Residential Foundation Insulation

January 2000

Introduction

Homes being constructed today are more energy efficient than those built even just a few years ago, primarily due to significant improvements in building products and techniques as well as development of high-performance heating and cooling systems and other appliances. However, the benefits of foundation insulation are often overlooked. Heat loss from an uninsulated, conditioned basement may represent up to 50 percent of a home's total heat loss in a tightly sealed, well-insulated home. Foundation insulation is used primarily to reduce heating costs and has little or no benefit in lowering cooling costs.

In addition to reducing heating costs, foundation insulation increases comfort, reduces the potential for condensation and corresponding growth of mold, and increases the livability of below-grade rooms.

Foundation types

Foundations are either full basement, slab-on-grade, or crawlspace. Deep frost lines and low water tables often make a full basement the primary foundation of choice in Kansas. However, slab-on-grade with walkout basement construction is common and home additions often have crawlspace foundations.

Full basements

Basements can be insulated either on the interior or exterior. Interior insulation can use conventional 2×4 framing (see Figure 1) with batt or wet-spray insulation. Unless the vapor retarder covering on the batt insulation is fire rated, it should be covered with dry wall.

Rigid foam is also used on basement interiors. Furring strips are used to hold the foam insulation in place. Extruded polystyrene, expanded polystyrene, or polyisocyanurate insulation boards can also be used. Fire codes require most foam insulation board to be covered with dry wall.

Exterior foundation insulation (see Figure 2) uses extruded or expanded polystyrene directly on the outside of exterior basement walls. Insulation exposed above grade must be covered to protect it from physical abuse and damaging effects

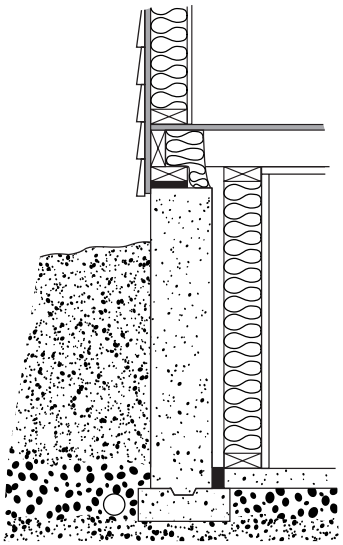

Figure 1. Interior basement insulation

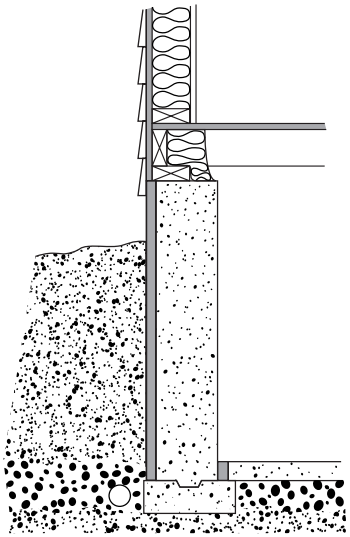

Figure 2. Exterior basement insulation

of the sun. Typical cover materials include roll metal stock to match the siding, cementous board attached to the sill plate, or application of a stucco-like finish.

A third option is to use a foam-form foundation system. Polystyrene foundation forms are set on conventional footings, much like building a Legos® wall. Concrete is placed into the forms where it cures to form both the structural and thermal components of the basement wall.

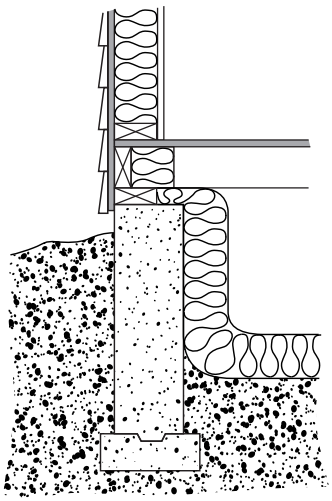

Figure 3. Interior crawlspace insulation

Exterior foam, either foam boards placed on the exterior of a conventional foundation or in a foam-form wall system, may provide a concealed entry path for subterranean termites. Termites can tunnel through and behind many foam products. If exterior foam insulation is used, a continuous metal termite shield must be used between the top of the foundation and the sill plate to force termites out of the foam and into view. Even then, treatment with conventional termiticides to stop the infestation may be difficult.

Foundation waterproofing, site and footing drainage, and termite treatments are similar for insulated and uninsulated basements. However, if exterior foam insulation is to be used, use waterproofing products compatible with the foam.

Crawlspaces

In many respects, crawlspace walls are just short basement walls. Exterior foam and foam-form insulation systems can be used. However, interior crawlspace wall insulation is usually either foam board or draped insulation. If foam insulation is used, it extends from the top of the foundation to the top of the footing. The cavity formed by the rim joist should be filled with fiberglass batts or a foam-in-place product. Most fire codes allow up to two inches of polystyrene exposed on the interior of a crawlspace before covering is required.

If crawlspaces are insulated with fiberglass or mineral wool batts, the batts are usually tacked to the sill plate and draped down and onto the floor. Four-foot-wide batts incased in a plastic cover work well when installed horizontally. Conventional 16- or 24-inch-wide batts leave voids between the batts and do not perform as well.

