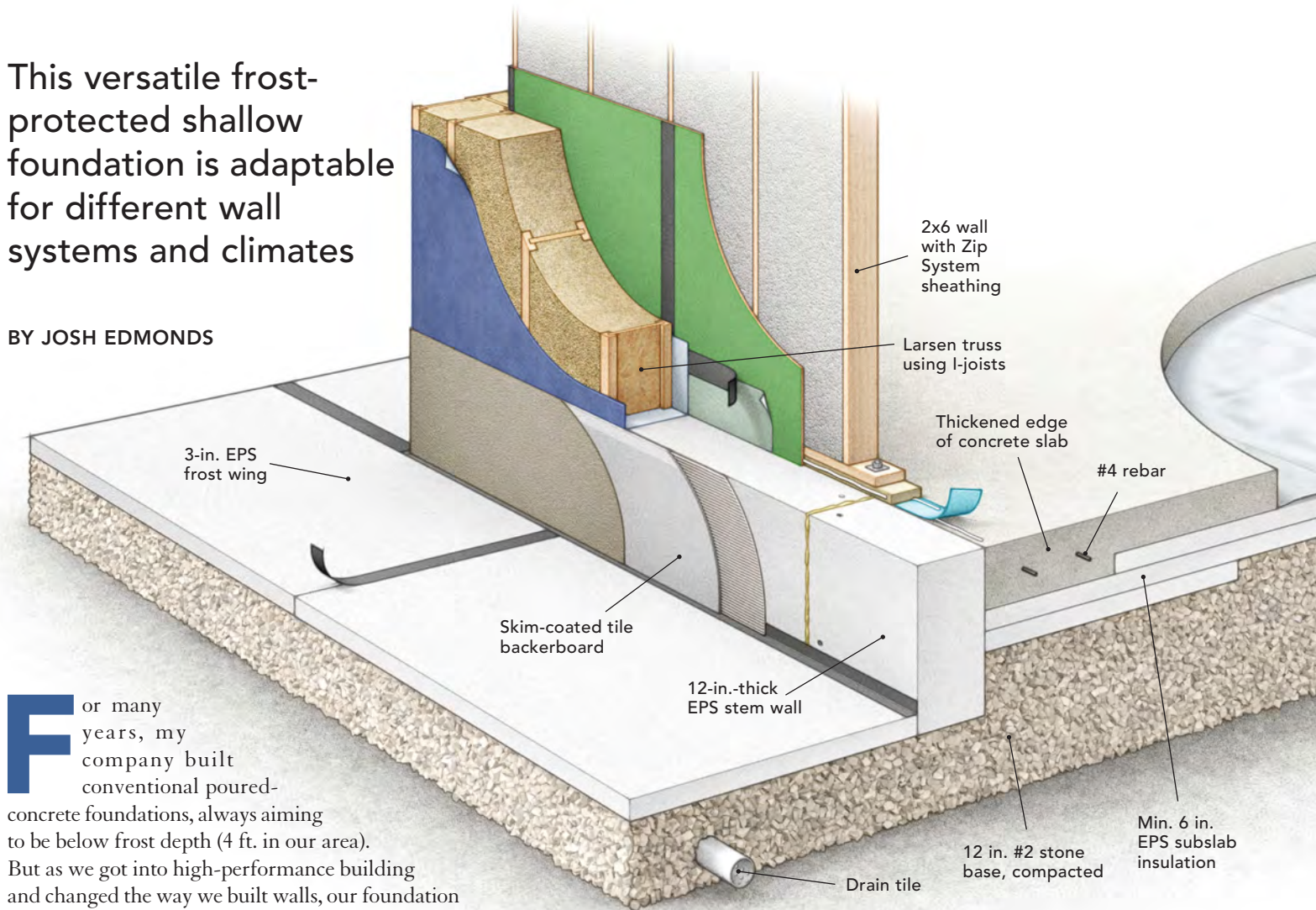


High-Performance

This versatile frost-protected shallow foundation is adaptable for different wall systems and climates

