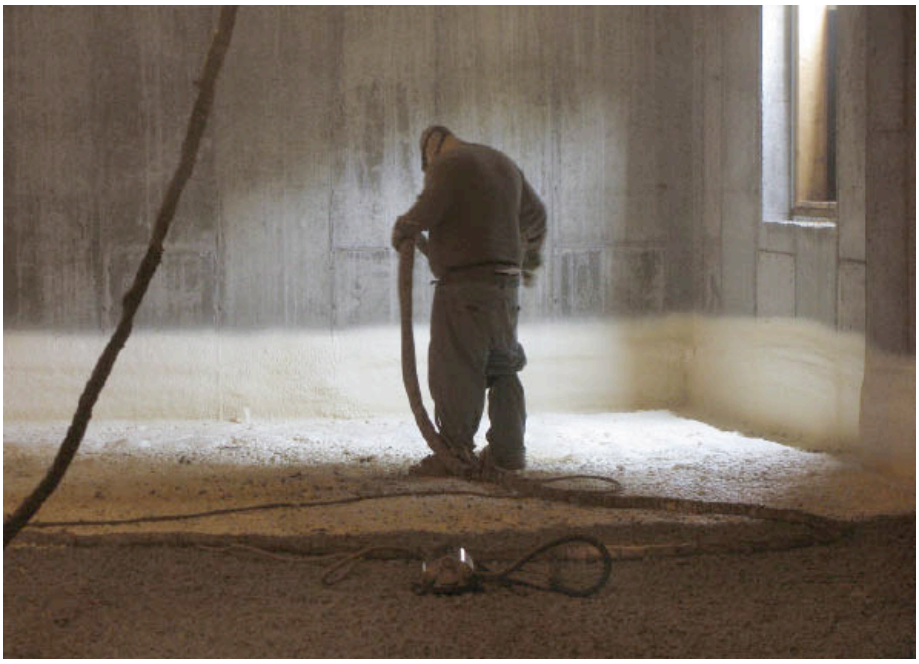
JANUARY 2010

Insulating a Slab With Spray Foam

Closed-cell polyurethane provides a vapor barrier and good R-value in a single application

by Mike Pindell



I'm a project manager for a spray-foam insulation contractor in New England. A good insulation package is a must in our climate, and we're always looking for sensible, practical applications for spray foam. Insulating under foundation and basement slabs using SPF (spray polyurethane foam) offers certain advantages over the more common method of using rigid foam board. As with any new technique, however, there are some considerations to take into account before using this approach for the first time.

Two-pound foam. Only closed-cell SPF can be used in a subslab installation; the open-cell foam does not have adequate compressive strength. Two-pound closed-cell foam has a compressive strength of 20 to 30 psi (depending on the specific brand used), which is generally acceptable for a typical nonload-bearing residential slab. Should there be a more stringent requirement, denser SPF formulations are also available.

Thickness. We typically recommend 2 inches of foam under a slab. At that thickness, closed-cell foam provides an effective moisture barrier and vapor retarder; it has a perm rating (using an ASTM E-96 test) of less than 1 at thicknesses greater than 1 1/2 inches. A 2-inch layer of 2-pound foam has an R-value of 12 to 14 (again, depending on brand), which is sufficient for most climates. As a rule, R-10 is adequate under most slabs.

Of course, while 2 inches is our standard recommendation, it's certainly possible to put down a thicker layer of insulation if desired.

Why SPF? In cold climates, insulating under a concrete floor is just common sense. But it's fair to ask why SPF should be used instead of rigid foam board. Perhaps the greatest advantage SPF offers is that it provides a monolithic layer of insulation, with no seams or other imperfections in the thermal barrier. Because it bonds aggressively and completely to just about anything it contacts, the foam creates a superior vapor barrier around plumbing and other slab penetrations (**see Figure 1**).

Figure 1. *Plumbing penetrations can be tricky to plug with rigid foam board; SPF seals seamlessly around obstacles with a few passes of the spray gun.*

Detailing foam board to provide an equally tight barrier takes time and great care. Getting the substrate sufficiently smooth and flat to evenly support the board takes a lot of effort too. SPF, by contrast, is totally forgiving of irregularities in the substrate. And as soon as the SPF cures — within 15 minutes — it can be walked on without concern for punching through into a concealed void (**Figure 2)**. There's also far less waste involved with SPF; there are no off-cuts or other discards. We can spray the exact amount required. "Extra" foam goes to the next job instead of into the dumpster.

