Reducing Air Leakage Through Envelope Retrofits: Does Your Building Suck?

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1. Introduction to air barrier continuity

2. Failure of air barrier systems

3. Diagnosing the problems

4. Common locations of air leakage paths

5. Fixing and preventing air leakage paths

6. Materials used

7. Success stories
Air Barrier Continuity

- Continuity is the most important characteristic of the air barrier system
- Allows the proper control of air movement into and out of building enclosures
- All six sides of a building enclosure must be continuous within themselves and in conjunction with each other
1. Introduction to air barrier continuity

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Failure of air barrier systems

• Failure of air barrier systems and their continuity will make buildings:
  • Less healthy
  • Unsafe
  • Less durable
  • Uncomfortable
  • Energy inefficient
Failure of air barrier systems

• Leads to:
  • Uncontrolled and uncontrollable air leakage

• Caused by:
  • Stack effect
  • Wind effect
  • Mechanical effect
Stack Effect
Wind Effect

Wind Pressure

High Windward Pressure

Suction On Leeward Side
Mechanical Effect

- Flue and Ventilation Effects
Moisture Transport over 1 Heating Season

TRANSPORT VIA DIFFUSION OVER 1 m²

TRANSPORT VIA AIR LEAKAGE THROUGH 4 cm²

1/3 Litre

1 meter

1 meter

30 Litres

2x2 cm hole
Failure of Air Barrier Systems

• Effects of uncontrolled air leakage on energy consumption:
  • High-rise multi-family – 40%
  • High-rise commercial – 22-46%
  • School building – 29%
  • Supermarkets – 2 to 4 times more leaky than high-rise and school buildings
  • Low-rise residential – 40%
Failure of Air Barrier Systems

• Effects of uncontrolled air leakage on energy consumption:

  • National Institute of Standards and Technology
  • 2004 NIST Study:
    “Investigation on the Impact of Commercial Building Envelope Airtightness on HVAC Energy Use”

Conclusion:
• Continuous Air Barrier Systems can:
  – Reduce air infiltration by more than 60%
  – Reduce energy consumption by up to 40%
1. Introduction to air barrier continuity
2. Failure of air barrier systems
3. **Diagnosing the problems**
4. Common locations of air leakage paths
5. Fixing and preventing air leakage paths
6. Materials used
7. Success stories
Diagnosing the problems

• Building envelope assessment
Diagnosing the problems

- Building envelope assessment
- Depressurization testing
Diagnosing the problems

• Building envelope assessment
• Depressurization testing
• Locating air leakage paths
Diagnosing the problems

- Building envelope assessment
- Depressurization testing
- Locating air leakage
- Infrared thermography
Diagnosing the problems

- Building envelope assessment
- Depressurization testing
- Locating air leakage
- Infrared thermography
- Energy saving analysis
  - EC 128
1. Introduction to air barrier continuity
2. Failure of air barrier systems
3. Diagnosing the problems
4. Air leakage paths
5. Fixing and preventing air leakage
6. Materials used
7. Success stories
Seal the air leakage pathways in this order:

- Seal top
- Seal bottom
- Seal vertical shafts
- Seal outside walls
- Compartmentalize
Air Leakage Paths

• Seal top of building

• Attics
• Roof/wall intersections and plenum spaces
• Mechanical penthouse doors and walls
• HVAC equipment
• Other roof penetrations
Air Leakage Paths

• Seal top of building
Air Leakage Paths
Air Leakage Paths

- Seal top of building
Air Leakage Paths

• Seal top of building
• The plenum
  - Air can be extracted through many different assemblies if air barrier systems are not in place
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Air Leakage Paths

• The plenum
  – Air can be extracted through many different assemblies if air barrier systems are not in place
Air Leakage Paths

- Seal top of building
Air Leakage Paths

• Seal top of building
Air Leakage Paths

- Attic Hatch
- Rigid Insulation
- Glue
- Latch
- Plywood Frame to hold Insulation
- Weatherstrip
- Caulk

ATTIC HATCH
• Seal top of building
Air Leakage Paths

- Seal top of building
Air Leakage Paths

- Seal top of building
Air Leakage Paths

- Seal the air leakage pathways in this order:
  - Seal top
  - Seal bottom
Air Leakage Paths

Seal bottom of building

- Defined as: “the ground floor and anything below grade”
- Typically a unique area of the building
- Soffits and ground floor access doors
- Underground parking access doors
- Exhaust and air intake vents
- Pipe, duct, cable and other service penetrations into core of bldg
- Sprinkler hangar penetrations, inspection hatches & other holes
- Seal core wall to floor slab
- Residential crawl spaces
Air Leakage Paths

- Seal bottom of building

![Image of air leakage paths](image-url)
Air Leakage Paths

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Air Leakage Paths

- Seal the air leakage pathways in this order:
  - Seal top
  - Seal bottom
  - Seal vertical shafts
Air Leakage Paths

