Building Science Bootcamp Foundations and Slabs

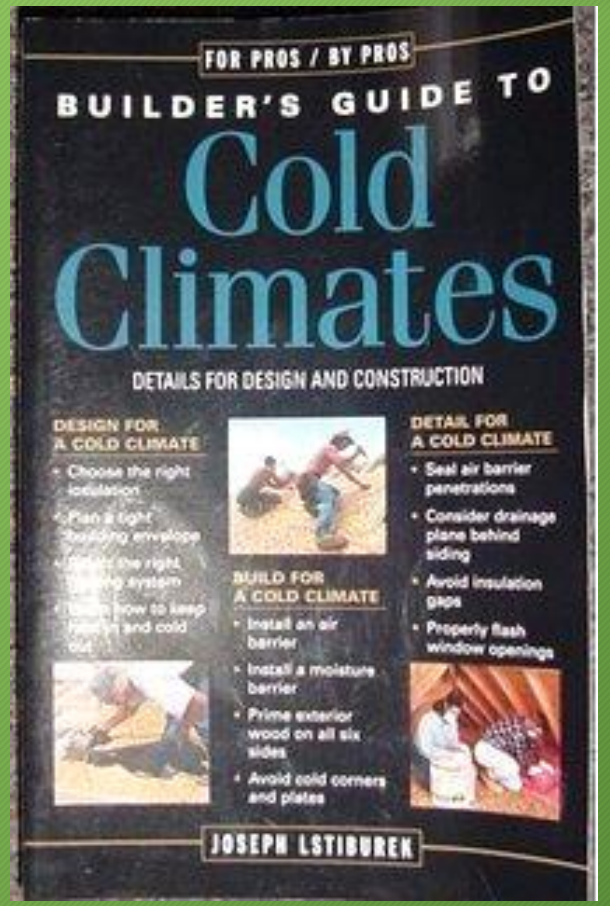
Understanding the Impacts on Comfort and Efficiency of Slab-on-Grade and Below-Grade Foundation Insulation

Building Science Bootcamp
Foundation and Slab Efficiency

Builder's Guide to Cold Climates

- The information in this training module follows the "best-practices" described in this manual,
- Manuals are by climate/region, and book costs about $100 used online,
- Cities include: **Denver,** Chicago, Boston,

And warmer climates like Las Vegas, Phoenix, Houston, Atlanta, etc.



Joseph Lstiburek,
Building Science Corp.

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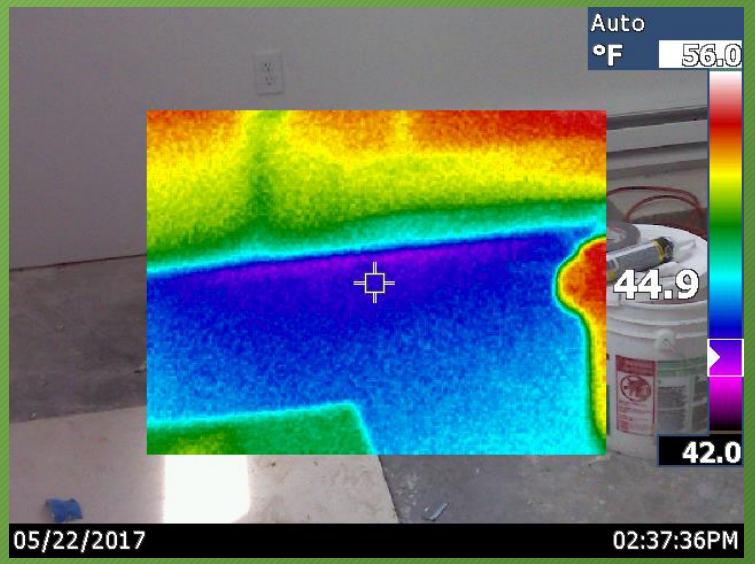
Question: Which code update first required basement and/or slab-edge insulation?



Answer: *2006, leaving countless uninsulated basements from prior building booms!*

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Foundation/Basement Wall Insulation:

- Inexpensive,
- Very Effective,
- Improves Comfort,

Need a blanket in the basement?

ANNUAL SAVINGS WITH BASEMENT WALL INSULATION

The energy savings of basement wall insulation vary depending on the local climate, type of heating system, cost of energy, and lifestyle of the occupant. Typical annual savings are provided in the table for a standard, 1,500 square-foot home with a conditioned basement that is heated by natural gas ($0.72/therm).

U.S. Cities	R-10*	R-20**
Buffalo, NY	$350	$390
Denver, CO	$310	$360
Minneapolis, MN	$400	$450
Seattle, WA	$280	$320
St. Louis, MO	$250	$290
Washington, DC	$250	$280

* Such as 2 to 3 inches of exterior foam insulation.