Figure 2. *The foam can be walked on only minutes after spraying, permitting multiple layers without significant delay. The 2x4 at this chimney base will be removed after spraying to provide the code-required gap between the flue and the foam.*

Cost comparison. The material cost for spray foam is higher, but once the labor to properly detail rigid foam board is taken into account, the installed price becomes competitive. Our installed cost for a 2-inch layer of closed-cell foam runs about $2.20 per square foot. Two-inch polystyrene board costs around $1.80 a square foot installed, but it has a lower insulating value of R-10. Also, the bigger the slab area, the more labor is required to detail foam board around the perimeter and penetrations. On slabs 2,500 square feet and greater, we often reduce our price slightly, which ends up making SPF the less costly route. And because of the time saved, the slab pour can be moved up in the schedule.

Prepping for Spray Foam

Preparing for SPF insulation under a slab involves most of the same preparations you would do before pouring any slab. The substrate should be well-compacted and fairly smooth. Subslab plumbing should already be in place (radiant tubing excepted), especially if it needs to run below the substrate, which is typical for disposal lines. Drainage systems, sumps, and radon ventilation systems should also be installed before spraying. And all columns, posts, and other point loads should already be transferred directly to appropriate foundations or footings. That may seem obvious, but more than once we've found this important detail overlooked when we show up to spray.

It's important to mask anything you don't want foam in or on. The fine overspray gets on just about everything in the immediate vicinity, hardens rapidly, and is extremely difficult to remove. Any surface, equipment, or hard-to-move tool that you don't want permanently speckled requires a protective covering. Plumbing stubs and similar projections should be thoroughly covered (**Figure 3**). We use a variety of materials for masking, including tarps, tape, plastic sheeting, trash bags, and plastic food wrap. We always do our own masking, but it's a good idea to confirm who's doing this work so there's no misunderstanding on spray day. It's also wise to clearly mark the intended top-of-slab height on foundation walls. That way, any possible discrepancies can be caught before the insulation goes down.

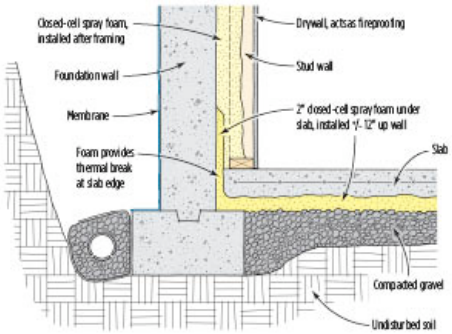
Figure 3. *Cured foam sticks tenaciously to most surfaces. Plastic food wrap protects these plumbing stubs from the overspray.*

Application

Spraying a large, flat expanse is a bit different than filling framing bays. Big open areas are fairly straightforward. Application usually begins in the middle of the slab area and works out to the edges. We spray the foam in 1-inch lifts. Thickness is determined by the size of the spray tip and by how quickly we apply the foam. The overall quality of the job depends mostly on the skill of the technician. An experienced applicator can lay down a smooth, uniform coat of foam that is relatively flat (we consider plus-or-minus 1/2 inch close enough). High spots are pretty easy to trim down with a hand saw.

Edge treatment. The slab perimeter calls for especially careful work. The greatest heat loss occurs at the edge of a slab, making a thermal break at this juncture critical to good performance. On a standard basement slab, we use one of two details at the perimeter, depending on whether the basement will be finished. If framed and finished walls are planned inside the foundation, we'll roll the foam about 12 inches up the walls (**Figure 4**). Since we often return after the framing is completed to insulate the foundation walls, we can simply tie the wall foam in with the slab insulation. The framing cavities can then be either left open or insulated with open-cell foam or other insulation. Building codes typically require exposed foam insulation to be covered by a thermal barrier. In a finished basement, drywall meets this requirement.

Finished Basement



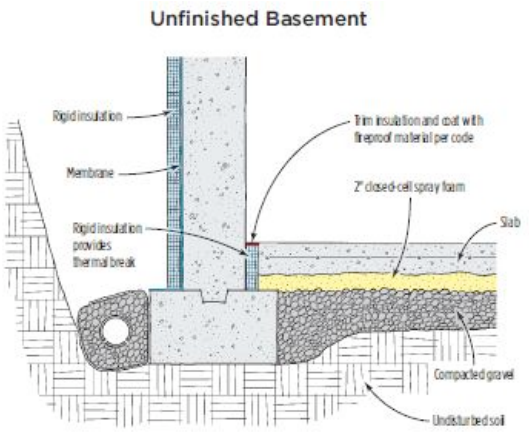


Figure 4. *When a finished basement interior is planned, the foam can run up the walls to create a thermal break at the slab edge (top). Drywall furnishes the code-mandated fire protection (middle). In an unfinished basement, rigid foam board provides a neat thermal break at the slab's perimeter (bottom). The excess can easily be trimmed flush with the finished slab and sprayed with a thermal barrier coating.*

