6

Foundation

Foundation Moisture

Aside from structural concerns, the most important consideration for foundation design is moisture. No client wants a wet basement. No client wants a damp basement. No client wants mold in their basement. The best way to ensure that a foundation stays dry most of the time is to include:

- Proper drainage
- Capillary breaks

You can't go back to add these later (for a reasonable cost) so the time to do it is when you build the foundation (see Figure 6.1). This applies to full foundations, to crawlspaces, and to slab-on-grade construction.

Even with these precautions, the foundation walls may still be damp at times. You can't guarantee that mold won't grow. You *can* minimize the potential for conditions that foster mold growth, and maximize the potential for walls to dry when they do get wet. Although the code calls for a vapor retarder on the interior (warm in winter) side of insulated foundation walls, a vapor retarder is **not recommended** on either side of the wall, to facilitate drying. The figures in this chapter show several possibilities for relatively forgiving, mold-resistant, insulated basement wall assemblies. If the proper drainage and capillary breaks are not present, it is better **not** to build a conditioned basement so that the foundation walls do not need insulating.

Energy Code Requirements

All basement spaces must be defined as "conditioned" or "unconditioned." See page 21, and Figures 4.1-4.2.

Conditioned Basements

In a conditioned basement, you must:

- Insulate the foundation walls on the inside or the outside of the wall. The required R-value depends on the results of your compliance analysis.
- Insulation must extend from the top of the wall to a depth below grade that is determined by climate (ECCCNYS 502.2.1.6,502.2.3.6, 602.1.5). See table below for specific requirements.

ECCCNYS Table 502.2.1.6 Foundation Insulation Depth	
Heating Degree Days*	**Depth Below Grade**
≤6000	24"
6001-8000	48"
≥8001	84"

* See page 31 for more information about Heating Degree Days.

- Insulate the band joist of the floor framing above the basement.
- Seal air leaks in the foundation walls and slab floor, as well as the sill / band joist area.
- If the foundation is insulated with rigid foam on the exterior, the insulation must be protected with a rigid, opaque and weather-resistant barrier that extends at least 6" below grade (ECCCNYS 102.4.1).

Important note: When you are doing compliance analysis on a conditioned basement, you must look at each basement wall separately and determine, wall by wall, whether the wall is more than 50% above grade or more than 50% below grade. Walls that are 50% or more above grade, must be added in with above grade walls in your calculations, and insulated to the same R-value. Walls that are more than 50% below grade are treated as "basement walls."

Unconditioned Basements

In an unconditioned basement, you must:

- Insulate the floor above the basement. The required R-value depends on the results of your compliance analysis.
- Insulate the stairwell between the basement and conditioned first floor.
- Insulate heating pipes and air ducts in the basement.
- Seal the ducts in the basement.
- Seal air leaks in the floor system between the basement and the first floor, such as wiring and plumbing penetrations, and weatherstripping on the basement door. Include the basement door in your calculations.

Slab-on-grade

Slab perimeter (edge) insulation must be installed where the slab is part of the conditioned space of the house. *This includes a slab-on-grade house or addition, the walkout portion of a heated basement, or a breezeway that shares a slab with the garage.*

Slab perimeters must be insulated where the top edge of the slab is above grade, or less than one foot below grade (see Figure 6.6). The R-value to use depends on the results of your compliance analysis. If the slab edge insulation is on the exterior, the insulation must be protected with a rigid, opaque and weather-resistant barrier that extends at least 6" below grade (ECCCNYS 102.4.1).

Slab perimeter insulation must run all the way to the top of the slab. It may go down, or down and across, for a total of 24" (climates less than 6000 HDD) or a total of 48" (climates more than 6000 HDD). If you are using the ECCCNYS Chapter 6 tables, 48" slab insulation is required in climates over 5,500 HDD according to table 602.1. See Figures 6.7-6.8 for examples.

Note: "Heating Degree Days" (HDD) are a measure of how severe the heating season is. With the exception of the southeast corner of the state (Orange, Putnam, Rockland and Westchester Counties, New York City and Long Island), all of New York has a climate of greater than 6000 HDD.

Crawlspace

The floor over a vented crawlspace construction must be insulated to the same R-value as a floor over an unconditioned basement, according to the compliance analysis. The walls of an unvented crawlspace must be insulated according to the R-value shown in the compliance analysis for "crawlspace walls."

