Passive House Implementation:

Regional Variations in Standards and Practice

Prudence Ferreira, CPHC
Passive House Practice Lead
pferreira@morrisonhershfield.com
www.MorrisonHershfield.com

Disclaimer: This presentation was developed by a third party and is not funded by WoodWorks or the Softwood Lumber Board.

Learning Objectives

Discuss how codes, policy and standards impact passive house implementation on wood-frame projects.

Introduce hygrothermal considerations by climate region.

Survey passive house design and detailing approaches for multi-family wood construction.

Context

"We owe it to the fields that our houses will not be the inferiors of the virgin land they have replaced. We owe it to the worms and the trees that the buildings we cover them with will stand as promises of the highest and most intelligent kinds of happiness."

– **Alain de Botton, The Architecture of Happiness**

Code and Policy Context

All 25% better than code (blue bar)….

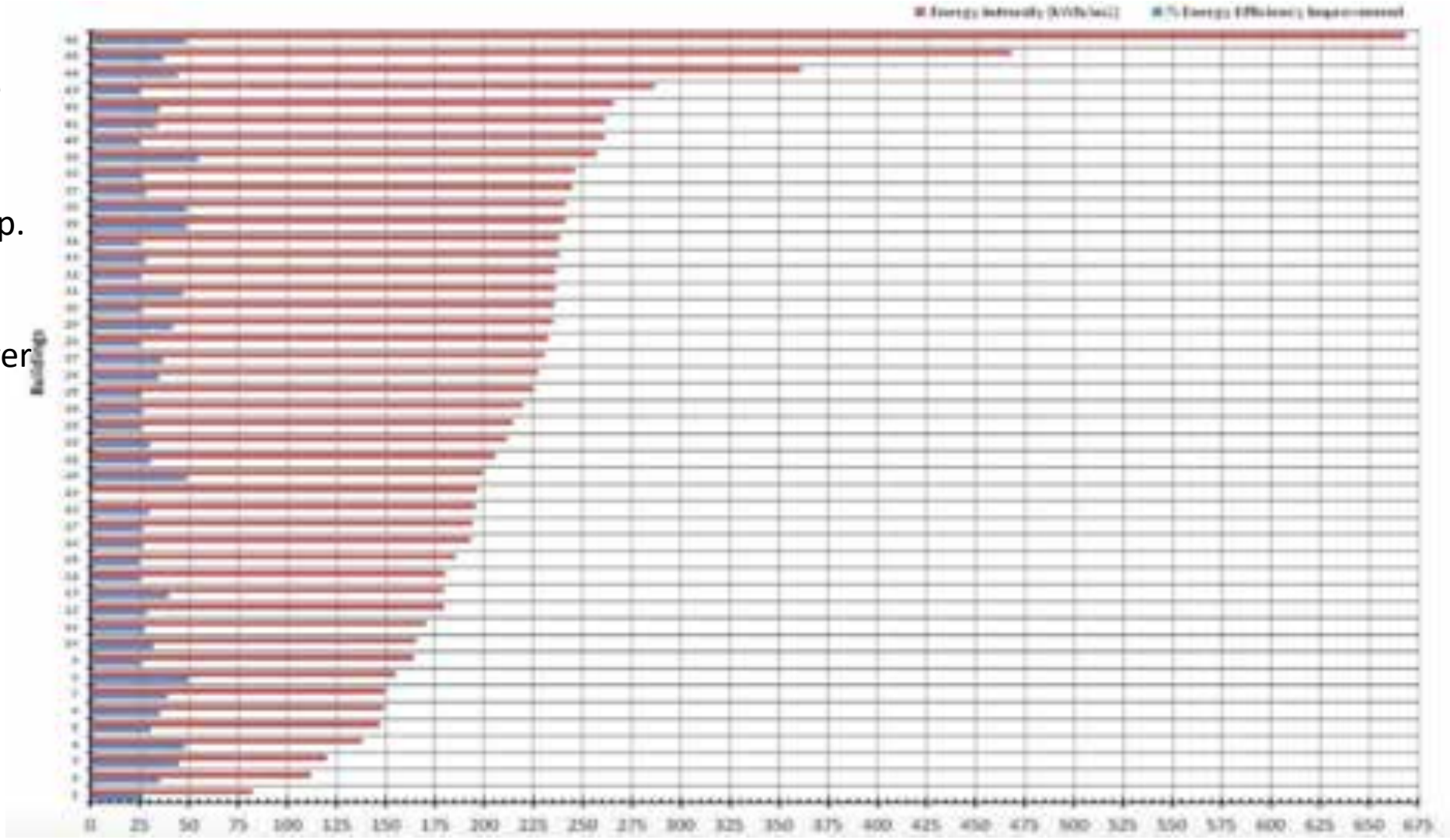
but EUI's all over the map.

Conclusion: % better modelling does not deliver consistent results.

Push for dynamic modelling that better reflects reality

And…..

Absolute targets



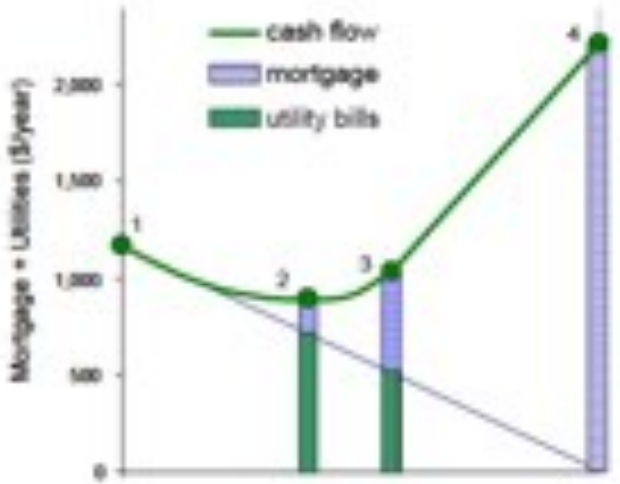
Passive House Principles

Images: IBI, PHI

PHIUS+ 2018 METHODOLOGY

Climate Specific & Cost Competitive Space Conditioning Criteria

Developed by US Industry



NREL BEopt optimizes upgrade package by climate

Standards defined as cost optimal/competitive sweetspot between conservation and generation

on the path to zero

Images: PHIUS

SPACE CONDITIONING

MUST MEET ALL 4 TARGETS!

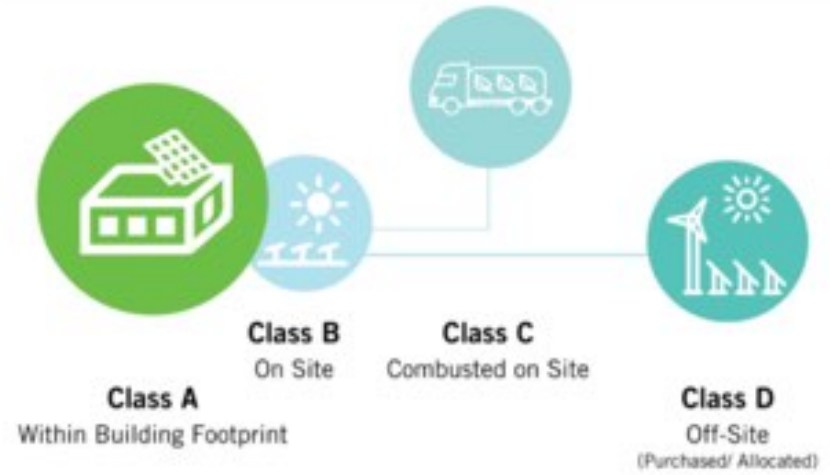
Annual Heating Demand ≤ A (kBTU/ft2.yr)
Annual Cooling Demand ≤ B (kBTU/ft2.yr)
Peak Heating Load ≤ C (BTU/ft2.hr)
Peak Cooling Load ≤ D (BTU/ft2.hr)

Different advantages for each:

- Low ***annual demand*** saves energy
- Low ***peak loads*** ensure comfort, resilience, and reduce mechanical system size

Image: PHIUS

Net Zero Buildings



NZEB Class	Definition		Site	Source	Cost	Carbon
A	Within Building Footprint		NBI			ILFI
B	On-Site					
C	Off-Site Renewable, Combusted		ILFI	LEED		
D-1	Off-Site Purchased	Same Grid Region Ownership Stake*				
D-2		Any Grid Region Ownership Stake*				
D-3		Same State Class/Tier I RECs in Compliance Market		PH		LEED
D-4		Any State Class/Tier I RECs in Compliance Market				
D-5		Other RECs				
D-6	Carbon Credits					

*Ownership stake: outright ownership, power purchase agreement, virtual power purchase agreement, community solar, renewable energy investment fund.

Images: BR+A

ZNE CODES

NATIONAL
IECC 2021
ZNE Appendix (residential)
IECC 2030 / ASHRAE 90.1-2031 = Approaching ZNE

CALIFORNIA
Title 24-2019
(residential ZNE)
Zero Code
(commercial proposed)

MASSACHUSETTS
Net Zero Carbon Stretch Code
Start 2022??
Fully implemented 2030??

Boston + Cambridge
ZNE zoning regulations
being developed

WASHINGTON DC
Appendix Z
(voluntary compliance path)

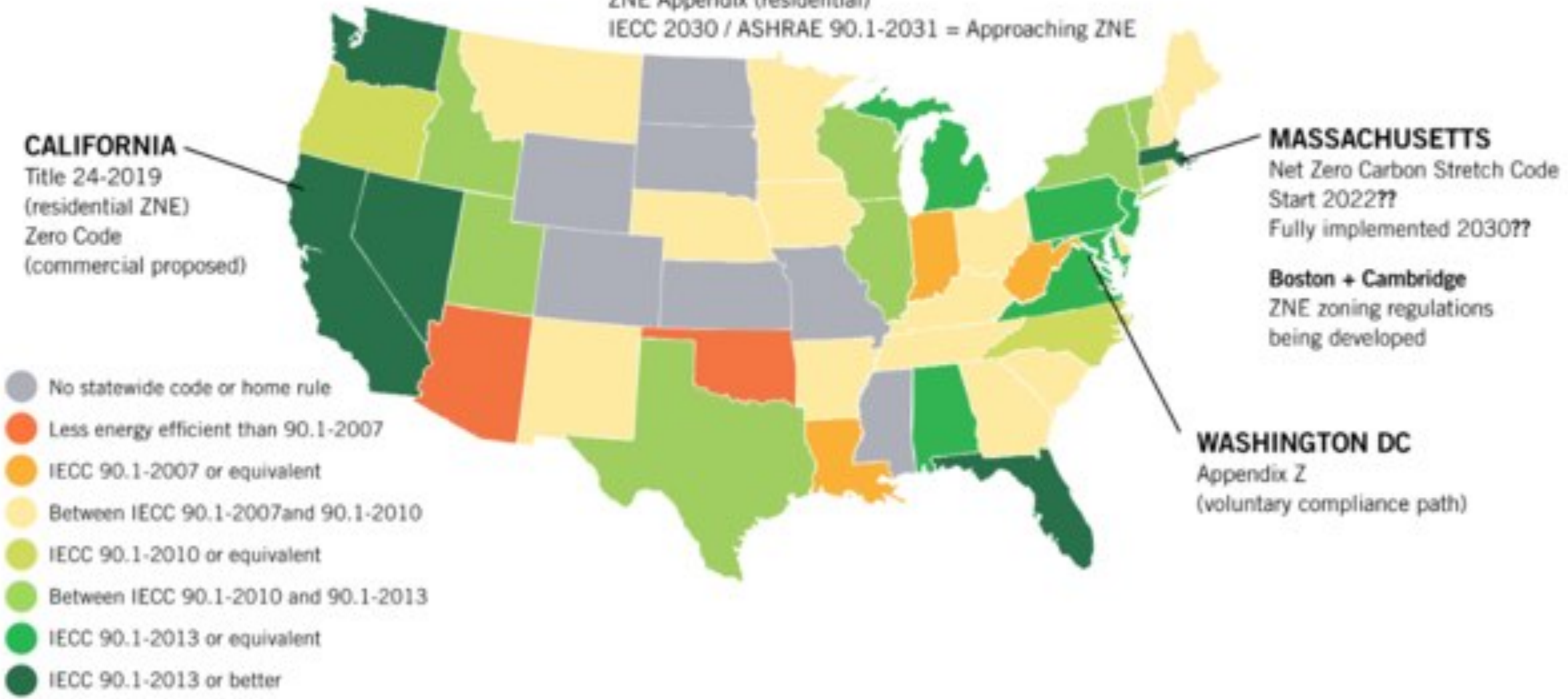
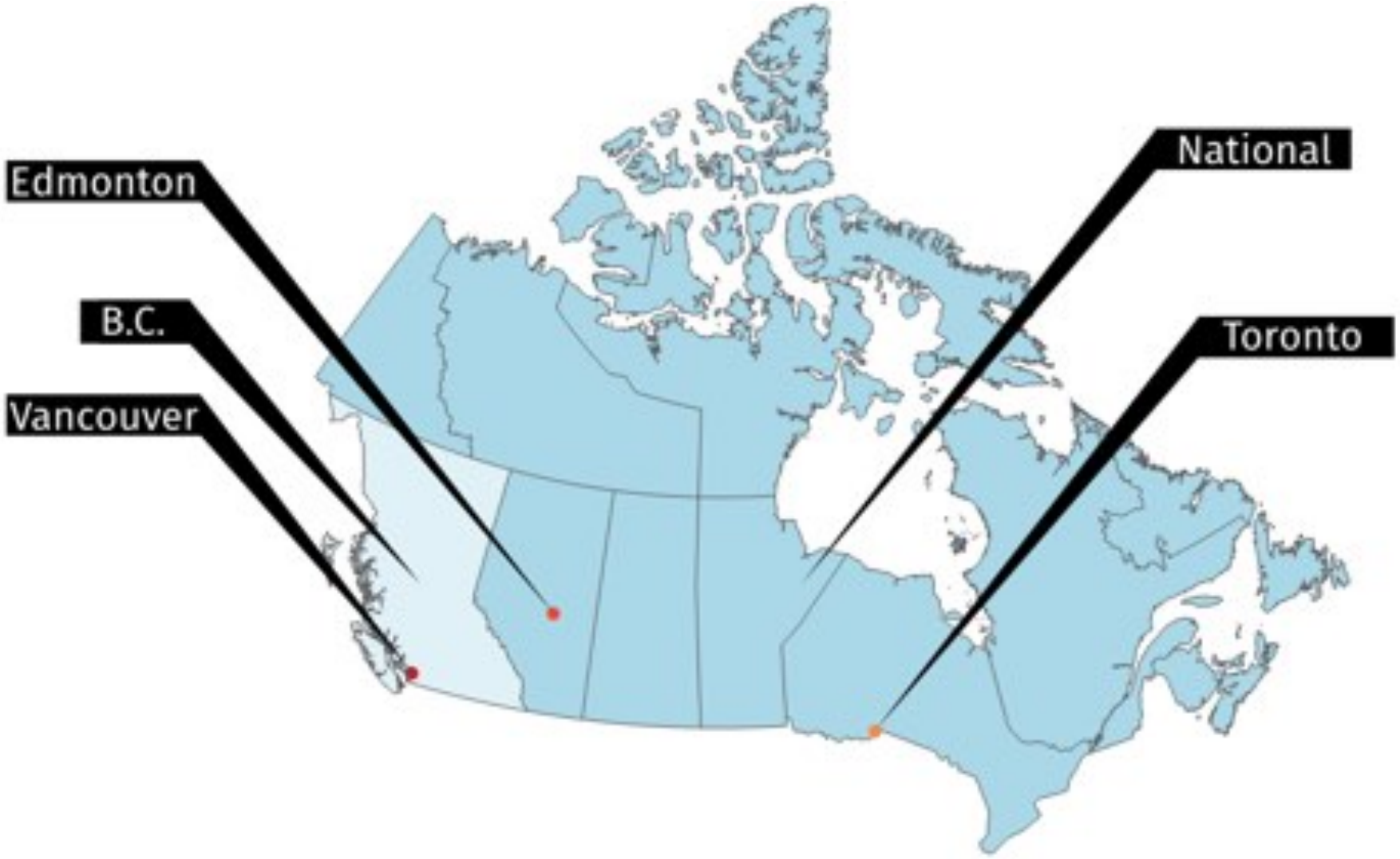


