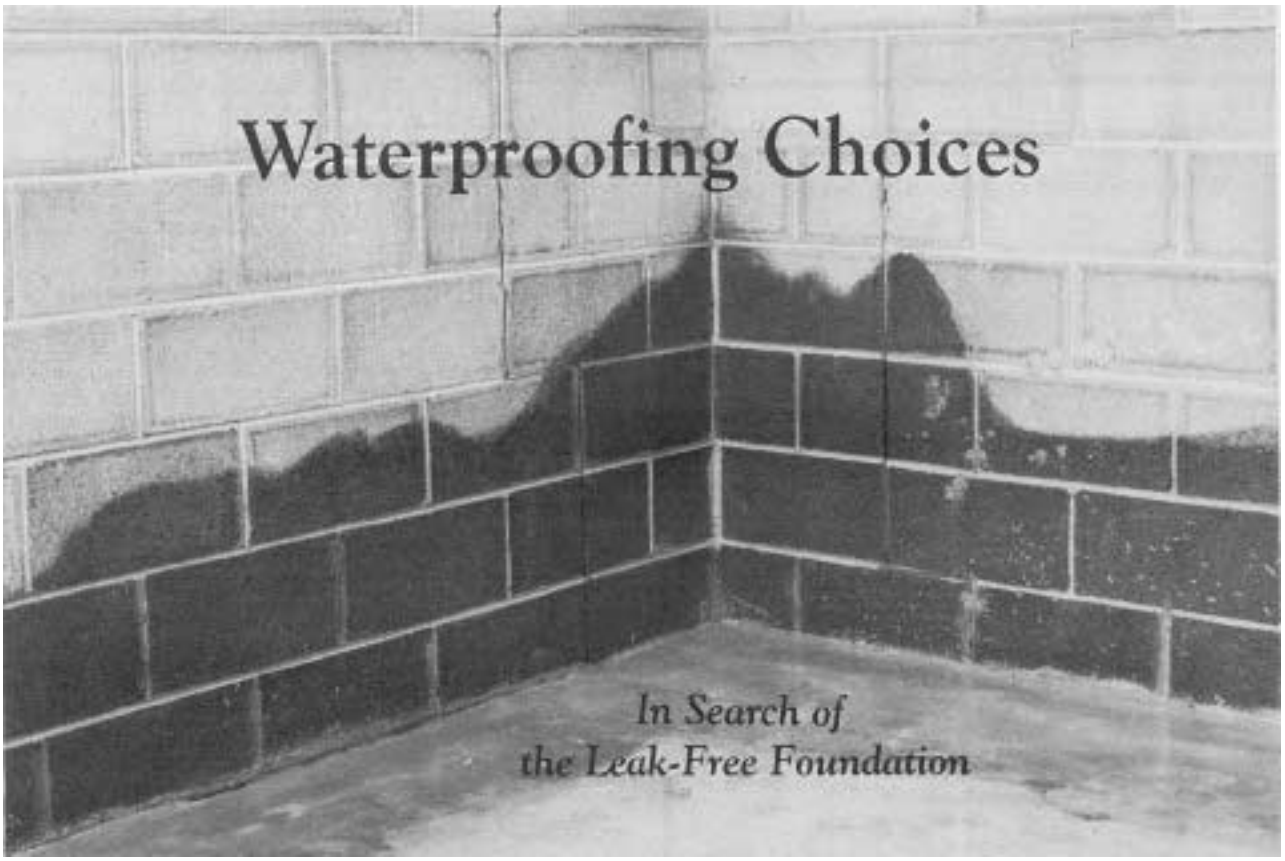


photo courtesy Thoro System Products

by Paul Hanke

Leaky basements are one of the four major sources of builder callbacks, according to the National Association of Home Builders (NAHB).

In fact, a 1983 NAHB survey showed that 88 percent of all builders questioned had received calls on leaky basements at some point in their careers — and that 80 percent of home owners questioned would spend an extra $400 to have their basements guaranteed not to leak.

Furthermore, a 1981 survey by Owens-Corning of more than 31,000 families nationwide showed that 44 percent of the basements in new homes leaked, as did 60 percent of existing basements.

According to engineer Brent Anderson, whose September 1985 article in *Progressive Builder* is the source of these statistics, callbacks related to basement leakage cost between $400 and $800 — money that comes "right out of a builder's profit," he says.

