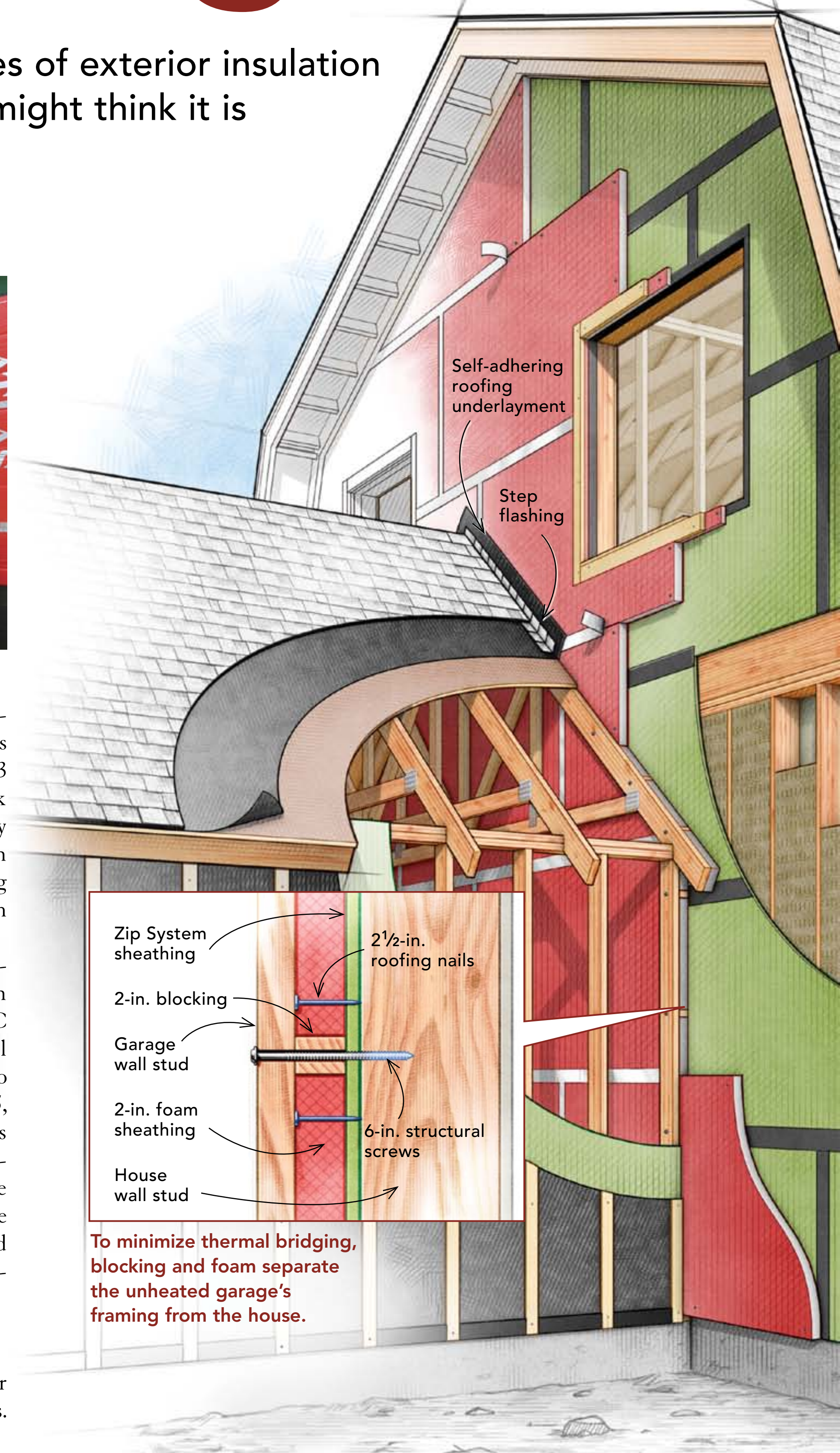
Detailing Walls

Navigating the challenges of exterior insulation isn't the nightmare you might think it is

BY STEVE DEMETRICK



To minimize thermal bridging, blocking and foam separate the unheated garage's framing from the house.

