HOME ENERGY GUIDE

TECHNIQUES TACTICS & TIPS

BASEMENT INSULATION

Minnesota Department of Commerce Energy Information Center

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We expect much more from our homes than we did just a generation ago. Adding interior space onto a home is expensive, so many of us are expanding our lives into a previously underutilized area of our homes – the basement. Formerly called "the cellar," we expect it to be conditioned and comfortable like the rest of our house. We are inclined to insulate them just like the other areas of our house. But basement walls and floors are unique because they are located below grade and are typically subject to significant flows of moisture from both inside and outside the house. Building scientists are currently conducting research to better understand the conditions and techniques for safely installing interior foundation insulation. It is important to keep the bottom line in mind: To make the basement comfortable. There are several ways to improve basement comfort in a safe and healthy way–many not even involving insulating the basement.

Comfort is about more than just insulation. Because of the unique moisture load on basement walls and floors, some insulation methods may make walls and floors subject to mold growth (see sidebar, "The effects of mold") which could lead to health problems for the home's occupants. Thus, this guide will focus its attention on cost-effective options for improving basement comfort that in the past have been given less attention. In this guide, the terms foundation wall and basement wall will be used interchangeably.

The guide examines the many options to improving basement comfort that do not involve insulation. Exterior foundation wall insulation is an excellent choice for new construction and additions, but is also recommended for existing basements. Also, special foundation wall products are available that simultaneously provide structural support and high insulation value–suitable for new homes and additions. Finally, this guide discusses interior insulation–currently popular in both new and existing homes. Basement moisture is also discussed. Most new homes have drainage systems, but an older home without a drainage system may have more reason for concern about moisture.

First things first

Achieving a comfortable basement at the least cost is the objective of most homeowners. But before making changes to the basement walls, begin by making changes in other areas of the home that will in effect improve the condition of the basement. Following are some steps to take to improve the comfort of the basement–and the rest of the home.

Step 1. Control air leaks in the attic. If the basement is cold in the winter, the first question to ask is "Is there too much air leaking in?" In many homes it feels cooler because there is a lot of air leaking out of the attic, and every cubic foot of air that leaks out must be replaced (see the Home Energy Guide "Attic Bypasses").

A lot of this air comes in through basement walls, meaning the basement will be cold. The adage "if

The effects of mold on the home and its inhabitants

Molds are fungi, a family of plants that includes mushrooms. Molds grow throughout the natural and manmade environment. Tiny particles of mold are continuously present in indoor and outdoor air. In nature, molds help break down dead materials and can be found growing on soil, foods, plant matter and other items. Molds produce microscopic cells called "spores" which are very tiny and spread easily through the air. Live spores act like seeds, forming new mold growths (colonies) when they find the right conditions.

Mold can cause structural damage to the home, which may or may not be covered by homeowner insurance policies. Seepage from exterior sources into the basement is typically considered a maintenance issue and is often not covered by insurance policies. Water leaks from a damaged roof and furnishings damaged as a result of the leak may or may not be covered by insurance policies.

Mold can also affect the health of people who are exposed to it. People are mainly exposed to mold by breathing spores or other tiny fragments. People can also be exposed through skin contact with mold contaminants (for example, by touching moldy surfaces) and by swallowing it.

The type and severity of health effects that mold may produce are usually difficult to predict, but can include allergic or toxic reactions, asthma episodes, infections and respiratory damage. The risks can vary greatly from one location to another, over time, and from person to person.

The Minnesota Department of Health does not recommend testing for mold. Instead, assume there is a problem whenever mold is seen or smelled. Testing should never take the place of visual inspection and it should never use up resources that are needed to correct moisture problems and remove all visible growth.

Sometimes, mold growth is hidden and difficult to locate. In such cases, a combination of air (outdoor and indoor air samples) and bulk (material) samples may help determine the extent of contamination and where cleaning is needed. However, mold testing is rarely useful for trying to answer questions about health concerns.

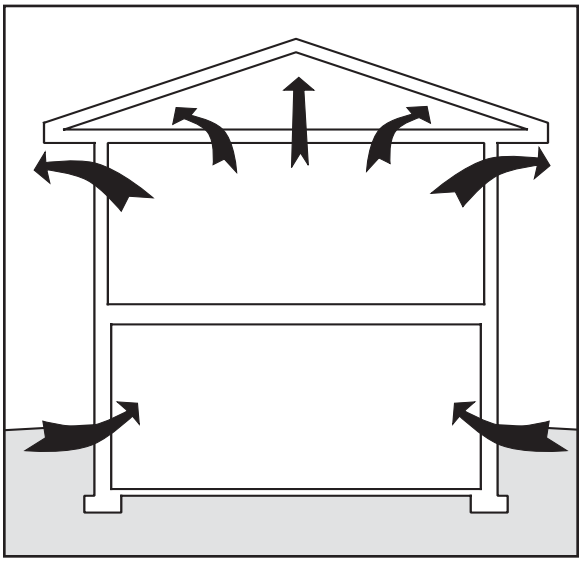


Figure 1
During the winter, warm air inside the house will cause the house to act like a big chimney, drawing air in at the lower parts of the house and exhausting the warm and moistened air wherever there is an opening in the wall or ceiling. This is called the "stack effect."

your feet are cold, put a hat on!" applies to homes as well–stop the warm air from leaking out of attic bypasses, and the cold air leaking into the basement is significantly reduced, thus increasing comfort. Taking care of attic bypasses has other benefits as well–in addition to saving lots of energy, it will help control ice dam problems.

It may be hard to imagine, but the air leaking in should not concern you as much as the air leaking out. That's because in cold climates such as Minnesota's, the air leaking out carries moisture with it. As the air cools, that moisture can condense out and deposit where it is not wanted. Air leaking out also is the principal cause of ice dams.

