

correcting basement moisture problems

FILED
MAY 10 1981
ST. PAUL, MINN.

Special Report 2—1981

AGRICULTURAL EXTENSION SERVICE
UNIVERSITY OF MINNESOTA



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Introduction

The purpose of this folder is to help Minnesota homeowners understand the types, causes, and remedies of basement moisture problems.¹ With this understanding, owners can make their homes more comfortable and energy efficient as well as save money by avoiding fraud and misrepresentation. This folder is divided into the following sections:

Situation/Overview

At least half of Minnesota homeowners, by reasonable estimate, have constant or periodic wet basements, a problem not advertised by owners at neighborhood parties nor through real estate agents at the time of sale.

The impact of excessive basement moisture is wide ranging: from the most serious, long-term impact of dry-rotted structural elements, to less severe, short-term impacts of musty odor, mildew, peeling paint, rust, efflorescence,² loose floor tile, warped paneling, and unusable space. Over half of owners with wet basements could correct this problem, without substantial expense, on a do-it-yourself basis. For owners with major problems, cost of correction may range from \$2,000-\$10,000.

Basement moisture problems may be aggravated by "weatherization"³ and, to a lesser degree, by increased use of air conditioning since wall and floor temperatures may be lowered below the dew point of the surrounding soil. Moisture may condense on these cooler basement surfaces (even though air conditioning removes some moisture) unless an adequate, insulated vapor barrier has been provided.

¹This publication is based on a survey of literature identified under the "references" section. The University of Minnesota does *not* currently have funds to test construction products, to carry out research on moisture-proofing basements, nor to provide campus-based consultation to homeowners with basement moisture problems. For further information or assistance, contact the organizations or obtain the references cited in this publication.

²Efflorescence is a generally harmless crystalline deposit, usually white in color, on the surface of masonry. For efflorescence to occur, moisture must be present in the masonry and this moisture must be moved to the surface by evaporation or other pressure. Efflorescence may occur due to wetting and drying of a single surface as well as moisture movement through a masonry wall.

³"Weatherization" includes weather-stripping, caulking, and similar actions that reduce interior-exterior air exchange as well as reducing interior temperature.

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Excessive basement moisture may also contribute to excessively high interior winter humidity, saturating sidewall insulation above the basement and promoting exterior paint failure.⁴

For individuals custom-building or buying a new house, the implications are clear: a dry, usable, and energy efficient basement is most likely in normal soil situations if drain tile is installed, and if a water-resistant membrane and rigid insulation are installed under the basement floor and on the exterior side of the basement wall before backfilling—at a cost of 70-90 percent less than correcting a problem after the home is built.

Cautions

Importance of Correct Diagnosis

Accurate determination of the types and causes of basement moisture problems is imperative BEFORE investing time, effort, or money in REMEDIAL ACTION. Failure to correctly diagnose the types and causes of the problem leaves the homeowner vulnerable to fraud and misrepresentation. There are two basic dimensions to this problem: 1) homeowners with moisture problems of a relatively minor type and cause may be persuaded by “sophisticated” salespeople to invest thousands of dollars in unnecessary remedies—homeowners in this situation usually are not aware they have been “ripped off”; and 2) homeowners with moisture problems of a relatively serious type and cause are convinced to purchase a relatively easy, moderately expensive “cure” that is discovered to be ineffective after the salesperson and contractor have disappeared.

Diagnostic Assistance

Homeowners who do not feel confident to diagnose the types and causes of basement moisture problems should not rely solely upon the recommendations of a salesperson or contractor. Rather, the homeowner should consider hiring an independent soils engineer experienced in basement water analysis.⁵

⁴In the winter, since frost prevents direct transfer of moisture from the soil to the exterior atmosphere, soil at 55°F, 100% relative humidity, exerts a pressure of .214 pounds per square inch (psi) into a basement heated at 75°F, .129 psi. Subsequently, the basement moisture exerts pressure of .129 psi throughout a 75°F house to the exterior at 35°F, .020 psi.

⁵For referral, contact your county or city building inspector or the Consulting Engineering Council of Minnesota, 5009 Excelsior Blvd., #126, Minneapolis, MN 55416 or phone 612-922-9696.

