

Taunton's

CONQUERING COMPLICATED ROOFS

A production roof framer shares his strategies for calculating the angles and offsets of irregular hips and valleys

Fine Homebuilding

ISSUE 301 // AUGUST-SEPTEMBER 2021





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62

HOT
CLIMATE,
COOL HOUSE

FEATURES



46

HELICAL-PIER
SOLUTION



40

DOORS MAKE
A DIFFERENCE

COVER STORY

34 Conquering Complicated Roofs

Strategies for calculating the angles and offsets of irregular hips and valleys

BY RYAN SMITH

40 All About Garage Doors

Buyers have a wide range of options for architectural style, material, and price

BY SCOTT GIBSON

46 Footing Retrofit in a Day

Using helical piers to add footings to an old house is faster, less disruptive, and comparable in cost to excavating and pouring concrete

BY DAN KOLBERT

52 Must-Have Concrete Tools

A longtime builder's labor-saving tools mean better concrete too

BY ANDY ENGEL

AUGUST/SEPTEMBER 1981, ISSUE #4

58 Framing an Open-Plan Saltbox

Structural stability can be a problem when the load-bearing partition is removed

BY PAT AND PATSY HENNIN

62 Energy-Smart by Design

Building orientation, passive-solar design, and a radiant-barrier roof are key to energy efficiency in a hot-humid climate

BY KILEY JACQUES

52
WORKING WITH
CONCRETE



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IN EVERY ISSUE

8 **FINEHOMEBUILDING.COM**

10 **CONTRIBUTORS**

12 **LETTERS**

16 **TIPS & TECHNIQUES**

- Stripped-screw fix
- Prevent bits from walking
- Build a dump truck ...and more

22 **KNOW THE CODE**
Back to the attic

26 **TOOLS & GEAR**

- Smart, tough worklights
- Deburring tool
- Superior sander ...and more

68 **HOUSES BY DESIGN**

77 **SPEC**

- Modular modern cladding system
- Ready-made shower pan
- Mess-free seal for plumbing penetrations ...and more

82 **ASK THE EXPERTS**

- Flashing a round window
- Flattening a wall
- Working around live wires

86 **BUILDING MATTERS**
When will we see the end of soaring lumber prices?

90 **KEEP CRAFT ALIVE**
Justin Fink, carpenter

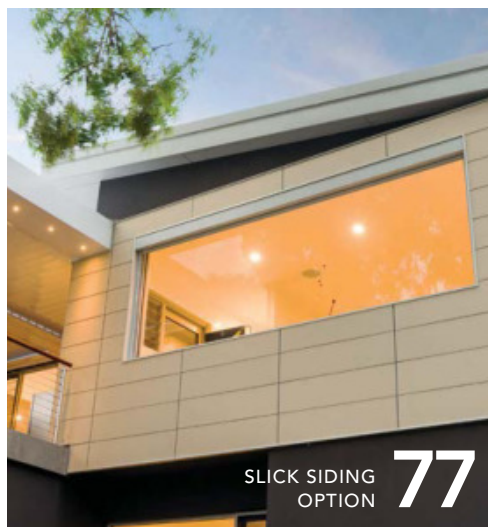
16

CUSTOMIZE
YOUR PPE



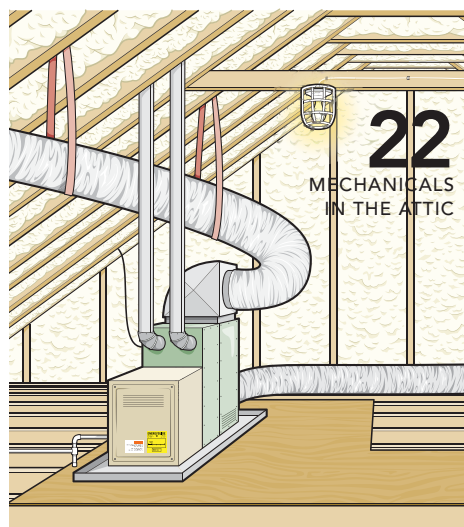
68

GAZEBO
GROWS UP



SLICK SIDING
OPTION

77



22

MECHANICALS
IN THE ATTIC



26

LIGHT YOUR
JOB SITE



82

PERFECT
DRYWALL
REPAIR



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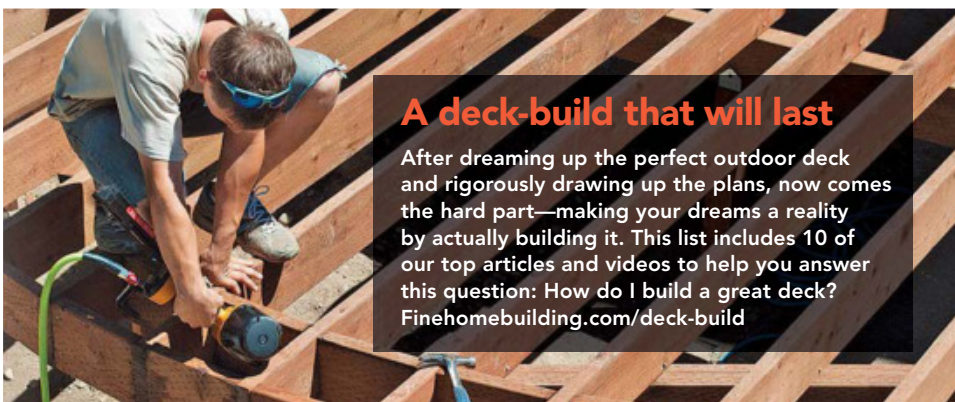
Building a foam-free vaulted roof

Builder Josh Salinger shares his plastic-free solution to manage moisture and allow for full-depth insulation while creating a vaulted roof assembly: [FineHomebuilding.com/videos](https://finehomebuilding.com/videos)



Ep. 354: Hiring your first employee

The editors respond to a question about taking the right steps to hire quality employees for a growing remodeling business. Watch all the episodes at [FineHomebuilding.com/podcast](https://finehomebuilding.com/podcast).



A deck-build that will last

After dreaming up the perfect outdoor deck and rigorously drawing up the plans, now comes the hard part—making your dreams a reality by actually building it. This list includes 10 of our top articles and videos to help you answer this question: How do I build a great deck? [Finehomebuilding.com/deck-build](https://finehomebuilding.com/deck-build)



Wood-fiber insulation launch planned for 2022—the first of its kind in North America

Wood-based loose-fill, batt, and board insulation will compete with mainstream products now on the market. Get more details at [FineHomebuilding.com/blogs](https://finehomebuilding.com/blogs).

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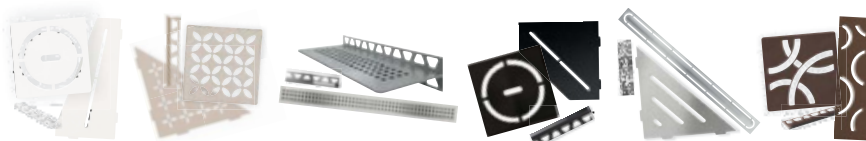
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THE VOICES OF EXPERIENCE



For the first 15 years of his career, **STEFAN STRAKA** (Tools & Gear, p. 28) focused on home building, with a particular interest in small, energy-efficient buildings and remote cabins. Although his main tasks were project management and lead carpentry, he jumped on opportunities to work on creative elements like custom doors, cabinetry, and built-ins. After moving from Portland, Ore., to Bellingham, Wash., he set up own workshop, where he alternates between millwork, cabinetmaking, and custom furniture.

RYAN SMITH ("Conquering Complicated Roofs," pp. 34-39) has been a framing carpenter since 1999, right out of high school. Roof framing always gripped his interest and has turned into a lifelong passion. He started in Oswego, N.Y., where most roofs were trussed, and eventually moved to Buffalo, N.Y., where he learned about stick-framing. Ryan owned his own company from 2006 to 2012, and currently works for 7 Construction as a lead carpenter—or as he calls it, "roof cutter." Or as he's known on instagram, @roofslayer2681.



A fourth-generation builder and self-employed contractor for over 38 years, **MYRON FERGUSON** (Ask the Experts, pp. 82-84) specializes in drywall and all its related aspects, including insulation, air-sealing, and decorative finishes. Last year, Myron decided to put his knowledge to use as a construction manager for the local Habitat for Humanity, which he describes as a rewarding and uplifting place to work. This past April, his team finished the first house he supervised from start to finish, and the next two are underway.

write an article

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Building in expensive times

I think a lot about the cost and value of what we do at *Fine Homebuilding*. If you're considering spending a bunch of money on new garage doors, Scott Gibson's article on pp. 40-45 will be worth the price of this issue. If you are more accurate the next time you frame a complex roof, then Ryan Smith's article on pp. 34-39 will be worth the cost of your subscription. That's one aspect of our cost and value. Another is the potential impact that our content has on home building, homes, and homeowners at large. Are we helping people build higher-quality, more durable, smarter, and more energy-efficient homes that are more comfortable and more beautiful to live in, and cost less to operate? I think so.

Of all the directions that our content takes, promoting more affordable housing is, I think, where we fail most. We could certainly do more to explicitly help people build with smaller budgets and for less-wealthy clients. I hope that even though we're not directly covering affordable housing, the articles we publish, in the hands of those who are engaged in building affordable homes, can at least help make those homes better. Maybe this is wishful thinking, and the truth is that the goal of owning a house is more out of reach than ever before. According to a study released earlier this year by the National Association of Homebuilders (NAHB), about 60% of American families can't afford a median-price home.

Since that study was released up to the day I wrote this letter, the price of many building materials continues to climb. For the latest reporting we could gather on the growing cost of lumber, see Building Matters on p. 86. Keep in mind that we send these issues to the printer weeks before they reach you. Maybe the market will have started to correct by the time you read this. I hope so. For most people, a home is the investment of a lifetime; the most money they will ever spend on a single purchase. And unless they are in it for the long haul, and the market is in their favor when it is time to sell, there is no guarantee that it is a good investment.

NAHB estimates that the cost increase in building materials is driving the price of a new home up as much as \$36,000. And yet, all the building professionals I speak with are super busy. This may be related to another phenomenon: a particularly low inventory of available homes for sale. Is it that simple? Are buyers and those wanting to remodel their current homes simply willing to pay these prices? Are builders changing their approach, and choosing alternative materials? Are these expensive times putting quality at risk? We'd be interested to hear how this is impacting you, your work, or your new build or remodel. If you have a story or helpful advice to share with others, please send it our way and we'll do our best to publish it in our next issue.

—BRIAN PONTOLILLO
editorial director

Are smart devices secure?

It was interesting to see the article on diagnostic smart thermostats by Doug Horgan in Tools & Gear (*FHB* #299). I have one, but I have not hooked it up to wireless internet. I cannot find any information on what data the vendor can see and what data the vendor maintains from the thermostat, and how secure the devices are. From what I can tell, these devices are easily hackable, which allows a hacker easy access to your home network and PC. It would also be easy to identify remotely that you are not home and when you are on vacation. While I would love to be able to turn up the heat when I am at the airport, I will not until I know that these devices have adequate security built in.

—KURT KOLSETH
Hawthorn Woods, Ill.

Author Doug Horgan replies: Certainly my smart thermostat knows a lot about my family: when we get up, when we go to bed, what temperature we like, and when we're out of town. My electric utility has even more of the same type of info, from my smart meter. I even deliberately installed second-by-second, circuit-level electrical monitoring that sends huge amounts of data to another company. Alexa knows when I'm in the room talking, my ISP knows where my internet traffic is going, my cell-phone provider knows where my phone is and who I talk with, and I'm on Instagram,

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Facebook, and Twitter. In the aggregate, the things my thermostat knows (and collects and stores securely—or very possibly, accidentally loses to the internet) are nothing unusual in today's world.

As to whether my house can be hacked via my thermostat—if I understand correctly, with any internet-connected device, that's a possibility. My guess is that the bigger companies have very good security including over-the-air updates, the smaller ones are not a good enough target to be worth hacking, and the off-brand video doorbells and similar poorly supported devices are quite risky.

I'm no expert, but the experts I follow say it's important to have a firewall and network address translation at your connection to the internet, which many routers have built in. All in all, it's important to consider that anything you connect to the internet has some possibility of being a route to hacking or to losing some personal data. My current opinion is that the former is unlikely and the latter is not as concerning as other things I do all the time, so for me, connected thermostats are worth the benefits, but I'd never say that this should be the same for you, or for the next person.

Home-run roof solution

You can imagine my amazement and delight when we had just put up the rafters of a vaulted roof and your issue with the article "A New Take on Insulating a Roof" (*FHB* #299) arrived. Using this method did increase labor and material cost, but I'm pleased with the final result. We now have a full 12 in. to insulate a



That was fast!
Reader Nico Foster has already adopted and completed the insulated roof assembly published just two issues ago on his own build.

superventilated roof system. I have a lot of confidence that this is a home run of a design solution. One technical note on the assembly: Due to our high snow loads, we decided to run 6-in. Timberlok structural screws into the rafters through the 2x4s for extra strength. A big thanks to the design-build crew that came up with the system and you at *Fine Homebuilding* for bringing it to your subscribers.

—NICO FOSTER
Silverton, Colo.

Consider restoration

I'm happily spending my Sunday afternoon reading the June issue (*FHB* #299). After reading Glenn Mathewson's Know the Code, "Energy codes as clear as glass," I feel the need to speak up on behalf of myself and the many skilled restoration professionals that are working on preserving existing windows in older homes with the combined goals of energy efficiency, aesthetics, and waste reduction in mind.

There are certainly instances where replacement windows are appropriate, and in many cases where original windows are too far gone to be affordably restored, replacements can be an acceptable alternative. However, there are also many products and techniques that we in the restoration world employ to make wood sash

and their respective openings function better and provide greater energy efficiency while keeping historic components of the building intact and out of the landfill.

In the letters section of the latest issue, the editor speaks of "shared objectives" with regard to climate change and steps we in the building trades can take to do better. There are many tangential weeds that one can get into regarding SHGC, U-factors, and infiltration rates, and there are plenty of studies showing the comparative effectiveness of new double-glazed windows versus single-pane windows with storms. The simple takeaway I get is that restoring an older window, weatherstripping the opening, and installing a well-sealed storm window is a much "greener" way to approach the challenge of living with inefficient windows.

Restoration is a viable and valuable way to improve on what is already there and lighten everyone's carbon footprint. I love your magazine and I learn a lot from each issue, but I would like to see more consideration given to our industry as the practice of throwing out the old while chasing the new seems shortsighted at best and environmentally catastrophic at worst.

—JEREMY KINDALL
Brookline, Mass.

your safety

Home building is inherently dangerous. From accidents with power tools to falls from ladders, scaffolds, and roofs, builders risk serious injury and even death. We try to promote safe work habits through our articles. But what is safe for one person under certain circumstances may not be safe for you under different circumstances. So don't try anything you learn about here (or elsewhere) unless you're certain that it is safe for you. Please be careful.

—BRIAN PONTOLILO
editorial director



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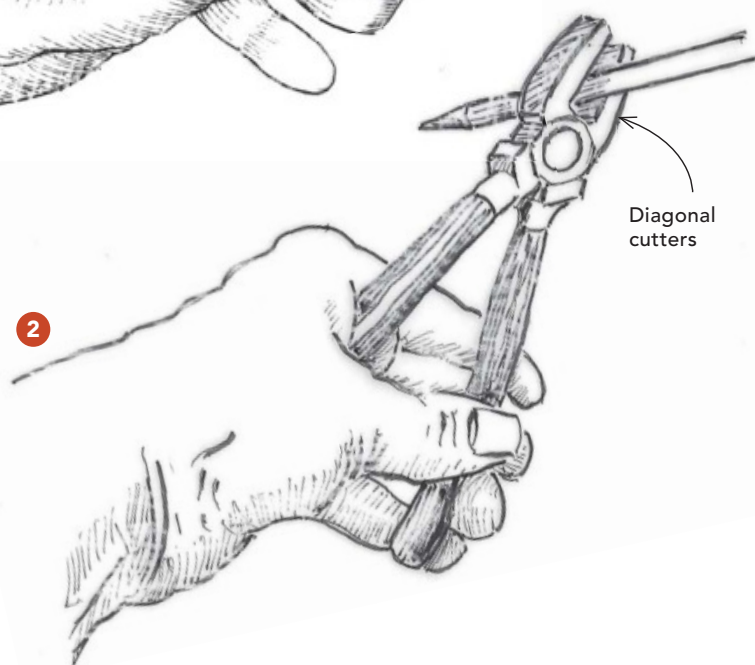
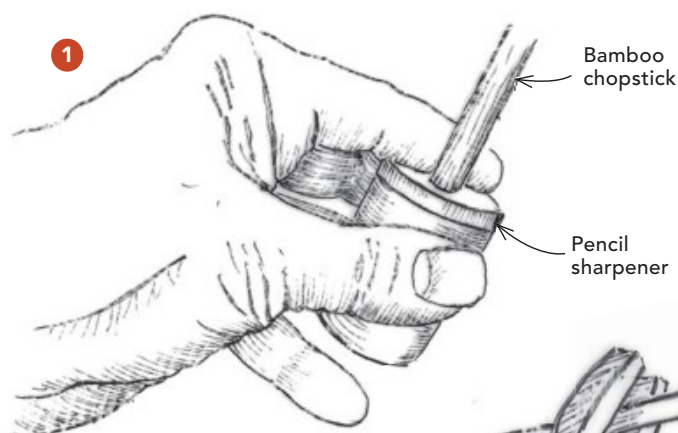
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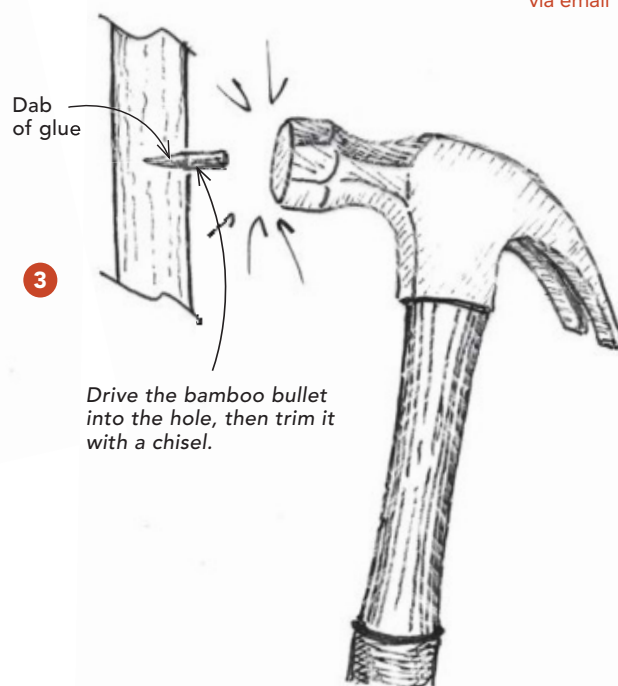
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Stripped-screw fix

My cabinetmaker father used to always carry dowel scraps in his nail pouch for filling stripped and oversized screw holes, but chopsticks work just as well. Sharpen the tip in a pencil sharpener (1), cut off the resulting cone with diagonal cutters (2), and drive the sharpened chopstick tip into the hole (3). Repeat until the chopstick is used up.

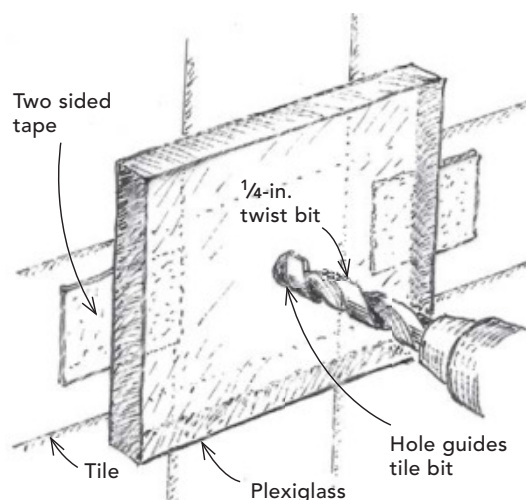
—PEETER VILLOMANN
via email



Drive the bamboo bullet into the hole, then trim it with a chisel.

Got a tip?

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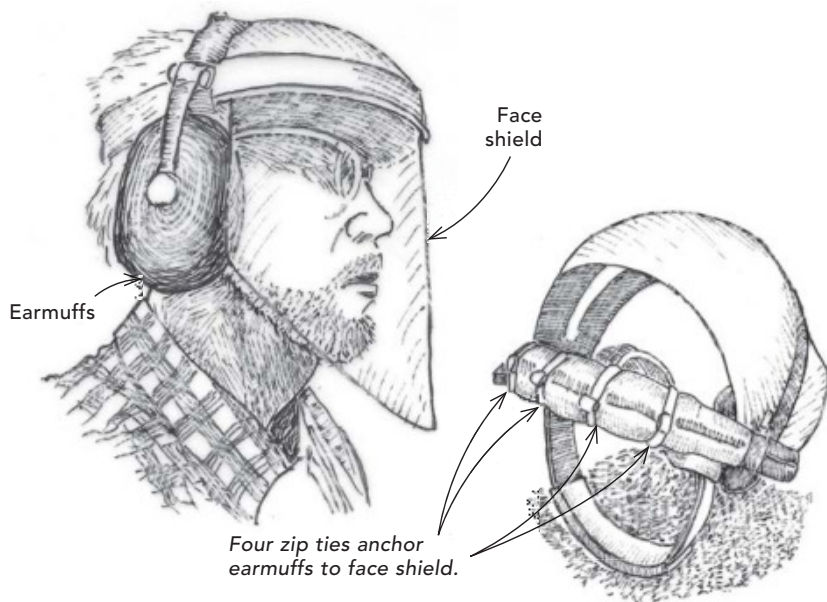
These bits were made for walking

The hole-saw shape of diamond drill bits used with porcelain tile makes it difficult to get them started. My solution is to drill a hole in a piece of plexiglass with a twist bit the same diameter as the tile bit you're using to drill the tile. Mark the hole location on the tile and use two-sided tape to mount the plexiglass to the tile. Drill a hole in the plexiglass with the twist bit and then use the hole to keep the tile bit from walking when you're getting started. Squirt a little water as you drill to cool the bit.

—DICK SNAVELY
Lexington, Ohio

First we went above.





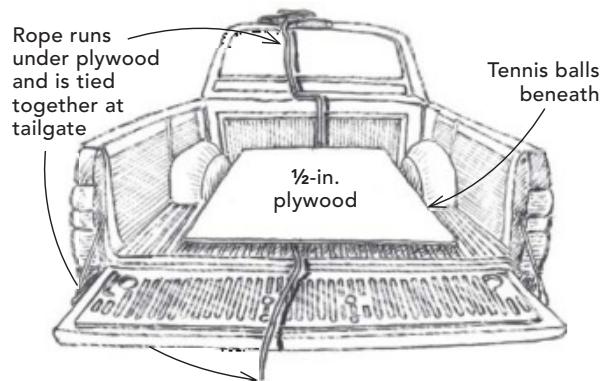
Face shield and hearing protection

I prefer earmuffs to earplugs and protecting my entire face with a shield rather than just safety glasses. When I couldn't find this setup locally amid recent supply shortages, I made my own face shield/earmuff protection. I used nylon zip ties to secure the muffs to the face shield. To my surprise it's both comfortable and easy to put on and take off.

—KEITH GOBEN
Seattle

Build a dump truck

Here is how I get bulky loads out of my pickup with minimum effort. First, I put about eight golf or tennis balls around the bottom of my truck bed. I lay a rope down the middle, and toss it over the cab of the truck—this is the pull line. Then I put a ½-in.-thick sheet of



plywood between the wheel wells, on top of the balls. I load the debris onto the plywood, tarp it, then pull the rope that was on the cab over the tarp and tie it down near the tailgate.

When I get to the dump, I drop the tailgate, untie the rope, and pull on both ends to slide the load out of the truck. When I'm done, I pick up the plywood, tarp, and tennis balls and go home without an aching back.

—STEVE LARSON
Santa Cruz, Calif.



TIMELESS TIP

ISSUE 3 // JULY 1981

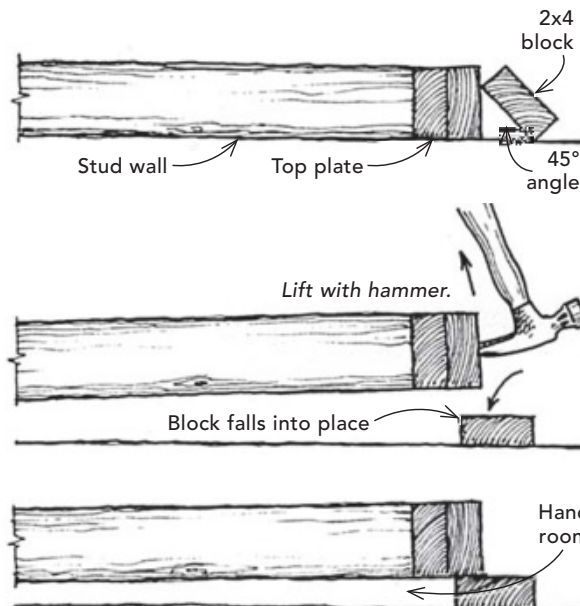
Two builders framing a wall on the floor need to get a lift before placing it. Dave Bullen's tip from *Fine Homebuilding* issue #3 shows how a couple of 45° 2x4 blocks makes it easy to get the right handholds.

—CHARLES MILLER

Hand room

Back when I worked in the tracts, a little trick made our lives easier when it came time to lift stud walls into place. Both people working on a wall would pick up a scrap piece of 2x4 and lean it against the top plate at about a 45° angle. Then we would bury the claw end of our hammers into the top plate deep enough to provide lifting purchase on the wall. Both workers lifting together would then raise the entire wall enough to allow the 2x4 blocks to fall under the top plate, providing hand room for the final lift from the other side

—DAVE BULLEN
Berkeley, Calif.



