 6	8-6	7-5	6-8	6-1	5-8	5-3

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Figure 5. When there is no joist cantilever (Example 2), multiply the actual joist span (10 feet) by the joist span factor (0.66) from Table R507.5(5) to find the effective deck joist span length (6 feet 7 3/16 inches). On Table R507.5(1), this length falls between the 6- and 8-foot joist-span columns, so you'll need to round up to the 8-foot column, do a quick analog interpolation, or calculate the interpolation (as explained in Figure 3). When there is less than a maximum cantilever, divide the actual joist cantilever by the actual joist span, then refer to Table R507.5(5) to find the appropriate joist span factor to apply, as shown in Example 3. The effective deck joist span length can then be used to determine the beam span as described.

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Replacing a Balcony Floor

A new meranti floor floating over an EPDM rubber membrane solves a leaky problem

by Emanuel Silva

Like many of my jobs, this one started out as a small leak repair but inevitably became a full-blown makeover—in this case, of a covered, third-floor balcony built into the gable dormer of an old Boston-area Victorian. My clients had noticed some minor water staining on the ceiling of the living space below the balcony and wanted me to fix that problem, as well as remove a pair of fixed windows from the arched openings in the gable wall and replace them with railings. When I assessed the job, I noted that the balcony floor had been framed with no pitch and was covered with asphalt roll roofing, not a good waterproofing combination for resisting the windblown rain that would inevitably make its way through the missing panes in the broken arched windows.

Demo

I started by removing the glass panels from the two arched openings, along with the attic door that led out onto the balcony, then stripped the aluminum siding from the lower part of the walls. To protect the living area below from water damage while I worked on the balcony floor, I covered the exposed wall sheathing with Grace Ice & Water Shield HT, a self-adhering rubberized asphalt membrane. I left the bottom 16 inches or so of release paper intact so that I could fold the membrane up while I worked on the floor-to-wall joint.

Next, I peeled away the roofing that covered the balcony floor. Underneath the roll roofing was a layer of small metal roofing panels that had been soldered together, along with continuous copper flashing at the eaves. Underneath it all was sawn board sheathing, which showed some areas of water staining around the center post between the arched openings and at the wall, indicating that water was draining back toward the building.

Tapered Sleepers

I wanted to give the roof underneath the new balcony flooring a positive pitch for better drainage, so using a jig to guide my circular saw, I ripped tapered sleepers from 2-by lumber. I laid these out on the sawn board sheathing 12 inches on-center, then spent the better part of a day carefully shimming the sleepers as needed to create a pitched but perfectly flat surface for new floor sheathing.

PHOTOS BY EMANUEL SILVA

Figure 1. The author installed tapered sleepers followed by Zip sheathing to pitch the roof deck away from the house (A). Then he installed recovery board over the sheathing (B), followed by the EPDM roof membrane (C). The author used a neoprene bonding adhesive to glue the membrane to the underlayment, and a rubber-to-rubber adhesive at lap joints in the membrane (D).

Once I'd screwed the tapered sleepers down, I sheathed the floor with 5/8-inch-thick Zip panels. I was anxious to cover and dry-in the deck quickly in case of bad weather, and once the seams, fasteners, and edges of the panels were covered with Zip tape, they created a weatherproof barrier that allowed me to rest easy at night without worrying about a tarp being blown away by a storm. I used both screws and spray foam adhesive to bond the sheathing to the sleepers.

EPDM Roofing

For a project like this, EPDM synthetic rubber roofing membrane is a durable choice that's relatively easy to work with. I ordered and rolled out a 10-by-25-foot sheet of 60-mil material in my clients' driveway, used a straightedge and marker to draw cut lines, then cut the sheet into manageable sections with a pair of heavy-duty shears.

I started by covering the Zip sheathing with a layer of 1/2-inch roof recovery board. These 4x8 panels—which come in various thicknesses with different R-values—are made for use with single-ply roofing, with a foam core for insulation and an inorganic coated glass facer compatible with the adhesives used with EPDM membranes. The panels are held in place with screws driven through large plate washers (**Figure 1**).

Next, I dry-fit the largest section of the EPDM membrane, which I sized to lap about a foot up the walls and fall short of the center post. I then marked the outside edge of this section of membrane onto the underlayment and used this reference line to lay out the smaller piece of membrane that would overlap the eaves and wrap around the column. This piece had to be carefully cut to fit around the column and over the roof-to-wall intersections at the two outside corners of the balcony.

I installed the smaller section of membrane first, positioning it and then carefully folding it back onto itself one area at a time. This allowed me to clean off the underside of the membrane with a special solvent before rolling the bonding adhesive onto both the membrane and the underlayment. Once a section is pressed into place, the bond is permanent, so it's important to work carefully.

I installed the second, larger membrane section the same way, using both the bonding adhesive and the special rubber-to-rubber adhesive where the second membrane overlapped the first near the column. Here, a minimum of 2 inches of overlap is required, though I allowed for quite a bit more on this project because of the balcony's small size and tight fit, which made maneuvering the sheet material a little tricky.

Post flashing. To create a watertight joint at the post, I cut four small squares of EPDM membrane sized to wrap up the post about 12 inches, wrap a couple of inches around the sides of the post, and overlap the roof membrane by about 4 inches. For a tight fit, I made folds in each section and a couple of cuts from

either side in the bottom leg so the membrane would conform neatly to the post and roof deck. Then, starting with the outside face of the column, I cleaned the back of a piece of membrane and applied membrane adhesive where it would overlap the roof membrane, and bonding adhesive where it would contact the wood post (**Figure 2**). Then I installed the other three pieces, finishing with the one facing the attic. At the four corners, I installed small EPDM patches, completely flashing the column to the roof membrane.

