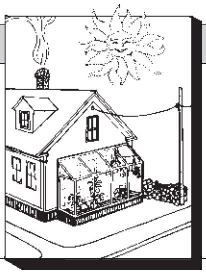
FOCUS ON ENERGY

The Ins and Outs of Foundation Insulation



by Terry Brennan and Chuck Silver

In a previous issue, I wrote about how to choose foundation systems for buildings, and why higher R-values are justified. This month, we'll compare insulating outside the foundation wall to insulating inside the wall. We'll also look at a new system for placing insulation within a poured wall.

Outside Insulation Options

The most common exterior insulation is polystyrene foam either in its extruded form (Dow blueboard, Foamular pinkboard, Amoco greenboard, etc.) or as expanded polystyrene (EPS), often called beadboard. The extruded products are about R-5 per inch thickness, and are particularly well-suited to underground applications since they have relatively high compressive strengths, and don't take on any appreciable moisture.

One disadvantage of foam is its cost: generally four to five times the cost per R of loose-fill products (like fiberglass). This high cost is generally weighed against the cost of creating a cavity to hold the less-expensive loose-fill insulation. With external foundation insulation, however, loose fill is not really an option.

Beadboard insulation is typically closer to R-4 per inch thickness. But since it is available in a variety of densities, the R-value may vary. The higher the density, the less likely water can penetrate and degrade the R-value, or worse, break up the insulation in freeze-thaw cycling. As a general rule, if you use beadboard below grade, keep it dry. Geotech Systems Corp. (100 Powers Court, Sterling, VA 22170; 703/450-2366) offers a beadboard foundation insulation with a different twist. Its "Insulated Drainage Board" has the beads held together by an asphalt binder in an "open" matrix that allows water to flow freely through it. A filter fabric is laminated to one side of the panel. the product is placed against the waterproofed basement wall where it provides an R-value of 3.5 per inch, and provides a positive drainage channel for water to drop to the footing drains. This assures that the insulation will stay dry (as long as the footing drains are operating properly).

Not to be outdone by the foam manufacturers, fiberglass manufacturer Owens-Corning and its Canadian counterpart Fiberglas Canada offer rigid fiberglass board as external foundation insulation. This is sold as "Baseclad" in Canada, and "Warm-n-Dri" in the U.S. Due to Owens-Corning's marketing strategy, however, the U.S. product is unavailable through building retailers. It must be purchased from an "Owens-Corning-Certified Independent Waterproofing Contractor." This product is available in 13/16-inch and 2 3/8-inch thicknesses (respectively, about 1 inch and 2 inches after compression) with an installed R-value of around 5 per inch. It, too, has the added feature of serving as a drainage channel, since the glass fibers are oriented in the panel to assure that water is transported down to the footing drains before it can soak through the panel.

Pros and Cons of Outside Insulation

There are several clear advantages to insulating on the outside. First and foremost, an unbroken insulation layer extends from footing to sole plate, neatly capping off the potentially leaky intersections of foundation, sill, rim joist, and sub-floor. This completely unbroken cover is hard to achieve with other methods, and impossible to do conveniently. If you are sheathing your walls in foam, then it is possible to continue this unbroken shield from the footing right up to the rafters.

A second, perhaps minor advantage, is that no space is stolen from the inside. This may only be an important consideration when the basement is to be fully developed. Interior framed walls may be a significant liability when every inch is needed.

Foam insulation is sandwiched between two layers of concrete in the new system from Composite Technology Corp. High-strength plastic ties hold the wythes together without creating thermal leaks.

Third, in a retrofit situation where the interior is already finished, it may be far more practical and less expensive to disturb the exterior, even if some landscaping must be replanted, rather than destroy and rebuild the interior walls. It is worth considering the Canadian "down-and-out" method for exterior insulation for retrofits. rather than excavating to the footing, you excavate about 2 feet down and install rigid insulation against the foundation. Then you excavate and run the insulation out from the building about 2 feet in a skirt around the foundation, slightly sloping down away from the building. This has proven to yield similar energy performance to the standard methods of running the insulation straight down the wall, since the heat must travel through a similar amount of thermal resistance before it escapes to the surface air.

