Tightening the Shell From Outside

A layer of sheathing over new exterior foam insulation flattens the walls and simplifies flashing and siding installation

by Mike Shepard

Our construction company recently completed a major remodel and energy retrofit of a split-level home in northern Vermont. In addition to requesting a long list of interior improvements, the owners wanted to reduce their energy costs by adding more insulation and replacing their leaky single-pane windows. The key to keeping the project within the budget was adding the insulation from the outside in order to preserve as much of the interior finish as possible.

Working with architect David Pill, we considered a number of options for retrofitting the exterior insulation. On previous projects, we had wrapped walls with one or two layers of blueboard, then fastened the siding to furring strips installed over the foam. But with that method, it's tricky to properly flash window and door openings to the drainage plane. And unless you actually need an air gap behind the siding, furring strips are also problematic:

Figure 1. The original EPS foundation insulation was seriously degraded by UV exposure and moisture (top). After cleaning off the stem walls and reapplying asphalt dampproofing, workers installed a double layer of 1½-inch-thick XPS foam, staggering and foaming the joints to minimize air intrusion (above). A peel-and-stick ICF waterproofing membrane protects the new foam from moisture below grade, while a stucco coating protects the above-grade portion from UV damage (right).

They have to be screened to keep bugs out, and keeping them flat — to avoid dips and bumps in the siding when the furring has been screwed through a couple of inches of foam — can be difficult.

We also considered retrofitting nailbase or SIPs panels, because either one would eliminate the need for furring strips. However, the cost would have been prohibitive on this project, so we improvised a similar — but less expensive — detail that we could build on site. First, we'd wrap the walls with 4-inch-thick polyiso roofing panels, which would substantially increase the wall's R-value, minimize thermal bridging, and help air-seal the home. Then we would fasten continuous OSB sheathing instead of furring strips directly over the foam. The walls would then be flat and ready for housewrap, flashing, and siding.

From the Ground Up

Because the homeowners had reported some damp areas in their ground-floor rooms, we first excavated a trench to the depth of the footing around the entire building. This enabled us to examine the foundation walls and make sure they were well-insulated and waterproof (**see Figure 1**). The existing 1½-inch-thick layer of EPS foam was deteriorating and virtually useless, so we replaced it with two layers of 1½-inch XPS foam, which has a higher R-value per inch than EPS foam (R-5 vs. R-3.6) and a lower water-absorption rate. To air-seal the assembly, we oriented the first layer of foam vertically and the second horizontally, staggering the seams between the layers and sealing all the joints in both layers with spray foam.

Walkout door. Around the existing walkout basement door, we left a uniform gap between the foam and the door's vinyl cladding, which we later trimmed out with cedar casings and returns. To protect the foam from impact damage around the door, we covered areas that would be exposed after finish grading with a layer of

½-inch cement backerboard glued with thinset to the foam.

Waterproofing. We waterproofed the foundation foam from the footing to about 1 inch below final finish grade with Colphene ICF peel-and-stick membrane (800/356-3521, soprema.us). To protect the above-grade portion of the foam, we troweled on three coats of Prepcoat B2000 parging (888/238-6345, durock.ca), lapping the parging over the waterproofing membrane an inch or so. We scarified the foam slightly before parging to improve adhesion, and embedded fiberglass mesh into the first coat for reinforcement. The two additional thin coats evened out the finish.

Rigid Foam Insulation

We wrapped the walls with 4-inch-thick sheets of IkoTherm, a rigid polyisocyanurate foam with an R-value of 6 per inch (888/766-2468, iko.com). These panels have a fiberglass facing bonded to both sides of the foam, making them more compatible with construction adhesive than foil-faced foams (**Figure 2**). Although they're generally used to insulate roof decks, we found that the 2x4 panels were readily available, easy to handle, and faster to install than a double layer of 2-inch-thick foam.

Unlike shingles or clapboards, vertical cedar siding creates a relatively flat wall plane, so we were able to glue the foam directly to it using low-VOC Titebond Greenchoice construction adhesive (888/533-9043, titebondgreenchoice.com). First we applied glue to the cedar siding, using a quart for every five panels; then we bedded each panel in the adhesive and temporarily held it in place with a few 7-inch HeadLok SIP panel screws driven through small plywood cleats. The cleats allowed us to pull the insulation panels tight to the siding without breaking through the facing. After giving the glue a night to set up, we began installing the sheathing, removing the cleats as we went.

