Curing the Leaky Foundation

by Henri de Marne

After poring over reams of articles, ads, new-product poop sheets and reports in an effort to update my 30 years of experience in building dry basements and crawl spaces (or drying wet ones), I am convinced that these modern methods offer little that's new under the sun (or, rather, below the surface).

For one thing, the theme repeated ad nauseum by every one of the writers describing these innovations is always the same: Provide proper foundation drainage, backfilling and grading. So what else is new?

Plain common sense and experience, combined with commonly available, inexpensive materials and practices, can accomplish wonders in waterproofing foundations. There's simply little need for some of the newfangled and costly materials.

Of course, I am talking about standard residential construction. Much of the material I reviewed describes waterproofing systems for earth-sheltered houses and nonresidential applications, for which more money can be budgeted to compensate for the considerably greater problems to which such projects are subjected, and the ultimate difficulties of repairs.

But this is not the case for average residential construction in which most builders and contractors are involved—and for whom cost control is essential to remain competitive and to build affordable housing.

Still, we have to face the truth: Foundation leakage is one of the biggest bugaboos plaguing residential construction today, according to a recent survey of the nation's builders by the National Association of Home Builders.

Yet water penetration of basement and crawl spaces is relatively easy to prevent in new construction and to correct, in most cases, after the fact.

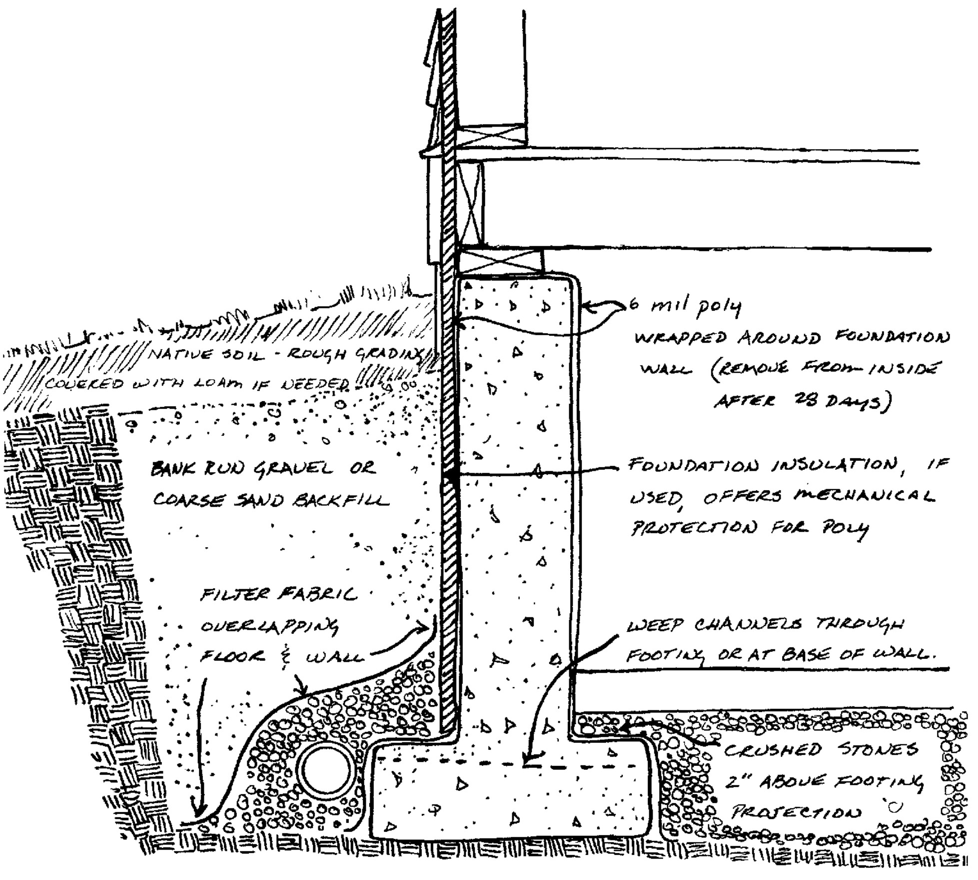
Obviously, the best time to render a basement or crawl-space foundation waterproof is at the time of construction. This doesn't require great expense, but it does require know-how and attention to details.

Foundation leakage most often occurs because surface and roof water are allowed to run down to the base of the foundation and exert hydrostatic pressure against it—pressure that is almost irresistible under normal construction practices.

Other sources of foundation leakage are underground springs and water tables, which can be *handled* underground. Surface water is best disposed of right on top of the ground.