Remedial Action

Over half of basement moisture problems, those solely caused by condensation, can generally be corrected by owners with some do-it-yourself skill. Approximately a quarter of basement moisture problems, those caused by seepage, can generally be corrected by owners with somewhat more do-it-yourself skill. The balance of basement moisture problems can generally be corrected only by owners with fairly strong skills, time, and energy. All levels of do-it-yourself repairs must be based on accurate instructions.

Remedial Assistance

Homeowners who do not wish to do some or all the work themselves should carefully select a contractor. Among traits homeowners should look for are:

1. *reputation*—check with the local building inspector, housing authority, and Minnesota Better Business Bureau.⁶
2. *experience and references*—a contractor in business for a long time and with a permanent office in the community and a list of area clients is more likely to be around if problems develop.
3. *memberships*—memberships in professional and trade associations such as area home builders associations, the Minnesota Masonry Institute, etc., usually indicate the contractor's interest in ethical practices and standards.
4. *insured*—the contractor should furnish a current binder of insurance for worker's compensation, property liability, and general liability insurance.
5. *licensed*—in municipalities requiring licensing, evidence of licensing should be furnished.⁷
6. *bonded*—if the contractor claims to be bonded, evidence of bonding should be provided.⁸

⁶Building inspectors and housing authorities are listed in the telephone white pages under city or county government. The Better Business Bureau is located at 1745 University Avenue, St. Paul 55104 or phone 612-646-4631. The fact that the BBB may not have a record of “unresolved complaints” is not a valid indicator of a firm's integrity. Recently, a multi-state basement water-proofing contractor allegedly continued to maintain a clear BBB record by sending employees to initiate, but not complete, remedial service.

⁷**NOTE**—Local licensing alone is not a completely valid indicator of satisfactory work.

⁸The major features of the three types of bonds are: a performance bond—guarantees satisfactory completion of the contract; a payment bond—protects the homeowner from subcontractor and supplier liens; and a contract bond—combines both features of performance and payment bonds.

7. *reasonable contract terms*—including: detailed specification of work and materials to be provided; amount, method and schedule of payments; contractor maintenance of bonding and insurance; clean-up and debris removal responsibilities; and any oral promises or guarantees. If in doubt, ask your attorney to review the contract before signing.
8. *warranties*—determine what is excluded, how long the warranty is valid, and whether it is transferable to a subsequent buyer of your home.⁹
9. *bids*—a written bid is important; however, it should not be the sole or even major reason a contractor is selected. Low as well as high bids should be viewed with caution since either may be undesirable.¹⁰
10. *knowledgeable*—since basement moisture proofing is a specialized field involving aspects of civil engineering, hydromechanics, and soil science, it is desirable for the contractor to have knowledge in these fields through formal education or to have access to this knowledge through consulting engineers.

There are many excellent basement and basement moisture-proofing contractors. Unfortunately, there are other individuals only interested in the homeowner's pocket book. It is the owner's responsibility to tell them apart.

Types of Basement Moisture Problems: Causes/Diagnoses/Remedies

As described in this section, basement moisture problems are of three types: condensation, seepage, and leakage. Condensation is largely the result of internal moisture production, occasionally intensified by vapor transmission from the soil through the basement floor and walls. Seepage is largely the result of surface run-off following rain or snow melt and may be intensified by liquid and vapor transmission from the soil by capillary rise. Leakage is the result of the foundation floor

being lower than the normal, seasonal, or periodical subsurface or ground water table.

The depth of the water table (normal and seasonal) as well as the type of soil between the basement and water table are critical variables. Moisture, in a liquid and vapor form, can rise as much as 12 feet above the water table through capillary rise in some silt soils. Capillarity does not occur in coarse soils such as gravel and occurs only moderately in sandy soils (2½-7 feet).

Water table depth and sub-basement soil conditions cannot be determined by surface examination alone. These variables may be approximated by review of geological and hydrological information available through local Soil Conservation Service offices or municipal sewer divisions.¹¹ These variables may be accurately determined only by a soil boring at the home site.

CAUTION:

Be wary of any claims by a salesperson that your basement moisture problem is caused by a high water table or capillary action based solely on his or her surface observations.

Condensation

Condensation is the most common basement moisture problem and is the most easily corrected.