For new construction I consider this approach to be foolhardy since rigid insulation placed horizontally on backfill (even compacted) is bound to break up and shift as the earth settles. In a retrofit, however, the insulation can be placed on undisturbed earth, so its chances of survival are greatly improved.

On the con side, there is a practical limit to exterior insulation thickness. It's difficult to install more than 2 inches of foam (R-10) on the outside of a foundation without a lot of tricky and unconventional detailing. When building with 2x6 walls, it is possible to cantilever the wall out as much as 2 inches beyond the deck to cap the top of the insulation and still have bearing the width of a 2x4. If you sheathe the walls in foam, it is possible to continue this layer down to the footings and yield 3 inches total (R-15) on the foundation. I've done a lot of "kicked-out" 2x6 walls, so I want to point out two minor disadvantages. First, the overall foundation dimensions and framing dimensions will be different which may cause some confusion on the job. It also may make dimensioning the plans (vertically aligning windows in the basement and framed walls above, for instance) a little trickier. Second, you will have to choose to have a foundation wall that is 27'-8" if you want an overall framed wall of 28'-0". Or, if you'd rather keep the foundation at 28'-0", the walls will be finished at 28'-4". These are nuisances, but not insurmountable problems.

Aside from the limitations on R-value, there are some other negatives associated with exterior foam. Typically, foundations are backfilled right after the deck is finished. If the foam is installed from footing to sill, the section above grade is highly susceptible to both physical damage during construction, and to degradation from ultraviolet light if left exposed for long periods. If the insulation is installed in two phases, with the first running up to grade and the second (above-grade) section left until later, some damage is likely to occur at the edges of the panels installed first. Also, there is extra effort in cleaning and fitting the two phases properly.

There are a host of products available for creating a weatherable finish over the exposed foam, ranging from metal to plastics to fiber-reinforced cement. These all entail a significant amount of labor and/or expense. I have seen some of these finishes damaged, and I question their long-term durability, particularly with regard to impact resistance.

The last and perhaps most serious problem with exterior foam is insect infestation. Because protective coatings are expensive, they usually stop just below finished grade. The foam may provide hidden entry to the wood structure for termites and carpenter ants. I once uncovered a stack of extruded polystyrene foam that had sat under a tarp for some months and was completely tunneled through and serving as a home for ants. I can't think of a reason why insects wouldn't choose to live in the foam on your building. Dow's response to this issue is to acknowledge it, and state that insulation in ground contact requires that the soil be treated with "soil poisons" (termiticides). No thanks.

Inside Insulation

Due to a considerable advertising effort on the part of foam manufacturers, many contractors don't realize that there are options besides exterior foam. Insulation on the inside of the foundation wall predates exterior treatments. The most common method is to build a stud frame, and insulate with batt fiberglass. A unique advantage to this method is that almost any R-value may be achieved while using the same 2x4 studwall, simply by moving the wall further into the room to create a bigger cavity. If R-19 is desired, move the wall in 2 inches from the masonry, and let the insulation stick out the backside of the wall. Better still, bring the wall in 31/2 inches and run an R-11 batt behind the frame horizontally, and a second R-11 batt in the stud frame vertically. This gives you an R-22 without any thermal bridging at the studs. For R-30 use an R-19 batt horizontally behind the wall in place of the R-11 one. If the loss of basement space isn't important, run an R-30 (9-inch) batt behind the studwall, and leave the stud cavity empty to allow for wiring and plumbing. If the vapor barrier is placed on the backside of the stud frame (applied before raising the wall) there won't be any penetrations for outlet boxes and switches.