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There's something about the simplicity and utility of old homes that gives them undeniable character. Traditionally, a home's architecture was based on its location and climate. Its materials were local. Form had no choice but to follow function. Many Colonial-era homes still stand, some with original siding, windows, and doors. There was some inherent durability in old-growth lumber, and craftsmanship was first-rate. You can also bet that every historic home you drive by has been well cared for. Thankfully, owners have been willing to spend the time and money on the maintenance that these homes require.

Fast forward to 2021. Builders have modern materials and techniques for waterproofing and air-sealing that hide behind the siding. Owners often want homes that require less maintenance. You can get just about any material you want in any part of the country, and there is an architect in every town able to design just about any style home. What hasn't changed is that exterior finishes are still the first line of defense against the weather, and they give a house curb appeal. Here's a house designed and built with exterior materials from ProVia that are durable, low maintenance, and full of charm.

SIDING

There's a reason vinyl owns the siding market—it's durable, it's affordable, it installs quickly and easily, and it's available in many styles. When insulated, it is also the only siding that can add to the efficiency and comfort of your home, providing a thermal break outside of the framing. ProVia's CedarMAX™ line is an insulated vinyl siding available in several styles of lap siding as well as the board-and-batten look shown here in Willow. With an R-value of 2.2, CedarMAX™ Board 'n Batten is listed as an approved product to help builders meet the ENERGY STAR for Homes program.

WINDOWS

ProVia's Aspect™ windows have multi-chambered vinyl frames for durability. They have triple-weatherstripping, insulated glass, and warm-edge spacers for energy efficiency, and are ENERGY STAR certified. Aspect™ windows come with a lifetime limited warranty on materials and workmanship, including glass breakage and seal failure, that is transferable to the next homeowner. Shown here are Aspect™ White double-hung windows with custom cottage grids.



DOORS

ProVia's Signet® doors have embossed wood grain for a traditional look, but are actually finished with a durable fiberglass skin that will never rot. The hardwood rails and stiles inside are dovetailed and glued for rigidity, and the interior is foam-filled for energy efficiency. Shown here is a Signet® Craftsman door with a Truffle finish. The line comes in several styles including Cherry, Mahogany, Oak, Fir, and Knotty Alder, each with a variety of available stains.

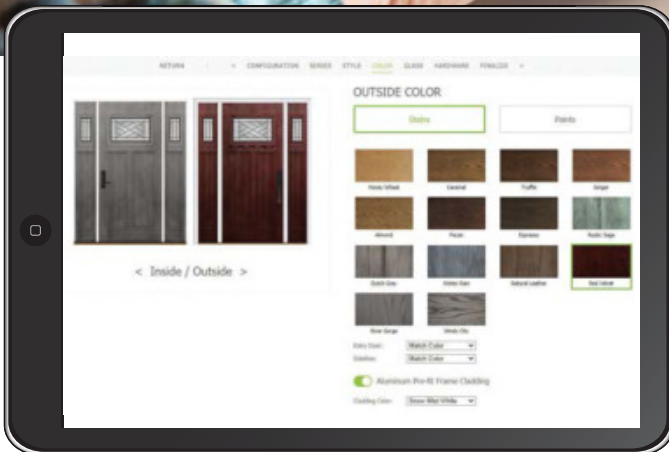
STONE VENEER

Manufactured stone has taken residential construction by storm because it is more affordable and easier to work with than natural stone, yet it is just as durable. Made from concrete, ProVia's manufactured stone is available in a variety of profiles, textures, and color palettes, from fieldstone, to river rock, to several quarried-stone styles. Shown here is a combination of the Shawnee Dry Stack and Buckingham Limestone products. ProVia's low-maintenance stone products carry a lifetime limited warranty and are certified by the National Concrete Masonry Association.

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their home with the perfect curb appeal



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DOORS | WINDOWS
SIDING | STONE | ROOFING

Back to the attic

When I was framing homes in the late '90s, temperature issues on second floors led some builders to add a second furnace in the attic to handle the top floor independently. I remember modifying truss chords with engineered repairs to support the extra equipment after new buyers complained of uneven heating. This practice carried on into my years as an inspector.

From an energy-conservation perspective in the early I-codes, the ducts in these attics, which were always vented, just needed to be insulated and, presumably, installed above the ceiling insulation. However, as energy codes grew more stringent, with tighter air-leakage requirements and the increased use of ACCA Manuals J, S, and D for energy loads, equipment selection, and duct design, many builders stopped putting HVAC equipment in vented attics, choosing instead to sacrifice marketable square footage on the second floor to create a furnace closet within the thermal envelope.

Around the same time HVAC equipment was coming down from the attic, the provisions for a “conditioned attic” (now “unvented attic”), introduced in the 2006 International Residential Code (IRC), were being cyclically updated

and expanded with each new edition. This was a new and interesting topic for innovative builders about a decade ago (see Martin Holladay’s “An Unvented, Superinsulated Roof” in *FHB* #224), but since then, many entry-level tract-home builders have embraced the unvented-attic approach. And with that embrace, HVAC equipment has again found a home in the attic.

Even if you aren’t using this approach to get more living space, you still get quite a bit of square footage within the thermal envelope that can be given

a useful purpose. Here are all the provisions in the latest IRC related to that location.

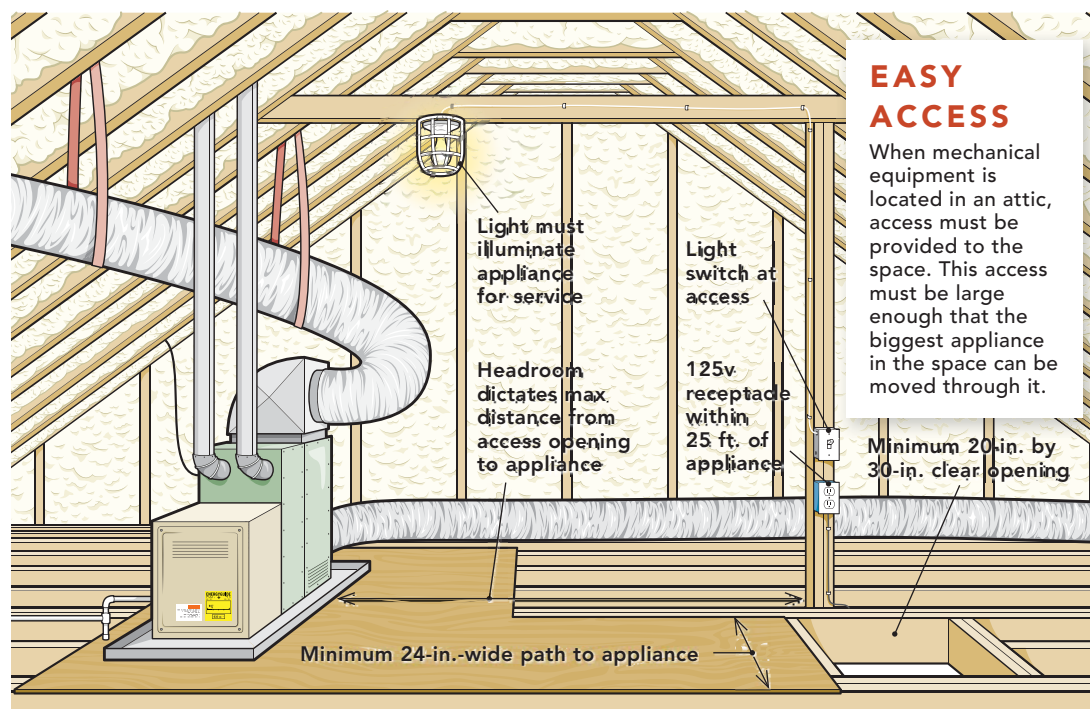
Manage condensation

Nothing in construction is an island, so while the insulation requirements for unvented attics may seem like an energy-code discussion, they’re also about moisture management—specifically condensation—which is addressed at the end of Chapter 8 (“Roof-Ceiling Construction”). The R-values and insulation arrangements described in this section are designed solely for control-

ling condensation in unvented cathedral ceilings and attics. Chances are that you’re going to need more insulation to meet the required thermal performance of these assemblies, which is addressed separately by climate zone in Chapter 11 (“Energy Efficiency”).

Provide an opening

Most single-family homes are built using wood framing, which falls into the category of what the code calls “combustible construction.” Buildings with combustible ceiling or roof construction enclosing attics



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that are at least 30 in. tall over at least 30 sq. ft. need an access opening, whether or not there are mechanical systems up there. Section R807.1 provides those details and requires that attic accesses have rough openings not less than 30 in. by 22 in. (specifically 22 in. wide by 30 in. tall if located in a wall). If the access is located in a ceiling, there must be at least 30 in. of headroom above it.

If you put mechanical equipment in the attic, access is required regardless of the size of the space. For these opening requirements, Section R807.1 points to Section M1305.1.2 in Chapter 13—“General Mechanical Service Requirements.” It’s important to mention that the provisions of Chapter 13 apply to, among other things, fuel-gas-burning equipment, which is specifically covered in Chapter 24 (I mention this only because some folks insist otherwise). Chapter 13, however, speaks to the final clear opening as opposed to the rough opening, and requires a minimum of 30 in. by 20 in. In addition, it also requires that the opening be large enough to remove the largest appliance, which may be larger than the minimum clear opening. That requirement could change soon, as a proposal for the 2024 IRC suggests a complete pull-down stair be required—stay tuned.

Once you have your head in the attic, if the appliance is right there, then get to work. If it’s not, you need to provide a passageway to it. The passageway clearance need only be 22 in. wide and 30 in. tall, so put on your kneepads for what could be up to a 20-ft.-maximum crawl. If the passageway has at least 6 ft. of vertical clearance

(across the whole 22-in. width), you can walk it up to a maximum 50 ft. The passageway must be built with solid flooring in accordance with Chapter 5, and it has to be at least 24 in. wide—more than the width of the required clearance.

Safety during service

We all know the code is about safety, but it’s not just for the full-time occupants. Recognition of service and emergency

The receptacle is there to aid in servicing the equipment, and if it happens to be on the same circuit as the appliance, it can’t be on the load side of the appliance’s disconnect. In other words, the receptacle needs to keep supplying power even if the appliance power is disconnected so that it can still be of use. In most cases, this receptacle is provided at the attic access opening adjacent to the required light switch, but if

it recognizes this attic passageway is not going to be occupied like the other parts of the house and offers a reduced minimum live load. In Table R301.5, the minimum design loads are provided and there are three choices for attics: Attics without storage, attics with limited storage, and habitable attics with fixed stairs. For the design presented in this article, “attics with limited storage” would be the appropriate choice and require a minimum

“...while the insulation requirements for unvented attics may seem like an energy-code discussion, they’re also about moisture management.”

personnel is embedded in the code in many ways, such as the requirement to provide a permanently installed light at or near the appliance. The switch for this light needs to be at the attic access so no one has to crawl down that tight path in the dark. Though a keyless fixture with an exposed lamp is the cheapest and most common way to provide light, an exposed lamp must either be protected or located so that no one will accidentally come in contact with it, while still illuminating the appliance. Most of these provisions are also found in Section E3903.4 in the electrical chapters of the IRC.

While tradespeople nowadays are likely to use cordless tools during service calls, the IRC won’t make that assumption. It requires at least one 125v, 15-amp or 20-amp rated receptacle outlet “on the same level” and within 25 ft. of heating, air conditioning, and refrigeration equipment (Section E3901.12).

a longer passageway with 6-ft. vertical clearance is provided, it often has to be located farther from the opening to be within 25 ft. of the appliance.

Know live and dead loads

So now we’ve got HVAC equipment, a technician, and maybe an apprentice on the truss bottom chord or ceiling joists. Can the framing support them? The furnace or other appliance is part of the dead load—the weight of permanent construction materials—and Section R301.4 makes it clear that the actual weight of “fixed service equipment” must be supported. For truss designs, this load must be included in the design assumptions for the trusses supporting the bottom-chord dead load. For ceiling joists sized prescriptively from the IRC span tables, there is no way to provide for this dead load specifically. For live loads—the weight of the people and their tools—the IRC rec-

20 psf (lb. per sq. ft.) live load be supported by the trusses or ceiling joists supporting the passageway and platform. When using the IRC tables in Chapter 8 to size ceiling joists, be sure to reference sizing for attics with limited storage.

I mentioned earlier that a proposal to require a pull-down stair at the attic access serving appliances was proposed for the 2024 IRC. It’s important to note that if this type of access is provided, it would not push the ceiling joist or truss bottom-chord design into the 30-psf live-load requirement for habitable attics. A habitable attic doesn’t have to be finished, but it does require a fully compliant stairway, just like one running up to a second floor. Such a stair would be overkill for accessing a passageway to a furnace or a stash of holiday decorations.

Glenn Mathewson is a consultant and educator with BuildingCodeCollege.com.



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Unilite is a European manufacturer of all types of industrial worklights. The three I tested below are powered by lithium-ion batteries, are impact resistant, and offer varying levels of water and dust protection. These lights are beautifully made and no detail has been value-engineered. If you're looking for durable, dependable, high-functioning worklights, Unilite is a sure bet.

Ben Bogie, project manager for BPC Green Builders of Wilton, Conn.



SLR-1000

The SLR-1000 is about the size of an old flip phone, and folds just like one. The body has a strip of LEDs for broad-area lighting and a second single-beam LED spot light on the end. The other side of the hinge is a hook and magnets with multiple detents that doubles as a stand. The strong magnets allow you to stick it to steel and iron and the hook allows you to clip it onto wires, small pipes, and more.

1000 lumens
USB-C charger
\$90

IL-175R

The IL-175R has a fold-out "baton" with led strips on both sides and a single LED on the end. It has a pen-style clip for attachment or storage as well as multiple magnets for near-limitless orientations. For probing into tight areas or working in small spaces, this light is awesome. Its slim size and magnets mean you can tuck it securely near the work and then adjust the baton to focus one of the three light options right where you need it.



175 lumens,
USB-C charger
\$60



CRI-2300

The CRI-2300 is about the size of a small dinner plate and has three brightness settings. Unilite calls it a "detailing light" for its ability to vary the color temperature, which you can adjust from 2700K to 6500K, in order to demonstrate what the lighting will be like when the space is lived in so you can accurately choose finishes. The CRI-2300 can be tripod-mounted and has no trouble fully lighting commonly sized rooms. Depending on the light intensity, it runs between two to eight hours.

2300 lumens
Combo AC/charging cable
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Deburring tool

I first saw this Deburring External Chamfering Tool by Sugelary in a pop-up ad while surfing the internet. I immediately thought about installing mudsills on a new foundation and how 80% of the J-bolts are thread-damaged. Sometimes it takes a couple of sacrificial nuts to get them back on track, which is a real time waster. So, I ordered a two-pack of the deburring tools from Amazon for \$15.

The tool is easy to use—just chuck it up on a drill and it's ready to go. The first time I tried it was when installing deck-railing posts and using threaded rod to connect the hardware. I cut the rod with a reciprocating saw, leaving a pretty rough cut, and then followed up with the deburring tool, which gave me a clean edge in just a few seconds. It's proven to be a great tool, and works on threads from 1/4 in. to 1 1/4 in.

Kevin Manning, lead carpenter at CSL Red House Design



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Superior sander

I ran a Festool Rotex 150 as my bench sander for many years, so when I was looking for a second sander to help alleviate some wrist pain that I'd developed, I decided to try out the Festool ETS EC 125/3 EQ. It quickly replaced all the other random-orbital sanders in my shop. The sander leaves an exceptional finish, its weight and balance let me sand comfortably for extended periods, and it has terrific dust collection. One feature that I have really come to rely on is the way the brushless motor stops nearly instantly when the unit is shut off. This makes switching tasks and changing out paper very efficient. While it may save only a few minutes over the course of the day, I find it makes my workflow smoother.

A few more positives: The size and balance of the tool make it easy to control while sanding, which means fewer flat spots and less oversanding when cleaning up profiles. Its low-profile grip and light weight make the tool agile and less tiring when working in awkward positions or overhead. In fact, I haven't found any serious downsides to this sander besides the cost (\$425). There are less-expensive random-orbital sanders that produce a good finish, but for a tool that I use extensively on almost every project, the smooth operation and excellent results make this one worth the price to me.

Stefan Straka, a cabinetmaker in Bellingham, Wash.

Photo: Stefan Straka



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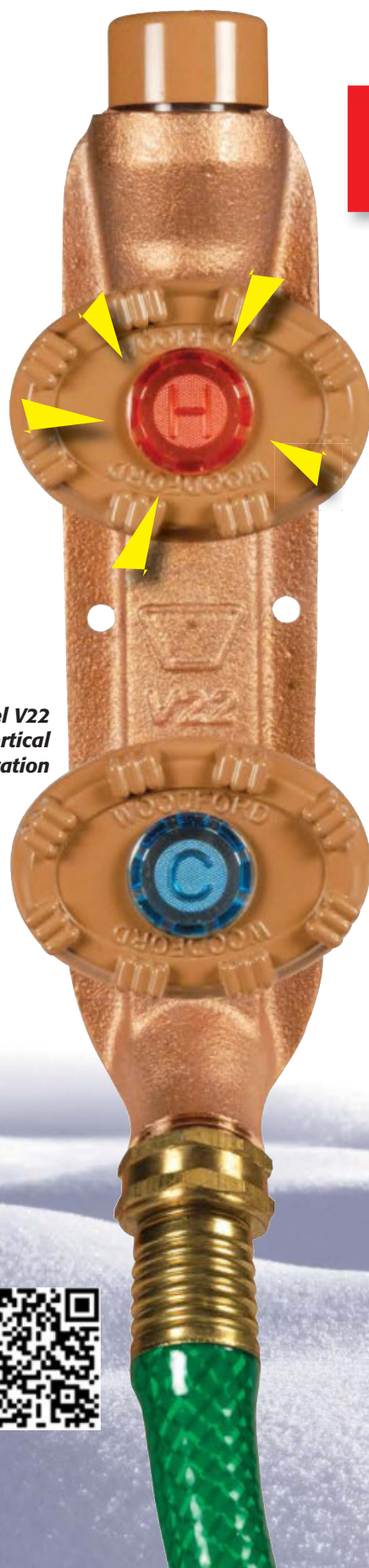
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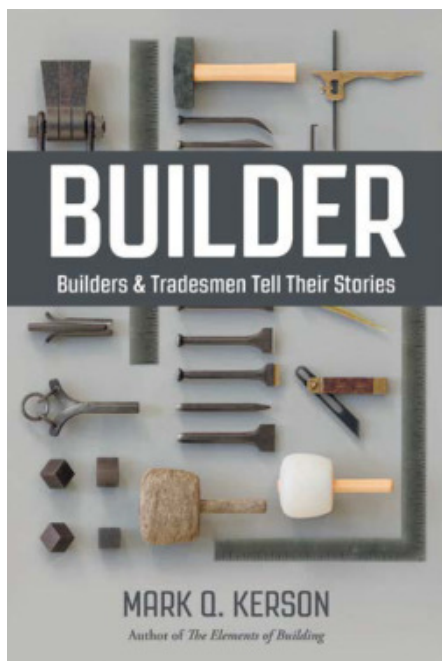


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A Builder full of wisdom

You'd think that by now I'd have read *The Elements of Building*, Mark Q. Kerson's highly-recommended book on the business of building. But I've never run my own construction company, so I haven't. When Mark's new book, *Builder*, arrived a few months back, the subtitle struck me: *Builders & Tradesmen Tell Their Stories*. If I've avoided the slog of learning about the business of building, I do like stories, and have now read a lot of this book of interviews.

Mark's questions are straightforward and repeated in most of the builders' interviews. This allows him to weave a narrative throughout the book with themes that include the nature of craft, the role of education for builders, the intersection of craftsmanship and business, and the value of learning from mistakes. There is wisdom in Mark's questions, but he doesn't belabor his introduction. He doesn't even take the time to explain the format of the book, though you'll pick it up quickly once you read a few interviews. One of my favorite parts is the word association: Mark provides a list of words like "integrity," "profit," and "gratitude," and the builders share what that word means to them. It's an easy-to-read, insightful part of each interview.

Fine Homebuilding readers will recognize a few names in the table of contents. Dan Kolbert, Matt Risinger, and David Gerstel are among the 28 builders Mark interviewed, but every person included has valuable building and life experience to share. If *Builder* is a bit folksy, it's equally full of wisdom from seasoned professionals. You'll find it in paperback for under \$30.

Brian Pontolilo, editorial director

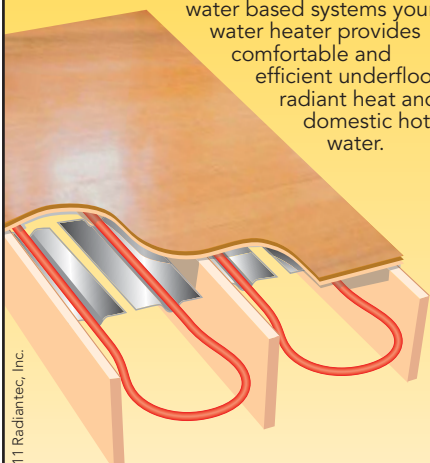
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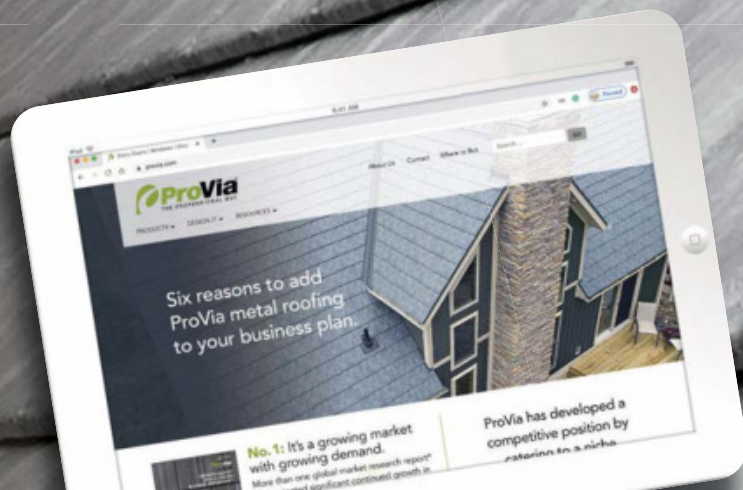
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Conquering Complicated Roofs

Strategies for calculating the angles and offsets of irregular hips and valleys **BY RYAN SMITH**

I didn't start out with great techniques for figuring out and cutting complex roofs. On roofs with bastard hips and valleys, I used to wait until the walls were up and use stringlines and squares to determine the angles. It kind of worked, but it wasn't perfect. After years of late nights and weekends spent inside and outside my garage tinkering with ideas and testing them out, and putting those lessons to work on real houses, I've learned how to figure out most things on my own. Now I can start figuring and cutting a roof before the rest of the crew has the first-floor deck finished (not that they're slow enough for that to happen).

A big part of my mostly self-taught roof-cutting education involved figuring out the angles and offsets for irregular hips and irregular valleys—what framers call bastards. A bastard is any hip or valley that supports different roof pitches on either side of it—say a 7-in-12 on one and a 12-in-12 on the other. This irregular geometry is a head-scratcher for a lot of carpenters. If you want to maintain equal, level overhangs, the bastard hip or valley can't land on a corner as one with equal pitches on both sides would. The hip or valley has to move off the corner in order to make this possible. How much it moves and to which side depends on the pitches and the depth of the overhang. The birdsmouth cuts and/or plate heights on top of the walls on either side of the corners are also going to be different.

There are ways to figure all of this out using a calculator alone, and there are many different ways to visualize this irregular geometry. I developed my own method of drawing it all out to see what's going on. I do one elevation drawing of the different pitches to determine the height above plate for the

common rafters. Then I create a plan-view drawing that I can use to see every angle I need to make the rafter cuts for every piece of the roof, as well as any deductions or additions I need to figure the rafter and ridge lengths. That said, I still use my construction calculator for some basic calculations rather than drawing some things out, partly to save time because I understand what's going on, and partly to keep the drawing from getting too busy.

I draw these things at full scale on sheets of plywood. For every house we frame, I always order two sheets of $\frac{3}{4}$ -in. square-edge plywood just for this. I hate trying to draw on OSB; it usually has too much texture for clean lines. It's important to make sure the edge you start from is square, otherwise the angles will be off (you can draw a square corner, but that isn't as easy as pulling a tape measurement off an edge). The thinner the lines, the more accurate everything will be. I sharpen my carpenter's pencil to a chisel point and hone it on a sanding block every couple lines. For measurements and straight lines, I use my tape measure, framing and rafter squares, and a long metal straightedge.

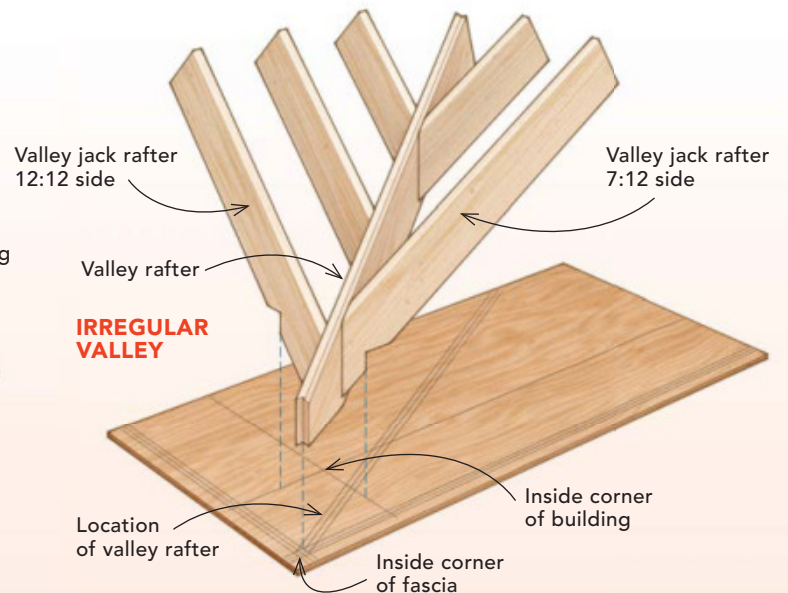
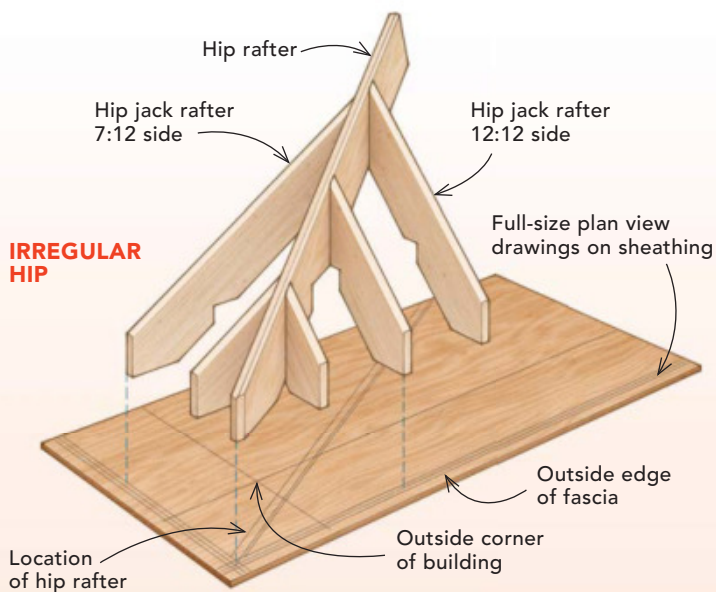
This is all to set up for calculating. Would I do it this way if I weren't self-taught? If I learned in a school setting or from another roof cutter, this method might not make as much sense to me. But it works, and it can be a good starting point for anyone trying to figure out how to frame complicated roofs. I'll cover efficient roof cutting in the next issue, so stay tuned. □

Ryan Smith is a lead carpenter for 7 Construction in North Tonawanda, N.Y. Drawings by Christopher Mills.



