Continuous Insulation for Code-Compliant, High-Performance Walls in Type V and Residential Construction

Module 4: Building Code Compliance

Revised 10/31/2016

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Building Code Compliance – Fire

- Fire safety requirements for foam sheathing
  - IRC Section R316
    - R316.3 – Surface burning characteristics
      - ASTM E84 or UL 723 - Standard Test Method for Surface Burning Characteristics of Building Materials
    - R316.4 – Thermal barrier
      - Foam needs to be covered by ½" gypsum or other approved material
    - R316.6 – Specific approval
      - NFPA 286, FM 4880, UL 1040, UL 1715, or other fire tests related to end use configurations

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Building Code Compliance – Fire

- Fire safety requirements for foam sheathing
  - IBC Chapter 26
    - 2603.3 – Surface burning characteristics
      - ASTM E84 or UL 723 - Standard Test Method for Surface Burning Characteristics of Building Materials
    - 2603.4 – Thermal barrier
      - Foam needs to be covered by ½" gypsum or other approved material
    - 2603.10 – Special approval
      - Foam shall not be required to comply with the requirements of Sections 2603.4 through 2603.8 where specifically approved based on large-scale tests

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Foam and OSB Comparison

General Characteristics	Foam Plastic Insulating Sheathing	Wood Structural Panel (WSP) Sheathing
Surface Burning / Flame Spread Index (ASTM E84)[1]	Generally, a Flame Spread Index of 75 or less (lower index number indicates less flame spread).	No code limits even though the reported flame spread index range is 74-172[2] for ½" oriented strand board (OSB) wood structural panels
Smoke Developed Index (ASTM E84)	Smoke Developed Index of 450 or less (lower rating number indicates less smoke developed)	No specific code limits, although WSPs are generally classified as a Class C sheathing requiring a smoke developed rating of 450 or less[3].
Thermal Barrier (typically ½" gypsum) required to separate the sheathing from the interior of the building.	Yes – except in specific cases such as attics and crawlspaces, or unless a full-scale fire test is performed	No *IBC* or *IRC* thermal barrier required.
Ignition Temperature	Greater than 600 F[4]	400 F – 500 F[5]

Table 1: Comparison of *IBC* and *IRC* Fire-Related Code Requirements for Foam Plastic Insulating Sheathing and Wood Structural Panel (WSP) Sheathing

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Fire Performance Advantages of Polyiso Sheathing

- Thermoset material (polyiso)
- Stays intact during fire exposure
- Remains in place during ASTM E84 tunnel testing
  - Meets or exceeds flame spread ratings
- Not all foam sheathing materials are equal
  - Thermoplastic materials (e.g., polystyrene)
    - Soften at 165°F
    - Melt at approximately 200°F
    - Drip and can continue to burn

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Topic #4 – Building Code Compliance – Structural

- Structural
  - Wall Bracing
  - Wind Pressure
  - Cladding Attachment

Source: hammerandhand.com

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Structural Code Requirements

- No Different for Walls with CI
- Integration with Wall Bracing (IRC R602.10)
  - Must have bracing with or without CI (no difference)
- Integration with framing requirements – stud sizing, connections, wind uplift load path, etc.
  - Must meet all framing requirements with or without CI (no difference)
- Wind pressure resistance of exterior wall covering assemblies (IRC R703.1.2)
  - "Wall coverings, backing materials and their attachments shall be capable of resisting wind loads…"

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Wall Bracing

- Design factors impact wall bracing decisions
  - fsc.americanchemistry.com/Applications
- Code-compliant bracing methods:
  - Over-sheathing
  - Foam between and/or over intermittent braced wall panels
  - Some proprietary products have wall bracing capabilities
- All methods have limitations, advantages and disadvantages

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Wind Pressure Resistance

- 2009/2012 IRC code provision supported by PIMA
  - Ensures all sheathing materials and claddings meet the code

703.1.2 Wind resistance. Wall coverings, backing materials and their attachments shall be capable of resisting wind loads in accordance with Tables R301.2(2) and R301.2(3). Wind-pressure resistance of the siding and backing materials shall be determined by ASTM E 330 or other applicable standard test methods. Where wind-pressure resistance is determined by design analysis, data from approved design standards and analysis conforming to generally accepted engineering practice shall be used to evaluate the siding and backing material and its fastening. All applicable failure modes including bending rupture of siding, fastener withdrawal and fastener head pull-through shall be considered in the testing or design analysis. Where the wall covering and the backing material resist wind load as an assembly, use of the design capacity of the assembly shall be permitted.

