

# The Stay-Dry, No-Mold Finished Basement

Rigid-foam insulation is the key to a comfortable living space

BY ANDY ENGEL

**F**inished-basement projects usually begin with visions of a game room for the kids or of a secluded spot for Dad to watch Sunday football games with his cronies. Just about as frequently, these projects end badly with black spots of mold, crumbling drywall, and a smell reminiscent of a dungeon. What goes wrong? In most cases, water becomes trapped behind a wood wall or floor and nurtures a bloom of rot.

However, it probably isn't a flood that causes the problem. Yes, bulk water, the kind that flows across the floor, needs to be eliminated before an attempt is made to finish a basement. (Some common measures include exterior waterproofing, functioning gutters, and/or an internal drain system.) But even if your basement looks dry, you easily can have problems when you enclose the concrete with a framed wall. The real villain here is water vapor, the invisible moisture that keeps concrete damp and makes cold-water pipes drip with condensation in the summer. This water



Before

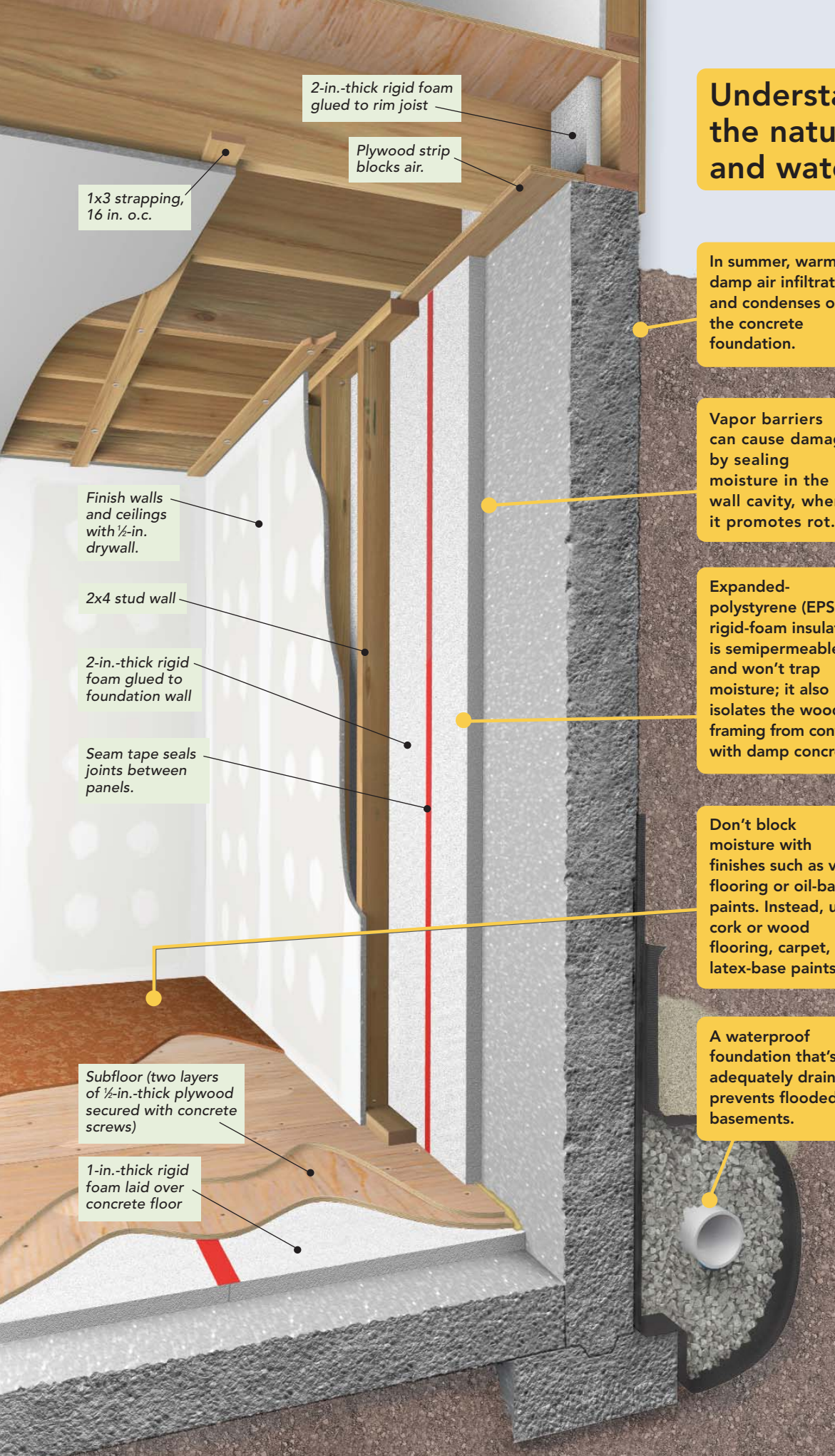


After

**A rec room that will last.** Built with conventional wall framing, a plywood subfloor, and rigid-foam insulation, this basement remodel doesn't trap moisture that can cause problems later. (By the way, the stair railing isn't finished.)