The first thing to remember is that surface water will not cause a problem if it is not allowed to penetrate deep into the ground.

So when building a new house, let's consider in order the several elements necessary to ensure a waterproof foundation.



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Leak-Proof Concrete

The most prevalent foundation material in the Northeast is poured concrete—a much misunderstood material. Concrete is a mixture of cement, sand, aggregate and water. The less water used in the initial mix and the slower its evaporation in place, the stronger the concrete. As a result of the chemical reaction between cement and water, it takes time for the gel that forms to swell and fill all the voids in the mix as it turns to rock. Hydration, as this process is called, must not be interrupted by careless practices that are too often the norm.

A mix with low slump needs only half of the water mixed in the batch to hydrate properly; the other half is there to make placing the concrete a little easier.

In the U.S., very little high-early-strength alumina concrete is used, which is too bad because this type of concrete reaches the same hardness in 24 hours as portland cement reaches in 28 days.

Type III portland Cement is not commonly used in residential construction, but some high early strength can be obtained by using an extra bag of cement per cubic yard. This increases the heat of hydration and causes the concrete to set faster—an important feature in winter concreting.

A practice that I recommend highly, and one that will assure a perfect concrete job, is to wrap the concrete in clear six-mil plastic shortly after the forms have been removed and the ties broken off. A 20-foot-wide roll will cover the wall faces, top and footings of a full basement while allowing the bottom to be weighed down with the crushed stones used under the slab and for the perimeter drain.

All joints between sheets should be taped. Black plastic usually should not be used except in winter, because the sun can cause it to create too much heat underneath.

The plastic should remain in place throughout the entire construction process so you'll have waterproof concrete. But be careful: if you try to drive nails into it for any reason at a later date, you might get a mouthful of broken teeth.

At this point some of you may be asking, "Hey, what about the foundation coating? How am I going to apply it without removing the plastic?"

Rejoice! You don't need it. The plastic does a better job than any commonly used coating and bridges any shrinkage cracks that may develop through the concrete.

The same is true of block foundations. You can save yourself the cost of parging by using plastic instead. Six-mil polyethylene should be adhered to the *top* of the foundation only, with either Flintkote 200-32 Nitrophalt adhesive or Monsey Products Co.'s high solid, nonflammable adhesive Seams should also be sealed with adhesive.

It must be remembered that what you are doing is not trying to apply a membrane similar to that used in swimming pools, but simply to break the capillary flow of water percolating down through the soil and into the foundation. Pinholes are of no consequence, since no hydrostatic pressure is involved.

Extreme care should be used, however, in backfilling to ensure that the plastic is not damaged. This is where you can kill two birds with one stone once again.

Insulation

In most areas of the country, foundation insulation is called for, and the best place to put it is on the outside of the wall, from the footings on up.

There are as many suggestions and recommendations on this subject as there are people making them, so I'll present you with my own.

Considering that one-inch-thick *extruded* polystyrene, with an R-factor of approximately five, blocks 74 percent of the heat loss through an eight-inch-thick concrete wall, and that the next inch saves only an additional 9 percent, one has to ask whether doubling the materials is worthwhile. If proper backfilling techniques are followed to ensure that the earth is reasonably dry earth against the foundation and that only a minimal amount of the foundation is exposed, the additional inch may not be cost-effective.

I realize this directly contradicts a number of authorities, but I have questioned some of them about their research and found that much of their work was computer generated or simulated without taking into consideration the buffering effect of dry earth.

In my opinion, only extruded polystyrene should be used as foundation insulation. It has stood the test of time better than most *expanded* polystyrene, urethane, and polyisocyanurate boards.

Expanded polystyrene (EPS), also known as bead board, is generally less reliable because there are so many manufacturers making it and because industry standards are only beginning to be developed.

Undoubtedly the better EPS products may effectively withstand soil pressures and resist moisture, but I have seen a number of cases where bead board has been totally crushed from two inches thick down to barely a quarter of an inch, completely disintegrated from soil and frost pressure and growing healthy crops of moss. I have never seen this with extruded polystyrene, but perhaps others have.

At this point, I should mention the relatively new fiberglass foundation insulation manufactured by Owens-Corning: "Warm-N-Dri."

In combination with its "Tuff-N-Dri," a sprayed-on polymer elastomeric membrane for concrete or block foundations, Owens-Corning has entered the foundation waterproofing and insulating business again after an earlier, disappointing try. But at approximately $1.25 per square foot, I question whether "Warm-N-Dri" is worth the cost when the combination of six-mil poly and one-inch-thick extruded polystyrene costs only half as much.

