Concrete slabs, specifically at slab edges, can be one of the more challenging assemblies to design and construct in the building enclosure. Current energy codes have attempted to address these challenges; however, construction methods have not evolved to the point of full code compliance. This webinar will analyze the implications of slab insulation on building energy consumption and occupant health, identify critical building code requirements that address slabs, and discuss challenges that arise with the design and trade-offs that occur in slab insulation and construction.

Learning Objectives

1. Understand the impact that slab insulation has on the overall performance of the building enclosure in residential structures.
2. Identify critical building code requirements that dictate the design and construction of concrete slab assemblies.
3. Analyze the effect that structural requirements related to occupant safety have on the energy efficiency of slab edges.
4. Realize the implications of specific design choices related to concrete slabs on the comfort and health of building occupants.
What is Building Science?

• “Building science is the cross-disciplinary collection of knowledge and experience required to understand and predict many aspects of the behavior of buildings and their systems, specifically including durability, comfort, energy, environmental separation, indoor air quality, acoustics, lighting, economics, and constructability.”

  - Dr. John Straube, 3rd Residential Building Design & Construction Conference

What is the Building Enclosure?

• “That part of any building that physically separates the exterior environment from the interior environment(s) is called the building enclosure or building envelope.”

  - Dr. John Straube, BSD-018: The Building Enclosure
Building Enclosure Functions

- Support (structural)
- Control (heat, air, moisture, smoke, odor, sound, fire, insects, etc.)
- Aesthetics (exterior and interior finishes)
- Distribution of Services (MEP)

Building Science Principles

- Heat Flow
- Moisture Flow
- Air Flow
Heat Flow Mechanisms – Conduction

- **Conduction**
  - Heat flow through a substance or material by direct contact
  - Conduction takes place within a single material or between materials in direct contact

- **Where does conduction occur in a home?**

Relative Humidity (RH)

- **Relative humidity** = (Partial Pressure) / (Saturation Pressure)

- Relative humidity depends on **TEMPERATURE**
  - An air mass with higher temperature can hold more moisture
  - An air mass with lower temperature can hold less moisture
  - RH drops as temperature increases
  - RH rises as temperature decreases

Dew Point

- **Dew point**
  - Temperature at which saturation vapor pressure equals partial pressure

- **Condensation**
  - Occurs when RH = 100%
  - Only occurs on a surface cooler than dew point temperature
Condensation

- When humid air (high RH) comes in contact with a cool surface, condensation can occur
- Where can condensation occur in a home?

Slab Edge Heat Loss

- Temperature of slab perimeter may be below dew point in heating climates for significant periods of time
  - Condensation risk
  - Even with temperature above dew point, slab edge heat loss can elevate relative humidity to levels high enough to support mold growth
Climate Zones in PA

2015 IRC Table N1102.1.2

Image Source: https://basc.pnnl.gov/images/iecc-climate-zone-map
### 2015 IRC Table N1102.1.2

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### 2015 IRC Section N1102.2.10 Slab-On-Grade Floors

- **N1102.2.10 Slab-on-grade floors.** Slab-on-grade floors with a floor surface less than 12 inches (305 mm) below grade shall be insulated in accordance with Table 402.1.2.
  - The insulation shall extend downward from the top of the slab on the outside or inside of the foundation wall.
  - Insulation located below grade shall be extended the distance provided in Table N1102.1.2 by any combination of vertical insulation, insulation extending under the slab or insulation extending out from the building.
  - Insulation extending away from the building shall be protected by pavement or by a minimum of 10 inches (254 mm) of soil.
  - The top edge of the insulation installed between the exterior wall and the edge of the interior slab shall be permitted to be cut at a 45-degree (0.79 rad) angle away from the exterior wall.
  - Slab-edge insulation is not required in jurisdictions designated by the code official as having a very heavy termite infestation.

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Options For Placement

- Interior/Horizontal
- Interior/Vertical
- Exterior
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Structural concerns:
- Edge distance of anchor bolts
  - ACI requires 1-1/2" CC for cast-in-place anchor bolts
  - Proprietary equivalent anchorage systems (ICC-ES approved) have differing requirements (i.e. 1-3/4")
- Bearing area of sill plate
  - If originally 2x6 wall, now with 3-1/2" bearing width, will act as a 2x4 wall
  - Special attention required for stud columns

Cantilevered Sill Plate
2015 IRC Section R403.1.6
Foundation Anchorage

• Language was added that now requires the anchor bolts to be located within the middle third of the width of the sill plate.

![Diagram showing anchor bolt placement]

Bolt should be in middle 1.125” of plate

3.5” wide ÷ 3 = 1.125”

5.5” wide ÷ 3 = 1.75”

Bolt should be in middle 1.75” of plate


• Compliance allowed by UCC Title 34, Chapter 403
• Intent:
  - simpler to build to and easier to enforce
  - more rational and flexible
  - focused on Pennsylvania in terms of climatic and other conditions; and,
  - equivalent to the provisions of the International Energy Conservation Code (IECC)
• Prescriptive (vs. requiring modeling)
• Allows trade-offs


Entrance Requirements

Tradeoff


40

42

43
Energy Enhancement Options

| Item | Slab edge insulation: Thermal break |

Energy Tradeoffs

3. **Slab edge insulation: Thermal break**

![Diagram of slab edge insulation with thermal break](image)

**3. Slab edge insulation: Thermal break**

**Summary:**

- Slab edge insulation shall be installed from the bottom of the slab to the top of the slab edge insulation or to the top of the slab, whichever is lower. Slab edge insulation shall be installed in accordance with the manufacturer's instructions.

**Note:**

- The thickness of the slab edge insulation shall be determined based on the thermal insulation requirements of the building code. Slab edge insulation shall be installed to provide a continuous thermal barrier between the slab and the ground.
Common Questions/Concerns

- Floating slab
- Beveled insulation
- Termites
- Vapor barrier placement

Floating Slabs – Cause for Concern?

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What About Beveled Insulation?

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What About Beveled Insulation?

Image Source: https://www.greenbuildingadvisor.com/article/insulating-raised-slab

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What About Termites?


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What About Termites?

Where Should the Vapor Barrier Go?

- IRC R506.2.3 – Vapor Retarder
  - “A 6 mil polyethylene or approved vapor retarder with joints lapped not less than 6 inches shall be placed between the concrete floor slab and the base course or the prepared subgrade where no base course exists.”
  - Vapor barrier should be placed in direct contact with concrete (best practice)

Example: Walkout Basement

![Image of walkout basement](image)
• Understand performance goals
• Define and design the building enclosure
• Dig into the details:
  - Prioritize structure
  - Comply with the applicable codes
  - Develop a complete detail
• Communicate the design!