** Such as with most insulated concrete forms.

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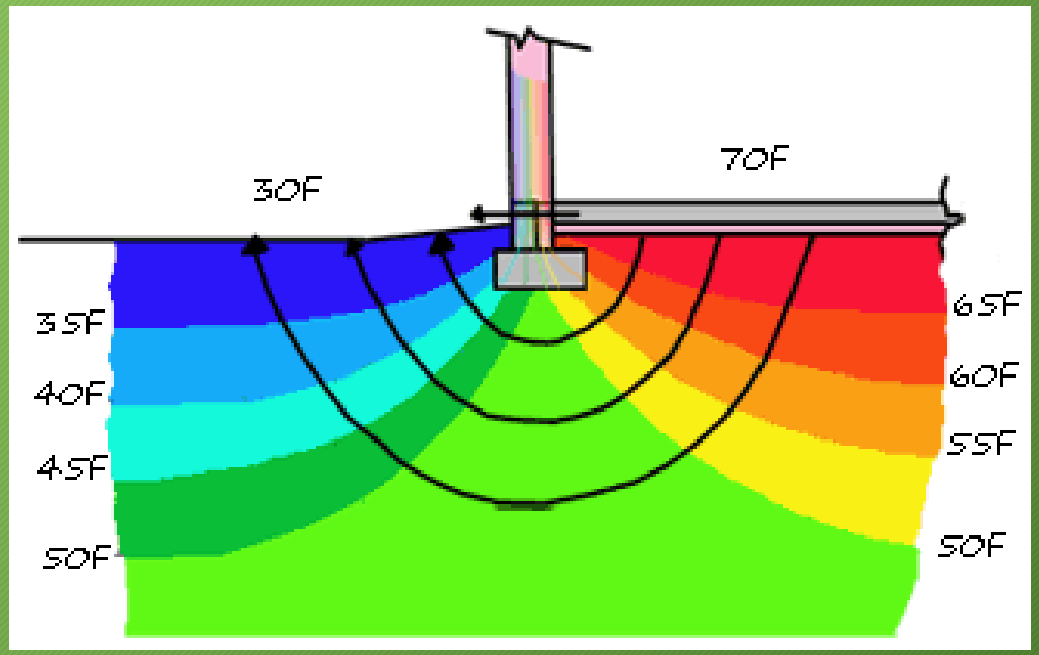
Slab-Edge and Slab-on-Grade:

- Frost-line is about 30” deep in Front Range, and 44” inches deep in the Mountains,
- Losses are constant, and nearly infinite…
- There is no limit to the amount of heat the frozen earth will remove from a building.
- Foundations once relied on heat escaping from the building into the ground to prevent freezing and frost heaving.



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Slab-on-Grade Heat Losses:

- It takes *20,000 BTU's* of heat an hour* to replace the heat absorbed or lost, per 1,000 square feet of uninsulated foundation wall or slab-on-grade floor.
- Making up for these losses with the typical residential HVAC system is very challenging, as these parts of the home are almost always colder than the rest.

**BTU = British Thermal Unit, about the heat produced from a single lit match.*

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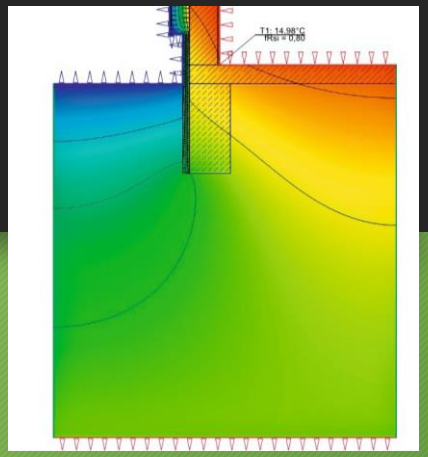
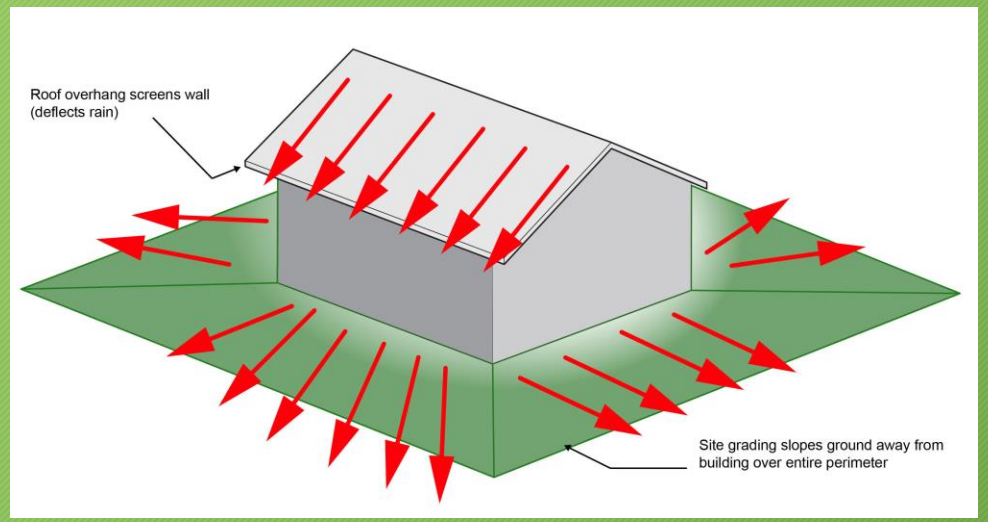
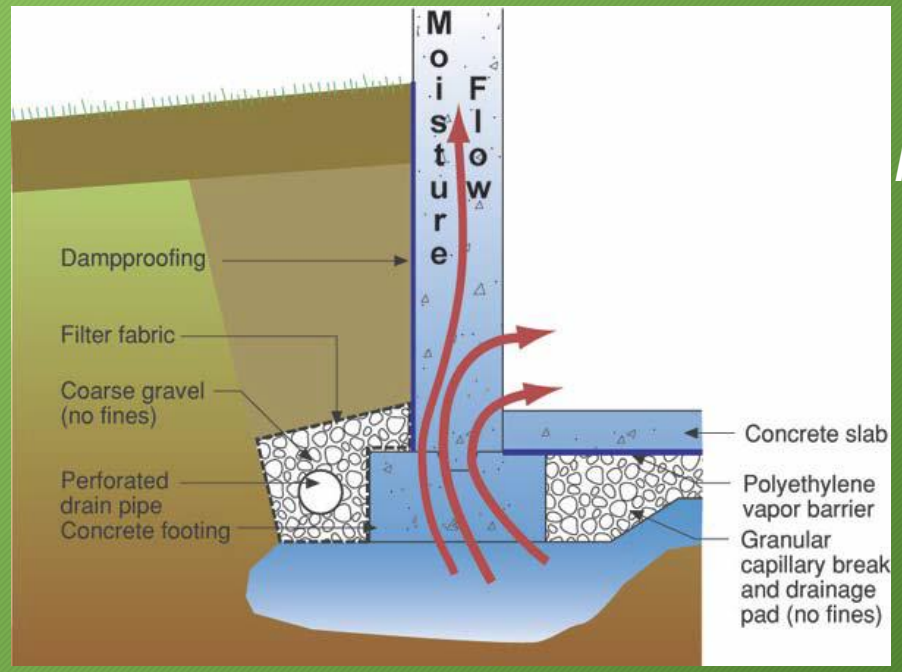


