Exterior Edge Insulation for Existing Foundation Slabs

Scope

In cold climates, install slab edge insulation when retrofitting existing slab-on-grade foundations.

- Remove dirt to fully expose the edges of the existing slab.
- Clean the exposed slab edge and apply damp proofing as a capillary break.
- Install non-moisture-sensitive rigid foam board insulation (such as extruded polystyrene [XPS] or mineral wool) along the edge of the slab of a slab-on-grade foundation to meet or exceed the insulation R-value required by code.
- Install from the top of the slab down to the depth required by code unless a termite inspection gap is required.
- Install a metal, cement board, or cellular PVC panel to conceal any portion of the insulation left exposed above grade. Note that if cement board is used, it should be a type that is not reinforced with wood fibers, or if it does contain wood fibers, it should be coated with acrylic latex paint on all six sides to protect it from water damage.
- Install a metal cap as an insect guard that conceals the top horizontal edge of both the insulation and the closure panel. Seal the cap to the slab edge with mastic. The metal cap and mastic should be continuous around the building perimeter.
- Replace the backfill, sloping away from the building.

See the U.S. Department of Energy’s Standard Work Specifications, for more on insulating slab foundations as well as information on general safe work practices.

See the Compliance Tab for related codes and standards requirements, and criteria to meet national programs such as DOE’s Zero Energy Ready Home program, ENERGY STAR Certified Homes, and Indoor airPLUS.
Description

In climates where the average monthly temperature for the coldest month of the year goes below 45°F, the temperature of the slab perimeter may be below the dew point of the interior air for a significant period of time.

Even when condensation conditions are not present on the slab surface, relatively cool temperatures near an uninsulated slab edge will tend to elevate the local relative humidity. As relative humidity rises, so too does the risk of mold, mildew, fungal growth, dust mites and other pests. This is a particular concern for carpeted slabs as the carpet can provide a medium and cover for these biological risks.

The installation of insulation over the edge of existing foundation slabs reduces the risk of these failures by increasing the temperature of the slab at the building perimeter during winter months and also increases both energy efficiency and thermal comfort. Rigid, non-moisture-sensitive insulations can be installed (extruded polystyrene (XPS) and mineral wool are most common) even over the edges of existing slabs after the building has been completed. This work can be performed by general contractors during new construction or by homeowners looking to improve the comfort and durability of their existing house.

Follow “How to” steps below for retrofitting insulation over existing slabs. For information on insulating slabs of various configurations in new construction, refer to the BASC Solution Center Guide “Slab Edge Insulation.”

How to Insulate an Existing Foundation Slab

1. Remove dirt and backfill to fully expose the existing slab edge.
2. Clean the exposed slab edge and apply damp proofing as a capillary break.
3. Install rigid non-moisture sensitive insulation (extruded polystyrene (XPS) or mineral wool, for example) along the edge of the slab for a slab-on-grade foundation to meet or exceed the insulation R-value required by code.
4. Install from the top of the slab down to the depth required by code unless a termite inspection gap is required.
5. Install a metal, cement board, or cellular PVC panel to conceal any portion of the insulation left exposed above grade. Note that if cement board is used, it should be a type that is not reinforced with wood fibers, or if it does contain wood fibers, it should be coated with acrylic latex paint on all six sides to protect it from water damage.
6. Install a metal cap as an insect guard that conceals the top horizontal edge of both the insulation and the closure panel. Seal the cap to the slab edge with mastic. The metal cap and mastic should be continuous around the building perimeter.
7. Replace the backfill, sloping away from the building.

Figure 1. Rigid foam insulation is installed along the exterior edge of an existing foundation slab. (Image courtesy of Building Science Corporation)
Ensuring Success

Make every effort to install insulation in such a way that it is in direct contact with the damp-proofed slab edge. This may be difficult if the slab edge is not completely flat. A semi-rigid (but non-moisture sensitive) insulation (such as mineral wool) may be used to better track with the profile of the slab, or you may wish to grind the slab edge to make it smooth. Note, however, that even when drainage mats are used between rigid insulations and concrete walls, the reduction in thermal performance from separating the insulation from the substrate is only about 3%-5%. In most cases, a perfectly flat slab edge is not required to achieve excellent performance. For similar reasons, taping the joints in the insulation is not required, although it may help keep the insulation in place during backfill. Any tape compatible with the insulation may be used (acrylic construction tape is typical).