We held the bottom edge of the foam

Figure 2. After removing the old windows and installing plywood window bucks, workers wrapped the walls with 4x8 panels of 4-inch-thick polyisocyanurate foam (top). The panels were glued to the vertical cedar siding, and plywood cleats secured with long screws were used to temporarily hold them in place until the glue set (center and above).



Figure 3. Before installing the AdvanTech sheathing, the carpenters cut slots for biscuit joints in the butt ends of the panels (left) and predrilled countersunk holes for the structural screws (above left). The sheathing was also glued to the foam panels with a low-VOC construction adhesive (above right).

panels 3/4 inch above the top edge of the XPS foundation foam, creating a gap that we would later fill with spray foam — to make sure the vulnerable joint at the rim joist was thoroughly air-sealed. We also spaced the foam panels at least 1/4 inch apart from each other and away from any penetrations, again creating a joint that we would later fill with spray foam. We cut and fit the foam board around the truss tails, filling in the gaps with spray foam to seal off the attic. The large 4x8 panels may expand and contract a little with temperature changes, but we're confident the spray foam will be flexible enough to remain adhered to the panel edges.

Sheathing

We chose 5/8-inch-thick tongue-and-groove AdvanTech OSB sheathing (800/933-9220, huberwood.com) instead of typical 7/16-inch OSB for a few reasons. First, the thicker, stiffer sheathing helped flatten out any unevenness in the foam layer when we pulled it tight against the insulation. Sec-



Figure 4. The tongue-and-groove profile along the edges and the biscuits at the butt joints (far left) kept the panel edges flat. Since the panel ends were biscuited together, the panels didn't have to be trimmed to fit the stud layout (left). An intentional 3/4-inch gap was left between the insulation-sheathing assembly and the foundation insulation and later filled with spray foam (above).

ond, we could biscuit-joint the butt edges of the sheathing, which — along with the tongue-and-groove profile on the long edge — also helped to create a flat wall plane, even on wall sections where we used small pieces of foam to fill in around openings. And finally, the thicker sheathing provided a strong substrate for the new fiber-cement siding.

To ensure good bite and prevent sagging, we had to hit the framing, so we laid out the stud locations on each sheet, then drilled countersunk screw holes 16 inches on-center (28 screws per full sheet of sheathing) with a 3⁄4-inch-diameter spade bit (**Figure 3, previous page**). The holes were just deep enough to prevent the screws' large washer heads from protruding beyond the plane of the sheathing. Along the panel ends, we also cut slots for large (#20) biscuits, also on 16-inch centers.

After snapping layout lines on the wall, we spread construction adhesive on the foam, again at a rate of a quart per five panels, then secured the sheathing with 9-inch HeadLok screws driven through the foam and sheathing into the studs (**Figure 4, facing page**). Even with the careful layout, we occasionally missed the framing and had to adjust the screw angle accordingly.

Wherever a butt joint fell on a stud, we countersunk the holes in place so that the washer-heads on the screws caught both sheets. It didn't matter if butt joints landed between studs because of the biscuits: As the screws pulled the sheathing tight to the foam, the biscuits held the panels flush to one another. After we were done, the sheathing layer was as flat and rugged as if it had been applied directly to the studs, and was ready for housewrap, flashing, window and door installation, and siding and trim.

Windows and Doors

When we removed the existing windows and doors, we built out the rough openings with bucks that would support the new

Figure 5. Sections of 3 1⁄4-inch by 3 1⁄4-inch by 1⁄4-inch steel angle were bolted to the wall underneath the door openings (left and above). The angles were then padded with PT blocks and shims until the door sills were fully supported (illustration, below).

