
Improvements to the building envelope make a big difference in energy efficiency and should be a high priority for any green remodeling project.

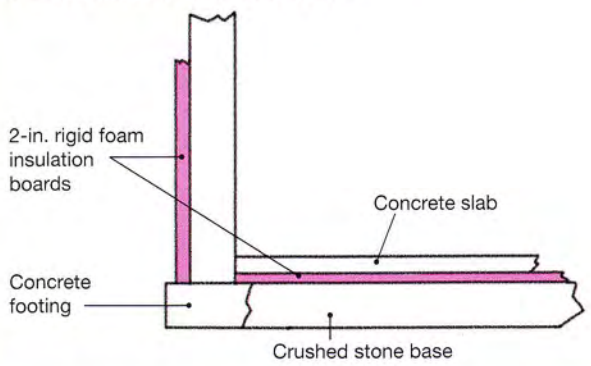
## INSULATING A BASEMENT

In most cases, it isn't practical to expose the outside of the foundation of an existing house. But if your renovation includes an addition, consider insulating the foundation from the outside. The best material to do this with is rigid foam, which comes in sheets of varying thickness. One inch is good; two is better. Insulating under the slab is also recommended. If you can't do both, I recommend insulating the slab. It's always possible to insulate the basement walls from the inside later on, but there's not much you can do about the floor once the concrete is poured. Especially if the basement will be used for living space, you don't want the floor to be cold.

Insulating basement walls and slabs can improve indoor air quality, too, because it prevents unwanted moisture. Condensation forms on surfaces that are colder than the dew point of the surrounding air. You see this every time you sip a glass of iced tea on a warm day. This can cause cold concrete surfaces to become damp, which can encourage the growth of mold. So insulating your basement properly not only improves the home's thermal performance but also can help ensure good indoor air quality. Yet another benefit of insulating concrete from the outside is that it puts thermal mass on the inside of the home's thermal envelope where it can do the most good. Insulated concrete actually stores heat rather than drawing it out of the house.

If you can't insulate the outside of the foundation, there are still significant improvements to be achieved by insulating from the inside. You won't get the benefit of the concrete's thermal mass, but it will improve your home's comfort and energy efficiency.

**A WELL-INSULATED FOUNDATION**




colder areas. Without any insulating barrier to slow it down, some of the heat in your house is absorbed by the concrete walls and floor of your basement. This makes the foundation a heat sink—a kind of negative radiator.

Why, then, doesn't the concrete become warm? It would, in fact, if there were something to keep the heat absorbed by the concrete from being conducted to the outside. Most basements, if they are insulated at all, are insulated from the inside. If done properly, this will keep most of the heat from escaping, or at least slow it down. This is not a bad solution, but there are better ones.

If concrete is insulated from the outside, it gradually absorbs heat and holds it. This can be a great energy saver because once the concrete absorbs heat, the exterior insulation slows the conductive transfer from the concrete to the earth, and some of that heat can then radiate back into your house.

### The wall assembly

When thinking about the thermal envelope of a house, it is helpful to look at the walls as a system. The frame, usually

**In most remodels, the foundation can't be insulated from the outside. Insulating the inside of a basement foundation with rigid expanded polystyrene sheets is an affordable alternative that reduces heat loss. For fire safety, the insulation board should be covered by drywall.**

**Rule-of-thumb load calculations don't apply. The high-performance building envelope of this remodeled duplex in Cambridge, Massachusetts, employs a continuous exterior layer of rigid foam insulation, resulting in heating and cooling loads 38% lower than conventional homes. The rightsized HVAC system is therefore smaller, less costly, and more economical to operate.**

could have an effective R-value of anywhere from 9 to more than 30. So it is essential to know how the wall is constructed and insulated. Is it built with 2x4s or 2x6s? Are the studs spaced 16 in. on center (o.c.) or 24 in. o.c.? (Remember, wider spacing allows for more insulation.) What kind of insulation was used, and how well was it installed?

By making reasonably accurate assumptions about how the walls are built and then calculating the total surface area of each type of material, it is then possible to arrive at the rate at which the house will lose or gain heat under various conditions. For example, more heat is lost through windows than through solid walls. But sunlight entering through south-facing windows can help warm a home's interior. If the sunlight falls on a material with thermal mass, like concrete, stone, or tile, or even walls with a double layer of drywall, that thermal mass will absorb heat from the sun and then release it slowly after the sun has set. All that has to be taken into account to understand a home's thermal characteristics.

Assumptions also have to be made about the rate of air infiltration—leaky homes lose heat much faster than tightly sealed homes. Even the fact that doors are opened whenever someone