1. *CAUSES*—When warm air, which is capable of holding a greater amount of moisture, comes in contact with colder surfaces such as basement walls, floors, and cold water pipes, moisture is deposited on these surfaces in the form of condensation.
2. *DIAGNOSES*—Tightly tape all sides of a small mirror or a shiny piece of metal or aluminum foil to the dampest basement surface. Twenty-four to forty-eight hours later, check the mirror, metal or foil:
 - If moisture is found on the room side, condensation is at least part of the problem. (**NOTE** —condensation may be occurring at the same time as seepage or leakage.)

⁹**NOTE**—It may be difficult to collect under a warranty if items are disputed (binding arbitration can remedy this problem) or if the contractor is out of business.

¹⁰A low bid may indicate lower quality materials, less skilled labor, a weaker warranty, or a less complete scope of work. Unethical or inexperienced contractors frequently use "low-ball" bids to get partial payments with no intent of completing a satisfactory job. By contrast, a high bid may indicate that a contractor places a premium on the job since he or she is committed to more lucrative jobs or, in the case of unethical contractors, is selling unnecessary material, labor, or warranty protection.

¹¹Local Soil Conservation Service (SCS) offices are listed in the telephone white pages (under U.S. Government Offices; Agriculture, Department of—). SCS soil and water table information is available for areas outside older built-up areas, to a depth of 6 feet, and for dominant characteristics in 2-acre mapping units. Important variations may occur within these mapping units, e.g., "perched lens" water tables, and below 6 feet. City engineers in municipal sewer offices have soil-boring records on a block basis for most built-up areas served by sewers. Variations are possible in areas between sewer site borings.

- If moisture is found on the wall side, seepage is the basic problem.
- If no moisture is found on either side, the problem is likely of seasonal or periodic cause. Re-test when moisture reappears.

3. REMEDIES

- Reduce or eliminate moisture producing activities throughout the house, especially in the basement, such as on-line clothes drying, showering without using a vent fan, use of an unvented clothes dryer, and storage of "green" firewood.
- Keep basement windows closed in the summer when it is warmer outside than in the basement.
- Insulate the cold water pipes.
- For small problem areas such as closets, use silca-gel, calcium chloride, or other chemical moisture absorbents.¹²
- If the aforementioned remedies are inadequate, install a dehumidifier.¹³
- For year-round condensation control as well as reduced heating and cooling costs, fur-out, insulate, and install a vapor barrier over basement walls.

CAUTIONS:

Seepage or leakage problems, if present, must be corrected before insulating (see pages 6-8). If seepage or leakage occur at intervals of five years or less, there is a risk of damaging the insulation and structure if the moisture problem is not corrected.

Although little information is available concerning the potential risk of frost-heaving damage when basement walls are insulated, some authorities recommend precaution and suggest the following protection (see figure 1): 1) excavate along the entire perimeter of the foundation to a depth of at least 8 inches below the finished soil grade or 16 inches below the siding, whichever is greater, to 4 feet away from the foundation; 2) install 2 inches of rigid polyurethane or polystyrene¹⁴ from the siding to the bottom