Problems with comfort in the house may be more noticeable during the heating season. During the winter, warm air inside a house will cause the house to act like a big chimney. Air is drawn in at the lower parts of the house, especially the basement, and exhausted wherever there is an opening in the wall or ceiling in the upper levels. This is called the "stack effect." (see Figure 1)

Step 2. Seal furnace ducts. Basements are also made uncomfortable by excessive furnace duct leakage. Leaky furnace return ducts are especially at fault. In the winter leaky furnace return ducts act to draw air out of the basement, which will increase the amount of cold air leaking in from the outside. Just as discussed above with attic bypasses, this means the basement will be colder. In the summer with a central air conditioner running, leaky return ducts will increase the amount of cool air drawn into the basement, instead of being delivered to the rest of the house as intended. As a result the basement air will be cold and clammy, while a second floor may be impossible to keep comfortable. Sealing furnace return ducts, with mastic tape or UL181-rated tape, will also improve the safety of other chimney-vented appliances in the basement by making it easier for those appliances to get the air they need to vent properly.

Step 3. Control basement moisture. As indicated earlier, basement walls and floors are subject to significant moisture flow– and too much humidity means discomfort. Fortunately, moisture can often be significantly reduced at its source. The first

place to look is outside, around the foundation (see Figure 2). Are rain gutters and downspouts cleaned out and positioned to keep water away from the foundation? Downspouts should lead water at least 10 feet away from the house. Also, make sure the ground slopes away from the foundation (even if a truckload of dirt has to be added around the perimeter of the house) and make sure that sidewalks, driveways or a neighbor's downspouts are not directing run-off toward the house.

If exterior control methods are ineffective, a contractor may need to be hired to install drain tile at the foundation footings. However, even when liquid water is under control, there will still be lots of water vapor inside the wall which makes installing interior insulation impractical. In that case, insulating the exterior is a better option rather than even considering interior insulation. The interior wall can be made attractive without having insulation inside (see sidebar "Decorative finishes for interior walls").

A dehumidifier may still be needed to keep basement humidity under control. For best performance, be sure to choose an ENERGY STAR labeled dehumidifier that can save, on average, $90 over its lifetime. Look for the ENERGY STAR label on products in stores or visit the web site www.energystar.gov to find listings of qualified units.

Step 4. Install high efficiency space heating and water heating appliances.

Just like attic bypasses, atmospherically vented appliances take air out of the basement (which, in the winter, is cold air coming through the basement walls) and send it up the chimney. Replacing the furnace and water heater with power vented appliances, or better yet sealed combustion appliances, will significantly reduce this excessive airflow. Not only will comfort be improved, but the fuel savings due to increased efficiency will help pay for the appliances. They are also safer, in that they are much less likely to backdraft harmful combustion products back into the house.

Step 5. Install efficient lighting in the basement. Gone are the days when fluorescent lighting was "cold." Today energy efficient fluorescent lighting in "warm" colors and dimmable. A Compact Fluorescent Light bulb (CFL) will cost more to purchase, but will use 75 percent less energy, last up to

Decorative finishes for interior walls

There are least two good choices to cover the unpleasant look of a concrete block or poured wall: decorative block or veneer plaster.

Decorative block. Decorative block has an ornamental facing on the side to be left exposed. There are a wide variety of rich textures, patterns and designs that offer interesting alternatives to a flat wall. Many attractive designs are available, talk with a contractor about options. For a list of contractors look under "Concrete Contractors" in the Yellow Pages, or contact the Minnesota Masonry Institute.

Veneer plaster. Veneer plaster is gypsum plaster specially formulated to provide specific workability, strength, hardness and abrasion resistance characteristics when applied in thin coats (1/16" to 3/32") over a solid base, such as concrete block. Veneer plaster is a strong and durable product that has excellent abrasion resistance resulting in minimum maintenance, even in high traffic areas. For a list of contractors look under "Plastering Contractors" in the Yellow Pages, or contact the Minnesota Lath and Plaster Bureau.

For an ICF (insulated concrete forms) wall, drywall will be required as part of the finished wall.

Electrical wiring in ICF walls and structural insulated wall systems (with the exception of permanent wood foundations) is typically located inside the wall and outlets are flush mounted.

For permanent wood foundation walls, decorative block and veneer plaster the electrical wiring and outlets should be surface mounted.