Wall flashing. According to Grace, EPDM membranes are not compatible with asphalt-based flashing products, such as Ice & Water Shield HT, which tend to degrade the EPDM (a butyl-based version of Ice & Water Shield, called Ultra, is suited for this application but was unavailable when I was doing this project). So where the roof membrane wrapped over the roof eaves and up the wall sheathing on the attic wall and on either side of the balcony opening, I first applied Henry Blueskin Butyl Flash self-adhering flashing to isolate the EPDM membrane from the asphalt-based Vycor Plus flashing tape that I used in conjunction with the Ice & Water Shield membrane.

Finally, I removed the release paper from the lower part of the Ice & Water Shield membrane and folded it back down over the Blueskin covering the top edge of the EPDM membrane extending up the walls. This should prevent any water that gets blown into the balcony during a storm from penetrating the walls or roof deck and getting inside the house.

Figure 2. The author flashed the column with four pieces of membrane folded and cut to fit, starting with the outside face followed by the two sides (A). Rubber-to-rubber adhesive was used to adhere the legs of the last section of membrane on the inner face of the column to the previously installed pieces (B, C). At the sides of the balcony, the author used butyl-based flashing tape to isolate the EPDM roof membrane from the asphalt-based Vycor flashing (D).

Balcony Floor

After completing the membrane installation, I used my tapering jig to cut more sleepers from 2-by pressure-treated lumber, which I then laid over the roof membrane with the tapers reversed to create a flat surface. These sleepers aren't mechanically fastened to the balcony floor; they are just laid in place on 16-inch centers over a protective second layer of 2 1/2-inch-wide EPDM strips and held down by the weight of the decking and by the trim around the perimeter of the balcony.

I prefinished the balcony's new red meranti 1x4 decking on all six sides with Penofin tropical hardwood penetrating oil, then installed it starting from the outside and working inward toward the attic wall. I fastened the decking to the sleepers with 16-gauge stainless steel nails, carefully sizing them so that they wouldn't penetrate all the way through the decking and sleepers into the roof membrane. To ensure a good bond, I also glued the decking to the sleepers with 3M 4200, a tenacious, marine-grade polyurethane adhesive sealant that I often use on deck projects. For a consistent gap between boards that would ensure good drainage off the roof below, I spaced the decking with 8d nails tacked to the sleepers during installation (**Figure 3**).

Figure 3. The author laid pressure-treated sleepers with a reverse taper over the membrane (A), then fastened 1x4 red meranti decking to the sleepers with marine-grade adhesive (B) and stainless steel nails (C). At the entryway to the attic, a short length of beveled siding tacked to the door sill over the membrane creates pitch for drainage (D). The author then waterproofed the sill with flexible flashing tape, which wraps up the jambs (E), then used regular peel-and-stick flashing tape to seal the sides of the opening to the WRB covering the wall (F).

Door

Before installing the new fiberglass entry door, I tacked a length of beveled siding to the subsill to create positive drainage, then flashed the bottom of the opening with FlexWrap NF. I sealed the sides of the opening to the Ice & Water Shield WRB with more flashing tape, spread a couple of thick beads of silicone sealant onto the sill and partway up the sides of the rough opening, and installed the door frame.

While the wall was out of plumb, I installed the door perfectly plumb and level so that it would operate properly (I don't believe in "ghost" doors). This resulted in door jambs that projected out from the wall, instead of being flush with the sheathing. This wasn't an issue on the inside, since the door opened into unfinished attic space, but on the exterior, it meant a couple of extra steps to case the door.

First, I flashed the sides of the jambs to the WRB with L-shaped lengths of Vycor Plus flashing tape. Then I added PVC rippings to the edge of the jambs with a 1/4-inch reveal, giving the jambs a little more depth and helping to support the head casing after it was installed.

I prefabricated the casing from a sheet of 3/4-inch PVC, using pocket screws to join the sides to the head casing, which I ripped to width to fit snugly against the balcony ceiling. Then, after fastening

Figure 4. The author installed the door frame to be perfectly plumb, but the wall was out of plumb, so the jambs projected out from the sheathing (A). To match the plumb door to the out-of-plumb wall, the author taped the jambs to the WRB (B) and added extensions before casing the door with PVC trim (C). Tapered PVC rippings were then used to fill the gap between the casing and the wall (D), while blocking was used to pad out the trim under the sill (E). New railings fabricated from PVC replaced the glass panels in the balcony's arched openings (F).

the casing "kit" to the jambs with Cortex screws that I later capped with plugs, I filled the gap between the wall and the sides of the casing with tapered rippings. Underneath the door sill, I added blocks to the bottom casing to bring it in plane with the rest of the trim (**Figure 4**).

Finishing Up

Once I had trimmed the new door with PVC, it was time to re-install as much of the old trim around the arched openings as I could. With a little help, I was able to bend wide rippings of 1/2-inch PVC, sized to fit, into the insides of the arches. Then I re-installed the curved interior and exterior casings. After installing a water table detail at the bottom of the walls, I used 8 1/4-inch-wide fiber-cement siding with a 7-inch exposure to match the look of the home's existing wide aluminum beveled siding.

