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Webinar Series

Building Science for Net Zero Energy Wood-frame Walls:

1. Exterior Insulation Selection
2. **Detailing with Exterior Insulation**
3. Detailing with Deep & Double Stud Walls

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Goal Today:

Understand building science principles and observe examples of the detailing of exterior insulated walls with various types and typical thicknesses of exterior insulation

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Recap: Webinar #1

Wall Target R-value

↓

Exterior Insulation Ratios

↓

Considerations for:
- Vapour Control
- Airflow Control
- Water Control
- Cladding Attachment

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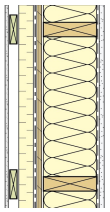
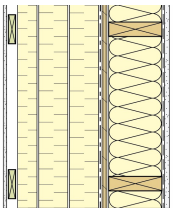
Outline Today:

- Recap – Building Science for Exterior Insulation
- Cladding Attachment through Exterior Insulation
- Detailing Examples & Considerations for AB/WRB Placement with Different Exterior Insulation Products





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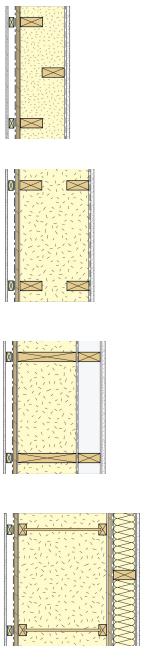
Webinar #3 Next Week

- Double Stud & Deep Stud Wall Systems
- Air & Vapour Control & Alternate Materials
- Detailing Ecxamples



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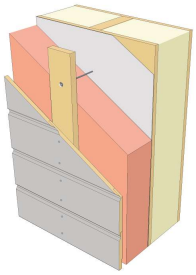
Exterior Insulation Types

Selecting Exterior Insulation

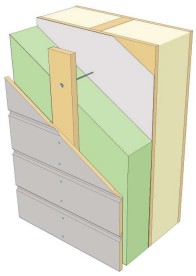
Impermeable



Rigid Foam Insulation

XPS | Polyiso | EPS* | ccSPF

Vapour **Permeable**



Rigid/Semi-rigid Fibrous Insulation

Mineral Wool | Wood Fibre | Cellulose Fibre | Fibreglass

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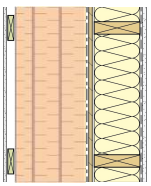
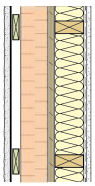
Safe or Cautionary Insulation Ratios? – Table B

Condensation risk due to **vapour** and **airflow** associated with selected exterior insulation ratio, indoor and outdoor conditions, and use of space

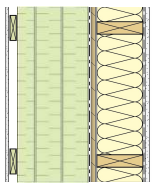
Safe (High Ratios)



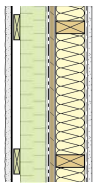
Cautionary (Low Ratios)



Safe (High Ratios)



Cautionary (Low Ratios)



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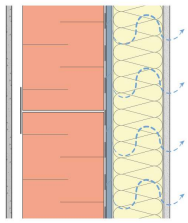
Guidance for Vapour Control

Vapour Control

Vapour flow is controlled by the exterior insulation

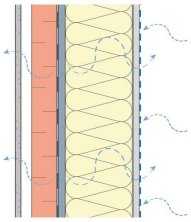
Vapour diffusion drying to interior is desirable

No interior vapour control layer necessary



Facilitate some inward drying, while still limiting outward vapour diffusion

Vapour retarder or smart vapour retarder material is recommended

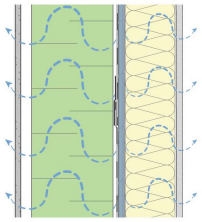


Vapour Control

Vapour flow is controlled by the sheathing

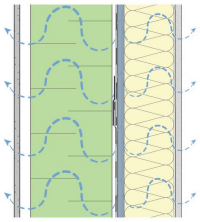
Vapour diffusion drying occurs both outwards and inwards when conditions permit

No interior vapour control layer necessary



Vapour diffusion drying occurs outwards and possibly to the interior depending on interior vapour control

Vapour retarder or smart vapour retarder material may be used



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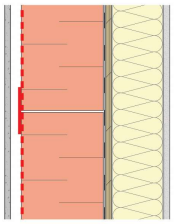
Guidance for Air Flow Control

Airflow Control

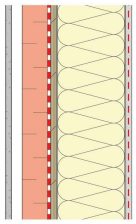
Exterior or mid-wall approaches most desirable

- Taped/sealed foam insulation
- Sealed Sheathing
- Sealed Sheathing Membrane



Risk of convective looping within cavity, provide some interior airtightness

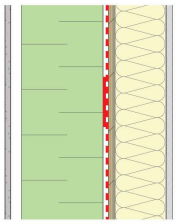
- Sealed Sheathing
- Sealed Sheathing Membrane
- **Airtight drywall to limit convection potential**



Airflow Control

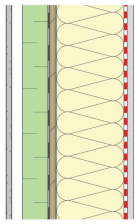
Mid-wall sheathing air barrier approaches most desirable

- Sealed Sheathing
- Sealed Sheathing Membrane
- Interior AB possible



Risk of convective looping within cavity, provide some interior airtightness

- Sealed Sheathing
- Sealed Sheathing Membrane
- Sealed Polyethylene, Drywall, or Interior Sheathing



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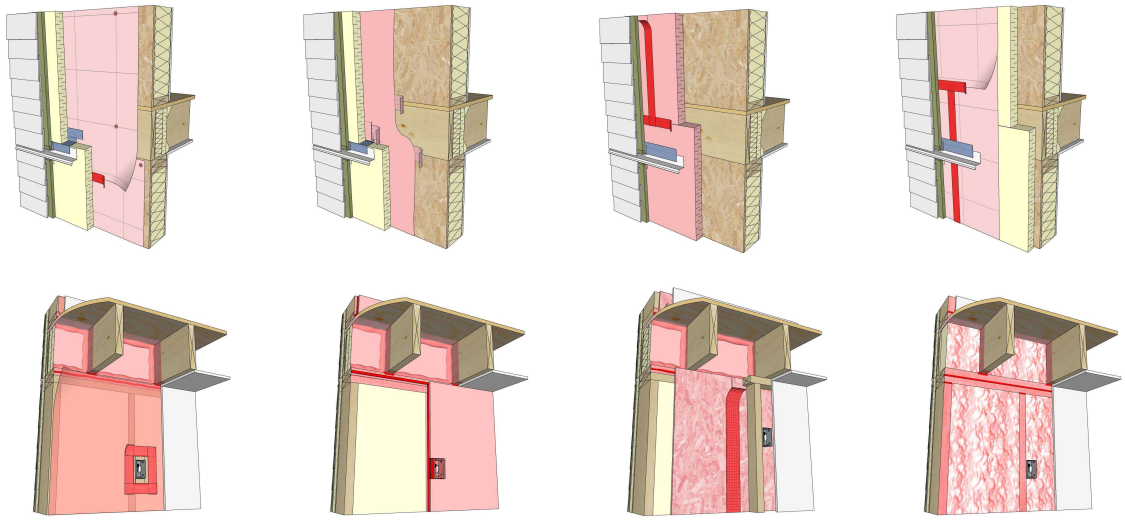
Air Barrier System Options



General rule of thumb – maintain some degree of interior airtightness with exterior air barriers until safe insulation ratios are achieved