Heat flows out

Foundations are subject to:

- High vapor-pressure, from run-off, etc.
- Condensation risk to adjoining lumber, like wall and floor assemblies,
- Constant winter heat losses,





Moisture flows in (and radon)

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Soil Moisture:

- **Dries-out slowly, at the rate of one foot in depth per month of dry weather (for clay soils),**
- Gutters, downspouts, and extensions essential,
- Irrigation can cause problems,
- Large parking lots and commercial areas adjacent to residential areas = run-off,
- Low-lying neighborhoods along river, creek, and lake shores.

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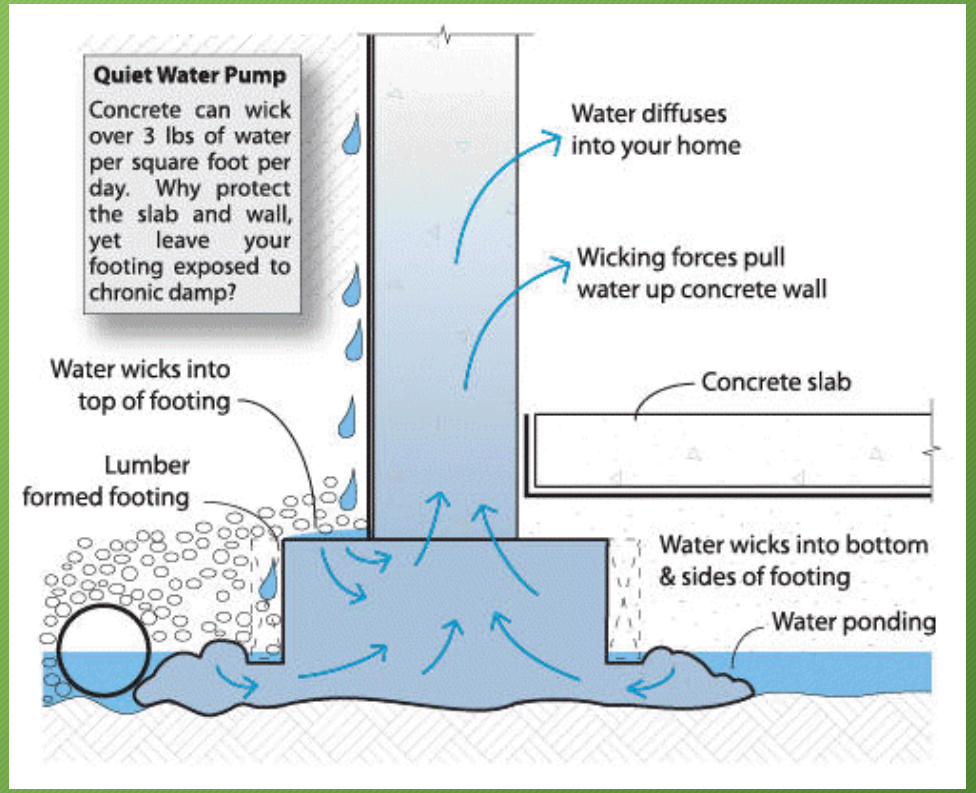
Foundations and Slab Moisture

Below-grade moisture issues are common, and can affect building durability, or create mold, or other indoor air-quality issues:

Concrete wicks water...



And should *"dry to the inside"*

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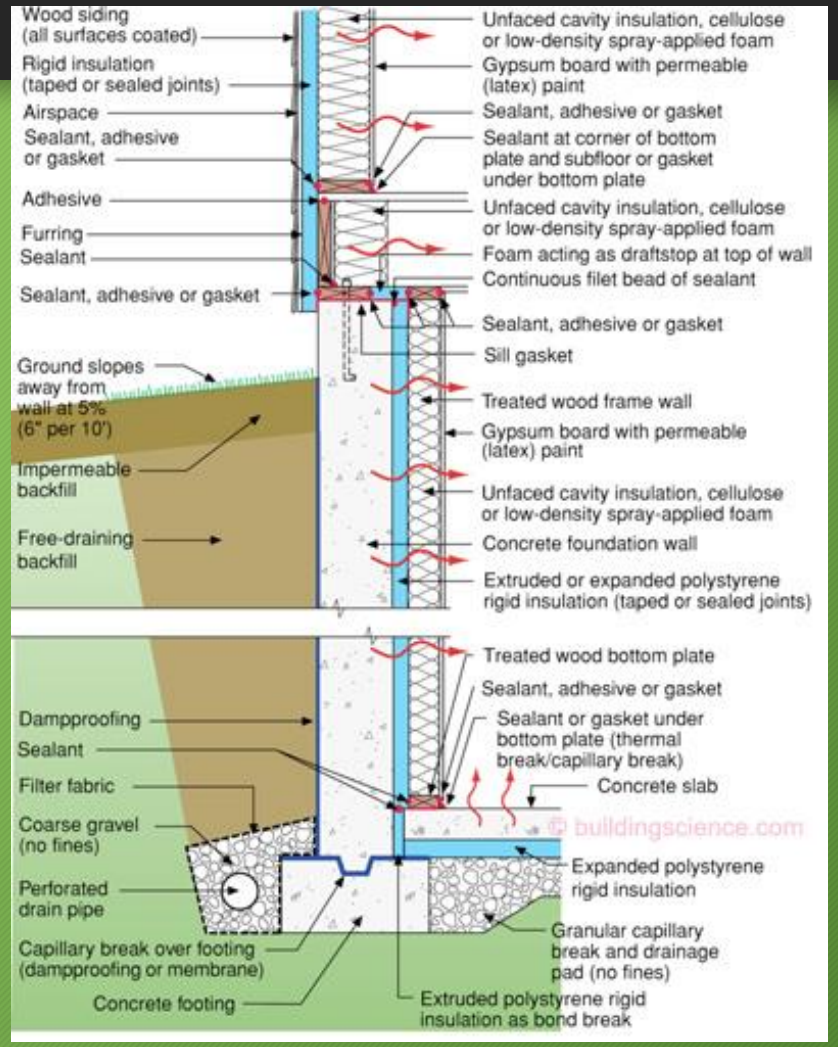
Key Features of Well-Deigned Slabs and Below-grade Walls:

- Exterior damp-proofing,
- Drainage (and good gutters),
- *"Vapor-open" i*nsulation for interior-side,
- Allows "*Drying to the Inside*",
- Consistent contact w/foundation,
- Mechanically fastened.

Diagram from Builder's Guide to Cold Climates, by Joseph Lstiburek, Building Science Corp.



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Foundation and Slab Moisture

Problems "Drying to the Inside":

- Don't use closed-cell spray-foam,
- No vapor-proof barriers covering wall or mudsill and rim-joist,
- With nowhere else to go, concrete moisture wicks into, and rots floor-frame (bottom right),
- Vapor-proof soil-gas liners should stop at footer / base of wall, to allow drying to the inside.

Below-grade low-perm rated materials = Too Risky!

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Foundation Insulation:

- PERFORATED vinyl-faced fiberglass drape, at right
- Perm-rating = >10 perms,

  (*same perm-rating as Tyvek*)
- Very small “dots” visible upon close inspection.

NOTE: basement/foundation wall insulation is not the same product used for commercial building above-grade applications, and is commonly considered interchangeable, but this is a mistake.

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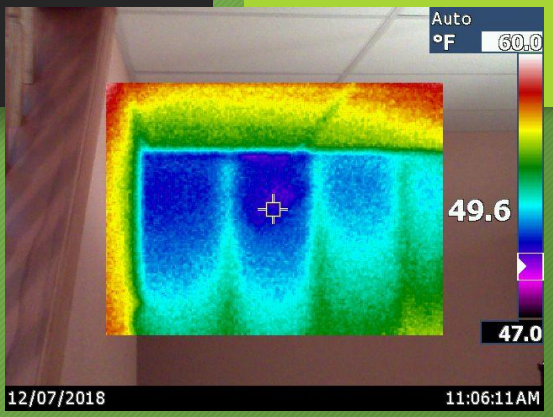
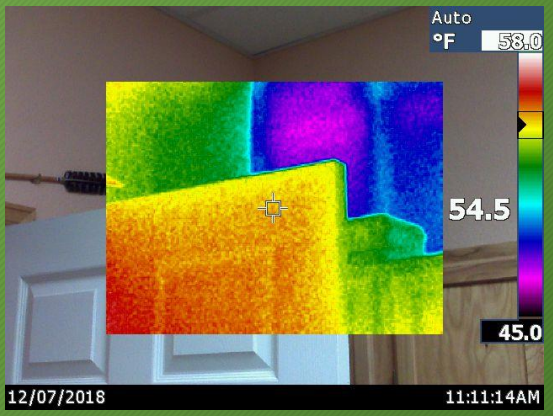
Un-permitted *"Finished"*
Basements:

- Walls often un-insulated,
- Higher building heating costs,
- Discovered at re-sale inspection,
- Too cold in winter to utilize/occupy,
- Costs 3.5x times more to retrofit than to insulate during construction.





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Energy-Code Question:
Should above-grade *"Skirts" be allowed in heating dominated climates?*

- Impossible to air-seal,
- Cold-ground absorbs heat from home,
- Heat easily passes through the ground and under the skirt to the outdoors,
- Ductwork is essentially unconditioned,
- Classic example of lowest upfront cost with highest long-term operational costs (especially w/electric or propane heat).

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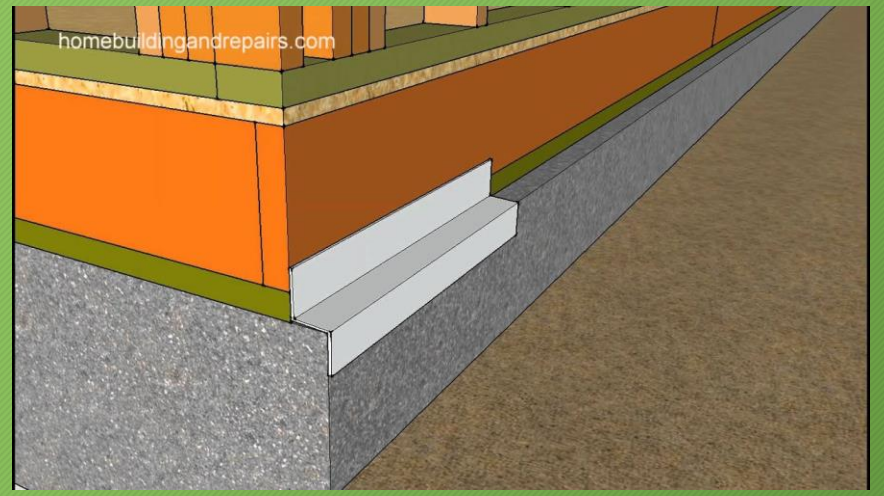
Slab-Edge Insulation Details: Flashing & Durability:
It has been challenging for some builders to resolve flashing and exterior foamboard protection issues with this code update, especially as an afterthought.

Homemade and It Shows.