Image: BR+A

Net Zero Ready Codes Canada



PH QAP Programs/Interest and Incentives

PHIUS For Nonprofits, Governments and Other Public Policy Professionals

Incentive Programs

The list below includes known, current incentive programs for PHIUS+ programs, projects may qualify for.

PHIUS+ SPECIFIC INCENTIVE PROGRAMS

- California
- Connecticut
- Idaho
- Illinois
- Massachusetts
- New Hampshire
- New York
- Ohio
- Pennsylvania
- Rhode Island
- Virginia
- Washington

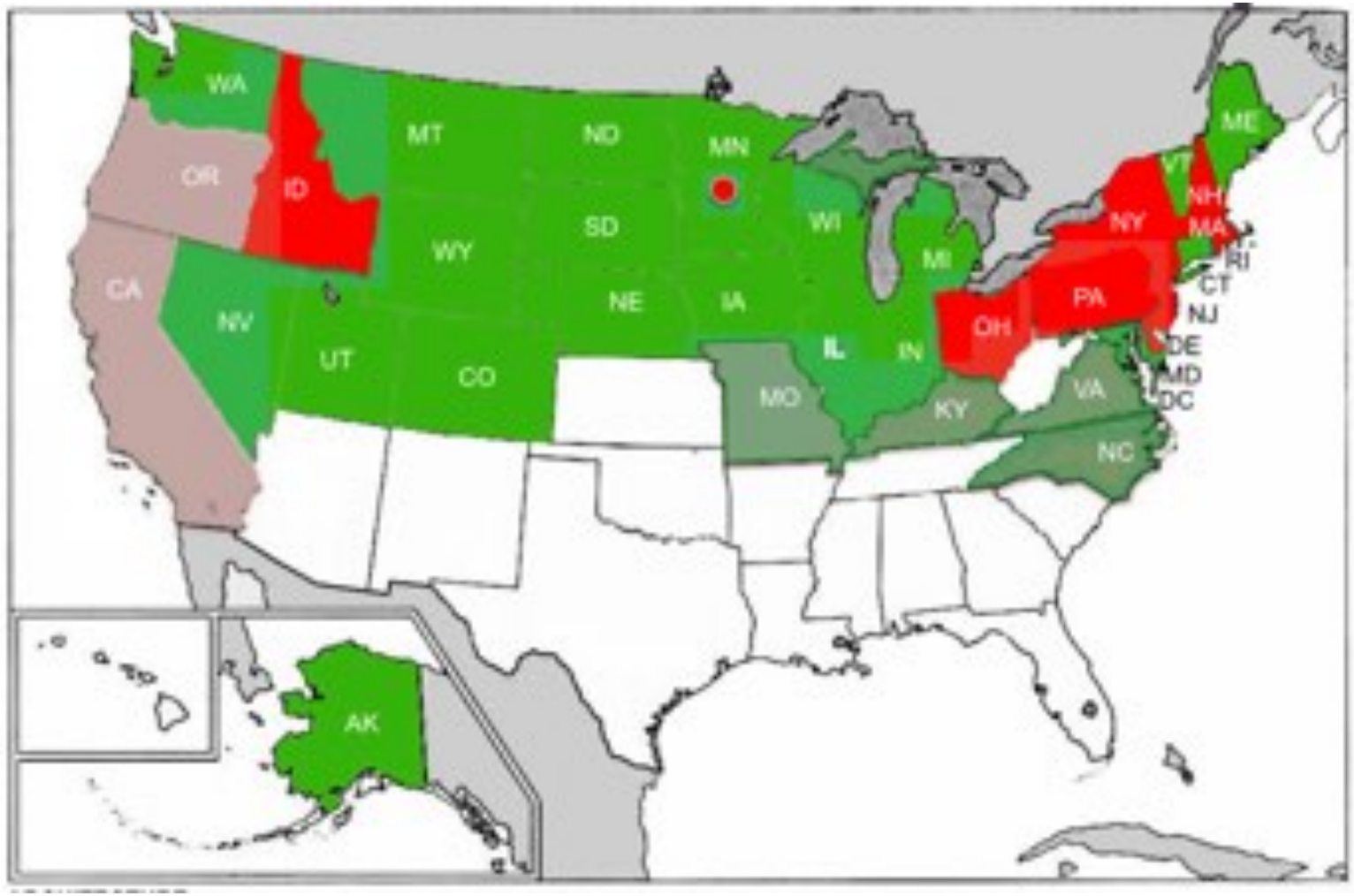


Image: Tim McDonald/Onion Flats

Hygrothermal Safety

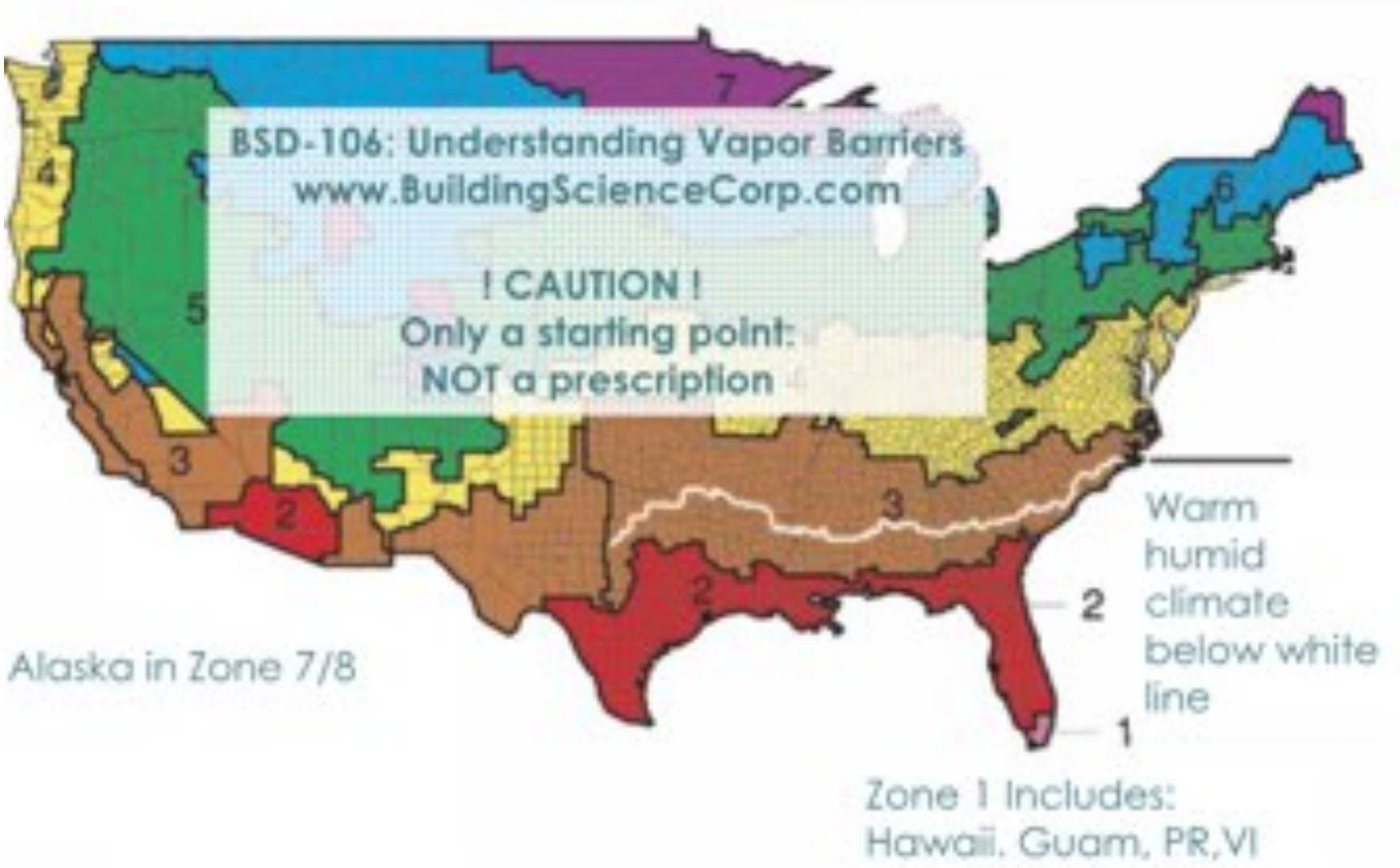
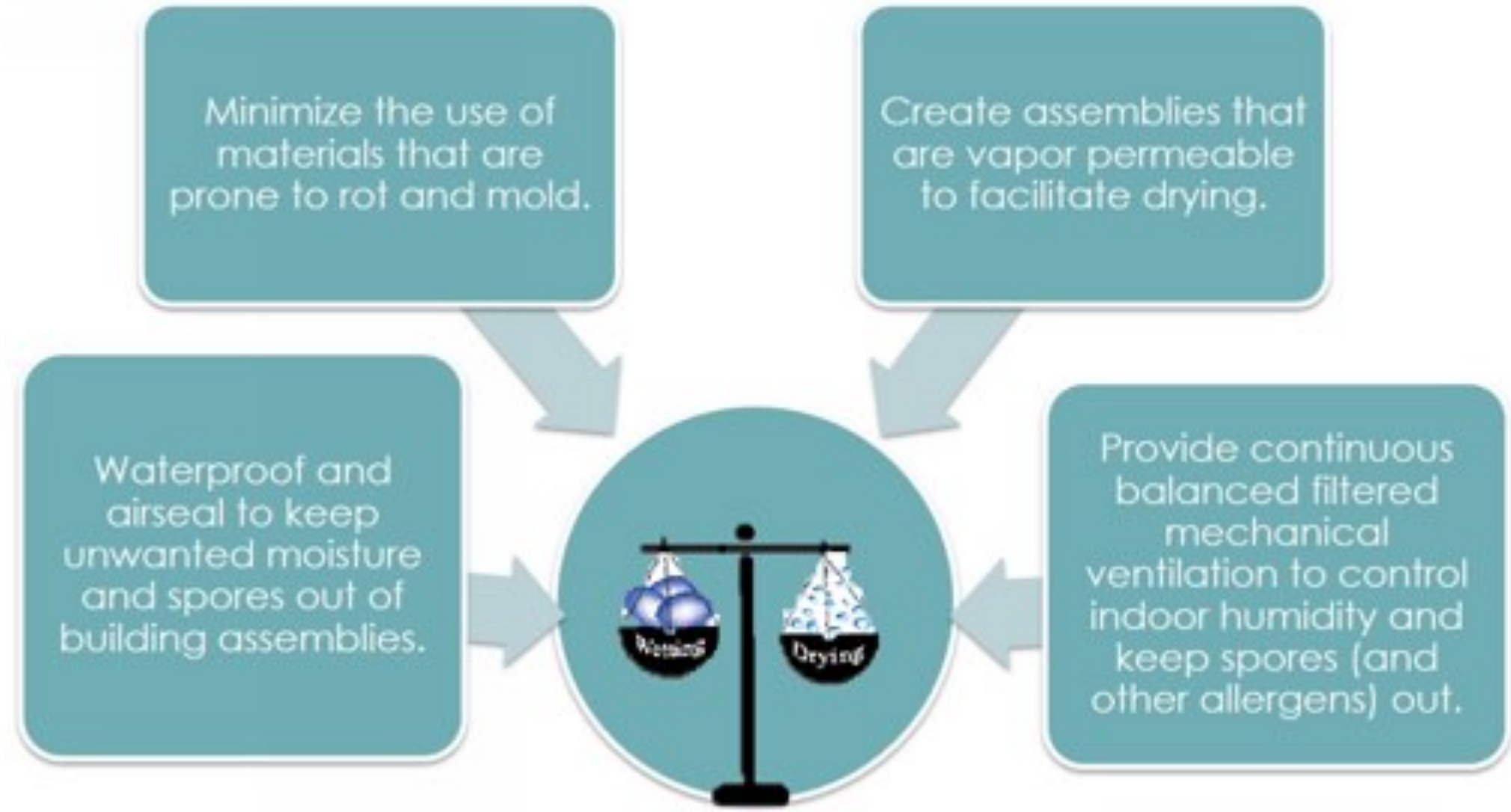