THE VIEW FROM ABOVE

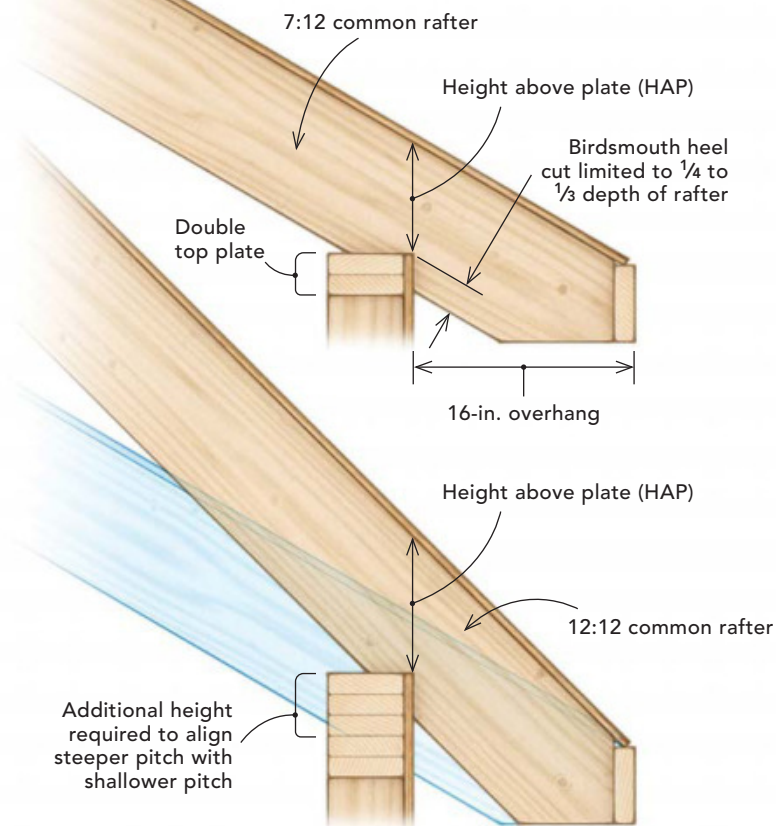
The plan-view drawing method shown in this article provides a bird's-eye view of how bastard hips and valleys intersect the outside edge of the walls they sit upon and the subfascia that gets nailed to them. The drawings to the right show how the irregular hip (left) and irregular valley (right) relate to the plan-view drawings (visible on the sheathing to the right) that we will create on the subsequent pages.



1 LAY OUT THE BIRDSMOUTHS

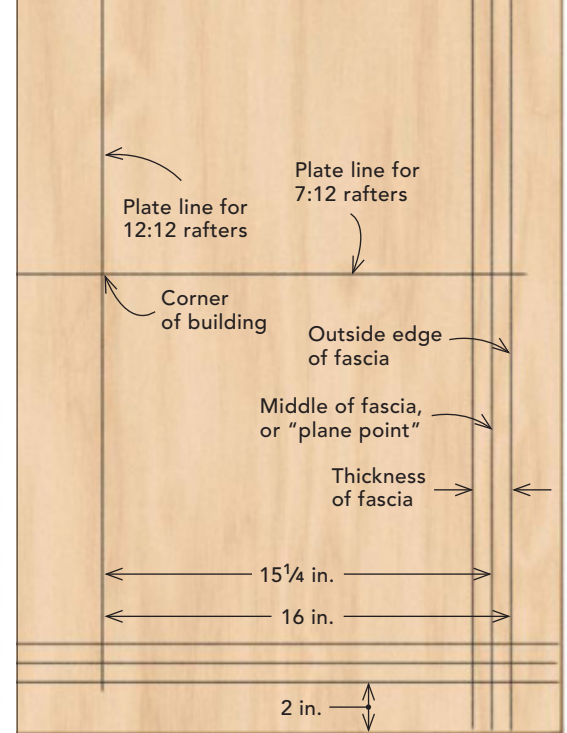
If you want equal and level overhangs, the different pitches on either side of a bastard require that adjustments be made to compensate for their different rises over the same run. The birdsmouth cuts, plate heights, or both will be different from one side of the corner to the other. You may have to add additional plates, a short cripple wall, or build the wall taller on the steeper side of the roof to position the rafters properly. Drawing this out makes it easier to visualize and to figure out the plate heights and the height above plate (HAP) for the birdsmouths.

Start by drawing the fascia and building line (the distance between the outside edge of the fascia and the building line is equal to the overhang), then extend the pitches back from the top center of the fascia, over and through the wall line; these lines represent the tops of the rafters. Drawing a pitch can be done by simply lining the 12-in. mark on the blade of a framing square with the top center of the fascia, marking



the appropriate pitch off the square's tongue, and connecting this mark back to the top center of the fascia. Once the lines for the tops of the rafters are drawn, measure and mark the depths of the rafters square off of them and draw lines indicating the bottoms of the rafters.

The HAP is somewhat dictated by code—there's a maximum you're allowed to cut into a rafter. In the International Residential Code (IRC), that max is one-quarter of the rafter material's depth. Where I work, we're allowed to go as deep as one-third—I've never been called on it, anyway. I use that requirement as a guide to establish the HAP at the back of the birdsmouth. After the rafters are drawn in, I draw the birdsmouth and the plate it sits on. From that, I can simply look at how the other rafters intersect the wall line to determine the birdsmouth cuts and additional plating or wall heights needed to support those. The top drawing shows a 7-in-12 common rafter on top of a standard wall. The bottom drawing shows that same rafter ghosted out with a 12-in-12 rafter superimposed. They start from the same point at the center of the fascia, but additional wall height is needed to support the steeper pitch.

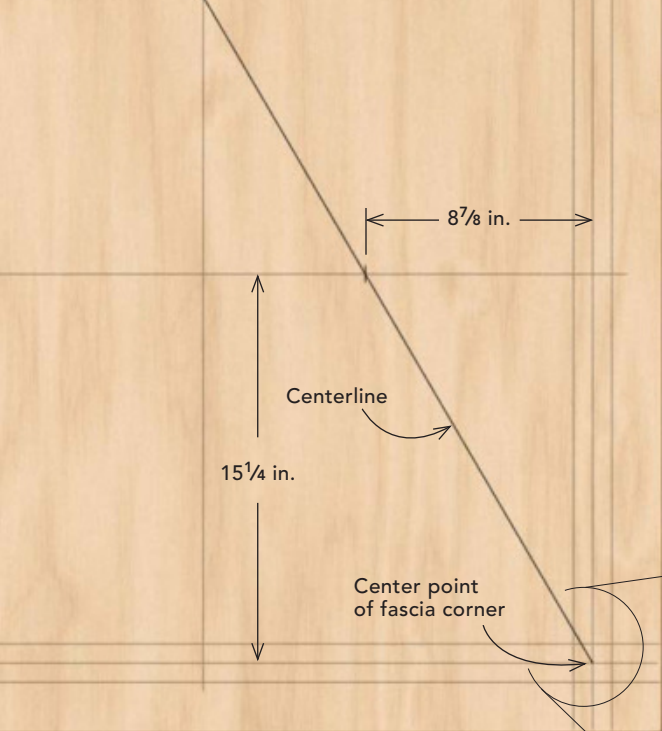


2 ESTABLISH THE OVERHANG

I start with lines representing the outside of the fascia. Beginning at the bottom right corner, draw lines 2 in. in from both edges, extending them to the edges at the top and bottom and left and right, making sure they're square to the edges of the plywood. The blade of a framing square, which is 2 in. wide, is an easy way to get this offset.

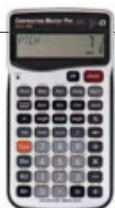
I then mark the thickness of the fascia, and half the thickness of the fascia, and draw lines extending to the end of the sheet to represent those. The half-thickness line is what I call the "plane point"—it's what I plane my sheathing to. You don't have to do it this way, but it makes for a clean transition from the fascia to the roof deck for the drip edge.

With the fascia established, I draw the plate lines that represent the outside face of the building. This is the overhang. Measure back from the face of fascia the full depth of the overhang in both directions. I'm working in actual dimensions; in this case, the overhang is 16 in., so I measure in 16 in. from the outside of the fascia. The intersection of these plate lines gives you both an inside corner and an outside corner.



3 MARK THE CENTERLINE

The next step is the key that opens all doors: establishing the plan-view angle of the hips and valleys. Hips always favor the steeper pitch; they'll move back along the plate that carries the steeper slope (it's the exact opposite with valleys). Here we're working with a 7-in-12 and a 12-in-12, and we need to determine where the two pitches come together. Our run is 16 in. from the outside of the fascia to the plate line. The plane point where I want the sheathing to hit the fascia is $\frac{3}{4}$ in. back from that, leaving $15\frac{1}{4}$ in. That's the run. In a construction calculator, punch in $15\frac{1}{4}$ -in. **Run**, 7-in. **Pitch**, then hit **Rise**. The 7-in-12 side of the hip rises $8\frac{7}{8}$ in. over that run. Now we need to figure out where the 12-in-12 side of the hip rises $8\frac{7}{8}$ in. That's easy with a 12-pitch, because it is a 45° angle from horizontal. So $8\frac{7}{8}$ -in. **Rise** on a 12-in. **Pitch** is $8\frac{7}{8}$ in. of run. (For another pitch, say a 9-in-12, simply punch in $8\frac{7}{8}$ -in. rise, 9 in. **Pitch**, then hit **Run**, and the calculator will tell you exactly what the run is that you need). To locate the intersection of the 7-in-12 and 12-in-12 on the plate line, measure $8\frac{7}{8}$ in. from the plane point along the 7-in-12 plate line and mark it. Strike a line from the center point on the fascia corner (it's the same plane point whether it's an inside or an outside corner) through the mark on the plate line, and extend this line to the edge of the sheet. This becomes the shared center for both hips and valleys. This line never moves. The hips will shift around it (the valleys won't), but that line will always be there. Mark this line as the centerline to keep track of what's what.



ADD ACCURACY If your drawing is accurate, you can measure everything you need right off the full-scale drawing. For accuracy when critical, use a construction calculator with the fractional resolution set to $\frac{1}{32}$ in. or higher.

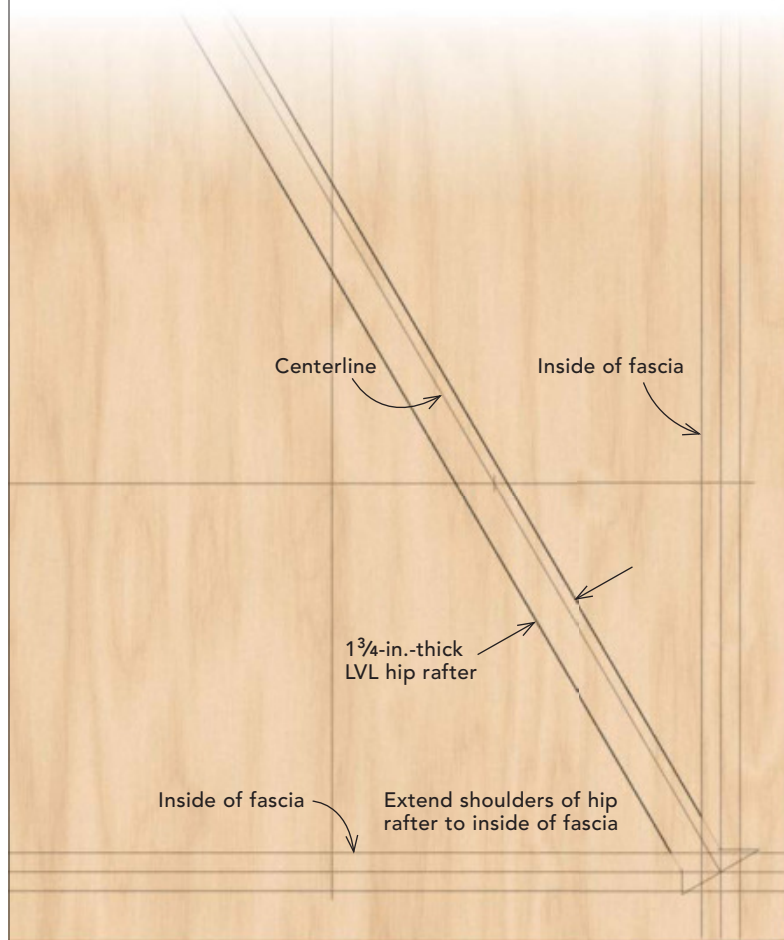
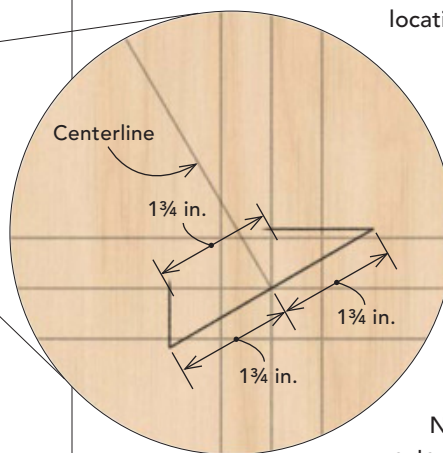
Rise Run Pitch

4 SHIFT THE LOCATION OF THE HIP

In order for the fascia to line up on a bastard hip and have equal overhangs, the hip has to shift over slightly. Figuring this out is easy using the French scribe technique. Draw a perpendicular line off the center corner of the fascia, measuring the thickness of the hip material in each direction. Here we're showing a $1\frac{3}{4}$ -in. LVL. Mark $1\frac{3}{4}$ in. in both directions off the end of the centerline. Then, from the ends of this perpendicular line, draw lines square to the center of the fascia (plane point). The distance between where these two lines hit the plane point is exactly the material width. Notice that these intersections are different distances from the centerline—this is called "plumb-line shift," and it has to happen to align the roof planes. The French scribe technique gives you the actual location of the shoulders of the hip rafter.

From those points, draw the outside edges (shoulders) of the hip. To do this, measure the distance from each of the points representing the shoulder of the hip back to the shared center, or just measure the length on one side, draw the line, and then measure and mark the material width ($1\frac{3}{4}$ in.) off that line. I only carry these lines to the inside of the fascia because that's where they get their tail plumb cuts.

Notice the bevel angles of those plumb cuts are right there.

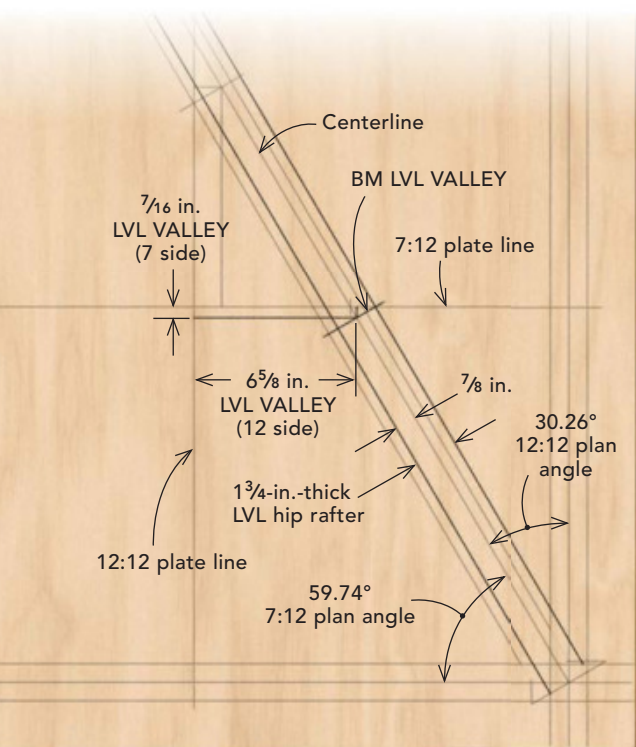
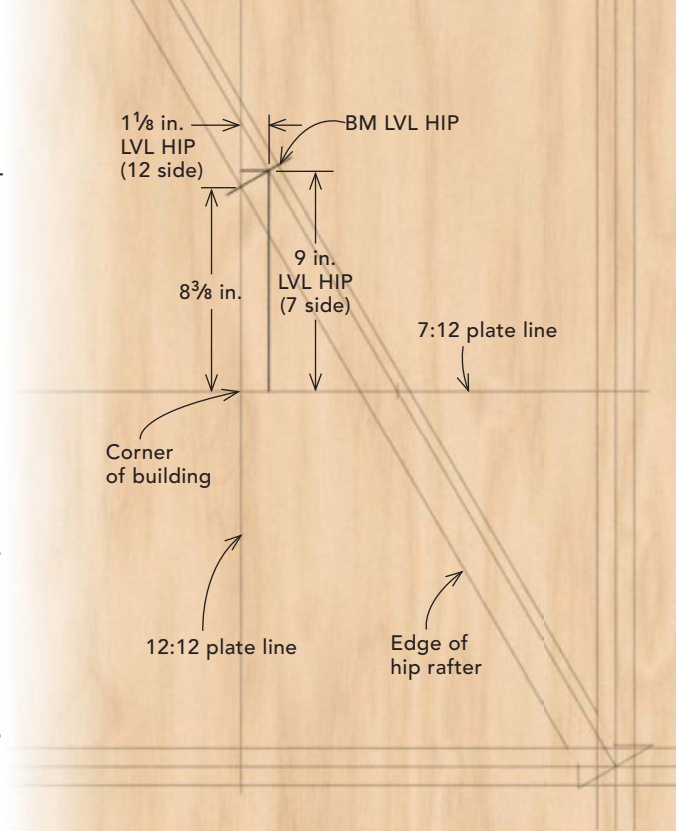


5 MARK THE BIRDSMOUTH

I don't want to cut a giant bevel on my birdsmouth—I'm going to square-cut that. But you can see where the hip hits the plate line. Square across the hip from this point. I usually extend this line to make it really obvious and label it—in this case "BM LVL HIP."

Then I mark deductions and other things that are important for layout. First, I mark the distance from the outside corner to the edge of the hip rafter—how far its edge is offset from the corner. That's a simple measurement—here it's $8\frac{3}{8}$ in. This is important mainly for marking the plate line when "stacking" (the roof-framer's term for assembling) the roof. We mark this measurement on the plate to know exactly where the edge of the hip is supposed to sit in relation to the corner.

To calculate the hip rafter's run, you need to know the run to the ridge from both plate lines; the hip's run is just the hypotenuse of that triangle. The distances from the plate lines to the centerline at the back of the birdsmouth—the point I'm calculating the hip's length to—become deductions or additions to the runs for each pitch. In this case, because the hip moves away from the 7-in-12 plate line, I'd subtract the distance from the corner to the center of the birdsmouth from the run on the 7-in-12 side (9 in.). The distance from the center of the birdsmouth to the 12-in-12 plate line gets added to the run on the 12-in-12 side ($1\frac{1}{8}$ in.).



6 CENTER THE VALLEY

Unlike hips, valleys don't need to shift off the centerline to maintain the proper overhang, so I center them on it. The trick here is to stop looking at the drawing as an outside corner and look at it as an inside corner. The biggest thing you'll notice is that the valley rafter shares the plate line with the shallower pitch, while the hip shares the plate line with the steeper pitch. That's always true.

Starting at the centerline, measure and mark half the thickness of the valley framing material in each direction—in this case, $\frac{7}{8}$ in. each way. Run these lines out to the edge of the sheet, starting at the inside edge of the fascia, which creates an inside corner on the end of the rafter. The angles at this corner are exactly what I'm going to cut on the end of the valley to catch the 2x subfascia.

I also square-cut the birdsmouth for the valley. Just like I did for the hip, I draw a line from where the valley hits the plate line square across the valley rafter.

Next I determine the adjustments I need to make to the run to figure the valley rafter's length from the ridge to the center of the birdsmouth. I mark lines from the point where the birdsmouth hits the centerline square to both plate lines. Here, that center point is $6\frac{5}{8}$ in. from the plate line on the 12-in-12 side, and $\frac{7}{16}$ in. from the 7-in-12 side plate. These lengths are used when calculating the run of the valley. In an irregular situation, valleys are always longer than hips, and the drawing provides an easy way to check that your calculations are correct. Measure the distance from the valley birdsmouth to the hip birdsmouth; the valley's run will always be longer than the hip's run by this amount.

7 FIND THE PLAN ANGLES

I typically draw in the ridges, but they're really only useful to include when you have a broken hip or want extra accuracy when calculating valley-jack lengths. All of the plan angles—which are also the bevel angles needed for cutting—are already on the drawing. You can use an angle finder or rafter square to measure them. If you want a bit more accuracy, you can use

math. One method is to simply plug the rise and run of one of the triangles on the drawing into a construction calculator and hit the **Pitch** button, and it will tell you the angle (in our example, 7-in. **Rise**, 12-in. **Run**, **Pitch** = 30.26°). Because we're working off of square corners, all we need to do to get the opposite bevel is subtract that angle from 90° ($90^\circ - 30.26^\circ = 59.74^\circ$).

The plan/bevel angles on any irregular roof that includes a 12-in-12 pitch are the easiest to figure; the plan/bevel angle of the 12-in-12 side is simply the slope of the opposite pitch. All you need to do to find that is look it up on a framing or rafter square or get it right out of the calculator (for the 7-in-12 pitch here, simply punch in 7-in. **Pitch**, **Pitch** to get 30.26°).

8 DEVELOP RUN, PITCH, AND BACKING ANGLES

For every 12 in. a common rafter runs, a regular hip or valley travels 16.97 in. This length (nearly 17 in.) is what framers call the “unit run” of a natural hip or valley. This is not the unit run, though, for irregular hips and valleys. You have to figure that out for whatever combination of pitches you’re working with. You can do this using a framing square right on the drawing, but for better accuracy, I calculate it. That’s easy when one side is a 12-in-12 pitch; you simply punch in one pitch as rise, the other as run, and hit diagonal (7-in. **Rise**, 12-in. **Run**, **Diag** = 13 $\frac{7}{8}$ in.). When neither pitch is a 12-in-12 (say one is a 5-in-12 and one a 9-in-12) there are a couple steps. First, punch in the shallower pitch as rise, the steeper as run, and hit **Pitch** (5-in. **Rise**, 9-in. **Run**, **Pitch** = 6 $\frac{11}{16}$ in.). Then punch in that calculated pitch as **Pitch**, enter 12-in. **Run**, and hit **Diag** to get the unit run (in that case, 13 $\frac{3}{4}$ in.).

For the example in this article, 13 $\frac{7}{8}$ in. is our unit run. That means our hip or valley rises 7 in. for every 13 $\frac{7}{8}$ in. of run along its length. This rise and run is also the pitch of our hip or valley rafter, and we need to know what that is in degrees. Again, we could simply measure it with an angle finder if we drew it out (which we will in a moment). I use the calculator. Punch in 13 $\frac{7}{8}$ -in. **Run**, 7-in. **Rise**, **Pitch** = 26.77°.

The unit-run measurement comes into play for rafter calculations, but also for figuring out the backing angles for the hips and valleys. I back-cut all of my hips and valleys so the sheathing has more of a surface to rest on, and it makes stacking

easier and more accurate. (I’ve had this argument with lots of other carpenters who don’t back-cut their hips and valleys. They argue it’s not necessary—and it’s not. But then you need to adjust the birdsmouth cut to bring the hip or irregular valley into plane with the other rafters. By back-cutting, you don’t; The jack rafters will plane with them perfectly. But really, back-cutting is more important with the valleys. When you have a valley plowed out, you don’t have to use a pencil or square to plane the top of the jack with the centerline of the valley. You just hold the top edge of the cheek cut on the jack flush with the shoulder on the valley, so you know it’s an absolute perfect plane.)

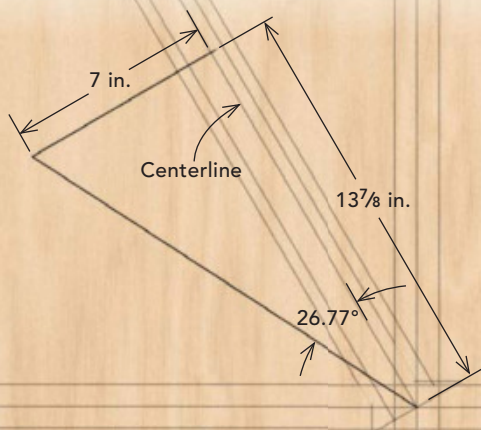
With irregular pitches, the angles on the shoulders of the hips and valleys are uneven. It’s easy to figure out these angles. Starting at the intersection of the centerline and plane point, measure up the unit run—in this case, 13 $\frac{7}{8}$ in. Then measure the shallower pitch perpendicular off of that—7 in. in this case. Connect the end of that 7-in. line back to the center of the fascia (plane point). The triangle this forms represents the hip or valley rafter laid on its side (you can measure the slope right from this with a protractor or angle finder).

