# Renovating Your Basement

## Research Report - 0308

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Building Science Corporation

Abstract:

*Heat loss through uninsulated basement walls can account for up to one-third of the heat loss from an average home. Installing insulation on basement walls is often inexpensive, easy to accomplish and frequently combined with "finishing the basement."*

# Renovating Your Basement

## for moisture control and to improve energy efficiency

Heat loss through uninsulated basement walls can account for up to one third of the heat loss from an average home. Installing insulation on basement walls is often inexpensive, easy to accomplish and frequently combined with "**finishing the basement**." Unfortunately, basement walls are often damp or are only dry on the surface because of evaporation of water into the basement air. Installing wood framing or fiberglass batts directly against basement walls subsequently leads to mold growth and decay of the wood due to fungal growth.

Insulating basement walls can be safely accomplished by assessing the moisture conditions of these walls and applying some basic "**building science**" to the design process. If walls are visibly wet at times or water occasionally drains from the walls onto the floor, an interior drain system should be installed before insulating and finishing the basement. This requires cutting the concrete floor to remove the outer 12 inches which permits the installation of a drainage system below the concrete slab as shown in **Figure 1**. If walls are periodically damp but never have water flowing down them, omitting the interior drainage system can be considered. In this situation compare the cost of installing the drainage system to the cost of replacing the finished floor if it gets wet.

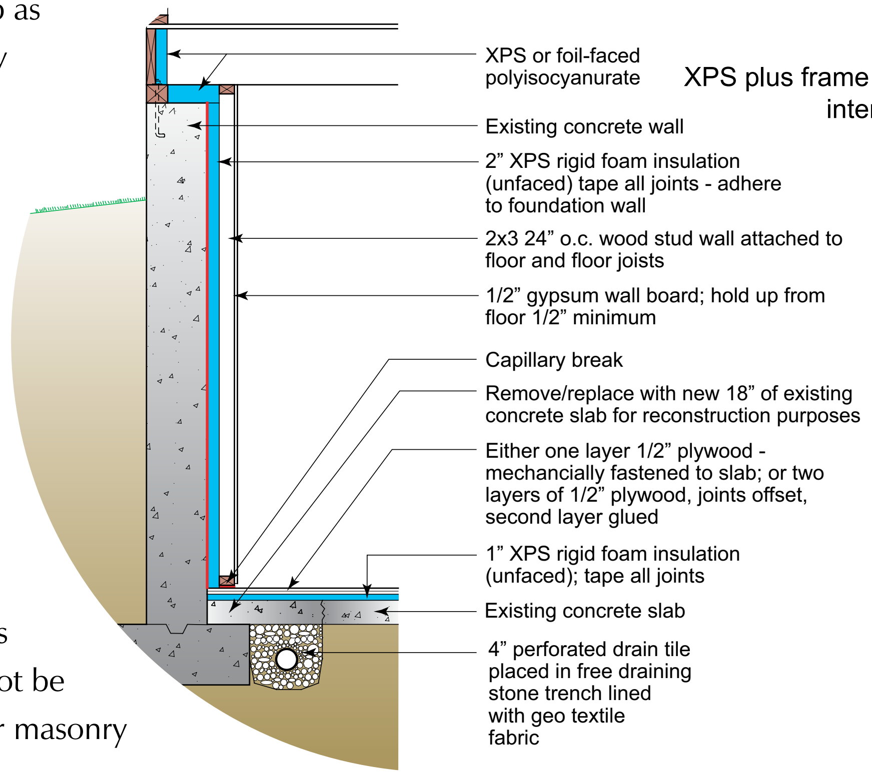


**Figure 1**
XPS plus frame wall and interior drain

The building science principles that apply to insulating basement walls and floors include the following:

1. Moisture sensitive materials such as wood, paper and fiberglass batts should not be installed in direct contact with concrete or masonry walls and floors.
2. Moisture tolerant materials that also do not absorb liquid water should be installed in contact with concrete and masonry surfaces. These materials will not deteriorate if they get wet and they also will not wet moisture sensitive materials that are in contact with them.
3. Moisture tolerant insulation installed in an airtight manner on basement walls and floors warms the first condensing surface above the dew point of the interior air. This reduces the probability of warm moist air condensing on cool surfaces.



Building Science Consortium
Architecture and Building Science
70 Main Street
Westford, MA 01886
P 978.589.5100
F 978.589.5103
www.buildingscience.com

The best insulation to install on basement walls in many homes is extruded polystyrene that comes in sheet or panels, 2-feet or 4-feet in width by 8- or 9-feet high. Extruded polystyrene (XPS) provides an R-value of 5 per inch, is moisture tolerant, and does not absorb liquid water, but does allow water vapor (water molecules in the gas state) to slowly pass through it. The semipermeable nature of XPS allows some drying of moisture through the panel but at a rate that is slow enough to prevent wetting of materials on the dry side of the assembly.