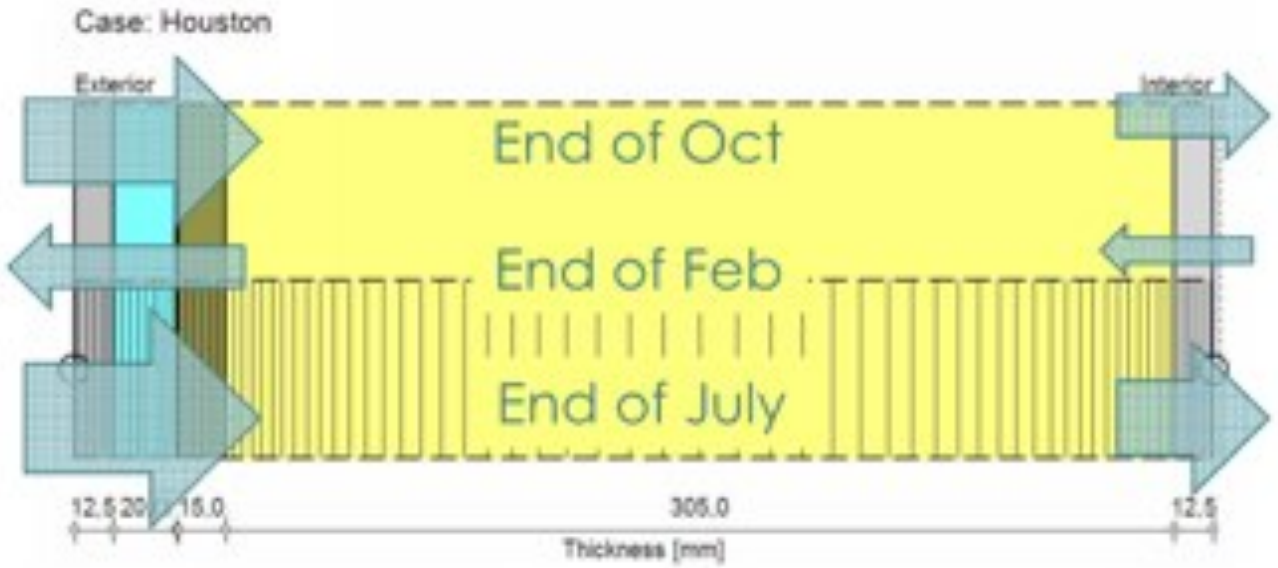
Image: Building Science Corp


Minimize the use of materials that are prone to rot and mold.
Create assemblies that are vapor permeable to facilitate drying.
Waterproof and airseal to keep unwanted moisture and spores out of building assemblies.
Provide continuous balanced filtered mechanical ventilation to control indoor humidity and keep spores (and other allergens) out.
Wetting
Drying
Prevent wetting and mold/fungus spore entry, promote drying.

