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Continuous Insulation Overview

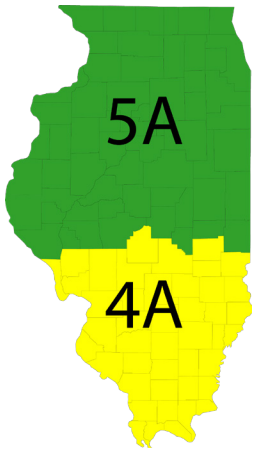
Continuous Insulation

Continuous insulation (ci) is defined as insulating material that is continuous across all structural members without thermal bridges other than fasteners and service openings. It is installed on the interior or exterior or is integral to any opaque surface of the building envelope.

Benefits of Continuous Insulation:

- Decrease heating and cooling loads, lowering energy consumption and utility costs.
- Improve thermal performance by eliminating thermal bridging.
- Often act as an air and moisture barrier depending on the material selected and proper installation.
- Enhance building durability by controlling moisture infiltration and minimizing the potential for mold or rot.

Mineral wool insulation is installed on the exterior of wall with furring strips. Image source: basc.pnnl.gov



Illinois climate zones, 5A and 4A.

Compliance Methods: Prescriptive R-Value Based Method

The R-value method requires meeting minimum insulation values from Table C402.1.3 (commercial) and Table R402.1.3 (residential). Cavity and continuous insulation must be calculated separately, and only the insulation's labeled R-value is considered; other materials are excluded as common assembly materials such as cladding and drywall are already accounted for in the anticipated assembly. This is the most restrictive method, but can avoid needing to perform calculations.

Example: In Table C402.1.3 below we've highlighted the maximum resistance to heat flow requirements for a Metal framed wall in Climate Zone 4 Group R (Residential). This requires at least R-13 cavity insulation along with at least R-7.5 continuous insulation.

Climate Zone & Group	Roofs			Walls				
	Insulation entirely above roof deck	Metal Buildings	Attic and other	Mass	Metal buildings	Metal framed	Wood framed and other	Below-grade wall
CZ4 All Other	R-30 ci	R-19 + R-11 LS	R-49	R-9.5 ci	R-13 + R-13 ci	R-13 + R-7.5 ci	R-13 + R-3.8 ci or R-20	R-7.5 ci
CZ4 Group R	R-30 ci	R-19 + R-11 LS	R-49	R-11.4 ci	R-13 + R-14 ci	R-13 + R-7.5 ci	R-13 + R-3.8 ci or R-20	R-10 ci
CZ5 All Other	R-30 ci	R-19 + R-11 LS	R-49	R-11.4 ci	R-13 + R-14 ci	R-13 + R-10 ci	R-13 + R-7.5 ci or R-20 + R-3.8 ci	R-7.5 ci
CZ5 Group R	R-30 ci	R-19 + R-11 LS	R-49	R-13.3 ci	R-13 + R-14 ci	R-13 + R-10 ci	R-13 + R-7.5 ci or R-20 + R-3.8 ci	R-10 ci

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Compliance Method: Prescriptive U-Factor Based Method

The code allows alternative methods to meet insulation requirements by evaluating the performance of the entire assembly, not just the insulation. Compliance is based on the maximum U-factors listed in Table C402.1.4 (commercial) and Table R402.1.2 (residential). This provides more flexibility to use different proportions of cavity and continuous insulation than the R-value method.

Example: In Table C402.1.4 below we've highlighted the maximum thermal transmission requirement for a commercial metal-framed wall in Climate Zone 4, Group R.

Climate Zone & Group	Roofs			Walls				
	Insulation entirely above roof deck	Metal Buildings	Attic and other	Mass	Metal buildings	Metal framed	Wood framed and other	Below-grade wall
CZ4 All Other	U-0.032	U-0.035	U-0.021	U-0.104	U-0.064	U-0.064	U-0.064	U-0.119
CZ4 Group R	U-0.032	U-0.035	U-0.021	U-0.090	U-0.064	U-0.064	U-0.064	U-0.092
CZ5 All Other	U-0.032	U-0.035	U-0.021	U-0.090	U-0.055	U-0.051	U-0.051	U-0.119
CZ5 Group R	U-0.032	U-0.035	U-0.021	U-0.080	U-0.055	U-0.051	U-0.051	U-0.092

Types of Insulation Materials

Commonly used continuous insulation materials include:

- Rigid foam boards
  - Polyisocyanurate (polyiso)
  - Graphite polystyrene
  - Expanded polystyrene (EPS)
  - Extruded polystyrene (XPS)
- Mineral wool
- Fiberglass rigid boards
- Spray-applied foam (depending on details)
- Wood fiber
- Cork

Key Factors that Affect Overall Assembly Performance and Durability

Framing factor

Given continuous insulation is not interrupted by framing, it is not impacted by the framing factor of a building. The framing factor is the percentage of any assembly's area made up of structural elements like studs and plates. It is important because these parts dramatically reduce insulation effectiveness by creating thermal bridges. For stud walls, the framing factor commonly ranges around 20-25%. Consider that a 2x4 wall with R-13 batt insulation with a 25% framing factor will see the effective R-value reduced by about 33% to R-8.7 due to thermal bridging. R-13 continuous insulation installed over top of the framing will be R-13 regardless of the stud wall it is mounted to (excluding thermal bridging due to fasteners and service openings).

