



## Presentation Outline

- 4 Key Lessons & Trends Influencing Mid-rise Wood Building Enclosures
  - Wood Framing & Effective Insulation
  - Air Barrier Methods, Details & New Materials
  - Problems & Solutions for Wood-frame Shrinkage
  - Maintenance & Renewals Considerations





### And When It Isn't Challenging Enough on Land...



### Building Enclosures for 5&6 Storey – What is Different?



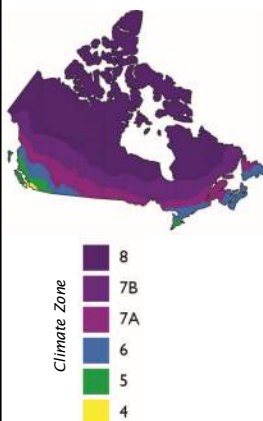
- Taller buildings = increased exposure to wind and rain
  - Need for better site protection, use of more robust assemblies and materials including roofing, claddings & windows, consideration of pre-fab
- More structural framing
  - Less space for insulation within studs
  - Unique wood/steel/concrete interfaces and details
- Non-combustible claddings & enhanced fire-safety considerations during construction & in-service
- Different energy code requirements than 3&4 storey & Part 9 wood-frame

## Building Enclosures for 5&6 Storey – Trends

- 10+ years experience with 5&6 storey wood-frame buildings on the west coast (BC, WA, OR)
- Continuous progression of building enclosure practices resulting from:
  - Building code changes incl. WA requirements for whole building air-tightness testing
  - Energy code changes pushing wall R-values beyond 2x6 studs w/ batt insulation
  - Pre-fabrication of walls, balconies and other components to speed-up construction
  - Unique details to accommodate or minimize the impacts of wood shrinkage
  - Reconsidered material, assembly, & detailing choices appropriate for increased exposure



## Minimum Performance Energy Code Targets for Midrise Wood-frame Buildings



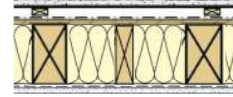
Climate Zone	Wall: Min. R-value	Roof - Sloped or Flat: Min. R-value	Window: Max. U-value
8	31.0	40.0	0.28
7A/7B	27.0	35.0	0.39
6	23.0	31.0	0.39
5	20.4	31.0	0.39
4	18.6	25.0	0.42

Minimum Effective R-values (NECB 2011)

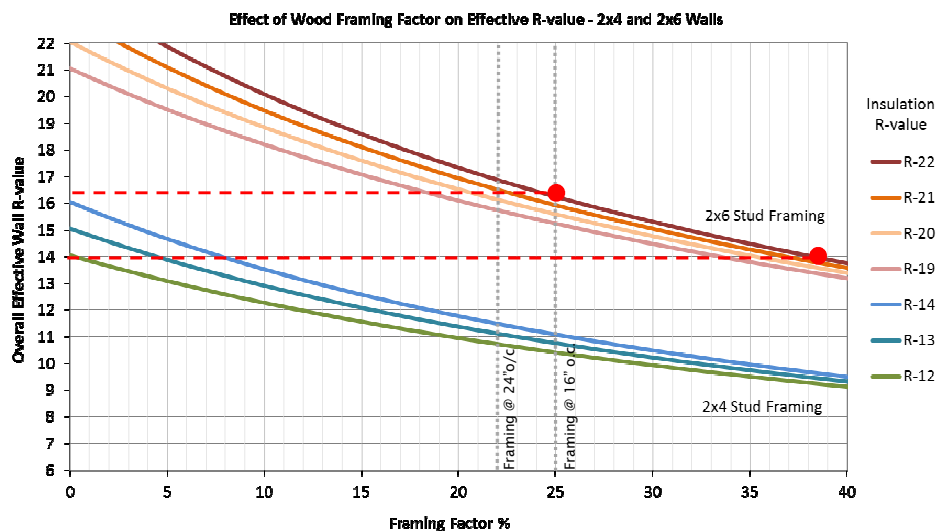


## Wood-Framing in Mid-rise Wood Buildings

- 5&6 storey wood-frame walls typically have less room for stud space insulation due to structure: studs, tie-downs, etc.
- Creates challenges to meeting prescriptive R-value requirements without exterior insulation
- Rethink shear walls on exterior walls