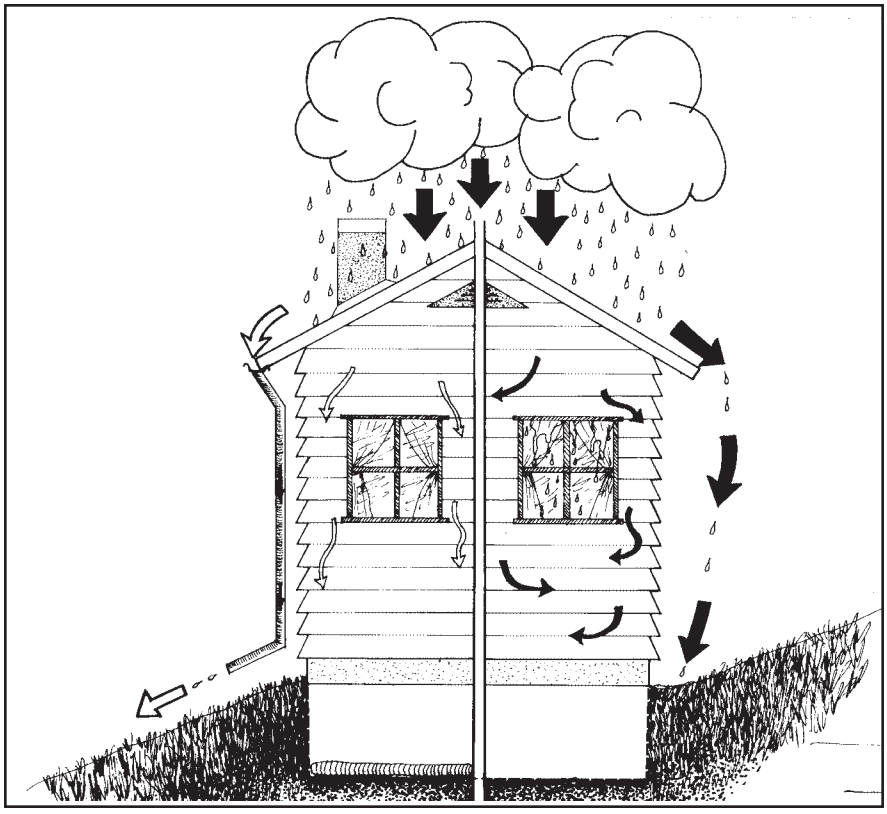


Figure 2
Gutters, a slope away from the house and drainage tile in the foundation keep the left side of this house dry. No gutters, a slope toward the house and no drainage tile expose the right side to moisture damage.

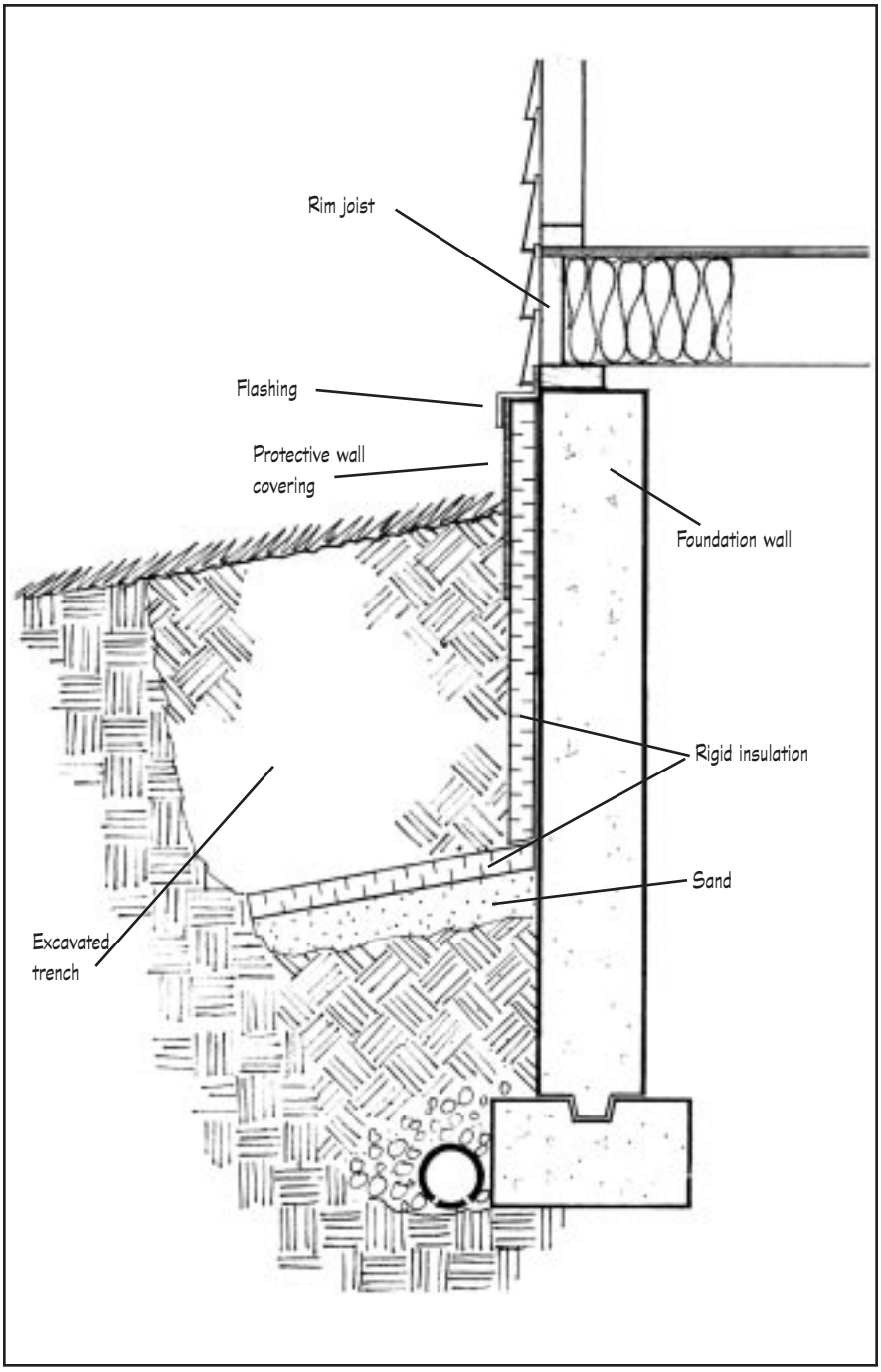


Figure 3
Basic parts of the foundation wall and the exterior insulation "apron" method.

10 times longer and produce more lumens (light) per watt (electricity used) than incandescent bulbs. Purchase an ENERGY STAR labeled CFL before Aug. 1, 2005, and you won't pay state sales tax.

To conserve space in basements, canister lighting that is recessed in the ceiling is a good option. If the light fixture uses spot or flood lights, be sure to know the difference before purchasing one. A spotlight directs the light more intensely in a smaller, tighter beam. A floodlight lights a broad area less brightly than a spotlight, and is recommended for general-purpose lighting. For more information, see the Home Energy Guide "Home Lighting."