ENERGY STAR

To achieve the ENERGY STAR rating, you may need to put slightly more insulation in your basement walls (or the floor over the basement) than you would to meet the code. Other recommendations:

- Install at least 4" of uniform sized, washed stone underneath the slab floor. This acts as a capillary break to help prevent absorption of ground moisture. It also makes it easy to add a sub-slab ventilation system for radon mitigation, if radon is found after construction (see page 116).
- Insulate basement slabs, even in unheated basements. 1" of rigid polystyrene foam under the slab will keep it warmer in summer and

reduce the chance of condensation which can wet the slab and lead to mold and mildew. This will also improve comfort and reduce moisture problems if the basement is finished off later.

- Do not install carpeting on below-grade slab floors unless the slab is insulated under its entire area, and the foundation is well drained. Moisture from condensation on an uninsulated slab, or drawn up by capillary action can lead to hidden mold and mildew problems in carpets.
- Always insulate under the entire surface of radiant heated slabs, even though the code does not require it. Most radiant equipment manufacturers specify insulation under the slab; if you are heating the slab, the insulation will reduce heat loss and improve comfort. Because of the high temperature of radiant heated slabs, a minimum of R-15 rigid insulation is suggested even though manufacturers may recommend less.
- Try to avoid crawlspaces. Where you do build over a crawlspace, be certain that the vapor retarder on the crawlspace floor is completely sealed at all seams and penetrations, and sealed to the wall.

Conditioned or Unconditioned?

The choice of whether to insulate the basement is yours, unless you have an intentional heat supply. There are several reasons for and against constructing a conditioned basement space:

- People often want to use basements. Even if they are not finished space, people often use basements for laundry, projects, storage or other uses. They really don't want the basement to be a very cold space in winter. If they do finish off the space later, it will be easier if the basement is already insulated.
- It's easier to air seal the foundation walls. Floors are usually far leakier than foundation walls, and are also harder to seal.
- There's no need to insulate HVAC ducts or pipes in a conditioned basement, which can save money.
- Warm basements are less likely to have condensation and related mold and mildew problems than cold basements.
- Insulating foundation walls has potential pitfalls. Exterior insulation may provide pathways for insects, must be protected, and tied in somehow with the wall above. Interior insulation cools foundation walls, and if drainage and insulation details are not built carefully there is substantial risk of condensation and mold growth.
- Insulating walls often costs more than insulating the floor over a basement.

Going Further

Other issues to think carefully about when planning foundation details include:

- **Concrete movement** and cracking can result in callbacks, air leaks and water entry in foundations. EEBA includes a discussion of concrete movement and control joints—which can reduce or eliminate these problems—as well as other foundation issues.
- **Moisture, drainage and capillary breaks**—Foundations are built in the ground. Depending on where you build, the ground is either sometimes wet or always wet. All foundations should be built with good drainage and moisture protection.
- **Insect entry**—Termites and carpenter ants can tunnel through rigid foam insulation. If the foam insulation is between the ground and the wood frame of the house, they can use it as a way to get to the wood without being seen. For this reason some model codes have prohibited the use of foam insulation above grade in termite-prone areas. While the Northeastern and mid-Atlantic states are not generally considered to be termite-prone, termite protection still warrants consideration.

  Termites don't eat foam board, but they will eat wood, causing structural damage. Carpenter ants don't eat either one, but they will nest in both and over long periods can cause structural damage.