BY JOSH EDMONDS



For many years, my company built conventional poured-concrete foundations, always aiming to be below frost depth (4 ft. in our area). But as we got into high-performance building and changed the way we built walls, our foundation system had to evolve. We started with double-stud walls

about six years ago, and were able to pair those with 4-ft. frost walls and maintain a thermal break between the interior slab and the outer frost wall. But as we strived for even higher levels of performance, we began looking at exterior insulation and Larsen truss assemblies that necessitated a different type of foundation. Further driving this evolution, many of our customers started requesting houses without basements. Our standard high-performance house uses a 2x6 structural wall with Zip System sheathing and 12 in. of exterior insulation supported by vertically mounted I-joists. For optimal performance, the insulation layer needs to be continuous from the walls to beneath the slab and over the building (a separate discussion). A frost-protected shallow foundation (FPSF) is an efficient way to handle the underslab part of this. The approach has been around for years, and there are a handful of off-the-shelf systems that can work well.

The problem we encountered was finding an FPSF system that would work with our various wall assemblies. No two clients want exactly the same thing, so we need the ability to vary the level of per-

formance of the foundation system along with the walls. We looked all over, and talked to a number of suppliers of ready-made systems. Some had some of the features we wanted, but none touched every base. We may be picky, but I have to stand face-to-face with our customers and answer the hard questions when something isn't just right. Accepting a foundation system that doesn't check all the boxes isn't an option.

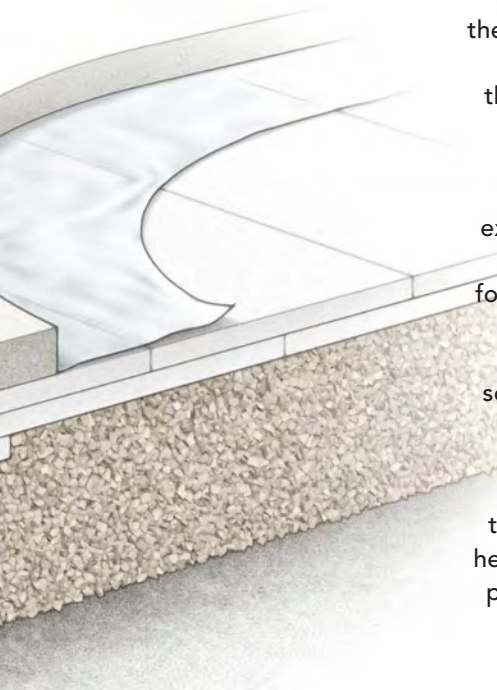
That led us to develop our own system. We found out we could order EPS foam in different sizes, thicknesses, and densities through our local building-supply center and have it on-site in about a week. From there it was a matter of designing a simple yet effective system we can assemble on-site and customize for various projects. Five houses later, we like what we've come up with—and our excavator likes it, our concrete subcontractor likes it, and our homeowners like it too. □

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Raft Slab

TWO-WAY HEAT SHIELD

This type of frost-protected shallow foundation relies on geothermal energy to keep the soil around and below the building from freezing. Our thickened-edge slab sits in a raft of EPS foam insulation, which itself is ringed with a skirt of insulation that extends beyond the building perimeter. The underslab foam slows heat loss through the floor and, along with the skirt, traps heat in the soil below the building. This, along with a thick gravel base and a perimeter drain to move water away from the structure, prevents frost heave while keeping the heat produced by the mechanical systems inside the house.



Different approach, different considerations

Building a raft slab is a different animal from a conventional foundation. Within the world of slab-on-grade options, frost-protected shallow foundation (FPSF) systems have their own set of considerations. Beyond the calculations (which you can find in the American Society of Civil Engineers' ASCE Standard 32-01), there are some critical considerations to keep in mind when selecting or developing an FPSF system.

The first is prep: How easy is the system to prep from an excavators point of view? We sub out excavation and are fortunate to work with an experienced operator, but we need to consider his work in addition to ours. If it's too complex or too confusing, the project will suffer.

Next is height: How much of the stem wall shows above ground and how much is below ground? Many of these systems rely on the back-fill outside the foundation to keep it in place. We like the ability to have 1 ft. showing and 1 ft. below grade. Code also plays a role in determining the depth requirements.

Perimeter foam is key to making this work. Minimum requirements for the thickness and projection of this frost skirt are determined by local code, but we go a bit above minimum for ease of mind and use 3-in.-thick EPS foam frost wings that extend 4 ft. from the building. Each inch of EPS has the insulation equivalent of 4 ft. of soil. We may be able to get away with less,

but it all comes back to risk assessment. The incremental cost of 3-in. foam vs. 2-in. foam is minimal, but a foundation issue down the road may be irreparable, both for our reputation and the physical building.