• Seal vertical shafts

  • Stairwell fire doors

  • Fire hose cabinets

  • Plumbing, electrical, cable and other penetrations within service rooms

  • Elevator rooms- cable holes, door controller cable holes, bus bar openings
Air Leakage Paths

• Seal vertical shafts
  • Garbage chute perimeter and access hatches
  • Hallway pressurization grille perimeters
  • Smoke shaft access doors
  • Elevator shaft smoke control grilles
  • Service shafts
Air Leakage Paths

- Seal vertical shafts
Air Leakage Paths

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• Seal the air leakage pathways in this order:

- Seal top
- Seal bottom
- Seal vertical shafts
- Seal outside walls
Air Leakage Paths

- Seal outside walls
  - Weather-strip windows, doors, including balcony/patio doors and seal window trim
  - Exhaust fans and ducting
  - All service penetrations
  - Baseboard heaters
  - Electrical receptacles
  - Baseboards
Air Leakage Paths

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• Seal the air leakage pathways in this order:
  - Seal top
  - Seal bottom
  - Seal vertical shafts
  - Seal outside walls
  - Compartmentalize
Air Leakage Paths

- Compartmentalize
  - Garages
  - Vented mechanical rooms
  - Garbage compactor room
  - Emergency generator room
  - High voltage rooms
  - Shipping docks
  - Elevator rooms
  - Workshops
Air Leakage Paths

• Compartmentalize
Air Leakage Paths

• Compartmentalize
RECAP: Seal the air leakage pathways in this order:

- TOP
- BOTTOM
- VERTICAL SHAFTS
- OUTSIDE WALLS
- COMPARTMENTALIZE
1. Introduction to air barrier continuity
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3. Diagnosing the problems
4. Common locations of air leakage
5. Fixing and preventing air leakage paths
6. Materials used
7. Success stories
Fixing & Preventing Air Leakage Paths

– Conduct building assessment

– Determine location and severity of air leakage pathways

– Identify internal pathways

– Develop scope of work to create air barrier continuity
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Materials Used

• 1-component polyurethane foam sealant

• 2-component polyurethane foam insulating air seal kits
Materials Used

- Door and window weatherstripping and seals
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7. **Success stories**
Success Stories

- 3 Schools
  - Built in 1970’s
  - Roof/Wall joints
    - Brimwood SPS – 9.4% electricity cost savings
    - Chester Blvd. PS – 17% electricity cost savings
    - Brookmill Blvd. PS – 36.5 electricity cost savings
Success Stories

• Donald St. Ottawa
  – Peak demand before air sealing – 772 kW
  – Peak demand after air sealing – 687 kW
  – Consumption reduction after air sealing – 12%
Success Stories

• Bridletown, Toronto
  – Peak demand before air sealing – 496 kW
  – Peak demand after air sealing – 454 kW
  – Consumption reduction after air sealing – 6.5%
Success Stories

How each air sealing measure contributed to combined demand reduction:

• Weatherstripping windows – 42%
• Weatherstripping exterior doors - 28%
• Sealing shafts – 14%
• Miscellaneous – 14%
Success Stories

• St. Hilda’s, Toronto
  – *Provincial Government Energy Program*
    • Weatherstripping windows and doors

• Sealing behind baseboards

• Sealing mechanical penthouse

• Sealing elevator shafts
Success Stories

• Baycrest Geriatric Centre, Toronto
  – Provincial Government Energy Program
    • Weatherstripping windows and doors
    • Sealing behind baseboards
    • Sealing mechanical penthouse
    • Sealing elevator shafts
    • Reduced energy costs
Success Stories
Success Stories

• Forest Laneway Apartments
  – Control smoke, odor & improve thermal comfort
  • Compartmentalize
    – Seal mechanical rooms
    – Fire stop service penetrations
  • Decouple floors
    – Seal fire cabinets, garbage chutes, air supply grilles
    – Weatherstrip fire, parking garage doors
Success Stories

• Cadillac Fairview Office Tower
  – Eliminate thermal discomfort complaints
    • Air leakage at mullions in curtain wall
    • Drill and plug mullions from interior
    • Used 2-component insulating air seal kits
Success Stories

• Trinity College, Toronto
  – Energy performance contract
  – Weatherstripping windows
Success Stories

• Muskoka School Board, Ontario
  – ESCO performance contract
    • Sealing roof/wall joints and roof level change
    • Weatherstripping doors and windows
    • Seal all exhaust penetrations
    • Seal soffits over entry exit doors
    • Compartmentalize mechanical room
Success Stories

• Gravenhurst High School, Ontario
  – ESCO performance contract
    • Cost of building envelope retrofit -- $6,740
    • Energy savings in first two winter months -- $4,893
Air Barrier Continuity

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Thank You

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