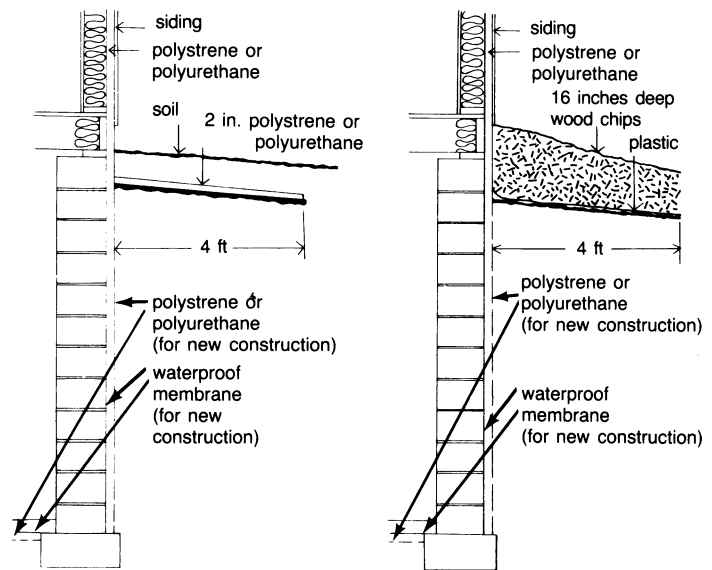


Figure 1: Basement wall frost-heaving protection options

of the excavation (**NOTE**—the rigid insulation should be capped with flashing at the top edge to prevent moisture penetration and, according to manufacturer's instructions, exposed areas should be protected from ultraviolet deterioration); and 3) install horizontally from the foundation to 4 feet out, with a slight downward slope away from the foundation, either 2 inches of rigid polystyrene or polyurethane covered with 8 or more inches of soil, or 4 or 6 mil polyethylene covered by 16 or more inches of wood chips.

Owners of homes located in plastic clay or silt with poor drainage or high water tables should be concerned with the risk of frost-heaving. If owners suspect these soil conditions, they may wish to verify their situation with the local Soil Conservation Service Office (see footnote 11). If these soil conditions are verified, the owner should seriously consider retaining the services of a competent soils engineer before insulating the foundation.

NOTE—Both temperature-related moisture pressure and capillary attraction in a masonry wall below grade is generally greatest from the exterior to the interior side of the wall. For this reason, an impermeable vapor barrier¹⁵ is recommended on the exterior or earth side of the wall. Owners of existing homes, who do not wish to excavate the

¹²Calcium chloride is available from a retail chemical supplier—see telephone yellow pages. Calcium chloride turns to a liquid when moisture is absorbed and must be disposed and replenished. **CAUTION**—Calcium chloride is highly corrosive and toxic.

¹³To obtain independent performance testing results of dehumidifiers, see the August, 1974 issue of *Consumer Reports*, available through your local public library.

¹⁴According to a report in *New Shelter* (October, 1980 pp. 66-74), extruded polystyrene is the product of choice. By contrast, expanded polystyrene ("bead board") is more subject to breakage and less resistant to soil chemicals. Polyurethane is the most expensive and is subject to moisture absorption.

¹⁵Vapor barriers or membranes are described in the last section.

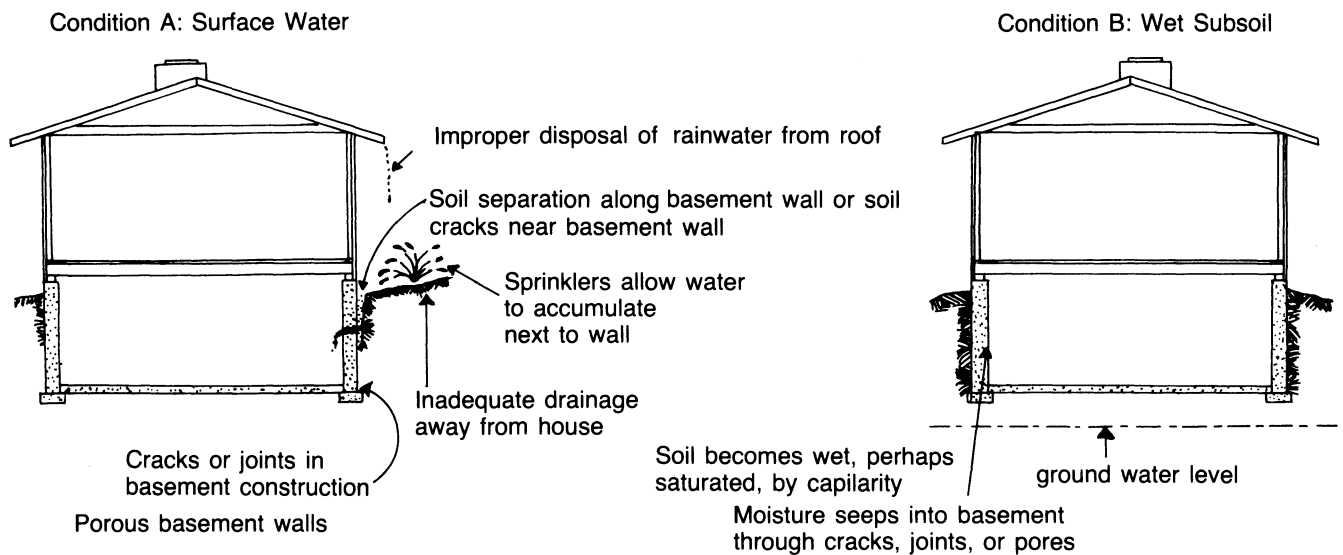


Figure 2: Causes of seepage, surface run-off and soil saturation

perimeter of the foundation, may install an impermeable vapor barrier on both sides¹⁶ of the furring strips and insulation.

