Assessing, Repairing, and Rebuilding **Basements**

Building Basements in Wet Locations

Wet basements are a common problem in Iowa. Our climate and soils "encourage" this problem. However, an Iowa basement can be dry if it is well-designed with adequate drainage.

A well-insulated, dry basement can furnish additional living space in your home at a relatively low cost. At the time of construction, measures to ensure an insulated, dry basement are not expensive. A warm, dry basement will increase the value of your home. However, after the basement is constructed and backfilled, adding insulation and draining water are expensive. Taking extra care in designing and building your basement will save you money and increase your satisfaction with your home.

This publication will discuss basement drainage, floor and wall design, concrete mixes and curing, insulation, and commercial basement products.

The Wet Basement "Solution"—External Drainage

Basements are not designed to be waterproof, only water resistant. When water in the soil is only a few inches above the basement floor, water can find openings and seep or flow into the basement. Water creates such high pressures that sealing cracks will not prevent water from leaking into the house if the soil around the house is saturated. For example, when the soil is saturated to 3 feet above the floor level, the force of the water is more than enough to lift the concrete floor slab. Obtain professional design assistance if you feel you will need a "waterproof" basement.

The main solution to the wet basement problem is to provide external drainage. Good external drainage consists of surface measures to remove water from the surface of the ground, and sub-surface measures that remove water from below the surface. Table 1 lists several surface drainage measures.

Subsurface drainage removes surface water that percolates into the soil during and after rain. It also removes water from springs, seeps, and rising water tables. Subsurface drainage must be adequate to keep the water level from rising to the top of the basement floor level. Often subsurface drainage is needed at one or more of the following locations:

- the yard,
- around the house footings, and
- under the basement floor.

All primary drainage systems near the house must be located *below* the finished floor height. Several options are available, depending on the drainage characteristics of the soil, the slope of the lot, the amount of surface water flowing across the lot, the seasonal high water table, and the outlets available for the water. Table 2 (on page 2) lists subsurface drainage measures.

Interior Drainage Options

You also can provide drainage in the interior of a basement. An accepted method is to place 4 to 6 inches of uniformly graded washed rock or gravel under the basement floor and provide a drain outlet.

If a free outlet or a storm drain outlet is not available, you will need a sump and a sump pump. The sump must have

Table 1. Surface Drainage Measures

1. Do not locate the house in a flood plain.
2. Do not locate the house in a drainageway, pothole, or low area.
3. Ask soil and drainage experts for help in evaluating the site.
4. Locate the house on the high part of the site.
5. Raise the house elevation so fill can be added.
6. Fill around the house so the soil slopes away from the house a minimum of 6 inches in the first 10 feet.
7. Soil around a new house will settle. After one year, refill to maintain the slope away from the house.
8. Grade the remainder of the lot with a minimum grade of 1 foot in 100 feet away from the house.
9. Use diversions and ditches to carry water around the house.
10. Put roof gutters on the house.
11. Discharge water from roof downspouts away from the house.
12. Do not dump downspouts into perimeter tile drains.
13. On hillside sites, cutoff drains may be necessary to divert water away from the foundation on the high side of the house.

IOWA STATE UNIVERSITY
University Extension

Pm-1561 Revised January 2010

adequate capacity to handle the heaviest flow. Check with local officials, neighbors, and contractors to determine the typical size required in your community. Over-excavate the sump area, and backfill with rock or gravel to increase the flow into the sump. A deep sump will help maintain the water table farther below the basement floor. The extra depth gives more reserve before water reaches the basement floor, and more storage in the pit, reducing pump cycling.

If the sump pump operation is critical for maintaining a dry basement, consider one or more of the following:

- a battery-operated backup,
- an alarm system, or
- an auxiliary gas-operated electric generator.

Because sumps are in direct contact with the soil, they form a possible radon gas entry point. Gas-tight sump pump covers are available from a number of sources. For more information about radon, contact your local Iowa State University Extension office, the Iowa Department of Public Health, and radon professionals.

An alternative interior drainage method, especially for existing houses, is to break out a strip of basement floor 12 to 16 inches wide next to the inside foundation wall. After the concrete is removed, dig a trench deep enough so that tile can be laid alongside or a little below the footing. The tile should be placed in a bed of filter gravel with a uniform slope of 1 inch in 15 feet toward an outlet or sump.

In such a case, a sump probably will be needed to collect water from the drain tile. Usually, the drain tile will drain the saturated soil. Under some extremely wet conditions, you may need additional tile lines under the center of the basement floor, exterior perimeter drain tiles, or other measures.

Basement Floor Design

Before placing the basement floor, excavate at least 6 inches of soil in order to place 4 to 6 inches of free-draining rock or gravel. Grade the excavation to a low corner and provide a tile line or sump to remove any water that might collect.