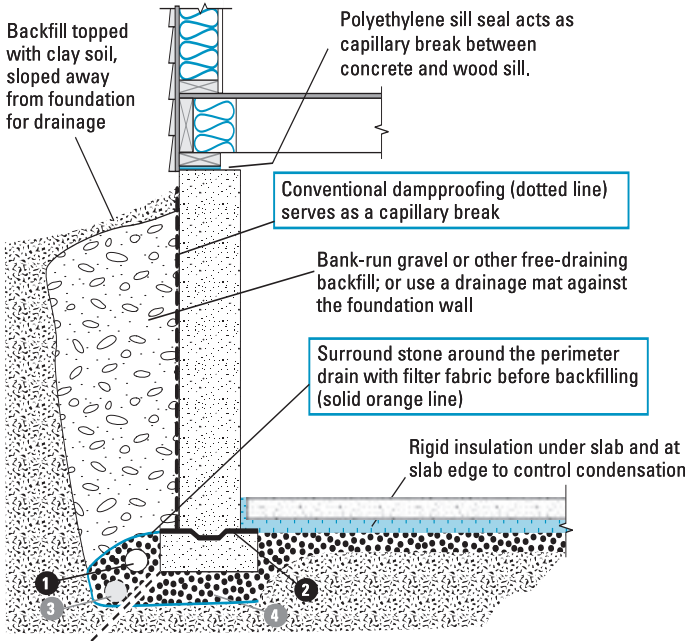
  There may be ways to effectively block insect entry from foam board to adjoining wood framing (or above grade foam sheathing); however, the details for such a system must be implemented very carefully. The energy code (and common sense) requires insulation in heated basements to the top of the foundation wall; after all, most heat loss occurs where the foundation wall is exposed above grade. You can't cut exterior foam board off at grade, so it may be better to insulate conditioned basements on the inside of foundation walls than to attempt an insect barrier between exterior foam and the wood framing.
- Alternative foundation systems—such as insulated concrete forms (ICFs) or precast concrete walls can speed up the construction process (especially in the winter) and provide a pre-insulated, airtight assembly. They can be very cost-effective, when compared to a poured concrete wall with a built-up insulated stud wall.
- Crawlspaces—Historically, many building codes have required passive vents in exterior walls and minimal vapor barrier protection for crawlspace floors. While this strategy may have helped to reduce moisture loads at times, it also introduced moisture in the summer when out-

door air is more humid than the cool crawlspace. Building science has shown that ventilating crawlspaces often does more harm than good, and codes are starting to catch up with the more sensible approach of building a tight crawlspace with good drainage and vapor control. In fact, national model energy codes are beginning to include exceptions that allow for unvented crawlspaces that are either vented to the interior, conditioned, or provide air to the return side of a heat and/or air conditioning system (IRC R408.2).

Basically a crawlspace should be built like a very short, conditioned basement (see Figure 6.9). There are three critical elements to consider: adequate footage drainage, thorough vapor barrier installation, and insulated walls. The vapor barrier should be at least 6 mils thick, and all seams must be sealed with a good quality tape (like 3M contractor's tape or Tyvek sheathing tape) or acoustical sealant. It should be mechanically fastened to the exterior walls, and all penetrations (including piers) must be sealed. Like any basement, it's important to keep inside air away from the foundation wall to prevent condensation.

FIGURE 6.1

Foundation moisture control*



1. Perforated drain pipe at footing level, drains downhill to daylight or to sump pit inside basement
2. Dampproofing or cement-based waterproofing applied to top of footing as capillary break between footing and wall (dark line)

Alternate Strategy—#3 and #4—more effective, where allowed by local codes. Note: the footing drain can only be installed below the footing level if the footing is completely supported by uniform sized washed stone, which is noncompressible. When in doubt about the bearing capacity of the underlying soil, consult a soils engineer.

3. Drain pipe installed below footing level (and beyond load bearing range of stone, as indicated by dotted line) to carry water away from footing
4. 4-6" *washed, uniform sized* stone (½" – 1½") under footing provides capillary break and drainage.

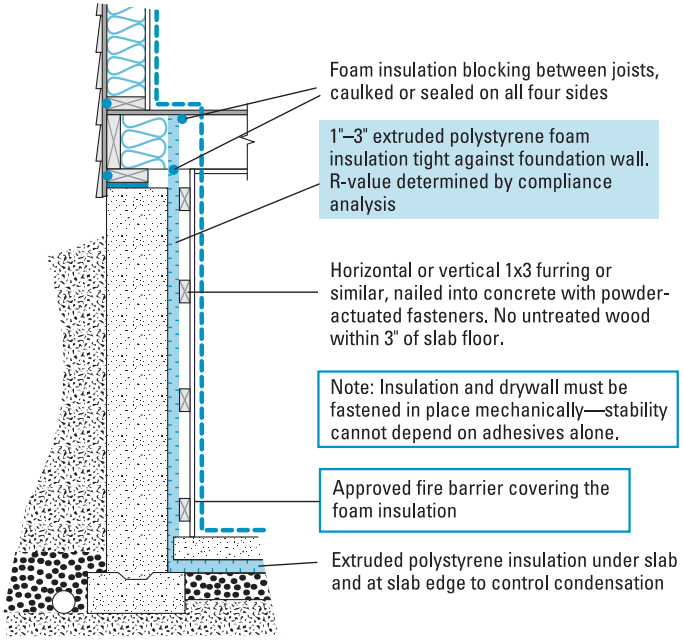
⚠ **CAUTION:** The stone surrounding the perimeter drain, under the slab and/or under footing must be uniform in size and washed (with no fine grains), to prevent settling or undermining.