Now that all of the "first things" have been completed, the basement may be completely comfortable, or you may wish to proceed with insulating the basement. Become familiar with the basic parts of a foundation wall (see Figure 3). The drawing shows a common construction technique referred to as platform framing, in which the floor joists sit atop a wood plate that in turn rests on the concrete foundation wall.

Exterior basement insulation

The preferred method, from a building science perspective, is to insulate the wall on the outside with rigid insulation suitable for below-grade installations–such as extruded polystyrene or rigid fiberglass.

The advantages are:

- Insulating the outside of the basement works well with dampproofing and foundation drainage. Insulation can act as a drainage layer, keeping surface and ground water away from the foundation.
- The basement walls are kept at room temperature protecting the structure, reducing the risk of interior condensation and increasing comfort.

The disadvantages are the disturbance of landscaping, the need to cover the insulation above grade, and leaving an unfinished interior basement wall.

Insulating the exterior will, in effect, tighten the basement walls and reduce the airflow. For more information, see the sidebar "Use caution if tightening the basement walls."

Insulating a basement from the outside is a good choice for newer homes and additions where the landscaping is not completed, or if the exterior foundation wall needs to be replaced. General directions for installing exterior insulation are described here, but always consult the insulation manufacturer's literature for specific installation techniques.

Insulating the exterior involves digging around the foundation. In all cases, the location and depth of utility services such as electrical lines, gas pipes, as well as telephone and cable TV hook-ups must be marked. In Minnesota there is one place to call, Gopher State One, to check the location of all utility lines on the property. Call 651-454-0002 in the Twin Cities metro area, or from Greater Minnesota call toll-free 1-800-252-1166.

The most practical way for the do-it-yourselfer to insulate the exterior is the "apron" method, as shown in Figure 3. This is a partial depth method, where insulation is placed against the wall to extend 12 inches below ground and a second piece is placed horizontally to extend about two feet out from the bottom of the vertical piece. Above ground it is best if the insulation extends high enough to cover the rim joists, but since it is often difficult to remove existing siding the insulation can be placed up to the bottom edge of the siding, then insulate the rim joist area from the inside. This method will effectively reduce most of the heat loss from the foundation.

To do this, add flashing to the under the exterior sheathing that covers the top of the exterior foundation wall. *This flashing is very important for directing water flow away from the foundation wall.* The top of the flashing must be placed behind the drainage plane of the wall, behind the sheathing. Then add a short section of exterior insulation from the rim joist down to 6" below grade. The insulation must be covered with a protective covering (see Figure 3).

Insulating down the entire wall to the footings is another method, but it is difficult and probably not cost-effective unless there is another reason to dig down, such as adding drain tile. This method requires a professional building contractor.

Step 1: Prepare the wall. Begin by digging a trench about 18 inches deep around the foundation. Clean the newly exposed wall area of dirt or other debris with a brush or scraper. If the black damp proofing is dry, cracked or missing, repair the affected area. Building supply stores carry bituminous coatings for this purpose that can be brushed on by the homeowner. Be sure to follow the manufacturer's instructions carefully and allow any new damp-proof coatings to dry completely before applying insulation.

Inspect all wall penetrations and surface mounted fixtures such as exterior taps, exhaust vents, electrical outlets, hose bibs and gas lines. These should be sealed to the foundation wall with a waterproof putty, grout or silicone sealant. If possible, extend fixtures out from the wall to accommodate the insulation. Hire a qualified contractor to move gas or electrical fixtures.

Step 2: Install flashing. Loosen the lower edge of the siding or stucco and building paper. Leave the siding pulled away about one-fourth inch from the wall so that a flashing (also called drip cap or J-channel) can be installed beneath it. The flashing allows the insulation to extend beyond the line of the siding or stucco and protects the insulation and foundation from rain. The flashing should be wide enough to cover the thickness of both the insulation and protective covering.

Slide the flashing into place under the existing siding or stucco and building paper before installing the wall insulation. There are many details necessary for a good installation. Refer to a good general construction or remodeling manual (check the public library) for details appropriate for the home.

Step 3: Install wall insulation. There are a variety of materials that can be used for exterior insulation. Common materials include: extruded expanded polystyrene, high density expanded polystyrene, foil-faced polyisocyanurate, and rigid fiberglass. If using expanded polystyrene ("beadboard") insulation, be sure to use a higher-density type, which will better be able to withstand the ground pressure. Extruded polystyrene can be used underground both vertically and horizontally as needed for the apron method. Rigid fiberglass and can only be used vertically against the wall, not for the horizontal apron piece. Whatever product you choose, plan to insulate to a level of R-5.

Use caution if tightening basement walls

Insulation applied to foundation walls, inside or outside, will change the air leakage characteristics of your home. The effect of changing the air leakage is not always predictable, so follow these steps:

- Purchase and install a carbon monoxide alarm on each level of the home, preferably one with a low-level display. Follow manufacturer instructions for installation; many advise against installing an alarm near a furnace or in the furnace room.
- Install a combustion air supply for all vented appliances including the furnace, water heater and fireplace. Follow State Building Code guidelines. See the Home Energy Guide "Combustion & Makeup Air" for more information.
- When replacing or installing any new combustion appliance choose only direct vent, power vent or sealed combustion appliances. This would apply to any furnace, boiler, water heater or hearth product regardless of fuel type.