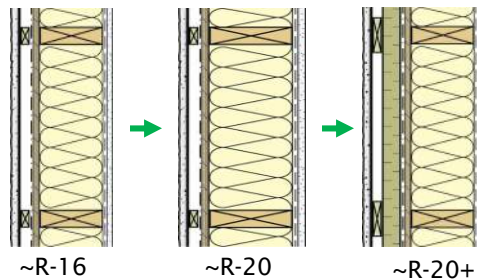
## Wood Framing Factor Impact on Effective R-values



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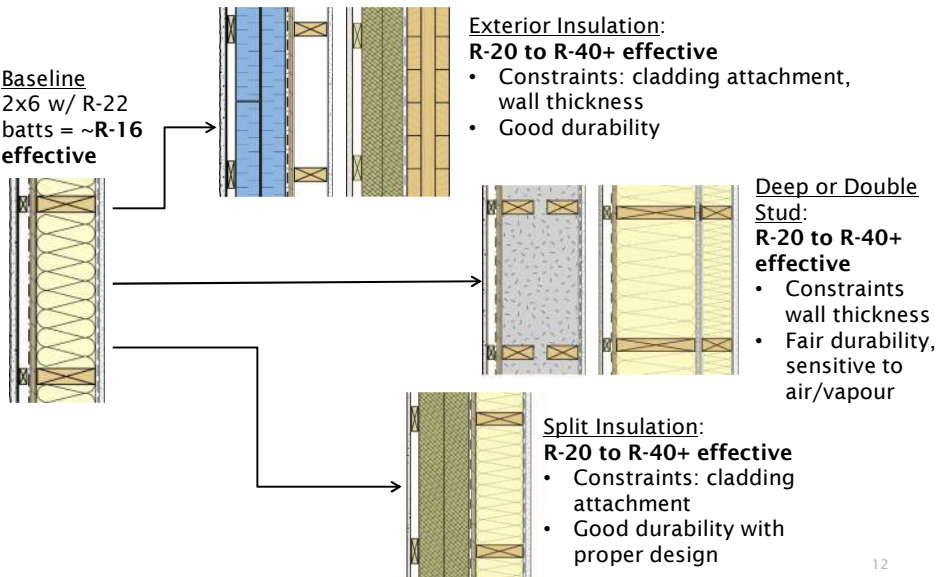
## Meeting Energy Code Wall R-value Targets with Exterior Insulation or Deeper Framing

- Code shift of prescriptive effective R-value targets to R-20 range (from ~R-16 in previous codes):
- 2x8 framing (w/ R-28+ batts)
    - › Limited if cavity full of framing, services and tie-downs etc.
  - 2x6 with 1 to 1.5" (R-4+) of exterior insulation



## Getting to R-27 to R-31 Effective Walls

Baseline  
2x6 w/ R-22  
batts = ~R-16  
effective

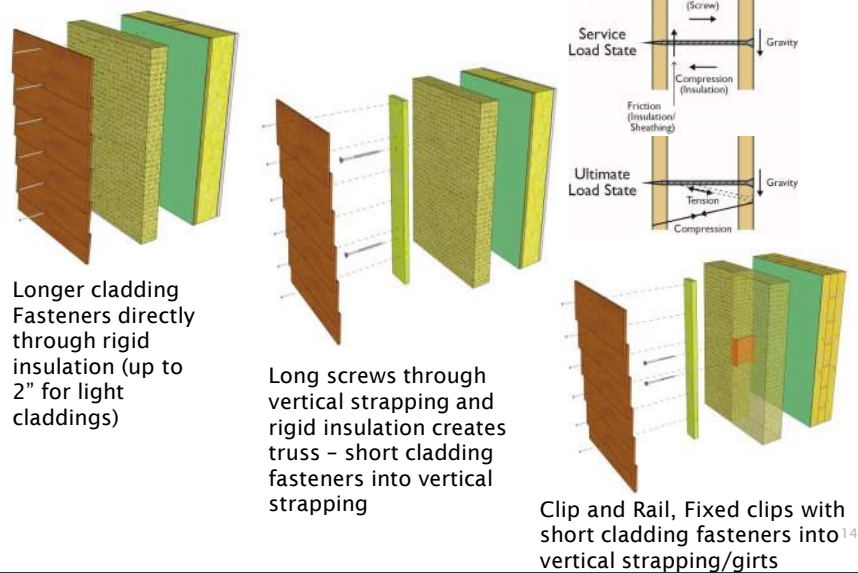


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## Exterior Insulation & Cladding Attachments