Drawing: John Hartman

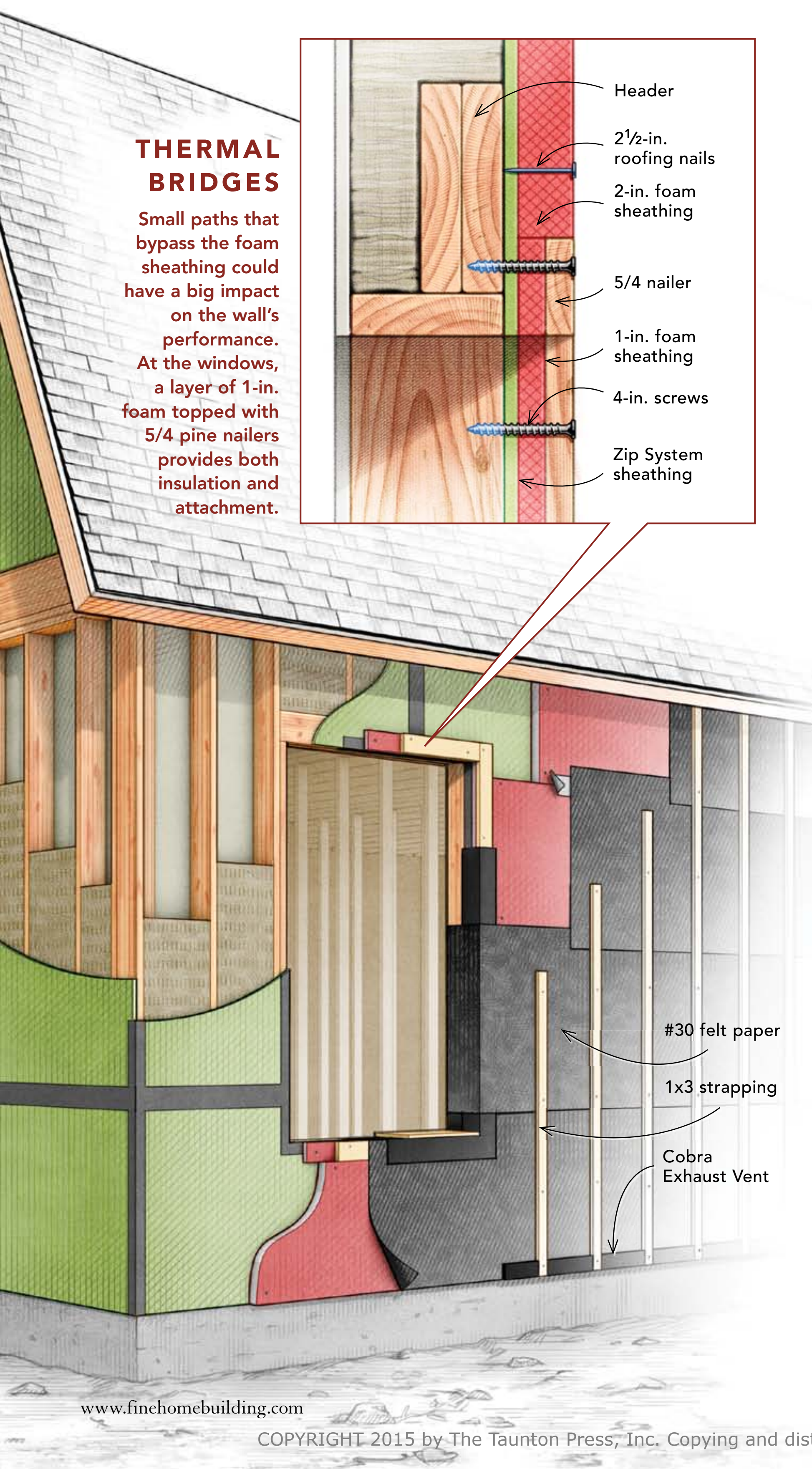
Wall construction has changed dramatically since I started in the trades 20 years ago. The 2x4 walls insulated with R-13 fiberglass batts that everyone built back then don't come close to complying with today's energy code in climate zone 5, where I live. And even with today's stricter codes, building just to code is like settling for a D in school. A house that only meets the minimum standard is the worst that can legally be built.