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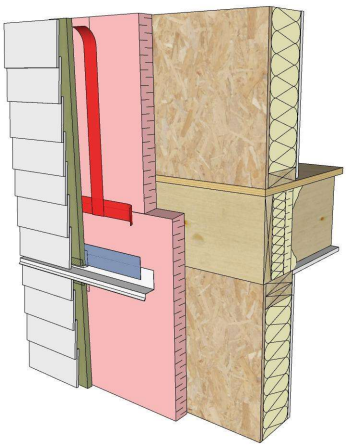
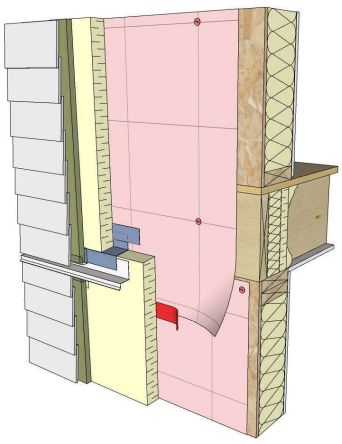
Most Common Air Barrier Approaches with Exterior Insulation



If rigid foam – use the foam as the air barrier or a backup membrane behind



If semi-rigid/rigid non-airtight insulation use a membrane or the sheathing behind as the air barrier

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Guidance for Water Control

Water Control

Water Control

Selection of Water Resistive Barrier (WRB) and rainscreen cladding recommendations based on exterior insulation type

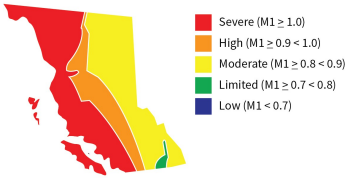
Low to Moderate Moisture Index

High Moisture Index or wetting risk

Moisture tolerant permeable insulation

Moisture sensitive permeable insulation

BC MOISTURE INDEX



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Guidance for Water Control

Low to Moderate Moisture Index

- Taped/sealed foam
- All details/flashings on exterior of foam
- Rainscreen recommended even when not required by code

High Moisture Index or wetting risk

- Taped/sealed foam with WRB behind
- Consider providing **small drainage space** between foam and WRB
- Rainscreen assembly required per code

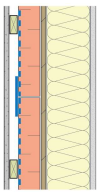
Moisture tolerant permeable insulation

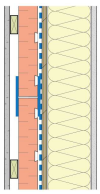
- WRB behind exterior insulation or applied over exterior insulation
- All details/flashings behind insulation, though without creating wetting pathway

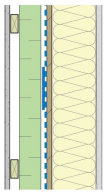
Moisture sensitive permeable insulation

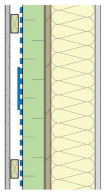
- WRB installed over exterior insulation
- All details/flashing on exterior of insulation

Rainscreen recommended even when not required by code









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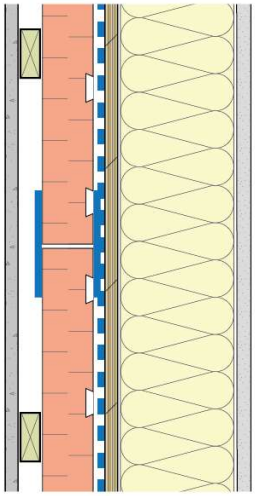
Drainage Behind Exterior Foam Insulation?



Drainage Mat

Drainable Housewrap

Grooved Insulation

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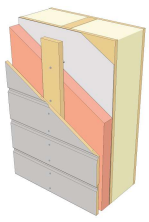
Guidance for Cladding Attachment

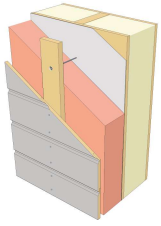
Cladding Attachment

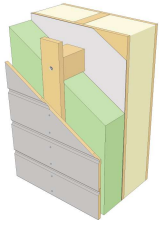
Cladding Attachment

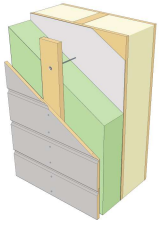
Selection of cladding attachment based on insulation type

≤ 2 inches thick	> 2 inches thick	Semi-Rigid	Rigid
Nail/screw directly through insulation or use strapping and long nails/screws	Use vertical strapping and long screws	Clips or blocking through exterior insulation	Per guidance at left for impermeable rigid insulation









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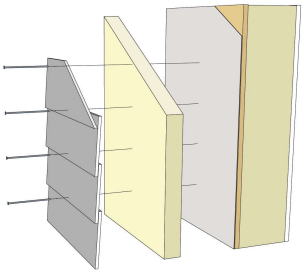
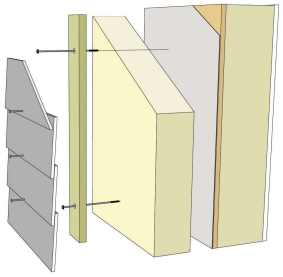
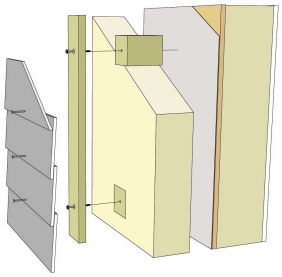
Cladding Attachment Through Exterior Insulation



Cladding fasteners (nails) directly through rigid insulation (for up to 2" and light claddings)



Long screws through vertical treated strapping and any depth of exterior rigid insulation creates truss – short cladding fasteners into vertical strapping



Rigid shear block type connection through insulation, short cladding fasteners into vertical strapping

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Cladding Attachment through Exterior Insulation









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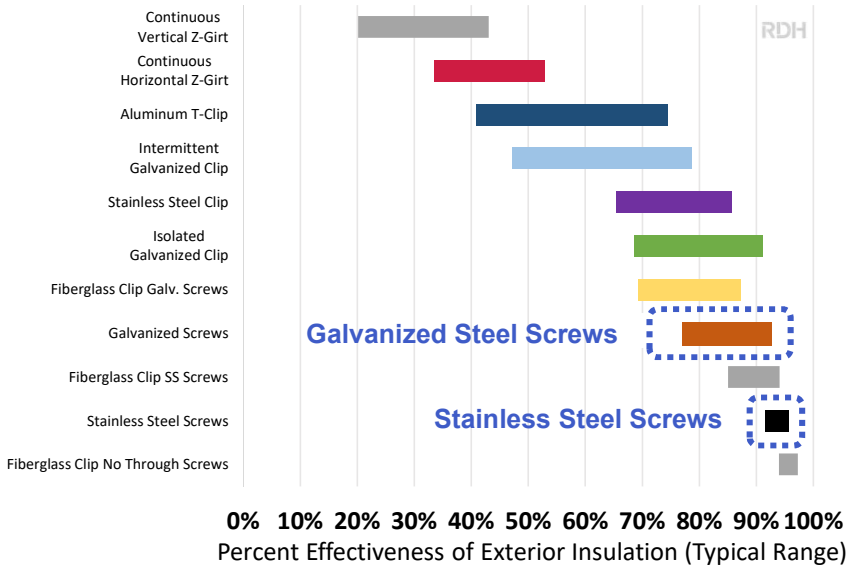
Thermal Effectiveness of Different Cladding Attachment Options



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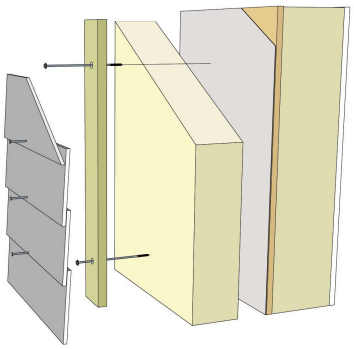
Long Screws Through Exterior Insulation

- Rapidly gaining popularity to meet increasing R-value requirements
- Highly effective, only 5-10% loss in wood framing
- Still uncertainty about:
  - How to do it
  - Allowable loads/claddings
  - Fastener types
  - Fastener spacing
  - Angle of installation
  - Deflection