I fabricated railings and balusters from PVC stock that I glued up and milled to match the balustrades on the house's lower porch. These railings are 36 inches high to meet the requirements of the local building inspector. ❖

Emanuel Silva, a JLC *contributing editor, owns SilvaLightning Builders in North Andover, Mass. Contact him at silvalightningbuilders@gmail.com.*


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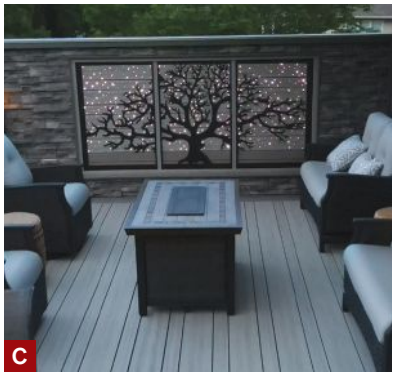
B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Tree of Life Privacy Wall

by Dan Pettit

Though only one of many unique elements in a multilevel outdoor living space that my company recently completed, the innovative "tree of life" privacy wall shown here plays a big role in bringing the project itself to life **(A)**. During the day, the 6-foot-high framed wall with stone-veneer cladding and a three-panel, plasma-cut-aluminum insert visually separates my clients from their nearby neighbors. At night, twinkling stars—created with the help of motorized fiber-optic lighting—ebb and flow from color to color against the tree of life backdrop to create a relaxing environment for my clients and their family members and guests **(C)**.

We used double 2x4 studs to frame the wall for strength and to provide a cavity between the inner and outer walls for running the wiring without having to drill through the studs. To reinforce the wall against wind pressure, we sheathed both sides and fabricated an engineered 3-foot-by-3-foot-by-1/4-inch stainless steel L-bracket to connect the free-standing end of the wall to the deck framing.

The aluminum insert is backed with Deckorators Voyage deck boards that match the color and alternating widths of the decking. We also clad the back of the wall with deck boards and trimmed it with matching Deckorators mineral-based-composite trim boards, which are more stable and less prone to thermal expansion and contraction than PVC trim.

The lighting system that illuminates the privacy wall during the darker hours is my secret sauce, consisting of commercial-grade, off-the-shelf components that I sourced online. While my design is proprietary, it basically consists of a fiber-optic generator that produces the colored illumination and controls effects such as color changes, dimming, and twinkling. Flexible fiber-optic light strands bundled into harnesses—which I routed through holes drilled through the privacy wall's deck-board cladding in a carefully designed pattern—deliver these lighting effects to my clients **(B)**. ❖

Dan Pettit owns Northern Outdoor Living in Hastings, Minn.

PHOTOS: A. ZACH PLUMB/COURTESY DECKORATORS; B, C. DAN PETTIT

AZEK EXTERIORS

Historic Yacht Club Reimagined With PVC Exterior

The Pentwater Yacht Club opts for siding and trim made of engineered polymers to withstand harsh lakefront conditions.

If you're fortunate enough to be on the waters of Lake Michigan, you may come across a short man-made channel on the lake's east side. Venture through it, because the channel leads to Lake Pentwater, where a white building gleams from the shoreline, beaconing with good food and good company.

That's the Pentwater Yacht Club, and it's been there since 1935. It's never looked so good.

A REIMAGINED BUILDING

In 2021, the century-old warehouse that had served as the clubhouse had fallen into disrepair. Club leadership and members decided to tear down the facility and rebuild with the ambitious goal of completing the job in time for the upcoming sailing season. That meant working at a brisk pace through the harsh Michigan winter.

The club contracted Grand Rapids, Michigan–based Rockford Construction to both design and build a reimagined clubhouse. The new building sits over Lake Pentwater on steel pilings and features ample outdoor seating on a two-level deck. Its white exterior, composed of AZEK Exteriors trim and shingle siding, reflects the historic charm of the neighborhood.

Cameron Buck, owner of C Buck Professional Builders, spent nine months as the framing and exterior siding contractor on the project. He was glad Rockford Construction specified AZEK for the siding and trim. It's the fourth-generation craftsman's preferred material.

"I always push homeowners and building owners in that direction," Buck says.

LOW-MAINTENANCE SOLUTION

Club leaders envisioned a low-maintenance structure that could hold up to the region's weather extremes. AZEK products are made of engineered polymers to resist moisture — crucial given the building is above water. Superior paint adhesion, thanks to PaintPro Technology, helps ensure long paint life and less frequent maintenance.

"It's going to see a lot of weather," Buck says, adding that the tight exterior of durable PVC siding and trim should stand the test of time. "It really helps limit callbacks. With AZEK, you avoid the possibility of the irregularities and twisting of wood boards."

Speed of installation was another factor. Operating on a tight timeframe meant using a material that was lightweight and easy to work with. On that front, AZEK delivers, Buck says. The AZEK Shingle product offers the classic look of cedar shingles but is lighter than wood and more durable.

For the window frames, Buck used a Kreg Foreman to make pocket holes — a technique that connects horizontal with vertical pieces using screws unseen on the backside.

"Then we just popped the frames into place, anchored them, and plugged them," Buck explains.

The fasteners were plugged with Cortex plugs that match the material, which means no sanding, caulking, or painting each nail hole.

Buck also appreciates that each AZEK board is precisely the same.

"When you meet up joints, you don't have to worry about cupping. You don't have to worry about sanding stuff out, because it's uniform," he says. "Every single stick is the exact same product."

Now that the renewed clubhouse is complete, Buck can take pride in a project that bears his craftsmanship, from the staggard shingle siding and the elegant molding to the window frames and extension jambs. It's all PVC, all durable, and all AZEK.