On this house, the combination of 2-in. foil-faced polyisocyanurate exterior foam and 6 in. of fiber insulation create a high-performance wall that exceeds the IRC requirements. But even meeting the minimum wall R-values required by the new energy code can be hard to achieve with cavity insulation alone. In climate zone 5, walls are required to be at least R-20, and standard batts yield R-19. In cold climates, exterior insulation in addition to the cavity insulation is becoming a de facto code requirement. But there are pitfalls, including moisture condensation, detailing challenges around windows and other penetrations, and the lack of a solid base for attaching the siding. Here's how I navigate them.

Walls that make sense

As a consultant on this build, I worked with carpenter Andrew Gallant of Gallant Builders on the wall details.

with Rigid Foam



THERMAL BRIDGES

Small paths that bypass the foam sheathing could have a big impact on the wall's performance. At the windows, a layer of 1-in. foam topped with 5/4 pine nailers provides both insulation and attachment.

Our combination of foil-faced foam and Zip System sheathing has created walls that are essentially impervious to moisture on the outside, meaning that they can only dry inward. To allow this, the wall cavities will be insulated later with unfaced fiberglass or mineral-wool batts, and the interior finish will be gypsum board, plaster, and vapor-permeable latex paint, all of which allow free movement of water vapor.

Because moisture generally moves from warm locations to cool ones, in this predominantly heating climate, the vapor drive is outward for most of the year. That makes controlling interior moisture a critical component of the house's system. Otherwise, water could condense on the back of the sheathing, causing rot. Accordingly, interior moisture will be managed by a combination of timed bath fans, kitchen exhaust fans, and an energy-recovery ventilator (ERV). Not too many years ago, the standard approach would have been to use an interior Class I vapor retarder such as polyethylene sheeting. Today we know that having vapor-impermeable surfaces on both sides of a wall traps any moisture that does sneak in, often leading to rot.

In addition to keeping out exterior moisture and air, being able to dry, and reducing thermal conductivity, walls also should be simple to build. A goal in all of my projects is to detail walls so that carpenters can build with familiar materials and tools. The walls shown here are a good example of that approach. The studs are 2x6s on 16-in. centers. The Zip System sheathing, with its seams carefully taped, doubles as the air barrier. Although the sheathing could also function as the house's water-resistive barrier (WRB), it was easier to detail the wall so that the WRB is just behind the siding.

Continuous foam significantly reduces thermal bridging through the studs and wall plates, increasing the total R-value of the wall. The assembly needs to be thought through before framing begins. The first step is to indicate on the plans exactly where the foam-insulation plane is located and then identify any places where there are connections that might break the continuity of the foam.

Installing the foam

The 4x8 sheets of 2-in. polyisocyanurate are fastened to the wall sheathing with 2½-in. roofing nails. Only a few nails per sheet are needed because 1x3 strapping applied later provides the real holding power. There are many ways to cut the foam. My tool kit includes a Festool track saw, a Japanese pull saw, and a Tajima retractable knife whose long blade is handy for making quick cuts when

DETAILING ROUGH OPENINGS

Sheathing with foam is mostly dirt simple, with windows and doors being the trouble spots. The main things to keep in mind are providing solid nailing while avoiding creating a thermal bridge, and providing adequate flashing to keep out water.

Create a thermal break. _Nail foam strips 1 in. thick and 3½ in. wide around the opening._

Install nailers. _Screw rough-pine 5/4x3 nailers over the 1-in. foam to build the assembly out to the plane of the main 2-in. foam insulation._

Butt the wall foam to the build-out. _Installation of the rest of the insulation is simply a matter of cutting to fit and fastening with 2½-in. roofing nails._

Add a solid sill. _To create a base for windows and doors, fasten a piece of ¾-in. sheathing to the bottom of the rough openings._

Proceed normally. _With solid nailing established, installing windows or doors and integrating them with the WRB and the flashings is the same as on any other job._

Photos facing page: Katelyn Gosselin

I'm not standing at the cut table. The foam seams are taped with 3-in. foil-faced tape.

Windows and doors are the biggest stumbling block with exterior foam. You need solid material at the surface to attach to. Building out to the plane of the foam with solid blocking would create a thermal bridge around every opening. Instead, Gallant nailed 3½-in.-wide rips of 1-in. foam around the windows, followed by 5/4x4 rough pine screwed to the framing through the foam, creating a thermally broken attachment point for the windows and doors. The 2-in. foam butts to this assembly. To create a solid base for supporting the windows and doors, Gallant screwed ¾-in. sheathing to the bottoms of the rough openings, which were built ¾ in. taller to accommodate the thickened sill. With this treatment, the window and door openings can be flashed just as on a typical wall.

