

## Durability and Moisture Control – Building Enclosure Design for the South WoodWorks

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#### **Course Description**

Building enclosures are responsible for controlling heat flow, air flow, vapor flow and a number of other elements. In the southern US, they are also essential for termite prevention. This presentation will explore design considerations associated with wood-frame building enclosures and the role of control layers in addressing items such as durability, termite prevention and control, and thermal continuity. Beginning with a review of building enclosure design fundamentals and considerations, it will then cover best practices for a variety of wood-frame building enclosure assemblies and details. Next, a brief overview of termites encountered in the South will be presented, with a focus on prevention and control strategies for multi-family and commercial wood buildings. A combination of initial design strategies to prevent termites from entering structures and proper maintenance programs for surveillance will be reviewed. Finally, critical details of building enclosure assemblies (walls, ground plane intersection, windows, roofs) will be reviewed with an emphasis on continuity of critical barriers against moisture and termites. The program will conclude with an interactive discussion and opportunity for attendees to engage.

#### **Learning Objectives**

- Review building science fundamentals and building enclosure design considerations for wood-frame buildings in hot and humid regions (with focus on Texas and Louisiana).
- Explore the role of control layers in building enclosures for elements such as heat flow, bulk water intrusion and air flow.
- Identify the types of termites found in the South and understand their paths of entry into building structures and the damage they may cause.
- Understand and apply the termite protection requirements of the International Building Code and local codes for multi-family and commercial projects.

#### Outline

- Mid-Rise Wood Framed Buildings in the South
- Building Science/Control Layers
- Material Types by Control Layers
- Building Code Requirements
- Design Development
- Challenging Details
- Construction Administration

## Mid-Rise/Wood Framed Buildings in the South



• Building Enclosures for Wood-Frames Buildings

- -Building durability
- -User comfort
- -Energy efficiency
- -Architectural finish
- -Resist and transfer loads



Southern Climate



• Coastal and Hot-Humid – Houston as an Example





• Extreme Weather



Picture Credit: PBS, "Katrina, 10 Years Later." https://www.pbs.org/wgbh/frontline/article/katrina-10-years-later-three-documentaries-to-watch/ Weather Underground, "Hurricane Harvey Strengthens to 110 mph Winds; Catastrophic Flooding Likely in Texas."

Water Infiltration





• Air Leakage







(cold outside) (hot outside) Mechanical Pressurization



• Thermal and Heat Transfer



Conduction

Convection

#### Radiation

#### Humidity Control





• Pest/Termite Control





Picture Credit: Canadian Wood Council, "Termites." https://cwc.ca/why-build-with-wood/durability/durability-hazards/termites/





- Water
- **1**. Deflection
- 2. Drainage
- 3. Drying
- 4. Durability



- Water
- **1**. Deflection
- 2. Drainage
- 3. Drying
- 4. Durability



Thermal insutation 4 Control Functions Vipor ectarder Ar Barner

- Water
- **1**. Deflection
- 2. Drainage
- 3. Drying
- 4. Durability





- Water
- **1**. Deflection
- 2. Drainage
- 3. Drying
- 4. Durability



Control Functions

Vapor Retarder

- Water
- **1**. Deflection
- 2. Drainage
- 3. Drying
- 4. Durability

"No wrong materials... Just materials used for the wrong applications"



Control Functions

• Air

Air leakage typically take place through:

- -joints, gaps and cracks in the construction
- -gaps created where the structure penetrates
- the outer skin of the building
- -cracks around door and window openings
- -gaps where services enter the building

#### Devil is in the details

• Air





• Air





• Thermal

- **BTU**: Unit for energy. The amount of heat required to raise the temperature of 1 lb. of water by 1 °F
- U-Factor: How fast heat passes through a material.
   BTUs that passes through 1 ft<sup>2</sup> in 1 hour for 1 °F temperature difference.
- **R-Value**: How well materials resist heat flow. R=1/U