"It will outlast me," Buck adds. ■

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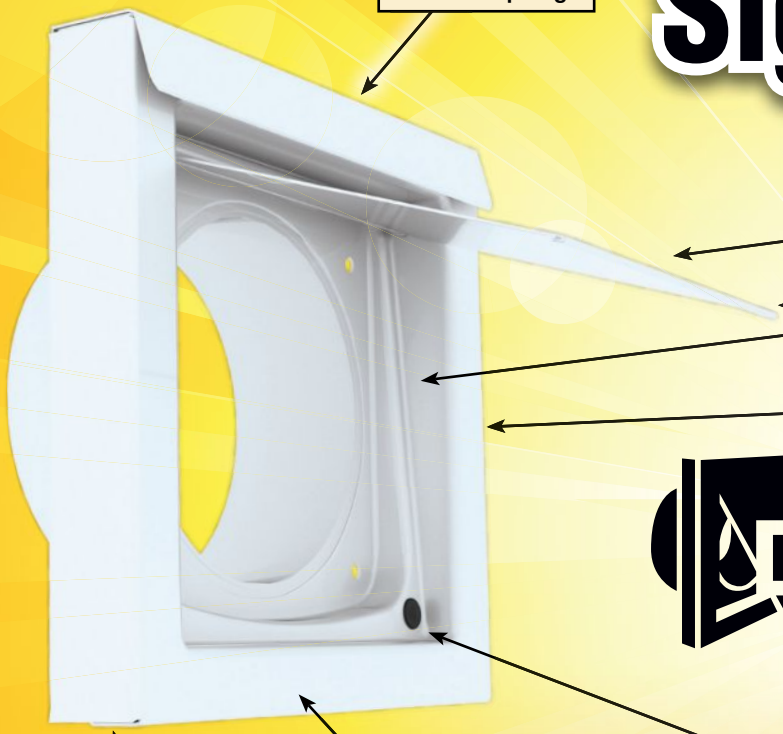

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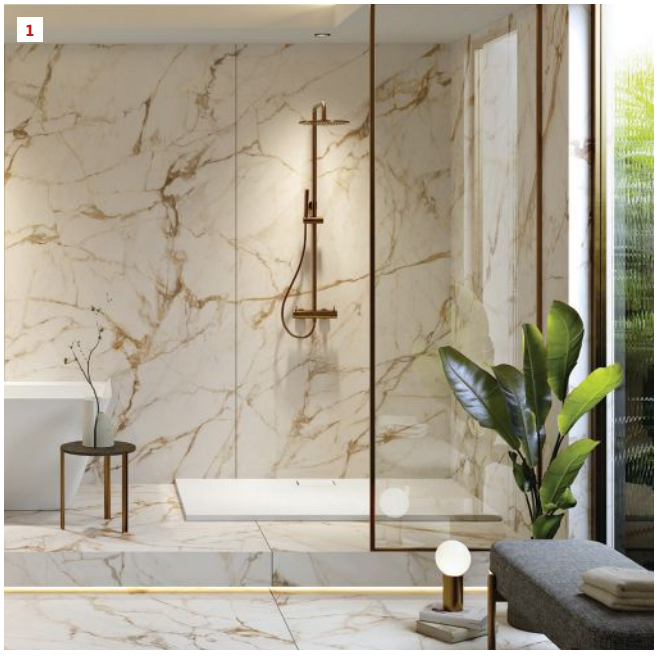
BY VINCENT SALANDRO



1. Multi-size Shower Tray
Composed of engineered stone and the manufacturer's compound of polyurethane and mineral fillers, the Largo shower tray from Acquabella is offered in a range of sizes—36x36, 36x66, 60x30, 60x32, and 60x36 (inches)—with the drain located on the longest side. The low profile enables a recessed installation for a flush-to-floor fit or a standard installation with a small lip. Trays are available in either a stone or a concrete finish. acquabella.us

2. All-in-One Decking Kit
Fortress Building Products customizable Deck Kits include steel deck framing, stairs, decking, Al13 Plus aluminum railing, and the hardware required to build out a 12-by-12-foot deck. Your customers can choose the configuration—free-standing or attached; the decking—Apex or Infinity I-Series decking (in a variety of colors); and the stair height—three, five, seven, or 10 steps, or no stair. Pricing starts around $7,300. fortressbp.com

3. Post-consumer Recycled Decking
Made by Avon Plastics from post-consumer recycled plastic, the Armadillo Essential line comprises grooved- and solid-edge deck boards with fluted bottoms; fascia; and 2x4s. The plastic-composite boards are capped on four sides with polyethylene and are available in four colors: dovetail, saw grass, saloon, and thunder (pictured). The manufacturer says deeper embossing makes the surface more resistant to scratching. Products come with a limited lifetime warranty and two years of labor coverage. armadillodeck.com

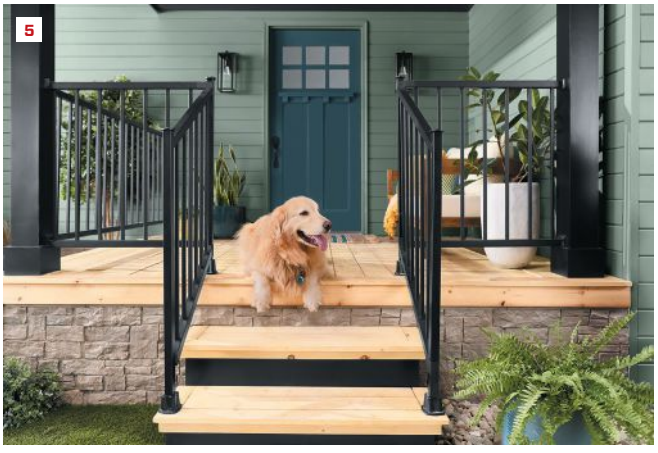
4. Enhanced Construction Tape
Avery Dennison has launched several new Performance Tape constructions. These include a low-VOC acrylic tape for interior, foam-bonding applications (FT 8299); an acrylic and rubber differential tape for bonding foam to plastic or vinyl (FBD 8393 and FBD 8393 12 PT, pictured); and a single-coated foil tape that reportedly performs well in high-moisture conditions and can be applied in temperatures as low as 0°F and withstand temperatures as low as -35°F and as high as 325°F (FL 0833 PCK). averydennison.com

5. High-Performance Exterior Paint
The upgraded formula for Dutch Boy Maxbond Plus exterior paint delivers extreme adhesion as well as improved dirt resistance, according to the company. Maxbond Plus can be applied directly over sound, nonpeeling, previously painted surfaces ranging from chalky to dirty to glossy. The company says the paint resists fading, mildew growth, and cracking and can repel rain within 90 minutes of application. dutchboy.com