TIP: One inch of rigid foam insulation under the slab will reduce the potential for condensation in the summer. Even if the foundation walls do not enclose conditioned space, condensation on the slab can contribute to moisture problems in the home.

***Note: *All* full and crawlspace foundations should incorporate these details.**

FIGURE 6.2

Conditioned basement or crawlspace with interior rigid foam



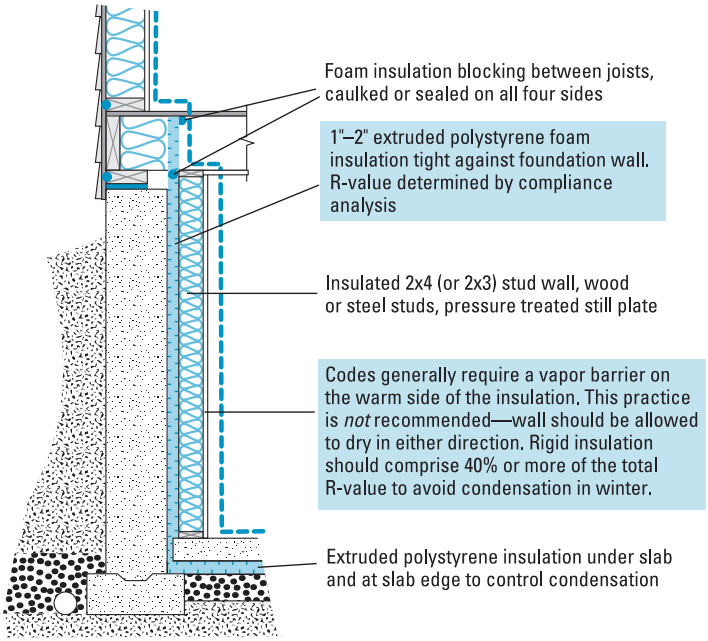
⚠ **CAUTION:** All vertical and horizontal joints in the insulation must be carefully sealed to prevent humid air from reaching the cool foundation wall, where it can condense.

TIP: Glass-faced gypsum board or cement "tile-backer" board is much less vulnerable to moisture than paper-faced drywall. It can be finished with the veneer (skim-coat) plaster. Use vinyl or fiber-cement components for base-board trim.

Foundation drainage and capillary break details not shown for clarity—refer to Figure 6.1.

FIGURE 6.3

Conditioned basement or crawlspace with interior stud wall



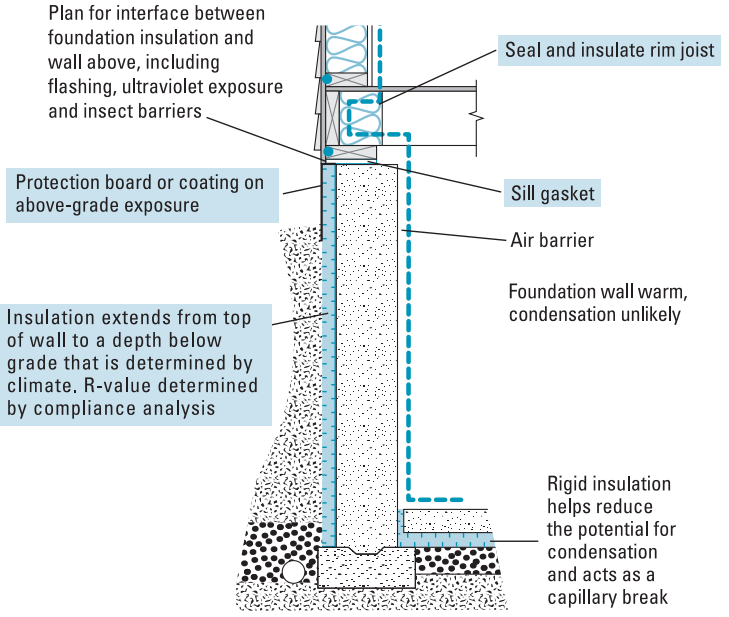
⚠ **CAUTION:** All vertical and horizontal joints in the rigid insulation must be carefully sealed to prevent humid air from reaching the cool foundation wall, where it can condense.