## Understanding the nature of basements and water



Moisture moves from wet to dry and from warm to cool. In the summer, damp soils and warm air outside make the moisture drive mostly inward. Humid outside air enters the basement and condenses on anything below its dew point: cold-water pipes, concrete walls, and floors. In particular, carpeted concrete floors can be a problem because they easily can become wet enough to support mold and dust mites.

Most basements dry out only in the winter when interior heat sucks the available moisture out of the basement and drives some moisture outward through the exposed portion of the foundation. There's also some drive-out through the foundation itself because the basement is warmer than the surrounding soil. The trouble is that the soil tends to be wet, and so has a limited capacity for drying.

There's a significant energy cost in moving this water through the foundation. The traditional response has been to frame walls next to the foundation, fill them with fiberglass, and seal them with a plastic vapor barrier. But a basement vapor barrier can trap moisture and promote rot. Basement floors built with a similar system fare no better.

In summer, warm, damp air infiltrates and condenses on the concrete foundation.

Vapor barriers can cause damage by sealing moisture in the wall cavity, where it promotes rot.

Expanded-polystyrene (EPS) rigid-foam insulation is semipermeable and won't trap moisture; it also isolates the wood framing from contact with damp concrete.

Don't block moisture with finishes such as vinyl flooring or oil-base paints. Instead, use cork or wood flooring, carpet, and latex-base paints.

A waterproof foundation that's adequately drained prevents flooded basements.



## PLYWOOD SUBFLOOR IS SUPPORTED AND

### Use rigid foam instead of wood for sleepers

To isolate the wood from moisture in the concrete, full sheets of EPS are laid on the concrete floor. Seam tape and expanding foam seal the seams against the infiltration of moist air.



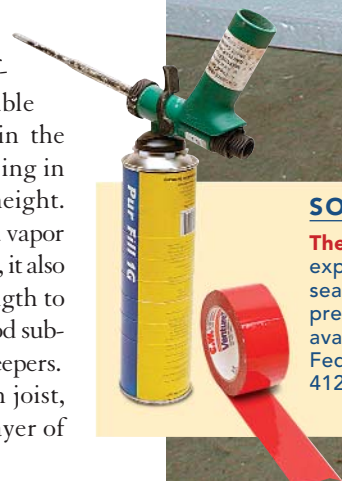
is always present. To reduce mold growth, water's contact with cellulose (paper, wood, etc.) has to be limited, and the water has to be allowed to escape.

Through research published by Building Science Corporation (sources below), I've found that rigid-foam insulation both thermally protects the basement and breaks the contact between framing and concrete. To avoid trapping moisture, I never install a vapor barrier. Instead, I use materials and finishes that allow moisture to diffuse. You can get rid of this diffused water by installing a dehumidifier or by extending the air-conditioning ductwork into the basement. I'm no expert in this area, so let an HVAC contractor figure out the specifics.

### Isolate and insulate the concrete

I use 2-in.-thick expanded-polystyrene foam (EPS, or styro-foam) on the walls and 1-in.-thick EPS below the plywood subfloor. This rigid-foam insulation is sufficient to make a noticeable temperature difference in the basement without crowding in the walls or the ceiling height. EPS is cheap, effective, and vapor permeable. Believe it or not, it also has the compressive strength to support a two-layer plywood subfloor without the use of sleepers.

After insulating the rim joist, I cover the floor with a layer of



### SOURCES OF SUPPLY AND INFORMATION

The foam gun, canisters of expanding-foam sealant, seam tape, and low-pressure dampers are available from The Energy Federation Inc. (800-379-4121; [www.efi.org](http://www.efi.org)).

Expanded-polystyrene (EPS) rigid foam is available at most lumberyards and home centers.

Much of the information in this article was obtained from the consulting firm **Building Science Corporation**; its Web site ([www.buildingscience.com](http://www.buildingscience.com)) has a wealth of information on building technology.