WARM + HUMID CLIMATE WALL ASSEMBLY HOUSTON

SEASONAL VAPOR DRIVE

is climate specific



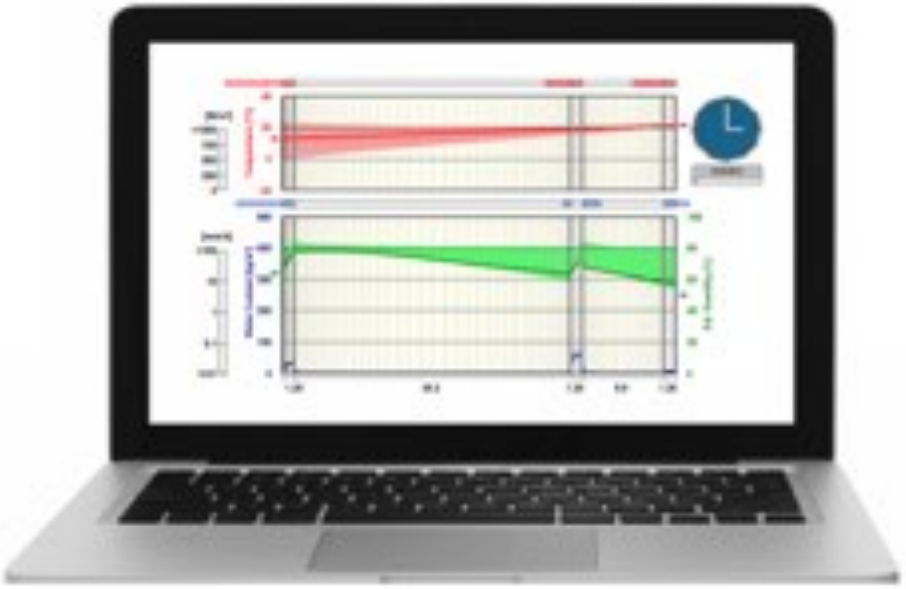


Image: PHIUS

FIBROUS INSULATION AIR | VCL | WRB WALL SECTION
MIXED HUMID CLIMATE

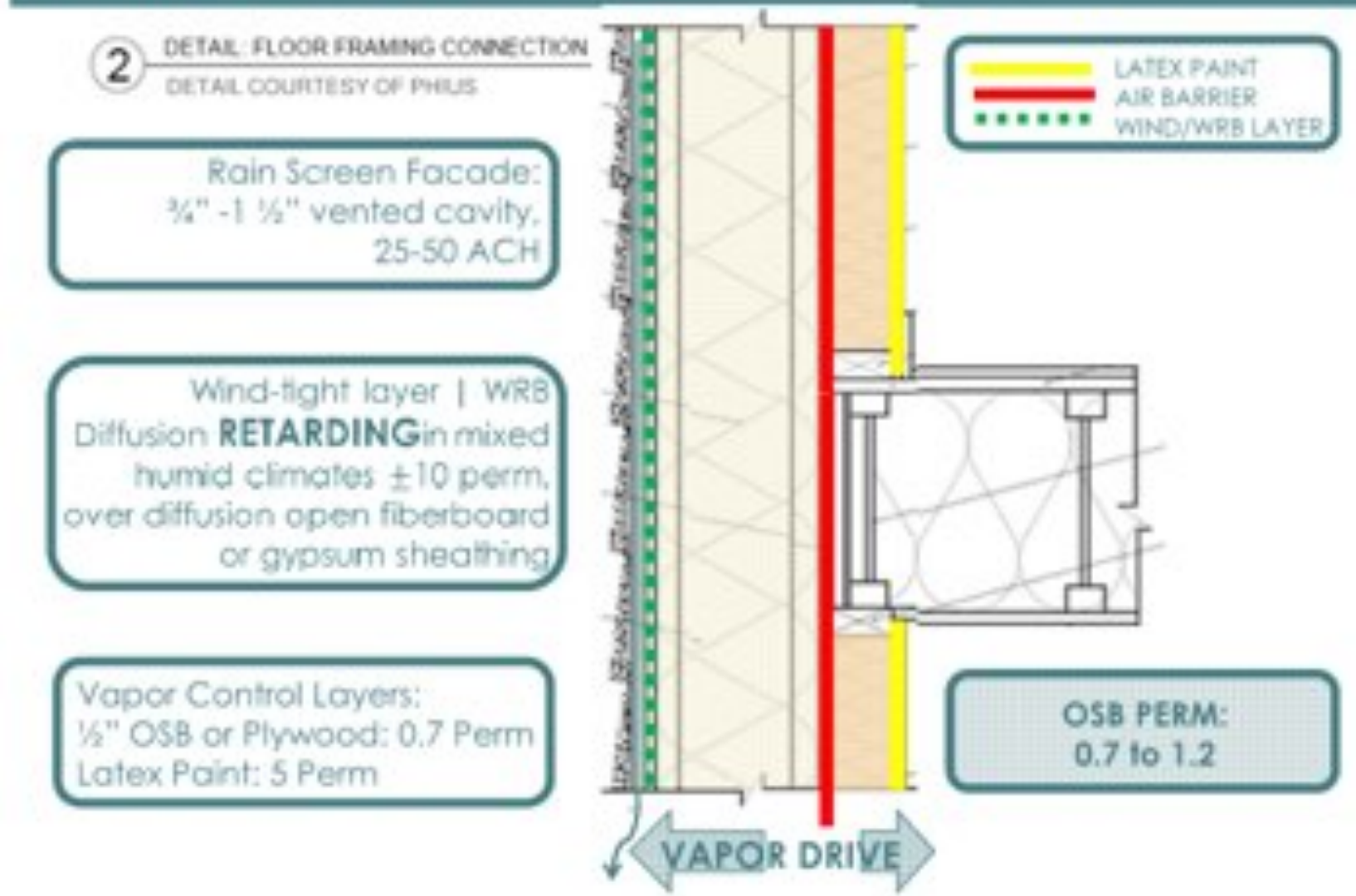


Image: PHIUS

FIBROUS INSULATION AIR | VCL | WRB WALL SECTION
COLD CLIMATE

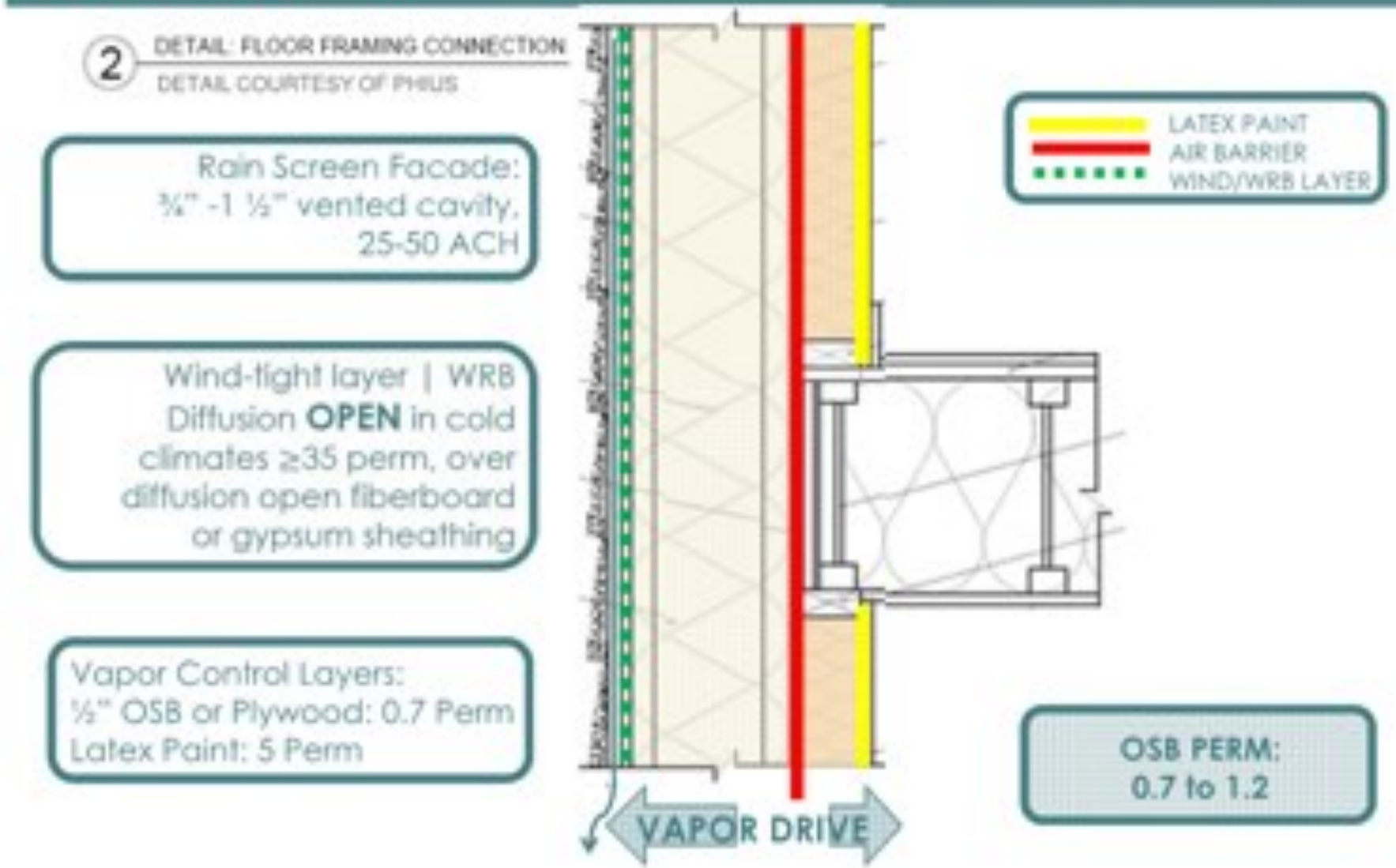


Image: PHIUS

EXTERIOR FOAM AIR | VCL | WRB WALL SECTION
MIXED HUMID CLIMATE V1 & V2

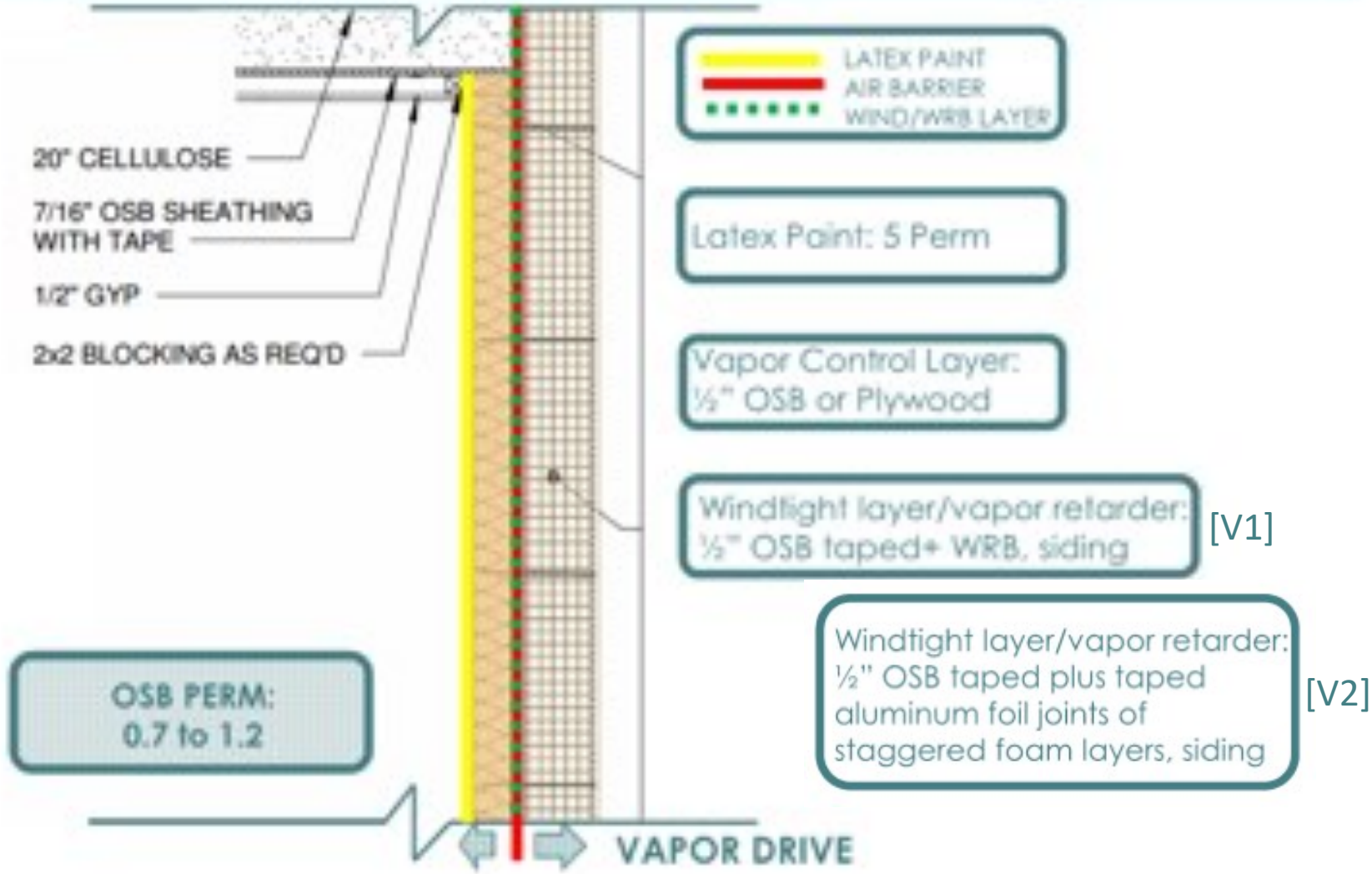


Image: PHIUS, Detail Adam Cohen

EXTERIOR FOAM AIR | VCL | WRB WALL SECTION
VERY COLD CLIMATE: HIGHER % OF FOAM V1 & V2

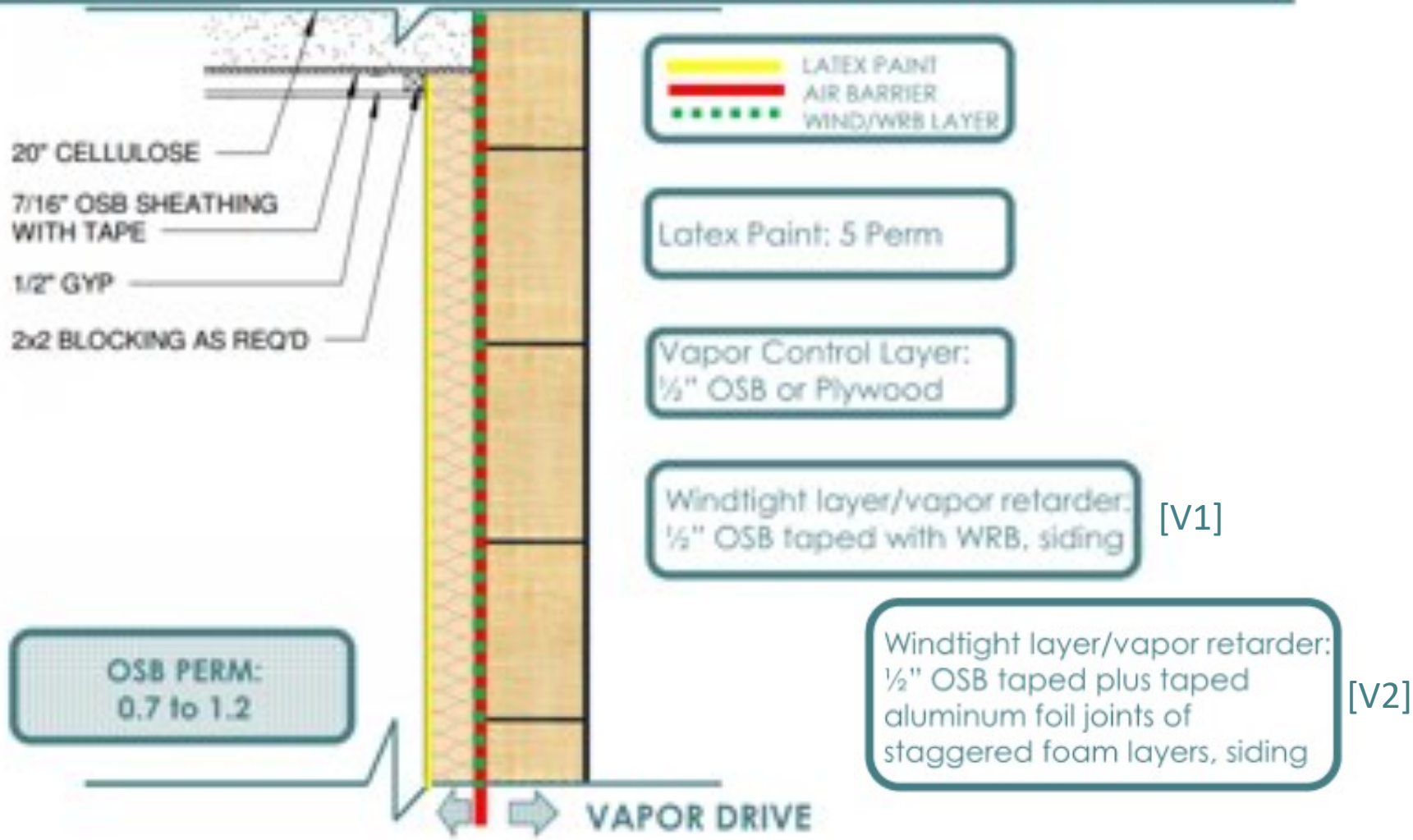
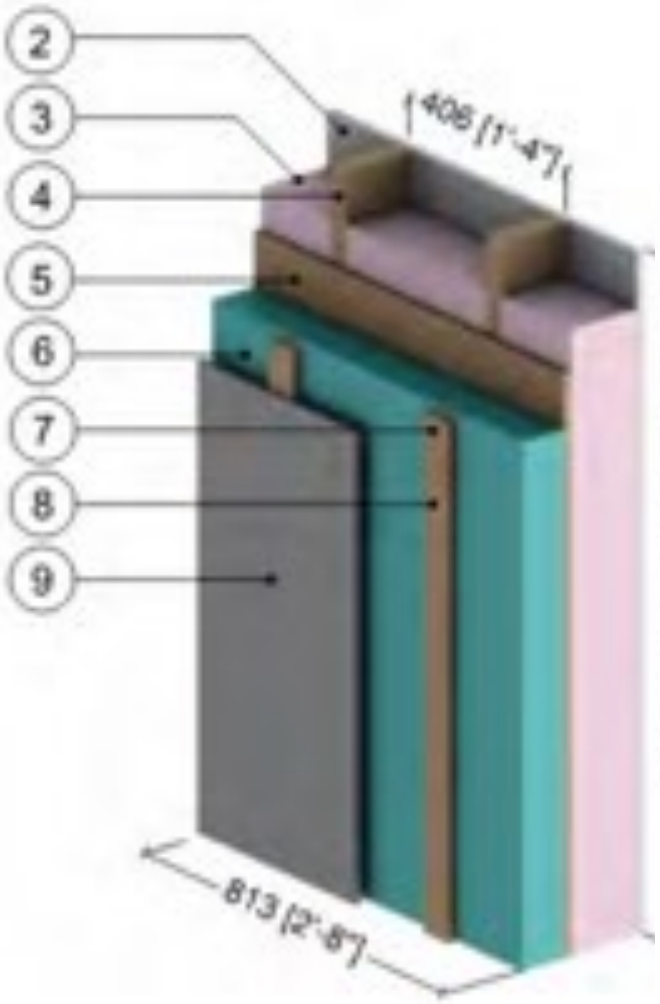
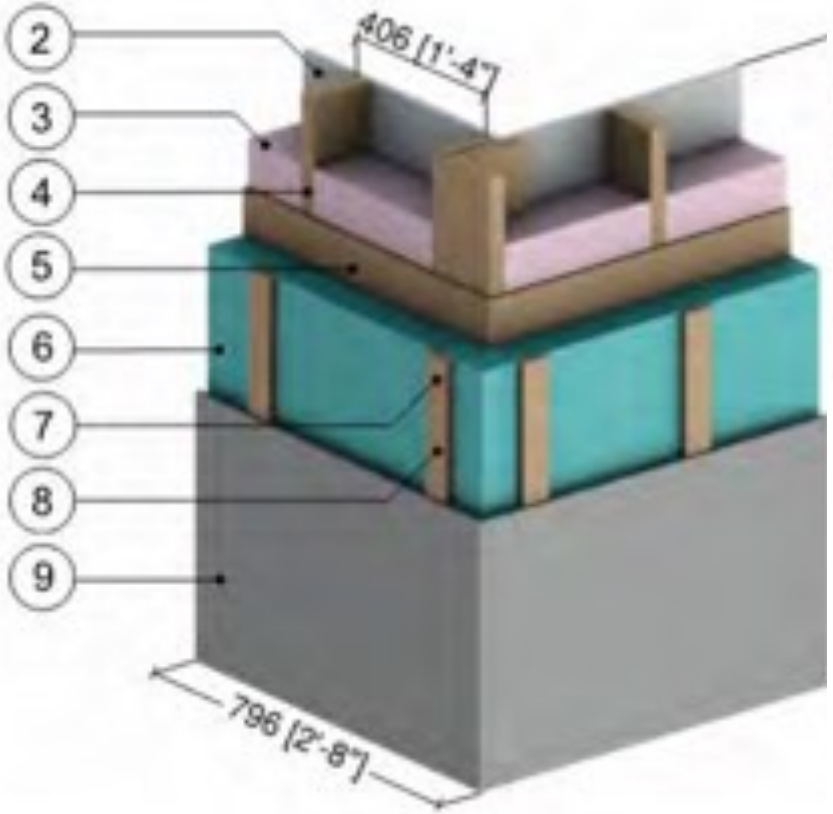
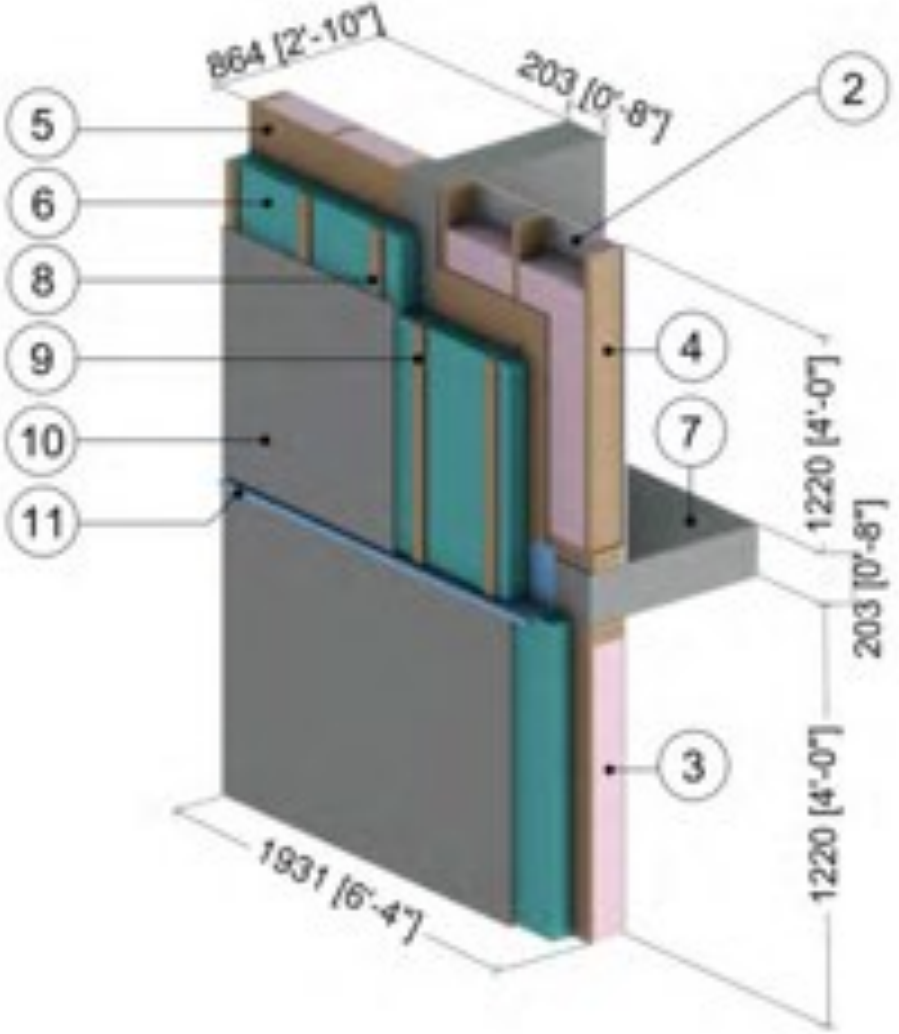


