A Better Wall with Exterior Foam

Why a longtime SIP builder turned to rigid polyiso for insulation

BY JONATHAN ORPIN

I've been a home designer, builder, and timber framer for more than 25 years, and I recently calculated that my projects have consumed almost 2 million sq. ft. of SIPs (structural insulated panels). I still use SIPs almost exclusively for roofs, where they serve as insulation, short-span structure, and premade overhangs.

When my firm used SIPs for sidewalls, however, there was a great deal more work involved in cutting openings and routing mechanicals, so almost 20 years ago, we started developing an alternative. Our goal was to find an open-cavity option that made installing mechanicals easier and was still well insulated.

The solution, which I refer to as the matrix wall, consists of conventionally framed 2x6 walls with either wet-sprayed or netted dense-pack cellulose in the cavities and polyisocyanurate foam on the exterior. Instead of using the foam as the weather-resistive barrier, I install housewrap and a rain screen of 1x strapping. The assembly yields an R-30 wall with negligible thermal bridging and a managed dew point (sidebar facing page).

Photos left, facing page: Loren Nelson. Drawing facing page: Bob La Pointe

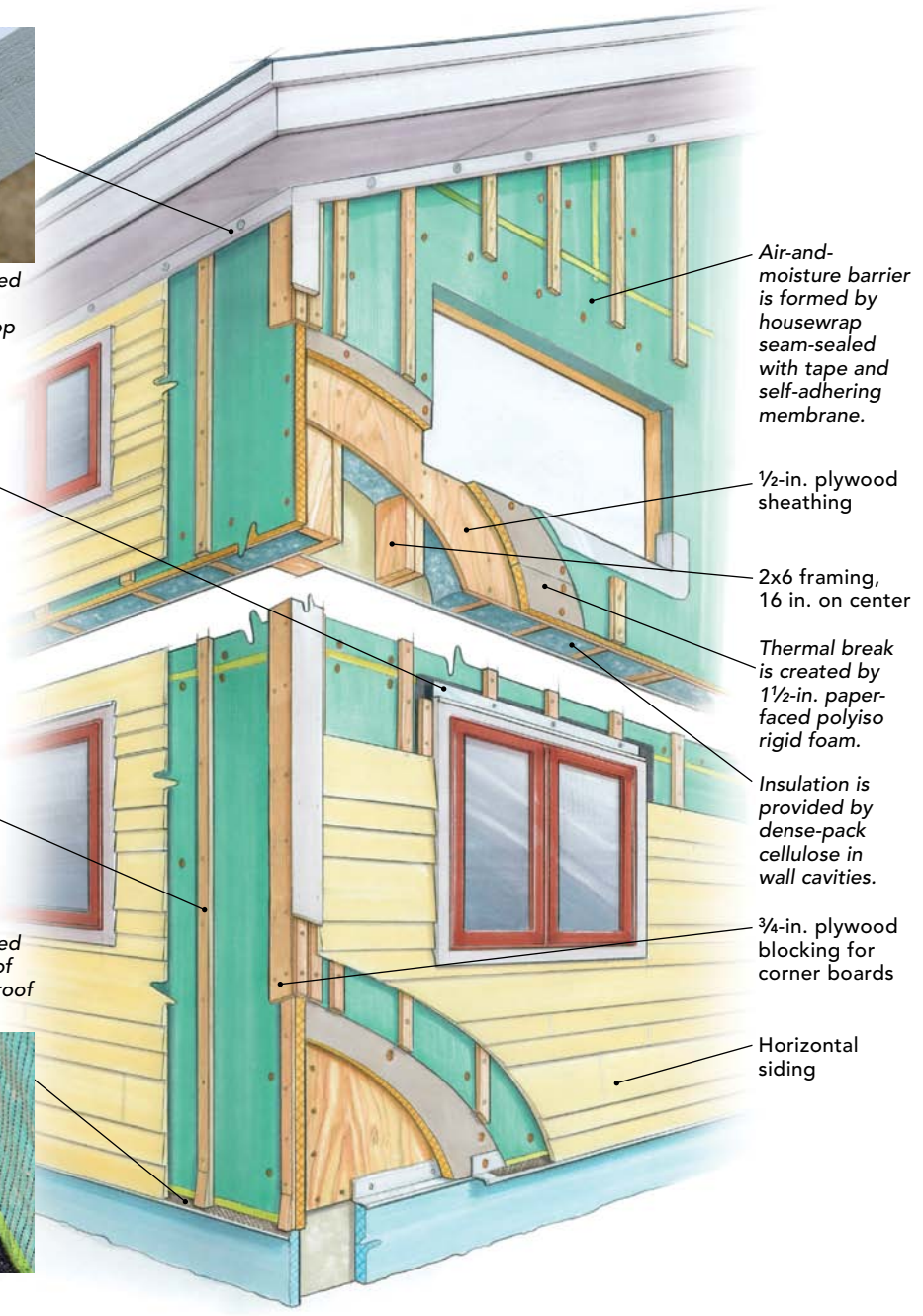
A LAYERED APPROACH TO WALL CONSTRUCTION

Rain screen is ventilated by mounting 3-in. circular vents in the top trim board.

Windows and doors are waterproofed with self-adhering membrane applied over the nailing flanges and housewrap. Z-flashing is applied over strapping at heads to direct water out.

Made of 1x2 strapping installed vertically 16 in. on center, a rain-screen wall breaks the capillary action of water and keeps siding dry.

Rain screen is ventilated by filling the bottom of channels with insectproof nylon mesh.



Air-and-moisture barrier is formed by housewrap seam-sealed with tape and self-adhering membrane.

½-in. plywood sheathing

2x6 framing, 16 in. on center

Thermal break is created by 1½-in. paper-faced polyiso rigid foam.

Insulation is provided by dense-pack cellulose in wall cavities.

¾-in. plywood blocking for corner boards

Horizontal siding

What's the R-value and cost?