Heat loss/gain = 
$$\frac{Area \times \Delta T}{R-Value}$$
, in BTUs per hour



- Thermal
  - U-factor for windows



Overall window

#### World's Best Window Co. Millennium 2000+ Vinvl-Clad Wood Frame lational Fenestration Rating Council® Double Glazing Argon Fill Low E Product Type: Vertical Slider CERTIFIED ENERGY PERFORMANCE RATINGS U-Factor (U.S./I-P) Solar Heat Gain Coefficient ADDITIONAL PERFORMANCE RATINGS Visible Transmittance Air Leakage (U.S./I-P) Manufacturer stipulates that these ratings conform to applicable NFRC procedures for determining whole product performance. NFRC ratings are determined for a fixed set of environmental conditions and a specific product size. NFRC does not recommend any product and does not warrant the suitability of any product for any specific use. Consult manufacturer's literature for other product performance information www.nfrc.org

#### • SHGC







• Thermal

Thermal bridging: an area of the building fabric which has a higher thermal transmission than the surrounding parts of the fabric Results in a reduction in the overall

thermal insulation of the structure.



Control Functions

Vispor Retarde



• Vapor

But where do you install it?







# **Material Types by Control Layers**



#### **Material Types by Control Layers**

• A single product may perform one or many of these functions



#### **Material Types by Control Layers**

• Water





Sheet Water-Resistive Barrier

Liquid-Applied Membranes

	Thermal	Water	Air	Vapor
Building paper				
Spun bonded polyolefin mechanically fastened house wrap				

	Thermal	Water	Air	Vapor
Fluid applied membrane				
Self-adhered membrane				
# **Material Types by Control Layers**

• Air



Sheet air / water resistive barrier



Fluid applied air / water resistive barrier

	Thermal	Water	Air	Vapor
Fluid applied membrane				
Self-adhered membrane				

# **Material Types by Control Layers**

	Thermal	Water	Air	Vapor
Spray foam				
Spun bonded polyolefin mechanically fastened house				
wrap				

# **Heat Transfer/Conduction**

• Thermal



Fiberglass batt



Mineral wool



Spray foam



XPS Extruded polystyrene



Polyiso Polyisocyanurate



EPS Expanded polystyrene

# **Material Types by Control Layers**



Classification:





Polyethylene



Class III: > 1.0 perms



Kraft faced batt



Gypsum

	Thermal	Water	Air	Vapor
Fluid applied membrane				Depends on formulation
				$\bigcirc$
Self-adhered membrane				Depends on
				iormulation

## Material Types by Control Layers

	Thermal	Water	Air	Vapor
Batt				Depends on formulation (faced)
Spray foam				Depends on formulation



## Texas

- Commercial: 2015 IECC Commercial Provisions
- Residential: 2015 IECC Residential Provisions
- Residential Single-Family: 2015 IRC

• Texas – Thermal Zones





• R-value Requirements for Exterior Wall – Texas

Building Use	Climate Zone	Assembly Maximum (U-Factor Method)	Insulation Min. R-Value
Commercial (2015 IECC section C402)	2 A and 2 B	U-0.064	R-13 + R-3.8ci or R-20
	3 A and 3 B	U-0.064	R-13 + R-3.8ci or R-20
	4 B	U-0.064	R-13 + R-3.8ci or R-20
Residential (2015 IECC section R402)	2 A	U-0.084	R-13
	3 A	U-0.060	R-20 or R-13 + R-5.0ci
	4 B	U-0.060	R-20 or R-13 + R-5.0ci

• R-value Requirements for Roof – Texas

Building Use	Climate Zone	Assembly Maximum (U-Factor Method)	Insulation Min. R-Value
Commercial (2015 IECC section C402)	2 A and 2 B	U-0.064	R-38
	3 A and 3 B	U-0.064	R-38
	4 B	U-0.064	R-38
Residential (2015 IECC section R402)	2 A	U-0.030	R-38
	3 A	U-0.030	R-38
	4 B	U-0.026	R-49

• Continuous Air Barrier Requirements – Texas (2015 IECC C402.5)