Unfinished basements call for a different approach. We insulate the perimeter with 2-inch foam board, ripped about 1 inch wider than the distance from the footing to the top of the finished slab. After placing this board around the entire perimeter, we spray up to it. The SPF locks the board in place as it expands, with no need for mechanical fasteners. Once the slab is poured and hardened, the foam board can be trimmed flush with the surface or left protruding. We use a similar approach in slab-on-grade construction where the slab is flush with the top of the stem walls. In the unlikely event that a building inspector requires a thermal barrier over this narrow strip of exposed foam, we can cover it with a spray-on intumescent coating, such as Flame Seal TB (713/668-4291, flameseal.com).

Protective measures. The liquid foam blasts out of the spray gun under high pressure and quickly fills the air with fumes and atomized particles. Working in this environment can irritate the lungs and mucous membranes, so we require anyone entering the installation area to wear respiratory and eye protection. Our technicians work in full protective gear with supplied-air respirators, which deliver fresh air through an external pump and hose (**Figure 5**).

Figure 5. *A supplied-air respirator is a must when spraying foam. A layer of clear plastic wrap keeps the face shield clean for repeat use.*

The installation area should be effectively isolated from adjacent spaces. In basements, we use plywood scraps and plastic sheeting to close stair holes and any other openings in the floor, like duct cutouts and plumbing penetrations. We always use a ventilation fan to depressurize the work area, so that fumes are exhausted to the outside while fresh air is drawn in.

It's safe to enter the area about an hour after spraying. We do insist that no other work be scheduled in the basement on the day of an SPF application, and we post all entrances, notifying workers that respiratory protection is required in the spray zone. And to avoid accidental ingestion of foam particles, we don't allow any smoking, eating, or drinking anywhere near the area.

Mike Pindell is a project manager for FoamRun Building Envelope Contractors in Ashby, Mass.

9 Comments so far...

We tried this approach recently and had a terrible time with the foam creating voids between the ground and the foam. We needed a fairly consistent thickness, and could not achieve this. We tried twice, and returned to 2 inch rigid after losing a week's time and costing 1 dumpster load. Great concept, but the execution failed.

Posted by: Nolden Johnson on January 8th 2010

Arctic Enginering as taught in Alaska teaches that the foundation wall should be insulated on the outside (cold side of the wall) (down to the footing,) because the temperature of the concrete wall will fluctuate less than if the insulation is on the warm side of the wall. This lowers the thermal stress in the concrete caused by freeze-thaw cycles.

Posted by: Akdogman on January 8th 2010

You state you would fill the studded wall cavities with open cell foam. I would be concerned about moisture getting in the open cell foam either through capillary migration in the wall or moisture moving through the foam and condensing on the concrete. Open cell foam, when wet, is a sopping mess. However, your diagram shows closed cell foam on the walls. Perhaps an oversight.

Posted by: R Jordan on January 9th 2010

Polyurathane foam will deteriorate with water exposure while polystyrene will not so I cannot beleive this is a good Idea. Clif

Posted by: on January 9th 2010

Robert- the diagram is correct, the open cell foam in the body of the article is a mistake. I would always recommend Closed cell in the basement for exactly the reasons you mention

Posted by: Mike Pindell on January 9th 2010

Clif where do you get the idea that polyurethane foam will deteriorate with water. Closed cell spray foam is highly water resistant, and this is a manufacturer recomended application.

Posted by: Mike Pindell on January 9th 2010

My concern would be with any long term chemical reaction with the ground (i.e. dirt) and the foam. Are there any stability studies that have been done with foam in direct contact with dirt?

Posted by: Bob Dalga on January 9th 2010

How would you treat for termites? The chemical would never get to the soil?

Posted by: Stan on January 10th 2010

We have built this way in all our houses in the Adirondacks for the past several years. Its works perfectly. Provided you prep

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well, the installation is fast and as idiot-proof as you can reasonably expect. The radiant slab stays nice and warm for many hours - we use 3 inches of foam. We also put the closed cell on the outside of the foundation wall below grade, and it works well as both additional vapor barrier and for heat retension.

Posted by: Jim Moore, PE on January 10th 2010

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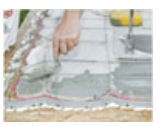		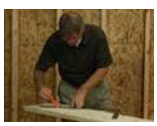	**Tricky window drainage details**		
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