Image: PHIUS, Detail Adam Cohen

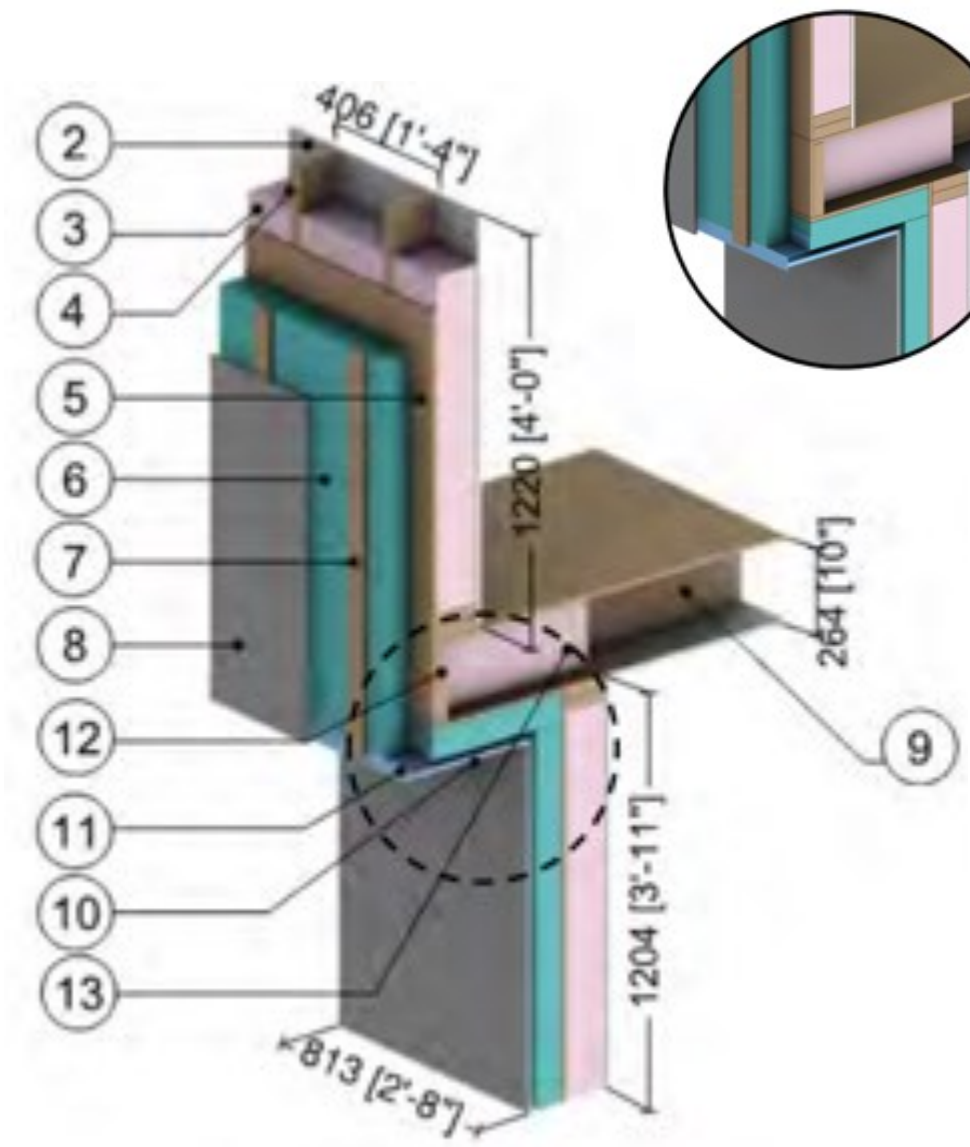
Exterior Foam Above Grade



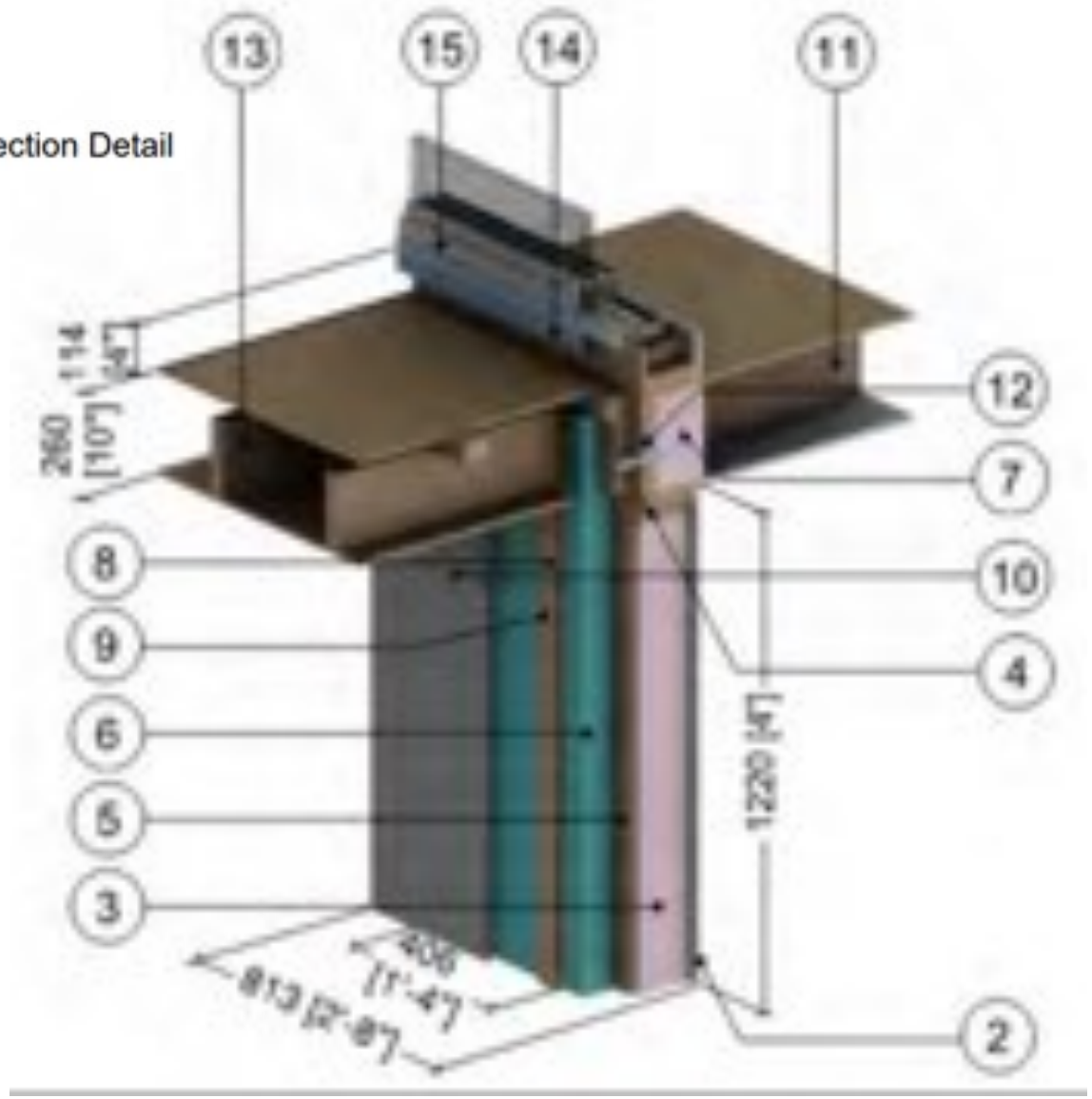




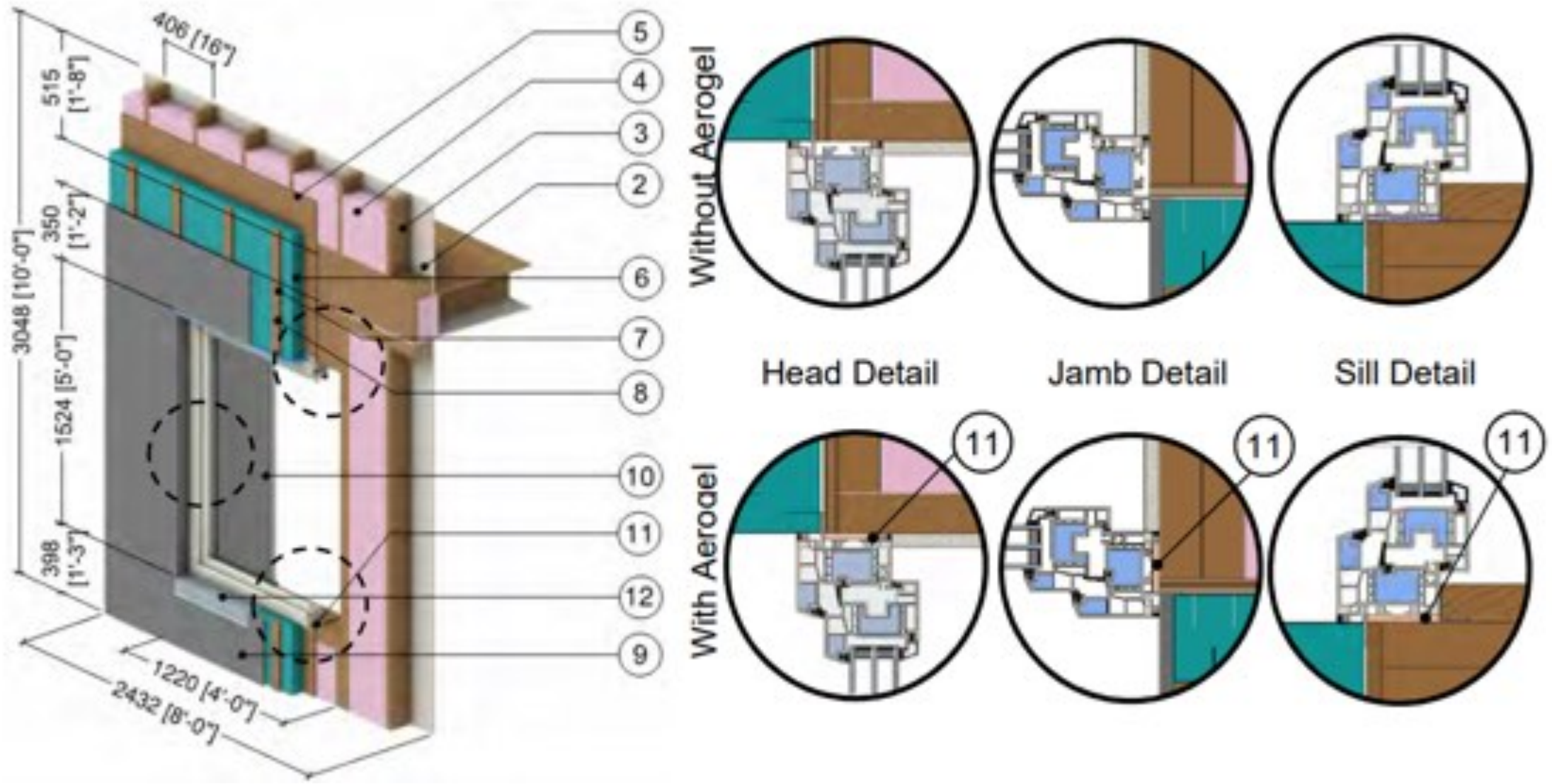
Exterior Foam – Soffit & Balcony



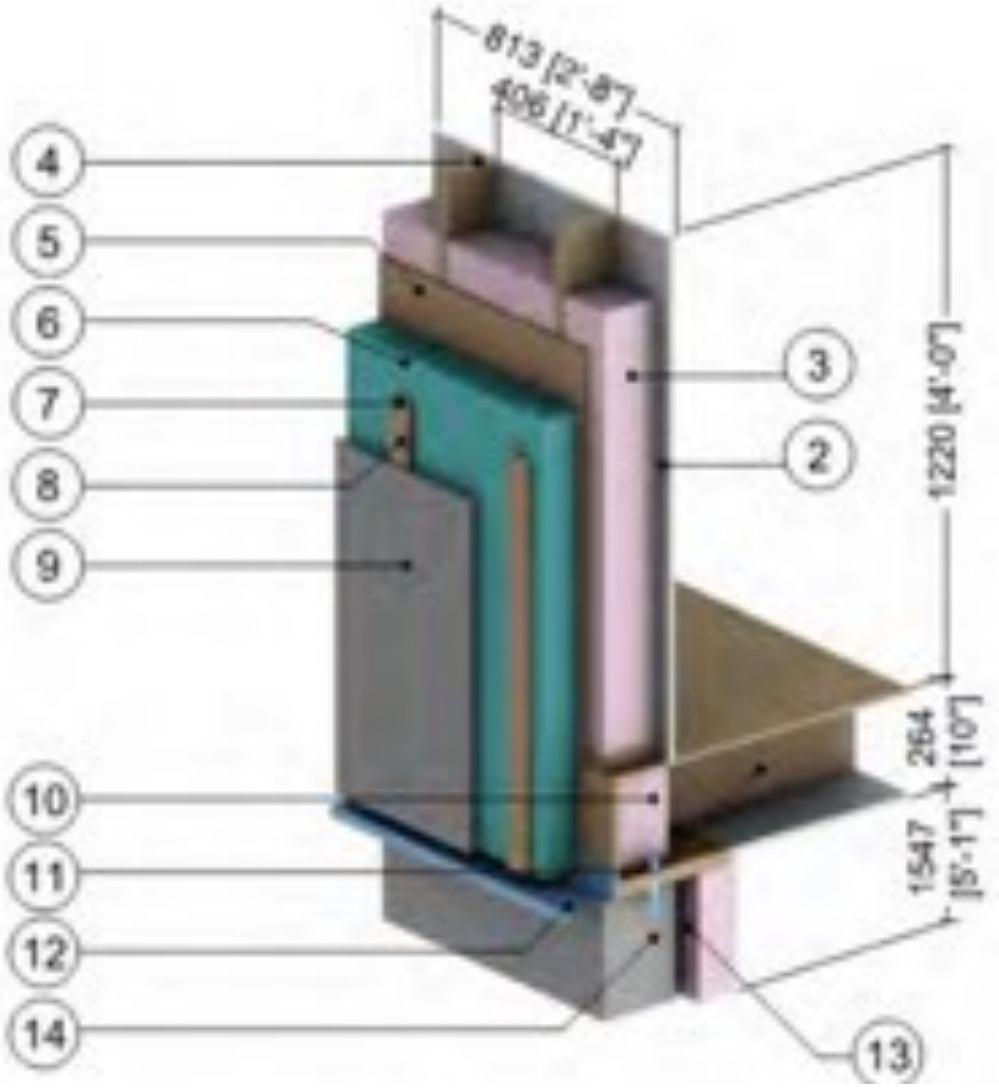
Soffit/Intersection Detail

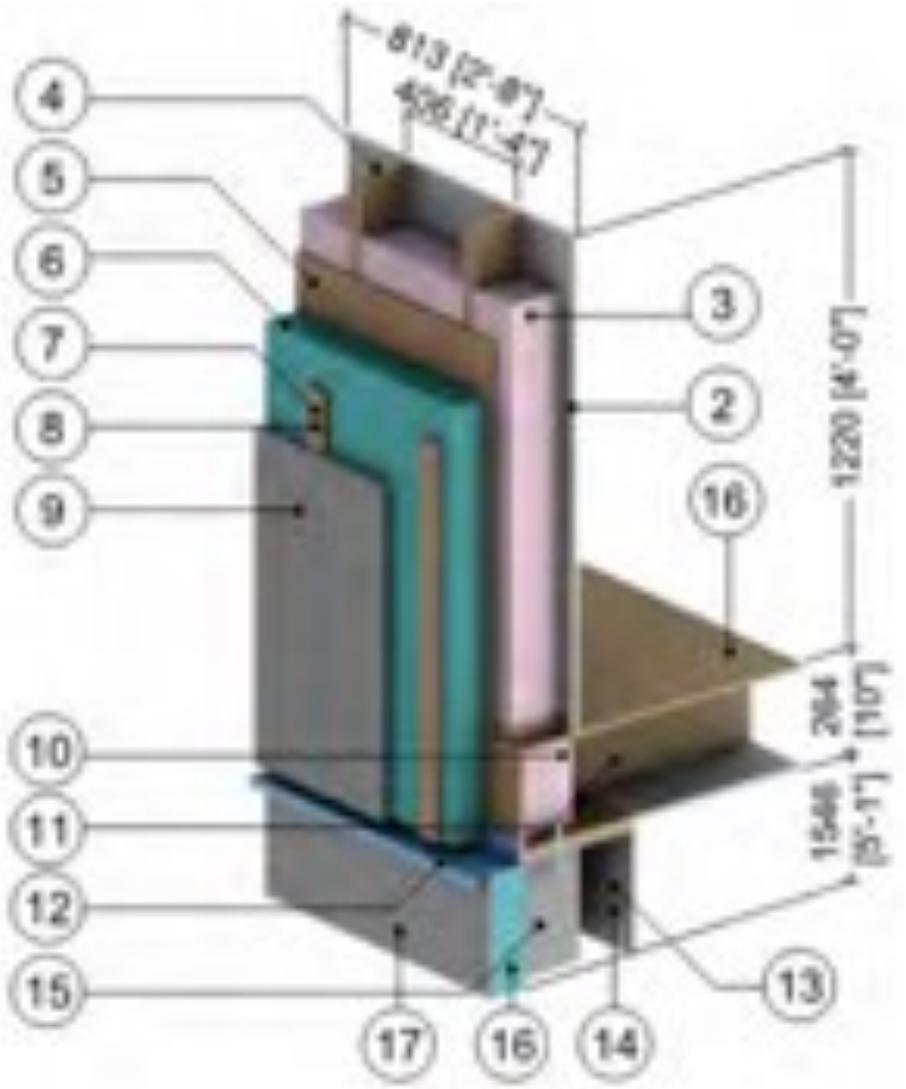


Exterior Foam – Punched Window

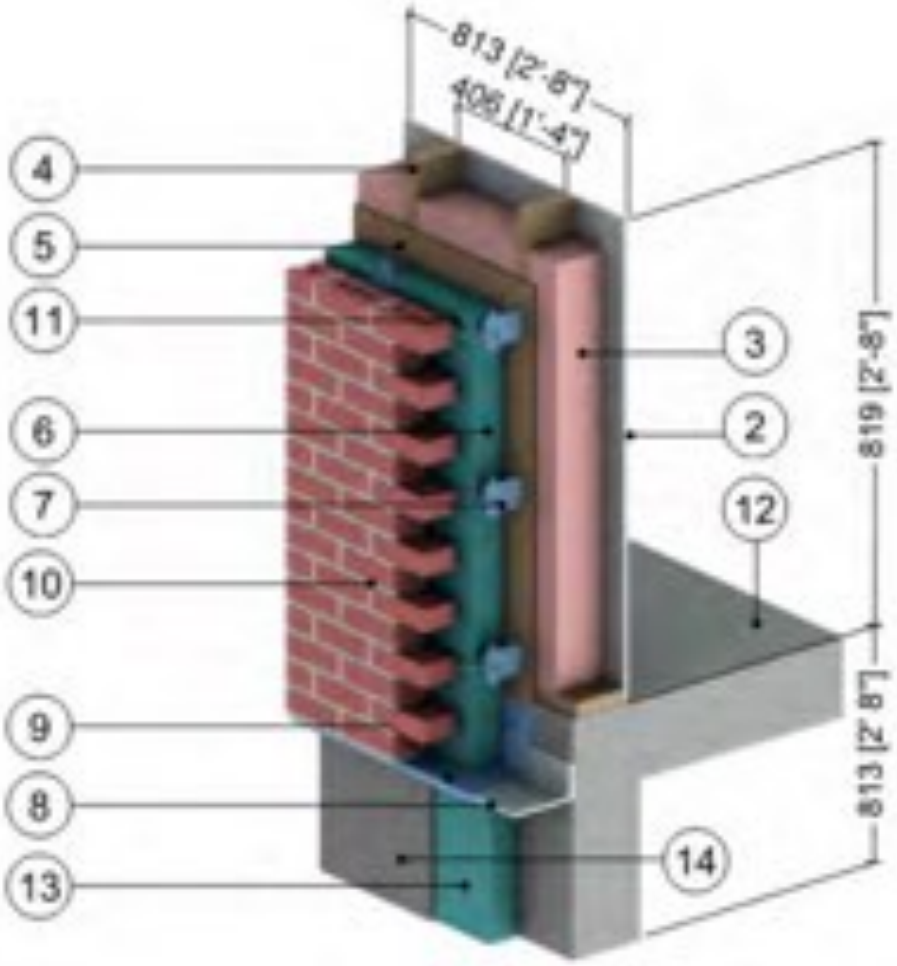


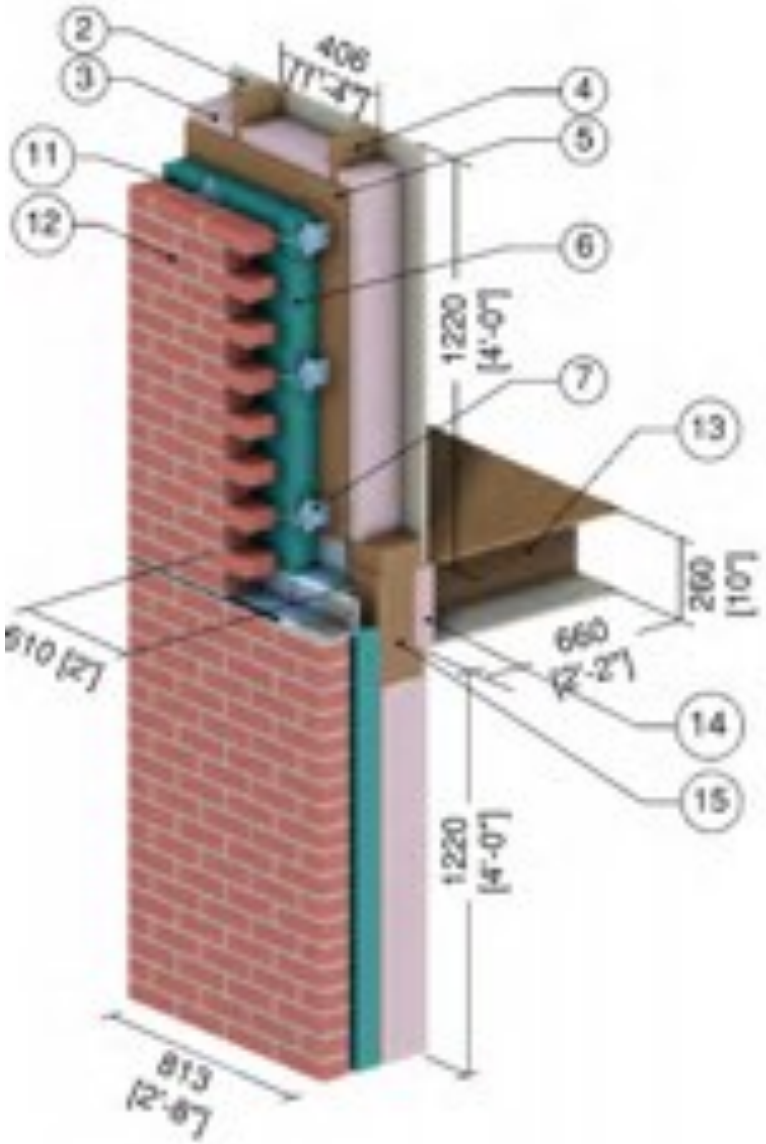
Exterior Foam – At Grade

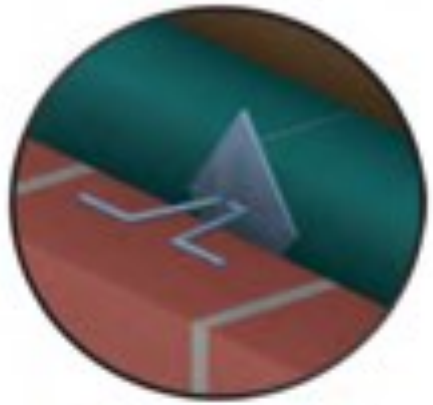




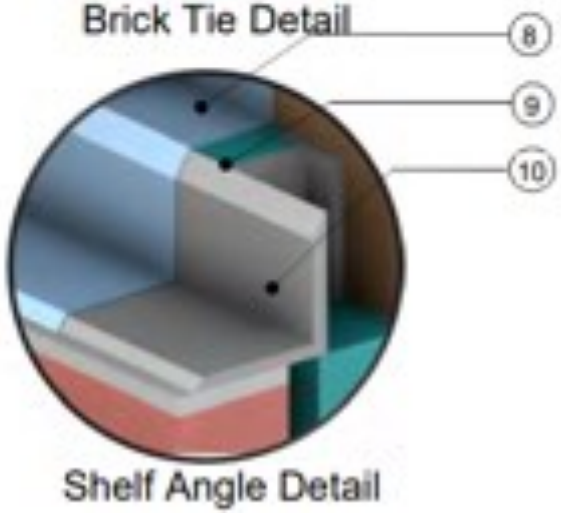
Exterior Foam - Brick Clad





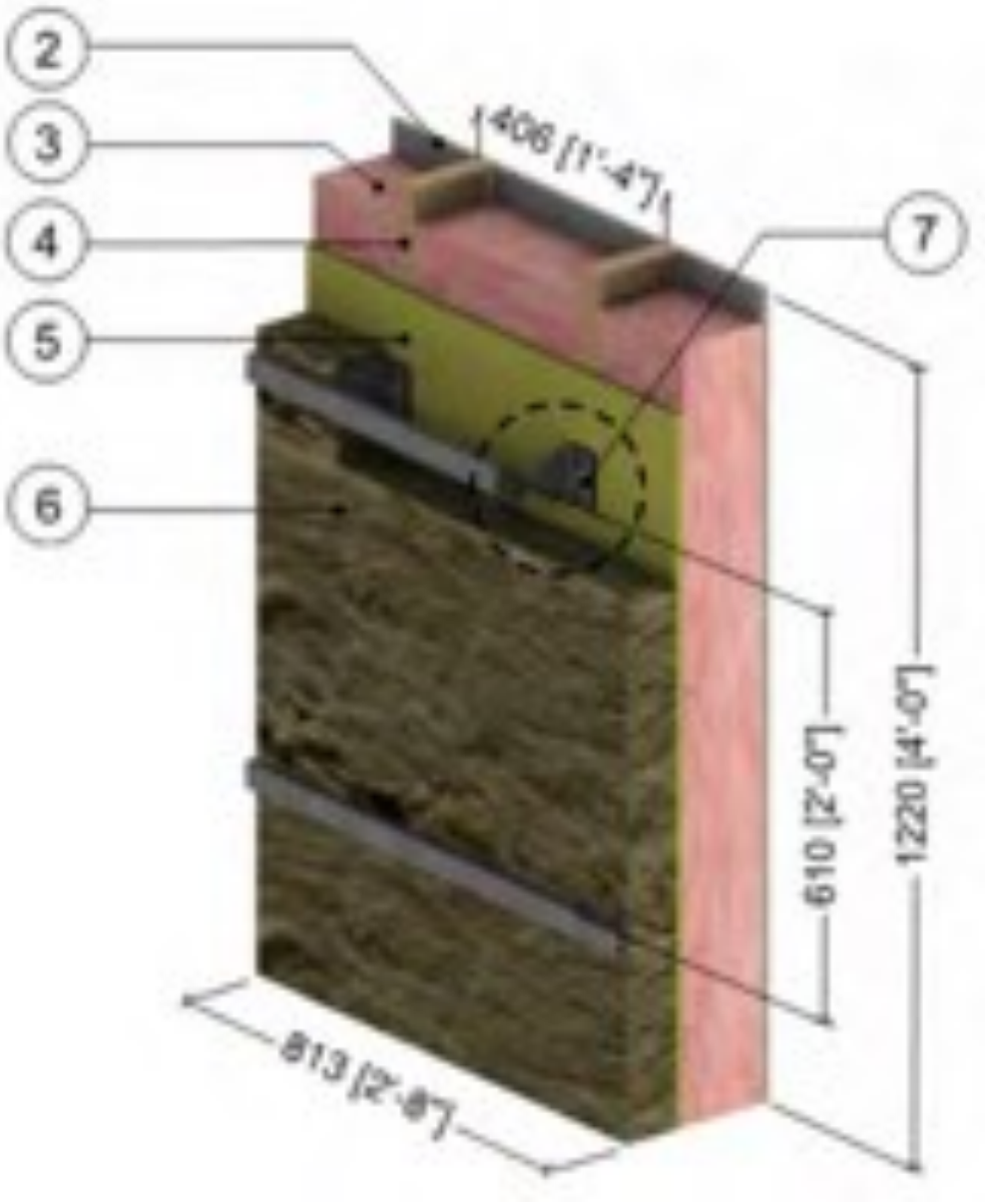


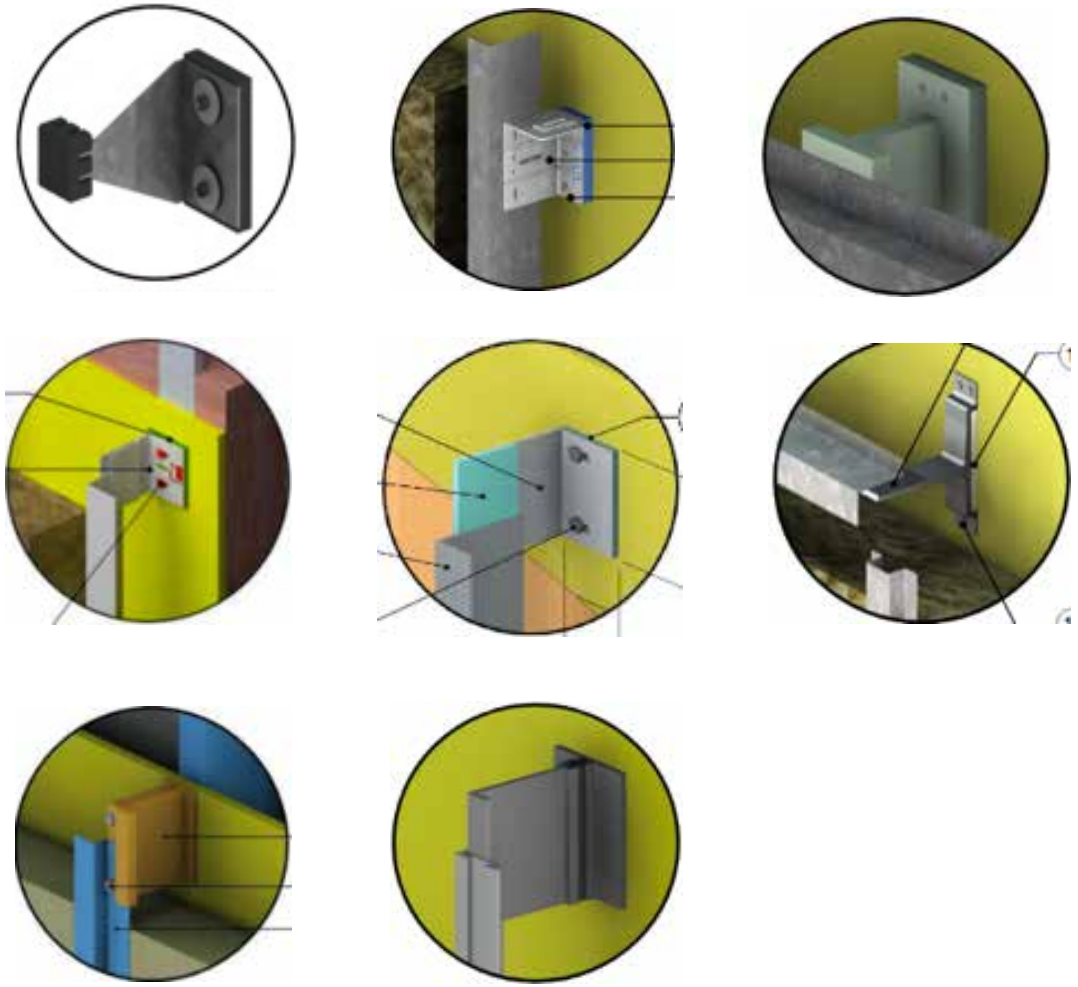
Brick Tie Detail



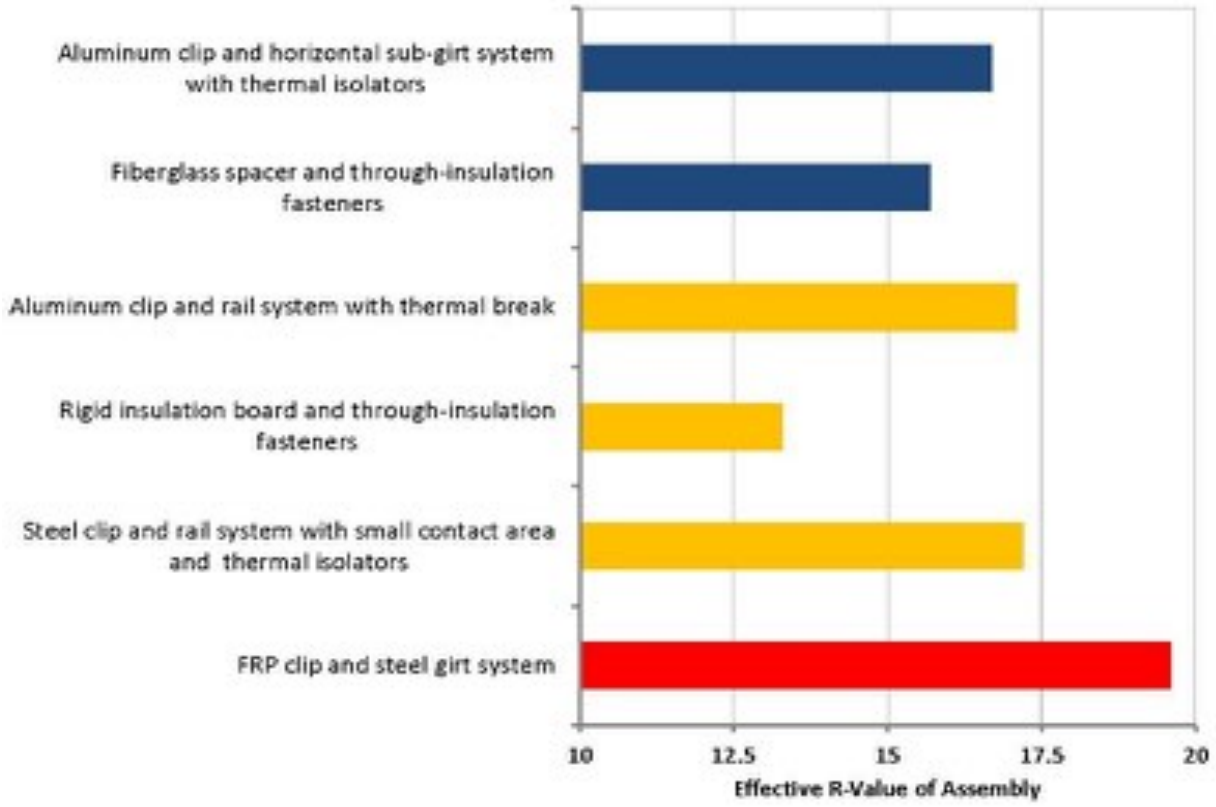
Shelf Angle Detail

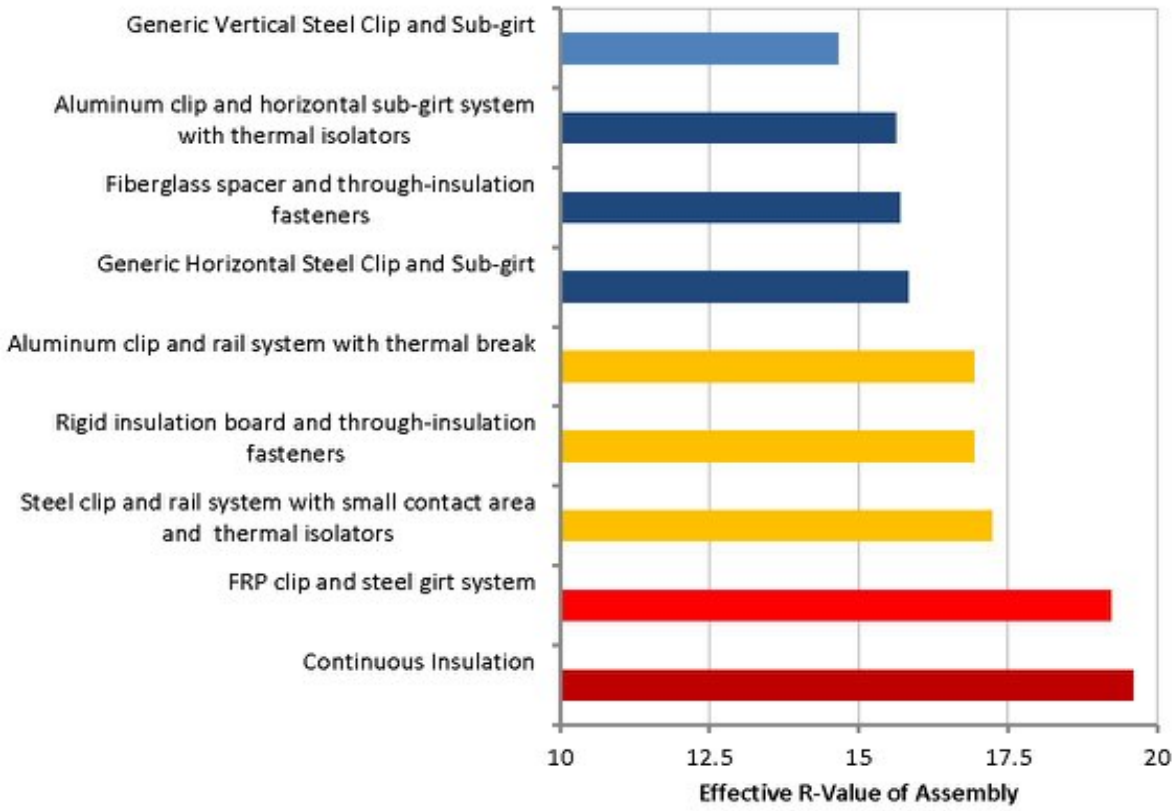