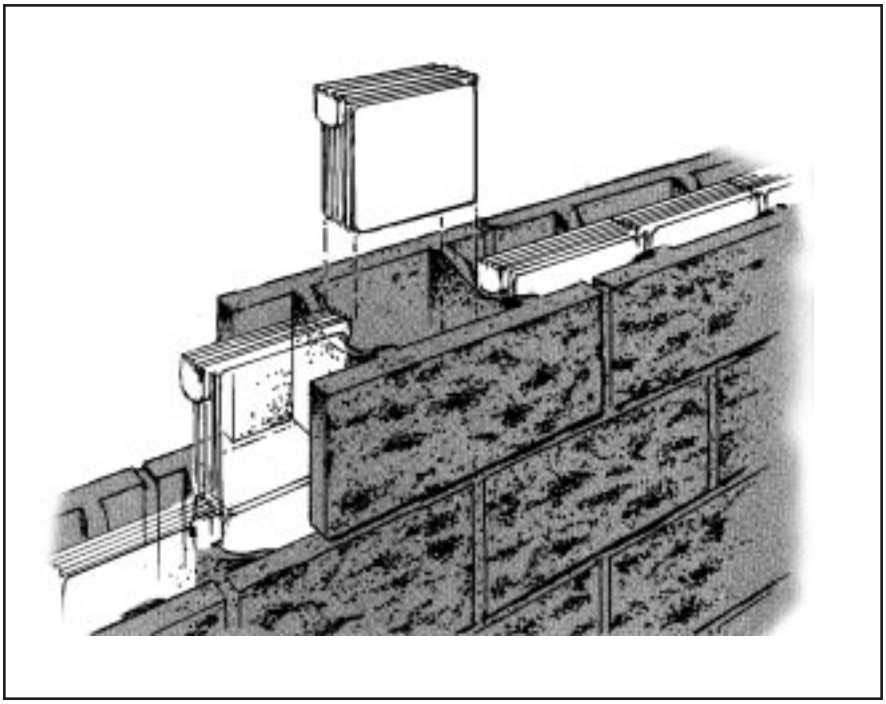


Figure 4
An integrally insulated block combines specially designed concrete masonry units with insulating blocks of rigid polystyrene or other insulation.

Increasing the insulation value beyond R-5 will insulate more, but is not as cost effective and it will be much more difficult to apply the necessary flashing.

The recommended method for applying and fastening insulation to basement walls depends on the type and thickness of the insulation and the soil conditions. Follow the manufacturer's requirements for attachment to the foundation wall. If the backfill is heavy clay, or other non-porous soil, attach a "ledge" of pressure treated lumber to the foundation wall at the bottom of the vertical insulation to help keep the insulation board in place.

Step 4: Install a protective wall covering. The insulation must be protected to avoid physical damage from lawn mowers or garden tools. In addition, all rigid insulation materials must be protected from direct exposure to sunlight. A number of materials can provide this protective covering: exterior grade plywood, stucco, cement, brick or treated siding.

Stucco or siding is often used because it is easy to color these materials to match the home. Stucco can be applied over a wire lath, which can be attached directly to the rigid insulation. Wear hand and eye protection when working with wire. (Some new stucco products do not require the use of a wire lath.) Check with the product manufacturer for exact wall preparation requirements.

Siding material such as exterior grade plywood can be applied over rigid insulation with a variety of fasteners. The protective coating should reach at least 6 inches below ground level.

Step 5: Backfill. When the siding, insulation and flashing are all in place the area can be backfilled with soil. Extra soil around the foundation may be needed to achieve a sufficient slope away from the house. A 1-inch drop for every 18 inches of travel is required to ensure proper run-off of rainwater. Be certain the contractor will take precautions while backfilling so as to not damage the insulation.

Structural insulated wall systems

For new homes and additions, or if replacing the foundation walls, there are several types of structural insulated wall systems to consider. Here, the insulation is actually part of the wall. There are three categories of structural insulated wall systems: permanent wood foundation, insulated concrete forms, and integral insulated block.

Permanent wood foundation (PWF) systems. Wood foundation systems were first developed in the 1960s, after the development of preservative-treated lumber and plywood allowed wood materials to be used in applications which previously would be subject to decay. Wood foundations also resist cracking, and are easy to insulate and finish for additional interior living areas.

Manufacturers that produce preservative-treated lumber, and related associations, have developed procedures and guidelines for constructing wood foundations. More than 300,000 U.S. homes have been constructed with wood foundation systems. Typically, walls are framed with 2x8 treated studs on 16" centers, or as specified by the designers. The Southern Pine Council publishes a useful Permanent Wood Foundation Design Manual, which has detailed construction drawings and photos.

Some people may be skeptical about the long-term durability or strength of PWF systems. However, accelerated aging tests, and use for over 40 years, attest to the durability of this system.

Permanent wood foundations for residences have been constructed in the U.S. for decades.

Integrally insulated blocks Several brands of integrally insulated block products are available that combine specially designed concrete masonry units with uniquely shaped insulating blocks of rigid polystyrene or other insulation. Be sure that the thermal performance of the integrally insulated block product has a certified evaluation from the National Concrete Masonry Association Concrete Masonry R-value Evaluation Program. The insulation blocks insulate the cores of the blocks, and to varying degrees, depending upon the manufacturer, reduces thermal bridging between the interior and exterior faces of block (see Figure 4).

A thermal bridge is a portion of a wall where heat is transferred at a higher rate due to a gap in insulation. Thermal bridges are necessary because most wall systems cannot be continuous insulation – there must be some structural connections to fasten the interior and exterior parts of the wall. Excessive thermal bridging will increase energy use, and because of this a thermal bridge area will be cooler in the winter which will increase the chances of moisture condensation.

Filling the cores of standard concrete blocks with insulating material (vermiculite, polystyrene beads, or urethane foam) is sometimes used to improve the thermal performance of a block wall. However, the thermal improvement is marginal; for example, a standard weight 12" block with empty cores has an R-value of 2.2, but when filled with vermiculite or polystyrene beads it increases to R-5, or with urethane foam the value is R-5.3.

Insulated Concrete Forms Insulated concrete forms (ICFs) are made of expanded polystyrene or extruded polystyrene (See Figure 5). ICFs are attractive to builders because the lightweight blocks or panels used to make them are easy to assemble, and they reduce construction time and transportation costs. The forms are left in place after casting, for both below-grade and above-grade walls.