To develop the backing angles, draw a line perpendicular to the “top edge” of this laid-down hip, starting anywhere along this top edge and back to the centerline (you’re going to develop the same triangle no matter where you start). Using that intersection as the center, set a compass to the length of the line you just drew, and swing an arc from where

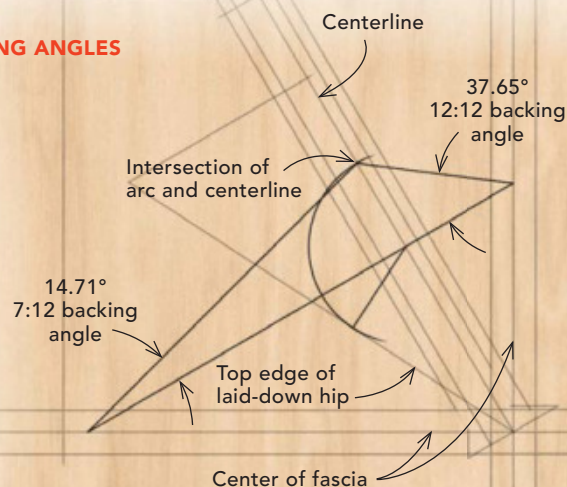
the line started back to the centerline. (You don’t need to actually swing an arc; you just need to mark the centerline up the same distance as the line from the centerline to the top of the laid-down hip.) Draw a line perpendicular to the centerline, running through the center point of the arc you just drew, going all the way to the plane point on both sides of the centerline. Connect the points where that line intersects the plane points back to where the top of the arc hits the centerline. What you get is a triangle that represents the backing angles for the hips and valleys. Again, you can measure these with a bevel gauge or protractor, or measure the rise and run of the triangles and use a calculator to get the angles. For these, the angles are 37.65° for the 12-in-12 side and 14.71° for the 7-in-12 side. Now, if you take any circular saw and try to set the bevel at 14.71°, it’s about impossible. If you bevel these at 15° and 38°, you’ll never see that difference. Label these angles on the drawing. If you want to go further, you can step off your on-center spacing from the plane point along the fascia in both directions and measure back to the hip to get the run for the common difference for jack rafters.

And with that, you have every piece of information you need to calculate every single piece of wood on the entire roof on a piece of plywood. Once everything’s penciled in, I go over it with different colors of fine sharpie to make everything easier to distinguish when figuring and so it holds up better under job-site conditions; pencil does tend to fade in the sun.

PITCH ANGLE



BACKING ANGLES



All About Garage

Buyers have a wide range of options for architectural style, material, and price



BY SCOTT GIBSON

The 1940s-era garage tucked behind our house is barely big enough for one car, and only part of the garage door is visible from the street. That's not an uncommon arrangement in my neighborhood, but a far cry from more contemporary house designs that have two or more oversized garage doors facing the street. Garage doors have become an important architectural feature, not just a way to get to the lawn mower.

In 2019, roughly 650,000 new single-family homes in the United States came with a one- or two-car garage, and industry experts suspect the replacement-door market is even bigger. That's a lot of doors. The most common variety is a door divided into a number of

horizontal panels that slide on a pair of steel tracks. These “upward-acting sectional doors” can be traced back to at least 1921, according to the Overhead Door Corp., and possibly as far back as 1906 with the introduction of a horizontal folding door sold by the Variety Manufacturing Co. of Chicago.

Sliding sectional doors solved several problems that homeowners had with traditional outward-swinging carriage doors. For one, the door is stored overhead when open, out of the way and safe from damage. Homeowners no longer had to shovel snow out of the way to open the door. And with the addition of counterbalancing springs, a heavy garage door was almost effortless to open and close. The

Doors



Aluminum and Glass

Aluminum frames work well for doors full of glass. You can choose the finish for the metal, as well as the opacity of the windows for light or privacy.

introduction of the electric door opener in 1926 simply sweetened the pot.

The Door & Access Systems Manufacturers Association, a trade group, lists dozens of manufacturers at its website. Online catalogs of big manufacturers, such as Clopay, Amarr, and Wayne Dalton, list dozens of choices in a range of styles. Doors can be faced in painted steel, wood, plastic composite, or fiberglass, or made with aluminum frames and glass panels. Manufacturers also offer two kinds of insulated doors and reinforced garage doors for high-wind areas.

Sectional doors are the most common type, but buyers also may find traditional swing-out doors, roll-up doors (more common in com-

MATERIAL MATTERS

Garage doors have come a long way. Not only are there many materials available, from inexpensive steel to luxe custom wood, but you also can select pretty much any style in your chosen material.



Steel

Steel is strong and durable, but it doesn't have to look old-fashioned. These carriage-house-style doors are steel with faux-wood composite cladding.



Vinyl

Typically available in light colors, vinyl is resistant to salt and humidity, so it works well in coastal areas.



Wood

Custom wood doors give you exactly what you want, but they can be expensive and need regular maintenance.



Wayne Dalton
Model 9800
insulated fiberglass

KEEP OUT THE COLD

Garage doors are available with and without insulation. Insulated versions have a polyurethane or polystyrene core. Insulation layers come in thicknesses of up to 2 in. and some versions include thermal breaks to enhance efficiency. R-values depend on the type of insulation and how thick it is. In addition to protecting the garage from heat and cold, insulated doors can offer benefits such as quiet operation and durability.



Polyurethane foam

Polyurethane foam injected between inside and outside faces of the door gives the highest insulating value while increasing strength.



EPS panels

Polystyrene bonded to the inside face of the door is protected by a vinyl backer. R-values are lower, but so are prices.



No insulation

A basic one-layer door comes at the lowest price, but without insulation the door is more prone to dents because of the lack of reinforcement.

mercial and industrial settings), and single-piece tilt-up doors. Prices vary considerably, from less than \$300 for a single-layer, no-frills steel door from a big box store to several thousand for an insulated high-end door in a custom color.

Steel dominates the market

Steel is far and away the most common choice for garage doors, says Mike Fisher, the executive director of the International Door Association. Steel covers the widest range of design, color, and price. At one end of the spectrum are doors consisting of a single layer of steel—what the industry calls a “pan door.” A midrange door would have two layers of steel with insulation in between. At the high end are four- and five-layer designs with custom paint, windows, and as much as 2 in. of insulation. These doors may include a composite overlay that looks like wood over a steel skin along with polyurethane or polystyrene foam.

The steel door with an embossed raised-panel design is the plain-Jane standard in the industry, but that popularity is declining in favor of the carriage-house or Shaker design that looks like an older-style carriage-house door that would swing open. Also gaining popularity is a smooth door reminiscent of a midcentury design you might have seen on *The Brady Bunch*.

Finishes typically consist of a galvanizing layer over the bare steel followed by a primer and a top coat. Higher-end finishes allow color-matching with house colors and

GARAGE DOORS*

Amarr
amarr.com

C.H.I. Overhead Doors
chiohd.com

Clopay
clopaydoor.com

Garaga
garaga.com

General Doors Corporation
general-doors.com

Haas Door
haasdoor.com

Midland Garage Door
midlandgaragedoor.com

Raynor
raynor.com

Wayne Dalton
wayne-dalton.com

GARAGE-DOOR OPENERS

Chamberlain
chamberlain.com

Genie
geniecompany.com

LiftMaster
liftmaster.com

Skylink
skylinkhome.com

*The Door & Access Systems Manufacturers Association, a trade group representing garage-door manufacturers, maintains a list of member companies at its website dasma.com.

SOURCE BOX

industrial-grade topcoats with multiyear warranties. Manufacturers typically offer hundreds of paint colors in addition to custom color-matching.

Doors also can be ordered with a plastic composite or fiberglass facing that's made to look like one of several species of wood. Unlike wood, composites won't rot, and they can be stained or painted.

For an upgrade, steel doors can be ordered with two types of insulation: polyurethane foam or expanded polystyrene (EPS). Polyurethane offers higher R-values, and like spray-foam used in houses, it fills irregularities inside the door cavity more effectively than sheet foam, in effect gluing the inner and outer steel layers together. Builders or homeowners worried about the high global-warming potential of chemicals used in polyurethane foam may want to check with the manufacturer to see if they've switched to a low-GWP blowing agent, or opt for EPS.

According to Clopay, in addition to protecting the garage from temperature extremes, insulated doors are quieter as they go up and down and also better at muffling the sound of an impact. But some builders might argue that an insulated door is not worth the extra cost (see sidebar, below). Expect to pay about \$1000 for a midrange three-layer insulated door, not including installation.

Windows are another consideration. They lower the overall R-value of an insulated door, but insulated glazing is an option, as is tinted and tempered glass. Windows are a traditional feature of carriage doors, and the glass

Is an insulated door worth the extra cost?

It depends on where you live and whether you use the garage for anything other than parking a car, says Mike Guertin, *FHB's* editorial advisor and a Rhode Island builder.

Guertin installed an R-12 garage door on his drive-under garage 25 years ago and says that even in very cold weather, with temperatures dipping as low as 0°F, the garage stays at about

45°F. That's without any source of heat in the garage. "That sounds cold," he says, "but compared to 20°F or 14°F, it's comfortable."

When he built a detached garage six years ago, Guertin installed an R-16 door. The garage has a layer of rigid polyiso insulation on the outside of the building, but no cavity insulation. With no heat source, the garage stays 15°F or so above what

the outside temperature is. If he's going to work in the garage, Guertin fires up a woodstove. The space heats up nicely and seems to retain heat fairly well.

Both the house and the detached garage are well-air-sealed. Even if the garage doors are not perfectly sealed, Guertin suspects there's not much of a stack effect in either building. Very little cold air is being drawn

into the garage because not much air is escaping through leaks in the building enclosure.

If he didn't care about temperatures in the garage being moderated, or if he weren't using the garage occasionally as a shop, Guertin said he would not spend the extra money for an insulated door. He'd just opt for a door that had adequate bracing for stiffness.

allows light into the space, enhancing visibility during the day. Adding windows typically adds about \$500 to the cost of a door.

Wood, aluminum, and vinyl

Garage doors made of wood have been a staple in the Northeast for many years, and many homeowner's associations still require them. These are rail-and-stile doors with thin plywood panels that come with or without a row of windows along the top of the door. But more stylish versions made to look like carriage-house doors that swing open are becoming increasingly available. The 7400 Series from Wayne Dalton, for example, is available in T1-11 plywood, hemlock, western red cedar, mahogany, and knotty cedar. These doors can be ordered with arched or square tops, windows, and one of many panel styles, including several with the characteristic X-brace reminiscent of a barn door.

Truly custom doors also are widely available for buyers set on a certain species of wood, panel design, and finish. This is the top of the market, where prices may hit \$10,000 or more for a one-off design bound for a celebrity mansion.

Wood is traditional, charming, and stylish, but it's also prone to a familiar list of disadvantages, including its tendency to decay if left in the weather too long without attention. Buyers should count on periodic refinishing, just as they would with any exterior wood components.

Aluminum is another material choice, typically as the frame material for doors made mostly of glass. Available in many styles, glass doors have a much more contemporary flavor than traditional styles like the carriage-house door. Frames can be ordered with a powder-coated or anodized finish and with a number of clear or opaque glazing options, and several choices for shades of tinted glass. Acrylic panels and insulated glass also are available. Aluminum and glass doors are significantly more expensive than basic one-layer steel doors.

Some but not all manufacturers also make vinyl-faced garage doors. They're available in a limited palette of light colors (no dark shades) and appear to be marketed for coastal areas because of PVC's resistance to corrosive salt air.

Doors for high-wind areas

Garage doors make houses in hurricane-prone areas vulnerable to catastrophic



Design on the fly. Upgrading your garage door is easy with an interactive website. Just take a photo of your existing door, upload it to the site, and have fun playing with different looks.

damage, a potential that is leading to more stringent code requirements for their assembly. In a report published by FEMA after Hurricane Andrew ravaged parts of Florida in 1992, the agency found that when garage doors collapse in high winds, the entire house could become pressurized, causing "partial or complete blowouts of major structural systems such as walls and roofs."

FEMA called for design improvements to garage doors, such as wind-resistant locks, stronger track assemblies, and reinforcements to make door sections more robust. Codes and standards in Florida were subsequently updated, with new provisions for wind-pressure ratings and impact protection from airborne debris. According to Fisher, Florida's response changed the door industry and helped set the stage for basic requirements nationwide. The 2021 International Residential Code (IRC) requires that all garage doors be labeled for wind-load ratings, although it will be up to individual states whether to adopt the 2021 IRC or modify it to suit local conditions.

Doors are rated for particular air pressures based on predicted wind speeds. The first step in choosing a door is to check with local building officials to find out what the code

requirements are, and then to choose a door that has been labeled to show it meets a particular wind rating. Impact-resistance ratings or other protection may also be required in areas where there is a risk of damage from windborne debris.

Sizing and ordering

Stock sizes for single-car garage doors are 8 ft. or 9 ft. wide and 7 ft. or 8 ft. tall. Double doors are typically 16 ft. or 18 ft. wide. Doors also can be ordered in custom sizes, in 2-in. increments for width and 3-in. increments for height.

Ordering a custom size may mean a slightly higher cost, but the industry has become more flexible over time. "Back in the day you'd have an inventory of garage doors because they were all white and they all had that same panel style," Justin Evans, Clopay's residential product manager, said. "Today there are so many colors, so many designs, so many window choices. There are really not a lot of stock items; pretty much everything is custom-made. Even when you order a standard size, I'd say eight times out of 10 it's made to order."

Interactive websites offered by a number of manufacturers give buyers a chance to virtually try out a wide range of door styles before making a decision and placing an order. At the Raynor website, for example, uploading a photo of your garage opens the door to a menu of choices for the style of door, window type, panel shape, decorative hardware, and color. When you find the door you want, you can save the file, email it to someone, and request a quote from a local dealer.

Because most manufacturers work through a network of local dealers who take care of installation, there's no instant price quote for the door you've chosen. Nor is there immediate feedback on how design choices affect the final price—for example, does the price go up or down, and by how much, when decorative hardware is added? Even so, these tools are a great first step in visualizing various types of doors on your own garage rather than a generic building pulled from a collection of stock photos.

I used the Raynor online app, submitted the design, and had a follow-up call from a local installer within a couple of days. □

Scott Gibson is a contributing writer for *Fine Homebuilding* and Green Building Advisor.



Simplicity and style. Quieter and with less hardware, wall-mounted openers leave more room for storage, but they are pricier than the typical ceiling-mounted options.

OPENER OPTIONS

Garage-door openers (or “operators,” as they also are called) look increasingly like many other internet-connected devices around the house. In addition to making the door go up and down on command, they also allow homeowners to monitor the inside of the garage remotely with a camera, open and close the door for a delivery driver or a neighbor, and lock up even when no one is at home.

The most inexpensive openers have basic safety features, no internet connectivity, and AC motors rated at ½ hp that are suitable for relatively light doors. Midpriced openers add features such as smartphone controls, motion-activated lighting, and dual-lens lights, says Gregory Martell, senior product manager at Chamberlain, a door-opener manufacturer. Top-end openers can lift heavier doors with motors rated at 1 hp or more, have battery backup, and use a belt-driven or wall-mounted lifting mechanism for less noise.

Installed prices range from about \$300 to \$900. If you want to do the installation yourself, models are available for under \$150. Here are some features to consider:

- **Belt drive, chain drive, or screw drive.** Chain drives are inexpensive and reliable but noisy. Replacing the chain with a steel-reinforced belt will make the system much quieter, Martell says. In addition to belt- and chain-driven openers, Genie, another manufacturer, also offers a direct screw-drive mechanism designed for heavy doors.
- **Overhead or wall mounted.** Standard openers include a ceiling-mounted motor that powers a chain-driven traveler to open and close the door. A wall-mounted unit is attached directly to the shaft of the opener, which both saves space and makes less noise.
- **AC or DC motor.** According to Martell, some openers have built-in inverters that allow the motor to run on direct current. These typically make less noise than AC models and are often found on openers with greater lifting capacity.
- **Battery backup.** Openers with an integral battery are required in California but are available anywhere in the U.S. A battery is mounted inside the unit and remains charged. When the power goes out, the door can still be opened and closed a number of times. (Doors also have pull cords that disengage the door from the drive mechanism so they can be opened without electricity.)
- **Lighting.** If high-intensity lighting is a priority, look for a model with integrated LEDs. Although homeowners can replace incandescent bulbs with off-the-shelf LEDs, Martell says these standard bulbs will interfere with the operation of the remote or reduce the distance at which the remote works. Integrated LEDs don't have that problem.

Door openers are designed to overcome the “moment of inertia” and get the door moving. Once that happens, the springs should do all or most of the work. Choosing the correct opener means matching the power of the motor with the weight of the door, Martell says, rather than trying to calculate how much horsepower the motor should have. Basic openers are designed to lift doors of up to 330 lb., according to Martell, but more powerful units with wall-mounted drive mechanisms will get an 850-lb. door going in the right direction.



Traditional system, smart technology. Ceiling-mounted openers are budget-friendly, and some can connect to WiFi so you can operate them from a smartphone.



Footing Retrofit in a Day

Using helical piers to add footings to an old house is faster, less disruptive, and comparable in cost to excavating and pouring concrete

BY DAN KOLBERT

Maine has the oldest housing stock in the country, so dealing with hidden conditions before we can start with the contracted work is par for the course. At best, this means some wiring needs to be updated during a kitchen remodel, a header needs to be beefed up, or we run into some rot when replacing windows or doors. It's not uncommon, however, for us to find that more costly structural issues need to be addressed. Worst-case scenarios often involve the foundation.

When the problem is all the way down at the footing, the work is usually riskier, dirtier, and more expensive than a lot of other repairs. This helical-pier solution to a footing retrofit solved for two of those challenges—we didn't have to shore up the house or worry about trench safety, and we didn't have much digging to do. The cost was about the same as retrofitting a concrete footing, but the work got done faster and less intrusively.

Support for additional loads

We'd been hired for an "add-a-level," turning a 1951 Cape with an unfinished attic into a two-story home with a big mono-pitch roof. Most of the structural work was straightforward—we were using clear-span I-joists to frame the new second-story floors and the same for the new roof rafters. This means that all the additional loads were on the existing bearing walls. Joe Leasure, our structural engineer, gave us specs for the headers we needed for the increased load, which we met by adding jacks to the existing headers and hiding new LVLs in the rim of the second floor. Leasure also told us to inspect the footings before starting the project.

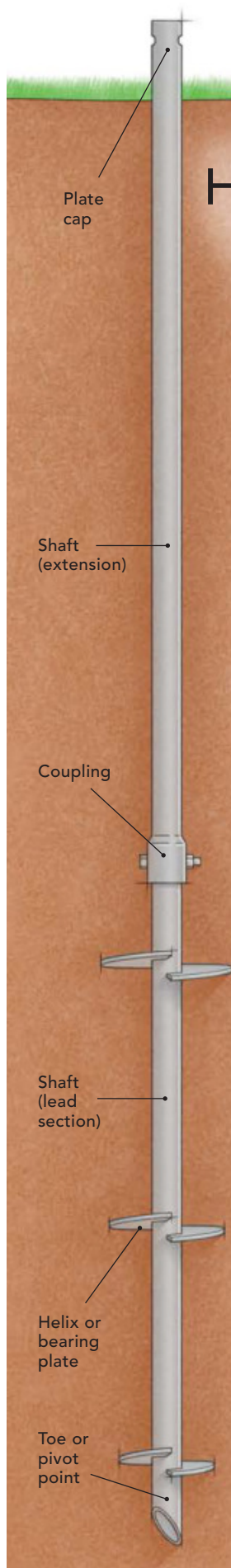
We were planning to rent an excavator to help with the roof demo, so we waited until we had it on-site to check out the footings. I haven't dug out very many existing foundations, so I didn't have any idea of the likelihood of our foundation meeting what we typically assume to be required in our area—concrete footings at least 16 in. wide by 8 in. deep, set on clay with a bearing capacity of 2000 psf (lb. per sq. ft.).

HELICAL PIERS ARE LIKE BIG SCREWS

There are technical differences between *pier foundations* and *pile foundations*. One is depth. Piles tend to be used in situations where little bearing capacity is found in the first few feet of soil and an atypically deep footing is necessary. For all but the trickiest sites, piers are more common in residential construction. Nevertheless, you may hear the terms used interchangeably, particularly in the case of helical piers, also called helical piles. That's because they are often used in situations where deep footings are needed in commercial construction.

Helical piers are not a new technology, but have been slow to be adopted by residential builders. That may be changing as more dealers and franchises come online. Helical piers can be used as footings for decks, as footings beneath new homes, and for repair work, as shown here. They are quick to install, disturb the site very little, and can be sized to support just about any load.

A helical pier is like a big screw with a shaft and bearing plates. Soil conditions and loads determine the necessary depth of the pier and diameter of the helixes, also called bearing plates. Helixes are only found on the lead section of the pier, and extensions are added when needed to drive the pier deeper. Bearing capacity can be verified by the amount of torque required to drive the pier during installation. At the top of the pier is a cap to which various heads can be attached. Usually welded to the cap or somewhere along the shaft, the head may be a bracket that can be bolted to a foundation, like the ones shown here, or it could be a base for a deck post, for example. —Brian Pontolilo, editorial director



For more on helical piers, see "It's Time to Consider Helical-Pile Footings," on Finehomebuilding.com.

PIER INSTALLATION, STEP BY STEP

Helical piers can be a one-stop solution for footings. The same company that installs the piers may also do the engineering. And they'll likely get the job done in a day, as was the case with this footing retrofit.



PILE DRIVER

Helical piers are installed with a hydraulic machine that screws the pier into the ground. For most residential jobs, a small machine can be used, which makes site access possible for many applications.



ANGLED IN

Because the crew is working tight to an existing home, the piers are driven on an angle for proper placement. When the full depth of the pier is reached, the top is pushed toward the foundation.



TORQUE CONTROL

The installer controls the machine from a handheld device and can even monitor torque to verify the pier has reached the necessary bearing capacity.



Unfortunately, we discovered that not only were our footings not up to spec, they were nonexistent. The house showed no signs of movement or cracks, so it seems the foundation had worked for the existing structure. But we couldn't add more load onto it safely.

We could have retrofitted conventional concrete footings to meet the required

load, but the one time I did that—on a 19th-century brick warehouse—we had to work around the building in a pretty labor-intensive process. To avoid undermining the foundation, we dug out and exposed 2-ft. sections of the bottom of the wall, left 2 ft. of undisturbed earth, dug out another 2 ft., left 2 ft., and so on, all around the perimeter.

Once we had poured the new concrete footings in the excavated sections, we started again on the areas we had left to support the building as we worked.

I didn't want to go through all of that work again on this project, and even if we could have maneuvered an excavator into the small backyard, the owner did not want us to dis-



MOUNTING BRACKETS

A large bracket is slipped over the top of the helical pier. The crew uses a hammer drill to drive pilot holes and then bolts the bracket to the foundation with concrete anchors.



TOPPED OFF

The pier is cut flush with the top of the bracket with a portable bandsaw.



WELDED ON

The filler material is added for a tight fit, and the bracket is welded to the pier for a strong connection.

turb their gardens. That's when I remembered my experiences with helical piers: We built a small guest house in a flood zone on helical piers to avoid having a basement in a risky location. We also used them for project involving a bathroom addition on an urban house with mature plantings. And I knew, from a friend who installs helical piers in

Alaska, that they are often used to repair foundations damaged by earthquakes and melting permafrost.

So I called Michael Brochu, who installed the piers on my other projects. He owns the Maine franchise of Quebec-based Techno Metal Post (TMP). They have franchises in nine countries in Europe and North

America, with in-house engineering to help with projects.

Piers and brackets do the trick

Brochu started by driving a sample pier. The bearing capacity of a helical pier is determined by the diameter of the helix and the measured torque required to drive the pier. With

FOOTING BASICS AND BEYOND

Footings support foundation walls and the weight of the building above, spreading the load of the structure evenly on the soil below and preventing foundations and the structures they support from buckling, sinking, or cracking. In many locales, footings are made of steel-reinforced concrete, but the International Residential Code (IRC) also allows footings to be made from crushed stone, and builders lucky enough to be working in parts of the U.S. with predictably stable soils may be able to pour extrathick foundation walls and skip separate footings altogether.

Soil type is an important consideration

Footing design springs from two variables: the weight of the structure and the bearing capacity of the soil. The heavier the building and the lower the capacity of the soil, the beefier the footing must be. As spelled out in Section 401 of the IRC, the presumed load-bearing capacity of soil ranges from a high of 12,000 psf (lb. per sq. ft.) for crystalline bedrock to as little as 1500 psf for clay and certain types of silty soils. When a building inspector suspects that the bearing capacity is less than 1500 psf, a soils investigation may be required.