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All Wall Coverings or Sheathings are Subject to Wind Damage

Wood structural panels

Fiber board

Foam sheathing

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Foam Sheathing Wind Pressure Requirements

- Foam sheathing must resist wind pressure as part of a wall covering assembly:
  - Cladding/furring secures foam to resist negative design wind pressure
    - Typical fasteners intended for temporary wind conditions
  - Foam sheathing material must:
    - Span between studs
    - Have adequate bending strength
  - Foam sheathing attachments can be designed for permanent wind load resistance

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Code Compliance Resources (wind pressure)

- ANSI/SBCA/FS 100–2012
  - sbcindustry.com/fs100.php
  - Provides path for code compliance and building official approval

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Vinyl Siding Over Foam Sheathing (wind pressure)

- IRC 2009/2012:

R703.11.2 Foam plastic sheathing. Vinyl siding used with foam plastic sheathing shall be installed in accordance with Section R703.11.2.1, R703.11.2.2, or R703.11.2.3.

Exception: Where the foam plastic sheathing is applied directly over wood structural panels, fiberboard, gypsum sheathing or other *approved* backing capable of independently resisting the design wind pressure, the vinyl siding shall be installed in accordance with Section R703.11.1.

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DOE/IBHS/ACC-FSC/NAHBRC/VSI Whole Building Wind Tunnel Test

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Results – OSB/wrap/vinyl

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Results – CI/vinyl (vinyl removed)

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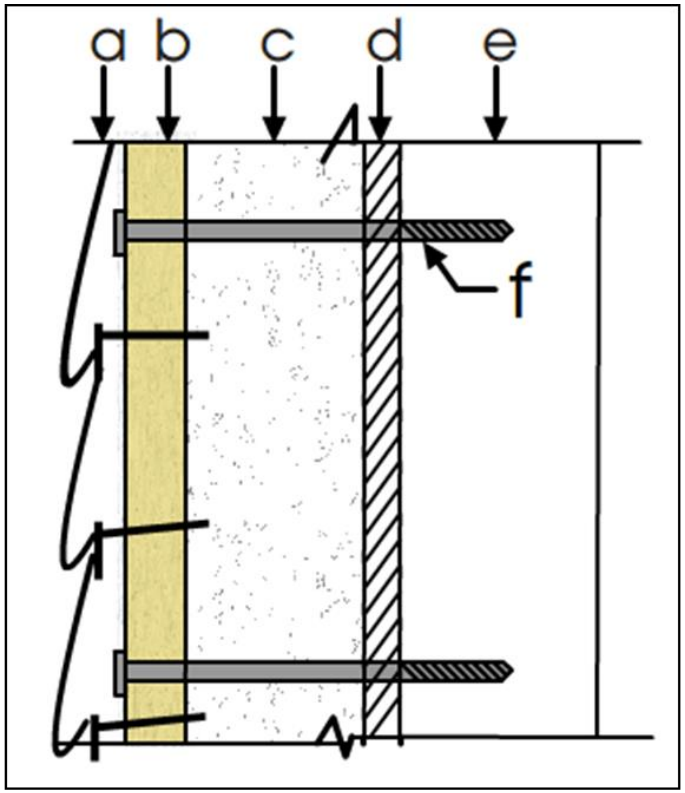
Cladding Attachment