Flashing Detail

Trim/Siding w/Exterior Foamboard

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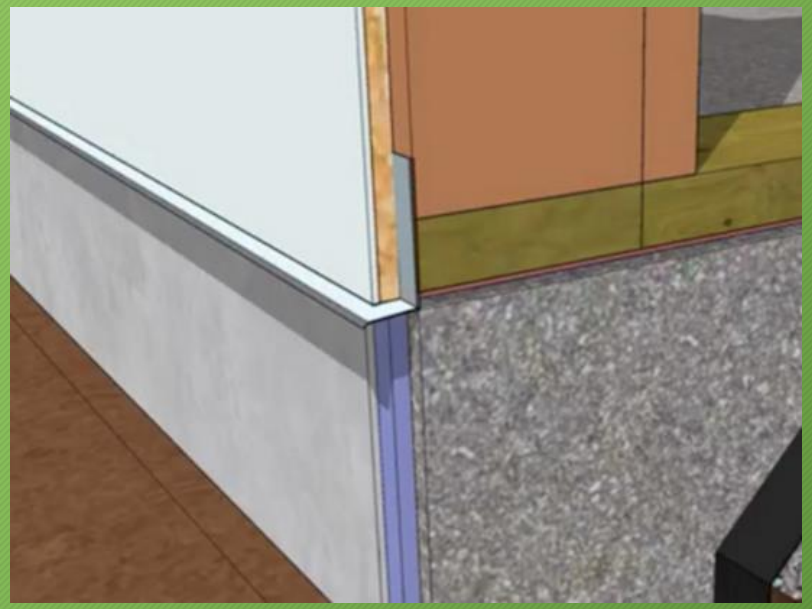
New Slab-Edge Insulation Protection products have arrived, like:

WallGUARD® – Concrete Faced Insulated Perimeter Wall Panels



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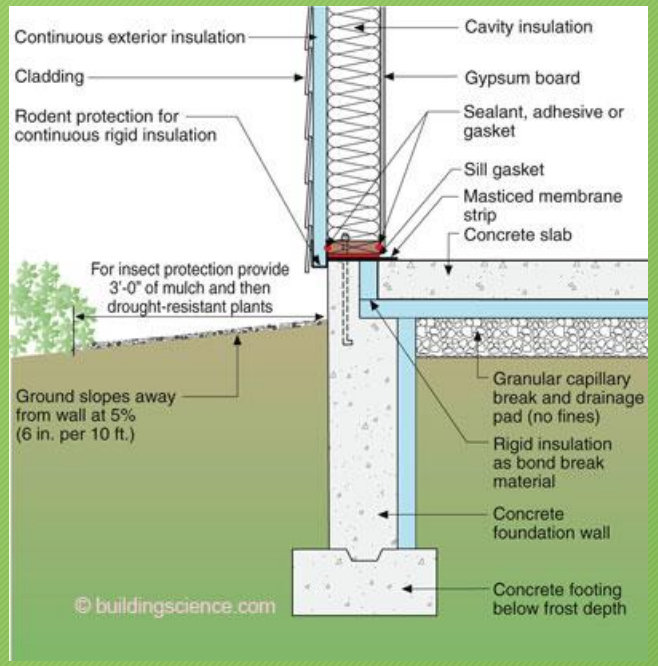
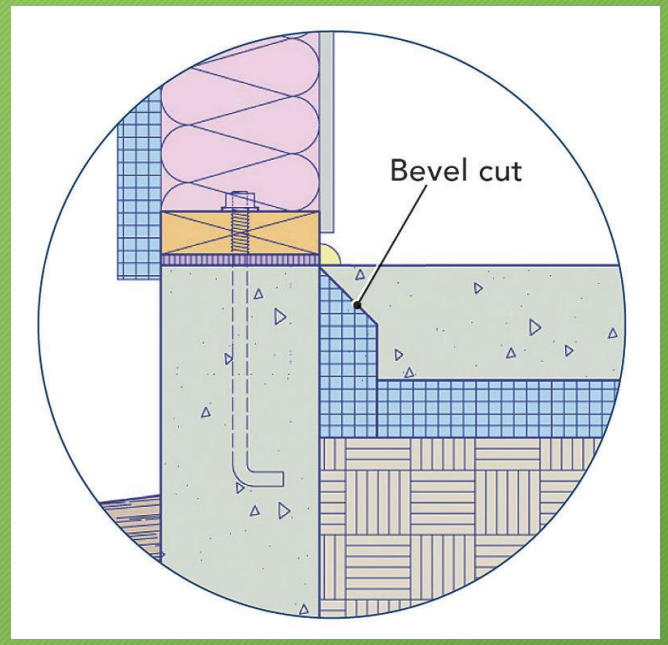
Examples/ideas for concrete, foamboard insulation, and wall junctions:

- Advantages of beveled-cut provides builders with peace of mind when framing exterior walls and provides consistency for flooring sub-contractors as well.
- Settles *"hanging bottom-plate worries"*.