Before pouring the concrete, place an impermeable water barrier over the rock and gravel. Polyethylene film is low in cost and easily installed, but it is easily punctured and difficult to seal at the edges. More durable products are polyethylene-coated kraft paper and glass-reinforced waterproof paper, extrusion coated on both sides with polyethylene. Use 8 mil or heavier material and do not puncture the barrier.

Use control joints, construction joints, and isolation joints, and fill them with a suitable caulk. Joints are needed where the floor abuts walls or columns, around floor and shower drains, around plumbing openings, around electrical conduits, and around all other floor penetrations.

Provide at least one and preferably more floor drains. Slope the basement floor toward the drains.

Basement Wall Design

Basement walls usually are constructed of wood, concrete block, or cast-in-place concrete. Basements constructed of any of the three can be dry.

For information on building a wood foundation, ask for *Permanent Wood Foundation for Housing*, Pm-955, available at your local Iowa State University Extension office. Wood basements constructed in accordance with recommendations from APA—The Engineered Wood Association—have an excellent reputation for being warm and dry. The APA recommendations are specific concerning surface and subsurface drainage.

Concrete block walls are widely used in Iowa. Walls should be constructed carefully, in accordance with recommendations from masonry groups, architects, engineers, and building officials. Remember that all joints should be struck, reinforcement should be used as needed for your soil conditions, and joints

Table 2. Subsurface Drainage Measures

- **Tile and Backfill.** Run a perimeter tile line entirely around the house outside the basement walls. The tile line must be lower than the finished floor height, which usually means that additional excavation is needed after the footings are placed. Grade or slope the tile line to a low spot and then drain it to a free outlet, storm sewer, or sump pump. Cover the tile line to prevent dirt from entering and plugging the line.

  Backfill with a porous material such as 1/2- to 1-inch diameter pea rock to within 18 inches of the surface. Use low-permeability soil for the top 18 inches of backfill to prevent entry of surface water. Do not use rock, gravel, stone, or bark because they allow large amounts of rainwater to enter the ground quickly.

- **Locate Groundwater.** If you suspect high water tables, make a test boring to approximately 15 feet to locate groundwater that can affect the performance of the basement. Water tables fluctuate, so make the boring during high water levels if possible.

- **Footing Drainage.** Provide drainage through the footings with 1 1/2-inch plastic pipe located through the footing 6 feet on center. In extremely wet locations, install an impaction strip of prefabricated asphalt membrane over the footing before the wall is cast.

should be used at windows, doors, and other stress locations.

It is important to seal concrete block walls on the outside. The recommended practice is to place two thin "parge" coats of concrete on the outer wall. The parge coats each should be a 1/4- to 1/2-inch thick coating of concrete brushed or trowelled over the block. They help seal the block and provide a good surface for a commercial basement sealing product.

The sealing product, often a bituminous mixture, must be applied as specified in product instructions. Two thinner coats, applied at right angles to each other, are better than one thick coat. Continue applying the sealing product down over the tops of footings to provide a complete seal.

To retard capillary action and help prevent radon entry, seal the inner surface of concrete block walls with a paint or waterproofing material. Select the material carefully, and use only a quality product. The first coat applied determines the holding power of any subsequent coatings. A poor quality material might have to be removed before applying any further sealant.

A bond beam or solid cap unit should be used at the top of the wall to prevent radon from the soil to flow through the block and into the basement.

Cast-in-place concrete using basement forms is widely accepted material for a residential basement. Proper design of the wall is important. Obtain qualified assistance to design the width of the wall, the reinforcing steel required, and the needed concrete mix.

Control joints should be no more than 20 feet apart. Joints are necessary within 10 feet of corners, at the sides of window and door openings, and at the floor and wall junction. Control joints should be at least 1/2 inch by 1 inch. Numerous sources such as the Portland Cement Association have guidelines available. The outside face of the joint should be caulked before backfilling.

Concrete walls should be damp proofed on the exterior with two coats of a commercial damp proofing product (usually a bituminous material). The two coats should be made at right angles to each other and continue down over the tops of footings to provide a complete seal.

Concrete Mixes and Curing

Use a low-water concrete mixture in basement construction. Excess water decreases the strength of the finished concrete, causes the concrete to shrink excessively as it dries, and leaves voids as the excess water evaporates. Weak concrete cracks more easily, shrinkage leaves cracks that moisture can penetrate, and voids allow water to seep.

Use only the amount of water needed for curing. Drier concrete requires more labor to place and finish. Make certain the labor is available before starting work, so the laborers will not be tempted to add excess water at the job-site, and then puncture the water barrier to allow the concrete to "dry."

Use air-entrained concrete with a 28-day minimum compressive strength of 3,000 psi, a maximum slump of 5 inches, and a minimum cement content of 520 pounds per cubic yard unless experience demonstrates that less cement may be used to produce acceptable concrete.