6. Panelized Wood-Grain Stone Veneer
Inspired by 19th century barns, Rivenwood from Eldorado Stone is a panelized stone veneer profile with wood-grain characteristics such as nails, breaks, and knots with a patina that blends natural wood colors with tonal grains. Available in three colorways, panels are 4 inches high, 35 3/4 inches long, and between 3/4 inch and 1 3/4 inches thick. eldoradostone.com

7. Hidden Deck Clip
The Grip-Rite Ninja Hidden Deck Clip is designed to save deck builders time when installing Wolf, Trex, and Fiberon grooved deck boards. Integral compression-fit levers hold the clip in place, helping to speed the installation of deck boards, while serrated metal teeth hold boards securely in place. Each clip is preassembled with a Grip-Rite PrimeGuard Max 316 stainless steel coated fastener, eliminating the frustration of and time spent fumbling for fasteners and manually threading them into the clip. Suggested retail price for a 50-square-foot box is $50 and for a 500-square-foot tub, $400. primesourcebp.com

8. Ledger Bracket for Brick Veneer Siding
To simplify installation of an attached deck to a house clad with brick or stone, DeckStruc steel ledger brackets are engineered to transfer loads from the deck ledger directly to the house framing, relieving the house band joist and the brick or stone veneer claddings from carrying any structural loads. Designed to be installed 4 to 5 feet apart, the brackets provide a 6-inch-wide gap between wall sheathing and the inside face of the deck ledger. They consist of an interior mounting channel that bears on the top plate of a framed wall and fastens between the floor joists, and an exterior ledger support that through-bolts to the mounting channel. Pricing starts at about $162 per bracket. deckstruc.com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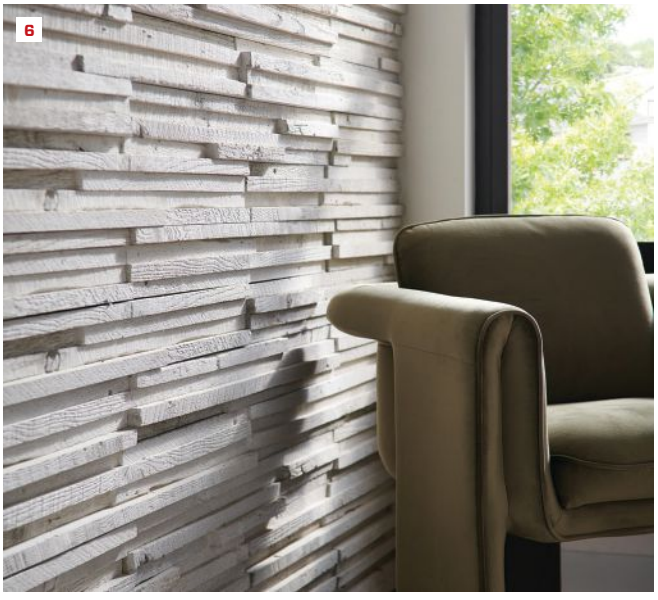
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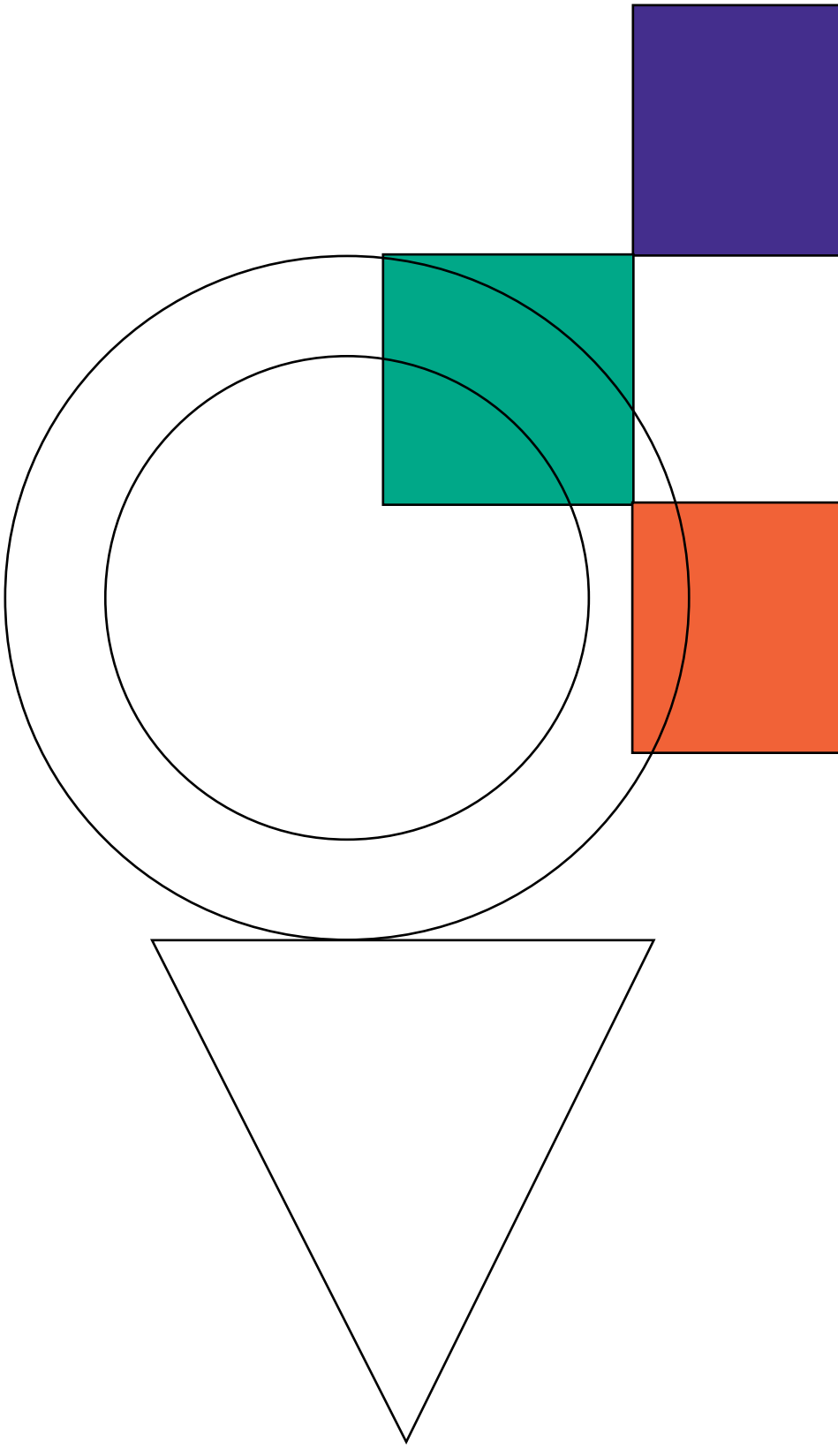
9. Four-in-One Exterior Insulation Panel
StoneCoat says its Fusion system replaces four layers of materials used in exterior wall systems: exterior insulation, sheathing, water and vapor barriers, and metal lath. Compatible with most exterior claddings, the carbon-neutral panels feature structural insulated sheathing and integrated masonry backing. Panels with standard 2-inch foam are rated at R-10; foam up to 6 inches thick is available. Seams are sealed with composite laminate tape to form a continuous air and water barrier. The company's cladding can bond directly to the panels. stonecoat.com