Alternative– Exterior Mineral Wool w/ Thermal Clips





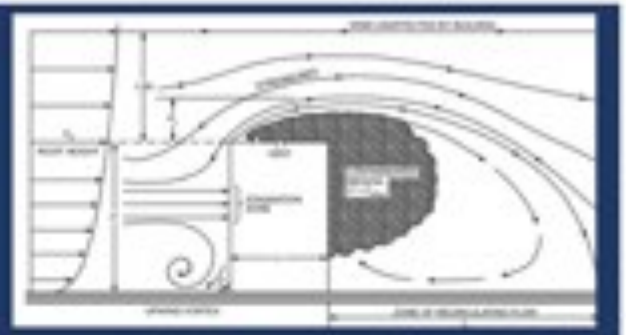
Structural Considerations





Example thermal performance comparison for a steel stud wall with 4” of mineral wool insulation and different cladding attachment systems a) set spacing of clips 16”x 24”o.c. and b) with structural capacity factored in

Considerations for Cladding Attachment Spacing

Wind Load: Wind pressures on a building will change the required spacing of cladding attachments to handle the dynamic loading. This can depend on location and on the height and shape of the building. Tighter spacings of clips may be required at building edges or at higher locations on the building where there is greater pressures, compared to the center of the wall	
Cladding Weight: The dead load from the weight of the cladding itself will impact how far apart the cladding attachments can be spaced to distribute the load to prevent failure of the clip or fasteners. Lighter weight claddings like metal panel can be spaced further than heavy claddings like stone or terracotta	
Deflection Limits: While the pull-out strength and structural capacity of the clips are important, there may be strict deflection limits on the substructure for the cladding itself to prevent cracking or warping. Even if clips themselves can handle the wind and deal load, the spacing may still be limited by the deflection criteria.	

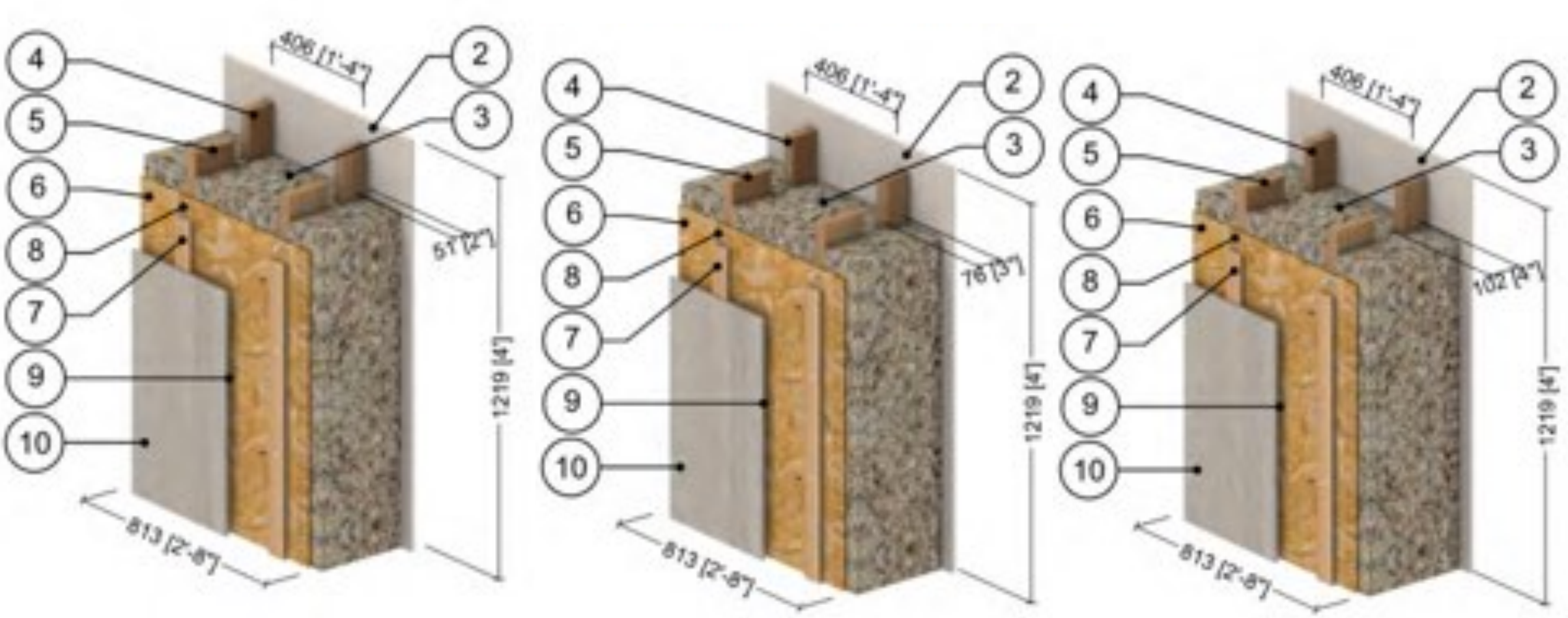
Constructability and Panel Layouts

Quantity	Vertical Layout	Horizontal Layout	% Increase
Total Rail Length	347 ft	223 ft	-36%
Number of Clips	105	111	7%
Clear Field Effective R-value	R-18.5	R-21.5	16%