Concrete curing for both walls and floors is one of the most important steps in producing durable, long-wearing, moisture-resistant concrete. Concrete is cured by applying water to the surface or by retaining water within the slab. Curing should be started as soon as possible without damaging the surface. It should continue for 5 days in warm weather or 7 days in cooler weather. The temperature of the concrete should not be allowed to fall below 50° F during curing.

Insulating the Basement

Properly insulating a basement prevents summer condensation. It occurs when warm, humid air enters the basement, cools, and can no longer hold as much moisture. Since soil temperatures often are cooler than air temperatures, this can be a summer-long problem.

The interior wall surfaces of insulated wood foundations are warm and usually do not present a condensation problem. However, the vapor retarder must be carefully placed during construction to prevent moisture vapor from entering and condensing in the wall.

The interior wall surfaces of uninsulated concrete block and concrete walls are cooled by the soil. To help prevent condensation, the walls must be insulated. The preferred location for the insulation is on the exterior side of the wall. The walls should be insulated from the footings up. Extruded polystyrene insulation, rigid fiberglass, and urethane foam can be applied to the outside of basement walls.

When exterior insulation cannot be used, interior insulation can be used by constructing a stud-frame wall on the inside and insulating the stud wall. Before insulating a basement on the inside, the basement must be dry except for condensation. Any water leaking into the interior wall insulation will destroy the insulation and could lead to the growth of health-damaging molds and mildews.

A small amount of insulation (R-3) under the basement floor slab can help reduce the amount of summer condensation that occurs on the floor surface.

Summer dehumidification often is necessary in conjunction with basement insulation for a completely dry basement. You can use a dehumidifier, an air conditioner, or both—but dehumidifiers are more effective. A dehumidifier adds heat, which increases the moisture carrying capacity of the air, and removes moisture. Air conditioners only remove moisture while they are cooling. On cool days and in cool basements they often do not operate long enough to keep the area dry.

Commercial Basement Products

A number of products are available to help keep your basement dry.

• Waterproof coatings on the inside of the walls, especially block walls, are recommended. These coatings greatly retard water seepage through the blocks. Most or all interior coatings will fail if exposed to saturated conditions over a long period of time. Do not depend on them to replace external drainage. There is a big difference in the effectiveness of these coatings. Consumer magazines, such as *Consumer Reports* and *Rodale Press*, often rate these materials.

• Exterior coatings, usually bituminous, are a standard damp proofing material. They should be used on all block or concrete walls.

• Perimeter drain tile, often plastic, is manufactured by a number of companies. Some tile is designed especially for perimeter use, and includes a drainage mat to keep dirt and rock from filling the tile. Check with your local suppliers to see what material they can obtain.

• Exterior drainage mats are made to move water around the outside of a structure. These mats often are constructed of plastic and supplied in 8-foot by 50-foot rolls. The mats can be used in place of rock and gravel both under the floor and along the wall. Check with suppliers for pricing and availability.

• Exterior sealants are used as caulking in joints. Below-grade sealants are available from building supply wholesalers.

• Exterior insulation that both retards heat flow and carries water down the wall to the perimeter drainage tile are manufactured by several companies. The insulation can be used in place of the rock backfill around the wall. The insulation has channels and/or grooves covered with fiber that carry the water. It is available in both rigid polystyrene and high-density fiberglass.

• Polyethylene, polyethylene-coated draft paper, and glass-reinforced waterproof paper extrusion coated on both sides with polyethylene are some of the wall covering materials available.

• Bentonite clay, a naturally occurring material that expands many times when wet, is an excellent sealing material for walls. It is available in brush-on, spray-on, and sheet form. It is self sealing, and is used on many commercial and earth-sheltered structures.

• Interior basement channels sealed to the joint between the wall and the floor and drained to a sump are an effective method to remove water from the wall and the wall/floor joint. Normally used as a retrofit installation, they also can be used in new house construction to both collect moisture and seal against radon entry at the joint.

Reviewed by Tom Greiner. Prepared by Tom Greiner and Stewart Melvin, former extension agricultural engineers; and Laura Sternweis, extension communication specialist.

This material is based upon work supported by the Extension Service, U.S. Department of Agriculture, under special project number 93-EFRA-1-0002.

. . and justice for all

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, gender, religion, age, disability, political beliefs, sexual orientation, and marital or family status. (Not all prohibited bases apply to all programs.) Many materials can be made available in alternative formats for ADA clients. To file a complaint of discrimination, write USDA, Office of Civil Rights, Room 326-W, Whitten Building, 14th and Independence Avenue, SW, Washington, DC 20250-9410 or call 202-720-5964.

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Jack M. Payne, director, Cooperative Extension Service, Iowa State University of Science and Technology, Ames, Iowa.