Quality Control of Air Barriers During Construction

BEST III Conference

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Agenda

• Introduction
• Air Barrier Guidelines and Building Codes
• Air Barrier Materials and Installation
• Construction Geometries
• Field Quality Assurance
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Introduction – Benefits of Air Barriers

• Reduce building energy consumption
  – Commercial buildings are not particularly airtight (NIST Study for US office buildings: 0.83 cfm/ft²)
  – For 3 nonresidential buildings (office, retail, apartments:
    • Predicted potential annual heating and cooling energy cost savings ranged between 3% and 36% in 5 cities.
    • Target Air Leakage (0.24 cfm/ft²) and Best (0.04 cfm/ft²)
    • Smallest savings in cooling-dominated climates (PHX & MIA)

  Source: June 2005 NIST Study prepared for DOE

• Allow more precise control over building interior conditions

• Can prevent premature failure of building enclosure cladding in certain climates.
Introduction – Benefits of Air Barriers
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Air Barrier Guidelines and Building Codes

• Federally-funded building projects

• U.S. Army Corp of Engineers
  – (0.25 cfm/ft² per ASTM E779)

• 2012 IECC requires an air barrier
  – Commercial construction (Max. 0.40 cfm/ft² per ASTM E779)
  – Except Climate Zones 1, 2, and 3

• State Building Codes require continuous air barriers:
  – FL, GA, MA, MI, MN, NY, RI, WI
<table>
<thead>
<tr>
<th><strong>2009 IECC</strong></th>
<th><strong>2012 IECC</strong></th>
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<tr>
<td>• Requires openings and penetrations in the building envelope be sealed with caulking or a gasketing system.</td>
<td>• Requires a continuous air barrier in the building thermal envelope. Provides three ways to comply with this requirement.</td>
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<td>• Limits air leakage rate of curtain walls and storefront entrances.</td>
<td>• Limits air leakage rate of fenestration assemblies (includes windows, skylights, curtain walls, store front entrances, garage doors, etc.)</td>
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Air Barrier Guidelines and Building Codes – 2012 IECC, Commercial Construction

C402.4 Air leakage (Mandatory). The thermal envelope of buildings shall comply with Sections C402.4.1 through C402.4.8.

C402.4.1 Air barriers. A continuous air barrier shall be provided throughout the building thermal envelope. The air barriers shall be permitted to be located on the inside or outside of the building envelope, located within the assemblies composing the envelope, or any combination thereof. The air barrier shall comply with Sections C402.4.1.1 and C402.4.1.2.

Exception: Air barriers are not required in buildings located in Climate Zones 1, 2 and 3.
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Air Barrier Materials and Installation

• Mechanically Attached (e.g. house wrap)
  – Generally acts as air and water barrier, typically vapor permeable
  – Sheet material fastened to exterior wall structure
  – Seams are lapped and taped
  – Fasteners installed with manufacturer provided washers
Air Barrier Materials and Installation

- Self-adhered sheet (e.g. rubberized asphalt sheet)
  - Generally acts as air and water barrier, traditionally a vapor retarder
  - Fully adhered membrane sheets applied to exterior sheathing
  - Seams are lapped, mastic or liquid membrane can be applied
Air Barrier Materials and Installation

- **Fluid-Applied Membranes** (e.g. asphalt emulsion, acrylic)
  - Generally acts as air and water barrier, available as vapor permeable and vapor retarder
  - Liquid membrane is applied to the exterior sheathing typically using a sprayer
  - No seams
  - Performance of membrane highly dependent on proper installation of material
  - Some have minimal track record
Air Barrier Materials and Installation

- Spray-Applied Polyurethane Foam (SPF) Insulation
  - Generally acts as air and thermal barrier, available as vapor permeable and vapor retarder
  - SPF Insulation is applied to the exterior sheathing, at transitions, and to interior spaces
  - Monolithic (no seams)
  - Performance of SPUF highly dependent substrate preparation
Air Barrier Materials and Installation

• Transition Materials
  – Provides continuous air barrier between wall systems
  – Rubber, self-adhered membranes, silicone membranes, metal flashing, sealant
  – Penetrations, fasteners
Air Barrier Materials and Installation
Air Barrier Material and Installation
Elevated moisture, improperly prepared substrates and ambient summer temperatures caused ccSPF shrinkage.
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Construction Geometries

• Changes in plane
  – Wall to roof
  – Transitions on elevations (bump outs)
  – Overhangs

• Interior conditioned spaces
  – Lab spaces
  – Natatoriums
  – Museums

• Locations where two or more materials intersect
Construction Geometries – Air Barrier Detailing

• #1 concern: CONTINUITY OF AIR BARRIER
Construction Geometries – Air Barrier Detailing

• Critical Details
Construction Geometries – Air Barrier Detailing

• Consequence of small leaks
Construction Geometries

- Conditioned Spaces
Construction Geometries
Construction Geometries
Open gap between penetrating steel
Construction Geometries

Open joint between steel members
Construction Geometries

Open transition between membrane and curtain wall
Construction Geometries
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Field Quality Assurance - Design

• Start early in the design phase (Schematics/DD)
  – Define air barrier in building enclosure (walls, roof, etc.) and transitions to fenestration, intersections, cladding types)

• Peer review
  – Identify any missing details
  – Identify incompatible materials
  – Identify difficult construction
  – Continually trace air barrier outline
  – Designer and contractor review
Field Quality Assurance - Design
Field Quality Assurance - Design
Field Quality Assurance - Construction

- Construction Mock-ups
Field Quality Assurance - Construction

• Field Inspection
  – Inspect materials
  – Establish installation procedures
  – Inspect preparation of surfaces
  – Inspection through-out construction
    • Different crews
    • Different workers
    • Weather
    • Lots of material
  – Verify correction of defective work
  – Building envelope commissioning
Field Quality Assurance – Construction
Field Quality Assurance – Verification and Testing

- ASTM E779 “Standard Test Method for Determining Air Leakage Rate by Fan Pressurization”
  - Quantitative testing
  - Zone balancing based on building layout
  - Air infiltration through envelope
  - Quantitative identification of performance
  - Does not identify breaches
Field Quality Assurance – Verification and Testing

- Quantitative testing
Field Quality Assurance – Verification and Testing

• Quantitative testing
Field Quality Assurance – Verification and Testing

• ASTM E1186 “Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems”
  – Qualitative Testing
  – Tracer smoke
    • Smoke generator
    • Pressurization versus depressurization
    • Visual identification to determine breaches
  – Infrared Thermography
    • Shows surface temperature of cladding
    • Indicates breach in air barrier or breach in thermal barrier
    • Sample opening verification required
Field Quality Assurance – Verification and Testing

• Qualitative testing
Field Quality Assurance – Verification and Testing

• Qualitative testing
Field Quality Assurance – Verification and Testing

• Infrared (IR) Thermography – Prior to Repairs
Field Quality Assurance – Verification and Testing

- IR Thermography – After Repairs
Summary

- Increased code air barrier requirements
- Identify air barrier materials and transitions
- Maintain continuity of air barrier
- Identify problematic geometries
- Require/provide construction mock-ups
- Perform frequent field inspection
- Perform verification testing and evaluation
Thank You

Questions?

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