Depending on the number of stories, the weight of the walls, snow loads, and the bearing capacity of the underlying soil, concrete footings for light-frame construction can range from 12 in. by 6 in. to 30 in. by 10 in. At the extreme end of the scale—a

three-story house with masonry walls, snow loads of 70 psf, and poor soils—concrete footings may be as massive as 49 in. deep and 19 in. wide. The IRC requires that footings be

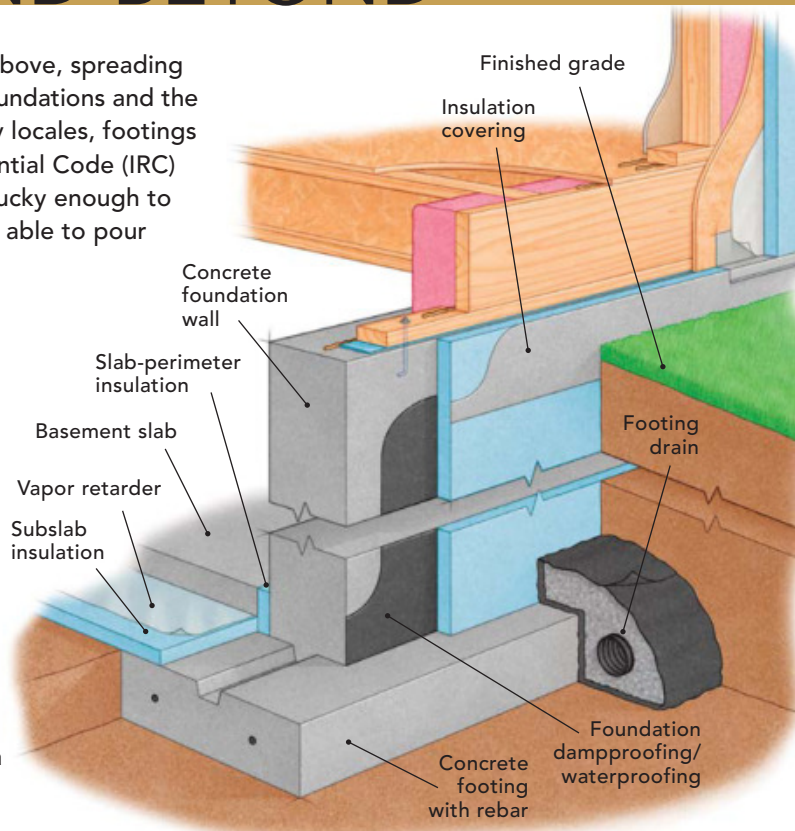
no less than 12 in. below undisturbed ground and placed below the local frost line.

The code also permits crushed-stone footings. As with concrete footings, the bearing capacity of the underlying soil and the weight of the structure guide design. Crushed-stone footings for a two-story house—assuming the light-frame walls of the house weigh 1800 lb. per ft.—range from 6 in. by 15 in. to just 4 in. deep and 13 in. wide, depending on the soil. The crushed stone must be consolidated with a plate vibrator in lifts no deeper than 8 in. Crushed-stone footings are what Superior Walls likes to see for its precast concrete wall sections. They're also used for permanent wood foundations.

Let experience and location be your guide

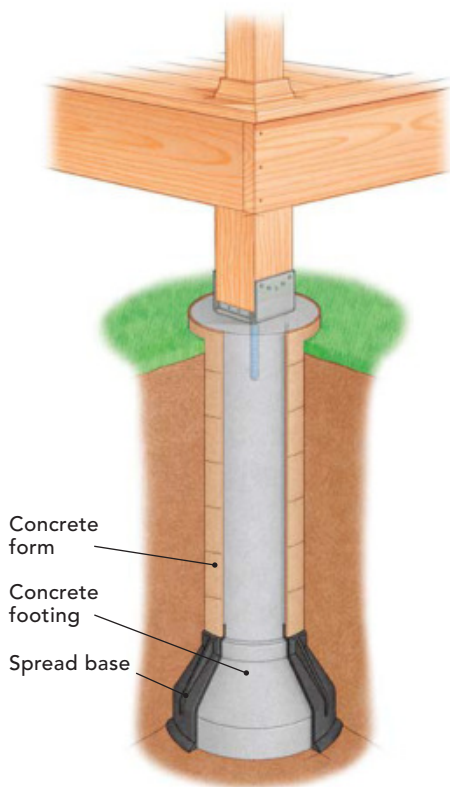
Rhode Island builder and editorial advisor Mike Guertin is often able to do his own soil tests with the help of a penetrometer (a device that measures soil strength), or he relies on published soil classifications for the area. Soils in the areas where he's used to working generally don't require the help of an engineer, so Guertin takes his cue on sizing footings from the prescriptive tables published in the IRC. In some situations, soil conditions are such in Rhode Island that Guertin can pour a 12-in.-wide foundation wall without separate footings. Walls might be poured on a 6-in. bed of crushed stone, or simply on undisturbed soil. With the right soil conditions, the 12-in. width of the wall meets the minimum footing requirements in the building code.

If Guertin is building houses on easy street, consider the difficulties that Texas-based designer Armando Cobo routinely faces in coming up with footings for the



Poured-concrete footings

Frost-depth steel-reinforced concrete footings are common in many parts of the country, particularly beneath basement foundations as shown here. Water-management strategies and insulation levels will vary by site and climate zone.



Concrete-pier footings

Commonly used for decks and porches, poured-concrete piers can also be used for frost-depth footings for homes and other buildings. A spread base may or may not be needed depending on soil bearing capacity.

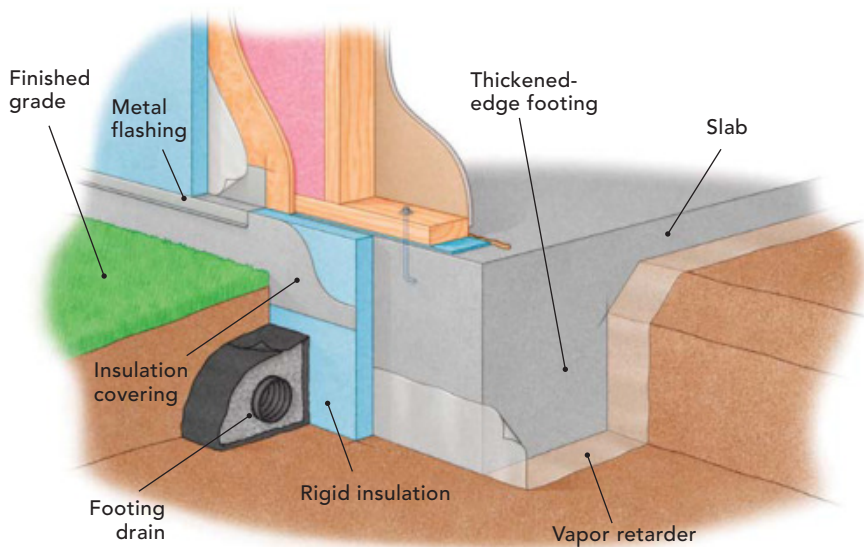
extremely expansive soils in parts of Texas where he works. There, he says, builders concern themselves with the “potential vertical rise,” or PVR, of the soil on a lot—how much the soil will go up (and then down) when it rains. The PVR determines the type of footing and foundation that will work on a particular lot.

When the PVR is estimated at 4 in. or less, a slab-on-grade foundation may work just fine. Between 4 in. and 8 in. of PVR, builders often go to a waffle slab, a monolithic pour with boxlike recesses cast into the bottom of the slab that absorb soil expansion when it rains, Cobo explained. This type of slab looks exactly like what comes out of a waffle maker, hence its name. When the PVR on the site is higher, say 10 in. to 12 in., a waffle slab might be supported by concrete-pier footings. Post-tensioned slabs—in which integral steel cables are tightened after the slab has been cast—are another common solution to lots with problem soils, as are pier-and-beam foundations.

Slab foundations are another option

Most slab-on-grade foundations are poured as monolithic structures—the footings are an integral part of the foundation. A slab foundation can speed up the construction schedule and reduce the amount of concrete that must be ordered. One variety is the thickened-edge slab. Around the outside of the foundation, the concrete might be 10 in. or 12 in. thick, while concrete in the middle of the slab would be less than half that. The idea is that the thicker edge bears the weight of the exterior walls, just as a separately poured concrete footing would. Frost-protected shallow foundations and raft slabs are similar, but use rigid insulation to prevent frost from getting underneath the slab.

—Scott Gibson, contributing writer



Thickened-edge slab

This type of slab-on-grade foundation allows builders to form the footing and foundation in one pour. Depth and dimensions of the thickened edge will depend on frost depth and soil-bearing capacity. Insulation R-values and location as well as necessary drainage will vary.

Leasure’s specs and the info from the test pier, the TMP engineer was able to design a system and tell Brochu the torque he needed to achieve during installation. Our site, like much of Portland, Maine, is marine clay, so we hit the torque relatively quickly. In sandier or unstable soil, you might have to add extensions to the pier to drive deep enough to achieve the required torque.

Based on the results of the test pier, the TMP engineer determined that we would need 12 piers with 12-in. helixes driven about 10 ft. deep. To prepare for the work, we rented a small excavator and dug a 2-ft.-deep trench along the two bearing walls, the front and back of the house. This allowed us to keep the piers and brackets hidden below grade when we backfilled.

Next Brochu and crew showed up with their hydraulic driver and the piers. To stay tight to the foundation, they drove the piers at a slight angle, and then pushed the tops toward the foundation when they’d reached the depth they needed. They slid brackets over the tops of the piers and, maintaining pressure on the piers with the driver, bolted the brackets to the foundation walls. Brochu recorded all the torque readings on each pier in case anyone needs documentation in the future.

If we’d had to lift any sections of the foundation, at this point they would have bolted temporary plates above the piers and used regular hydraulic bottle jacks set on top of the piers to push the house up. But because there were no signs of movement, we were just shoring up in preparation for the increased load of the second-floor addition.

Once all the brackets were bolted on, the crew cut off the pier flush with the top of the bracket and welded the piers to the brackets. We then back-filled and were able to proceed with the job. Other than the fresh excavation, no hints of the work done remained.

Versatile and cost effective

This house had a specific problem for us to solve, but you can use this helical-pier technique to repair other foundation systems as well. Slabs on grade are relatively easy. Block walls are harder because you need to attach to the footings, since the block itself will separate if you lift from them. As I mentioned, you can also use helical piers to lift and level foundations.

On the project shown here, the cost of the work was about \$14,000. That included renting an excavator, setting the piers, and digging and backfilling the trenches. We saved time and didn’t have to pour any concrete, and perhaps the most helpful thing was that we didn’t disturb the interior at all. □

Dan Kolbert is a builder and remodeler in Portland, Maine. Photos by Scott Gibson.

Must-Have Concrete Tools

A longtime builder's labor-saving tools mean better concrete too

BY ANDY ENGEL

Knowing the tools needed to place and finish a concrete slab is a road map to doing good concrete work. Most of the hand tools are relatively inexpensive, and most of the more expensive ones can be rented. Concrete is pretty safe stuff most of the time, though it can cause chemical burns, particularly with extended contact. Long pants, long-sleeved shirts, rubber overboots, and gloves are called for when working the wet slab. Safety glasses aren't a bad idea either. When saw-cutting, but sure an electrical saw is plugged into a GFCI outlet and wear safety glasses, hearing protection, and at least an N95 dust mask or respirator because of the silica dust.

It takes surprisingly little water for concrete to complete the chemical reactions that make it hard—so little it would be unworkable without some additional water. To be workable, concrete must be wet enough to flow tight to the forms and for air bubbles to escape. The wetter concrete is, the easier it is to settle into the forms—but

the weaker it will ultimately be. That's because concrete's strength is related to its density. From a chemical standpoint, any water that isn't necessary for the reaction just takes up space. When that water eventually evaporates (which can take weeks), it leaves tiny voids that reduce the density and strength of the concrete. Also, if it's too wet, the water on top of a slab won't evaporate fast enough to allow tooling before the underlying concrete is too hard to work. Adding plasticizer to the mix costs a little more money, but it temporarily lowers the slump of the concrete without affecting its ultimate strength.

Whether your tools are rented or bought, washing the concrete off before it sets up is crucial. The higher the water pressure in your hose, the easier it is to clean concrete tools. The pressure in the hose on board every concrete truck is Niagara-like. Ask the driver if you can use that water to wash off your tools before the truck leaves. □

Former editor Andy Engel is a builder in Roxbury, Conn.

SET UP REINFORCEMENT



The first phase of concrete work involves no concrete. Assuming the ground is properly compacted and the gravel below the future slab is level, reinforcement is the first step. Most concrete footings and foundations have some rebar in them, and slabs frequently have rebar or reinforcing wire.

Concrete is very strong in compression, but will crack when placed in tension. Steel rebar adds tensile strength to concrete. Wire mesh keeps the surface of the slab in plane should cracks develop.



BOLT CUTTERS

Simple tools, bolt cutters' main purpose in concrete work is to cut welded wire mesh to size. An 18-in. cutter is perfect for this task. You can also use a grinder with an abrasive wheel or a circular saw with a carbide or abrasive blade made for metal-cutting, but the bolt cutters are just as fast and don't require power or batteries. Be sure to wear a face shield when working with cutoff wheels, which sometimes shatter, throwing partial discs of carborundum and fiberglass at high velocity.

TIE TWISTER

On small jobs, rebar can be wired together with pliers and 14-ga. steel wire. (The standard lap required when joining bars lengthwise is 40 bar diameters—i.e., #4 bar, which measures $\frac{1}{2}$ in., must overlap at least 20 in.). If you only have a couple of pieces, this is no big deal. For bigger projects, use a tie twister with special rebar wires, which speeds up the tying process dramatically.



REBAR BENDER/CUTTER

Rebar is hard steel—cutting it isn't something you do with bolt cutters. It is also as hard to bend as it is to cut. For cutting on small jobs, you can get away with an angle grinder. For bending in a pinch, I've stuck the end of a piece of rebar in the trailer-ball hole of an F-250's bumper and used that as a fulcrum. The results were serviceable but not great, and mostly limited to #4 bar. A rebar bender/cutter makes for much neater, more easily controlled bends, and cuts rebar much faster than a grinder.



ROTARY HAMMER

It's common to abut new concrete to existing—for example, when building an addition to a house. The plans should specify a doweled connection, which simply means you drill into the existing concrete so lengths of rebar can be inserted into place. Some circumstances call for the dowel to be epoxied into place, while others require some movement and the engineer will call for the rebar to be greased so the concrete doesn't adhere. The number, depth, and diameter of the rebar dowels will be specified on the engineering drawings. In any case, the tool to use for drilling the holes is a rotary hammer. Most contractors already own one, but you can rent them too.

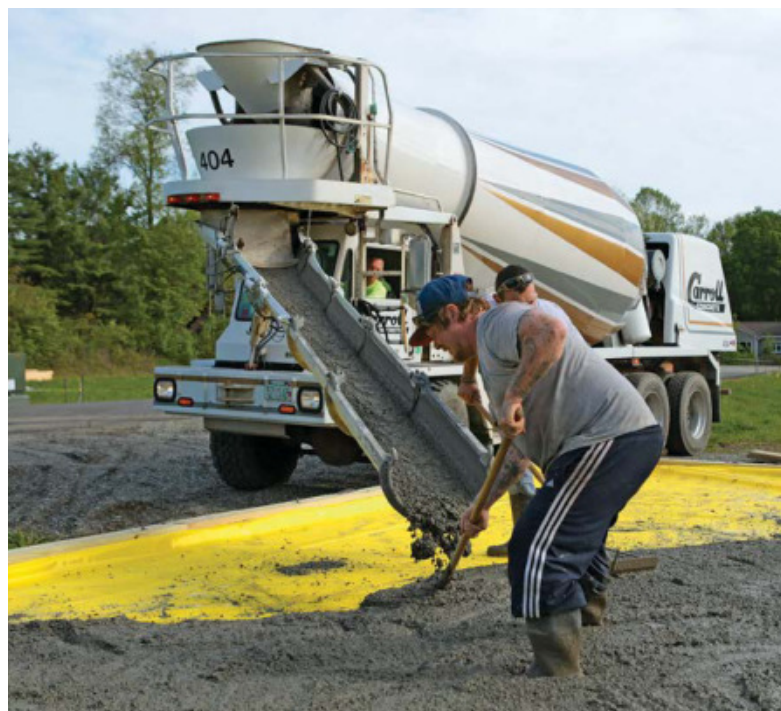


PERFECT METHODS OF PLACEMENT

Concrete is heavy. A standard 10-cu.-yd. truckload weighs 40,000 lb. and is enough for 750 sq. ft. of 4-in.-thick slab, accounting for spillage and assorted variances. You'll want to move as little concrete by hand as possible while also moving fast. Concrete begins setting up the instant the first water is added, and ready-mix companies only give limited time to unload the truck once on-site.

FRONT-DISCHARGE TRUCK

Obviously, the simplest method of placement is to get the ready-mix truck close enough to the hole so that the truck's own chute can place the concrete. I had an epiphany about this process when I moved from New Jersey to Connecticut 25 years ago. In Jersey, all the trucks had rear-wheel drive and rear discharge. They could get pretty close, but because the driver had no direct line of sight, he could only help you out so much. And because of the rear-wheel-drive configuration, firing up the backhoe to drag a concrete truck out of the mud was a regular event. Connecticut introduced me to front-discharge, all-wheel-drive concrete trucks. I have yet to see one stuck in the mud. And because the driver can see and control the chute from inside the cab, the concrete mostly ends up exactly where you want it. If you can't get close enough with the truck's standard chutes, ready-mix suppliers can often send additional chutes for a reasonable upcharge. Longer chutes are at a more shallow angle, so you may have to pull the concrete.



STEEL WHEELBARROW

Wheelbarrows are an obvious and cheap vessel for moving concrete (or mixing it by hand). Don't buy a plastic wheelbarrow. They are lighter but flex when loaded, making them very difficult to maneuver around a site. A high-quality steel wheelbarrow is rigid and far easier to push when full of wet concrete. Your concrete wheelbarrow should also have solid tires—few things make me lose my temper, but a flat tire on a wheelbarrow full of concrete is one of them.



POWERED WHEELBARROW

Concrete buggies (or "mud buggies") are big, motorized wheelbarrows. They're a great way to move concrete from the street to the backyard. If you have more than a couple of yards that need wheeling, consider renting a buggy.



CONCRETE PUMP

An even easier way to move concrete long distances is with a pump. Concrete pumps are specialized trucks or truck-pulled trailers. Concrete from the mixer flows into a hopper on the pump truck, and that truck pumps it to where the concrete is needed. There are two main types of pump truck. Line or grout pumps push the slurry through a 4-in. hose that gets manhandled around the site. Boom trucks have hydraulic-controlled booms so the truck driver can move the concrete hose and outlet to where you need it. Unless you're experienced, it's a good idea to hire a crew with a boom truck. Some have mechanical arms with a 100-ft. reach. Neither is cheap, but for large projects where you need to move a lot of concrete quickly or for sites with difficult access, they're the way to go.



PORTABLE MIXER

Hand-mixing in a wheelbarrow is often fine for small concrete jobs, but a portable mixer is faster and will save your back on bigger projects. Portable mixers are also ideal for larger jobs where there is no ready-mix plant or site access is impossible for a concrete truck. Sizes range from the smallest models found at home centers that sell for a few hundred dollars to large tow-behind machines that can mix nearly 1/2 yd. of concrete at a time and sell for thousands. At least two sizes will be available at good rental yards.

VIBRATORY SCREED

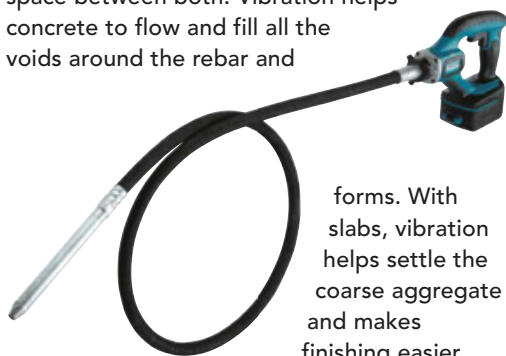
I will never do another big slab without renting one of these—ever. Screeding a big slab by sawing back and forth with a 2x4 or metal screed works, but it's exhausting. Vibratory screeds work by attaching a gasoline-motor-powered vibrator to either its own integral metal screed or to a 2x4. The tool's vibration settles the concrete while replacing the hard physical labor of screeding. Renting one of these for your next slab is the best tip in this article, hands down.



VIBRATOR

One tool that's useful with both walls and slabs is the concrete vibrator. A slender metal mechanism powered by a flexible shaft that ties to either an electric or gas motor, concrete vibrators help settle wet concrete into its forms. Every rental yard in existence will have a concrete vibrator. The key is to vibrate sparingly.

Concrete is a mix of Portland cement, water, and large (gravel) and small (sand) aggregate. The sand fills the spaces between the gravel, and a slurry of Portland and water fills the space between both. Vibration helps concrete to flow and fill all the voids around the rebar and



forms. With slabs, vibration helps settle the coarse aggregate and makes finishing easier.

Using one takes

a delicate touch—excessive vibration can separate the large and small aggregate too much, weakening the concrete. For that reason, don't hit the rebar or the sides of the forms with the vibrator any more than you can help. If appearance is a concern, you can tap the forms with a hammer or take the blade out of your recip saw and run it up and down the form a little bit. Don't get carried away, though, because vibration liquefies concrete and the added hydraulic pressure can blow out the forms.



COME-ALONG

The simplest, most useful tool you aren't using is the come-along, also called a placer. Essentially a solid rake, the come-along is the perfect tool

for pulling and rough-leveling concrete for a slab. Do not use a steel landscape rake to move concrete—this will segregate the aggregate, seriously reducing the strength of the concrete. There is a hook on top of a come-along to pull up reinforcing wire when needed.

CONCRETE TAMPER

Composed of wire mesh in a frame with a pair of handles, a concrete tamper pushes the coarse aggregate down into the surface of a slab to make finishing easier. However, it can settle the aggregate too deeply, increasing the likelihood



of freeze-thaw cycles scaling the top of exterior slabs in cold climates. Therefore, tampers should be used judiciously and only on slabs not subject to freezing. Their use should be limited to very stiff (low-slump) concrete or concrete with unusually large aggregate such as 1½-in. stone.

What slump?

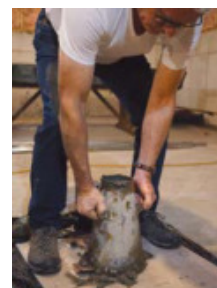
Slump is determined by filling a special cone with a sample of fully mixed concrete, removing the cone, and measuring how much the wet material sinks (or "slumps"). A 4-in. slump is considered the standard for structural purposes, but without special tools 4 in. is unworkable. Most residential concrete is placed at a 5-in. or 6-in. slump. It's a balancing act, and the tools you use to settle concrete into its place and to level slabs are crucial to the success of the job. For concrete work such as footings, a shovel and a piece of rebar are most

of the tools you'll need. All that you have to do is move the concrete through the forms, jab the shovel (or in tight places, the rebar) in a few times, and bang on the side of the forms with a hammer to burp out big air bubbles.

A mag float

(p. 56) does a fine job of tooling the top of the concrete level with the forms.

Slabs and walls are a different story. There, the fit and finish of the concrete becomes much more important. Most builders, myself included, hire out foundation walls. The forms are heavy and expensive, the work takes experience, and mistakes are costly.



FINISHING BRINGS IT HOME

Finishing is when the magic happens and where concrete skills really shine. It's also the most nerve-wracking time because the window when concrete is workable shrinks rapidly. Concrete finishing is done in a specific sequence, and each of these tools is appropriate only at certain times during the process. Using them incorrectly can affect the finish and durability of a slab.

BULL FLOAT

Screeding leaves a coarse surface that needs smoothing to be useful. A bull float is the first tool in the sequence and is used immediately after screeding to remove ridges and fill hollows while slightly depressing the coarse aggregate. The aluminum blade of the bull float doesn't seal the surface of the concrete the way steel does, which is one difference between a bull float and a steel trowel. At this stage, it's important not to seal the concrete to facilitate evaporation of the excess water.

Bull floats are typically about 8 in. by 48 in. They have sectional handles that assemble to as long as 18 ft., allowing the user to stand outside the concrete while floating. The handle joins the float with a universal joint, so you can twist the handle to change the float's angle of attack: Lowering the handle raises the front edge of the float slightly, making it easier to push the float away from you; raising the handle does the opposite.



KNEEBOARDS

Once the slab begins to set, you need to get on it to trowel it without leaving deep footprints. Concrete finishers use kneeboards that spread out their weight like snowshoes for this task. You can buy nice aluminum kneeboards with integral kneepads—but while these look plush, they aren't cheap, and I've never seen them used in residential construction. More typical are pieces of 1/2-in. plywood about 8 in. wide and 2 ft. long with strips of wood fastened to the front edge to make them easier to pick up.

To use kneeboards, you walk out to the center of the hardening slab and then kneel down on them to float or trowel. Working backward toward the edge of the slab, you smooth out the marks left by the boards—and, inevitably, the toes of your boots—as you go.

MAG FLOAT OR WOOD FLOAT

Mag is short for magnesium, the metal mag floats are made from. In decades past, wooden floats served the same purpose. Mag floats smooth the lines from the bull float, and on small jobs are often used in place of bull-floating. They're employed as the bleed water evaporates and the top of the concrete begins to lose its sheen. Mag floats don't polish the surface, but rather "bring up the cream," meaning they further help to embed the coarse aggregate below the surface and bring moisture up from below as that on top evaporates. The point is to create a surface that's open to allow bleed water to evaporate, for further finishing with a steel trowel or concrete broom.

EDGER AND GROOVER

Edgers are small steel trowels that impart a radius edge to slabs.

This edge is less prone to chipping and friendlier in use than

a square one would be. I use edgers at two points during the finishing process. The first is shortly after bull-floating. At this point, the goals are to separate the wet concrete from the forms to minimize chipping when the forms are removed, and to push the coarse aggregate down to allow a smooth finish to be imparted later. The second time I edge is after steel-troweling or brooming to give the slab a smooth, finished edge.

A groover is like a two-sided edger, used to mold control joints and decorative joints into the slab. It works fine for sidewalks and broom-finished patios, but I prefer to saw-cut control joints in garage and interior slabs because I think it looks better.





STEEL TROWEL

The final tool used for a smooth slab, steel trowels are used after all the sheen from the bleed water is gone, but before the concrete is too stiff to work. A darby is a larger version of a steel trowel, with two handles. The trick to using a steel trowel is to keep the leading edge slightly elevated as you smooth the last remaining ridges and compact the surface. Pool trowels can be a useful finishing tool as well. Their rounded corners are less likely to leave ridges in the concrete.

Steel trowels should not be used on air-entrained concrete—these are finished with a mag trowel. Steel trowels close off the pores on the surface of the concrete, trapping in air that should be allowed to escape. Another common mistake is to sprinkle water on a slab that's setting up too fast. Both of these things can lead to scaling and other surface failures. If it's a hot day and it seems likely that the concrete will set faster than you can finish it, have the batch plant add retarder to the mix to buy extra time.