A thermal camera can be used to evaluate the effectiveness of the insulation at the slab edge from the exterior. A close match between slab temperature and the outdoor air temperature reveals minimal heat loss at the base of the building.
Climate

Slabs in different climate zones require different levels of thermal protection. Refer to the Compliance tab for code requirements.

Note that some local codes include provisions for termite protection. In areas where termite inspection strips are required, the insulation and cover panel should be held down from the top of the slab and the slab edge left exposed along the upper edge. The amount of slab edge to remain exposed is dictated by the local code.
Training

Right and Wrong Images

Display Image: Picture2.png
None Available
Compliance

The Compliance tab contains both program and code information. Code language is excerpted and summarized below. For exact code language, refer to the applicable code, which may require purchase from the publisher. While we continually update our database, links may have changed since posting. Please contact our webmaster if you find broken links.

2009 - 2018 International Energy Conservation Code (IECC) and International Residential Code (IRC) Minimum Insulation Requirements: The minimum insulation requirements for ceilings, walls, floors, and foundations in new homes, as listed in the 2009, 2012, 2015, and 2018 IECC and IRC, can be found in this table.

2009, 2012, and 2015 IECC

Section R402.2.9 (R402.2.10 in 2018 IECC), Slab-on-grade floors. Slab insulation requirements are shown in Table R402.1.1 (Table R402.1.2 in 2015 IECC). R-5 must be added to the requirement for heated slabs. The insulation depth is to the depth of the footing or 2 feet, whichever is less in Climate Zones 1-3 (for heated slabs).

2018 IECC

R402.2.10. Slab insulation requirements are shown in Table R402.1.2. R-5 insulation shall be provided under the full slab area of a heated slab in addition to the required slab edge insulation R-value for slabs as indicated in the table. The slab edge insulation for heated slabs shall not be required to extend below the slab.
### Table 1. Minimum Insulation Requirements for New Homes as Listed in the 2009, 2012, 2015, and 2018 IECC and 2009, 2012, 2015, and 2018 IRC *

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>Ceiling R-Value</th>
<th>Wood Frame Wall R-Value</th>
<th>Mass Wall R-Value* (2009 IRC: k)</th>
<th>Floor R-Value</th>
<th>Basement Wall R-Value</th>
<th>Slab R-Value &amp; Depth</th>
<th>Crawl Space Wall R-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30</td>
<td>30</td>
<td>13</td>
<td>13</td>
<td>3/4</td>
<td>3/4</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>30</td>
<td>13</td>
<td>13</td>
<td>4/6</td>
<td>4/6</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>30</td>
<td>13</td>
<td>13</td>
<td>20 or 13+5h</td>
<td>5/8</td>
<td>19</td>
</tr>
<tr>
<td>4 except Marine</td>
<td>38</td>
<td>49</td>
<td>13</td>
<td>20 or 13+5h</td>
<td>5/10</td>
<td>8/13</td>
<td>19</td>
</tr>
<tr>
<td>5 and Marine 4</td>
<td>38</td>
<td>49</td>
<td>13</td>
<td>20 or 13+5h</td>
<td>13/17</td>
<td>13/17</td>
<td>30f</td>
</tr>
<tr>
<td>6</td>
<td>49</td>
<td>49</td>
<td>20 or 13+5h</td>
<td>20 or 13+5h</td>
<td>15/19</td>
<td>15/20</td>
<td>30f</td>
</tr>
<tr>
<td>7 and 8</td>
<td>49</td>
<td>49</td>
<td>21</td>
<td>20 or 13+10h</td>
<td>19/21</td>
<td>19/21</td>
<td>38* IRC: 30f</td>
</tr>
</tbody>
</table>

For Si: 1 foot = 304.8 mm.