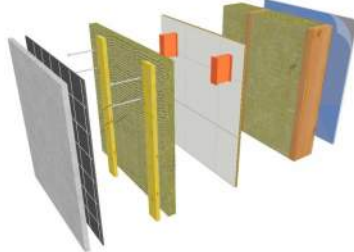


## Cladding Attachment through Exterior Insulation



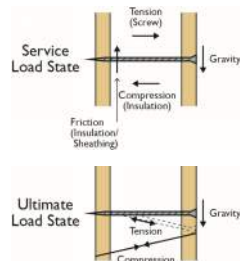
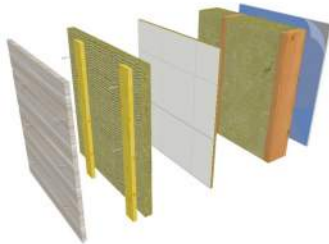
## Cladding Attachment through Exterior Insulation

*Thermally Efficient Clip & Rail Systems*



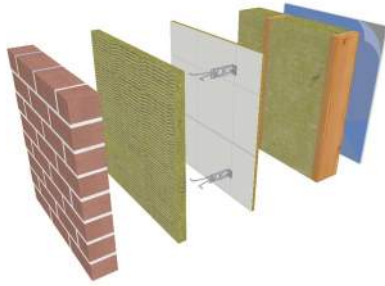
## Cladding Attachment through Exterior Insulation

*Screws through Exterior Insulation & Vertical Strapping*





## Masonry Ties



## Prefabricated & Super Insulated



~R-40 pre-fabricated walls, 6" rigid mineral wool over 2x6 framed & insulated wall



### Split Insulated Wall - Case Studies



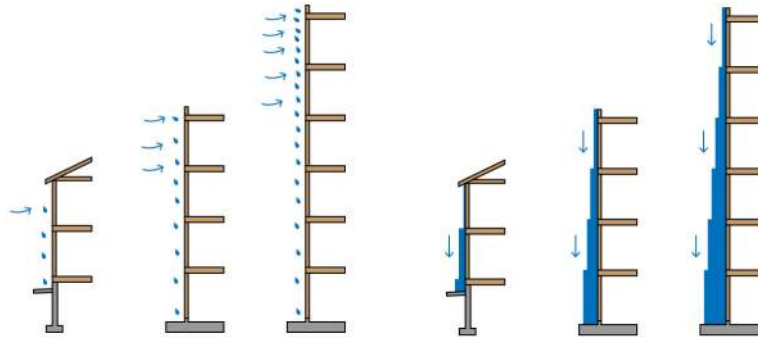
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### Split Insulated Wall - Case Studies



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## Midrise Wood-frame Buildings & Exposure



- 5&6 storey midrises = increased driving rain exposure and wind pressures
- Requires more robust water control and air barrier system strategies than 1-4 storey buildings

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## Wood-frame Mid-rise Air Barrier System Trends

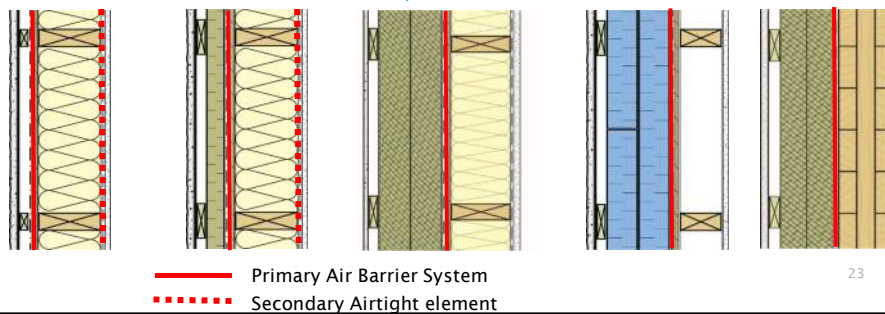
- Trend towards **exterior air barrier approaches (at sheathing plane)** utilizing rigidity & simplicity of exterior sheathing
- **Sealed sheathing membrane approach** (vapour permeable AB/WRB)
  - Mechanically attached (taped & sealed), \$
  - Self-adhered membrane, \$\$\$
  - Liquid/fluid applied, \$\$\$
- **Sealed sheathing approach** (plywood/OSB/ext. gypsum AB) w/ loose WRB
  - Sealed sheathing joints (sealant or tapes), \$\$
- Use of interior approaches not as common or as effective for mid-rise buildings
  - Sealed poly not appropriate for this height
  - Airtight drywall not widely used