Confronted with figures like these, the importance of understanding what causes basement leaks and what can be done about them becomes apparent.

There are three basic areas of concern in controlling basement leakage: having proper site and drainage conditions, ensuring the concrete work is of high quality, and applying a true waterproofing product.

It is common practice in residential construction merely to apply a thin coat of asphalt tar to the outside of a foundation wall in an effort to keep water out of a basement. Tar coatings, however, should be considered only as a *dampproofing* measure and not be relied upon to completely seal out water — especially where below-grade living spaces, such as finished basements or earth-sheltered houses, are concerned.

Today's asphalt tar is refined to the point where it has lost virtually all of its elasticity and crack-bridging characteristics. What's more, it emulsifies in water, slowly dissolving away until only a mere stain may be left on the wall.

At best, asphalt tars offer a measure of protection against the capillary draw of water into the basement wall, but they cannot stop serious leaking. The solvents in cold-applied asphalt tars also may react adversely with exterior polystyrene insulation which is another constraint on their use.

The first real line of defense against water leakage is to keep water away from the building. Once site conditions are properly attended to, a variety of true waterproofing products is available for new and retrofit applications.

Site Conditions

Step one in keeping water away from a building is to investigate subsurface conditions.

You can best determine the existence and depth of the seasonal high-water table by digging a hole at the construction site. This should be done as early as possible in the spring, when groundwater conditions are at their worst and when you actually may be able to observe water dripping into the excavation on one or more sides.

If you must dig at a drier time of year, call in a soils expert who can view the soil profile and tell you where the highest level of groundwater usually occurs based on the color, texture and "mottling" of the soil.

If the high-water table is above the floor level of any proposed below-grade living space, you are well advised to abandon the site altogether or to at least raise the level of the building. The building might be raised by using excavated earth to berm the raised exterior walls and thereby maintain some earth-sheltering effect while providing positive drainage away from the building.

During your exploratory dig, you also should determine the type or types of existing soil at the site. Well-drained gravel to footing depth is an asset. Poorly drained clay or a layer of compact hardpan will inhibit drainage and therefore require imported backfill to improve conditions.

After the wall has been poured, install a perimeter drain tile of perforated PVC around the building to collect water that percolates through the soil. The pipe should be laid on top of a shallow bed of crushed stone and pitched 1/4 inch per foot to daylight or storm sewer. (Rigid pipe is best for this purpose.)

Cover the pipe with a thin layer of stone, checking to see that the highest point of the pipe is four inches below the level of the top of the slab floor within.

Next comes a layer of hay, fiberglass insulation or special "filter fabric" to prevent silting. Well-drained native soil or imported "bank-run" gravel can then be backfilled to within 12 inches of finished grade. One foot of topsoil, again pitched away from the building on all sides, caps the operation.

If the site slopes downhill toward the building from any side, a shallow surface ditch—a "swale"—should be provided to direct surface runoff away. (Henri de Marne gave a detailed description of these procedures in the May '83 issue of *NEB*.)

All of these measures are designed to get surface and subsurface water away from the foundation walls before it can build up hydrostatic pressure and force its way into the structure.

In addition to these measures, commercial drainage enhancers may be used below grade. "Enkadrain" is one such product. It consists of an open, three-dimensional mesh of compression-resistant nylon matting bonded to a polyester fabric. Installed with the mesh side next to the concrete, water passes through the filter fabric and then falls harmlessly down to the perimeter drain below.

Similar products for this purpose include Mirafi's "Miradrain" and Owens-Corning's "Warm-N-Dri" basement-wall insulation (a semirigid fiberglass insulation board with a directional-fiber orientation).

I have seen a demonstration where a completely saturated piece of Warm-N-Dri was held horizontally without leaking a drop, but when tilted vertically, the water ran out freely. Field reports indicate that the nominal one- or two-inch-thick by 4'x8' boards are not wetted more than 1/8 inch deep under normal subsurface conditions.

Remember, however, that Warm-N-Dri is an *insulation* product with excellent drainage characteristics. It is not marketed by Owens-Corning as a true waterproofing material. In fact, the company has its own proprietary waterproofing product for application to concrete walls.

Quality Concrete

Some foundation leaks occur because of shrinkage and other problems with the concrete wall itself. While concrete is fairly watertight, proper mixing, placement and curing are essential for good results.