Some jurisdictions require a ventilated crawlspace to help control moisture. Vent requirements are significantly reduced if the floor of the crawlspace is covered with plastic sheeting with joints overlapped and taped to reduce crawlspace moisture. If required, install operable vents so they can be closed. Don't forget to fill the rim joist space with fiberglass batt or foamed-in-place foam to complete the insulation treatment.

The floor over the crawlspace can also be insulated. This raises the thermal envelope from the crawlspace walls to the space floor. While this technique offers many advantages, piping must be freeze-proofed and heating and cooling ducts must also be insulated.

Slab-on-grade

Heat loss is greatest at or near the exterior grade. To reduce heating costs and reduce the cold-floor syndrome common to slab-on-grade construction, insulation is critical. Exterior foam insulation, (see Figure 4) similar to exterior basement insulation, works well. Insulation should extend from the top of the slab to the top of the footing. Foam insulation inside the footing is also common. It is necessary to provide

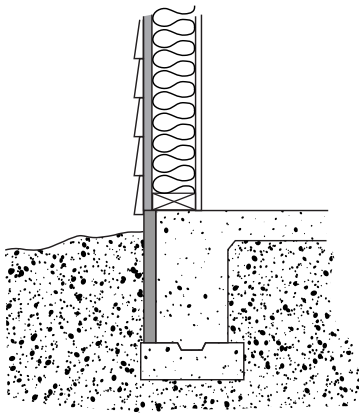

Figure 4. Slab-on-grade insulation

a thermal break to prevent thermal wicking from the slab to the outside. Installing a pressure-treated nailer or beveled slab edge provide the thermal break while still allowing floor-covering attachment.

Insulation levels

Climate, cost of fuel, efficiency of heating equipment, and type of foundation determine the cost-effective level of insulation. Kansas is divided into three climate zones depicted in Figure 5. Table 1 provides "Minimum" and "Better" recommendations for each of the three Kansas climate zones.

Table 1. Foundation insulation R-values

	Zone 1	Zone 2	Zone 3
Basement walls			
Minimum	10	9	8
Better	15	15	13
Crawlspace walls			
Minimum	16	16	10
Better	1 6	16	10
Slab-on-grade			
Minimum	5	5	5
Better	10	10	10

"Minimum" recommendations provide an acceptable level of performance. "Better" column values provide additional savings and should be considered, especially if the price of your heating fuels exceeds the following levels: natural gas above $6.50 per MCF, propane above $.60 per gallon, or winter electric prices above $0.055 per kWh.

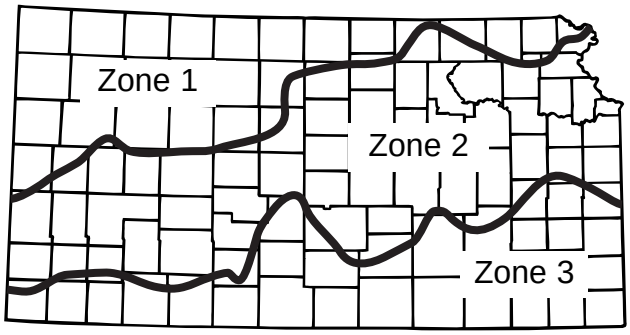

Figure 5. Kansas climate zones

Savings from insulated foundations vary with fuel price, heating equipment performance, and climate. Table 2 provides an estimate of potential for energy savings based on the three foundations types, three Kansas climate zones, and two fuels prices.

The cost of full-basement foundation insulation will vary but Midwest builders have reported prices between $800 and $1,200. If the mortgage of a new home were increased by $1,200, the increase in home payment would be $106 annually for a 30-year, 8% loan. The combined heating and mortgage costs would be similar and the home would be more comfortable and provide a healthier indoor environment.

Table 2. Estimated annual savings potential of foundation insulation

	Zone 1		Zone 2		Zone 3	
Energy costs	Low	Medium	Low	Medium	Low	Medium
Full basement	$125	$180	$90	$140	$70	$110
Crawlspace	$50	$75	$45	$65	$30	$50
Slab-on-grade	$65	$95	$60	$85	$45	$65

Further information

Additional information about residential foundation insulation can be found in *Builder's Guide to Foundation Insulation*, by Joseph King, Coriorlis Assoc., Lawrence, Kansas, 1999. A videotape presentation on foundation insulation is available from Engineering Extension at Kansas State University. Both the brochure and videotape are available by contacting Engineering Extension at 785-532-6026. In addition, *Builder's Foundation Handbook* is available from the U.S. Department of Commerce, National Technical Information Service, and is an excellent manual for foundation design.

For questions regarding this fact sheet or further information on foundation insulation, please contact Engineering Extension at 785-532-6026. This fact sheet is posted on the Kansas State University Engineering Extension Web page at *www.oznet.ksu.edu/dp_nrgy/ees*. Other KSU Engineering Extension Fact Sheets posted at this site include the following:

- Tips for Purchasing an Energy-Efficient Home
- Selecting a Home Heating System
- Selecting a Home Cooling System
- Energy-Efficient Mortgages
- Energy-Efficient Windows
- Residential Insulation
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