*The IRC code requirement differs from the IECC code requirement, as noted.

a. Table adapted from Table R402.1.1 in the 2009 and 2012 IECC and Table R402.1.2 in the 2015 and 2018 IECC (Table N1102.1 in 2009 IRC, Table N1102.1 in 2012 IRC, and Table N1102.1 in 2015 and 2018 IRC).

b. 2012, 2015, and 2018 IECC: R-values are minimums. When insulation is installed in a cavity which is less than the label or design thickness of the insulation, the installed R-value of the insulation shall not be less than the R-value specified in the table.

c. 2009 IECC: R-values are minimums. R-19 batts compressed into a nominal 2x6 framing cavity such that the R-value is reduced by R-1 or more shall be marked with the compressed batt R-value in addition to the full thickness R-value.

d. Refers to fenestration requirements not shown on this excerpted table.

e. 2009-2018 IECC: “10/13” means R-10 continuous insulation (called “insulated sheathing” in 2009 IECC) on the interior or exterior of the home or R-13 cavity insulation at the exterior of the basement wall. “15/19” means R-15 continuous insulation on the interior or exterior of the home or R-19 cavity insulation at the interior of the basement wall. Alternatively, compliance with “15/19” shall be R-13 cavity insulation on the interior of the basement wall plus R-5 continuous insulation on the interior or exterior of the home.

f. 2009-2018 IECC: The first R-value applies to continuous insulation, the second to framing cavity insulation; either insulation meets the requirement.

g. 2012 IECC: The first value is cavity insulation, the second value is continuous insulation. Therefore, as an example, “13+5” means R-13 cavity insulation plus R-5 continuous insulation.

h. 2012 IECC: First value is cavity insulation, second value is continuous insulation or insulated siding, so “13+5” means R-13 cavity insulation plus R-5 continuous insulation or insulated siding. If structural sheathing covers 40 percent or less of the exterior, continuous insulation R-value shall be permitted to be reduced by no more than R-3 in the locations where structural sheathing is used – to maintain a consistent total sheathing thickness.

i. 2009 IECC: “13+5” means R-13 cavity insulation plus R-5 insulated sheathing. If structural sheathing covers 25 percent or less of the exterior, insulating sheathing is not required where structural sheathing is used. If structural sheathing covers more than 25 percent of exterior, structural sheathing shall be supplemented with insulated sheathing of at least R-2.

j. 2018 IECC: Mass walls shall be in accordance with Section R402.2.5 (N1102.2.5 in 2018 IRC). The second R-value applies where more than half of the insulation is on the interior of the mass wall.

2015 and 2018 IECC

See Residential Chapter 5 for requirements regarding additions, alternations, and repairs to existing buildings.


Section R101.4.3 (Section R501.1.1 in 2015 and 2018 IECC). Additions, alterations, renovations, or repairs shall conform to the provisions of this code, without requiring the unaltered portions of the existing building to comply with this code. (See code for additional requirements and exceptions.)
Table N1102.1.1 (Table N1102.1.2 in 2015 IRC). Slab insulation requirements are shown in Table below. R-5 must be added to the requirement for heated slabs. The insulation depth is to the depth of the footing or 2 feet, whichever is less in Climate Zones 1-3 (for heated slabs).

2018 IRC

Table N1102.1.2. Slab insulation requirements are shown in the Table below. R-5 insulation shall be provided under the full slab area of a heated slab in addition to the required slab edge insulation R-value for slabs as indicated in the table. The slab edge insulation for heated slabs shall not be required to extend below the slab.


Section N1101.3 (Section N1107.1.1 in 2015 and 2018 IRC). Additions, alterations, renovations, or repairs shall conform to the provisions of this code, without requiring the unaltered portions of the existing building to comply with this code. (See code for additional requirements and exceptions.)

Appendix J regulates the repair, renovation, alteration, and reconstruction of existing buildings and is intended to encourage their continued safe use.

Slab-on-Grade Insulation - Code Compliance Brief

Overview:

The intent of this brief is to provide code-specific information about slab-on-grade insulation to help ensure that the measure will be accepted as being in compliance with the code. Providing notes for codes officials on how to plan review and conduct field inspections can help builders or remodelers with proposed designs and installations and provide jurisdictional officials with information for acceptance. Providing the same information to all interested parties (e.g., code officials, builders, designers, etc.) is expected to result in increased compliance and fewer innovations being questioned at the time of plan review and/or field inspection.