Several studies have indicated that the cost, (all materials and labor for the finished wall) of providing approximately R-10 insulation on a foundation wall is about the same whether it is done externally or internally. With the stud frame approach, the incremental cost for going from R-11 to R-30 is only the cost of the additional fiberglass (about 25¢/square foot). Compare this to adding R-20 to the exterior. If it were possible to add 4 inches of foam to the 2-inch layer, you would add about $1.20 per square foot to the cost in just the foam, without even considering the extra flashing and protection details.

If the basement is to be finished,

this is further incentive for the interior method, since the system provides a finished interior wall and easy opportunity for conventional wiring and plumbing. This approach has great flexibility in terms of construction sequencing, and since it's indoors, can be saved for rain-day work (always a consideration in New York State). The only significant disadvantage to this method is that the rim joist area of the first floor is more difficult to insulate and seal properly on the inside. This is exactly the same situation that occurs at the second floor deck in platform framing. We usually insulate this area with batt insulation to achieve the same R-value as the wall, and then use snug fitting foam blocks between the joists (caulked in place) to extend the vapor retarder up to the underside of the plywood subfloor. Admittedly it's more work and less airtight than continuous foam on the outside, but on balance, I think the approach wins hands-down.

I have been asked what the effect is of insulating the foundation wall on the inside, versus having the foundation wall within the heated envelope. I have yet to hear of any problems (freeze/thaw damage) associated with isolating the wall from the heated space. As for including the thermal mass within the insulated envelope, I don't believe there is a significant benefit from the additional thermal mass in the basement unless there is a conscious attempt to direct sunlight onto the walls, or some active method of circulating heat into them.

Insulation Within the Wall

It would be nice if there was a way to pour a foundation wall with the insulation in it so there would be no need for further work on either side of the wall. A unique method for achieving this has been developed by Composite Technologies Corporation (CTC) (525 East 2nd Street, P.O. Box 1888, Ames, IA 50010; 800/232-1748). The company has found a way to place rigid insulation in the middle of a concrete wall so that when the forms are stripped, the wall is complete, with no need for protecting the foam on the outside, or creating a fire barrier on the inside. If this approach were taken with conventional metal ties, a wall with 2 inches of blueboard would yield an R-value of only 7.76 due to the thermal short circuiting through the steel (at only 0.5% of the wall area!). With the CTC plastic connectors made of fiber-reinforced polymer, the wall has an R-value of 10.49. (These results are based on CDC-sponsored tests conducted by Engineering Research Institute, at Iowa State University.)

The key to the system are the unique high-strength, low-thermal conductivity connectors, which are available in a range of configurations for pre-cast or site-cast applications. A 12-inch poured-in-place wall can be constructed with 4 inches of extruded polystyrene (R-20) in the center with 4-inch concrete wythes on each side. The chemically-resistant ties are placed 12 inches on-center in each direction. The amount of concrete used is the same as in an 8-inch poured wall. Through a marketing agreement between CTC and Dow, Styrofoam is available (through Dow's distribution network) predrilled for these ties. If strap-type ties are used with metal formwork, CTC makes a sleeve that isolates the ties from the pour. The strap-ties are removed entirely when the forms are stripped, and the slots are then sealed.

Although the pour may be slowed a little with this approach, the system is a significant time saver when compared with other methods of creating an R-20 poured wall. In tests conducted at Engineering Research Institute, the strength of a 10-inch poured wall with 2 inches of Styrofoam in the center was slightly less than that of a solid 10-inch poured wall, with comparable reinforcement. Note that the insulated wall had only 8 inches of concrete in it. This sounds promising to me, although I've not yet used the system myself.

Which system makes the most sense for you will depend on what R-value you wish to achieve, cost and scheduling concerns, and whether you or your client plans to finish the interior walls. ■

Terry Brennan and Chuck Silver currently run training seminars on energy-efficient construction for the New York State Energy Office.