## Shift to the Exterior Air Barrier

- Industry shift in midrise wood buildings from the use of interior air barrier approaches (poly, drywall) to exterior sheathing approaches as the primary air barrier element
- BUT! still need to maintain a reasonable degree of airtightness at interior side of cavity insulation (convection suppressor)
- Vapor barrier/retarder at interior side depending on insulation ratio & type

With enough exterior insulation – risk for condensation at sheathing decreases as does need for interior air tightness



## Airtightness Does Not Happen By Accident!





### Mechanically Attached Air Barrier Systems

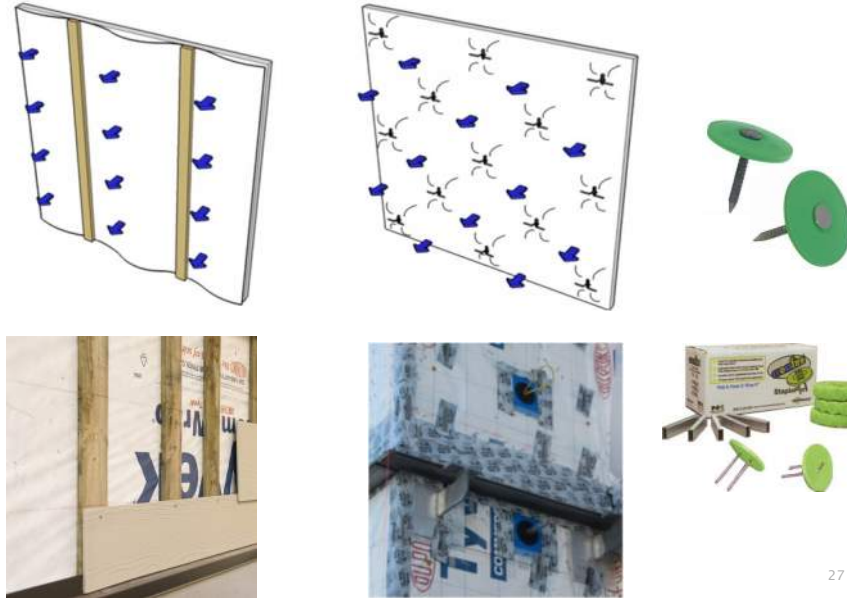
- Loose sheet membrane is mechanically attached to wall with cap staples/nails
- All laps, joints, and penetrations sealed with tapes, self-adhered membrane and/or sealants
- Can work for midrise, but becomes challenge at 5-6 storeys



### Challenges with Mechanically Attached Air Barriers & Wind During Construction



### Rigid Support for Mechanically Attached Air Barriers During Construction & In-Service



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### Exterior Insulation Sandwich Support for Mechanically Attached Air Barriers



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### Interfaces & Challenges – Exterior Air Barriers



### Interfaces & Challenges – Pre-stripping

→ Pre-stripping AB membrane is often recommended at framing interfaces & roof-wall transitions – but usually forgotten!



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## Interfaces & Challenges – Parapet Air Sealing



## Interfaces & Challenges – Better Parapet Airsealing





### Self-Adhered Air Barrier Membranes

→ Self-adhered membrane sheets (typically vapour permeable) applied to sheathing along with tapes/self-adhered membranes at interfaces



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### Self-Adhered Air Barrier Membranes



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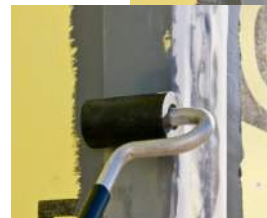
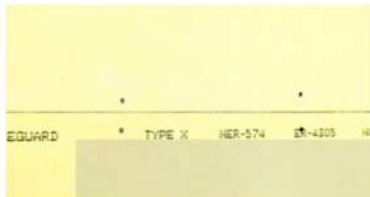
### Liquid/Fluid Applied Air Barrier Membranes