# INSULATED WITH RIGID FOAM



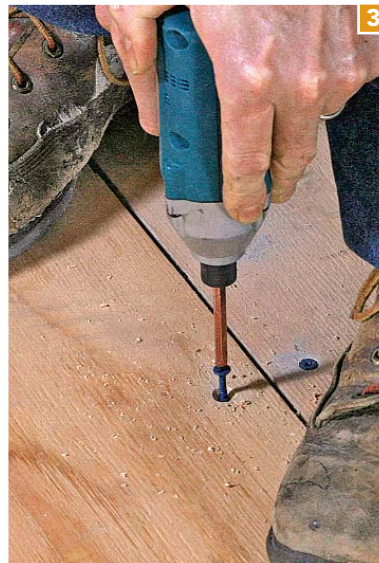
1

## Two layers of plywood go down with screws

After drilling and counter-sinking pilot holes (1, 2), the author attaches the first layer of ½-in.-thick plywood with 2½-in.-long concrete screws (3). To allow for expansion, ¼-in. gaps are left between each sheet and around the room's perimeter. Laid at right angles to the first layer, a second layer of plywood is fastened with 1½-in. drywall screws and spans the joints between sheets to make a stronger floor. (4).



2



3



4



1-in.-thick EPS. On top of this, I lay the subfloor, then build a regular stud wall against the foam on the walls.

Keeping wood from contacting concrete is critical. Fail here, and you're inviting water in through capillary action. You could use pressure-treated plywood and framing lumber, but I think that's false security and an unnecessary expense. If you've got enough moisture in the wall or the floor to cause rot, then you've also got the right conditions for mold growth, something that pressure-treated lumber won't prevent.

It's also possible to skip the stud wall and to screw furring strips to the concrete through the foam, but I don't like that approach for two reasons. First, I haven't seen many basement walls that are as plumb or as straight as I can build a stud wall. Unless you want to spend days playing with shims, the furring strips will mimic the defects of the foundation. Second, furring strips don't have the depth that allows easy installation of electrical boxes. □

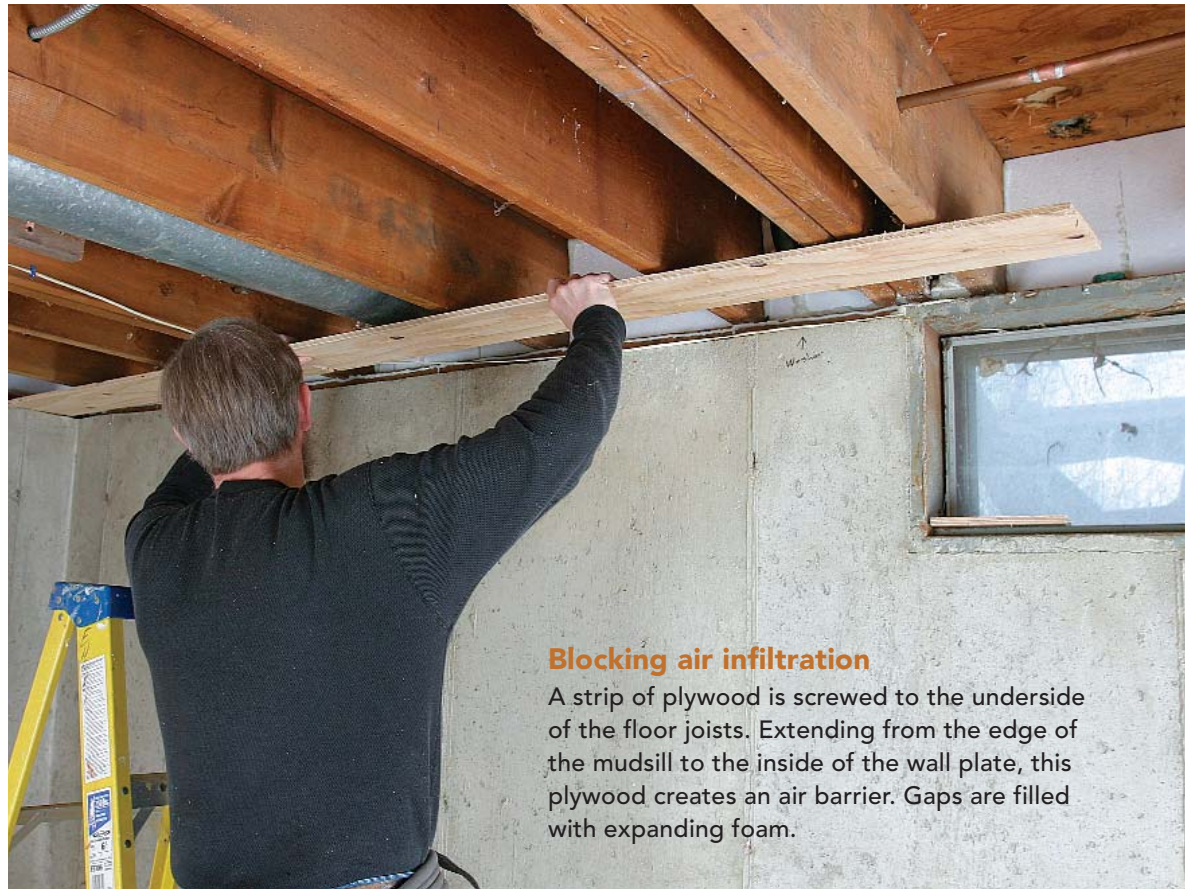
Andy Engel is a builder and writer who lives in Roxbury, Conn. Photos by Charles Bickford.