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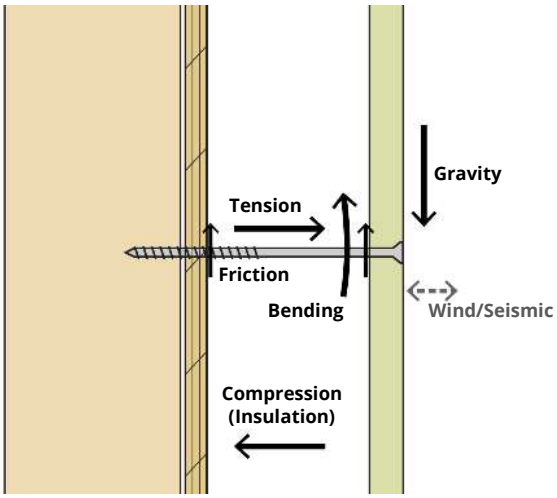
Design & Forces



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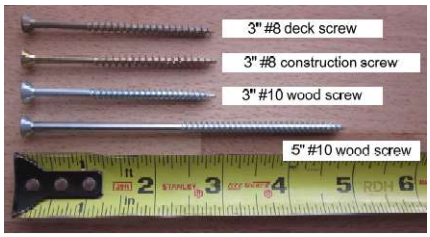
Structural Testing



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Testing Results – Load vs. Displacement

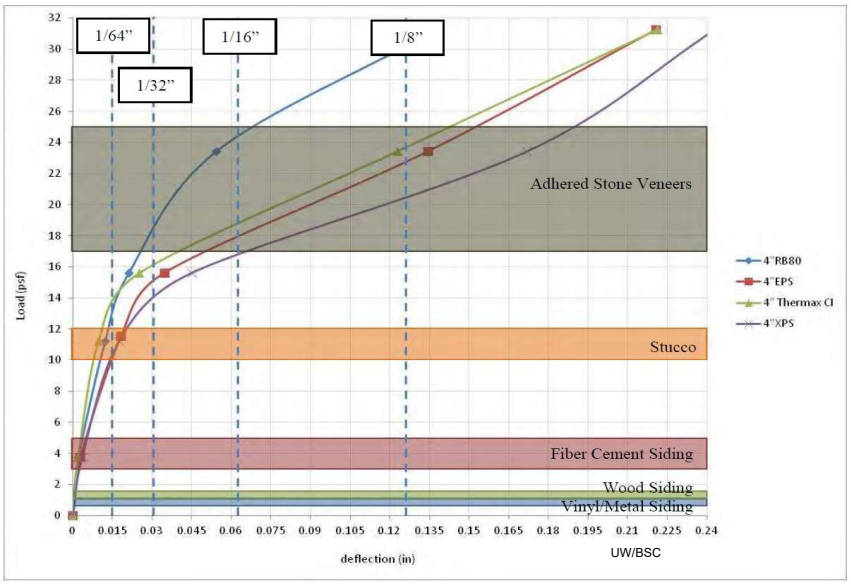

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Figure 9: Short term deflection testing results (4" thick insulation)

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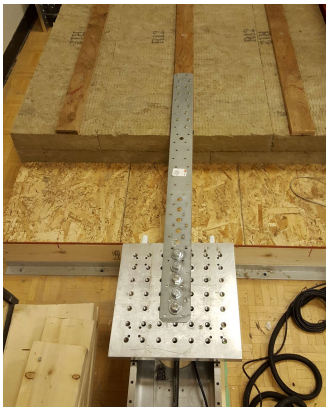
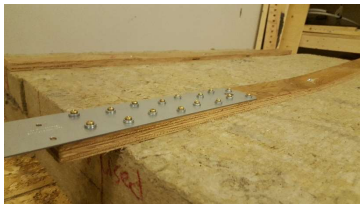
Testing of Thicker Exterior Insulation

- 3", 6", 9" and 12" thicknesses of insulation
- Different insulation types (rigid mineral wool and XPS) and different compressive strengths
- Different screw head types (pan and countersunk)

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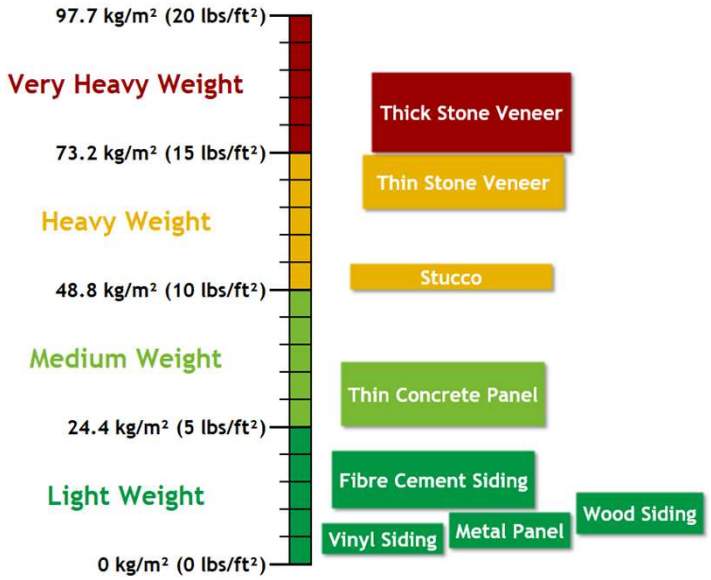
Cladding Weights

- Most claddings are actually "light weight" with only a few products being heavier



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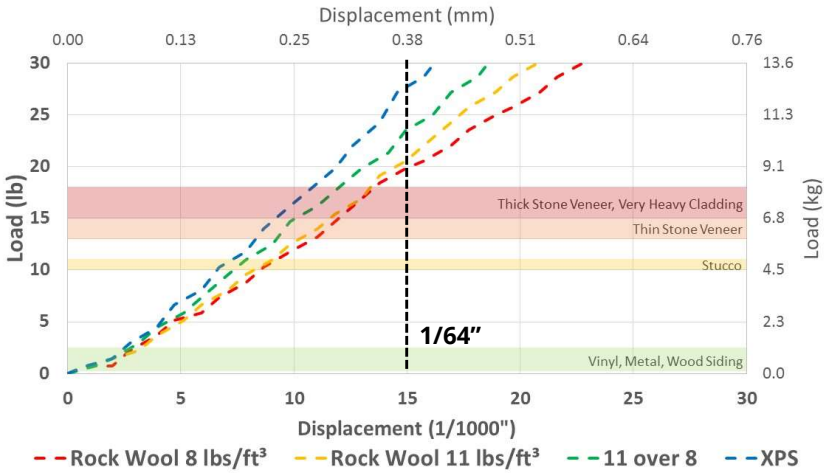
Testing – By Insulation Type

Load Displacement for Different Insulation Types (6" Thick)



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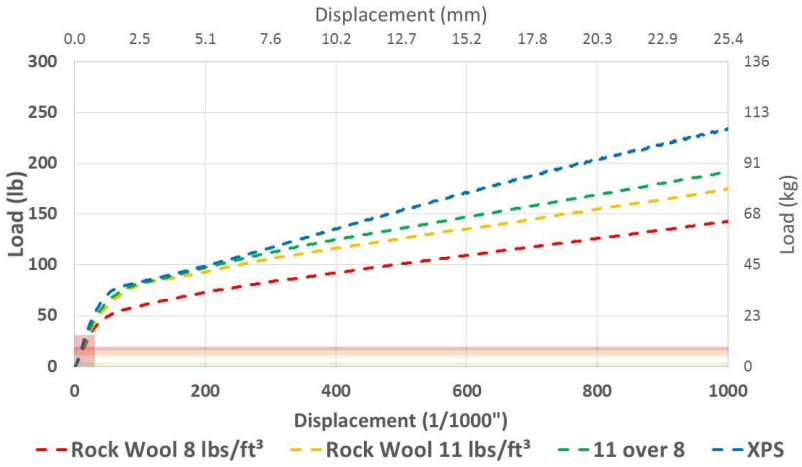
Testing – By Insulation Type

Load Displacement for Different Insulation Types (6" Thick)