TIP: Glass-faced gypsum board or cement "tile-backer" board is much less vulnerable to moisture than paper-faced drywall. It can be finished with the veneer (skim-coat) plaster. Use vinyl or fiber-cement components for baseboard trim.

Foundation drainage and capillary break details not shown for clarity—refer to Figure 6.1.

FIGURE 6.4

Basement with exterior rigid foam

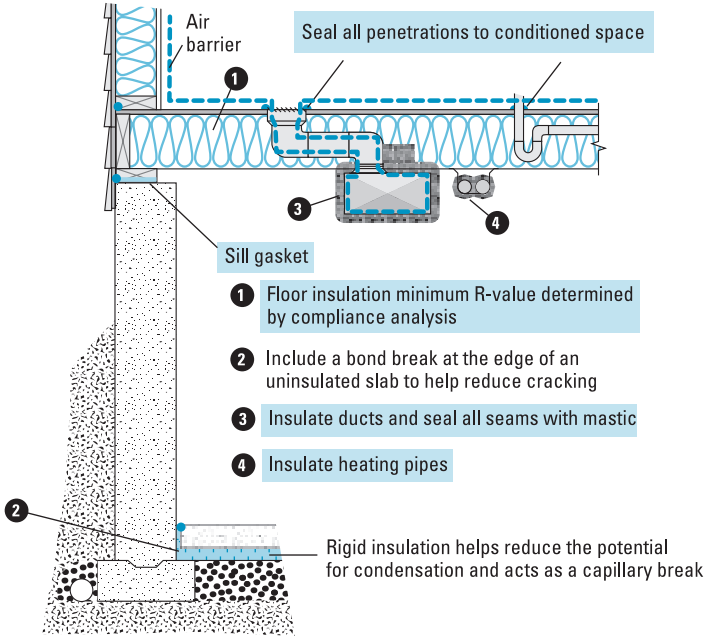


⚠ **CAUTION:** Exterior foam insulation may provide a pathway for termites and carpenter ants to reach framing. See page 33.

Foundation drainage and capillary break details not shown for clarity—refer to Figure 6.1.

FIGURE 6.5

Unconditioned basement



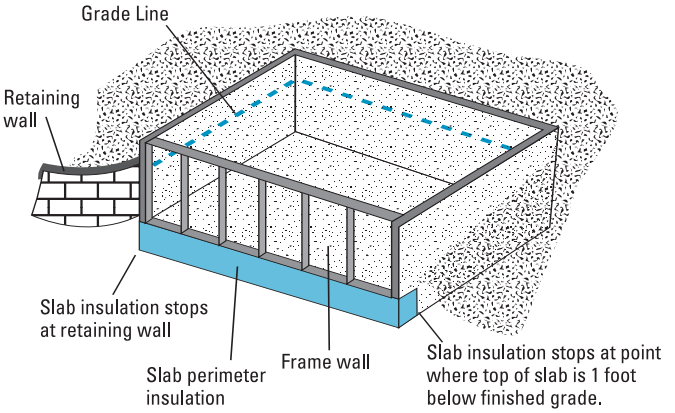
TIP: One inch of rigid foam insulation under the slab will reduce the potential for condensation in the summer. Even if the foundation walls do not enclose conditioned space, condensation on the slab can contribute to moisture problems in the home.

If conditioned space is adjacent to an unconditioned space (e.g., in a partially finished basement), then the wall between these two spaces must be insulated according to results of the compliance analysis.

Foundation drainage and capillary break details not shown for clarity—refer to Figure 6.1.

FIGURE 6.6

Slab edge insulation, walkout basement



This is a view of a basement with a frame wall on one side, showing the placement of slab perimeter insulation.