ICFs are basically forms for poured concrete walls that stay in place as a permanent part of the wall assembly. The forms, made of foam insulation, are either pre-formed interlocking blocks or separate panels connected with plastic ties. The left-in-place forms not only provide a continuous insulation and sound barrier, but also a backing for drywall on the inside and stucco, lap siding, or brick on the outside. Although all ICFs are identical in principle, the various brands differ widely in the details of their shapes, cavities and component parts.

Gypsum wallboard or other sheathing is applied using nails, screws, or adhesive according to the ICF manufacturer's instructions. The R-value of an ICF system runs up to R-18 and above. Because the forms are designed to resist the load of wet concrete, they must be relatively thick to accommodate that load. The resulting two layers of insulation provide the high R-value.

Installing an ICF wall is not necessarily an easy or sure solution to moisture problems. Little research has been done on the long-term performance of ICF walls. It is important to remember that an ICF wall is just like any other when it comes to moisture. If moisture becomes trapped behind the interior finish, deterioration is likely to follow. Thus, as with all foundation wall systems, waterproofing the exterior is recommended. The extra protection now will prevent future moisture problems and result in a dry basement.

State Energy Code requirements

The Minnesota energy code does require foundation wall insulation for new homes and foundation wall additions. The energy code does not require insulation be added when finishing basement walls in an existing home.

Figure 5
An insulated concrete form (ICF) is made of expanded or extruded polystyrene. ICFs are basically forms for poured concrete walls that stay in place as a permanent part of the wall assembly.

How to test for dryness

A dry wall has the following characteristics:

1. It has an effective soil drainage system that does not permit any liquid water to enter the wall and floor slab regardless of basement interior and soil moisture conditions for the life of the building (excluding catastrophic conditions such as natural floods).

2. It has an internal drainage system that can remove liquid water from sources such as vapor condensation and plumbing failures regardless of whether such failures are caused from within the wall (such as pipe leaks) or inside the basement (flooding from a blocked sewer).

This definition excludes superficially dry walls, that is, walls that appear dry but in fact are not. Sometimes, such walls are wet to begin with and only appear to be dry on the surface. More often, superficially dry walls only appear dry because they continuously evaporate soil-source liquid water to the basement interior. Once this drying potential is removed or substantially retarded by the interior foundation insulation system, then the walls become wet very rapidly. With new construction there are reports of basement wall systems failing due to mold and rot just a few months after initial occupation.

The design and specification of a drainage system capable of meeting the above requirement is beyond the scope of this guide and thus cannot be addressed. However, it is very strongly recommended that the effectiveness of the drainage system be thoroughly field-tested before any interior insulation is applied. In Minnesota, such testing only can be done when the ground is not frozen and when the ambient relative humidity is not too low (mid-spring to early fall). In new construction, the test only should be performed after backfilling is complete and the house has been sealed but prior to the commencement of heating, that is, under unheated basement conditions. This should occur not less than 2-3 weeks after backfilling is complete. The test procedure in principle is very simple, consisting of the following steps:

1. Cover a northern quadrant of the interior bare basement wall (floor to sill plate) with clear 6-mil. polyethylene such that the polyethylene extends at least 10 ft along each wall away from the corner. Seal the polyethylene edges only to the wall, sill plate and floor with appropriate sealing tape or construction adhesive.

2. Soak the ground outside the wall around the chosen quadrant with water in a band no more than 3 - 4 ft wide so that the above-grade portion of the basement wall and rim joist area are washed with water. The precise volume of water required is not known, but a wetting period extending overnight for about 12 hours (so as to minimize evapotranspiration from the soil surface) at a reasonable flow rate should suffice.

3. After soaking has ceased, observe the polyethylene for a period of at least 2 weeks. If the wall surface becomes wet or any condensate that has collected on the interior surface of the polyethylene does not evaporate or drain away, then the wall is by definition wet and interior insulation of any kind should not be installed on the walls of that basement.

SOURCE: Rim Joist and Foundation Insulation Project Final Report, see References (page 10).

Interior insulation methods

Building scientists have reported concern that interior basement wall insulation could likely create of conditions favorable to formation of mold and mildew. This is especially a concern with walls that may not be perfectly dry (see sidebar, "Test for dryness"). Newly constructed basement walls have drainage–older basement walls generally do not. The fact is, as indicated at the start of this brochure, that basements are unique. What should be done will depend a lot on the conditions of the particular basement, and there is no cookbook answer that fits in most cases. Researchers are studying alternate solutions for basement walls and ways to determine which solution will work for a particular home.

The cause for concern about interior insulation is that it will be cold behind the insulation, which, after all, is why the wall is being insulated. If any moisture comes through the concrete wall from outside it can collect behind the insulation. Also, if room air is permitted to migrate behind the wall, it will be cooled and moisture will condense out which will give a media to support growth of mold and mildew. Mold spores are ubiquitous – and will multiply if given a favorable environment and undisturbed for a period of time. (see sidebar, "The effects of mold," page 2).

Interior basement insulation is covered last because, although popular, it may be prone to accumulating moisture with subsequent risk of mold and mildew. *Basement walls that are not absolutely dry should not be insulated on the interior.* Many excellent drainage systems are available to drain liquid water away from the foundation wall. However, even if a wall is well drained of liquid water, it may still contain a lot of water vapor. If the wall is insulated on the inside, this vapor could condense behind the insulation providing a culture for mold growth.

Insulating the interior will, in effect, tighten the basement walls and reduce the airflow. For more information, see the sidebar "Use caution if tightening the basement walls (page 5)."

Waterproof paint, by itself, is not an effective remedy against moisture problems. After resolving outside sources of the problem, then waterproof paint can be applied before insulating and

finishing the inside. (For additional information, see the Consumer Reports article cited at the end of this guide.)