- Moisture-resistant insulation, such as fiberglass, mineral wool, polystyrene, or polyurethane, is preferred to cellulose. If polystyrene or polyurethane is used, at least ½-inch sheetrock must be installed for fire protection. A water resistant sheetrock may be used on the lower portion of the wall as extra protection from moisture damage. Approximately ½-inch should be left between the sheet rock and the floor for further protection from moisture.
- If substantial basement remodeling is planned, install a rigid polystyrene or polyurethane insulation covered by a water-resistant membrane (described on page 7 and footnote 14) under the new floor. The new floor may be either a concrete slab or a wood subfloor laid over wood runners (screeds). This water-resistant membrane may continue up the foundation wall for more complete moisture protection.

¹⁶Authorities appear to agree that a vapor barrier must be installed on the warm or room side of the wall. However, at this time, there does not appear to be consensus concerning the dual side application of a vapor barrier in basements. The dual application recommended in this folder is made in light of substantial exterior to interior temperature-induced moisture pressure affecting Minnesota basements. This recommendation is an alternative to an exterior foundation wall/soil vapor barrier.

Seepage

Seepage is a fairly common basement moisture problem and may be moderately easy and inexpensive to correct.

1. **CAUSES**—Soil becomes wet and perhaps saturated due to run-off of roof rainwater (absence of gutters or inadequate downspout leaders), soil settlement along basement wall, lack of a positive grade away from the foundation, window well collection of rainwater, or excessive watering of lawn or shrubs next to the foundation wall. The seepage problem may be compounded by porous masonry walls, deteriorated joints, or cracks.
2. **DIAGNOSES**—Relatively small or moderate amounts of water will enter the basement. Interior standing water may be observed, perhaps localized around cracks or joints. Exterior standing water may be observed along the foundation wall following rain or snow melt. Localized areas of wetness may be observed on the floor or wall indicating capillary transfer.
3. **REMEDIES**
 - Install or repair gutters and downspouts.
 - If necessary, install downspout leaders, splash blocks, or both to discharge roof rainwater at least 36 inches from the foundation.

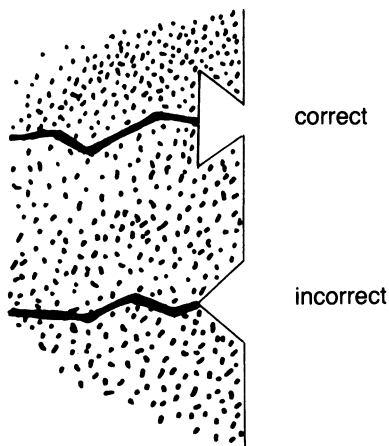


Figure 3: Crack repair preparation

- If needed, install clear (plastic or other) window well covers. Look below window wells for seepage stains.
- Check adjacent driveways, walks, patios, etc., to be sure there is a positive drainage away from the house.¹⁷
- If seepage is occurring under little or no pressure, test two coats of a waterproofing paint or compound on a basement wall problem area. If the test is successful after several weeks of trial, cover the entire problem area.¹⁸
- If seepage is occurring through holes or cracks larger than 1/8 inch, these holes must be cleaned out and patched.

For small cracks or holes with minor seepage, simply wire brush the blemish and fill completely (do not leave air pockets) with a mix of mortar cement or, better yet, hydraulic cement (faster setting, expands when wet).

For larger cracks or holes with considerable seepage, a dove-tail groove (see figure 3) must be chiseled out before patching as described above.

¹⁷The finished grade should fall at least 6 inches from the foundation at a point 10 feet away from the home. If there is a substantial slope towards the home, an interceptor ditch may be built at least 4 feet from the home toward the slope; this ditch should be at least as deep as the foundation footings, contain drain tile and sump pump, and be backfilled with coarse gravel.