The water-to-cement ratio should be kept to a minimum; in general, no more than six gallons of water should be used per sack for maximum watertightness.

It's also important to remember that shrinkage occurs while drying. When concrete is cured for seven days at 50 percent relative humidity, only 30 percent of the total shrinkage will occur within the first 30 days, with the remainder taking place over the next six months to two years. During this time, shrinkage (or settlement) cracks may develop, and existing cracks may widen.

A true waterproofing coating must be able to bridge minor cracks. Ordinary tar cannot, so other measures are called for.

Waterproofing Products

Once you have done your best to provide good drainage and quality concrete work, the final line of defense against water is applying a waterproofing product to the wall (or roof) surface.

Horizontal and vertical surfaces have different requirements, which affects the selection of materials and the method of application. A variety of generic waterproofing products exists.

Liquid-applied coatings include neoprene, such as Gates Engineering's "Gacoflex," or liquid urethane, such as Gates' "Gacoflex U-66" or Carlisle Tire and Rubber's "Liquiseal."

These products may be applied by spraying, rolling, troweling or using a squeegee. Both horizontal and vertical grades exist. Extreme care must be taken when applying these liquids, because the solvents can be highly toxic.

Single-ply membranes are perhaps the most common contemporary waterproofing material. Basic materials used for these products include butyl, EPDM (ethylene propylene diene monomer), neoprene, CPE (chlorinated polyethylene) and rubberized asphalt sheets.

All are laid either loose or in mastic, with sealed laps at all joints. Sheets range in width from 54 inches to as much as 45 feet, with lengths up to 125 feet.

Butyl sheets are available in thicknesses of 30 to 60 mils and widths of 54 inches to 45 feet. Brittleness occurs at about -40 F. Butyl apparently is difficult to bond to concrete and consequently is laid loose on horizontal surfaces, although some people use a grid pattern of mastic.

The material also stretches easily in the sun or under its own weight in vertical applications. Once glued in place and backfilled, tremendous stresses can occur as the stretched material contracts to its original size, which could result in torn seams. Carlisle Rubber is one source of butyl sheets.

The water-to-cement ratio in concrete should be kept to a minimum. In general, no more than six gallons of water should be used per sack of cement for maximum watertightness in concrete.

EPDM comes in thicknesses ranging from 20 to 60 mils and may be loose laid or fully bedded. Like butyl, it is difficult to apply to vertical surfaces because of its stretchiness. Brittleness occurs at -75 F.

Joints are sealed with special contact cement. Narrow EPDM strips often are used as flashing for bentonite-clay applications. Carlisle Rubber is one source of EPDM sheets.

Neoprene, another synthetic rubber product, is said to be somewhat easier than EPDM or butyl to splice and mold to the contours of the supporting surface. It also is used for flashing and may be loose laid or fully adhered. Thicknesses vary from 30 to 120 mils, and widths from 54 inches to 45 feet.

Prices reportedly have dropped in recent years, giving neoprene an increasing share of the market. Carlisle Rubber and Gates Engineering are sources.

CPE products are manufactured by exposing polyethylene to chlorine gas, yielding a flexible polymer sheet. It is laminated to a bonded polyester backing for strength. Common sizes for underground waterproofing applications are three to five feet wide by 100 feet long.

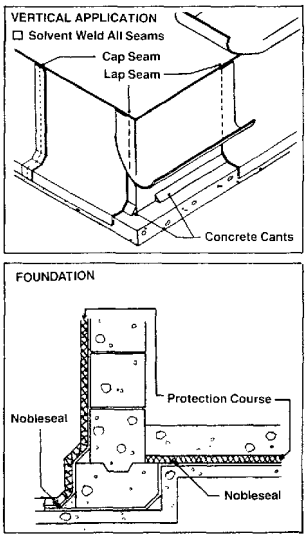
CPE may be applied loose or with a full water-based mastic, and seams may be solvent welded or cemented. Some people specify a grid pattern of adhesive rather than completely loose sheets to isolate lateral migration in the event of leaks. "NobleSeal" from the Noble Co. is a CPE product.

photo courtesy Owens-Corning

Applying Owens-Coming's "Tuff-N-Dri" system on a foundation wall.

Rubberized asphalt products, such as "Bituthene" from W.R. Grace Co., are made in sheet form by bonding the material to an integral polyethylene sheet. They can be used on horizontal or vertical surfaces.