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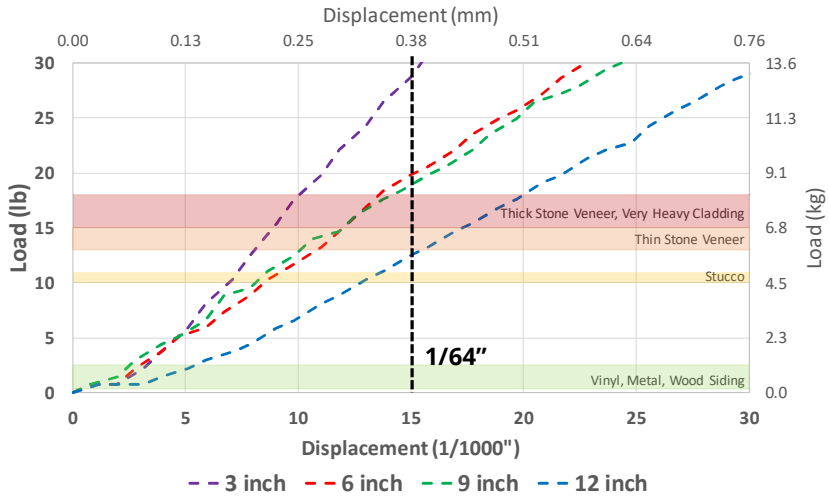
Testing – Insulation Thickness

Load Displacement for Different Mineral Wool Thicknesses



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Testing – Insulation Thickness

- For the record, this is what 12” of insulation looks like…

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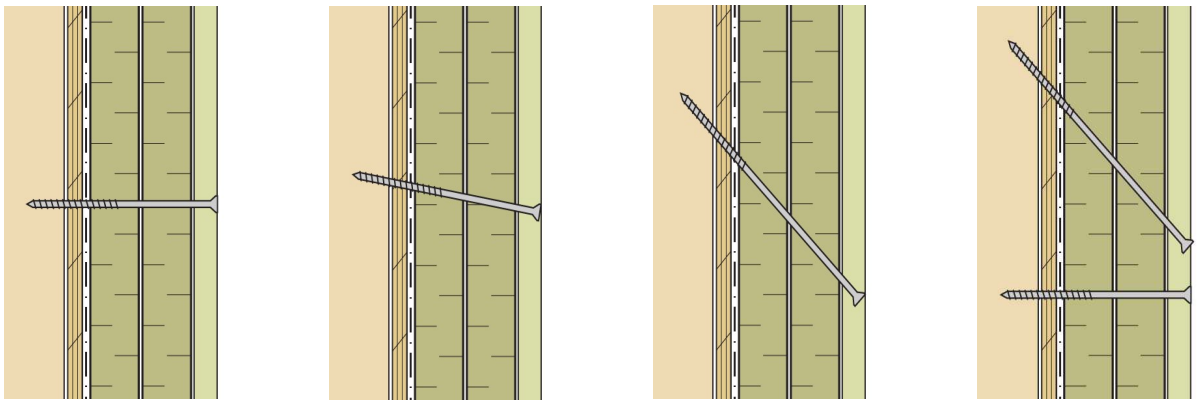
Testing – Different Fastener Arrangements



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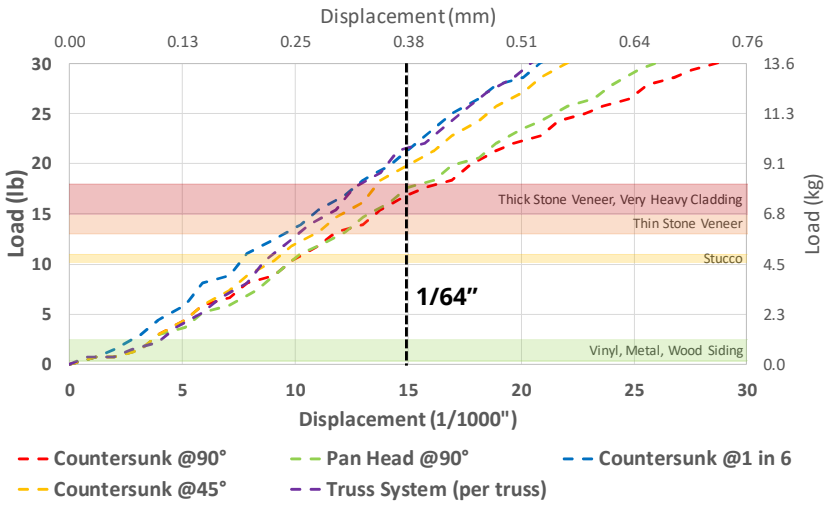
Testing – Fastener Arrangements

Load Displacement for Different Fastener Arrangements



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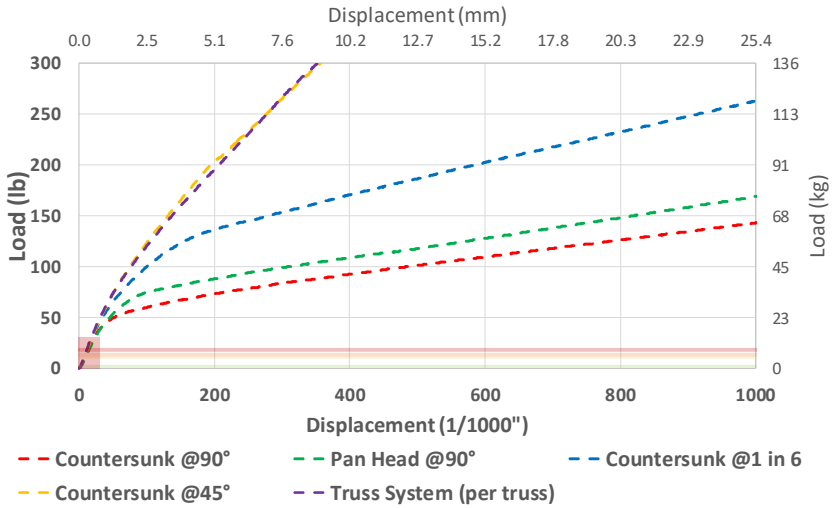
Testing – Fastener Arrangements

Load Displacement for Different Fastener Arrangements



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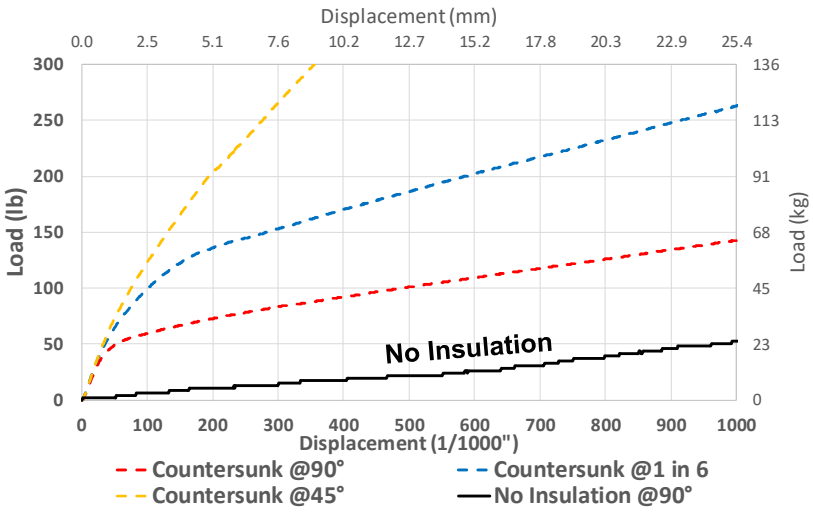
Testing – Is this just the fastener?