'Hey, what about the foundation coating? How am I going to apply it without removing the plastic?' you might ask. Rejoice! You don't need it.

The Canadians have used this unidirectional fiberglass foundation insulation (marketed in Canada under the name "Base-Clad") for years, and they claim no problems with it. My concern would be that if native soil, regardless of its geological makeup, can be used as backfill as claimed, frost could cause compression and thus reduce the water passageways and the insulation's R-factor. The National Research Council of Canada and Owens-Corning say this hasn't been a problem.

Below-Grade Drainage

Whichever system of foundation coating and insulation you use, everyone agrees that a permanently working drain is essential.

My favorite system—one that is time-tested, easily constructed, inexpensive and makes use of readily available materials—is as follows: Install a perforated pipe in a bed of crushed stone at the base of the footings. Contrary to common recommendations, there is no need to slope the bottom of the trench or the pipe to an exit.

We all know that water seeks its own level. Therefore, if the bottom of the trench is reasonably flat, water won't build up at the base of the footings as long as the point of exit is below the bottom of the perimeter drain and any outlet pipe has a slight downward slope.

If you think that sloping the bottom of the trench can only provide an additional margin of safety, think again. Such action can undermine the footing under repeated wet conditions.

In fact, a perforated pipe is needed only in the case of severe surface-water penetration—an inexcusable blunder—or when underground springs or a high seasonal water table exist. Spaces between the crushed stone allow enough passage for water, and in all but the most severe cases, water will travel through the bottom layer of crushed stone under the perforated pipe.

Most drain tile or pipe failures occur because the drain has silted. Whether fine sand is used or the native soil is simply backfilled over the crushed-stone drain, water percolating down through this fine or disturbed material will carry particles through the crushed stone and eventually fill the pipe.

Again, many people have recommended using saturated felt or rosin paper. These people haven't dug up any failed systems and are simply passing on what they have read elsewhere, helping to propagate poor advice.

Rosin paper not only turns into papier-mache when wet, but it leaches into the drain tile and helps to plug it. Asphalt-coated felt, which sheds water, simply directs the water and silt along the sides of the trench and through its own joints or breaks—the end result is the same.

Back in the '50s and '60s, before the energy crisis hit, I was working in an urban center where nature's own filters were not available, so I used fiberglass insulation after peeling off the vapor retarder.

In more rural areas, where mulch hay is available, a deep layer of approximately 12 inches makes a very fine filter when compressed by the weight of the backfill. Sod (with the green side down for once) also works very well, as do marsh grass and seaweed.

Today we are fortunate to have excellent filter fabrics such as Typar and Mirafi, which are easy to handle and reasonably priced.

When installing filter fabric over a crushed-stone bed, do not skimp by simply laying a strip of fabric over the stones. Where the trench is narrow, it is best to cut a strip of fabric as wide as needed and pin it with nails against the trench wall before placing the stones. Once the crushed-stone drain bed is completed, the filter fabric should be folded over it and extend a few inches up the foundation wall.

In the case of a wide trench, where the stone bed does not fill the entire bottom but forms a rounded conduit at the side of the footings and the base of the foundation walls, be sure that the filter fabric covers the entire surface of the stone and overlaps trench floors and foundation walls by a few inches.

Another source of drain failure is tree-root clogging. This is particularly a problem if willows are planted within 50 feet of the house. If willows cannot be avoided, the amount of crushed stone should be greatly increased to discourage root growth.

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Another frequent recommendation is to install a clean-out pipe to grade as a way to remove silt from perimeter drain tiles or pipes. Stop and think for a moment before you decide whether to go to the hassle or expense.

How many times have you heard of someone running a garden hose down this pipe to flush silt out as recommended? How many times have you yourself done it and, if so, with success?

I venture to say that *no* owner does it in a timely fashion—and that the only way to effectively flush it in the first place would be to enlist the local fire department and its large, powerful hoses.

Flushing is more likely to be attempted after basement leakage is noticed—and by that time, it's too late. No amount of water could dislodge the sediment clogging the drain pipe at that point; in fact, it probably would cause more leakage in the basement.

It's also too late for augering after a leak is detected, because augering could seriously damage the Schedule 10 pipes used for drainage purposes.

Backfilling

Backfilling is another crucial phase of the total waterproofing package.

I would urge, plead and beg all cold-climate builders *never* to backfill with heavy native soil consisting of clay or silt. This applies even if you use one of the in-plane drainage mats applied against the foundation to provide passage for water to reach the footing drain quickly. Based on my experience, expanding soils in cold regions can cause serious damage to foundations. I have been involved in repairing many of them.