Slabs lose energy primarily as a result of heat conducted outward and through the perimeter of the slab. Installing slab insulation around the perimeter of the slab will reduce heat loss and make the slab easier to heat. According to DOE's Building Energy Codes Program Helpdesk, slab-on-grade insulation has been one of the more commonly addressed topics on code compliance for the past several years. Even though the requirements have essentially remained the same in the International Energy Conservation Code (IECC) and International Residential Code (IRC) versions 2009, 2012, and 2015, commonly asked questions continue to be asked about placement of insulation, depth of insulation, the thermal break between conditioned and unconditioned spaces, and additions or retrofits to existing homes. This brief provides an overview of slab-on-grade insulation requirements, insulation protection, and flashing.

Plan Review:

Per the IECC/IRC, Section R103.3/R106.3 Examination of Documents. The code official/building official must examine or cause to be examined construction documents for code compliance.

This section lists applicable code requirements and details helpful for plan review regarding the provisions to meet the requirement for slab-on-grade insulation.

- **Construction Documentation.** Review the construction documents for the details describing slab insulation installation and construction techniques.2

  — 2015 IECC/IRC, Section R103.2/N1101.5 Information on Construction Documents. Construction documents should include information about the insulation material and the R-value.

- **Insulation.** 2015 IECC/IRC Section R402.2.10/N1102.2.10 Slab-On-Grade Floors. Slab-on-grade floors with a floor surface less than 12 inches below grade should be insulated in accordance with information provided in the Insulation and Fenestration Requirements by Component Table, which is reproduced following this paragraph. Slab-on-grade insulation should extend downward from the top of the slab on either the outside or inside of the foundation wall. When a slab is independent from a perimeter foundation wall, insulation may be installed either on the exterior of the foundation wall or between the foundation wall and the slab. Insulation located below grade, as required in Climate Zones 4 through 8, should extend the length specified in the table by any combination of vertical insulation, insulation extending under the slab, or insulation extending out perpendicular to the building. Insulation extending perpendicular away from the building should be protected by pavement or by not less than 10 inches of soil. It is permissible by the codes that the top edge of insulation installed between the exterior wall and the edge of the interior slab be permitted to be cut at a 45-degree angle away from the exterior wall. Slab edge insulation is not required in jurisdictions designated by the code official as having a heavy termite infestation. Slab-on-grade insulation requirements for the 2012 and 2009 versions of the IRC/IECC are found in the following sections:
Excerpt from the Insulation and Fenestration Requirements by Component Table R402.1.2/N1101.1.2 (2015 IECC/IRC).

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4 except Marine</th>
<th>5 and Marine</th>
<th>6</th>
<th>7, 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slab R-Value</td>
<td>R-0</td>
<td>R-0</td>
<td>R-0</td>
<td>R-10</td>
<td>R-10</td>
<td>R-10</td>
<td>R-10</td>
</tr>
<tr>
<td>Depth</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>2 ft</td>
<td>2 ft</td>
<td>4 ft</td>
<td>4 ft</td>
</tr>
</tbody>
</table>

Insulation to R-5 should be added to the required slab edge R-values for heated slabs. For heated slabs in Climate Zones 1 through 3, install the insulation to the depth of the footing or to 2 feet, whichever is less. A heated slab is a type of construction that has a slab-on-grade concrete floor with a heating system embedded in or beneath the slab floor. Building additions that include a slab-on-grade construction also are subject to the slab edge requirements listed in the IECC/IRC.

- **Insulation Protection.** Confirm that the construction documents specify proper insulation protection if applicable. Rigid foam board is typically used for insulating slabs.
  
  — *2015 IRC, Section R403.3.2, Protection of Horizontal Insulation below Ground.* Horizontal insulation placed less than 12 inches below the ground surface or that portion of horizontal insulation extending outward more than 24 inches from the foundation edge should be protected against damage by use of a concrete slab or asphalt paving on the ground surface directly above the insulation or by cementitious board, plywood rated for below-ground use, or other acceptable materials, approved by the code official, placed below ground directly above the top surface.

- **Flashing.** Confirm that the construction documents specify the proper location for installing flashing and flashing material.
  