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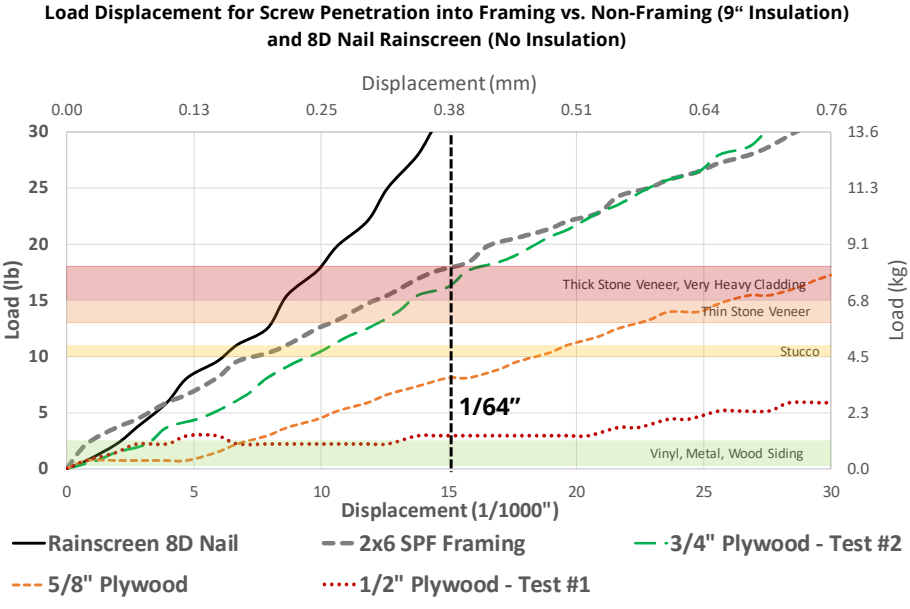
Testing – What if we miss the stud?



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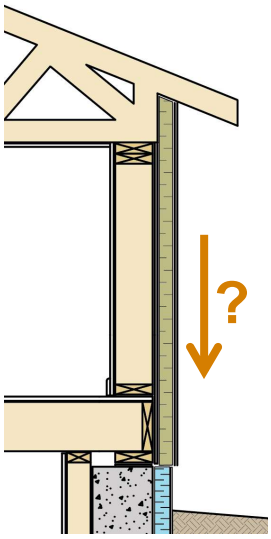
Deflection - How much is too much?

- Difficult to define precise deflection limit but many claddings can easily accommodate 1/8" (125 mil, 3mm) deflection
- Staged loading of the support system helps to "pre-deflect" the strapping prior to cladding completion
- Can see it is different than strapping direct to sheathing, but not much



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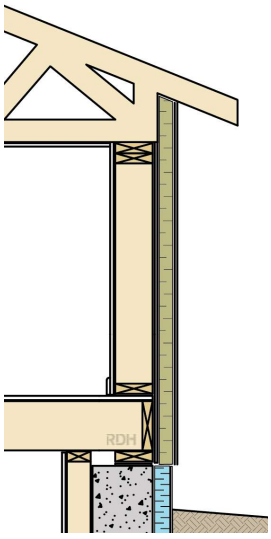
Deflection - How much is too much?

- Comparison: Wood Shrinkage
  - One wood-frame storey: Double top plate, single bottom plate, 8' ceilings, rim joist
  - Assume 19% initial MC and 10% final MC at equilibrium with interior
  - Wood shrinkage due to drying
    - 0.25%/MC across grain
    - 0.0053%/MC with grain
  - Approximately **3/8" (375mil, 10mm)** shrinkage in one storey height
    - **Roughly 10x** more than measured deflection in test for any arrangement



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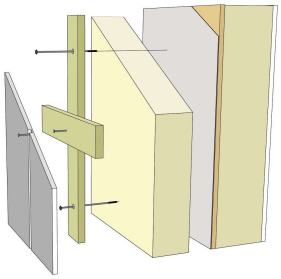
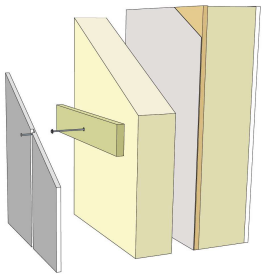
Cladding Attachment – Vertically Oriented Claddings

Recommended



Cross Strapping to Allow Drainage & Ventilation

Light Claddings in Dry Regions / Low Moisture Index Only:



Horizontal Strapping – No Drainage/Ventilation

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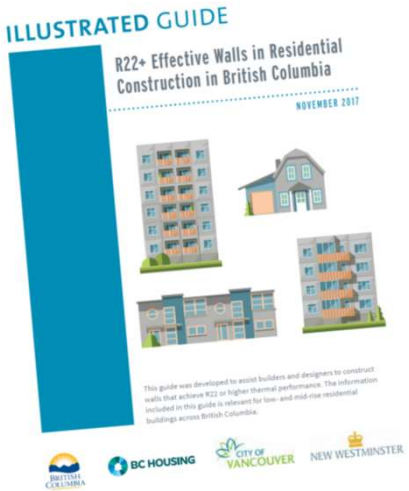
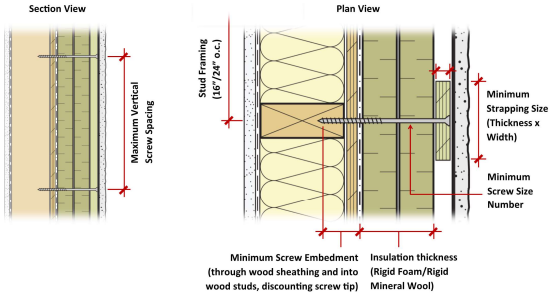
Reference Material & Design Tables





Fastener/Strapping Installation Requirements—Light Weight Cladding					
Thickness of Exterior Insulation	Maximum Vertical Screw Spacing	Minimum Screw Size	Minimum Screw Embedment	Minimum Strapping Size	
				Rigid Foam	Rigid Mineral Wool
Light Weight Cladding Below 5 lbs/ft² - 16" o.c. Stud Framing					
1" to 2" *	24"	#10	1"	3/8" x 1-1/2"	3/8" x 2-1/2"
>2" to 8"	16"				
Light Weight Cladding Below 5 lbs/ft² - 24" o.c. Stud Framing					
1" to 2" *	16"	#10	1"	3/8" x 2-1/2"	3/8" x 2-1/2"
>2" to 8"	12"				

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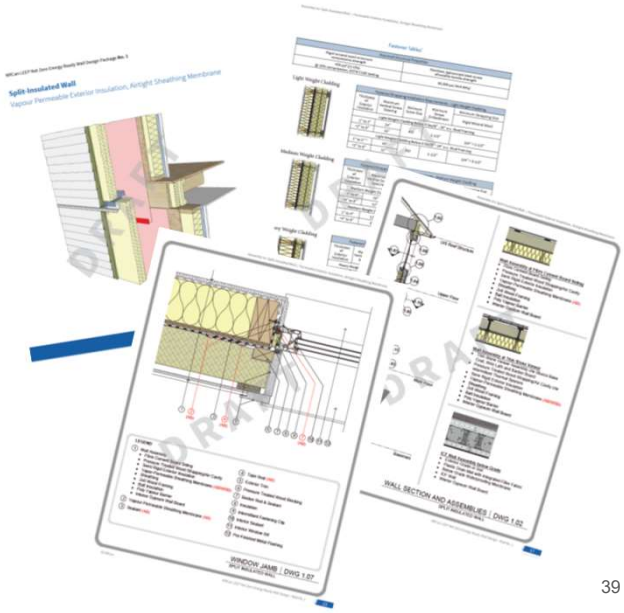
NRCan Net Zero Energy Wall Guidelines

- Series of 4 Building Science Guidelines being developed for 4 common near net zero ready wall systems, R-30 to R-40 range (e.g. 4-6" of exterior insulation on 2x6)
- Covers design & construction considerations
- Provides Effective R-value Tables
- Commentary on building Science guidance (Air, Vapour, Water) for each and rationale
- Includes cladding attachment fastener tables, costing information and Builder Checklists