Threshold Support Details

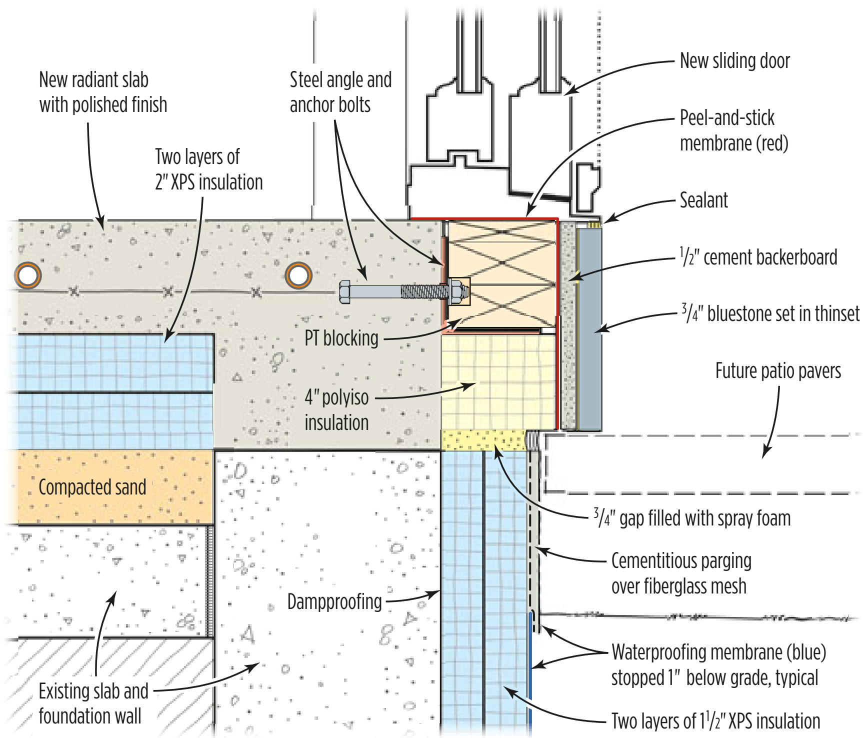

Figure 6. Spray-foam was used to seal the plates and boost R-values at the truss heels, and any open stud bays were filled with damp-spray cellulose (left). After the sheathing was wrapped with housewrap, window and siding installation was typical (above).

windows and doors at the new sheathing plane. The window manufacturer (Loewen, 800/563-9367, loewen.com) was able to provide us with double-glazed U-0.28 units that closely matched the size and total glazing area of the originals, yet still fit snugly inside the bucks.

We built the bucks from 3⁄4-inch CDX plywood salvaged from the interior demo. They extend from the interior plane of the wall studs to the exterior plane of the wall insulation, and are sealed to the rigid foam with spray foam. When we installed the sheathing, we were able to screw the sheathing directly to the bucks, providing extra support for the windows and a solid surface for fastening the window and door nailing flanges.

The doors needed additional support. Under each opening, we bolted a section of 3⁄8-inch angle to the wall, either directly into framing or to anchor bolts cast into the new concrete radiant slab floor (**Figure 5, previous page**). Then we attached PT wood blocking and shims to the angles as needed to fully support the door sills, driving screws through small predrilled holes in the steel.

Finishing the Thermal Envelope

Once the foam and sheathing were in place, our insulation sub finished the thermal envelope from the inside. First, he used high-density closed-cell spray foam to fill in the shallow truss rafter bays over the exterior walls and to seal the soffits and other bypasses into the attic (**Figure 6**). He then topped off the existing R-19 fiberglass batts with another 18 inches of cellulose. In places where we'd removed drywall during the demolition phase, we pulled out the old fiberglass batts and reinsulated the stud bays with damp spray cellulose.

Before hanging drywall, we scheduled a blower-door test, which took place on a cold February day. Preliminary results showed a respectable air leakage rate of 500 cfm50, even before the technician toured the house with her IR camera to help us pinpoint air leaks in the envelope that we had missed. Even though we haven't done final testing, we anticipate that the home's air exchange rate will be well below 3 ACH50.

Cost

The IkoTherm panels we ordered through our local lumberyard were packed in 11-panel bundles, so we ordered 77 panels at $57 per panel to cover about 2,400 square feet of wall area. We allowed three man-hours of labor to install each panel and cover it with sheathing, for an installed cost of about $7.45 per square foot. By comparison, wrapping the house with a double layer of 2-inch blueboard and strapping would have cost about $8 per square foot, while we estimated that nailbase or SIP panels with an equivalent R-value would have cost at least $10 per square foot.

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