

Moisture Problems From “Dry” Basements

by J. D. Ned Nisson

If your feet are cold, put a hat on — an improbable but true old folk saying. Here's a new one: If your windows are wet, waterproof your basement.

We've known for a long time that much of the moisture that condenses on windows in winter, or promotes mold growth in summer, comes from the basement or crawlspace. In fact, a 1986 survey of 500 homes conducted by the University of Illinois Small Homes Council, found a strong correlation between attic moisture problems and wet basements or crawlspaces. The new discovery is that even “dry” basements and crawlspaces may be significant sources of moisture in homes.

I constantly hear of moisture problems in tightly built new homes where there seems to be no apparent source of excess moisture. In light of new research, I suspect that one important moisture source in these homes is the seemingly dry basement or crawlspace.

Given all the effort required to install vapor retarders, air retarders, and ventilation systems to prevent damage from indoor humidity, it may be worthwhile to pay more attention to controlling moisture sources in the basement, in this case vapor diffusion and air leakage.

Below-Grade Moisture Diffusion

A unique set of tests at the University of Minnesota Underground Space Center showed that dry basements can, in fact, contribute significant amounts of soil moisture to a home. The study also showed that exterior wall waterproofing alone is only marginally effective at solving the problem.

Minnesota researchers constructed four small test basements in a well-drained sandy site at the center's Foundation Test Facility. Over a four-month period, they measured 50 gallons of moisture entry through a poured foundation and 36 gallons through a block foundation. (Why more water entered through the poured concrete than the block in this test is unclear.) Both surface water and deep ground water are sources of this moisture, which rises up by capillarity and evaporation into the sandy soil and then diffuses into the basement

through the concrete walls and floor.

To test the effectiveness of exterior wall waterproofing, the Minnesota scientists installed 2 inches of Styrofoam on the outside of one foundation. Contrary to expectations, the Styrofoam only slightly reduced moisture entry, from 36 gallons to 30 gallons. An identical basement with interior foam insulation showed significantly better moisture control, with only 14 gallons measured. Why should interior wall waterproofing work better than exterior wall waterproofing?

The explanation, according to researcher Louis Goldberg of the Underground Space Center, is that much of the moisture enters up through the footings (see Figure 1). Interior wall waterproofing is inside the footings and thus isolates them from the basement interior. Exterior wall waterproofing, on the other hand, is outside the footings. For truly effective moisture control with exterior wall waterproofing, the footings must also be waterproofed. More on that later.

Below-Grade Moist Air Leakage

Underground air leakage into houses has become an important issue since radon was discovered in homes. But radon is just one component of soil gas. Another is water vapor. In fact, during winter, soil gas is usually saturated (100% relative humidity) with water vapor. Whenever a basement is at a lower atmospheric pressure than the surrounding soil (caused by exhaust fans, combustion appliances, or the “stack effect”), soil gas enters through cracks and penetrations and carries moisture into the basement.

A study conducted by the National Research Council of Canada found that in one test house, 7.5 gallons of water per day were drawn in through basement air leakage when the house was depressurized with a small 125 cfm exhaust fan. In a similar study, conducted by the Canada Mortgage Housing Corporation, nearly 10 gallons of moisture per day were pulled into a series of test houses near Ottawa.

To fully control below-grade moisture entry, therefore, the foundation must be properly sealed against air leakage as well as moisture diffusion. Fortunately,

many of the techniques used to seal a basement against radon, such as caulked control joints in slabs and airtight sump covers, will also help control water vapor.

Block Vs. Poured Foundations

Block foundations are more prone to moisture intrusion than poured foundations. Air circulation within the cores apparently acts as a pump, distributing moisture over the entire wall area. Blocks are also very porous to air. You can literally blow through most concrete blocks, so it is especially important to seal them against air and moisture leakage.

Research results from the University of Minnesota suggest that, although advanced moisture control should be worthwhile for any foundation, the need is most critical with block construction.

Practical Underground Air and Vapor Barriers

Do we need to rethink (or begin to think) about air and vapor barriers below grade? Certainly, many homes do just fine without special barriers around the foundation. But given the continuing occurrence of moisture problems, particularly in small tightly built homes, better below-grade moisture control systems may make sense.

As with above-grade air and vapor retarders, proper design is

mostly common sense. The vapor retarder should be a durable low-permeable material that covers most of the foundation on either the inner or outer surface. Neither concrete nor block is a good vapor retarder. Some type of membrane or parging must be applied.

The air barrier, on the other hand, must be durable and should be continuous over the entire foundation. Concrete is a suitable air barrier as long as it isn't cracked and all seams and penetrations are sealed.

As with above-grade air and vapor barriers, a single material component, like sealed polyethylene sheeting or rigid foam, can serve as both an air and a vapor barrier. If poly is used on the foundation exterior, the plastic should be heavy-duty (minimum 6 mil) and preferably made for below-grade use. Recommended products include *Cross-Tuff* (Manufactured Plastics and Distribution, Denver, Colo.; 303/296-3516), *Dura-Tuff* (Yunker Industries, Lake Geneva, Wis.; 800/236-3328), and *Tu-Tuff* (StoCote Products, Richmond, Ill.; 800/435-2621). Another option is to build a stud wall on the interior and place the poly under the drywall as you would in a typical outside wall.