¹⁸Since waterproofing paint or compound costs range from \$10-\$45 per gallon, you should see April, 1981 *New Shelter* or July, 1974 *Consumer Reports* magazines available through your library, for testing results of waterproofing paints and compounds performance. **NOTE**—Cracks and holes must be patched before painting or coating, (see item above). If cracks occur after application, leaks may reoccur. Best results require a two coat application over surfaces completely free of old paint, dirt, oil, grease, soap, and efflorescence.

When seepage is entering under pressure from the outside, a "weep pipe" should be installed at the floor-wall junction where pressure is greatest (see figure 4). After chiseling a dovetail groove, patching should start at the top and finish at the bottom of the crack. If water continues to be discharged through the "weep pipe," leave the pipe in and divert the discharge to a sump or drain via a hose. If you desire to remove the "weep pipe," replace the pipe with a cone-shaped plug of putty-like consistency, hydraulic cement, or mortar mix. If this plug fails to prevent seepage, reinstall the "weep pipe" and refer to the following "leakage" section.



Figure 4: Weep-pipe installation

- If seepage is occurring at the wall-floor junction, the following alternatives exist:

If the seepage is light, a double thickness of waterproofing compound may be used to seal the joint.

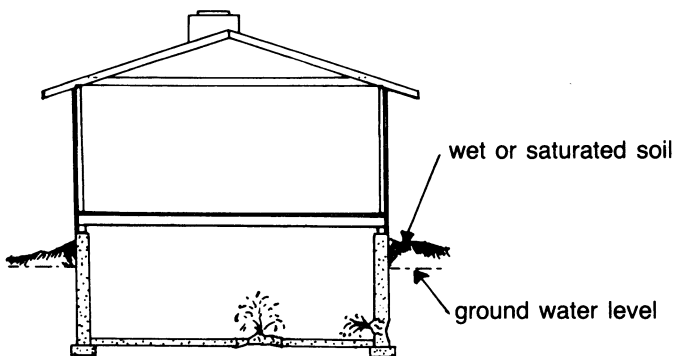
If the seepage is moderate, a 2-inch-wide, 1-inch-thick dovetail groove must be chiseled out, brushed out, and cleaned before a mix of hydraulic or mortar cement is used to build a cove-shaped patch.

If the seepage is heavy or under pressure, "weep pipes" should be installed to discharge seepage through hoses or concrete formed troughs built along the wall and carry it to a sump or drain. If this arrangement is unsatisfactory, see the following "leakage" section.

Leakage

Leakage is the least common basement moisture problem and the most difficult and costly to correct.

1. **CAUSES**—Extremely high ground water level which may be aggravated by heavy, dense clay or silt soils that form an impervious layer preventing moisture drainage away from the foundation. Leakage may occur in any soil type, especially near marshes or in hilly areas where ground water has been intercepted.
2. **DIAGNOSES**—Large amounts of water will enter the basement, generally under some degree of pressure, through cracks in the wall, floor, or wall-floor joint. In severe situations, the concrete walls or floor may buckle and rupture (see figure 5) or, in extremely severe and fortunately rare situations, the entire floor or structure may “float.” (see figure 6) Owners who suspect a high ground-water level or impervious soil problem should contact their local Soil Conservation Service Office for diagnostic assistance and referral (see footnote 11). Frequently, neighbors with similar basements will experience similar moisture problems.



Water enters under pressure through any openings

Hydrostatic pressure or “flotation force” can cause the concrete to buckle and rupture or can “float” structure

Figure 5: Wall or floor rupture

3. **REMEDIES**—Homeowners with leakage problems need to realize that corrective action is not simple and is generally expensive, messy, and time consuming. Homeowners who fail to face up to these facts are vulnerable to fraudulent claims, ineffective remedies, and wasted investments.