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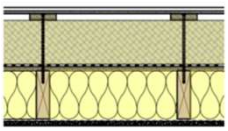
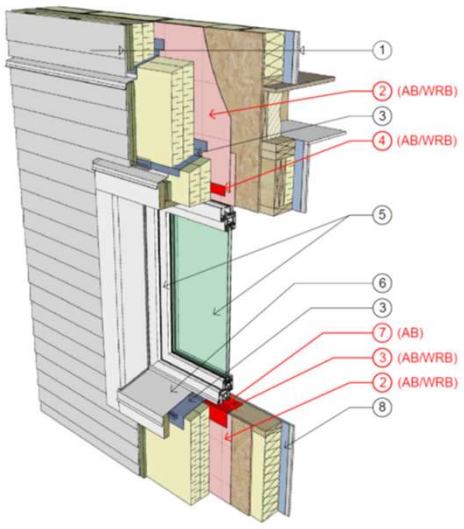
Detailing Guidelines – NRCan Net Zero Energy Ready Walls

Assembly Type 1 - Split Insulated Wall, Vapour-Permeable Exterior Insulation, Air Tight Sheathing Membrane



Wall Assembly at Fibre Cement Board Siding

- Fibre Cement Board Siding
- Pressure Treated Wood Strapping/Air Cavity
- Semi Rigid Exterior Insulation
- Vapour-Permeable Sheathing Membrane (AB/WRB)
- Sheathing
- 2x6 Wood Framing
- Batt Insulation
- Poly Vapour Barrier
- Interior Gypsum Wall Board



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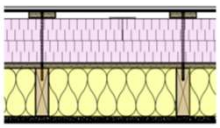
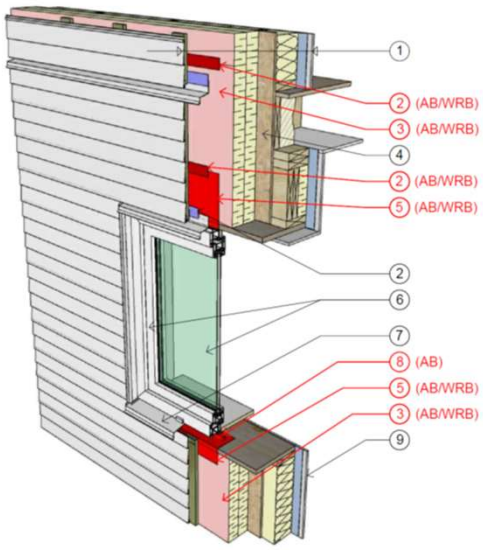
Detailing Guidelines – NRCan Net Zero Energy Ready Walls

Assembly Type 2 -
Split Insulated Wall with Tape Sealed Joints for Air Tight Exterior Insulation



Wall Assembly at Vinyl Siding

- Vinyl Siding
- Pressure Treated Wood Strapping/Air Cavity
- XPS Insulation with offset Joints and Tape Sealed at outer Face (AB/WRB)
- Sheathing
- 2x6 Wood Framing
- Batt Insulation
- Interior Gypsum Wall Board sealed to Wood Framing along Edges
- Vapour Retarder Paint



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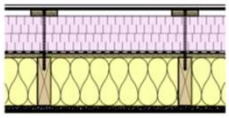
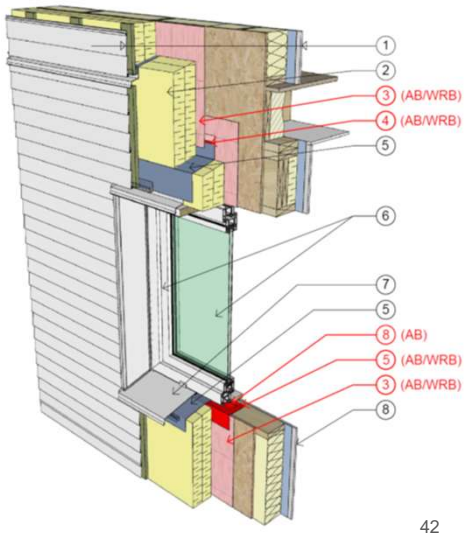
Detailing Guidelines – NRCan Net Zero Energy Ready Walls

Assembly Type 3 - Split Insulated Wall, Air Tight Sheathing Membrane with Integral Drainage Surface and Exterior Insulation



Wall Assembly at Vinyl Siding

- Vinyl Siding
- Pressure Treated Wood Strapping/Air Cavity
- XPS Insulation with offset Joints and Tape sealed at outer Face
- VP Sheathing Membrane with Drainage (AB/WRB)
- Sheathing
- 2x6 Wood Framing
- Batt Insulation
- Interior Gypsum Wall Board sealed to Wood Framing along Edges
- Vapour Retarder Paint



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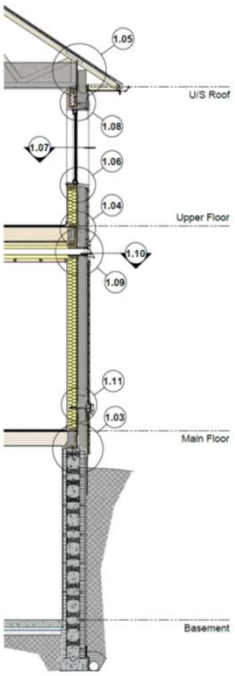

Typical Details

DWG 1.03 | Base of Wall at Foundation

DWG 1.04 | Cladding Transition at Floor Line

DWG 1.05 | Wall & Roof Interface

DWG 1.06 | Window Sill

DWG 1.07 | Window Jamb

DWG 1.08 | Window Head

DWG 1.09 | Wall Penetration at Duct - Section

DWG 1.10 | Wall Penetration at Duct - Plan View

DWG 1.11 | Wall Penetration at Receptacle - Section

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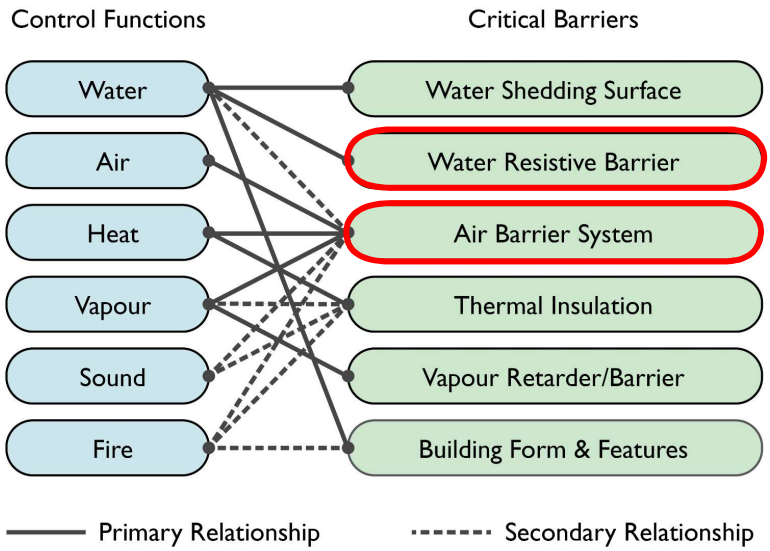
Building Science Detailing Considerations