Stem-wall thickness is a big deal; we like to have some flexibility. One house may have 12 in. of exterior insulation, but another may have 6 in. We need to have the option for both within the same foundation system.

Another consideration is finish and protection. There are lots of ways to protect the foam above grade (and below if you're in termite country), and this is what people are going to see in the finished product.

Finally, the inner foam: Some systems come with inner foam and some require you to supply your own. Some details can complicate its placement. For example, is a grade beam necessary, or even possible with the chosen foundation system?

LAYING THE STEM WALLS AND FROST SKIRT

Our system has layers of redundancy. It starts with 12 in. of compacted #2 stone with drain tile laid around the perimeter. This ensures that water will always have a place to go. Next comes the heart of the system, the stem wall, which is made of 60-psi EPS foam that's 12 in. thick and 2 ft. tall. These blocks come in 8-ft. lengths. We start with the corners, fastening them square with 18-in. structural screws, then fill in between. Once they're properly sited, squared, and straightened, we add the skirt.



CAREFUL CUTS

To cut blocks to length, first use a circular saw set to full depth to cut as deep as possible all around, then finish with a reciprocating saw with a long arborist blade or handsaw, using the kerfs to guide the blade.



TOE THE STRAIGHTS

The infill blocks get toe-screwed together with 8-in. coarse-thread structural screws—two offset in opposite directions in the top, and one on each side near the bottom.



VERIFY LENGTHS

Once the stem-wall blocks are set, verify wall lengths. If one is long, simply shorten a block; if short, you may need to cut a new block, or leave a small gap and fill it with spray foam.



KERF TO TRIM

If a wall is just a smidge long, remove the screws between two blocks and run a reciprocating saw with a long blade down the joint, then refasten.



STRING AND STRAIGHTEN

Sink structural screws 2 in. in from each corner and pull a stringline tight along each wall line to use as a reference to straighten the stem walls. Our excavator lays down a thin layer of fine stone under the stem wall, which is easily moved to fine-tune the elevation of the stem-wall blocks. The top of the stem wall is also the top of the concrete, so it is imperative to get the height right.



CHECK DIAGONALS

Pull diagonals after straightening to make sure everything's square. You can nudge an entire wall line with a knee tap or, for smaller increments, a few good slaps. Restraighten if necessary.



ROUGHING-IN MECHANICALS

Once the stem wall is set, it's time to place mechanicals. We run all the subslab plumbing lines, electrical entrance conduit, radon pipe, incoming water line, and anything else that is going to be under the slab. To make laying the interior foam easier, we try to keep the horizontal plumbing below the foam. We could put our supply lines here, too, but we prefer to run them through walls and ceiling chases.



STRING SETS ELEVATION

SECURE IN PLACE

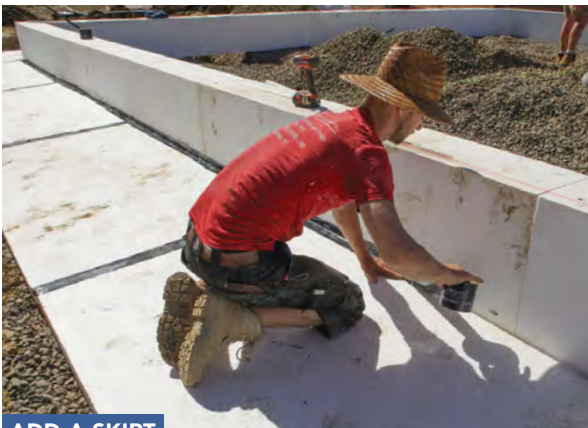
Taut stringlines flush with the stem walls serve as reference for the location and depth of the drain system, as well as the incoming electric and water lines. Crossed stringlines can serve as crosshairs to site stub-ups.

We drive wooden stakes into the gravel, and secure the incoming water line and electrical conduit to them with cable ties, using cutoffs of foam to keep them spaced.



FILL AND FLUSH

Spray-foam any gaps between frost-wall blocks and trim the overflow flush once it's firmed up.