Because of the polyethylene component, they must be backfilled shortly after installation to prevent exposure to ultraviolet radiation, which can make them brittle. Typical widths are three to four feet with 60-foot lengths, making them somewhat easier to handle than larger sheet products—but also requiring more seams, which increases the number of potential leak spots.



Application detail for NobleSeal.

Bituthene is self-adhesive and moderately self-healing after the backer sheet is removed, but a primer coat must first be applied to the supporting surface—at temperatures above 40 F to preserve the self-adhesive qualities.

These products reportedly have a high degree of "memory," meaning that any wrinkles created during application eventually may return. Laying in a full bed of mastic decreases this risk.

Polymeric asphalt coatings, such as Owens-Coming's "Tuff-N-Dri," are an elastomeric mixture of rubber and asphalt, resulting in a significant improvement over the qualities of ordinary asphalt. They can be elongated up to 1,200 percent (800 percent for Tuff-N-Dri) with 90 percent recovery, and therefore have a much greater crack-bridging ability than ordinary asphalt.

Tuff-N-Dri is spray-applied exclusively by contractors licensed by Owens-Corning. It has a 10-year limited warranty solely for vertical applications.

Cementitious coatings such as "Thoroseal" may be used for both interior and exterior applications. Cementitious coatings typically are made of cement, fine sand, water and various chemical additives.

Interior application is especially well-suited to retrofit work, but it must be remembered that in such so-called "negative side" applications, any water forcing its way through the wall tends to push the material off the inside surface to which it is adhered. (For exterior applications, water pressure will force the material tighter against the wall.) Bond strength between the product and the wall is critical in such cases.

Bentonite is a naturally occurring volcanic clay material that is extremely expansive. The clay swells when it comes into contact with moisture, forcing each minute particle — up to 10 trillion in a single cubic inch — to push more tightly against its neighbor, thereby creating a very effective water seal.

Bentonite clay used to be available in spray and trowel-on forms, but at least one major manufacturer withdrew its products from the market several years ago, reportedly because of a small but persistent failure rate on horizontal applications.

The form of bentonite remaining on the market is a 4'x4' by 3/16" "Volclay" panel that sandwiches the clay material between cardboard. Backfilling must be done immediately after installation to prevent rain from decomposing the cardboard and washing away the bentonite. Joints may be sealed with one of two special joint-seal products.

Bentonite also should be applied only over completely smooth concrete or *treated* wood substrates. It requires a constant minimum pressure of 30 p.s.f. — equal to about six inches of soil cover — to work.

Some problems have been reported with roof applications of this product, so I would be inclined to err on the side of safety and use sheet materials for roofs.

Charles Lane, former assistant director of the Underground Space Center at the University of Minnesota, says the panels are not suited for residential use because they are too difficult to apply properly. In addition, bentonite reportedly does not perform well in saline soils, which argues against their use in coastal regions.

One final note on bentonite: Some applicators reportedly have injected liquified bentonite into the soil around existing houses in an effort to stop leaks without expensive excavation. Two points must be made about this method.

First, it's extremely unlikely that a uniform layer of bentonite of the necessary thickness could be installed in this manner —which is important for bentonite to work. Second, once in place, the liquid bentonite will dry and shrink to its original volume. This shrinkage undoubtedly produces cracks and voids that very conceivably could cause leaks.

Retrofit Applications

Paint-on products are available for retrofit applications on interior walls, but as already noted, these products can be forced off the wall by water pressure from the outside.

In April 1981, *New Shelter* magazine reported on tests of 22 different basement waterproofers by its "Product Testing Workshop." About one-third of the products tested were deemed effective, while 40 percent were judged "unacceptable" even after two coats.

Because the quality of these products apparently varies so greatly, their use should be limited to retrofit cases where exterior application cannot be justified economically and where surface regrading cannot solve the problem.

Before applying any interior waterproofing product, conduct a simple test to determine whether moisture actually is coming *through* the wall. Dry a small section of the wall with a portable hair dryer, then tape a scrap of polyethylene sheet to the wall and leave it in place for 24 hours.

If the moisture falls between the poly and wall, you have a leak. If it occurs on the indoor face of the poly, you have a condensation problem, which requires a different solution.

Details

Specific applications and construction details are beyond the scope of this article, but some general comments can be made.

Locations that require attention include joints between sheets of different waterproofing materials, expansion joints, flashing and penetrations through the waterproofing. Cant strips are required at intersections like walls and footings.