Without a doubt, this method of framing is more expensive than conventional platform framing. We find these shop-built walls to cost about $5.50 per sq. ft. for the client. Shipping, installation materials, site labor, and a crane push the cost to between $10 and $13 per sq. ft., depending on location, site conditions, and all the things that change a theoretical estimate into reality. This base cost includes 1½ in. of rigid foam at about $1.10 per sq. ft., strapping at about 10¢ per sq. ft., and the extra labor to install them. Even the cellulose costs more than fiberglass batts, though generally by only 15¢ to 25¢ per sq. ft. The 2x6 walls built in this manner are rated R-30.1. As a comparison, a SIP wall filled with 5½ in. of expanded polystyrene (EPS) costs about the same but is rated R-22.

Of course, thermal performance means little if the walls allow water and air infiltration, and establishing durable water and air barriers lies in the installation details: foaming sheathing seams, taping housewrap, and flashing windows.

We also think that our solution is better than the currently popular "flash and fill" option that uses an inch or so of closed-cell foam sprayed against the inside of the stud bays. Placing the insulation inside the wall cavity doesn't address thermal bridging, and this technique also has been shown to develop gaps when the framing dries and shrinks.

Here is a look at one project where we did most of this work on site.

Wall assembly is part of a larger system

Because it's more efficient to build as much of the wall assembly as we can in our shop, I design walls as a series of panels as large as possible that still can be loaded onto a truck. Although we prefer to install rigid insulation before shipping, the job featured here was in a jurisdiction that required a site inspection of the sheathing's nailing pattern, so we installed insulation after the walls were up.

The panels are placed on a flatbed in the opposite order of their installation, and we remove them with either a crane (our preference) or an all-terrain extendable-boom forklift. The seams of each panel are caulked before the adjacent panel is set to prevent airflow through the gap in mating studs. All sheathing seams are air-sealed with canned spray foam, too.