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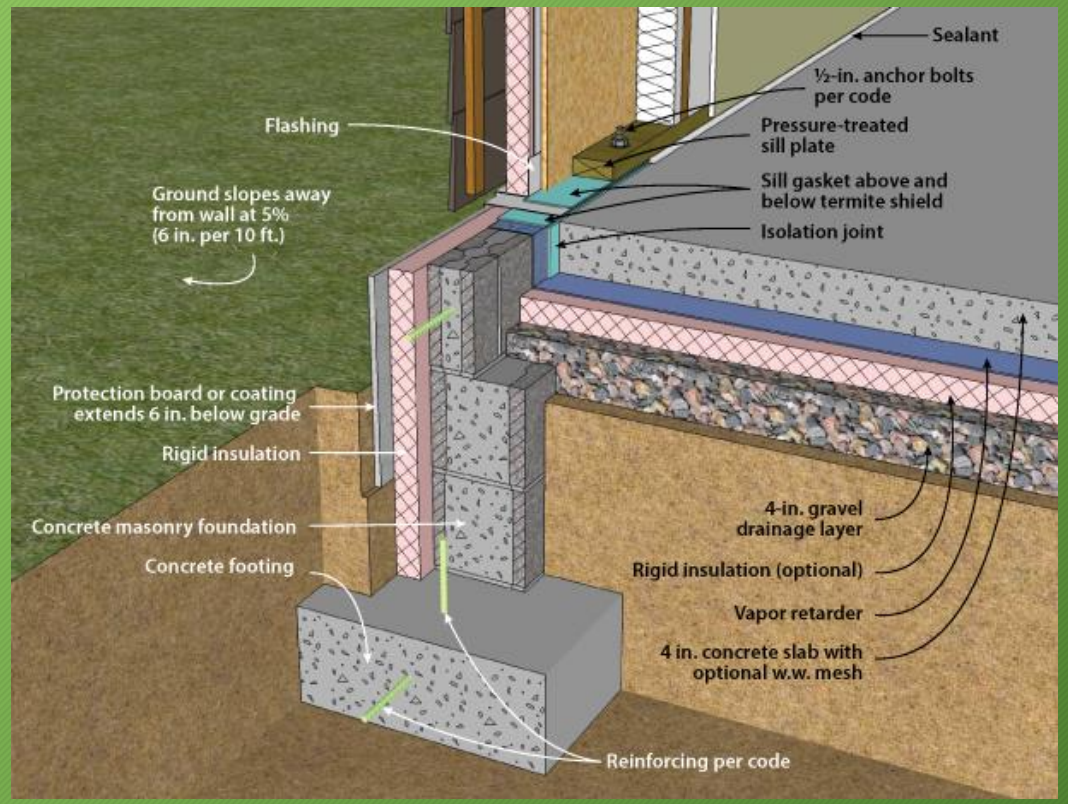
Slab-Edge and Under-Slab Insulation:

Best Aspects of This Assembly Profile:

- Continuous exterior insulation from wall above to foundation below,
- Bottom-plate of exterior wall rests firmly and squarely on concrete foundation.



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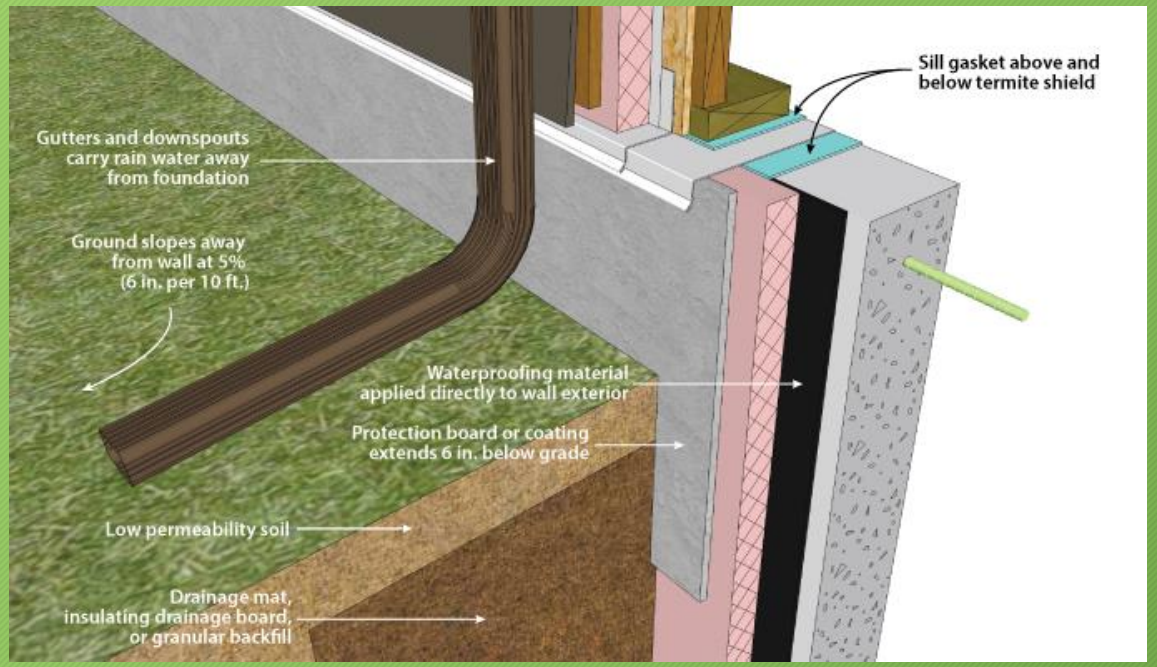
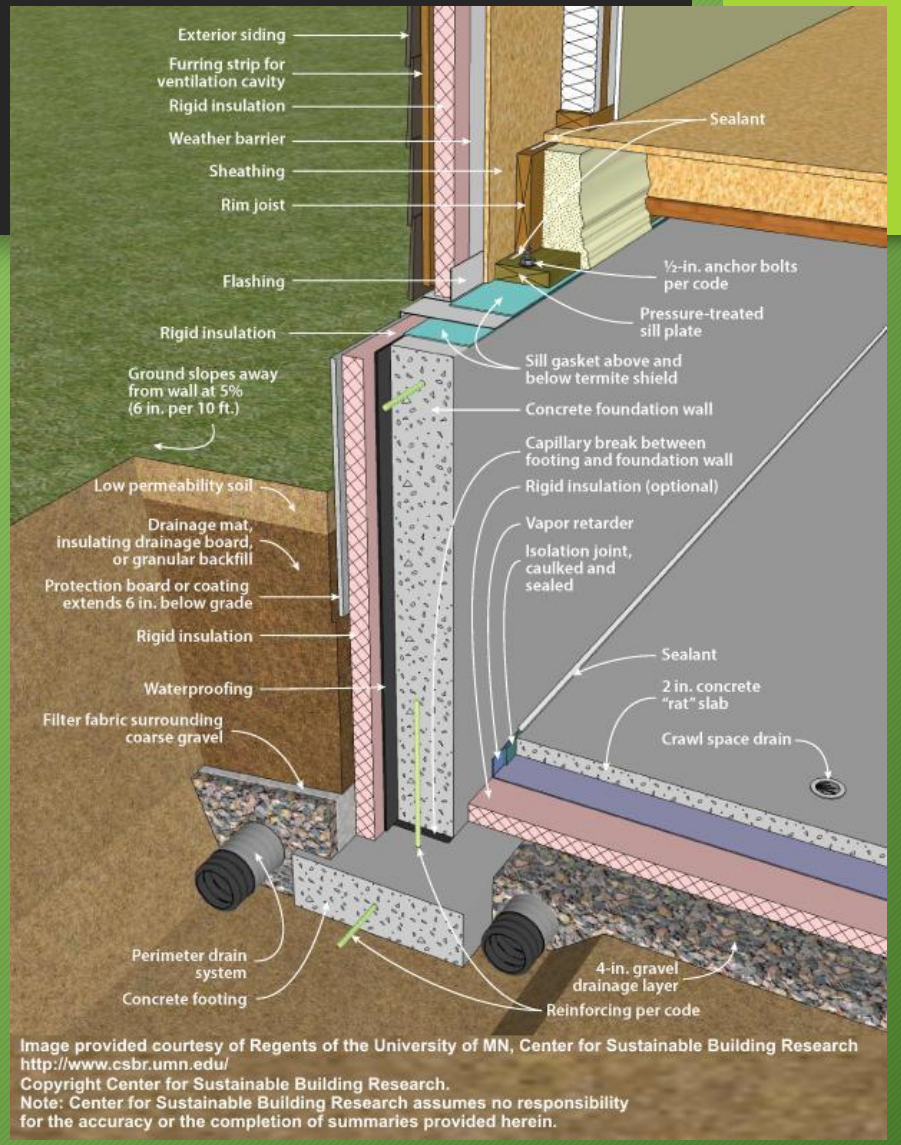
Diagrams of insulated foundation/slab details with: flashing, damp-proofing, capillary breaks, sealants, rock-board, framing, and foamboard insulation.