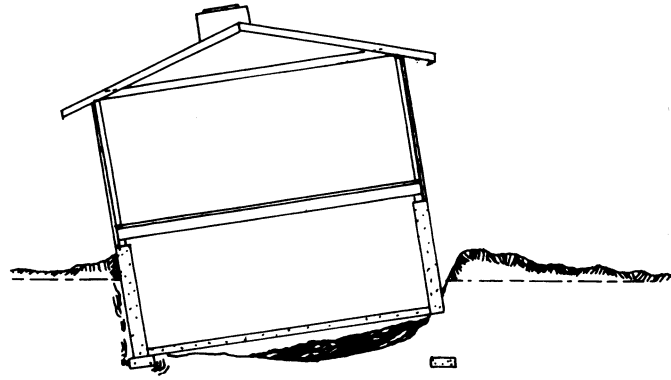


Figure 6: Floating

- In moderately severe situations, caused by a high water table, it may be possible to relieve water pressure with a “weep pipe” baseboard sump pump(s) system.¹⁹
- In severe situations, a combination of drain tile installed under the floor at the perimeter of the interior foundation wall with “weep pipes” (floor must be broken up) and a sump pump may remedy the problem.²⁰
- In extremely severe situations, it will be necessary to excavate the exterior of the foundation and subsequently to seal the exterior foundation wall with a continuous waterproof membrane (see figure 7) as well as to install exterior drain tile to a sump and sump pump; a homeowner facing this unpleasant task should consider insulating the exterior of the foundation wall before back-filling (see figure 1). If this action does not relieve floor moisture conditions, the floor may need to be repoured over a continuous waterproof membrane as noted in footnote 19.

CAUTION:

Be wary of exterior clay injection or exterior pressure injected waterproofing techniques as an easy answer. These techniques have proven to be of little or no value, according to a Franklin Research Institute

¹⁹If the sump is surrounded by a layer of clean gravel—the more the better—holes may be drilled into the upper portion of the sump to relieve under-floor pressure. If substantial floor replacement or a new concrete floor are undertaken, see next section for membrane and insulation recommendations. In severe situations involving the walls, the membrane may be continued with careful attention to sealing up problem walls. This may help to relieve wall moisture problems.

²⁰For additional protection from wall or wall-floor moisture, install a perimeter gutter sloped to the sump when the floor is repoured.

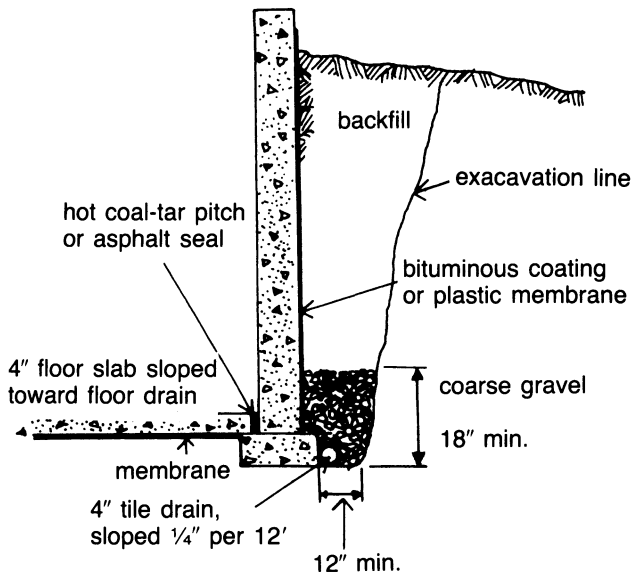


Figure 7: Continuous waterproof membrane

study. The study revealed that pressure injection of Bentonite, an accepted waterproofing substance, through 1-inch holes, 12 inches apart, did not uniformly seal foundation walls. Homeowners considering exterior injected techniques should receive evidence that the technique has been evaluated by an independent testing laboratory according to American Society of Testing Material (ASTM) standards and accepted by the Federal Housing Administration (FHA) for loan purposes.

Water Resistant Construction For New Homes

Prevention as opposed to correction of basement moisture problems is less costly, easier, and more effective when building or rebuilding a foundation. The specific types of water-resistant techniques and materials that should be used will depend upon site, soil, and water-table conditions,²¹ as well as the degree of "insurance" the owner or builder desires. The following information summarizes water-resistant techniques and materials:

Poured concrete without additional treatment—commonly used in well-drained soil, properly mixed, poured, and cured concrete is generally sufficient. If the poured concrete is "honey-combed" with porous openings, the exterior surface should be treated as described below.