Further resources:
https://web.ornl.gov/sci/buildings/conf-archive/2007%20B10%20papers/080_Kosny.pdf

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Key Factors that Affect Overall Assembly Performance and Durability (cont.)

Insulation ratio guidance
When using a combination of cavity and continuous insulation, there is a risk of condensation occurring at the interior face of the sheathing if it falls below dew point. The ratio guidance specifies the minimum amount of continuous insulation required in relation to cavity insulation to prevent condensation issues and improve overall wall performance. As a general rule, having continuous insulation of less than 31% of the total insulation value in climate zone 4A (southern IL) or less than 41% in climate zone 5A (northern IL) risks condensation damage within an assembly.

Further resources:
https://buildingscience.com/documents/building-science-insights-newsletters/bsi-100-hybrid-assemblies#t01

Example of Wall Construction

Plan Coordination with Non-Insulation Trades: Ensure electrical, plumbing, and HVAC work that will penetrate the insulation is finished before insulating or identify where other trades might damage insulation and plan for remediation.

Seal Wall Details: Use sealants, fluid or tape (Fig. 1), to seal air/water leaks; avoid combining multiple wires/pipes into single holes when possible as the spaces between can be more difficult to seal. A common example of this issue (as seen in Fig 1) is the installation of HVAC line sets which contain two pipes in close proximity through a single opening.

Prepare Openings: Use bucks (Fig. 2) or frames to align windows/doors with the exterior continuous insulation thickness and apply flashing. The image shows a window installed at the sheathing and a extension frame (or buck) to accommodate the planned continuous insulation.

Apply First Insulation Layer: Begin at the bottom; secure panels tightly with appropriate fasteners.

Apply Second Insulation Layer: (Fig. 3) Stagger seams; orient facer as needed for climate.

Install Bug Screen: Add screening at the base of continuous insulation to keep insects out.

Mark Stud Locations: Use laser or chalk lines to mark studs for cladding attachment.

Install Furring Strips: (Fig 4) Install vertical attachment strips or rain screen material to allow drainage and ventilation.

Install Cladding: Attach cladding to attachment strips to complete the wall assembly.

Fig 1: Flexible tape is used to air-seal around wiring holes in the coated sheathing. Image source: basc.pnnl.gov


Fig 2: Framing is built around the window before exterior rigid foam is installed on the exterior walls around the window. Image source: basc.pnnl.gov

Fig 3: Installing the 2nd layer of CI.
Image source: https://buildshownetwork.com

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Select Appropriate Fastener

Use the manufacturer-recommended fastener or fastening system on the appropriate spacing. Some of these may include:

1. **Plastic Cap Nails and Staples:** (Fig 5) for thin, lightweight insulation.
2. **Insulation Screws with Washers:** (Fig 6) to support heavier insulation and finishes.
3. **Shimming Screws:** (Fig 7) are ideal for installing attachment strips due to their ability to adjust the surface depth
4. **Adhesive Based Fastening:** (Fig 8) ideal for the areas where mechanical fasteners can't be used.
5. **Clips/Brackets/Systems**, to support thicker or multi-layer CI systems.
6. Other manufacturer recommended fastening methods

Additional resources:
Visit IBC or IRC for guidance on screw length needed:
-Table R703.15.2 in 2021/2024 IRC
-Chapter 26 in 2018/2021 IBC
-Chapter 14 in 2024 IBC

Fig 4: Furring strips provide the drainage gap between rigid foam continuos insulation and siding.
Image source: basc.pnnl.gov

Fig 5: Plastic cap nail.
Image source: www.homedepot.com

Fig 6: Insulation screw with washer. Image source: www.theunderfloorheatingstore.com

Fig 7: Topstar shimming screw. Image source: www.grkfasteners.com

Fig 8. Rigid board insulation being glued to a roof assembly.
Image source: https://eliteroofing.com

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Who We Are

SEDAC is the Energy Code Training Provider on behalf of the Illinois EPA Office of Energy. Attend SEDAC's workshops and webinars to learn more. We also offer online courses and technical support.

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