<b>Building Use</b>	Component	Criteria
	General Requirements	<ul> <li>A continuous air barrier shall be provided throughout the building thermal envelope</li> <li>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</li> </ul>
Commercial	Exception	• Air barriers are not required in buildings located in Climate Zone 2 B
Commercial	Air Barrier Construction	<ul> <li>The air barrier shall be continuous for all assembles that are thermal envelope of the building and across the joints and assemblies</li> <li>Air barrier joints and seams shall be sealed, including sealing transitions in places and changes in materials</li> <li>Penetrations of the air barrier shall be caulked, gasketed or otherwise sealed in manner compatible with the materials and location</li> </ul>

• Continuous Air Barrier Requirements – Texas (2015 IECC C402.4)

Building Use	Component	Criteria
Residential	General Requirements	<ul> <li>A continuous air barrier shall be installed in the building envelope</li> <li>The exterior thermal envelope contains a continuous air barrier</li> <li>Breaks or joints in the air barrier shall be sealed</li> </ul>
	Ceiling/Attic	<ul> <li>The air barrier in any dropped ceiling shall be aligned with the insulation and any gaps in the air barrier shall be sealed</li> <li>Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed</li> </ul>
	Walls	<ul> <li>The junction of the foundation and sill plate shall be sealed</li> <li>The junction of the top plate and the top of exterior walls shall be sealed</li> <li>Knee walls shall be sealed</li> </ul>

# **Design Development**



• Low Mass



• Barrier



• Rainscreen



• Drainable



**Typical** 

Recommended

# **Typical Roofing Systems**

• Low Slope



**Typical** 

Recommended

# **Typical Roofing Systems**

• Steep Slope



### **Typical**

### Recommended

# **Design Development**

## • Hygrothermal Modeling

 A computer program that analyzes the movement of heat, air, and moisture based

on

- Constituent of wall assembly
- Climate
- Orientation
- Initial conditions
- -After analysis, the program outputs
  - Water content in different layers of wall assembly over time
  - Whether mold is likely to grow in the assembly



## Radiation UV through glass

- Low-e coating
- Tinted glass

## Convection

within air space

- Subdividing air spaces (more panes)
- Inert gases

# Conduction

• Thermally broken frame





# **Design Development**

- Discipline Coordination
  - Architect
  - Waterproofing Consultant
  - Structural Engineer
  - MEP/HVAC Engineer
  - Civil/Site Drainage Engineer
  - Fire Protection Engineer
  - BECx Consultant
  - Sustainability Consultant





## • Wall to Slab at Grade



• Podiums – Wall and Window Flashings





### • Podiums – Detailing Recommendations



• Field of Wall – Open Seams/Insufficient Overlap



• Field of Wall – Open Seams/Insufficient Overlap



## • Field of Wall – Damaged WRB



• Building Corners



• Building Corners - Detailing Recommendations



• Punched Windows - Improper WRB Detailing at Head



• Punched Windows – Poorly Adhered WRB at Corners





• Punched Windows – Detailing Recommendations


• Other Wall Penetrations – Lack of Flashing at Fire Sprinkler



• Other Wall Penetrations – Lack of Flashing at Pipe Penetrations



## • Other Penetrations – Detailing Recommendations





• Balconies – Back Slope to Walls





• Roof-to-Wall Connections – Detailing Recommendations



• Roof-to-Wall Connections – Sealant at Transitions





• Field of Roofing – Slope and Drainage





## • Field of Roofing – Penetrations



No sealant



Properly clamped and sealed



- Critical Meetings
  - Pre-Construction Meetings
  - Pre-Installation Meetings
  - Mockup Reviews
  - Witness Testing Meetings
  - OAC Meetings



Project Name Preconstruction Meeting Agenda WPM Project No: Dxx-xxxxx-xx June 24, 2020 Location: Skype Meeting

Property Manager:		nager: Name: John Doe
		Address: 123 Main St, Houston, TX 77010
		Phone: 713.xxx.xxxx
		Email: jdoe@walterpmoore.com
Engineer:		Name: John Doe
		Address: 123 Main St, Houston, TX 77010
		Phone: 713.xxx.xxxx
		Email: jdoe@walterpmoore.com
Contractor:		Name: John Doe
		Address: 123 Main St, Houston, TX 77010
		Phone: 713.xxx.xxxx
		Email: jdoe@walterpmoore.com
1.	Intro	eduction
520 107		
11.	Preconstruction Meeting Items	
	1.	Communication
	2.	Designation of responsible personnel
	З.	Working hours
		(1) 5 M 2 M 2 M 2 M 2 M 2 M 2 M 2 M 2 M 2 M