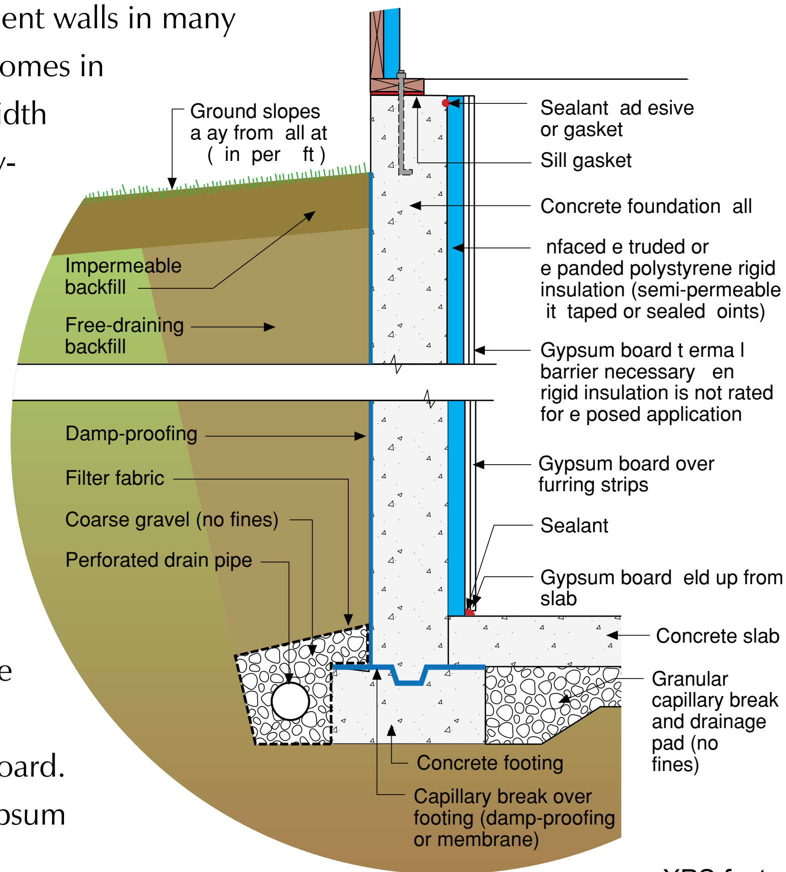


**Figure 2**
XPS fastened with furring strips and covered with gypsum sheathing

The main disadvantage of XPS is that it is flammable and therefore must be protected by a 15 minute thermal barrier such as 0.5 inch of gypsum board. In a below grade space such as a basement, a gypsum board without paper facings is recommended.

The extruded polystyrene sheets can be held in place by wood furring strips that are attached through the XPS with power driven nails or screws. Gypsum board or other thermal barriers are then attached to the furring strips. The joints between sheets of insulation should be sealed with tape or fiberglass mesh and mastic. Another option is to install one inch of XPS and then build a 2X3 or 2X4 frame wall just interior to the XPS. Unfaced fiberglass batts can be installed in the frame wall for additional insulation. These details are shown in **Figure 1**. Closed cell sill seal should be installed between the bottom plate of the wall and the concrete floor.

**Figure 2** shows 2 inches of XPS insulation held in place by furring strips. **Note** that no perimeter drainage system has been installed. The thickness of the XPS will depend upon the climate and whether additional insulation will be added in a frame wall. We recommend a minimum of 1 inch of XPS up to a maximum of approximately 2 inches.

**Photograph 1**
XPS against basement wall with framed wall

**Photograph 1** shows a basement wall with 1 inch of extruded polystyrene that is trapped in place by the additional wood frame wall. **Photograph 2** shows a basement wall with 2 inches of extruded polystyrene, joint sealed with tape and held in place by furring strips. The XPS was initially held in place by adhesive, but building codes require that the insulation be mechanically attached to the wall.

Since basement floors can have moisture problems similar to those described for basement walls, the moisture characteristics of a concrete basement slab must be assessed before installing a finished floor. Basement floors may appear to be dry but only because ground moisture passing through the slab is evaporating into the interior air space. If this is the case, installation of impermeable flooring may lead to the accumulation of water on the surface of the slab or in the flooring material.

Water may also be condensing on the surface of the concrete when the surface temperature of the slab is cooler than the dew point of the basement air. The deep ground temperature of the slab is cooler than the dew point of the basement air. The deep ground temperature under a basement slab is frequently near 55°F throughout the year. Poor interior humidity control or the introduction of exterior air during spring and summer may result in dew points above 55°F. When condensation occurs on unfinished concrete the moisture is quickly absorbed by the concrete and is never visible. Painting the concrete surface or installing thin tile may result in accumulation of a thin layer or water on the surface of the floor.

**Photograph 2**
XPS against basement wall with furring strips

Properly insulating a concrete slab can provide a warm dry surface on which carpet or other flooring can be installed. If a concrete slab is in good repair and does not have significant water problems (liquid water on the surface) sheets of extruded polystyrene can be installed directly on the slab. The joints between sheets should be sealed with tape or mesh imbedded in mastic. A plywood floor can then be "**floated**" over the XPS insulation in either of two ways. If sufficient room height is available wood sleepers (2X4 or other dimensional lumber) can be installed to which the flooring is mechanically fastened. This is illustrated in **Photograph 3**. If room height is minimal, tongue and groove plywood with the butt ends of the plywood joined can "**float**" above the XPS insulation. Wood biscuits are one method for jointing the butt ends so that one sheet cannot ride up above the next sheet.

If the concrete slab is in poor condition a new concrete slab can be placed over rigid extruded polystyrene insulation. Since the XPS is vapor retarder, no polyethylene vapor barrier is needed under the new concrete slab. If significant moisture is present on the old concrete slab, a drainage mat can be placed under the new concrete slab. The drainage mat provides a pathway for water to move laterally to the interior drainage system. Soil gases such as radon could potentially be evacuated from the space created by the drainage mat.

**Photograph 3**
XPS installed over basement slab; wood sleepers will support plywood flooring

## About this Report

This report was prepared for the US Department of Energy's Building America Program.

Direct all correspondence to: Joseph Lstiburek, Building Science Corporation, 70 Main Street, Westford, MA 01886

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