  — *2015 IRC, Section R703.8.5 Flashing.* Flashing should be located beneath the first course of masonry above the finished ground level, above the foundation wall or slab, and at other points of support including structural floors.

  - Section R703.4 Flashing. Approved corrosion resistant flashing should be applied in shingle fashion to prevent entry of water into the wall cavity or penetration of water to the building structural framing components.

**Field Inspection:**

Per the 2015 IECC, Section R104, Inspections, construction or work for which a permit is required is subject to inspection. Construction or work is to remain accessible and exposed for inspection purposes until approved. Required inspections include footing and foundation, framing and rough-in work, plumbing rough-in, mechanical rough-in, and final inspection.

Per the 2015 IRC, Section R109, Inspections, the wording is somewhat different in that for onsite construction, from time to time the building official, upon notification from the permit holder or his agent, can make or cause to be made any necessary inspections. Further details are provided for inspections regarding foundation, plumbing, mechanical, gas and electrical, floodplain, frame and masonry, and final inspection. Any additional inspections are at the discretion of the building official.

This section provides details for inspecting to the specific provisions for slab-on-grade insulation where one or more specific type of inspection per the IECC or IRC may be necessary to confirm compliance. Verifying code compliance for slab-on-grade insulation would be at the foundation inspection.

- Confirm that the insulation material meets ratings approved on the construction documents.
- Confirm that insulation has been installed properly so the insulation coverage is continuous and complete. The following websites provide information on slab insulation installation.
  

• Confirm that proper insulation protection has been installed, if applicable, per approved construction documents.
• Confirm that proper flashing has been installed, if applicable, per approved construction documents.

Technical Validation(s):

This section provides additional information and helpful resources.

• Case Study: Exterior Rigid Foam Insulation at the Edge of Slab Foundation, Fresno, California (2013):
  Author: IBACOS
  Publication Date: October 2013

• Guide for Slab Edge Insulation: https://basc.pnnl.gov/resource-guides/slab-edge-insulation

• Measure Guideline: Hybrid Foundation Insulation Retrofits (2012):
  Author: Building Science Center
  Publication Date: May 2012

• Slab Edge Insulation for All Climates, Information Sheet 513:

• Technology Fact Sheet Slab Insulation: Improve Comfort and Save Energy in Homes with Slab-on-Grade Floors,

• Thermal Enclosure System Rater Checklist,
More Info.

Access to some references may require purchase from the publisher. While we continually update our database, links may have changed since posting. Please contact our webmaster if you find broken links.

Case Studies

1. Technology Solutions Case Study: Exterior Rigid Foam Insulation at the Edge of a Slab Foundation, Fresno, California
   Author(s): IBACOS
   Organization(s): IBACOS
   Publication Date: October, 2013
   *Case study describing installation of exterior rigid foam insulation on a slab foundation.*

2. Technology Solutions Case Study: Innovative Retrofit Foundation Insulation Strategies, Minneapolis, Minnesota
   Publication Date: August, 2015
   *Case study describing methods to retrofit foundations and basements in climate zones 6 and 7.*

References and Resources*

1. Excavationless: Exterior-Side Foundation Insulation for Existing Homes, Minneapolis, Minnesota
   Author(s): NorthernSTAR
   Organization(s): NorthernSTAR
   Publication Date: September, 2014
   *Case study describing novel technique for installing exterior spray foam on foundation walls that uses high-pressure water sprayer and a “hydro vac” to remove dirt along the foundation wall.*

2. Measure Guideline: Hybrid Foundation Insulation Retrofits
   Author(s): Ueno, Lstiburek
   Organization(s): Building Science Corporation
   Publication Date: May, 2012
   *Document providing information on basement insulation, air sealing and water management retrofits.*

3. Slab Edge Insulation for All Climates, Information Sheet 513
   Author(s): Building Science Corporation
   Organization(s): Building Science Corporation
   Publication Date: May, 2009
   *Information sheet about insulating slabs.*

*Publication dates are shown for formal documents. Dates are not shown for non-dated media. Access dates for referenced, non-dated media, such as web sites, are shown in the measure guide text.

Contributors to this Guide

The following authors and organizations contributed to the content in this Guide.

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