Felt paper keeps out the rain

The most critical element of any wall assembly is the WRB and its flashings. On this project, the taped Zip System sheathing and the taped foam act as redundant WRBs, but the primary WRB is #30 felt paper and self-adhering flashings that go over the foam. From remodeling century-old oceanfront homes that stayed dry, I know that properly lapped and flashed felt paper works over the long term. I'm not so sure about WRBs that rely on the adhesion of tape to keep out water.

The felt paper is attached with 2½-in. roofing nails and is lapped shingle-style over all of the window and door flashing, as well as over the roof step flashing. To avoid having to hand-drive pounds and pounds of roofing nails to hold the felt paper if the wind kicked up, Gallant worked in small sections, installing the felt paper and following up immediately with strapping.

With very tight houses, it's important to seal the small holes made for items such as wires and pipes. On a Passive House I built, a first-floor window leaked significantly during a rainstorm through a 1-in.-long tear in the flashing tape. In a typical house, that wouldn't result in a pronounced leak, but this house was extremely airtight. The problem was located in the second-floor wall, where two 6-in. holes for the ERV intake and exhaust hadn't yet been connected. The wind depressurized the house through these holes. Because the house had so few leaks, enough negative pressure was created to suck water in.

With that in mind, wires for outside lights were taped to the sheathing prior to the installation of the foam. Once taped, wires were routed down the face of the wall a few inches and to the fixture or outlet to prevent water from following the wire into the wall. Larger holes for pipes or ventilation fans were first air-sealed at the sheathing with EPDM gaskets (foursevenfive.com) and then flashed to the foam with 3M's All Weather Flashing Tape.

The final step before installing the siding was to attach the 1x3 vertical strapping over the foam to provide nailing for the siding and trim. The strapping is fastened through the foam and the sheathing to the studs with 5-in. screws. The ¾-in. space formed by the strapping creates a generous drainage gap for water that gets behind the siding. The airspace also will ventilate the siding so it can dry evenly, resulting in a more durable installation and paint job. I know of similar houses that have gone 15 years without repainting. To keep vermin out of the space while allowing airflow, Gallant nailed Cobra Exhaust Vent between the strapping at the bottom of the wall. □

Steve DeMetrick is a builder and residential energy consultant in Wakefield, R.I. Photos by Andy Engel, except where noted.

There's more than one way to skin a house

Of the four common types of insulating sheathing, the foil-faced polyisocyanurate used here offers the highest R-value per inch (R-6.5). In addition, it's readily available and practically vapor impermeable (it's a Class I vapor retarder). Extruded polystyrene (XPS) is also readily available, is slightly vapor permeable (Class II), and offers an R-value of R-5 per in. Expanded polystyrene (EPS) may be a little harder to find, has an R-value of around R-4 per in., and is several times more vapor permeable than XPS (although it still falls within the Class II range). Finally, there is mineral-wool board, a denser material than mineral-wool batts. Mineral wool is open to vapor transmission and has an R-value of about R-4 per in.

Foil-faced polyisocyanurate
R-6.5 per inch

Extruded polystyrene
R-5 per inch

Expanded polystyrene
R-4 per inch

Mineral wool
R-4 per inch

Insulation ratio determines vapor-retarder type

When designing a wall, think about the risk of condensation within the wall cavity. The inside of the sheathing must be kept warmer than the dew point so that moisture doesn't condense there, so the ratio of exterior insulation R-value to cavity insulation R-value is critical. Either the exterior insulation needs to be sufficient to keep the sheathing above the dew point, or the cavity insulation needs to leak enough heat to achieve the same end. Colder climates require higher ratios and/or less permeable vapor retarders. To find the insulation ratio of a wall, divide the exterior R-value by the cavity R-value. In the chart at left, use the insulation ratio and the climate zone to determine whether a vapor retarder is needed, and if so, what class to use (e.g., Class II: kraft facing; Class III: latex paint).

Climate zone	Class II interior vapor retarder	Class III interior vapor retarder
1 to 3	No limit	
4	0.2	
5	0.2	0.35
6	0.25	0.5
7	0.35	0.7