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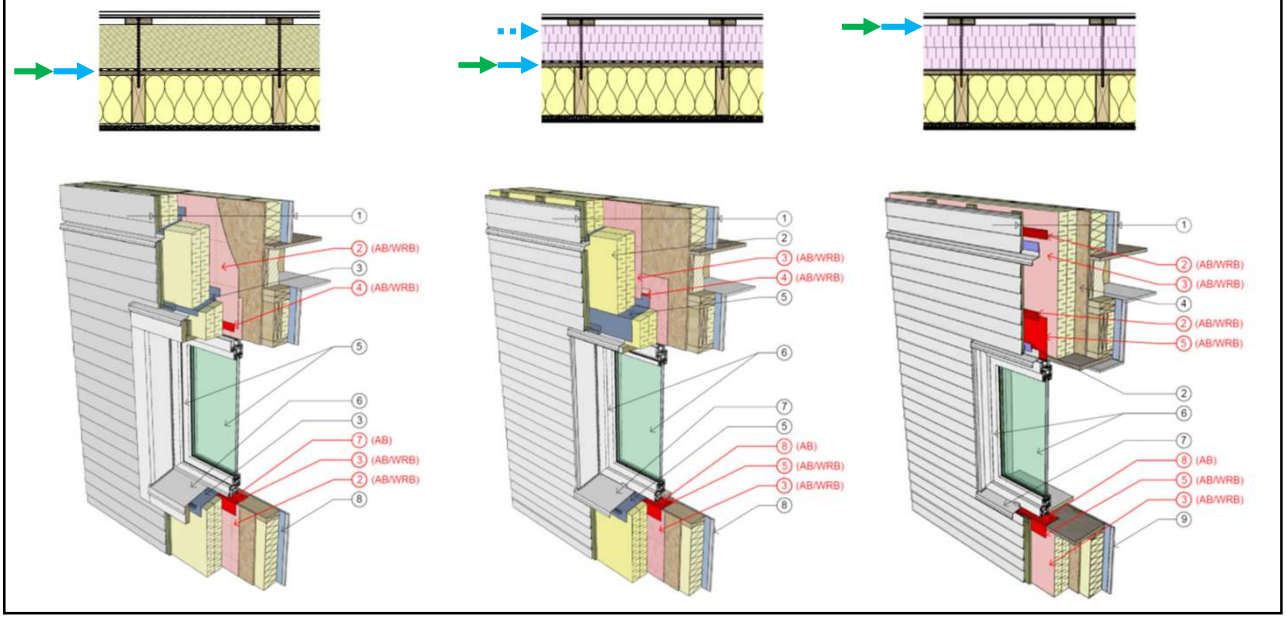
Detailing Considerations – AB/WRB & Insulation Type



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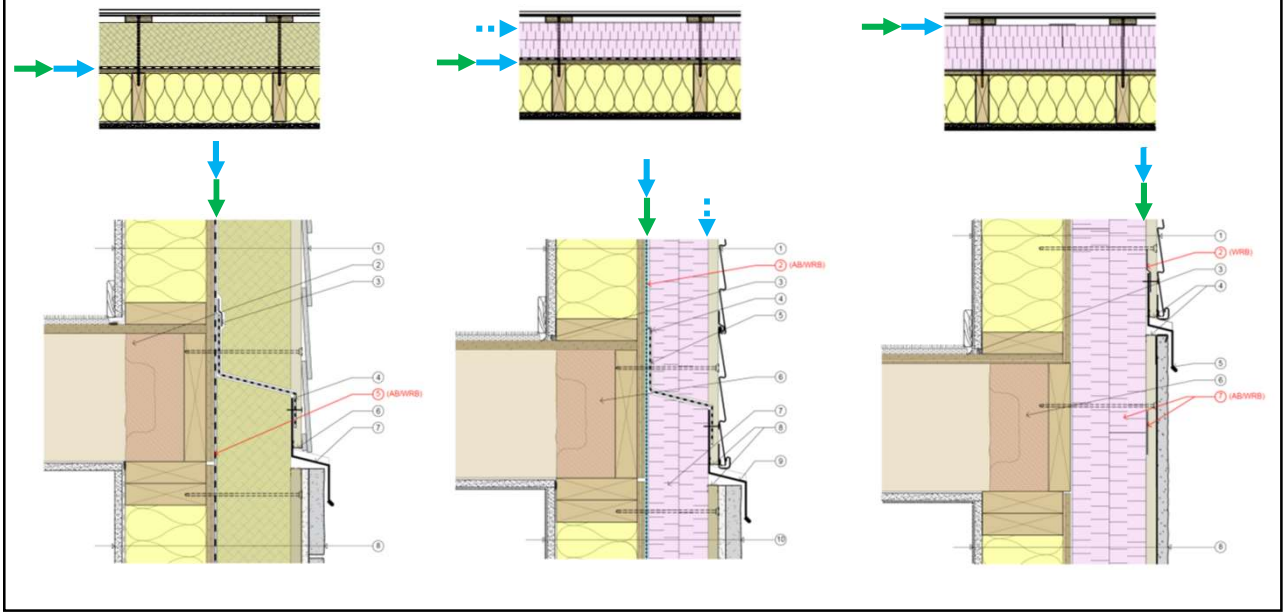
Detailing Considerations – Cross Cavity Flashings



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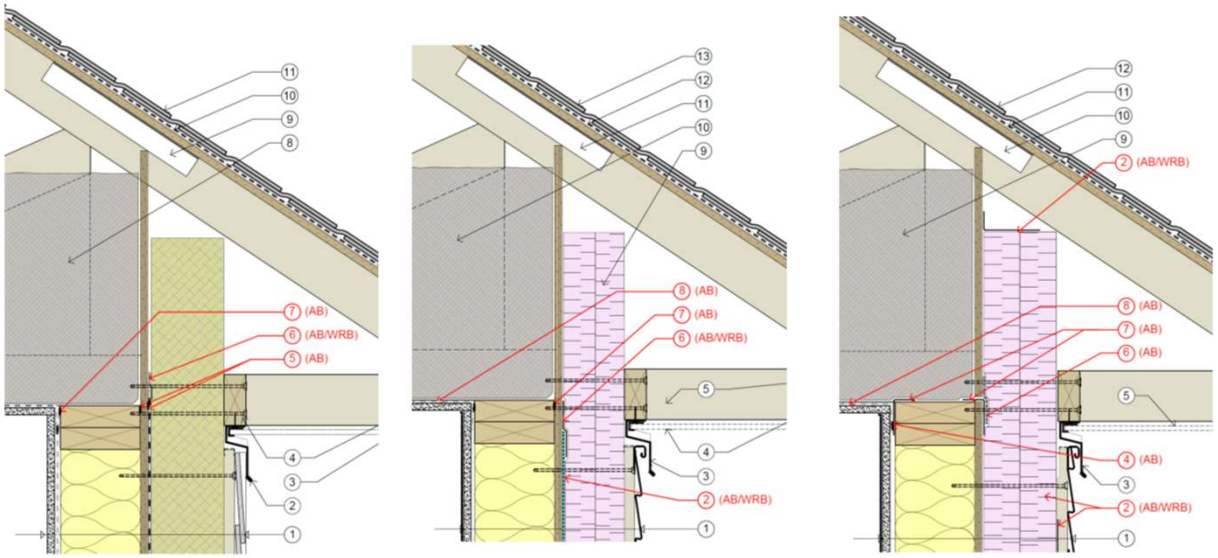
Detailing Considerations – AB Transfer @ Roof