A recommended interior insulation system

For dry interior basement walls, extruded polystyrene insulation with a wall side vapor retarder is a recommended insulation system. This is intended for an extruded foam plastic insulation (extruded polystyrene, or equivalent with a similar water vapor permeability) and is designed to keep the insulation protected from exterior moisture sources. The rigid insulation will serve as its own partial vapor retarder (allowing drying of any absorbed moisture to the inside).

There are several steps for this interior insulation approach. See the Appendix at the end of this guide for important details. For insulating the rim joist, see sidebar "How to Insulate the Rim Joist."

Step 1. The basement exterior wall must first be insulated. This is necessary to retard air convection within the wall and vapor transport in the concrete masonry block cores. Add a short section of at least R-10 *exterior insulation* from the rim joist down to 6" below grade. This must be flashed properly and covered with an appropriate protective covering.

Step 2. A continuous sealed wall side vapor retarder is recommended from the floor to the top of the wall (see Appendix details A, B and C) to accommodate the increased moisture potential on the foundation side of the wall. This will typically be installed first and the insulation will follow.

Step 3. In this design the insulation functions as the interior side partial vapor retarder. Therefore, this insulation board must be continuous and sealed as well. This may be as simple as taping the seams with a very durable tape, such as metal foil tape.

Step 4. A 2x3 framing must be installed in front of the insulation to support the insulation and provide a cavity for plumbing and electrical services. Regardless of whether the basement is finished or not, the furred-out gypsum is necessary for compliance with the fire code. The drywall should be hung on cavity wall framing.

Special note: It is important to point out that this interior insulated wall has reduced drying ability, should the foundation become saturated. If the insulation ever becomes wet due to a water leak or flooded basement, the wall may need to be disassembled and replaced after the foundation has dried.

Summary

To improve basement comfort:

- Take care of attic bypasses
- Seal the furnace return ducts and insulate supply ducts throughout the basement
- Install efficient basement lighting
- Consider installing exterior basement wall insulation
- For basement wall interiors, finish without insulating

If hiring a contractor:

- Measure your requirements and obtain cost estimates from suppliers or contractors. Ask to see manufacturer's literature on the insulation you purchase.
- Check on low-interest loans that may be available for home energy improvements. Call the Energy Information Center to find out about current funding sources.
- Obtain permits from your city officials before remodeling your house or its electrical or plumbing system.

If applying exterior basement wall insulation yourself:

- Excavate around the foundation and clean the wall of dirt and debris.
- Loosen siding or stucco to install flashing.
- Insulate wall by selected method.
- Apply a protective covering to the insulation and backfill excavation carefully.
- Nail down siding and flashing.

How to insulate the rim joist

To insulate and to prevent moisture buildup in the rim joist cavity, it is recommended not to stuff the rim with fiberglass batt insulation. Instead use an interior exposure rated foil-faced polyisocyanurate insulation. The interior exposure rating is very important for your safety. Install the polyisocyanurate with the label side showing so the building inspector can verify that it is interior exposure rated. Seal the foil-faced insulation in place by caulking the edges. Under some conditions contractors can install a spray applied foam insulation product when it is protected by a piece of fiberglass insulation.

Carpet is not recommended on basement floors

Homeowners are advised to NOT install carpet over an uninsulated or unheated cement slab because it may be susceptible to mold and mildew. The basement floor is generally cooler than the basement air temperature, and installing carpet would lower the temperature even more. If the basement humidity is high enough, the temperature of the floor under a carpet may, in certain areas of the floor, be below the dew point of the air. Under this condition, a small amount of liquid moisture will form under the carpet, making conditions right for mold growth in those areas. The moisture formation may be so slight that you could not see it from the top of the carpet.

If the basement floor is already insulated or has under floor heat, then carpeting may work.

However, for a basement floor that is not insulated or heated before it is laid, then our simple advice is to apply only a hard surface product; there are many fine alternative products in a variety of price ranges, including ceramic tile, vinyl, marble & stone, linoleum, or other hard surface. Small, machine-washable decorative area rugs may be used on top of the hard floor surface, but it is not advised to use full-size room rugs.

References and Resources:

"Rim Joist and Foundation Insulation Project Final Report," Louise F. Goldberg, University of Minnesota Center for Sustainable Building Research, College of Architecture and Landscape Architecture; and Patrick H. Huelman, Department of Wood and Paper Science. Entire report available at: http://www.buildingfoundation.umn.edu/MainPage.htm

"The Dry Basement," Consumer Reports, June 2002
Web Site: www.consumerreports.org

"EEBA Builder's Guide Cold Climate," Energy & Environmental Building Association. Phone 952-881-1098. Web site: www.eeba.org/

"Renovating Your Basement–Moisture Problems," Canada Mortgage and Housing Corporation. (go to http://www.cmhc-schl.gc.ca/ and search for "Renovating Your Basement")

Minnesota Department of Health
Web site: www.health.state.mn.us

Minnesota Masonry Institute Phone: 612-332-2214.

