Basements
Expansion of Conditioned Space

- Conditioned space boundaries moving towards exterior surfaces of building
- Garage isolated from house by air barrier/pressure boundary
- Garage ventilated and conditioned independently of rest of conditioned spaces
Mechanisms of Flow

- Liquid
  - Gravitational
  - Capillary
  - Osmosis

- Vapor
  - Diffusion
  - Convective

Hydrostatic Pressure
Suction Pressure
Solute Concentration
Vapor Pressure
Air Pressure
Roof overhang screens wall (deflects rain)

Site grading slopes ground away from building over entire perimeter
Rain water falling on roof is collected in gutters

Overhang protects the ground around the foundation from getting saturated

Down spouts carry rainwater from the roof away from the foundation

Capillary break under plate

Polyethylene vapor diffusion retarder in direct contact with concrete slab

Granular drainage pad (coarse gravel, no fines)

- Keep rain water away from the foundation perimeter
- Do not place sand layer over polyethylene vapor diffusion retarder under concrete slab
- Where vinyl flooring is installed over slabs, a low water-to-cement (w/c) ratio (≤ 0.45 or less is recommended) to reduce water content in the concrete; alternatively, the slab should be allowed to dry (less than 0.3 grams/24 hrs/ft²) prior to flooring installation
Rain water falling on roof is collected in gutters. Overhang protects the ground around the foundation from getting saturated.

Flash roof into gutter. Down spouts carry rainwater from the roof away from the foundation.

Ground slopes away from the foundation. Capillary break under plate. Polyethylene ground cover acting as both an air barrier and a vapor barrier.

Conditioned space. Interior grade of crawlspace higher than surrounding grade.

- Keep rain water away from the foundation perimeter.
- If the interior crawlspace is lower than the exterior grade, a sub-grade perimeter footing drain is necessary as in a basement foundation.
- The crawlspace is conditioned space; it is part of the “interior” of the building and should be heated, cooled and ventilated as part of the building’s heating, cooling and ventilating strategy.
Rain water falling on roof is collected in gutters.
Overhang protects the ground around the foundation from getting saturated.
Flash roof into gutter.
Down spouts carry rainwater from the roof away from the foundation.
Ground slopes away from the foundation.

Impermeable top layer of backfill (clay cap) prevents ground adjacent to foundation from getting saturated.
Free-draining backfill (or drainage board) filter fabric above and below drain pipe.
Coarse gravel (no fines).
Perforated drain pipe located below floor slab level (piped to sump or daylight).
Pipe connection through footing contracts exterior perimeter drain to granular drainage pad under basement slab.

- Keep rain water away from the foundation perimeter.
- Drain groundwater away in sub-grade perimeter footing drains before it gets to the foundation wall.

Concrete foundation wall.
Groundwater flow is downward (not horizontal) under the influence of gravity to the perimeter drainage system.
Capillary break over footing.
Slab isolation joint.
Polyethylene vapor diffusion retarder.
Granular drainage pad (coarse gravel, no fines).
- Patios and decks lower than floors and slope away from building
- Garage floor lower than main floor and slope away from building
- Driveway lower than garage floor and slope away from building
- Grade lower than main floor and slope away from building
- Stoops and walkways lower than main floor and slope away from building
- Kick out flashings or diverters direct water away from walls at roof/wall intersections
Control joint at steps in foundation wall

Control joints at corners

Control joints are sealed with flexible sealant at the exterior prior to backfilling

Control joints at window openings

Sealant

Diagonally cut 2 x 2’s in forms provide goose neck joint

Saw cut joint
Internally Insulated Basement
Externally Insulated Basement
Basement Insulated in the Middle
Basement Insulated Both Externally and Internally
Structure of house on foundation must be shifted outward to compensate for thickness of exterior insulation

Protection layer/system
Capillary break on exterior foundation wall

Capillary break under slab

Capillary break on top of footing
Continuous fillet bead of urethane sealant between 2" XPS bond break and foundation wall
Continuous fillet bead of urethane sealant between 2" XPS bond break and concrete slab
2" XPS bond break
4" concrete slab with welded wire mesh placed at mid-depth
6 mil polyethylene vapor barrier
2" XPS rigid foam slab insulation
Embedded hydronic tubing

Free-draining backfill
Liquid-applied capillary break (must dry tack-free) applied on top of footing prior to placing/casting concrete foundation wall
Keyway
Filter fabric placed under perimeter drain and wrapped around gravel
Coarse gravel (no fines)
4" PVC pipe through bottom of footing connecting interior and exterior gravel beds
4" perforated perimeter drain

4" gravel pad (no fines)
Filter fabric
Undisturbed native soil or engineered fill as determined by soil conditions
Continuous concrete footing 2'-0" wide and 10" deep
Sealant, adhesive or gasket (typ.)