→ Liquid/Fluid applied membranes (roller, brush or spray) applied to sheathing with joint/gap fillers or reinforcing



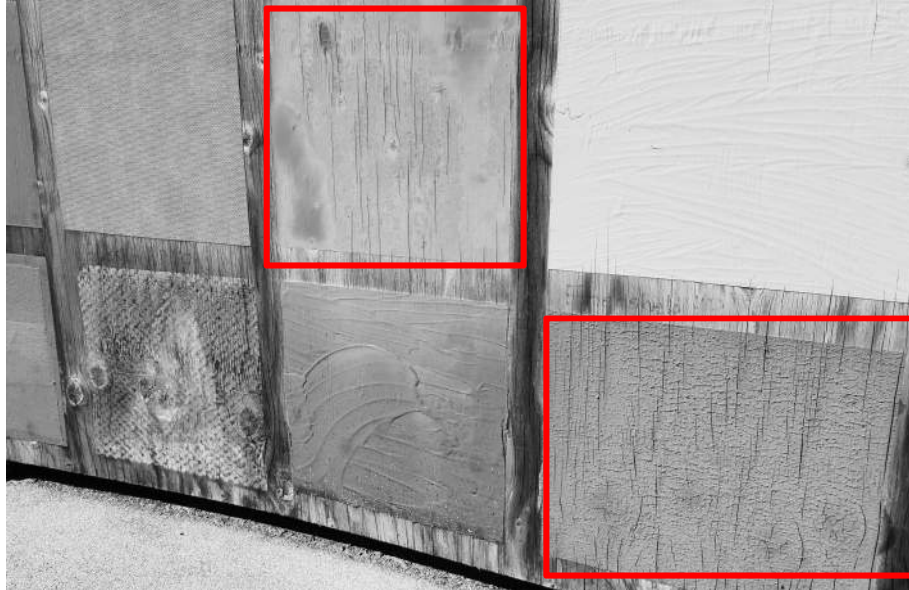
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### Joints in Liquid Applied Air Barrier Membranes

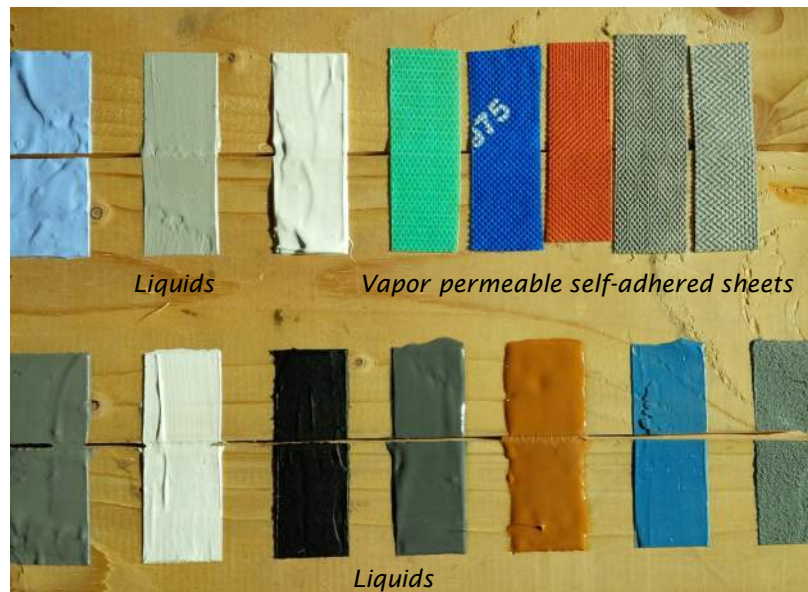


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### Liquid Membrane Selection & Substrate Movement?