FIGURE 6.7

Slab on grade with interior insulation

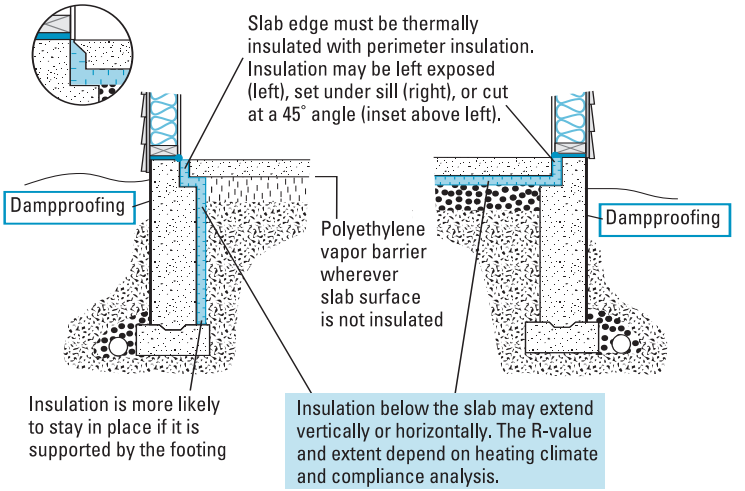
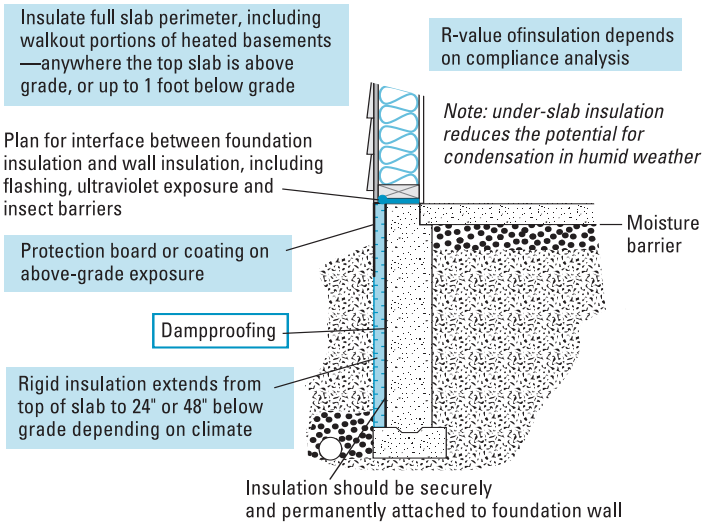


FIGURE 6.8

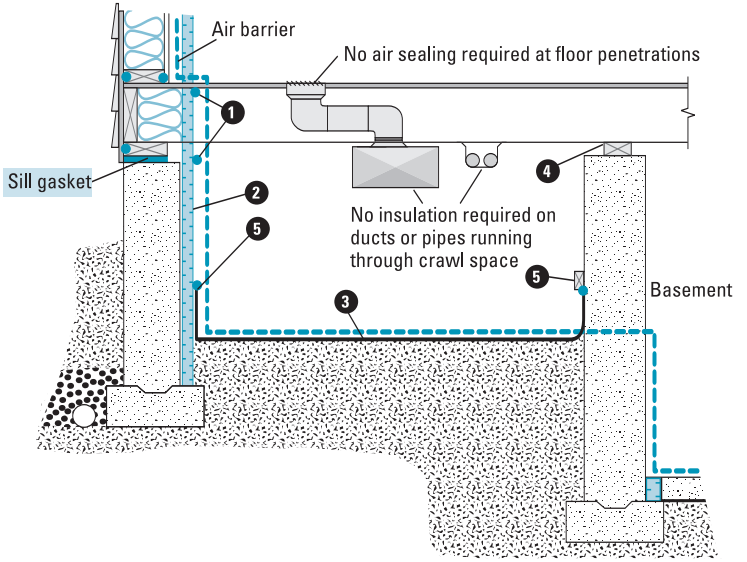
Slab on grade with exterior insulation



⚠ **CAUTION:** Exterior foam insulation may provide a pathway for termites and carpenter ants to reach framing. See page 33.

FIGURE 6.9

Conditioned, unvented crawl space with interior insulation



1. Foam insulation blocking between joists, caulked or sealed on all four sides
2. Insulation must be in substantial contact with wall, with no gaps between pieces. It also must extend—vertically or vertically and horizontally—from the top of the wall to a minimum of 24" linearly from ground level.
3. A minimum 4-mil thick polyethylene vapor retarder is required by most codes. It is highly recommended to install 6-mil or laminated poly, lapped 12" and taped at all seams, and mechanically fastened and sealed to all walls, piers, columns, and service penetrations
4. No air sealing or insulation needed next to conditioned spaces
5. Extend vapor retarder 12" up walls and columns, and attach with nailer and adhesive

TIP: To avoid moisture problems in crawlspaces, install the same drainage and capillary breaks as for a full basement (see Figure 6.1).

Foundation drainage and capillary break details not shown for clarity—refer to Figure 6.1.