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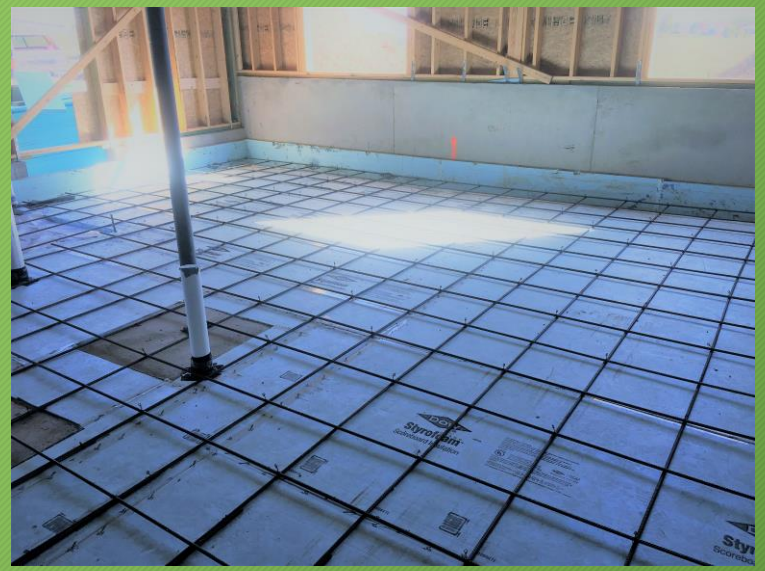
Energy-Star Certification: $2,500 Tax Credit

- Building must have 50% lower heating and cooling costs vs. 2006 Code.
- Below-slab insulation is *"low hanging fruit"* to achieving better HERS Score.



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Basement Slab Insulation:

- **R-value of 8” of Concrete = R1.3**
  (the same as a single-pane window)
- ***20,000 BTUs LOST per 1,000 sq ft***,
  per-hour during heating season,
- Energy code requires slab insulation for hydronic/boiler in-floor radiant heating systems, but benefits all homes in the long run.

“Isn’t the ground 55° degrees?
Yes, once you reach a depth of 12 ft, and even that’s 20-degrees below indoor temps. It can be below-freezing to a depth of 4 ft.

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Walk-Out Basements:

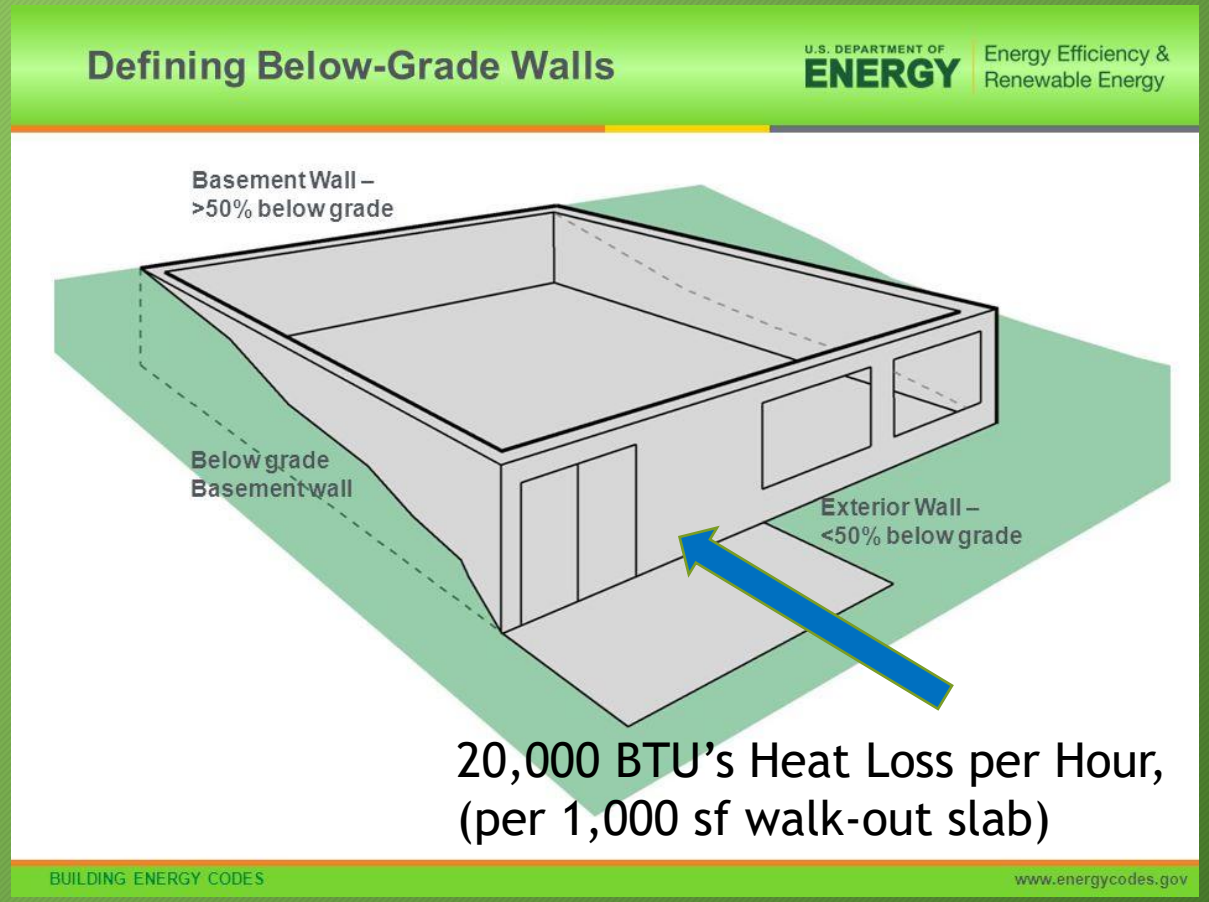
- Common reason for comfort complaints,
- *"Too cold"* to utilize/occupy in winter, (especially when north facing)

Questions and Concerns:

- Is this a *"below-grade"* basement slab, or *"slab-on-grade"* foundation,
- Above-grade vs. below grade walls?,

Answer:

Energy-modeling software like the REMRate HERS-Score and Manual JDS consider it to be 50% below-grade & 50% slab on-grade.



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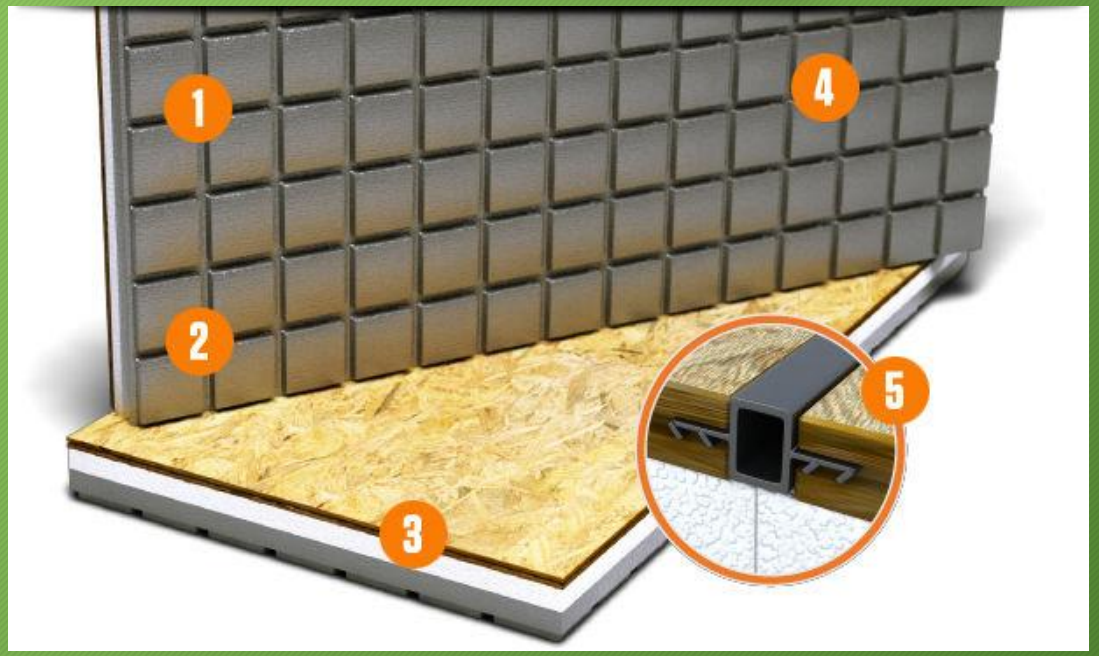
Retrofit Insulated Subfloor Panels:

- Slab-on-Grade Retrofit and Basement Finishes,
- Garage to Living Space Conversions,
- Older Tri-Level Homes w/ Ground-Level Slabs,
- Materials = $3 per square foot, w/connectors.
- R-value = R7 (prevents 85% of heat loss).



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Pre-lightweight concrete pour in basement w/radiant floor heat:

Slab-on-grade office finish w/R-7 poly-iso, T&G OSB, laminate:

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Above-Code Basement Finish:

- Walls = 1” ESP vapor-open R3 foamboard insulation, plus R-13 unfaced fiberglass,
- Floors = 1.5” XPS foamboard insulation w/laminated OSB plywood.

Greatly reduced winter heat losses for very low heating cost and exceptional comfort.

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To Learn More about Energy Codes or Green Building, please contact:

Community Development

https://www.larimer.org/building

Building: 970-498-7700 or

Planning: 970-498-7683

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