- ACC-FSC, NYSERDA and SFA research
  - Adopted in NY energy code
  - Additional research for DOE/BA by BSC.
- 2015 IRC-
  - Connection requirements
  - Code compliance
- Proprietary fasteners/connectors also available
- Siding fastener embedment must be maintained
- See DrJ DRR 1410-08: Attachment of Exterior Wall Coverings Through Polyiso Sheathing to Wood or Steel Wall Framing



(a) cladding (b) furring or WSP (c) FPIS (d) optional wall sheathing e.g. gypsum, WSP (e) wall framing (f) fastener

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Building Code Compliance - Building Science

- Building Science
  - Water-Resistive Barriers (WRB)
  - Air Barriers (AB)
  - Vapor Retarders (VR)
  - Moisture Control

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Water-Resistive Barrier

- Rain water is main concern
- WRB equivalence
  - Confirmed by code compliance research report as defined by the IBC Sections 104.11.1 Research reports and 1703.4.2 Research reports.
- Foam sheathing products + flashing tapes = WRB
- Meets energy code and WRB requirements
  - Designer/Builder must consider cost of WRB and insulation strategy

R703.2 Water-resistive barrier. One layer of No. 15 asphalt felt, free from holes and breaks, complying with ASTM D 226 for Type I felt or other approved water-resistive barrier shall be applied over studs or sheathing of all exterior walls.

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Wait a minute!

- Does foam sheathing trap water in walls with vapor retarder on the outside of a wall?
  - Non-drainable EIFS contains foam sheathing
  - Not so fast!
- Past problems with EIFS
  - No drainage of cladding
  - No WRB layer

THESE PAST PROBLEMS WITH EIFS HAVE ALL BEEN ADDRESSED IN MODERN BUILDING CODES

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Past EIFS Problems are Misapplied to CI

- Past problems with EIFS
  - Face sealing not done or done incorrectly
  - Leaky window units
  - Roof/wall flashing not installed or improperly installed
  - Used with interior vapor barrier in mixed warm-humid climates

THESE PAST PROBLEMS WITH EIFS HAVE ALL BEEN ADDRESSED IN MODERN BUILDING CODES

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WRB Addresses the "H_2O Fear"

- WRBs
  - Required for nearly all sidings and wall assemblies
  - Must be applied in addition to foam sheathing when not used as the approved WRB layer
- Use WRB and flashing to prevent water intrusion and drain water as required by code and good practice
- Follow current code requirements and research reports

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Proper Use of VR with Foam

- Suppresses Condensation and Promotes Drying
- IRC has vapor retarder options for CI
  - Zones 1 and 2: Low perm on exterior side of wall
- Class III vapor retarder
  - Greater than 1.0 perm but less than or equal to 10 perm (e.g. latex or enamel paint)

R702.7.1 Class III vapor retarders. Class III vapor retarders shall be permitted where any one of the conditions in Table R702.7.1 is met.

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“Warm Wall” VR Requirements

TABLE R702.7.1
CLASS III VAPOR RETARDERS

CLIMATE-ZONE	CLASS III VAPOR RETARDERS PERMITTED FOR:[a]
Marine 4	Vented cladding over wood structural panels.
	Vented cladding over fiberboard.
	Vented cladding over gypsum.
	Insulated sheathing with *R*-value ≥ 2.5 over 2 × 4 wall.
	Insulated sheathing with *R*-value ≥ 3.75 over 2 × 6 wall.
5	Vented cladding over wood structural panels.
	Vented cladding over fiberboard.
	Vented cladding over gypsum.
	Insulated sheathing with *R*-value ≥ 5 over 2 × 4 wall.
	Insulated sheathing with *R*-value ≥ 7.5 over 2 × 6 wall.
6	Vented cladding over fiberboard.
	Vented cladding over gypsum.
	Insulated sheathing with *R*-value ≥ 7.5 over 2 × 4 wall.
	Insulated sheathing with *R*-value ≥ 11.25 over 2 × 6 wall.
7 and 8	Insulated sheathing with *R*-value ≥ 10 over 2 × 4 wall.
	Insulated sheathing with *R*-value ≥ 15 over 2 × 6 wall.