10. Self-Sealing Joist and Ledger Deck Tape
Camo self-adhesive butyl Joist + Ledger Deck Tape self-seals around fasteners to protect wood deck framing against moisture. The tape can be applied to the top of joists and ledger boards, between joist hangers and the ledger, between rim joists and fascia, and between framing and joist hangers. The 65-foot roll is available in three widths: 1 5/8 inches ($29), 3 1/8 inches ($57), and 6 inches ($114). camofasteners.com

11. Fast-Cure Acrylic Roof Coating
GacoFlex A48 single-component, high-build, acrylic roof coating can be applied up to 80 wet mils thick in a single pass. The manufacturer says the coating, which can be applied for maintenance over most existing roof substrates, offers a long roof life, strong adhesion, high tensile strength, and reflectivity. The water-based solution is zinc-free, contains zero VOCs, and can be sprayed from a standard acrylic spray system. It is resistant to rain as soon as 30 minutes after application and cures fully in about eight hours, according to the manufacturer. gaco.com

12. Interior and Exterior Hybrid Sealant
DAP AMP (advanced modified polymer) hybrid All Weather sealant is approved for both exterior and interior applications. The manufacturer says the formula creates a weatherproof and waterproof seal that can protect against fading, discoloration, and damage from harsh weather and endure expansion and contraction caused by sun, heat, cold, wind, and rain. Paint- and water-ready in 30 minutes, the sealant can be applied on wet and damp surfaces and used in temperatures from 0°F to 140°F. A 9-ounce container costs $11. dap.com

JLC



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Cordless Nailers for Trim Work

BY TOMMIE MULLANEY

Most days, I use one of my pneumatic nailers powered by a Makita quiet series compressor for the light framing and trim work that I do. It's hard to beat this combination for its light weight, durability, consistency, and lack of recoil. But when a jobsite is lacking power, or I'm on a quick punch-out job, or I don't want to lug a compressor up a set of stairs, battery-powered nail guns shine. I'm not one of those carpenters who have switched over to battery-powered nailers completely (I've found them to be too heavy to carry around on a toolbelt all day), but I've come to appreciate their versatility, portability, and convenience compared with that of their pneumatic siblings. Recently, I've been trying out four 18-volt-battery-powered offerings from Metabo HPT: a 15-gauge angled nailer, a 16-gauge straight nailer, an 18-gauge brad nailer, and a 23-gauge pin nailer. What follows is an overview of each nail gun, including an explanation of which gauge works the best for the task I am completing.

MultiVolt Brushless 15-Gauge Angled Finish Nailer. This nailer (NT1865DMAS) is a versatile and powerful tool capable of shooting 15-gauge nails up to 2 1/2 inches long, a recommended length for installing interior door jambs. With this great power comes increased weight—7.6 pounds without a battery—something that I definitely noticed when nailing overhead. On the other hand, the added weight didn't bother me when I was installing interior door jambs, and I didn't have to worry about tripping over a hose while moving the door slab back and forth.

This gun has a standard magazine capacity of 100 nails ranging in size from 1 1/4 inches to 2 1/2 inches, and it can shoot up to 800 nails per charge with the new, smaller, 2.0-Ah compact battery that comes with the kit. While the compact battery saved on weight, I found the battery life to be far less than that of the larger Metabo batteries, so for installing door jambs all day, I opted for one of the larger MultiVolt batteries that are compatible with the nailer. This nailer has a dry-fire lockout and comes with a built-in belt hook, but with the additional weight, I tried to keep the gun on a rolling cart versus my toolbelt when not in use. Suggested retail price: $300.

MultiVolt Brushless 16-Gauge Straight Finish Nailer. I consider this gun (NT1865DMST) to be the Swiss army knife of nailers and find myself using it for fastening larger trim details such as poplar crown where I need the holding power without the large hole that a 15-gauge nailer leaves, as well as for fastening smaller trim. It weighs in at 6.6 pounds without a battery, a weight I found bearable but certainly noticeable when on my belt or at the end of the day. This nailer also has a built-in belt hook that can fold out of the way and dry-fire lockout.