Concrete block, or "honey-combed" poured concrete with two 1/4-3/8-inch-thick coats of portland cement plaster²² plus two coats of bituminous waterproofing—commonly used, this technique is generally sufficient in well-drained soils. The plaster serves to seal the porous, open-textured surface of masonry while the bituminous coating²³ protects the plaster from moisture-related damage due to freezing and thawing.

Masonry (poured or block) with a water-resistant membrane—Since any type of untreated masonry can transmit considerable amounts of ground moisture into the home, a water-resistant membrane is recommended under the floor and generally between the foundation wall and soil, or between the wall and exterior insulation. Types and characteristics of membranes include:

1. **Roofing felts**—most commonly used in older construction. Three-foot rolls are lapped 4-6 inches and sealed with hot tar or asphalt; roofing felts may be double layered. Advantages: relatively low cost. Disadvantages: relatively short life span and low durability as well as poor water-resistant properties (15 pound felt = .600-2.000 perm rating, 55 pound felt = .030-.080 perm rating).²⁴
2. **Polyethylene or "poly"**—popular in recent constructions. Four- to six-mil-thick 100-foot rolls up to 32 feet wide are lapped at least 6 inches and no attempt is made to seal laps. Advantages: low cost and easy installation. Disadvantages: easily torn or punctured thus reducing actual water-resistant properties from a perm rating of .100.²⁵

²²The application of portland cement plaster is known as "parging." Bituminous coatings may be applied by brush, spray, or trowel. Spray application is least expensive but least acceptable to coat irregularities which must be sealed for effective waterproofing. Bituminous coatings may incorporate one or more plies of cotton, felt, or glass-fiber fabrics. The greater the number of plies of fabric and coats of bituminous, the greater the resistance to hydrostatic pressure.

²³**NOTE**—Bituminous coating must not be used if an exterior rigid foam insulation such as polystyrene or polyurethane is to be applied directly to the foundation wall (bituminous materials deteriorate foam insulations and therefore one of the membranes described in items 3-7 should be used).

²⁴The lower the perm or permeability rating, the better the resistance to moisture transmission.

²⁵This disadvantage may be partially offset if the poly is protected from abrasives in soil by rigid insulation.

²¹Contact your local office of the Soil Conservation Service (see footnote 11) for soil and water table analysis assistance.

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Issued in furtherance of cooperative extension work in agriculture and home economics, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Norman A. Brown, Director of Agricultural Extension Service, University of Minnesota, University of Minnesota, St. Paul, Minnesota 55108. The University of Minnesota, including the Agricultural Extension Service, is committed to the policy that all persons shall have equal access to its programs, facilities, and employment without regard to race, creed, color, sex, national origin, or handicap. \$1.

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ACKNOWLEDGEMENTS

The following individuals are respectfully recognized:

James L. Anderson, Extension Soils Specialist, Agricultural Extension Service, University of Minnesota, St. Paul

Kelton D. Barr, Hydrogeologist, Barr Engineering, St. Paul

Bob Hanson, Executive Director, St. Paul Area Housing Authority, St. Paul

Arthur Hultgren, Construction Analyst, U.S. Department of Housing and Urban Development, Minneapolis

Gene Malis, Rehabilitation Training Director, Dakota County Housing and Redevelopment Authority, Eden Prairie

Louis P. Matis, Senior Project Engineer, Braun Engineering Testing, Minneapolis

Howard Norzika, Executive Director, Minnesota Masonry Institute, Minneapolis

Catherine Paulsen-Carley, Rehabilitation Specialist, Westside Neighborhood Housing Services, St. Paul

Roger A. Peterson, Extension Residential Energy Specialist, Agricultural Extension Service, University of Minnesota, St. Paul

Dick Sweere, Vice-President, Stuart Construction, Minneapolis

Sally Thomas, Construction Analysis, U.S. Department of Housing and Urban Development, Minneapolis

and especially to **Eileen Anderson**, Hennepin County Urban Extension Agent, University of Minnesota and other Extension Agents who perceived homeowners' plight with basement moisture problems and were faithfully persistent in a University of Minnesota response to this situation

Criticisms and recommendations for revision to this publication are encouraged. Such comments may be made in writing through any county office of the Agricultural Extension Service, University of Minnesota, or directly to the author who is solely responsible for publication content.

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