POWER TROWEL

I've never used one, but I regularly see professional finishers using a power trowel. It's a great option for large slabs because its gas engine doesn't get tired and it can cover more ground before the concrete is too hard to work. The secret to using this tool is to get it on the concrete at the right time. Start too early and it will sink into the fresh concrete, making a mess; wait too long and you won't be able to smooth surface imperfections.

Power trowels can be equipped with float, finish, and combination blades. Talk to the rental company about what you're trying to do and they can set up the machine for your project. The machine's handle is how you control the direction of the power trowel: Lift up on the handle to move left; push down to go right.

CONCRETE BROOM

Sometimes you don't want the polished surface steel trowels create on concrete. Usually this is because they can be slippery when wet. In these cases, a broom finish is called for. After mag-floating and while the concrete is still wet, a broom simply is dragged across the surface of the slab. Any broom can be used, but special concrete brooms are available with finer or coarser bristles depending on the finish desired. Brooms are also available that attach to a bull-float handle, extending the finisher's reach so you don't have to walk on the slab to broom it. Once the slab is broomed, an edger is used to finish the corners.

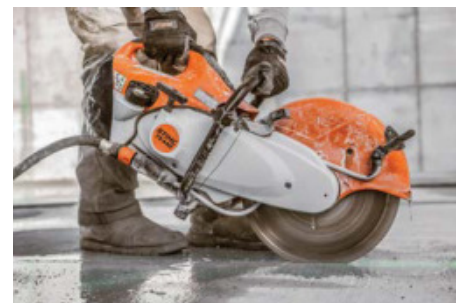


CONCRETE SAW

The old saying is that there are two kinds of concrete: Concrete that has cracked, and concrete that hasn't cracked yet. Assuming everything else was done correctly, thermal expansion is the main cause of cracking. It's essentially unavoidable.

The way to avoid cracks looking like defects is to saw-cut control joints a day or two after the pour. Saw cuts are straight and look deliberate, not like mistakes. Saw cuts should be one-quarter the depth of the slab, and the slab should be divided into rectangular sections that are as close to square as possible to even out the amount of movement between saw cuts. For residential purposes, 10-ft. squares are about right, although the size isn't a hard-and-fast rule.

You can use a circular saw with an abrasive or diamond blade for small cuts, but even better is a gasoline-powered concrete saw, which is rentable. Also described as a cutoff machine or power cutter, a concrete saw is the preferred tool for bigger jobs, but only outdoors unless you have a carbon monoxide death wish.



FRESNO TROWEL

Out West, concrete finishers routinely use Fresno trowels to finish concrete. Fresnos are larger than a handheld steel trowel and they attach to long handles like a bull float, making them ideal for large slabs. The downside is that because they're larger than a hand trowel, they don't compact the concrete surface as much, so the surface can end up less durable. Like smaller steel trowels, Fresnos should only be used after the concrete has been floated with a wood or mag float.



Framing an Open-Plan Saltbox

Structural stability can be a problem when the load-bearing partition is removed

by Pat and Patsy Hennin

Many houses built with energy efficiency and contemporary design in mind just don't look very homelike to lots of people, so builders are taking a second look at the ability of traditional styles to accommodate alternative technology and a modern, open interior while maintaining the dignity befitting a house. The saltbox is inherently efficient, with its high heat-collecting south face and its low north wall, often backed by wind-buffering closets. In some modern incarnations, though, it is also inherently unstable, with structural characteristics that place dangerous outward thrust on bearing walls. Appropriate framing can solve this problem, and result in the best of both worlds—open space within, and the traditional saltbox silhouette outside.

Development—The saltbox style evolved from the center-chimney Cape Cod, 1½ stories with a peaked roof, which was both simple and symmetrical (drawing, facing page, top). The side walls of the traditional Cape are built to equal heights and tied to each other with joists at floor and ceiling levels. Rafters are locked into compression at the roof peak, and the ceiling-level joists neutralize the tendency of the roof load to push the walls out. Above the walls the rafters and joists form triangles, the most solid of shapes, while corner braces (more triangles) give the walls rigidity. A Cape is very stable.

In its pure form, a saltbox is a Cape with a shed addition, which often continues the roof line at its original slope. The original rear wall (A in the drawing) becomes a shared load-bearing partition, and the new roof exerts no outward thrust because shed roofs place their loads equally on both bearing walls (A and B). An old-fashioned saltbox is as stable as the Cape it evolved from.

Today's saltboxes, though, are usually erected from scratch by builders who want a traditional look outside, but large, open spaces inside—and this can be the source of many structural problems. The saltbox's exterior walls and rafters by no means form a free-standing arch, and dispensing with the common partition or the joists that tie the rafters together destroys its structural integrity. Under heavy loads, such a building will collapse. If you want a sound, open-plan saltbox, you have to compensate for these missing structural elements.

Framing a new saltbox—One way to deal with the outward thrust of the roof is to eliminate rafters and build the entire structure in bents of progressive heights conforming to the shape of



A modern saltbox under construction in upper New York state. Framing is basically traditional, but the common partition between Cape and shed has been replaced by posts and beams to open up the interior. Photo: Patsy Hennin

the saltbox roofline (drawing, facing page, bottom). No rafter ties are necessary, so the house can be open vertically as well as horizontally—great if you want a cathedral ceiling. Each bent is made up of a purlin (a timber running parallel to the ridge) resting on posts that help form the end walls, which also become the bearing walls. (In a conventional Cape, the front and rear walls are the bearing walls.)

Purlins up to 18 ft. long are cost-effective, so assuming the tall wall is to the south, this method can provide clear spans from east to west of up to 18 ft. You can add sections of up to 18 ft. to the east or west. If you have special needs, you can replace one or two common posts with a beam that will support the weight of purlins. If you need to span more than about 12 ft. under loading conditions similar to Maine's, look into using a steel beam. Steel companies will size them for you, and they probably won't ruin your budget.

There are probably as many ways to frame up a new saltbox as there are housebuilders, but let's run quickly through one way you could proceed, taking as our example a house that is, in effect, two saltboxes of different heights slightly offset. This is probably the hardest case, and if you can frame it, you'll be able to frame any similar design.

The foundation must support the weight of the loaded building in the soil of the site and against heavy wind loads. For example, we can use pressure-treated 6-in. to 9-in. diameter utility poles anchored to concrete pads below frost level, attaching heavy 6x10 sills to them with steel strapping, as shown in detail C. In this case,

we would space the posts 8 ft. o.c. from north to south and 9 ft. o.c. from east to west, so that a row of them would run front to back under the center of each part of the structure. You could, of course, pour a perimeter wall or a slab, and make the sill connection with bolts set right into the concrete.

Joist hangers are the simplest way to connect joists to sills, but they are expensive and aren't sized to accept roughsawn lumber. We usually set the joists 16 in. o.c. on top of the sills. We use 16d nails to attach 2x10 headers to the joists' ends, take careful measurements corner to corner, and use a sledge to persuade the whole shebang into square. Then we toenail the joists into the sills with 10d nails. Subflooring (plywood, diagonal boards or flakeboard) is fastened to the joists with 8d nails, and we've got a platform to work on.

The post-and-purlin bents can go up as units, but putting up the side walls first makes it easier to keep the roofline straight. The walls are framed right on the deck. We usually use 4x6s, 4 ft. o.c., with 2x6 top and bottom plates and install horizontal blocking every 4 ft. up the height of the walls to act as a nailing surface for asphalt-impregnated sheathing, which breathes better, prevents infiltration better and is cheaper than plywood. Bracing against wind racking can be achieved with either plywood in the corners or diagonal steel or wood bracing. If you are framing with roughsawn lumber, 20d galvanized box nails are standard fasteners. Use 16d common nails with milled wood. Tilt the side walls up, nail the bottom plates through the deck into the joists with 20d nails, and brace the walls with 2x4s or the like while you get the 4x10 purlins up and in place.

Small diagonal blocks under each purlin will keep them all sitting perpendicular to the floor, the attitude in which they're strongest. One of the best ways to secure the purlins is to use a ¾-in. self-feeding 18-in. carbide bit to drill two holes through purlin, block, top plate, and 6 in. into each post. Use a sledge to drive ¾-in. rebar into each hole to anchor the purlins solidly in place (detail B). Toenail 2x10 blocking to the top plate between purlins, trimming it to the proper height. This blocking helps keep the purlins from twisting. Extending the purlins 18 in. or so beyond the posts allows for overhangs at east and west.

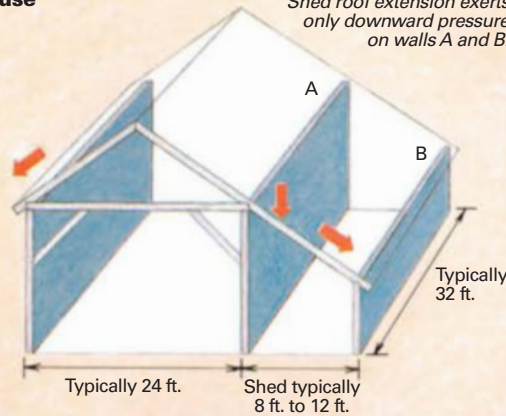
Where the purlins of the lower house section lie against rather than on top of posts, we notch the posts out 2 in. deep (detail A), and also bolt

From Cape Cod house to saltbox

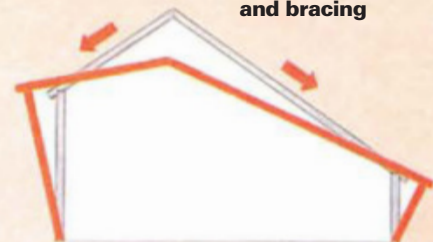


Roof and snow load push wall outward; joists tie walls together and neutralize outward thrust. Corner braces prevent racking.

Shed roof extension exerts only downward pressure on walls A and B.

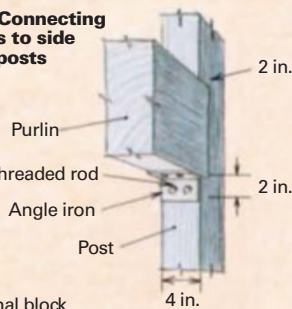


A saltbox without interior framing and bracing

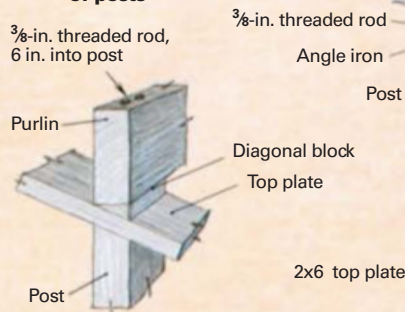


When the common partition and the second-floor joists are neither included in the design nor compensated for, nothing neutralizes outward thrust. The ridgeline sags, and the building may collapse.

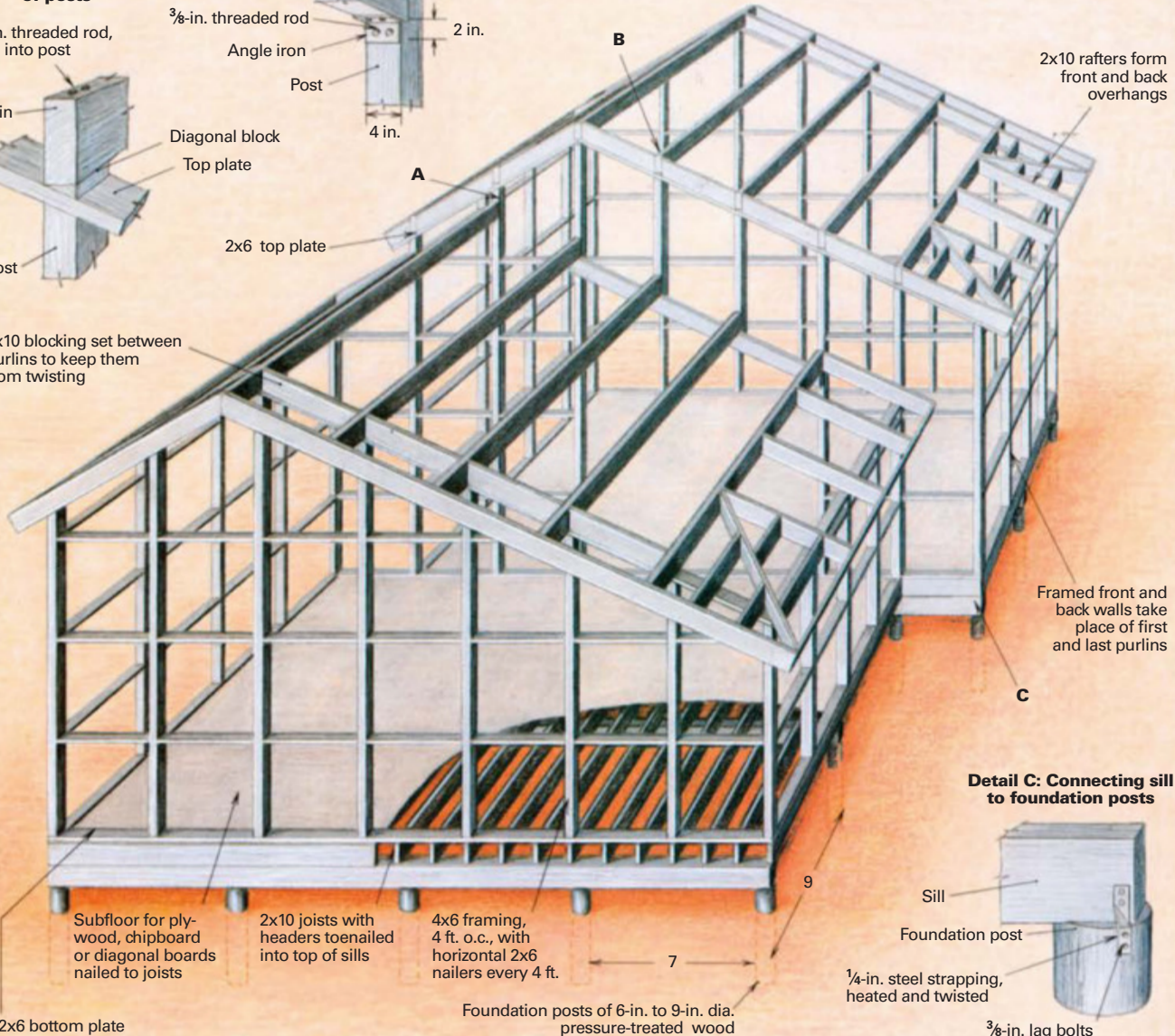
Detail A: Connecting purlins to side of posts

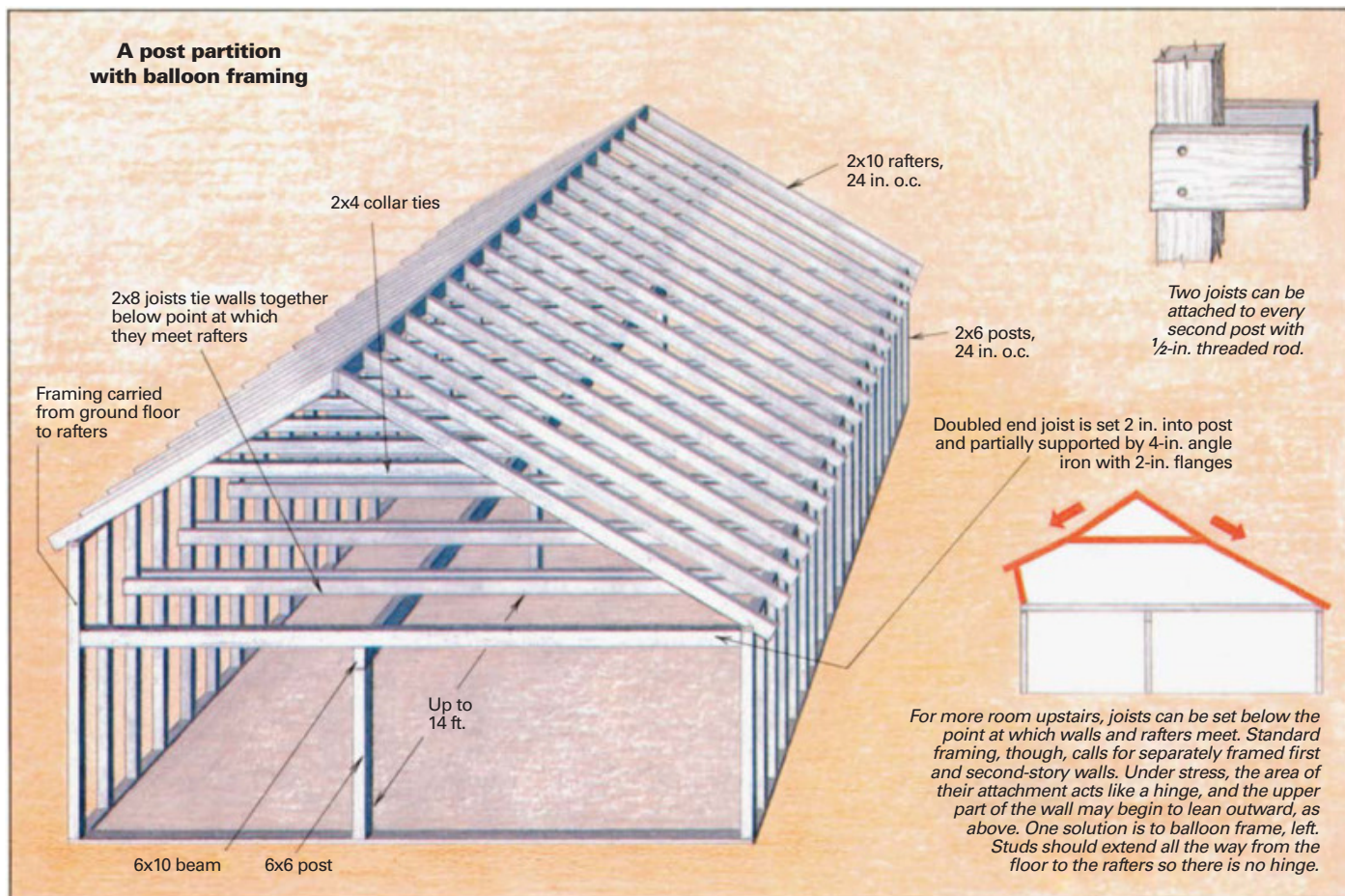


Detail B: Connecting purlins to top of posts



Framing a post-and-purlin saltbox with an offset extension





Sizing a beam

A beam must be large enough to support the “dead” load of the structure above it and the “live” load (of snow or activity) that is imposed on it. Calculating the size of a beam is a two-step process: First, add up the various loads on the structure and decide how they are bearing on the beams. The weight is either spread evenly (a uniform load) or concentrated (a point load). A point load typically requires a beam twice as large as the same uniform load would. Second, choose a beam of the right shape and species to resist the load.

The first load calculation is a bending moment problem in engineering terms. More than 40 formulae analyze the ways a load tends to break a beam, depending on the type of load (uniform or point), and on the beam and how it is supported (at both ends, cantilevered, with ends overhanging and so on). *Architectural Graphic Standards* is a useful reference for typical beam placement formulae; your local library probably has a copy.

As an example, let's size a purlin like one shown in the drawing on the previous page. This purlin is supported at both ends, with a roof load and a snow load spread evenly along its clear span (unsupported length)—a simple beam with a uniform load. The bending moment (M), or load that will break it, is calculated by:

$$M = \frac{WL}{8},$$

where W is the weight carried by the beam (the load per square foot multiplied by the top surface area of the beam in square feet) and L is the unsupported length of the beam in inches. Assuming that the posts are spaced 4 ft. on center, this beam will carry a rectangle of roof area above it 4 ft. (halfway to its neighboring purlins) by 18 ft. (the length of the clear span), or 72 sq. ft. On each square foot is the weight of the snow plus the weight of the roof structure itself. Check your local building code's snow-load estimate; in Maine it is 40 lb./sq. ft. The weight of the structure varies, but a typical figure is 10 lb./sq. ft. Hence the total weight on this

purlin is 50 lb./sq. ft. Returning to the formula,

$$W = 50 \text{ lb./ft.}^2 \times 72 \text{ ft.}^2 = 3,600 \text{ lb.}$$

$$L = 18 \text{ ft.} \times 12 \text{ in./ft.} = 216 \text{ in.}$$

$$M = \frac{WL}{8} = \frac{3,600 \text{ lb.} \times 216 \text{ in.}}{8} = 97,200 \text{ in.-lb.}$$

The amount of wood needed to resist this load is the section modulus (S), found by dividing the bending moment M by the fiber stress value (f) on the species of wood, or the pounds per square inch that the species can carry. *Architectural Graphic Standards* and many wood and building guidebooks list allowable stress values for structural timber of commonly used species. Eastern hemlock, our usual choice, can carry 1,200 lb./sq. in. This section modulus is calculated as follows:

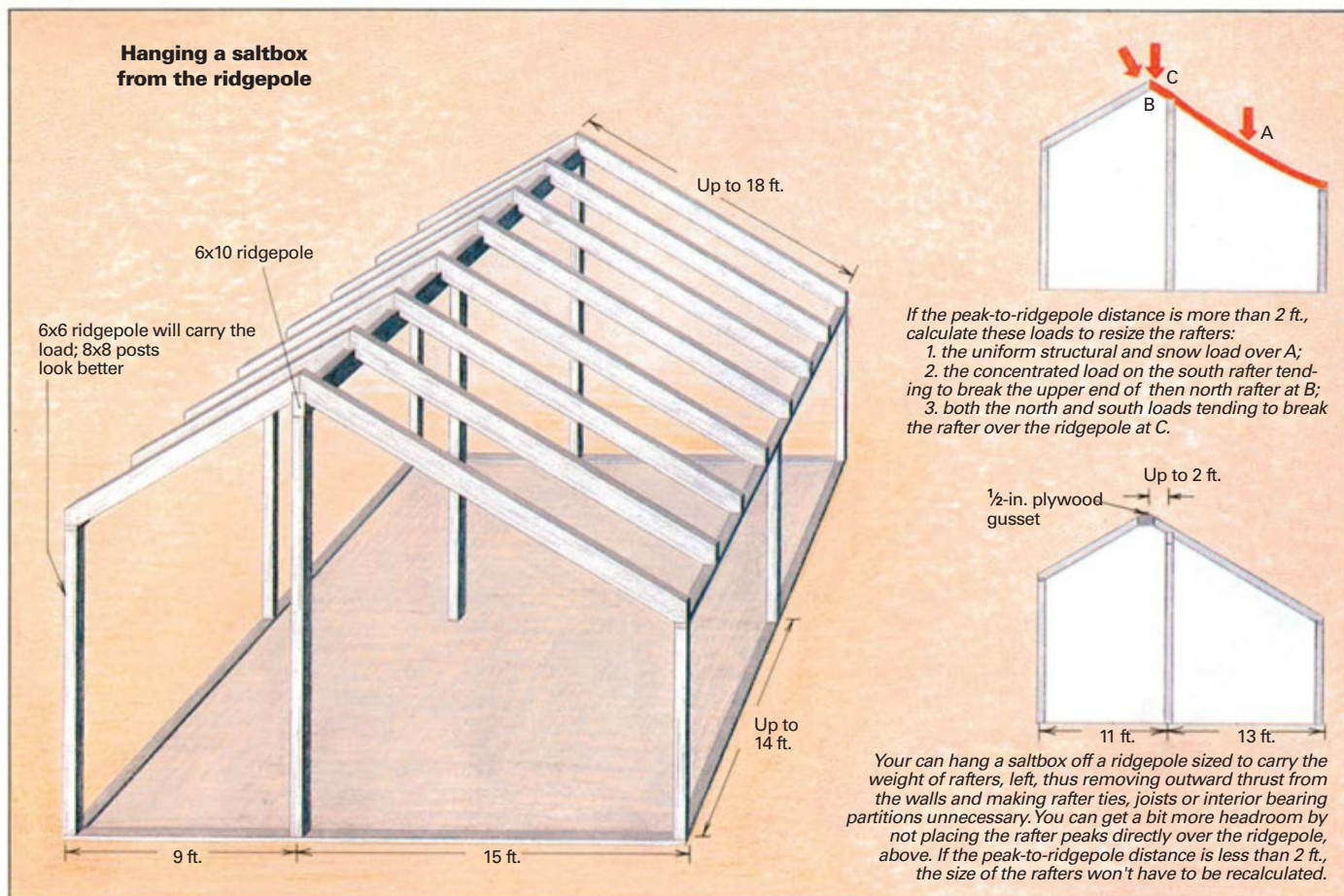
$$S = \frac{M}{f} = \frac{97,200 \text{ in.-lb.}}{1,200 \text{ lb./in.}^2} = 81 \text{ in.}^3.$$

The section modulus is just a theoretical shape. The actual concrete dimensions of the lumber are calculated by the formula

$$S = \frac{bd^2}{6},$$

where b is the breadth in inches and d the depth in inches of the beam. We usually use roughsawn lumber, where a 2x4 is really 2 in. by 4 in.; for milled lumber, use the planed-down dimensions. To find the right size beam, substitute various sizes for b and solve for d. The strength of the concrete dimensions must be equal to or greater than the theoretical shape, in this case 81 in.³. For example, if b is 4 in., d is 11 in. If b is 6 in., d is 9 in. Since lumber is sawn in 2-in. increments, order a 4x12 or a 6x10. Either will do. There are tables that will size joists and beams, but rarely can you find one that will size a timber as large as these purlins. Also, most tables aren't written for roughsawn lumber. —Patsy Hennin

Hanging a saltbox from the ridgepole



angle iron with 2-in. flanges onto the posts with $\frac{3}{8}$ -in. threaded rod at the bottom of the notch, creating the 4-in. bearing surface required by most building codes.

We don't set purlins on top of the first and last posts. Instead, we frame the 4x6 front and rear walls up to the proper height. We set 4x6s 4 ft. o.c. with 2x6 top and bottom plates and blocking, just as in the side walls. The asphalt-impregnated sheathing goes on with $1\frac{1}{2}$ -in. roofing nails. We also extend rafters from the front and back purlins to create overhangs at the north and the south.