Drainage plane

Sealant

Sill gasket (capillary break)

$\frac{3}{8}''$ fiber cement
Spray foam
Sealant

Drainage plane/housewrap

Capillary break
Spray foam
1/2" steel stud assembly
Concrete foundation wall
Gypsum board

Bond break
Sill seal thermal break and capillary break
Concrete slab

Dampproofing
Filter fabric
Coarse gravel (no fines)
Perforated drain pipe

Capillary break over footing (dampproofing or membrane)
Concrete footing

Polyethylene vapor barrier
Granular capillary break and drainage pad (no fines)
Crawl Spaces
Crawl spaces must be completely connected to either the outside or the inside.
Crawl spaces must be completely connected to either the outside or the inside. Vented crawl spaces work. Unvented conditioned crawl spaces work.
Don’t Do Stupid Things
Leaky air handling unit and supply ducts

Air handling unit

Supply

Return

Supply

Depressurized conditioned space inducing infiltration
Diagram illustrating air handling unit supply and return systems.
Smart Thing
Continuous polyethylene vapor diffusion retarder/air flow retarder

Membrane sheet waterproofing under steel column or masonry pier

All joints/seams taped

Interior crawl-space concrete support pad

Masonry support pier

Steel support column

Capillary break
Conditioned Crawlspace Not Unvented Crawlspace

Need Supply Air

50 cfm/1000 ft² of Crawlspace Area

Or

Dehumidification
4x10 transfer grille to first floor conditioned space

Interior wall

Subfloor

Floor joist

Duct open to crawlspace
Alternative Detail

Unfaced cavity insulation, cellulose or low density spray-applied foam insulation

Gypsum board with (latex) paint

Sealant, adhesive or gasket

Sealant at corner of bottom plate and subfloor or gasket under bottom plate

Unfaced cavity insulation, cellulose or low density spray applied foam

Sealant

Sill gasket

Protective membrane also acts as capillary break

Top courses filled solid

Rigid insulation (fire rated) (taped or sealed joints)

Masonry foundation wall

Continuous polyethylene vapor barrier/air barrier (all joints taped) taped to perimeter rigid insulation

Capillary break over footing

Concrete footing below frost depth

Dampproofing

If exterior grade is lower than interior crawl space grade, no perimeter drain is necessary

Ground slopes away from wall at 5% (6in. per 10ft.)

Rigid insulation

Adhesive

Protective membrane

Building paper (behind rigid insulation)

Stucco
Smart Thing
Any type of flooring/floor finish

Floor sheathing (OSB or plywood)

Foil-faced isocyanurate
Slabs
Latex paint (vapor permeable, but water repellent)

Polyethylene "skirt" attached to form; remains in place after form is removed

Capillary break under framing (polyethylene strip)

Capillary break (plastic/polyethylene ground cover) extending under grade beam and upwards to grade
Plain
Hollow Back
Scratch Back
Hollow or Scratch Back
Roof flashing

Vent stack

Continuous polyethylene vapor barrier/air barrier (all joints taped)

Polyethylene mechanically attached to foundation wall perimeter and sealed

Perforated drain pipe trench covered with course gravel (no fines)

Sealant at all penetrations in air barrier

Perforated drain pipe at perimeter connected to vent stack
Perforated drain pipe added to "T" in order to couple sub-slab pressure field to vent stack.
Continuous exterior insulation

Cladding

Rodent protection for continuous rigid insulation

Cellular PVC protection board

For insect protection provide 3'-0" of mulch and then drought-resistant plants

Ground slopes away from wall at 5% (6 in. per 10 ft.)

Rigid insulation

Cavity insulation

Gypsum board

Flashing set in mastic sealed to slab

Sealant, adhesive or gasket

Sill gasket

4” Concrete slab

4” granular capillary break and drainage pad (no fines)

Concrete grade beam

Polyethylene vapor barrier extended under grade beam where it also acts as a capillary break
Flashing set in mastic and sealed to slab

Removable strip of insulation and protection board
Brick veneer
Air space
Rigid insulation
Flashing under rigid insulation
Flashing set in mastic and sealed to slab and sealed to concrete grade beam for brick veneer
Fiberglass tie
Cavity insulation
Gypsum board
Sealant, adhesive or gasket
Sill gasket
Concrete slab
Granular capillary break and drainage pad (no fines)
Rigid insulation
Concrete grade beam below frost depth
Polyethylene vapor barrier extended under grade beam where it also acts as a capillary break

Ground slopes away from wall at 5% (6 in. per 10 ft.)
Concrete grade beam for brick veneer