### Crack Bridging Challenges



### Liquid Applied Air Barriers & Pre-fab Wood



### Some Challenges with Liquids

- Liquid/fluid applied membranes appealing from a ease of use and detailing stand-point
- Wide range of chemistries, thicknesses and material properties
- Proper application can be challenging in wet and/or cold environments
- Product offerings have improved considerably in recent years - many options available





### Sealed Sheathing Approach

- Joints in sheathing (plywood, OSB, exterior gypsum) are air-sealed with sealant, strips of self-adhered membrane, and/or high-quality tapes
- Proving to be very effective & cost efficient AB strategy



### Sealed Sheathing Approach

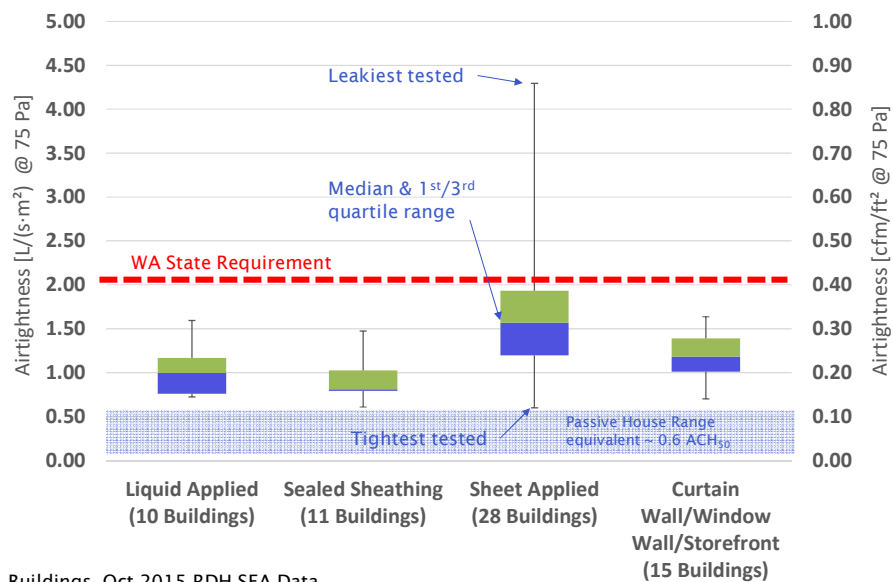


## Sealed Sheathing Approach – Water Control

→ Mechanically attached Water Resistive Barrier (WRB) installed loosely over top of sealed sheathing, but not taped and detailed as the air-barrier



