Avoiding Building Envelope Defects

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Introduction

- Employee Owned Integrated A/E firm
- Multi-discipline staff includes Mechanical, Electrical, Structural Engineers, and Architects
- Approximately 700 Employees, 14 Offices
- In Business Since 1946
- Pioneered Field of Building Science in 1960’s
- Recognized for Technical Expertise, Client Focus, and Collaborative Approach
Avoiding Building Envelope Defects

Outline

- Design / Building Science
- Detailing Issues / Failures
- Building Envelope Commissioning
When Things Go Wrong
Avoiding Building Envelope Defects

- **Good Construction**
  - Good Design: Success
  - Poor Design: Failure

- **Poor Construction**
  - Good Design: Failure
  - Poor Design: Failure
Defining the Building Envelope

- Separates exterior from interior
- Separates conditioned from unconditioned spaces
- Separates areas with different interior conditions
- Controls migration of air, heat, and moisture
<table>
<thead>
<tr>
<th>Building Envelope Design Factors</th>
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<tr>
<td><strong>Control heat flow</strong></td>
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<td><strong>Control air flow</strong></td>
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<tr>
<td><strong>Provide strength</strong></td>
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<tr>
<td><strong>Control radiation</strong></td>
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<tr>
<td><strong>Control vapor diffusion</strong></td>
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<tr>
<td><strong>Control rain penetration</strong></td>
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<td><strong>Control fire</strong></td>
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<td><strong>Control sound</strong></td>
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<tr>
<td><strong>Be durable</strong></td>
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<tr>
<td><strong>Be economical</strong></td>
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<td><strong>Be aesthetically pleasing</strong></td>
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<td><strong>Be easy to build</strong></td>
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Building Envelope Factors
Heat, air and moisture control

Heat Flow

Vapor Diffusion

Interrelated

Rain Penetration

Air Flow

Interrelated

8
Wetting Mechanisms

From Exterior:
- Rain
- Air leakage (infiltration)
- Vapor diffusion (infiltration)

From Interior:
- Air leakage (exfiltration)
- Vapor diffusion (exfiltration)
Condensation

- Occurs when air cools to dew point temperature
- Can occur due to air leakage
- Can occur due to vapor diffusion
- Can occur due to thermal bridging
Interior Heating
Interior Cooling
Vapor diffusion occurs due to movement of water molecules directly through materials.

Air leakage occurs through joints and intersections between different materials.
Vapor Diffusion vs. Air Leakage

4x8 sheet of gypsum board with a 1 in² hole
Interior at 70°F and 40% RH

30 quarts of water
Primary Moisture Sources
Summary

- Rainwater
- Air leakage (condensation)
- Vapor diffusion (condensation)
Some common approaches
- Mass wall
- Rainscreen
- Concealed barrier
- Face seal or surface barrier
Mass wall: *relies on absorption & evaporation*
Mass Wall Joint Detailing Critical to Success

- Best practice joint design
  - avoid single stage joints
- Minimum width 5/8”-1”
- Exterior weather seal
  - prevents most rain entry
  - Weeped for drainage
- Air seal
  - design continuity
  - protected from weather
  - second line of defense
Rain Penetration Control

- **Rain-screen**: relies on 2 layers with drainage

**Figure 3 Rainscreen Wall Assembly**
Requirements of Rainscreen Walls

- Water shedding surface (Rainscreen)
- Secondary moisture barrier
- Drainage path from secondary moisture barrier to outside
- Ventilated cavity increases drying potential
Concealed barrier: relies on multiple layers
Face seal (Barrier): relies on sealed exterior
Defective assemblies

Original design not maintainable.