**continued**

## FRAMED WALLS ARE ISOLATED

### An insulated band joist stops thermal bridging

Insulating the joist bays with 2-in.-thick EPS will keep air leaks and cold spots to a minimum. Minimal amounts of expanding foam applied around the edges of each piece act as both a sealant and an adhesive.



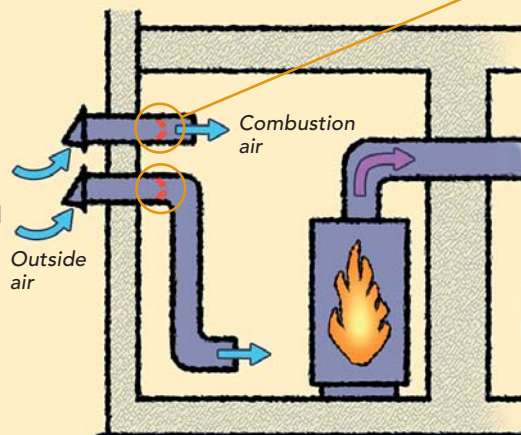
### Blocking air infiltration

A strip of plywood is screwed to the underside of the floor joists. Extending from the edge of the mudsill to the inside of the wall plate, this plywood creates an air barrier. Gaps are filled with expanding foam.

## Air quality and fire safety in the basement

One of the effects of finishing a basement is to cut off leaks that may have been supplying combustion air for the boiler, furnace, or water heater. Failure to replace this air supply could contribute to backdrafting and the possible buildup of lethal amounts of carbon monoxide.

Unless the appliance manufacturer provides specs that say otherwise, the rule of thumb is to provide makeup-air ducts leading to the outside that are twice the size of the combined flues. In this basement, the boiler and water heater share a



Fabric damper



## FROM THE FOUNDATION'S MOISTURE

### Make the foam on the walls as tight as possible

After the floor is done, the walls are insulated with EPS sheets trimmed for a friction fit and glued to the foundation with expanding foam (1, 2). Seams and gaps are filled with the foam and taped. Plywood scraps keep the sheets in place until the glue sets (3). Unlike furring strips, a stud wall goes in plumb and straight, and allows room to run any utilities normally (4).



6-in.-dia. flue. I provided two 6-in. supplies, one that ended at the ceiling level and one that ended near the floor in the mechanical room. To prevent these ducts from chimneying nice, warm air to the outside, they were fitted with fabric dampers (photo facing page; sources p. 80) made for this low-pressure application.

One other safety consideration is basement egress. Most building codes require habitable basements to have two exits in case of fire. This basement already had two doors, so that requirement wasn't an issue. Lacking the second door, I'd have had to provide a code-approved egress window (a 5.2-sq.-ft. opening within 44 in. of the floor, leading to a 36-in. by 36-in. well with ladder rungs leading to grade). Last, if your home isn't already so equipped, install hard-wired smoke and carbon-monoxide detectors in the basement.

## Reader Response

### Get the foundation drain in the right place

In your article “The No-Mold Finished Basement” (FHB #169, pp. 78-83), the drawing on p. 79 shows the bottom of the foundation drainpipe above the grade of the finished concrete floor. In soils with a high silt or clay content, that basement would be wet because the water level has to get as high as the bottom of the perforated drainpipe before it exits the crushed-stone well created in the soil surrounding the foundation.

We always put our drainpipe at the bottom of the footing to prevent seepage from the joints in the concrete. Also, after the exterior of the foundation has been waterproofed, we put filter fabric only on the top and on the side of the crushed stone because it will most likely be contaminated from backfill sand washing vertically down from above rather than from the hard-packed surface below.

—LONN M. LIVENGOOD  
via email