Minnesota Lath and Plaster Bureau Phone: 651-645-0208.
Web site: www.mnlath-plaster.com/main.htm

National Concrete Masonry Association Phone: 703-713-1900
Web site: http://www.ncma.org/

Southern Pine Council / Southern Forest Products Association
Phone: 504-443-4464. Web site: www.southernpine.com/

Insulating Concrete Forms Association Phone: 888-864-4232.
Web site: www.forms.org

Portland Cement Association This site has a nation-wide listing of producers & suppliers of ICF systems. Phone: 888-333-4840.
Web site: www.concretehomes.com

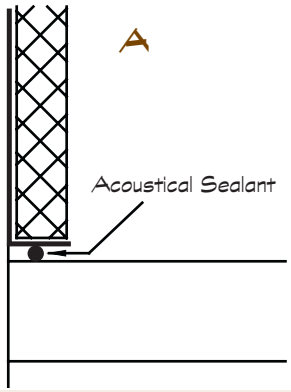
APPENDIX

Details for the recommended insulation system for dry interior basement walls

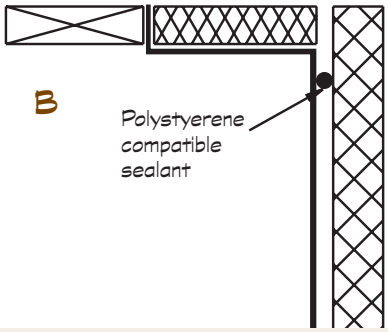
Special note: Interior foundation insulation of the kind recommended should not be installed on wet basement walls or on walls that can become continuously wet after the installation is complete. This includes superficially dry walls, that is:

Wet walls that appear to be dry on the interior surface prior to insulation installation.

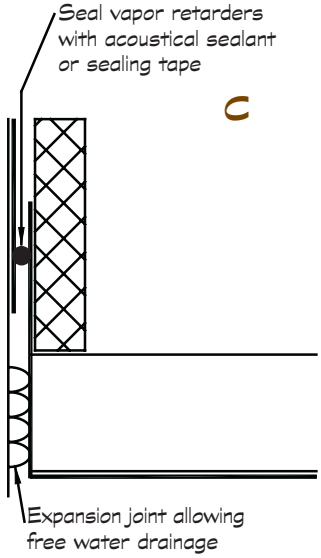
Walls that remain dry only because of their ability to continuously evaporate soil-source liquid water to the inside. This is a particular problem for new construction that does not have an effective liquid water management system. This effectiveness needs to be demonstrated by field-testing (see the sidebar "Test for dryness") before the recommended interior insulation systems are installed.



Detail A:
This detail is required to prevent interior air from reaching the cooler foundation wall, and, to prevent incidental condensation or bulk water moving across the basement slab.



Detail B:
This bead of foam compatible sealant is important to prevent air migration behind the extruded polystyrene insulation. For instance, humid house air could be drawn in and condense on the wall side vapor retarder. It would then be trapped or potentially emerge from the bottom over the wall side vapor retarder and onto the basement slab.



Detail C:
This detail can be used for new construction and serves two critical functions. Tucking the wall side vapor retarder behind the sub- slab vapor retarder allows for any condensation or minor bulk water to drain beneath the slab. Secondly, the sealant prevents sub-slab moisture from rising into the space between the wall side vapor retarder and the extruded polystyrene. It is advisable to seal the foam insulation to the under slab vapor retarder as well, to prevent house air from reaching the cooled wall side vapor retarder. This may be redundant, as the upper sealant (see detail B) should limit this flow. However, this additional seal can be accomplished by placing a bead of foam compatible sealant at approximately the same height as the bead shown and by pushing the insulation against the bead as the insulation is set into place.

Minnesota Department of Commerce

Suite 500
85 7th Place East
St.Paul, MN 55101-2198
www.commerce.state.mn.us

Energy Information Center

Twin Cities:
651-296-5175

TTY: 651-297-3067

Statewide toll free:
1-800-657-3710

E-mail:
energy.info@state.mn.us

This information will be made available, upon request, in alternative formats such as large print, Braille, cassette tape, CD-ROM.

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Minnesota Home Energy Guides

This guide is one in a series of publications designed to help Minnesotans save energy in their homes. Copies of the titles listed below are available by calling or contacting the Minnesota Department of Commerce.

CD-ROM contains all of the Home Energy Guides as well as several other publications of interest to homeowners, builders and contractors.

Appliances advises consumers on what to look for in energy efficient appliances and includes information on efficient operation and maintenance of refrigerators, freezers, washers, dryers, dishwashers, cooktops, ovens, and home office equipment.

Attic Bypasses explains how to find those "hidden air passageways" and fix them to prevent costly heat loss and damage to roofs, ceilings, walls, and insulation.

Basement Insulation discusses options to improving basement comfort, many not even involving insulation. It also provides details on exterior basement insulation, special foundation products and recommendations on interior insulation.

Caulking and Weatherstripping describes how to identify sources of air leaks, lists various types of caulk and weatherstripping, and provides illustrated how-to-apply instructions.

Combustion & Makeup Air describes the causes of dangerous combustion air problems and tells how to install an outside combustion makeup air supply. It also tells how to test your home for combustion air problems.

Energy Saving Landscapes describes how to use trees and shrubs for long-term energy savings, and lists trees appropriate for energy-savings.

Home Cooling tells you how to cool without air conditioning, and provides information on buying and operating energy efficient air conditioners.

Home Heating describes proper maintenance techniques and helps you become an educated shopper if you are buying a new heating system.

Home Insulation helps the homeowner evaluate the benefit of added insulation, providing information on buying and installing insulation.

Home Lighting looks at new technologies for residential lighting, identifying four basic strategies and providing examples for putting them into practice.

Home Moisture describes symptoms of moisture problems, lists common indoor and outdoor causes, and discusses preventive and corrective measures.

Indoor Ventilation describes the types of home mechanical ventilation systems that are available, the amount of ventilation air needed, and how best to operate and maintain the system.

Low Cost/No Cost addresses the often overlooked energy saving tips for all areas of your home.

New Homes discusses a wide range of options for increasing energy efficiency beyond the normal building code requirements. Subjects covered include insulation, ventilation, air-vapor controls, heating and cooling, windows, doors, and appliances.

Water Heaters helps you determine whether to buy a new water heater or improve the old one. It explains the efficiency of different types of water heaters and provides installation tips.

Windows and Doors helps you decide whether to replace or repair windows or doors and gives a good summary of energy efficient replacement options.

Wood Heat offers advice on purchasing and installing a wood stove, with special emphasis on safety.