## How Well Is the Industry Doing – WA State Data



## Passive House Airtightness



<0.6 ACH @50 Pa  
~0.035 cfm/ft<sup>2</sup> @75 Pa



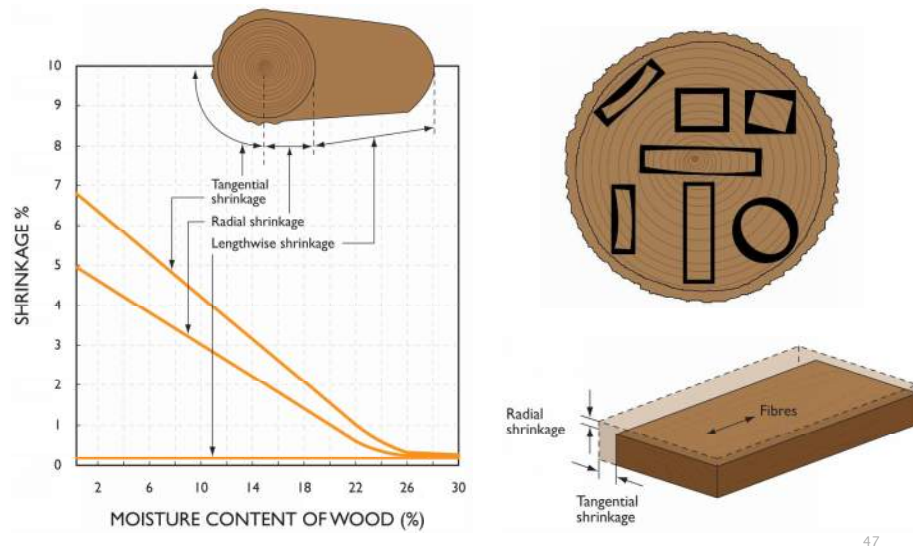
## Passive House Airtightness



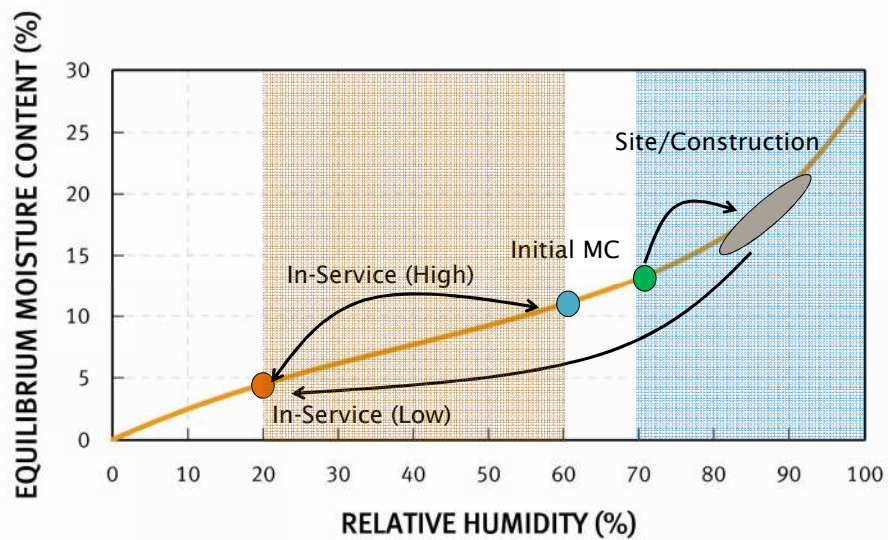
0.13 ACH @50 Pa  
~0.014 cfm/ft<sup>2</sup> @75 Pa

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## Behaviour of Wood in Construction



## Wood Moisture Content vs Relative Humidity



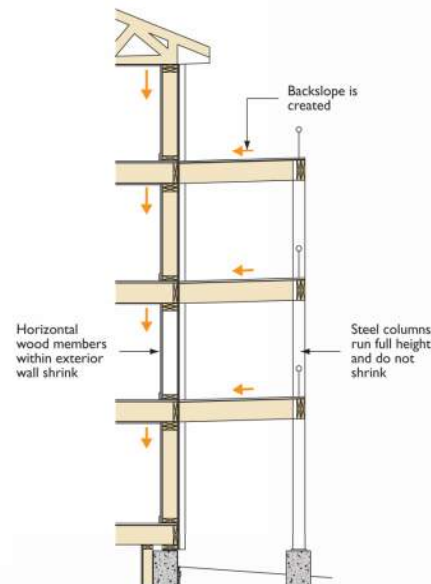
*Wood shrinkage is 0.20% to 0.25% in dimension per 1% change in MC*



## Design for Wood-frame Movement

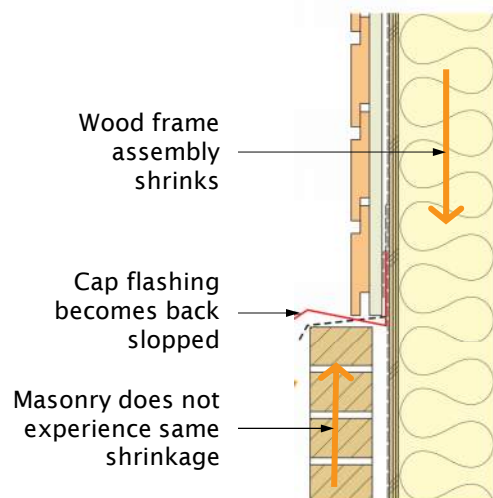
### → Wood-frame Shrinkage

- Total shrinkage dependant on amount of tangential/radial grain wood and the initial moisture content
- Differential movement is a real concern when detailing, especially for 5&6 storey wood-frame buildings
- Shrinkage generally in range of:
  - › ¼" per floor in dry cases,
  - › ½" per floor in typical cases,
  - › ~1" per floor in extreme cases
- Several buildings monitored by FP Innovations confirm this



## Behaviour of Wood in Construction

### → Detailing for **Differential Shrinkage** is Most Important...



### Issues Wood-frame Shrinkage Can Cause



### Issues Wood-frame Shrinkage Can Cause



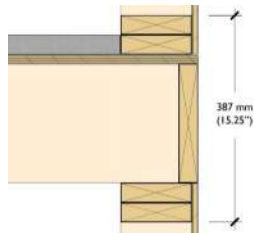
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## Solutions for Wood-frame Shrinkage

- Keep wood dry during construction
- Cover horizontal surfaces including roofs, balconies, window sills & rough openings as soon as possible to limit wetting
- Pre-fabrication of walls & other components to speed up construction