Of special concern is the joint between a concrete foundation wall and its footing, or between a slab floor and the adjacent wall.

Of special concern is the joint between a concrete foundation wall and its footing, or between a slab floor and the adjacent wall. Waterstops, such as bentonite tubes or rubber or PVC products, should be applied at these joints.

Earth-covered roofs should have a definite pitch to prevent ponding. Wood

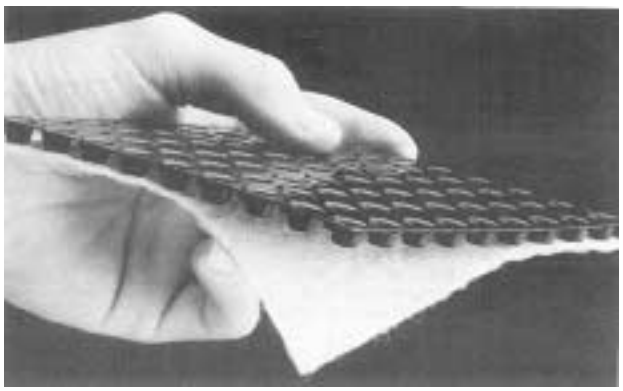


photo courtesy Mirafi, Inc.

Miradrain, the prefabricated drainage structure from Mirafi, Inc.

photo courtesy Geomatrix Systems

Enkadrain subsurface drainage mat prior to backfilling.

plank-and-beam roofs require the installation of plywood or particleboard sheets above the planks to provide a smooth surface for applying the waterproofing product. Lap joints and seals are critical.

Finally, it is considered good practice to place the waterproofing membrane *underneath* any exterior insulation that is used. This minimizes expansion and contraction due to temperature changes and thereby enhances the life of the waterproofing.

All manufacturers provide detailed specifications and application manuals for their products that should be followed strictly if warranty protection is expected.

In addition, an excellent book by Brent Anderson, *Underground Waterproofing,* devotes an entire section to clearly illustrated construction details for virtually every situation you're likely to encounter. (See "Further Reading.")

Keep in mind that with proper site preparation and installation, modern waterproofing systems should provide years of effective protection against leaks. Factors that must be considered in selecting a specific product include field constraints, size, horizontal or vertical application, in-place cost, warranty period, ease of application and local availability. ■

Further Reading

• "Basement Waterproofers," by the staff of *New Shelter.* April 1981, page 38.

• "Guard Against Basement Leaks," by Brent Anderson in *Progressive Builder,* September 1985, page 17.

• *Underground Waterproofing,* by Brent Anderson. WEBCO Publishers, 110 S. Greeley, Stillwater, Minn. 55082. 62-page paperback, $7.50.

• "Waterproofing Methods and Products," by Charles A. Lane in *Earth-Sheltered Living,* March-April 1984, page 23.

• "Waterstops," by Frank A. Randall Jr. in *Concrete Construction,* June 1984, page 569.

Product Suppliers

Bituthene
(rubberized asphalt sheet)
W. R. Grace Co.
62 Whittemore Ave.
Cambridge, Mass. 02140

Enkadrain
(drainage board)
Geomatrix Systems
Enka, N.C. 28728
704/667-7668

Gacoflex
(neoprene liquid and solid)
Gates Engineering
100 S. West St.
Wilmington, Del. 19801
302/656-9951

GeoTech
(drainage board)
GeoTech Systems Corp.
1516 Spring Hill Rd.
McLean, Va. 22102
703/667-7668

Miradrain
(drainage board)
Mirafi, Inc.
Box 240967
Charlotte, N.C. 28224
800/438-1855

NobleSeal
(CPE sheet)
Noble Co.
614 Monroe St.
Grand Haven, Mich. 49417
616/842-7844

Sure-Seal
(butyl, neoprene and EPDM sheet)
Carlisle Tire & Rubber Co.
Box 99
Carlisle, Pa. 17013
717/249-1000

Thoroseal
(cementitious coating)
Thoro System Products
Standard DryWall Products
7800 NW 38th St.
Miami, Fla. 33166
305/592-2081

Tuff-N-Dri
(insulation board)
Warm-N-Dri
(polymeric asphalt coating)
Owens-Corning
Protective Coatings Division
Fiberglass Tower
Toledo, OH 43659
419/248-7750