For SI: 1 pound per cubic foot = 16 kg/m^3.

a. Spray foam with a minimum density of 2 lb/ft^3 applied to the interior cavity side of wood structural panels, fiberboard, insulating sheathing or gypsum is deemed to meet the insulating sheathing requirement where the spray foam *R*-value meets or exceeds the specified insulating sheathing *R*-value.

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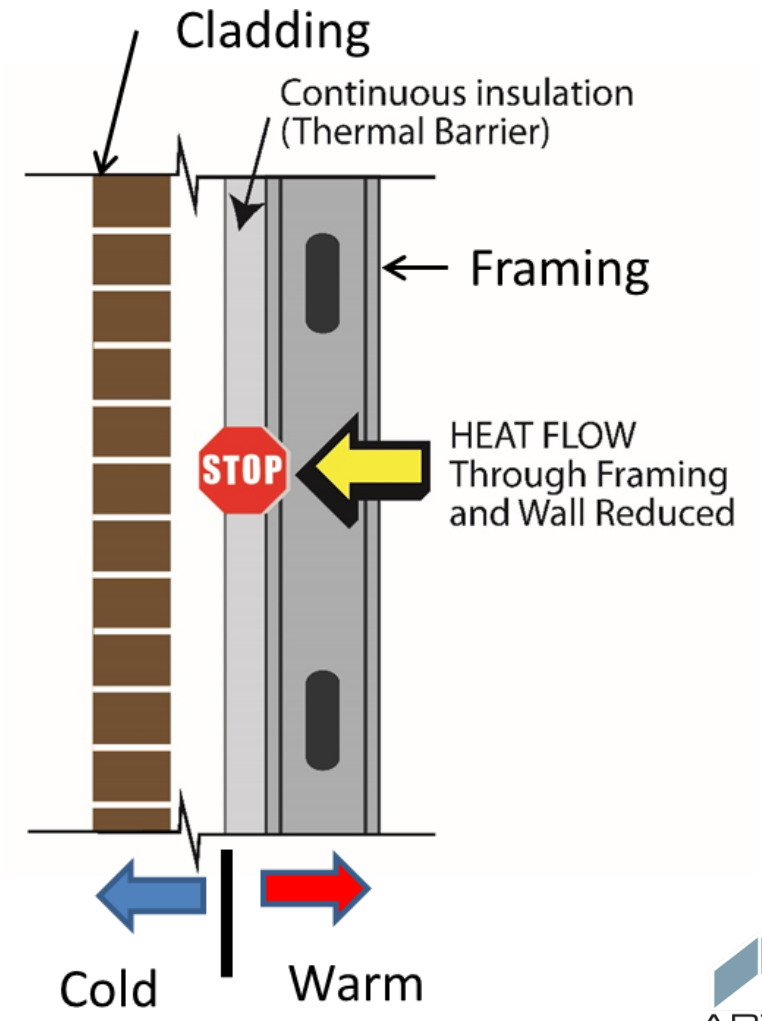
Foam Sheathing Creates Warm, Breathable Wall

- Continuous insulation
  - Reduces condensation
- Non-insulated sheathings
  - Greater condensation potential



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Foam Sheathing has Flexible Vapor Resistance Properties

- Foam sheathing has a successful track record:
  - WRB moisture performance
  - VR properties:
    - Full vapor barrier to
    - Semi-permeable to
    - Permeable
- Meets any climate/application requirement

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Air Barrier Requirements

- Air permeability ≤ 0.004 cfm/ft^2
- These materials comply with ASHRAE 90.2:
  - Portland cement stucco
  - Plywood, OSB sheathing
  - XPS and foil-faced Polyiso foam sheathing
  - Gypsum board
  - Spray foam

AIR BARRIER. Material(s) assembled and joined together to provide a barrier to air leakage through the building envelope. An air barrier may be a single material or a combination of materials.