Photos by Tommie Mullaney

For trim work that requires holding power, the author prefers Metabo HPT's MultiVolt 15-gauge angled finish nailer **(1, 2)**. Metabo HPT's 16-gauge straight finish nailer weighs about a pound less and leaves a smaller hole **(3)**.

With the 2.0-Ah compact battery, the 16-gauge finish nailer is capable of shooting 950 nails per charge, and up to three nails per second with zero ramp-up time. The magazine capacity is 100 nails ranging in size from 1 inch to 2 1/2 inches, making the nailer suitable for a variety of applications. Suggested retail price: $300.

MultiVolt 18-Gauge Brad Nailer. Metabo says that its new and improved 18-gauge brad nailer (NT1850DF) is 30% smaller and 31% lighter than its previous model. Now weighing only 4.4 pounds (without a battery), it still has the same 100-nail magazine capacity that handles 5/8-inch to 2-inch brads, and keeps other great features, such as the LED light, from the first generation. That 31% weight reduction is a very big improvement, especially for overhead work, resulting in a lot less fatigue. The belt clip on this gun comes with the kit and can be installed with a supplied Phillips-head screw.

This versatile brad nailer can shoot 1,300 fasteners per charge when fitted with a 2.0-Ah battery, which lasted up to a whole workday for me, depending on the project. Because of the small holes it makes, this is the nailer I reach for the most out of all the gauges for fastening trim work, with the exception of interior door jambs. When additional holding power is required, I will switch to a 15-gauge or 16-gauge nailer. Suggested retail price: $280.

One thing to be aware of with all three of these nail guns is that the tiny compressed air cylinders that power their firing pins—Metabo HPT calls it an air spring drive system—might occasionally need to be recharged. While you can send the tool back to the company for recharging, you can also purchase a $65 adapter and do this yourself. Considering that the adapter consists of two pieces of brass and a short rubber hose, it's not exactly a cheap fix, but by attaching the adapter to the gun and a regular compressor, you can quickly return the gun to full pressure.

MultiVolt Brushless 23-Gauge Pin Nailer. This compact nailer (Model NP18DSALT) has a different firing mechanism that left me with mixed feelings. Looking at the spec sheet, I'd say it has great features, such as the ability to fire 3,000 nails per charge, a weight of only 3.3 pounds, and an LED work light, making it convenient to use. But when I fired the gun, each shot had a weird vibration that was very different from what I felt with its larger siblings, due in part to the spring and cam internal action versus the compressed canisters used in the larger-model nailers.

When using a 23-gauge pinner, I am typically nailing stain-grade moldings or delicate pieces, and with this nailer's recoil, I struggled to get it to perform like a pneumatic. The gun size and features are great, but I would love to see some improvement in its overall performance before I got another. Suggested retail price: $230.

New battery. If you've ever used the original Metabo HPT nailers, you may have been frustrated by the lack of battery gauges on the batteries and by the slightly confusing gauges on the guns that weren't convenient to use. While the gauge remains on the guns, Metabo HPT's new batteries—including the 2.0-Ah batteries that come with these kits—now have a traditional-style four-block battery gauge that is clear to see and easy to operate.

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Metabo HPT's 18-gauge brad nailer **(4)** and 23-gauge pinner **(5)** both have onboard battery gauges **(6)**, though the company's new 2.0-Ah battery has a simple meter that is easier to read. If a nailer loses power, a reduction valve set (Hitachi 371208 J-394) is available for refilling the air chamber **(7)**.

Kreg ACS Plunge Saw

BY GARY STRIEGLER

I am not an early adopter. When I first discovered track saws, it was a good five years before I bought one, primarily because of sticker shock. But once I did, I quickly found out what I had been missing, and it wasn't long before I was regularly using a track saw for trimming doors, safely cross-cutting sheet goods, making long tapers, cutting wide shelving, and making all kinds of angle cuts.

Most of my track saw experience has been with models offered by Festool and DeWalt, the companies that first introduced them to market. Now, however, most tool companies make a track saw in both corded and cordless versions, and—surprisingly—one of the more affordable corded options is from Kreg Tools. Its ACS (adaptive cutting system) plunge saw has many of the same features—such as a positive stop position for blade changes, a chip guard, and a riving knife—as more expensive models from other track saw manufacturers. With its 6 1/2-inch-diameter blade, it can make cuts up to 2 1/8 inches deep at 90 degrees and 1 1/2 inches deep at 45 degrees; the bevel is adjustable from -1 to 47 degrees.

This saw also has one unique feature: The blade is on the left side, so it is easier for right-handed users to see the cut. I know, the track guides the cut, but I still want to be able to check it and make sure I'm not straying off my cut line or over- or under-cutting. It's driven by a 120-volt, 12-amp, variable-speed motor with an electronic brake.

The saw comes with a small dust bag that catches a lot of dust, but it fills up quickly. If I am cutting outside or just making a couple of cuts, I don't take the time to hook up dust collection, but the saw can also be hooked up to a standard vacuum.

When it comes to power, smoothness of plunging action, and adjusting the depth of cut, I can't say it is quite on the same level as the best track saws I've used, but its performance is perfectly adequate for the kind of work I do.

Unfortunately, the saw isn't compatible with tracks from other manufacturers. If you need a track longer than Kreg's 62-inch-long guide track, you can join tracks together with available connectors. For some long cuts, I like to clamp the track, and Kreg makes a clamp that fits under the track. I've used its clamps but have discovered that clamps from other manufacturers fit the Kreg track fine and work better (of course, they cost more too).