- 4. Tentative construction schedule
  - a. Phasing
- 5. Use of the premises

## • Submittals and Shop Drawings

\*\*\*Fuld-verify how far the wisdow hand and/or jamh wicks out at each floor\*\*\* \*\*\*Z-Flashings should be custom-made to ensure tight fit\*\*\*

- Dry fit the Z-flashing onto the storefloor justb. Where the Z-flashing meets the window sill, out a
  1" square off of the bottom of the 1 %" leg of the Z-flashing. This will allow the middle section
  and the 2" leg of the Z-flashing to run part the window sill.
- 2. Clean the existing of the abaraments storefront jumb with a wat mg to remove dust and dat.
- Clean the back side of the 1 %" leg of the window just 2-flashing with a wei jug to remove dust and dirt
- Apply double-sided tape (manufacturer TBD) to the backside of the 1 11° log of the window jumb Z-flashing. Tape should be centered on the 1 10° log.
- Adhery Z-flading to the jamb of the storefront. Prove tightly along the full height of the flading to ensure adherence.
- Screw 88 x 2 1/5" golvanized screws at 1,2" on center through the 2" leg of the Z-flashing and into the wood framing members next to the storyfront jamb.
- Install 47 Typed rape ever the joint where the Z-flashing neets the exterior sheathing. 2° of the tape should drare to the flashing: the remaining 4° should athere to the sheathing.
- 8. Overlap the lovek Stacco Wrap over the face of this new 6- Tovek tape.
- Install another piece of G. Townstage over the edge of the TyPic Stocco Wrap. This tage should extend onto, and remainster by the middle section of the Z-flagsing.
- 10. Repeat Stops 1 1 on the opposite jumb.
- Fold the Tyrek Storeo Wap a the head of the window up. Mead flashing routs by installed below this Storeo Wap.
- 12. Clean the exterior of the abundence simulation band with a starting to remove dust and dirt.
  13. Clean the back side of the 1 %<sup>-1</sup> for of the window head Z chadding with a wet gag to remove dust
- and dirt. 14. Apply double-sided tape (Approximation per THO) to the backade of the 1 15" log of the window head
- Z.-flashing: Tape should be demicrobion the 1 %" leg.
   Addervi Z.-flashing to the head of the transform. Prove tartify along the full length of the flashing to ensure adherence.
- (6) Server 88 v.2.35° golvanized across in 12° on center through the 3° leg of the Z-disthing and into the structural books. The head fit bineral-boold extension? on each side beyond the justific Balange installed in Stops 1...9 above. The 3.5° reg of the best flashing MUST be installed over the top of the 1.9° log of the pands flashing.
- Install 6<sup>11</sup> Evolving even the joint where the Z-flashing meets the evention sheathing. 3<sup>-</sup> of the tape sheadd affere to be flashing, the representer 3<sup>-</sup> should affere to the sheathing.

3M All Weather

ing Tape 8067

18. Pull down the eniuting Tyring Stacco Wran and overlap it onto the head flashing.

#### WPM NOTES:

 As previously noted, WPM recommended that the existing aluektost be removed and reinstability where waterproofing regimes already to rough therming around permanen of assuming stranding to anound permanent of assuming stranding to considered more vulnerable to future water recovers mousts but it properly installed and mantserved should maligne fusile water influston.
 Existing strandings found with existing stranding brow putalling flashing assembly





• Field Mockups





## • Quality Assurance Testing





# Summary

- Building enclosure is critical for the durability of buildings and well-being of residents
- Building enclosure must address all weather elements: water, air infiltration, thermal, and vapor
- There are a variety of control layers available, need to be selected based on the requirements and location of the building
- Detailing of control layers at transitions and discontinuities must be designed from below-grade foundation to the roof
- Construction administration is essential to ensure conformance of construction to design



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