The Footings Question

The Minnesota research clearly suggests that homes will be drier

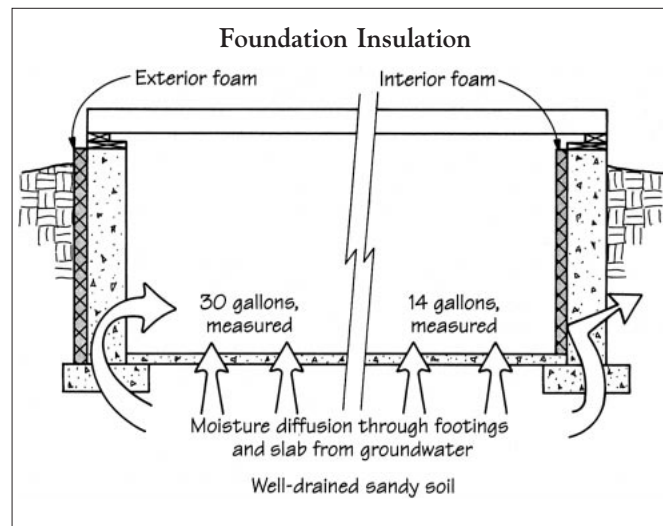


Figure 1. Researchers at the University of Minnesota discovered that exterior foam insulation (left) did little to reduce moisture penetration into block basements. Apparently, significant amounts of moisture rise up into the wall through the footings. Placing the insulation on the interior surface (right) was far more effective since it places the footings outside the waterproof layer.

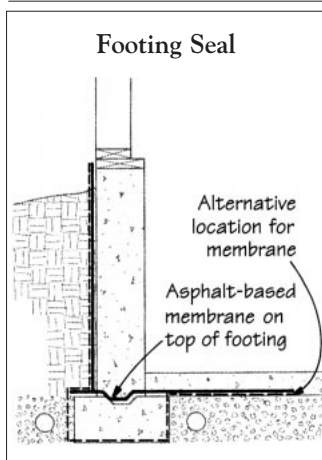


Figure 2. The best foundation air/vapor barrier is a continuous long-lasting membrane installed under the slab, over the footing, and up the exterior wall surface. Alternatively, the membrane can be installed around the outside of the footing.

if the soil beneath the footings is isolated from the foundation by installing a waterproof layer either on top of or underneath the footings.

Goldberg suggests placing a layer of high-density extruded polystyrene on top of the footing. Vertical rebar must be set in the footing to tie it to the foundation wall. Not only does it serve as a vapor retarder, says Goldberg, but it also forms a very watertight seal between the footing and foundation wall.

Dow Chemical (maker of Styro-foam) and UC Industries (maker of Foamular) both make high-compression (60 psi) foam board for this type of application. According to a Dow spokesperson, Swedish builders commonly use the high-density foam either on top of or underneath footings for thermal and moisture protection.

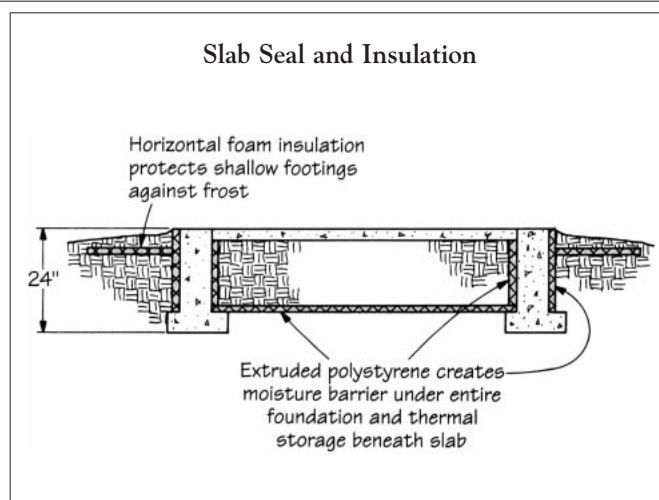


Figure 3. The extruded-polystyrene insulation inside the foundation wall and under the slab forms a continuous moisture barrier under this house, located in northern Minnesota. Although the footings of the frost-protected shallow foundation are above the frost line, they are protected from freezing by the horizontal insulation.

Despite engineering assurances and Swedish documentation, most builders will be reluctant to build a house on rigid foam. A more palatable alternative is a durable waterproofing membrane. W. R. Meadows, Inc. (Elgin, Ill.; 800/342-5976) sells a line of special reinforced asphaltic membranes for foundation moisture. The company recommends that the membrane be installed over the top of the footing and lapped up the exterior wall surface (see Figure 2), but it can also wrap around the bottom of the footing.

Can We Move to Slabs Now?

One interesting outgrowth of the University of Minnesota research is an innovative slab-on-grade house demonstration. Why would anyone try to demonstrate slab-on-grade construction in an area where basements are king?

Northern Minnesota is plagued with radon and moisture problems. The purpose of the project, which is cosponsored by the local Home Builders Association, is to demonstrate a low-cost practical solution to these soil-gas problems.

The house has a frost-protected shallow foundation with rigid foam serving as both an insulation and a moisture barrier on the inside foundation surface and under the slab (see Figure 3). The extra cost of the foam is offset by reduced excavation and concrete costs. ■

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