On the roof, 1-in. boards over the purlins do double duty as both sheathing and ceiling. They are nailed to each purlin with three 8d nails. This ties all the purlins together and further reduces the likelihood of their twisting. At the peak, we fasten boards from both sides of the roof together with $\frac{1}{16}$ -in. or 22-ga. metal secured with 5d nails. Our post-and-purlin saltbox is now framed and sheathed.

Modifications to traditional framing—There are techniques other than post and purlin that can result in a structurally stable open-plan saltbox. One is simply to modify traditional framing by replacing the common wall with a series of structural posts topped by a beam sized to support the rafters above (drawing, facing page). Here in Maine, we can use reasonably sized beams to span up to 14 ft. In areas where a smaller snow load can be expected, you could span greater distances. This technique results in

an open horizontal space, but the joists tying the walls together block vertical openness.

If you want an open first floor and also more room on the second, set the joists below the level at which the rafters meet the top plate. Then install collar ties near the peak of the roof. You'll still need the common partition or a row of posts, but this technique increases the headroom at the south wall, and will give you more space for upstairs rooms. It imposes great point loads on the south studs, though, and snow loads could make the south wall bend at the plate between the first and second floor framing. The best solution is to balloon frame—use studs long enough to carry in one piece all the way from the first floor through the second floor to the rafters, and use enough of them to divide the loads down to a minimum per stud and rafter. In Maine we often use 2x6s, 24 in. o.c. as studs, and set our rafters 24 in. o.c. also.

Hanging from the ridgepole—Another way to eliminate outward thrust is by using a ridgepole sized as a beam to carry the weight of the rafters (drawing, above). Sizing a beam is explained in the box on the facing page. If you attach the rafters to the ridgepole with angle iron or rebars, or gusset them to each other over the ridgepole, the building will hang like a tent from the ridge. You no longer need second-floor joists or rafter ties, because there is no outward thrust. As with the purlin method, the house can be open vertically as well as horizontally. Rafters up to 18 ft. long make economic sense, and in

Maine ridgepoles can span up to 14 ft., so clear interior spans in a saltbox could reach 24 ft. by 14 ft., and the only obstruction in a 24-ft. by 28-ft. room would be a single post in the middle.

If you need more space north or south of the obstruction caused by the rafters and ridgepole, you can set the peak several feet away from the ridge, as in the drawing, above right. The southern rafters are in compression against the northern rafters, and are exerting a downward pull on their high ends. Technically, this is a point load on cantilever, and the ridgepole can be as much as 2 ft. from the peak without affecting the size of the rafter. If you want the peak even farther from the ridge, you have to consider three types of load when you calculate the size of the rafter, as shown in the drawing, top right.

You can build a safe, open-plan saltbox using any of these methods, or a combination of several. Draw the floor plan first and think about which technique would obstruct your pattern least. If necessary, fiddle with your floor plan a little so that you can use a method that will guarantee a stable house. If changing your floor plan is too traumatic, consider using steel beams to allow longer safe spans. Remember that you always have to account for the outward thrusts created by disturbing the original simplicity and balance of the Cape/shed combination that we now call the saltbox. □

At time of writing, the Hennins were directors of the Shelter Institute in Bath, Maine, an owner-builder school which they founded in 1973.

Energy-Smart by Design

Building orientation, passive-solar design, and a radiant-barrier roof are key to energy efficiency in a hot-humid climate

BY KILEY JACQUES

This contemporary “farmhouse” is located in the booming urban hub of Central Austin, Texas. It belongs to an older couple whose objectives in having it built included downsizing from a much larger suburban home, reducing their carbon footprint, and living a more pedestrian-oriented lifestyle. To that end, they charged Barley & Pfeiffer Architecture with designing a comfortable, healthy, and resource-efficient house that would blend into the neighborhood of small-scale post-World War II homes.

Principals Peter Pfeiffer and Alan Barley have been designing high-performance homes in Texas’s hot-humid climate for over 30 years. Their projects commonly include metal roofing, deep overhangs, awnings, and other shading devices, as well as a combination of fiber-cement lap siding and locally sourced limestone veneer. Their intention is always to design energy-smart structures that rely most heavily on site orientation and passive-solar design and natural ventilation rather than HVAC systems. They also place great emphasis on good indoor-air quality. Peter’s ventilated radiant-barrier roof system is chief among their design strategies. It took 40 years to develop, and this house is the beneficiary of his decades-long research.

Two floors are better than one

The north-facing lot measures just 60 ft. wide by 96 ft. deep. To accommodate the desired volume of living space, they needed to build up rather than out, which has benefits in a hot climate. First, because roofs are a major source of solar





DYNAMIC CONFIGURATION The galvalume metal is a historically appropriate roofing material for Texas vernacular homes. Pitched roofs are best for this climate, which sees annual torrential rains; they also allow for 30-in. overhangs, which protect against solar gain. Although it appears from street view to be a typical garage, this "car pavilion" functions as a patio, an outdoor cooking area, and a pet-washing station.

gain, decreasing a roof's size relative to the building's volume reduces that gain. They advise clients to put the money saved by shrinking the roof surface into better building materials. Second, it minimizes the perimeter and interface between the wall system and the foundation slab, which is notoriously vulnerable to air infiltration—a major consideration when seeking to curb energy usage. “More house over less foundation is a more efficient house to build per square foot,” Peter says, adding that building up rather than out also means less impervious coverage, which helps with stormwater management. Plus, a stacked, compact house with an air handler at the center supports shorter duct runs, which further reduces energy consumption by decreasing losses to friction along the ducts.

Cooler from the start

Energy demands can be mitigated right off the bat by correctly orienting the house on the lot. “A house should be inherently energy efficient without reliance on mechanical systems,” Peter notes. “You can get 10 times more out of your house by designing it to respond to the climate.”

This house is sited to be shut off to intense western sun and open to south-southeasterly breezes. To help capture those breezes, Alan says houses in this climate should try to incorporate screened porches and connected outdoor living areas. Come winter, the house shields those spaces from northwesterly winds, making them more comfortable. By adding fireplaces to screened porches, they can be used nearly year-round. The porch on this house not only takes in the prevailing breezes, it also works in sync with the stair tower, which acts as a passive-thermal siphon to draw warm, moist air up and out upper-floor windows. “Enhanced natural ventilation for homes in the south is becoming vogue again,” Peter says, “as people are becoming more and more aware of indoor-air-quality issues.”

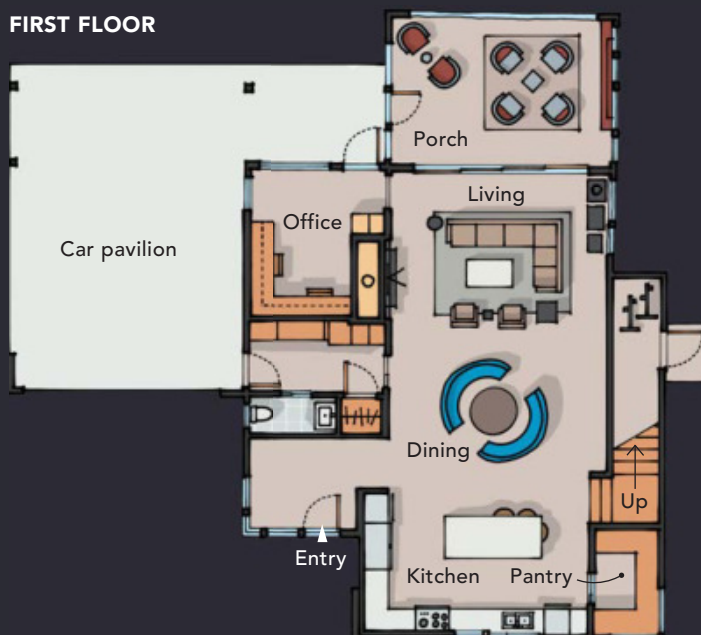
Another of the architects' preferred strategies is putting all of the bedrooms on the second floor and using two separate air-conditioning systems, one for each floor. This makes for a more energy-efficient home because mechanical cooling can be targeted depending on time of day and occupant location. “It is better to have the redundancy of two separate systems that are sized only for the load they're handling,” Peter explains. “One system for two floors is never right, and then you have an oversized system running one part of the house or another.”

For Peter and Alan, the main priorities when designing for a hot-humid climate are addressing infiltration of outside air and controlling solar radiation. This house has 2x4 walls with closed-cell spray foam that acts as an air barrier and controls humidity; the attic is unvented while the roof above it is vented to remove water vapor and improve the roof's thermal performance. Heat gain is further addressed with calculated shading of the windows using 30-in. overhangs and awnings. Additionally, the tight building envelope is positively pressured; negative pressure taxes cooling equipment and brings in dust and other contaminants that reduce indoor-air quality. Their general approach is to bring outside air into the house by way of either a mechanical system

ORIENTED FOR COOLING

To block unwanted solar gain, the house is primarily closed to the west. Conversely, to capitalize on prevailing breezes, the living room and screened porch face south-southeast. The master bedroom is farthest from the street on the second floor, and acts like a screened porch with windows on three sides for optimal natural ventilation.

FIRST FLOOR



SECOND FLOOR



SPECS

Bedrooms: 2

Bathrooms: 2½

Size: 2450 sq. ft.

Location: Austin, Texas

Architect: Barley & Pfeiffer Architecture,
barleypfeiffer.com

Builder: Risinger Homes,
risingerbuild.com

North
▼

0 4 8 16 ft.

Floor-plan drawings: 07sketches/Bhupeshkumar M. Malviya



EASY ON THE EYES Shaded clerestory windows on the northwest side of the house provide balanced, glare-free natural daylighting for the main living areas, including the living room and screened porch.



HEALTHY AND HARMONIOUS

The kitchen faces the street and is lit with soft northern light throughout the day.

A ROOF SYSTEM 40 YEARS IN THE MAKING

Architect Peter Pfeiffer traces the genesis of his radiant-barrier roof design back to the early 1980s, when spray foam was gaining popularity. "When we were first thinking about applications for spray foam, adding it to attics was a radical change agent for the construction industry," he recalls. As a young architect, he felt ventilating attics to keep them cool made little sense because the major heat source was solar radiation, which he reasoned should be prevented from entering the attic in the first place. "Trying to fight radiation with convection, which is what venting is, is a weak strategy from a physics standpoint," he explains.

Peter determined that air leakage was number one on the list of reasons for excessive energy usage. Consider that most air conditioners are set up to suck air out of the house, cool and dehumidify it, and send it through a network of ducts back into the house. When ducts are not airtight, they leak, and a good percentage of that conditioned air never makes it into the home. The house then "goes negative," meaning it takes 100% of the air out to condition it but doesn't return all of it, which creates negative air pressure. That forces the house to suck makeup air from every crack and crevice. The result can be a 20% or greater energy loss. The process also brings hot, humid air into the house, which the air conditioner then needs to handle.

The knowledge of this energy loss led to efforts on Peter's part to make duct-blaster tests a code requirement, which would ensure conditioned air is not lost outside the envelope. But even sealed ducts can be less effective if they are located in an unconditioned attic. Peter envisioned not only sealed ducts but also

a sealed attic space, with a system for venting the roof deck to reduce heat gain and keep the attic as cool as possible.

Ventilated attics cost a lot of energy and money while lessening occupant comfort due to high humidity and poor air quality. The growing popularity of recessed can lights exacerbated the problem—installation required puncturing holes in the ceiling, which allowed heat from the attic into the living areas below. This, combined with the dark roofs common at the time, made for a solar-collecting roof assembly. Air-conditioning ducts with minimal R-4 insulation were being subjected to high heat. For these reasons, Peter began thinking about attic radiation barriers.

At first, it was a matter of draping a 4-ft.-wide roll of foil between rafters, which would cut attic temperatures by 15°F to 20°F. He then developed a system that would be easier for builders to install: foil-laminated plywood sheathing. It was branded "Kool Ply," and it informed the product now sold as LP TechShield.

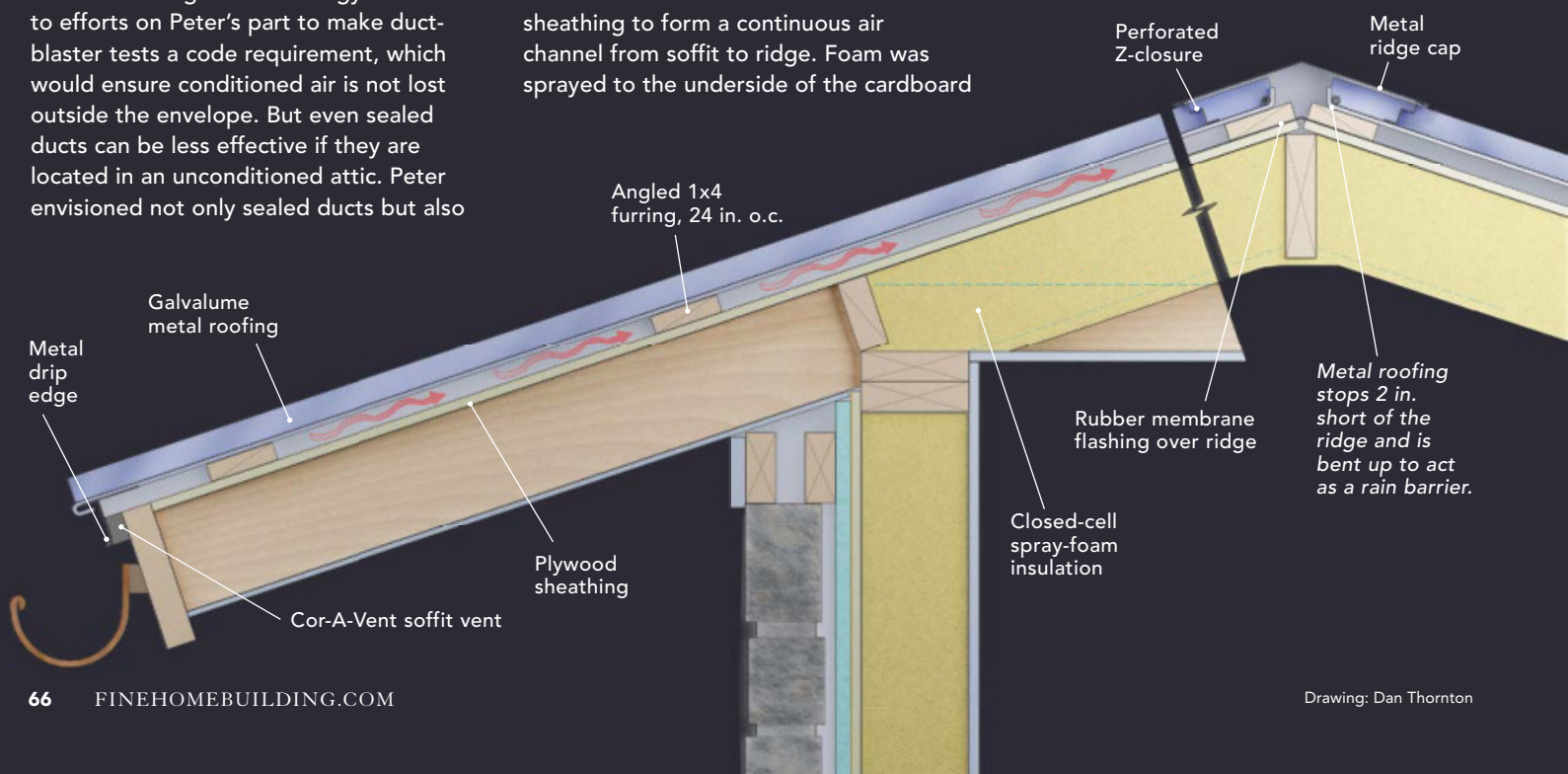
When spray foam started to take off as residential insulation, it was expensive but effective; it enabled much tighter houses and reduced the need for caulking and gaskets to stem air infiltration. It also eliminated the call for netting beneath rafters in order to blow in insulation for a cathedral ceiling.

Peter experimented with installing cardboard beneath the radiant-barrier sheathing to form a continuous air channel from soffit to ridge. Foam was sprayed to the underside of the cardboard

and rafters, creating a ventilated roof system with a sealed attic. It was a costly approach, and Peter wanted an alternative. "It dawned on me that galvalume—a new product at the time that coated sheet metal with zinc and molten aluminum—could be an advancement," he explains.

Galvalume panels reflect a fair amount of incoming radiation. The panels' performance can be boosted by providing an air space under them, which minimizes conduction to the roof deck and, because of galvalume's low emissivity, allows the panels to act as a radiant barrier. Peter started out using 1x4 vertical furring strips 24 in. o.c. from soffit to ridge, with another layer running horizontally. To reduce the cost of the assembly, he switched to using one layer at about a 45° angle (parallel to the roof valleys), which provides adequate ventilation with about half the furring.

Further iterations of the assembly included an air-venting strip in the soffit, which required cutting into the sheathing above to create a gap for air to escape. That left the sheathing edges exposed to moisture, so Peter added 1-in. gaps between the furring-strip ends to create more air pathways and increase drying potential. He decided to stop the furring and galvalume 2 in. shy of the ridge, and bend the metal up between the ribs to act as a barrier to wind-driven rain. He used 18-in.-wide strips of sheet metal to make a





MAXIMIZED AIRFLOW The spacing between the 1x4s creates myriad pathways for air to travel. Orienting them on an angle rather than horizontally and vertically saves material.

ridge cap—9 in. on each side. That allows air to come out the top, but rain can't get in.

The next evolution moved the air intake from the soffit to a Cor-A-Vent strip installed behind 1¼-in. D-style galvalume drip edge. This configuration brings air into the roof system without having to fuss with the soffit. In time, Peter adjusted this Cor-A-Vent detail to include a 45° angle; when it sat flush with the soffit, it hindered air movement. He also decided to run the furring strips farther apart to increase air movement: 24 in. o.c. with 2-in. to 3-in. gaps between the ends.

"This roof system came out of decades' worth of nuancing and getting feedback from builders," Peter says. "Elevating the roof cover off the decking to induce above-sheathing ventilation is as important as increasing solar reflectance, and may be the stronger player in reducing heat gain."

Peter says the system works in all climates. In cold-weather locations, it stops snow melt and subsequent ice damming; if heat rises up from the attic and through the foam, it leaves through the ridge. And because the furring also works as a rainscreen, it is suited to wet climates too.

like an Ultra-Aire conditioning unit or a barometric damper that opens when the house pressure goes below neutral. This allows fresh air into the return-air chamber; it is then filtered and dehumidified.

Ventilated radiant-barrier roof

Peter's roof design is paramount among his firm's cooling strategies. It uses unpainted galvalume, which he says thwarts about 72% of the radiation that hits it. That means only a small percentage of solar radiation penetrates through to the space below. Lifting the metal roofing off the sheathing with diagonally run furring strips—spaced 24 in. o.c. with 3-in. gaps between the board ends—creates a ¾-in. gap from soffit to ridge for continuous movement of air through the ridge vent. The underside of the galvalume works like a foil-faced radiant barrier, so little absorbed heat is transmitted into the attic. The metal roofing also dissipates heat quickly at night, which means it is not radiating heat inward. To create an additional barrier to heat, the area between the rafters is sprayed with closed-cell foam. In short, it is a system to mitigate solar heat gain, thereby keeping the sealed attic space below as cool as possible.

A builder's take

Matt Risinger, the builder on this project, included Peter's radiant-barrier roof on his first spec house and has been using it ever since. He is sold on its efficacy, although he prefers Zip System sheathing because the roof-deck seams can be taped and the flexible flashing works well on plumbing penetrations. In terms of constructability, because the roof is up on 1x4s, roofers have toe boards across the entire surface. One consideration for general contractors that Matt notes is determining whether the framer or the roofer should install the furring.

What else do builders need to know? It's pricey—all of those 1x4s add up—and it's important to be cautious about underlayments and penetrations. There are potentially two layers of flashing, and penetrations in the roof decking create air gaps. If they are not flashed at the roof deck and water gets through, there could be a leak that goes undetected.

One house among many

After decades spent fine-tuning both passive and active systems for dealing with Texas heat, Barley & Pfeiffer Architecture has a large collection of low-energy, maximum-comfort homes to their credit. This home is young among them.

Peter makes a final and noteworthy point: Resiliency in Texas looks different than it does in cold climates. This last winter aside, the state's power system is typically most vulnerable during the summer and hurricane season; plus, the region is dealing with temperatures that average 10°F to 20°F warmer than two decades ago. Handling heat is a bigger threat than going without. Nonmechanical cooling strategies that function independent of the grid are imperative. As this house testifies, he and Alan have it pretty well dialed in. □

Kiley Jacques is senior editor at Green Building Advisor. Photos by Ryann Ford.

HOUSES

ARCHITECTURAL CHALLENGES AND SOLUTIONS

BY DESIGN

CURATED BY JANICE ROHLF



MODERN REMODEL IN A TRADITIONAL NEIGHBORHOOD

In love with their site and neighborhood, but not with their house, Studio MM's clients approached them about transforming their traditional Tampa, Fla., bungalow into a home that would meet the needs of their immediate and extended family. They were particularly intent on renovating it into a modern home—the first of its kind in the historic Hyde Park district of Tampa. While the original bungalow was not listed as a historic structure, there were a number of strict Architectural Review Committee (ARC) design guidelines they needed to follow. The primary concern was that the new home fit in with the fabric of the neighborhood, requiring careful attention to massing, setbacks, texture, horizontal articulation, and overall scale of the home. Studio MM made compromises with the ARC on materials, ultimately deciding on a muted gray stucco with warm wood accents. Another joy and challenge of the site was the presence of a number of Grand Oak trees, well known in this district. The architect worked to design the house on the existing footprint of the bungalow to minimize disturbances and to preserve the majestic trees—no small feat in transforming a bungalow into a contemporary home. Ultimately, Hyde Park House brings a bold, fresh perspective to the neighborhood, while paying its respects to neighbors and the intentions of the district.

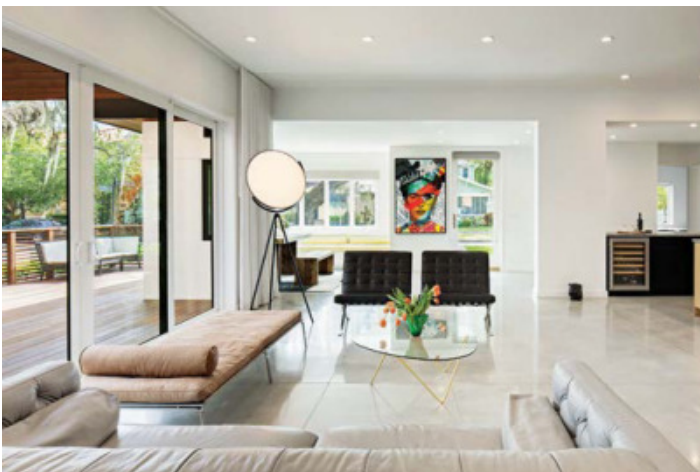
Designer Studio MM, maricamckee.com

Builder Robert H. Delafield, Inc., delafieldinc.com

Location Tampa, Fla.

Photographer Brad Feinknopf/OTTO









Designer AAM Architecture & Design, aamcapearchitect.com

Builder The Valle Group, vallegroup.com

Location Falmouth, Mass.

Photographer Dan Cutrona Photography

GAZEBO GROWS UP

The *coup de grâce* of a substantial back-of-the-house-living space renovation is a freestanding, two-level gazebo. The challenge was to locate the gazebo in a spot that didn't block the views of the spacious backyard from either inside the house or from the deck and patio. Connected to the deck, but not to the house, the gazebo satisfied the homeowners' desire for a moderately sized, low-profile structure separate from the main house (not an attached screened porch) that was architecturally interesting yet didn't break the bank. Consistent with the architecture and scale of the colonial-style house, the gazebo's hip roof is less obtrusive than a gabled one would have been, and its shape creates a cathedral ceiling inside that offers great opportunities for design with its exposed timbers. The gazebo's windows are screened panels with transparent glass below. Practically speaking, the lower level of the gazebo is a boon, as the ample space is used for storing bicycles, gardening paraphernalia, outdoor furniture, and more.





SMALL PREFAB WITH A BIG IMPACT

Alchemy's lightHouses are a predesigned solution for ADUs (accessory dwelling units) used as replacement housing, cabins or guest houses, short-term rentals, home offices, or age-in-place dwellings. Plant Prefab, a California-based factory, executed this carefully crafted beta-prototype lightHouse to provide temporary accommodation while a larger house is built on the same lot. The structure embraces the luxury of less with its spacious interior and contemporary specs and finishes including its unique exterior light with awning and ID plate. The simple but elegant kitchen has a solid white-oak storage shelf and a storage bench with movable backs that convert to sleeping space. A minimalist storage core contains the utilities, a washer/dryer, and a sprinkler system. The fully tiled bath has a zero-threshold shower, frameless glass panels, and a touchless faucet on a Dornbracht Alape sink. Delivered as a complete prefabricated module, the envelope is very low energy, with exterior insulation and a sustainable cedar rainscreen skin. Alchemy's lightHouse system complies with most city or county ADU guidelines. They are placed on permanent full, perimeter, or slab foundations and can be designed to be built atop a new garage structure.

Designer Alchemy, alchemyarch.com **Builder** Plant Prefab **Location** Sebastopol, Calif.

Photographer Brian McCloud





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NEW AND NOTABLE PRODUCTS

FRIDGE FOCAL POINT

Refrigerators aren't typically known for being the most artful part of a kitchen, but when we can hand-curate everything from sink faucets to backsplashes, why shouldn't the largest kitchen appliance also reflect the thoughtfulness we put into the rest of our living space? Samsung is making headway on this problem with its new line of customizable Bespoke refrigerators. The three options—4-Door Flex, Flex Column, and Bottom Freezer—can be combined and configured to fit the specific needs of the space. But the best part is the ability to pick from a wide color palette, with hues from pink to navy, which can be mixed and matched on different panels and chosen through Samsung's online design studio. Plus, if you redecorate down the road, you can update and swap out the panels.

This refrigerator isn't just for looks: It produces two different sizes of ice and comes with a Flex Zone compartment that can switch between fridge and freezer temperatures. Prices start at \$1300.