Moreover, particles of heavy soil may clog the filter fabric and render it useless. Filter fabric should be covered with coarse, porous material like coarse sand or bank-run gravel. I suggest backfilling almost to the top of the trench with it so that any water reaching it can filter quickly down to the drain.

Coarse backfill material does not expand during freezing weather and tends to compact during installation, thus making mechanical compaction unnecessary.

Where the excavation trench around the foundation is quite wide, it is easy to reduce the amount of coarse material needed by gently dumping a band of it against the foundation and following with native soil pushed over the lip to even out the level. These procedures should be alternated until you reach the top.

A narrow band of coarse material against the foundation walls is all that is needed to provide drainage and guard against frost pressure.

Above-Grade Drainage

When the trench backfill is completed, it should be rough graded with native soil approximately a foot deep at the foundation wall and taper to nothing 10 to 12 feet away.

This provides an impervious, or nearly impervious, protective layer over the porous material. And because it is sloping, it carries water away from the foundation before it has a chance to penetrate "deep into the earth.

Top it off with loam to ensure a healthy stand of grass. Avoid flower beds against the foundation; if the owner must have them, place them a few feet away where the visual effect is the same from a distance.

If gutters and downspouts are to be used, make sure the downspout discharges onto large concrete splash blocks slanting away from the house. Avoid downspout systems designed to drain roof water under the ground. They may become disconnected or broken from soil movement, and they can cause the very problems you are attempting to prevent if the breakage goes undetected.

When gutters and downspouts are not used, don't simply let water fall off the roof onto the soil or break its fall with a crushed-stone-filled ditch or bed. Both create a moat-like effect that defeats the purpose, since the only way for the trapped water to go is down.

The best way I have found to solve this problem is to lay a row of rectangular 1" x 12" x 12" flagstones end to end at the drip line and flush with the soil. Because they follow the recommended slant of the grade, the falling water will mostly bounce and certainly run away from the foundation. And the flagstones are not subject to deterioration.

Patios, stoops and walks also can present a potentially serious problem if they are allowed to settle or crack and direct water toward the house. The backfilling procedure recommended earlier should alleviate most of this risk, since the coarse granular fill tends to pack as it is placed. Nevertheless, care should be exercised to reinforce and underpin them as needed.

Some Final Notes

Finally, something must be said about how to deal with any water that reaches the perimeter drain in spite of your best efforts.

I would caution against the use of dry wells to dispose of water. Every time I read of someone suggesting it, I cringe.

A solid pipe with a slight slope should be connected to the perforated footing drain pipe if one is used, or to the crushed-stone vein if one is not. It should be carried down slope to daylight if the land's topography allows.

Be sure to cap the end with hardware cloth to keep rodents from building nests inside, and surround it with a small fieldstone culvert and apron to prevent soil from building up around the opening.

Where daylight discharge is not possible, another means of evacuation must be provided. When there is a crawl space or basement and no way to provide daylight discharge, weep holes should be provided at the top of the footings or at the base of the foundation walls.

In block construction, this is accomplished easily by using U-shaped galvanized channels of the same thickness as the mortar joints. They should be placed upside down on top of the footing at regular intervals.

With poured concrete construction, the easiest way I have found to deal with the situation is to nail two-inch-by-two-inch blocks flush with the top of the footing forms every four feet or so. The blocks should be wrapped with poly and stapled. This doesn't interfere with placing the wall forms, and the blocks can be easily knocked out when the wall forms are removed.

The sub-slab crushed-stone bed should be thick enough to extend above the footing projection by at least two inches. It should be covered with six-mil poly, and the slab poured over it.

Some builders go to the expense of installing a second perimeter drain system inside the footing below the slab, tying into the outside drain or leading it to a sump. Again, this is unnecessary because the spaces between the crushed stones provide enough passageways for the free flow of water to the eventual outlet.

A sump made out of a large flue liner is built in a corner of the basement or crawl space. It should sit on top of and be surrounded by a six-inch cushion of crushed stone. The installation is completed with a submersible sump pump discharging through a band joist.

I also would caution against the use of dry wells to dispose of water. Every time I read of someone suggesting it I cringe, having seen a great number of failures.

If the ground under the house is porous, a dry well is not needed—and neither, generally, is a perimeter foundation drain. And if the soil has poor percolation, a dry well will fill quickly when you need it most, and water will back up. Such is the stuff of which nightmares are made. ■