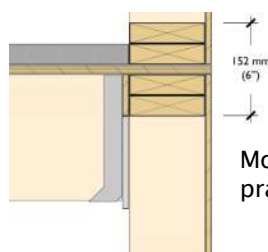
## Solutions for Wood-frame Shrinkage



Traditional platform framing = maximum shrinkage potential



Use of engineered floor joists & headers



Modified platform framing practices - hung joists



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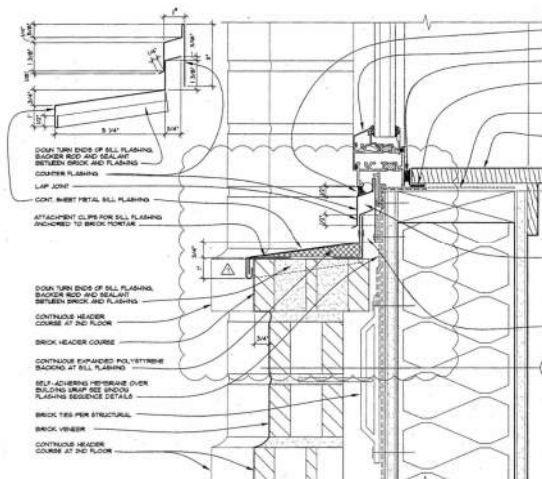
## Solutions for Wood-frame Shrinkage

→ Elevator Shafts - Match shrinkage potential by using all wood components rather than concrete block, concrete or steel framing



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## Solutions for Wood-frame Shrinkage



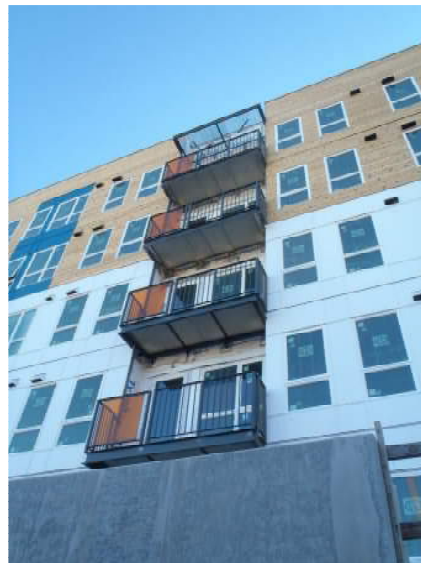
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### Architectural Design for Wood-frame Shrinkage



### Pre-fabricated Balconies



### Pre-fabricated Steel Balconies



### Maintenance and Renewals

- Recognize how 5&6 storey buildings can impact long-term maintenance & renewal options
- Above 4 storeys - can no longer use a ladder!
- Need to provide fall arrest anchors for Bosun chair & swing-stage access
- Boom lifts - design for movement around the building (gardens, landscaping etc.) and structural support on concrete podium slab



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## Maintenance and Renewals

- Dryer exhaust vent cleaning
  - Easily accessible from balconies or roof?
  - Additional lint clean-out
  - Condensing units?
- Durable enclosure components
  - Minimal maintenance claddings & finishes
  - Durable sealants & coatings
  - Minimal maintenance windows, high quality hardware & dual seal glazing units



## Additional Resources

- Building Enclosure Design Guide – Wood-frame Multi-Unit Residential Buildings (2011)
  - Current update being finalized with latest information & new details, release late 2017
- Guide for Designing Energy Efficient Building Enclosures (HPO, CWC, FP Innovations, 2013)
- Illustrated Guide R-22 Effective Walls in Wood-frame Construction in BC (HPO, COV, 2015/17)
- FP Innovations – Mid-rise Wood-frame Construction Handbook (2016)



A graphic with a dark background featuring abstract blue and yellow-green curved shapes. A vertical yellow line is on the left. The text "Discussion + Questions" is in white. Below it, in smaller white text, is "FOR FURTHER INFORMATION PLEASE VISIT" followed by "→ www.rdh.com". Then "OR CONTACT ME AT" followed by "→ gfinch@rdh.com". At the bottom is the RDH logo with "CELEBRATING 20 YEARS" in a blue arc and "EST. 1987" in small orange text. Below the logo is the tagline "MAKING BUILDINGS BETTER™".

**Discussion + Questions**

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