ADD A SKIRT

Rake the gravel to create a slope away from the building and add the frost skirt. Tape the joints (here we used Zip System flashing tape) to help keep the skirt in place during backfill and seal the skirt to shed water away from the building.



STEADY THE DRAINS

Secure drains in place with rebar or wooden stakes driven on both sides below the connector, and tape around the entire assembly.



PLUG THE HOLES

To keep concrete from filling conduits and drains, plug all openings with foam and tape. We make plugs of foam using a hole saw, then cut them flush with a recip saw before taping.

FILL AND FOAM

A reinforced thickened edge around the perimeter helps distribute the weight of the structural walls that will sit on top of it. The illustration (p. 64) shows how the layers of 3-in. EPS foam are staggered to create it, as well as the use of stone fill. A walk-behind plate compactor works well to compact the stone without pushing the stem walls out of alignment.



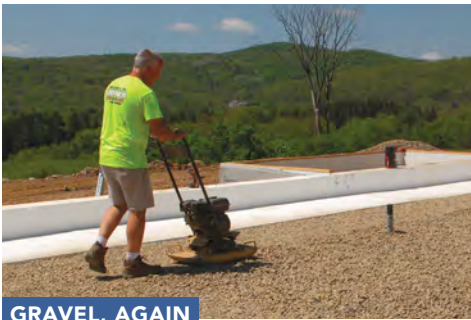
BALANCE THE FILL

Slowly raise the grade on both sides of the stem wall at the same time to keep it from shifting. The interior gets #2 stone, starting with a perimeter band wide enough for the first layer of foam. The frost skirt is covered with clean fill.



START OF SUBSLAB FOAM

Once the inner fill is at the right elevation around the interior perimeter, we start laying the first band of 3-in.-thick subslab foam.



GRAVEL, AGAIN

More gravel is added to bring the rest of the interior flush with the first layer of subslab foam, then it's compacted.



ADD ANOTHER LAYER

The next layer of foam covers the entire interior, lapping over the perimeter layer and the gravel, with the seams staggered.



CUTOUTS FOR MECHANICALS

Use hole saws to make cutouts for round penetrations. Various saws and knives work for odd-shaped cutouts.

STEM-WALL FINISH

The exterior finish starts at the same time as the first layer of interior foam. We like to leave 10 in. to 12 in. of the top of the stem wall exposed above grade to keep the siding off the ground, and our protective layer of parged-cementboard extends at least 6 in. below grade. The backfill on the outside is slightly lower than the gravel on the inside at this point just to make this job easier. We've been finishing these foundations to look similar to parged-block foundations or concrete stem walls, though there are other methods or finishes that could work as well, or along with elements of this approach.



ROCK ON

We rip 3-ft. by 5-ft. sheets of Durock Cement Board in half lengthwise, then butter and notch both the board and the foam stem wall with thinset mortar, and set the Durock firmly into the thinset.



THICKENED EDGE

We install the third layer of foam inset 2 ft. from the perimeter to create a thickened edge, which gets rebar reinforcement. The placement of the sheets ensures all areas have a least 6 in. of foam.



FILL THE GAPS

As each foam layer goes down, fill any gaps around mechanicals or abutting sheets with spray foam.



FINAL LAYER

Cover the foam with a sturdy vapor barrier—here we used 6-mil poly sheeting—carefully cutting out for penetrations. Let it hang long around the entire perimeter so it can be sealed to the wall sheathing later on. Tape seams and around any penetrations with high-quality tape for a good vapor seal.



COUNTERSINK AND SCREW

Use an old countersink bit to create countersinks at the four corners and center of each board, and fasten with coarse-thread screws.



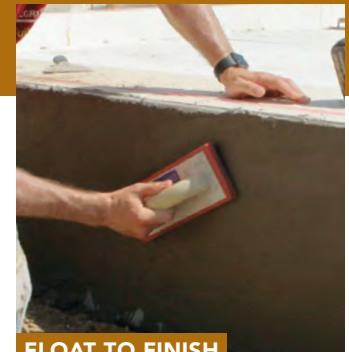
TAPE THE SEAMS

Before parge-coating, we tape the joints with fiberglass mesh tape embedded in thinset.



PARGE OVER ROCK

Apply a parge coat of fiber-reinforced bonding cement over the surface of the Durock.



FLOAT TO FINISH

Finish the parge coat with a sponge float for a slightly textured appearance.