If you are on the fence like I was about buying your first track saw, I think the Kreg saw is a great option for all but the most demanding users. The saw and a track sell for around $400 (the saw alone sells for $300, and a track sells for $100), so unless you are committed to cordless tools, the Kreg ACS plunge saw is an option worth considering. kregtool.com

Gary Striegler, a JLC contributing editor, owns Craftsman Builders, in Fayetteville, Ark. (craftsmanbuildersnwa.com), and teaches workshops at the Marc Adams School of Woodworking. Follow him on Instagram at @craftsmanbuilders.

The Kreg ACS plunge saw has a 6 1/2-inch-diameter blade and works with the company's 62-inch guide track **(1)**. The saw features a blade-left design **(2)**. Tracks can be joined together with special connectors and fitted with clamps **(3)**.

Photos by Gary Striegler

BY TIM HEALEY

Thomas Midgley Jr. (Inventor)

This year marks the 100th anniversary of a benign-sounding automobile fuel, Ethyl, first being offered for sale in the U.S. at a filling station in Dayton, Ohio. (Dayton was home to Dayton Engineering Laboratories, or Delco, a subsidiary of General Motors that served as its research division.) It was hailed as a "gift from God" by a Standard Oil executive because it solved a major technical issue hampering a nascent automobile industry—engine knock. "Knocking" was the term used to describe the way engines stuttered and violently jerked when put under strain, typically while passing or going uphill—a persistent problem.

Comprising gasoline and the fuel-additive tetraethyl lead, Ethyl (leaded gasoline) was a hit, and within a year, General Motors, Standard Oil, and the DuPont Corp. had jointly formed the Ethyl Corp. to mass produce it. Combining lead with gasoline to produce this miraculous new, high-octane fuel was the brainchild of Thomas Midgley Jr., a bespectacled employee of Delco Labs.

Born on May 18, 1889, in Beaver Falls, Pa., Midgley had inventing in his blood. His maternal grandfather patented many designs related to circular saw blades (he invented the inserted-tooth saw blade used in sawmills). His father did work to improve the design of automobile tires in the early 1900s.

In 1916, Midgley was hired at Delco labs and was soon tasked with developing an effective yet inexpensive anti-knock additive for gasoline (at this point in time, it wasn't clear whether automobiles would run on gasoline or clean-burning ethyl alcohol). Midgley worked tirelessly, testing everything from iodine to melted butter and eventually settling on tetraethyl lead (TEL) in 1921. TEL was cheap to produce and could be patented (as opposed to ethyl alcohol) and had the potential for enormous profits. And even though lead had been known to be a neurotoxin since Roman times (so, for some 2,000 years), Midgley and company turned a blind eye to the potential dangers of using TEL as a fuel additive.

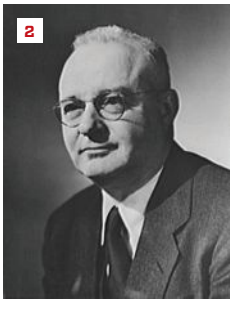
The public was repeatedly told that Ethyl gasoline posed no health risks. Ever the showman, Midgley washed his hands with Ethyl fluid for reporters, stating that "he was not taking any chance whatever, in doing so." (Apparently inventing wasn't the only thing in his blood; a bout of acute lead poisoning caused Midgley to take an extended medical leave in 1923.) Within a decade of its first sale at that Ohio filling station, tetraethyl lead was in 90% of all gasoline sold in America. The Ethyl Corp. was highly lucrative, and by the 1950s, its profits would be in the billions.

Not to be undone, in 1925, Delco tasked Midgley with developing a safer alternative to the toxic refrigerants used by a home-refrigerator startup, Frigidaire, which had recently been acquired by GM. His team discovered a seemingly ideal nontoxic refrigerant, dichlorodifluoromethane (aka "Freon"). Invented in 1928, Freon helped turn Frigidaire into a household name. Decades later, scientists realized that Freon (as well as other chlorofluorocarbons) were destroying the Earth's ozone layer. In his book, *Something New Under the Sun*, historian J. R. McNeill notes that Midgley, "had more impact on the atmosphere than any other single organism in earth's history."

In 1940, Midgley contracted polio. He died four years later when he became entangled in his last creation, a hoist system to lift himself in and out of bed.

1

2



4

3

5

Tetraethyl lead was branded as "Ethyl" **(1)**. Thomas Midgley Jr. circa 1940 **(2)**. Folksy ads were common (the word "lead" was never used in promotional material) **(3)**. A gas station attendant "fills 'er up with Ethyl" **(4)**. Fresh milk is put in a Frigidaire cooled with Freon circa 1940 **(5)**.

Photos: 1, gaspumpheaven.com; 2, 4, 5, Library of Congress; 3, Flickr.com

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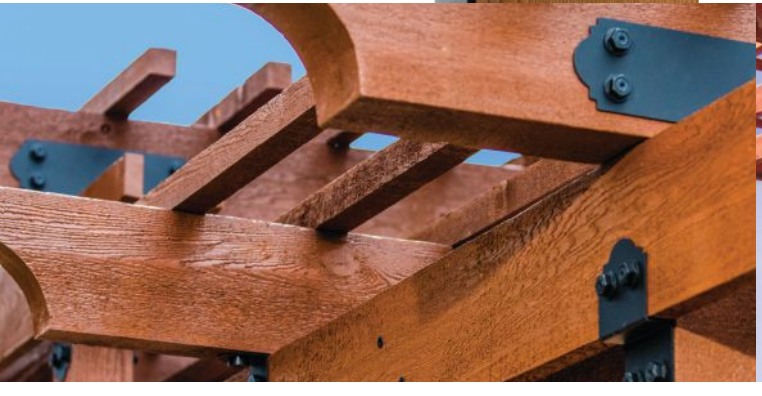

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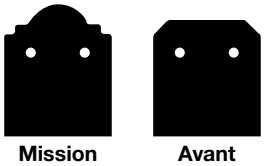

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