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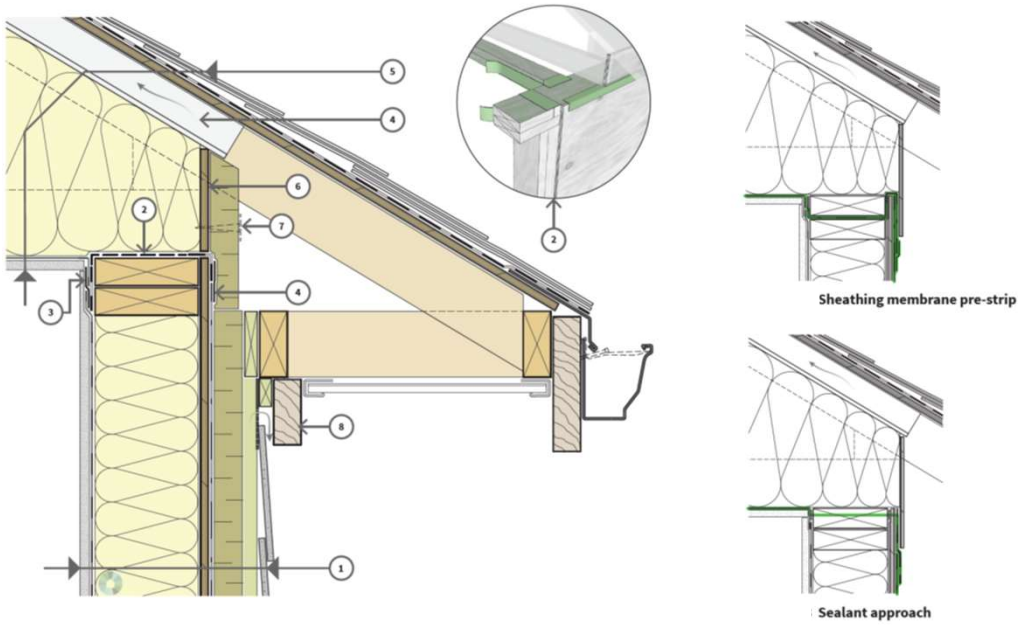
Exterior to Interior Air Barrier Transfer Options



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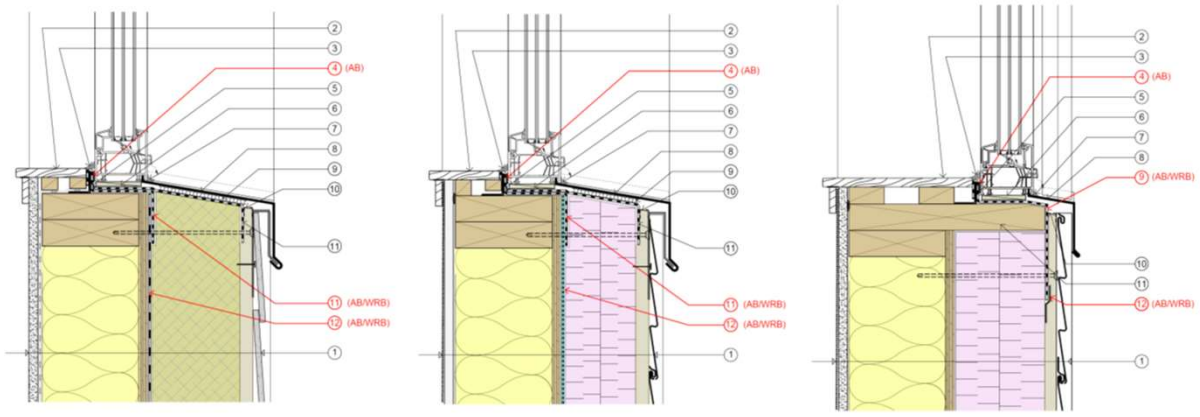
Detailing Considerations – AB/WRB Transfer @ Window Sill



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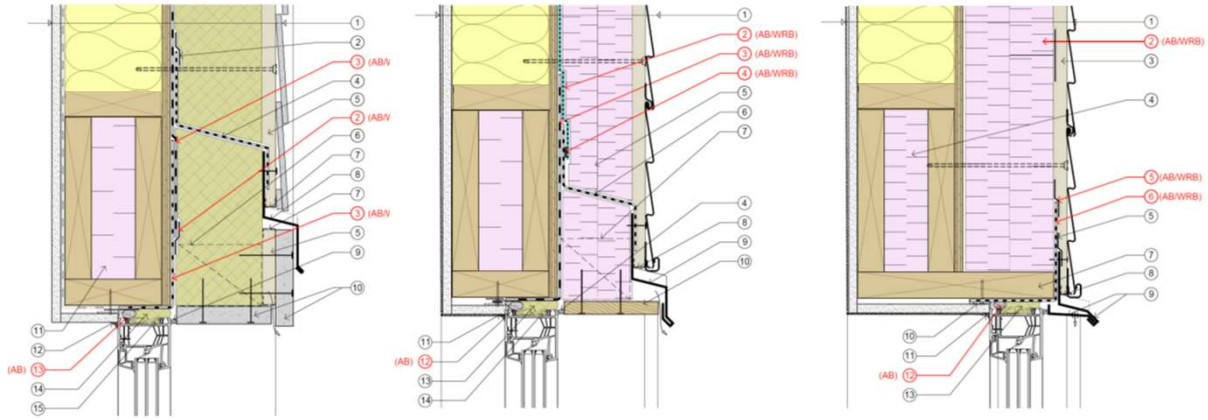
Detailing Considerations – AB/WRB Transfer @ Window Head



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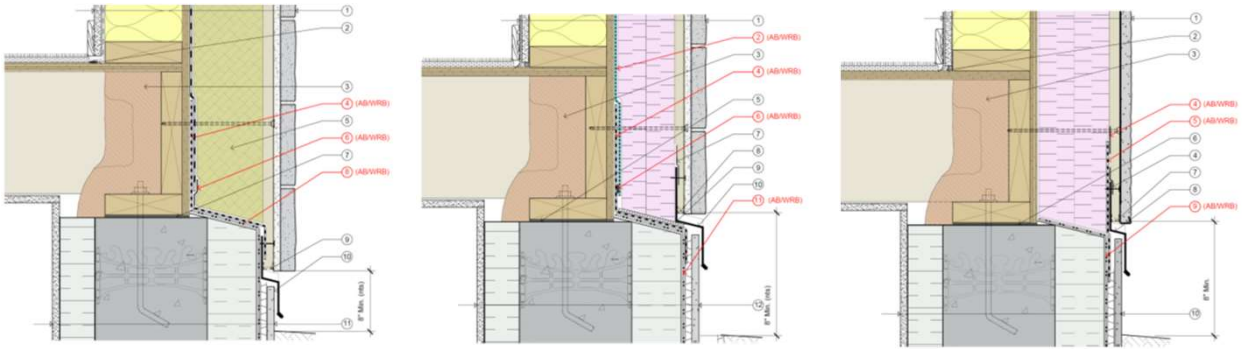
Detailing Considerations – AB/WRB Transfer @ Base of Wall



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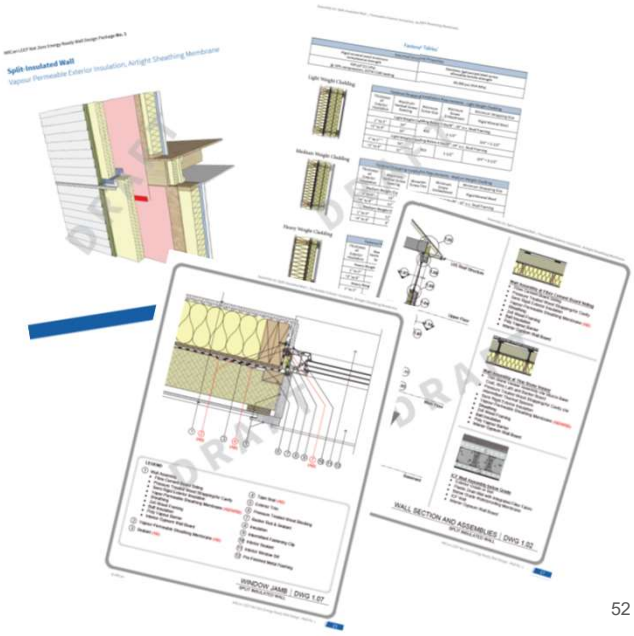
Key Points

- Exterior insulation - placement of AB/WRB control layers depends on thickness and properties of insulation
- Cladding attachment with long-screws (or one of many different clips) for structural support
- Understand your options, choose which works best for your project and preferences
- Guides coming early summer



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