—Lana Melonakos-Harrison,
assistant editor

MODULAR MODERN CLADDING SYSTEM

If you're in need of a sleek siding material that will last for decades and will never need to be refinished, Glen-Gery's Terraçade facade system looks like a great option. Made of colorfast ceramic, the large tiles have molded-in grooves that hang on tabs on vertical galvanized-steel mounting rails. The rails pair with an air and water barrier to create a well-drained and ventilated rainscreen wall assembly.

Plus, the sturdy, UV-resistant, noncombustible tiles and complementary aluminum trim pieces help the walls stand up to fire, sunlight, and impacts. The metric-sized tiles are just shy of a foot tall and come in widths of either 600mm or 1200mm (approximately 2 ft. and 4 ft.). Finish choices include several matte earth tones in smooth or sand-blasted textures, glossy glazes in six bold colors, and two bright faux-wood grains. Prices are around \$20 to \$35 per sq. ft. including the tiles, installation hardware, and aluminum jointing strips. —Rob Wotzak, digital brand manager



READY-MADE STAINLESS SHOWER PAN

Finally, Infinity Drain has released a curbless, presloped shower base with a built-in drain for residential applications. That means no more struggling with the origami of folding rubber membranes to build a watertight shower floor. Just set the base in thinset mortar and run your wall substrate over the sides, and you're ready to install your tile. The pan is available in a ready-made 30-in. by 60-in. version, or you can order custom bases—but only on orders of 10 or more, which is ideal if you need them for multiple projects or houses with multiple bathrooms. The stainless-steel bases come with either a linear drain or a center square drain, with several options for decorative drain covers or a tile-in cover along with multiple finish options. The Stainless Steel Shower Base carries a lifetime guarantee against waterproofing failure. —Fernando Pagés Ruiz, home builder and developer



MESS-FREE SEAL FOR PLUMBING PENETRATIONS

Sealing foundation penetrations can be tough; the common approaches using hydraulic cement and sealant fail more often than not. I've found Innerlynx mechanical seals by Advance Products & Systems to be a reliable alternative. Each seal is a "chain" of compressible links, connected together and sandwiched by small plates and bolts. They are placed in the annular space between a round hole in a foundation and the pipe passing through it. When the bolts are tightened, the links compress and expand to form a tight seal that can hold back nearly 100 ft. of head pressure. For residential use, the seals include EPDM rubber links, composite plates, and steel nuts and bolts, but there are other options for high temperatures, chemical/oil exposure, and firewall assemblies. The seals can be inspected and tightened if needed over the life of the building. Pricing depends on pipe and hole sizes—use the manufacturer's chart or online calculator to choose the right size for your application. A seal for a 1½-in. pipe through a 3½-in. sleeve is about \$30.

—Ben Bogie, high-performance builder

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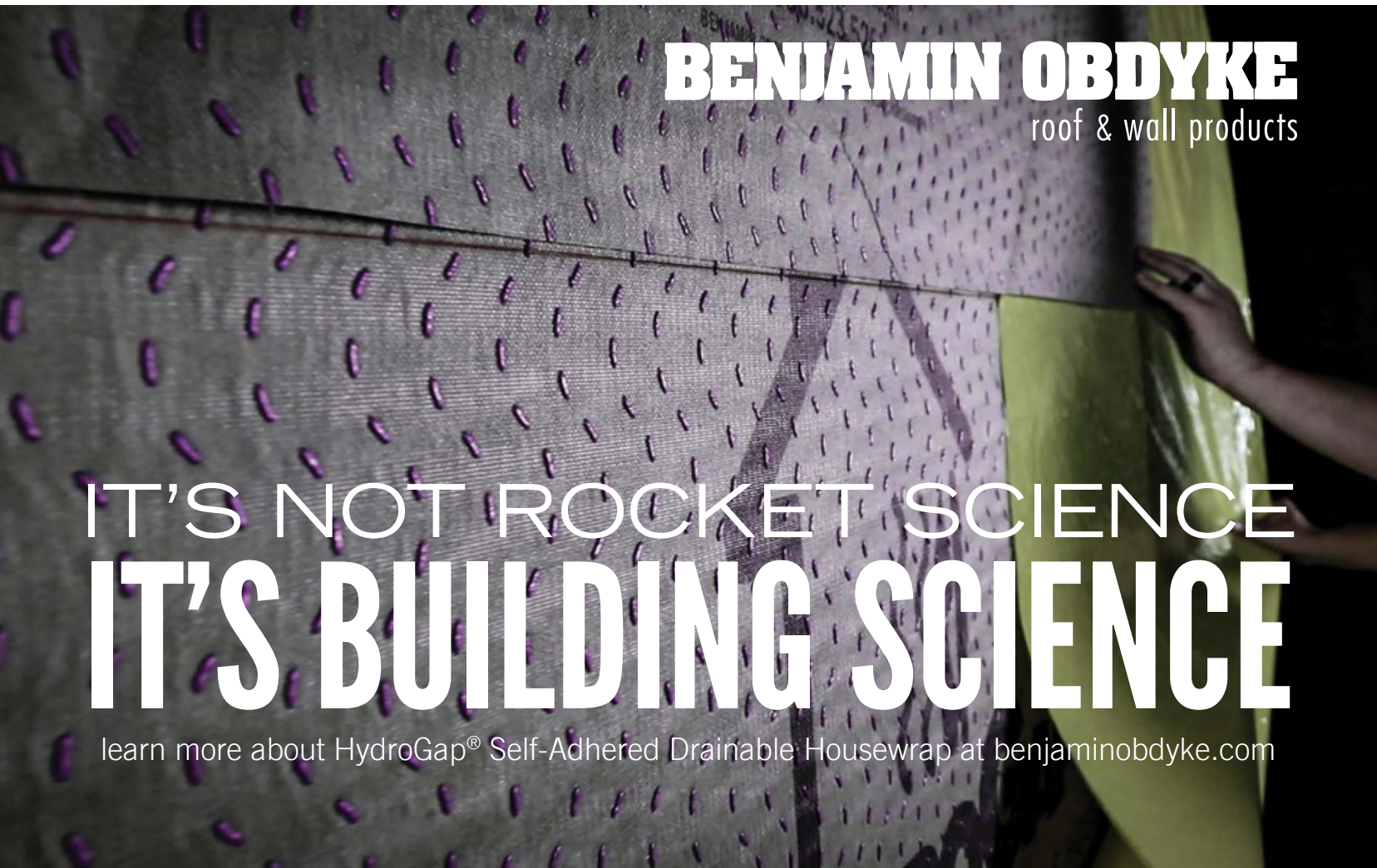
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FRAMING DOUBLE-STUD WALLS

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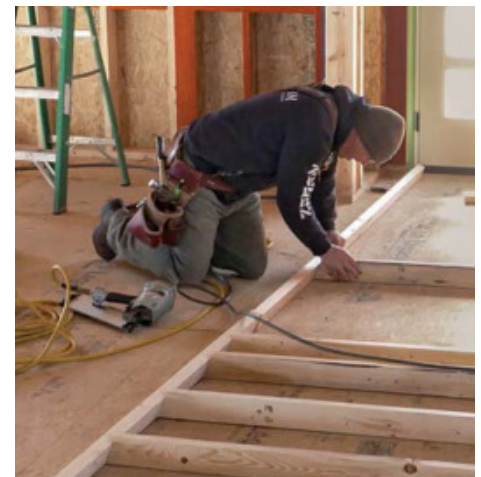
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To provide extra room for insulation and create a thermal break in the wall cavities, builder Ian Schwandt and his wife, Sara, chose to build double-stud walls in their high-performance home. If you can frame one wall, you can build double-stud walls, which are simply two nearly identical stick-framed walls with a space between them. Like the exterior wall, the second interior wall is easy to build on the floor and then raise up. Here, the wall has a pitched top plate to meet the rafters of a vaulted ceiling. The thick walls will provide the family extra comfort against Wisconsin's cold winters and help ensure they reach Passive House levels of performance.

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askthe experts

YOUR QUESTIONS—PRO ANSWERS

Flashing a round window

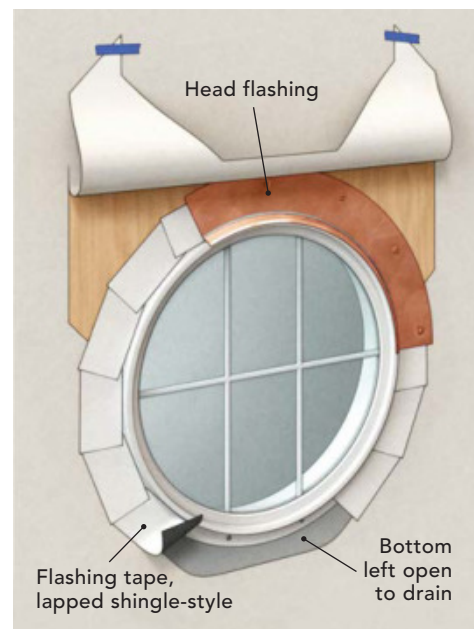
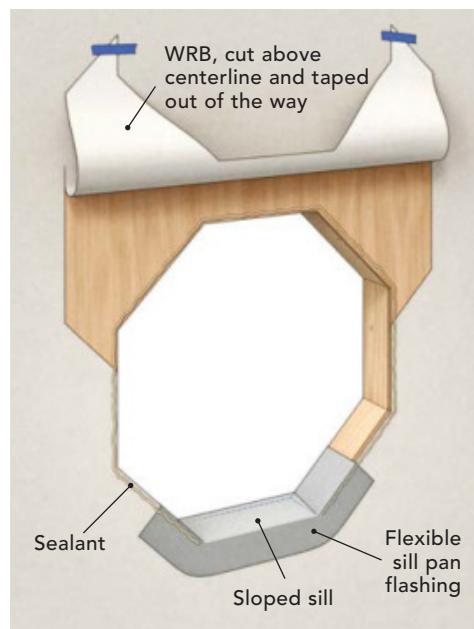
I have to install a round wood window on an upcoming project. I know how to integrate the water-resistive barrier (WRB) and flashings on a rectangular unit, but I'm not sure how to do this with a round one. Can you help?

—VICTOR GOSTMAN
via email

Ben Bogie, a project manager for BPC Green Builders in Wilton, Conn., replies: Flashing a round window is pretty similar to flashing a rectangular window, but there are a few nuances to consider.

Like any other window installation, the first step is preparing the rough opening with some form of pan flashing. It's a good idea to pitch the sill toward the outside with a scrap of clapboard siding, shimmed plywood, or a simple bevel rip of wood—a few degrees goes a long way. Most framing for round windows ends up as some kind of polygon with six or more sides, the bottom of which is horizontal. Seal the horizontal sill and a few inches up the angled sides with either a flexible flashing tape or a fluid-applied flashing. There's no perfect way to do this with a round window, but the overarching goal is to direct any incidental leakage toward the lowest point where it can weep out.

With the rough opening prepped, install the window per the manufacturer's recommendations. With a mechanically attached WRB (housewrap), make a horizontal cut 2 in. to 4 in. above the centerline of the window and fold the WRB up and out of the way.



SAME IDEA, DIFFERENT SHAPE

The materials and the order in which they're layered are the same when flashing a round window as they are for a rectangular one, but you may have difficulty bending a metal head flashing on-site. Architectural metal fabricators can make one for you; flexible vinyl is another option.

squeeze sealant behind it except at the lowest spot—leave it out in that location so water can drain from the sill pan. From this point, we can treat flanged and cased windows essentially the same way. You can cut a nonstretchable flashing tape in short sections, applying them by working from the bottom up (leave a couple inches of the bottom untaped so the sill can drain) in shingle-lap fashion. Tape the bottom of the window flange or edge of the jamb to the WRB. At the centerline, begin taping to the sheathing. Use a roller or squeegee to firmly bed the flashing tape. Alternatively, you can use a flexible flashing tape to flash the window in far fewer pieces.

Now you can tackle the head flashing. There are a few ways to approach this, but the general idea is to flash from the centerline up. The least expensive method is to use

a flexible vinyl head flashing purpose-made for the application. With this approach you'll want to consult the manufacturer's documents for details. Most rely on a combination of sealant and flashing tape to complete the flashing. An old-school but perfectly effective alternate option is to form sheet lead to the curve. The nicest solution, in my opinion, is to make a custom copper head flashing. This can be done by competent metal roofers or architectural metal fabricators.

With any of these head flashings complete, the final step is to fold down the WRB over the vertical leg of the head flashing, tack it in place with staples or tape, and tape the cuts.

Flattening a wall

I'm remodeling an older house. The plaster was removed in a previous renovation and all the walls and ceilings are dry-

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Fill and feather. If you don't want to go to the trouble of removing drywall and shimming studs to remedy a recess in a wall, you may be able to fill the low spot with setting compound. If the bow is only obvious because of its proximity to trim, filling the area adjacent to the trim and blending in the compound a few feet up the wall may do the trick.

walled. They're wavy in spots, but I can live with this in most places. However, it's very obvious where the stair stringer runs straight along a wall that bows in about $\frac{3}{4}$ in. over about 5 ft. Is there a way to correct this without tearing out the drywall?

—JANE HARVEY
via email

Drywall expert Myron Ferguson replies: Although you don't want to remove the drywall, tearing it off, ripping shims to bring the studs into plane, and re-drywalling that section may be the easiest option. Still, a $\frac{3}{4}$ -in. recess can be filled with a setting compound such as USG's Durabond. You may need a few layers for best results.

For smaller areas you can sometimes get away with just filling along the stair stringer and blending the compound a couple of feet up the wall. In other cases you may fill in the entire recessed area. Fill most of the area with setting compound

using a darby (a long, two-handed float) or wide taping knives. Use a regular (air-drying) lightweight compound for finish coats, which is easier to smooth and blend to the wall.

One last thing: It sounds like you might be working over a painted surface. A common problem here is air bubbles rising up through the compound. This can require an extra finish coat or two to fully eliminate. A trick if you are having trouble with air bubbles is to apply a finish coat of slightly thinned compound over the entire area, and then let it set for 20 minutes or so before starting to smooth it or remove excess compound. I find that USG Plus 3 is the best compound for this.

Working around live wires

Our crew regularly works around overhead electric service cables when reroofing houses. I can't find any clear information on what the OSHA rules are and how to com-

ply. Most of the information I found was about using cranes and aerial lifts where the required distance was 10 ft. Nothing about roofers working along rake edges where the overhead lines are anchored or roofing around service masts that penetrate the roofs. What are the safe working distances and what can we do when we have to work within a foot or two of live wires?

—JOHN TECHO
via email

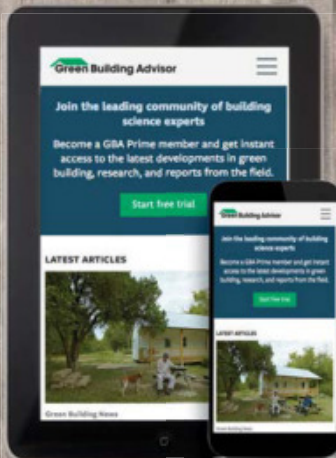
Scott Asprey, a safety consultant and trainer, replies: Working within 10 ft. of live wires, the same distance you read about in the section on cranes, triggers certain OSHA requirements for everyone. It is not uncommon for roofing companies to find themselves in trouble because of a lack of understanding about this issue. Failure to insulate or even move the lines can result in steep fines—over \$13,600 for serious violations. OSHA subsection 1926.416 (a), Protection of Employees, reads, “No employer shall permit an employee to work in such proximity to any part of an electric power circuit that the employee could contact the electric power circuit in the course of work, unless the employee is protected against electric shock by deenergizing the circuit and grounding it or by guarding it effectively by insulation or other means.”

Even though the vast majority of service entry cables are insulated, that insulation is not to be considered a full system of protection because it's often old and cracked. You've heard of situations where someone has struck a power line with a ladder and been electrocuted. It is the responsibility of the employer to ensure that all hazards are eliminated and proper protection is in place.

Having the power turned off temporarily or the wires moved is the best protection. Alternatively, most power companies will supply an insulation boot or blanket on request to cover wires in a work zone. The blankets are generally considered a means of protection, but if anyone were to be electrocuted, the presence of the blanket might not help when it comes to OSHA because insulated blankets are not permanent barriers and can move if not affixed correctly.

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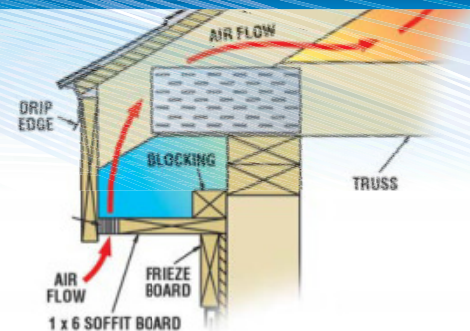
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When will we see the end of soaring lumber prices?

Like many other parts of the U.S. economy, the lumber industry saw prices fall in the spring of 2020 as the COVID-19 pandemic took the country by the throat. Sawmill prices for framing lumber started to decline in the second week of March, and a month later had dropped to their lowest level since the previous summer. Then something weird started to happen.

Despite ongoing business closures and rising unemployment, lumber prices began to climb. The widely watched Framing Lumber Composite Price index published by Random Lengths bottomed out at \$348 on April 10, 2020, and other than an eight-week dip late in the year, it has been on the rise ever since. The average for May was \$1479 per 1000 bd. ft., a four-fold increase. Random Lengths' Structural Panel Composite Price index showed a similar pattern, rising from \$349 per 1000 sq. ft. in April 2020 to \$1584 last month.

The unprecedented run-up in prices has affected everything from dimensional framing lumber to building products made with wood components, such as windows and doors. Increases have added nearly \$36,000 to the cost of an average new home, according to the National Association of Home Builders (NAHB). A recent NAHB newsletter said the total

cost to a builder for all lumber and manufactured lumber products to build an average single-family home was \$16,927 in April 2020, and \$48,136 a year later—that's an increase of 184%.

A convergence of factors

Rising lumber prices can be attributed to a variety of factors, according to Random Lengths editor Shawn Church. In a telephone call, Church said everything from labor shortages and restraints in the supply of timber to low mortgage rates and a surge in remodeling have played a part.

"Demand has been driven by various factors going back to last April as the pandemic

cutbacks really overshot the true demand, which proved to be resilient."

Stuck at home because of the pandemic, consumers took their government relief checks along with money they had saved because of an inability to travel and poured it into their homes, Church said. The result was an unprecedented run on building materials at home-improvement stores. At the same time, many Americans who had been living in cities in order to enjoy short commutes to work suddenly found themselves telecommuting. They realized they didn't have to live in a cramped apartment or condo and could instead move to the suburbs where they

supplies were squeezed by a decades-long infestation of mountain pine beetles. In the Pacific Northwest of the U.S., a lot of timber was on federal land and off-limits to loggers. Only in the southern pine region of the southeastern U.S. are timber stocks on the rise.

Even the echoes of the Great Recession of 2008 are in play. When that housing bubble burst, the lumber industry tooled its mills to run at a lower level of production, and it just hasn't managed to catch up.

"Really, on the supply side the industry milling capacity has not risen to an adequate level to meet the demand we see today," Church said. "Demand for housing has really catapulted

"...everything from labor shortages and restraints in the supply of timber to low mortgage rates and a surge in remodeling have played a part."

emerged," Church said. "When it hit, the industry cut production sharply, anticipating a major setback in demand. But that didn't really happen. One reason was that the industry was declared essential and construction was allowed to continue with only a few interruptions in a few cities and regions. The industry

would have more elbow room. That meant more buyers for single-family homes.

The problem was that some mills that had shut down early in the pandemic had not yet reopened, while lumber supplies in three out of four major North American growing regions remained tight. In western Canada, Church said,

from a level of a year ago. At the start of 2020 we were at 1.2 million, 1.3 million housing units, and we've jumped to 1.6 or 1.7 million now. The industry simply doesn't have the capacity to supply this level of demand."

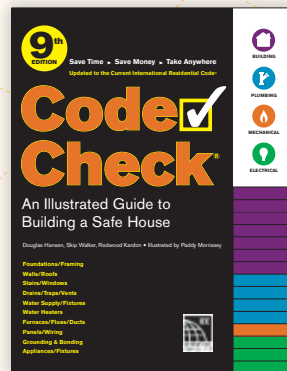
Dustin Jalbert, senior economist with Fastmarkets RISI, said by telephone that lumber

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producers last spring looked at unemployment figures and how sectors of the economy were faltering. They thought back to the housing fallout in 2005 to 2009 and acted accordingly.

"They curtailed and cut production pretty heavily in April and May, thinking demand would fall, and that never happened," he said. "Instead, it sort of surged. A lot of wholesalers and distributors sold off their inventory; liquidated. So, the whole supply chain is really, really lean for wood and it's creating all this chaos and volatility. Basically, demand is the opposite of what everyone thought."

Builders react to tough conditions

How have builders responded? NAHB took a look at this question last spring as it conducted its NAHB/Wells Fargo Housing Market Index survey. The most common reaction, from 47% of those responding, was to include a price-escalation clause in sales and construction contracts. Another 29% pre-ordered lumber, and an additional 22% sought lumber-price guarantees from their suppliers. Just 13% of the respondents said they were doing nothing.

While builders often were successful in getting suppliers not to bump prices, most guarantees ended in less than a month.

Pioneer Builders, a spec builder of high-end homes in Washington state, has found that buying materials well ahead of when they will be needed has helped. In addition to working with its lumber supplier over the years, the company last year bought enough lumber to build a house and had it delivered on the

"off chance" that there would be shortages down the road, said company vice president Bryan Uhler.

"That was a good move as far as lumber prices go, although we didn't see the possible shortages here," Uhler said in an email. "Now we're doing the same thing—buying a house of material ahead of the supply shortages that we may face. As long as fiscal policy remains as it is and the Fed stays on their track, prices will not come down, they will only get worse."

Not all builders are in the position to buy a house worth of lumber and put it away, and homeowners facing quickly rising home costs may be priced

Some builders change their habits

Higher prices have prompted some builders to rethink the way they build houses.

"Lumber prices are crazy at the moment," Steve Knapp wrote on Green Building Advisor's Q&A forum. "Standard Zip is [well above] \$50 a sheet in some areas. So I was wondering how builders are adjusting. Are you moving to other materials such as glass-fiber sheathing, which seems to be a cheaper alternative to Zip or exterior plywood?"

The question solicited dozens of replies. Malcolm Taylor, for example, suggested that more builders would start adding bracing to walls and eliminate

pass on to a future homeowner, and most of the price increases will have to come out of my bottom line. It's too risky to build specs right now."

Where will it end?

Uhler, like Church, has seen ups and downs in the market before. "We've also been in business since 1978," Uhler wrote, "so we've been through the booms and busts. The boom always leads to a bust."

Jalbert said that lumber production in the southeast is a bright spot, and that softwood coming in from central Europe and parts of Scandinavia will help relieve some supply shortfalls. But over the short term, the market fundamentals that

"They curtailed and cut production pretty heavily in April and May, thinking demand would fall, and that never happened. Instead, it sort of surged."

out of the market. With those worries in mind, a block of 36 industry groups in March appealed to U.S. Secretary of Commerce Gina Raimondo to look into the lumber supply chain, identify the causes for rising prices, and "seek immediate remedies that will increase production."

"Home builders and construction firms that have signed fixed-price contracts are forced to absorb these crippling increases in materials prices and costly delays in deliveries; there is a significant risk that many of these firms will be forced out of business," the letter said.

Raimondo met with NAHB officials again in late May, according to NAHB.

sheathing altogether. That wouldn't be permitted in seismic zones, but some production builders already are doing that.

"I'm in the middle of framing two 900-sq.-ft. commercial workshops that rely on let-in bracing and use horizontal strapping for the walls and roofs," Taylor said. "That is saving about \$7000."

Some suggested insulating concrete forms (ICFs) might start to look more appealing as lumber prices rise, even if foam and concrete have higher environmental price tags.

And then there came this comment from Kye Ford: "I have solved the crazy increase in lumber prices by not building. There is only so much I can

have driven up prices are not likely to change dramatically.

"My best guess right now is that in the next few months we are going to see prices continue to rise," he said. "I do think when you get into the latter part of summer and into fall, seasonal demand will start to trickle down, and buying by distributors will slow down. That will be the beginning of a price correction. But I don't think we're coming back to \$300 or \$400 per 1000 bd. ft., at least not in the next year or two."

Scott Gibson is a contributing writer at Green Building Advisor and Fine Homebuilding magazine.

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CELEBRATING PASSION FOR BUILDING

At age 38, with a wife and young child at home, Justin Fink walked away from a career in publishing and into self-employment in the building industry. He started Fink & Son Carpentry and Woodworking, a remodeling company that found its niche working on historic homes in and around central Connecticut.

A year into remodeling full time, Justin has hit his stride doing the work he's always loved to do. He has hired his first employee, has as many projects as his business can handle, and is embracing making a living as a carpenter. "I wake up every single morning excited to get to the job site, and when Friday comes around I'm looking forward to Monday when I can get back there," he says.

Shifting careers is rarely an easy decision, but a career in building has been a long time coming for Justin—in many ways, it was years in the making. As an editor for *Fine Homebuilding*, Justin spent 16 years developing some of the most thorough how-to building content available, working alongside experienced and knowledgeable craftspeople in the trades. The relationships and projects he built both inspired and empowered him, and led him to the brink of self-employment several times over the years. Finally, setting aside comfort and fear, he plunged headlong into carpentry, tackling some of the most demanding work around—the preservation of historic and pre-war homes.

"I feel like there is a lost connection to the way we used to build houses, and I wanted to focus on that. I decided early on that I'm going to do careful work using really high-quality materials," Justin says. Fortunately, he has found that clients who live in old houses tend to love and appreciate their homes in a way that's suited to the diligent approach Justin prefers to take to construction. It's important to him that he remain a hands-on carpenter; he only aspires to scale his business to make it sustainable and to keep him doing the kind of work that he enjoys doing most. —Rob Yagid, executive director, Keep Craft Alive

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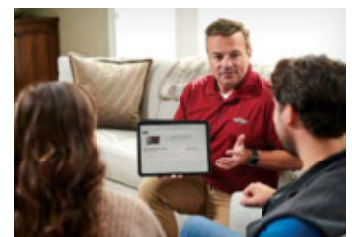
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