Next, we attach the rigid polyisocyanurate. Made by a variety of manufacturers, such as Hunter or Firestone, the 1½-in.-thick paper-faced polyisocyanurate has an R-value of 6.5 per in. I chose the paper-faced rather

SEAL THE ENVELOPE AGAINST AIR AND WATER

Sheathing has gaps, too. *Before installing the rigid insulation, fill the sheathing seams with polyurethane spray foam.*

Rigid-insulation installation. *A cap nailer is the fast way to install panels. It's important to follow the manufacturer's nailing recommendations. Seams between panels are sealed with polyurethane foam.*

Rolling out. *Each 9-ft.-wide roll of housewrap is installed in as continuous a sheet as possible. Fewer taped seams mean fewer air or water intrusions. Cap nails are used to fasten the housewrap. Once seams are taped, the top and bottom of the walls are sealed with self-adhering membrane.*

Pitch the water out. *It's an old trick, but it still works. A piece of beveled siding cut to the length of the sill is tacked in place on top of a healthy bead of caulk with the wide side inboard.*

Wrap the sill. *A length of flexible self-adhering membrane is installed over the beveled siding and wrapped up the lower corners, extending about 12 in. above the sill.*

Walls and moisture

Vapor drive and dew point (the point at which the temperature causes water vapor to condense into liquid) are complex topics that include issues of climate, indoor humidity, and the necessity of a high-performance wall assembly. Some literature suggests that it's a bad idea to install rigid insulation on the exterior in cold climates because higher moisture always moves to lower moisture. The implication is that if you don't have a strong vapor retarder on the inside surface (polyethylene installed beneath the drywall, for instance), your wall cavity will be compromised by condensation. After 20 years of successful projects, my experience tells me that by including the following details, a wall assembly will not have moisture problems:

- **an exterior water-resistive barrier of housewrap sealed with tape;**
- **enough exterior rigid insulation to keep the wall sheathing and stud cavities above the dew point;**
- **cellulose insulation, as it can dry to the inside if needed; and**
- **a properly functioning ventilation system such as an ERV (energy-recovery ventilator) to balance and control the buildup of internal moisture.**

Photos center, facing page: Loren Nelson

A BETTER WAY TO INSTALL WINDOWS

Rather than relying on the window's nailing flange *to attach windows to the walls, the author screws three 3-in. by 4½-in. galvanized plates (model MP4F, USP Structural Connectors) to the outside of each of the window's side jambs. Once he has flashed the sill (facing page) and the window is in place, he uses the exposed half of the plate as a handle to adjust the relative position of the unit.*

When the unit is in place, he tacks the outside corners of the nailing flange to the siding around the rough opening. Inside, he screws the galvanized plates to the framing. To make the window's perimeter watertight, he seals the flange with overlapping layers of self-adhering flashing applied against the housewrap.

than the foil-faced foam because I think it presents less of a condensation plane. Both types do a great job of keeping the sheathing warm. We install the foam with a cap nailer loaded with 2½-in. siding nails; then we cut out openings with a handsaw. As an additional means of air-sealing, we apply canned polyurethane spray foam at each seam. We've used this technique for many years in climate zones 4, 5, and 6 without any failures due to moisture degradation.

Housewrap and windows are installed next

The next step, installing housewrap, is perhaps the most critical. It is our main weather-resistive barrier, so we install it on top of the foam so that it can guide down and out any water that gets behind the siding. We use Benjamin Obdyke's GreenGuard because of its perm rating of about 20, which we think is a good balance between not trapping moisture and being too permeable.

Once the housewrap is tucked into the rough openings, we cut a length of beveled cedar siding to fit on the sill and then cover it with a flexible self-adhering waterproof membrane to create a sill that drains to the outside. We've had good results with Fortifiber Building Systems' FortiFlex.

We don't rely on the flanges that come with a window when installing it over 1½ in. of foam (photos above). Rather, we use 6-in. self-adhesive flashing membrane over the flanges and onto the housewrap. We also make sure the housewrap above the window is lapped on top of this flashing and sealed with tape to waterproof the window head.

Detail the rain screen

Finally, we install ¾-in. by 2-in. strapping to create a drainage plane behind the siding. This detail not only makes a firm nail base for the siding and trim, but it also allows the siding to dry from both sides and permits any moisture—liquid or vapor—to escape. The majority of siding is horizontal, so it's logical that the strapping is installed vertically. When we are using vertical siding, we install the strapping at a 45° angle so that the drainage path to the bottom becomes as open as possible.

The strapping creates a bit of complexity at the windows, particularly at the head flashing. We install aluminum Z-channel over the strapping to direct water over the front lip of the window top. □

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