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Installation Details

- Must be installed per manufacturer's instructions
- Architects can provide construction details for plan approval
  - DRR No. 1404-04 at http://drjengineering.org/products/polyisocyanurate
  - Provides path for code compliance and approval
  - DXF files also available

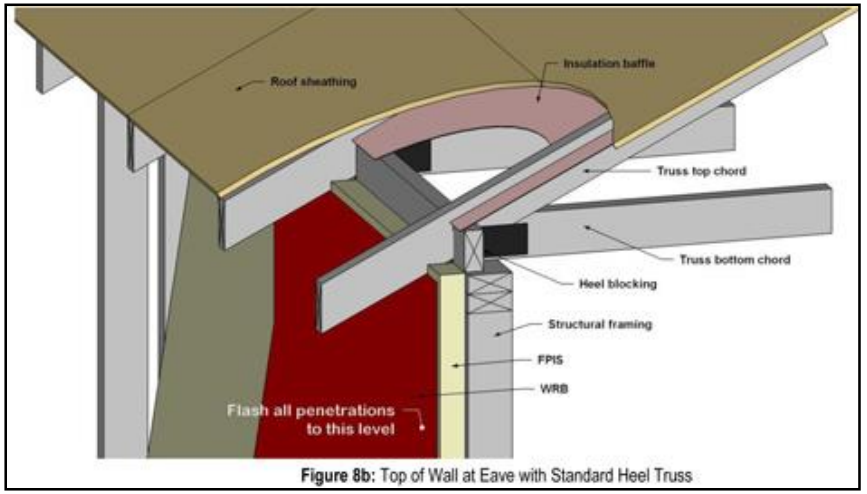

Figure 8b: Top of Wall at Eave with Standard Heel Truss

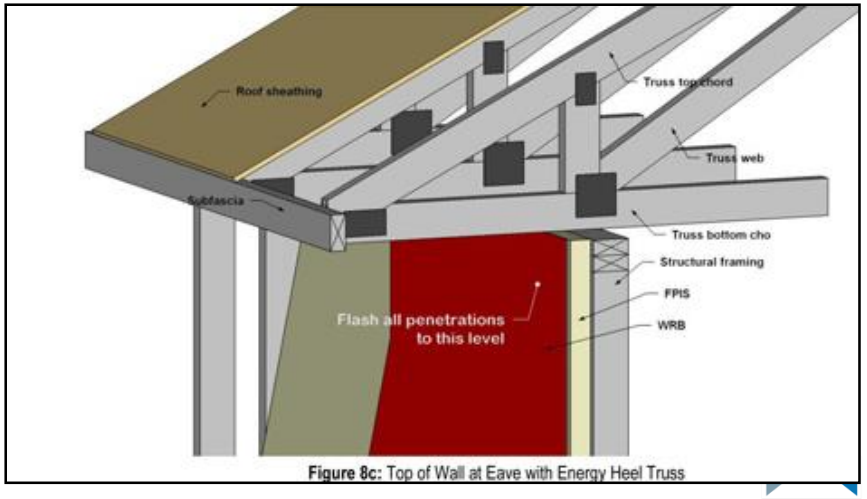

Figure 8c: Top of Wall at Eave with Energy Heel Truss

Installation Details

- Detailing of CI wall assemblies with 6"+ of foam
  - DOE's Building America Program
  - Alaska REMOTE house

Image 2.4: Extension Jambs attached directly to a window

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Detailing Tips

- If no more than 2” of CI on a 2x4 wall
  - Total wall thickness for window and door frames is no different than 2x6 construction
  - 3.5” + 2” = 5.5”
- For thicker applications of CI:
  - May need to “box out” window and door openings
  - Corner/trim details required
  - Furring can provide siding attachment and positive securement

Building Code Compliance and Installation Best Practices Support

- Code compliance resources:
  - drjengineering.org/products/polyisocyanurate
- Best practices for installing Polyiso:
  - drjbestpractices.org/installation
- Building Science technical resources:
  - www.appliedbuildingtech.com