Maintenance attempted based on bad advice

Extensive damage to wood framed walls behind EIFS
Failures not limited to wood framed buildings

Wood rots, steel corrodes
Stucco Failure
Steel Stud / Stucco

Defective assemblies

Concealed barrier stucco
Insufficient drainage / drying capacity behind cladding resulting in moisture damage
High risk assembly with very limited service life
Moisture damage resulting in corrosion and failure of attachments – catastrophic failure
Not all mass walls are created equal

Avoid single-wythe CMU
Defective Detailing

Water leaking through interfaces
Rough opening around window not flashed or drained properly.
Deficient window interface detailing results in moisture damage to wall framing and interior finishes
Material Issues

Manufacturer’s Spec Bulletin

DESCRIPTION:
A non-reinforced polyvinyl chloride, waterproofed, impermeable sheet, composed of elastomeric substances which have been reduced to a thermoplastic state and formed into a continuous sheet available in the following thicknesses:
Type 20 (.020") weighing approx. 22 ounces per sq. yd.
Type 30 (.030") weighing approx. 33 ounces per sq. yd.
Type 60 (.056") weighing approx. 60 ounces per sq. yd.
Roll Sizes: Type 20, rolls 150' long, 48" and 72" wide. Types 30, rolls 100' long, 48" and 72" wide. Type 60, rolls 50' long, 48" wide. Can be slit to multiple widths.

FEATURES:
York's Wascoseal® membrane is intended for use as a concealed waterproofing membrane on foundation walls and under concrete slabs and is often used as thru-wall flashing. Material will not be physically deformed when stretched at room temperature nor will it tear or rip. It will show no cracking or flaking when bent through 180 degrees over a 1.52” mandrel and then bent at the same point over the same size mandrel in the opposite direction through 360 degrees. The material is suitably stabilized to resist exposure without physical deterioration when tested in accordance with A S T M standard D-827 for a period of not less than 400 hours. It is resistant to acids, alkalis and caustics. RECOMMENDED FOR CONCEALED APPLICATIONS ONLY. Recommended adhesive is York Type R® Cement. Specification Bulletin No. 216. DO NOT USE ASPHALT BASED MASTICS.

“… is often used as thru-wall flashing”

“… DO NOT USE ASPHALT BASED MASTICS.”
Material Issues

Manufacturer’s Website

**WATERPROOFING: WASCOSEAL**

Ensure below-grade protection with our tough WascoSeal® Waterproofing Membrane

Ideal for air and dust barriers, basement walls and basement floors, WascoSeal® waterproofing membranes are made of rugged, tear-resistant PVC that is carefully calendared for uniform thickness to inhibit puncture during installation.

*NOTE: Not recommended for use as through-wall flashing*
Trade Coordination
Insulation Continuity

- Consider loose-fill or spray foam for improved continuity
Wood Framed Cavity

Steel Framed Cavity

Higher Thermal Transmission
Thermal Problems

Stud shadowing on inner and outer faces
Thermal Problems
Extreme Cases

- Surface Mold Growth
Some Design Considerations

- Design for continuity of insulation
- Minimize thermal bridges
- Avoid air flow through/around insulation
Heat Flow Control

Framed Wall Construction with Continuous Insulation
Building Envelope Commissioning

• Trade Submittals / Shop Drawings
• Pre-Construction Meetings
• Mock-Up Construction / Testing
• Initial Assemblies
• Field Review
• Field Testing
Building Envelope Commissioning
Visual Review

Visual Inspection: visual review for discontinuities in air/weather barrier and proper installation
Qualitative Testing: Air Bubble Tracing is another method of identifying small discontinuities not evident from visual review by using differential pressure and a surfactant solution.
Qualitative Testing: Smoke Tracing can be used to identify discontinuities in the air barrier not evident from visual review using differential pressure and a smoke source.
Qualitative Testing: Infrared Thermography measures thermal gradients caused by air leakage showing discontinuities not otherwise evident from visual review.
Quantitative Testing: Blower Door used to measure whole building air leakage rate
Avoiding Building Envelope Defects Summary

Design:
- Select appropriate systems and assemblies
- Separate incompatible materials
- Focus on the details, continuity at interfaces critical

Commissioning:
- Communication: construction team and trades understand the design.
- Field review: Site observation and testing
- Documentation: Photographs and field reports establish a standard of care.
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Good Construction

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