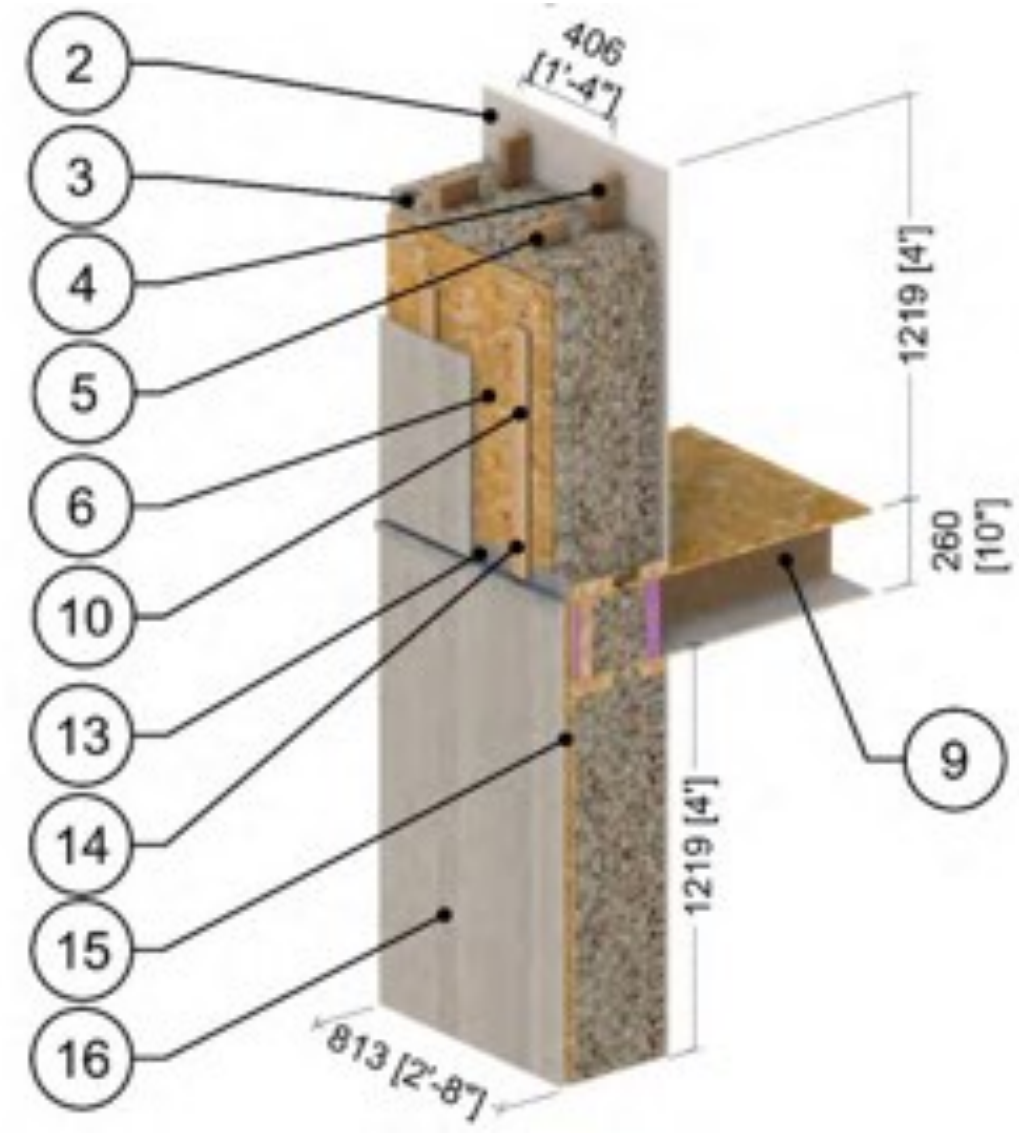
Example rail layout impact on thermal performance

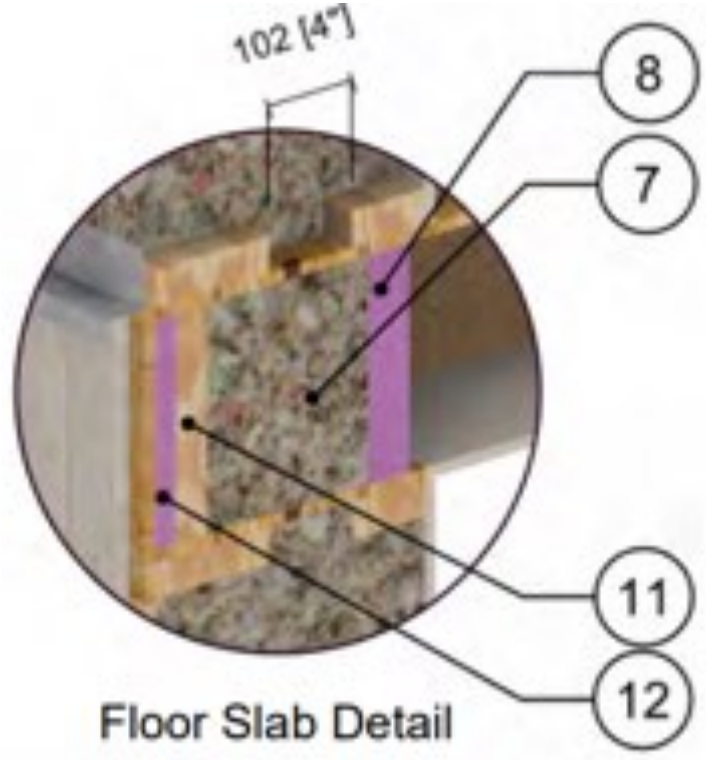
Wood-Based Approaches – Double Stud

Interior Insulated Double Framed Wall 2x6 and 2x4 Wood Stud (16" o.c.) Wall Assembly with 2" – 4" Gap – Clear Wall

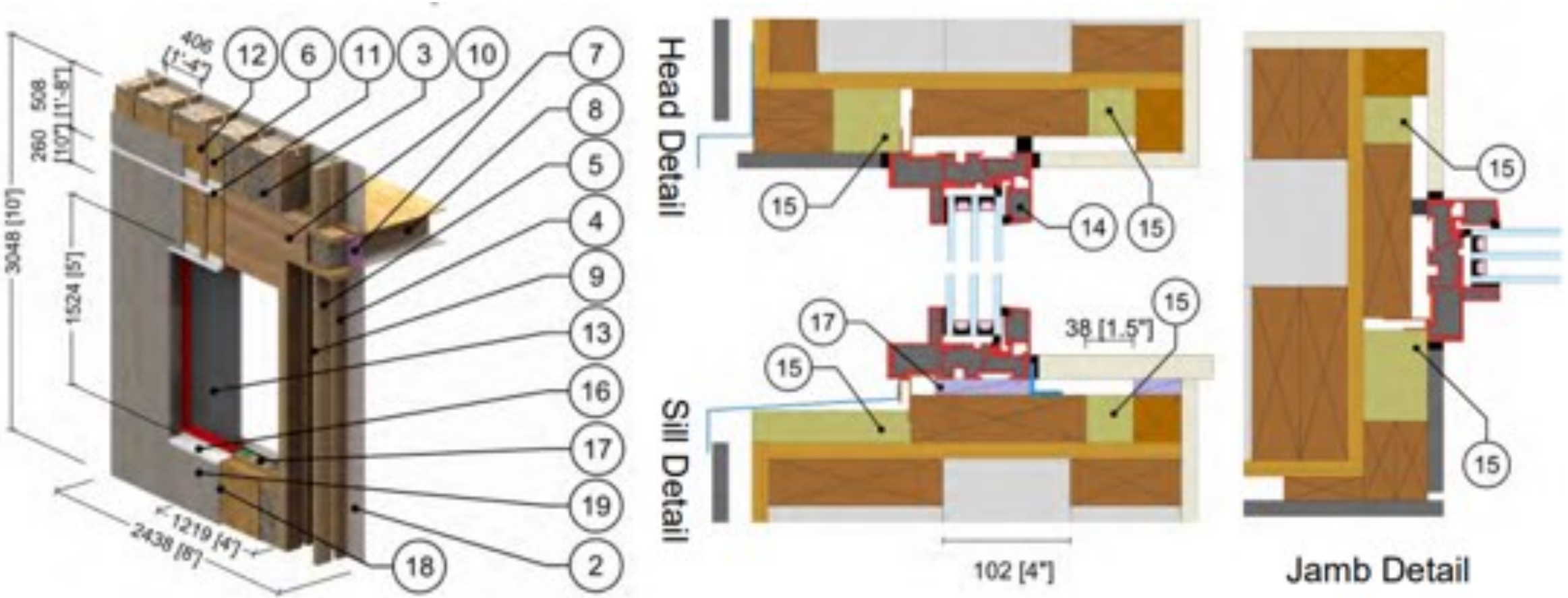


Wood-Based Approaches – Double Stud





Wood-Based Approaches – Double Stud



Wood-Based Approaches – Mass Timber

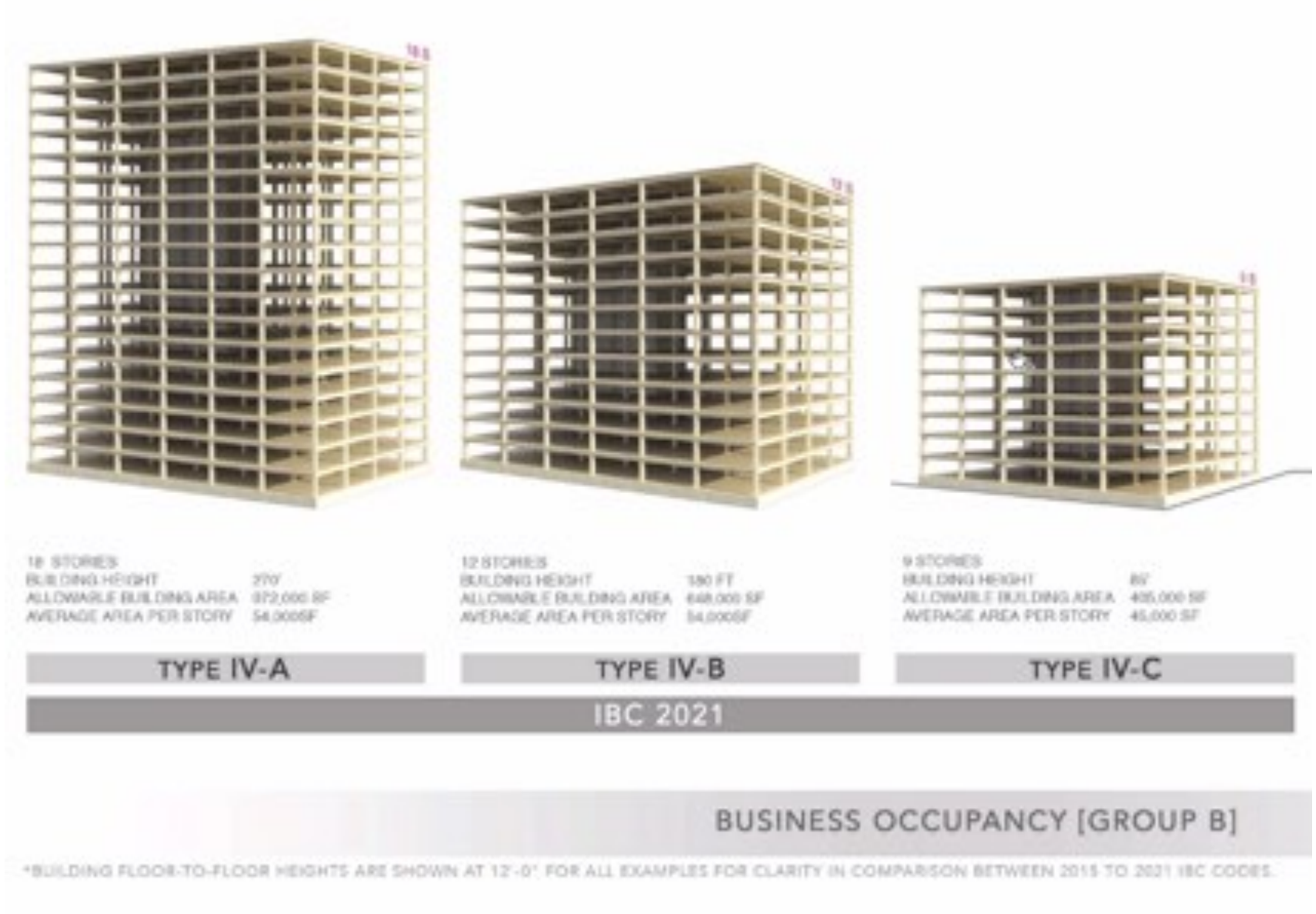
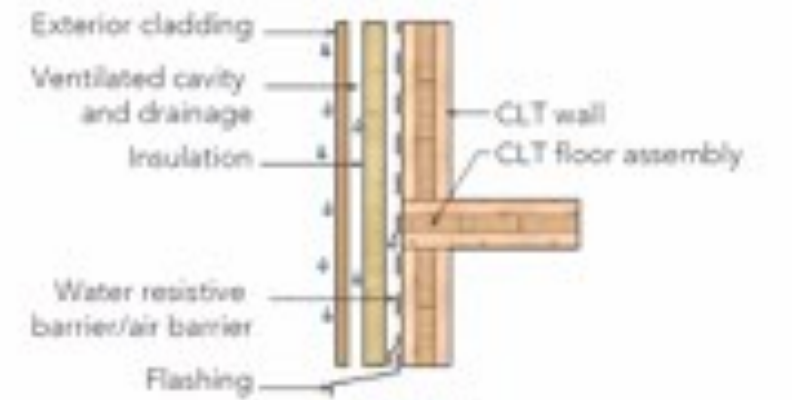
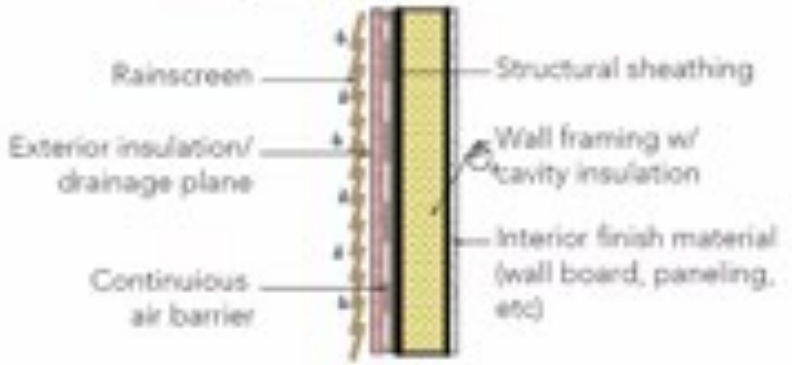


Image: Susan Jones- Atelier Jones

Wood-Based Approaches – Mass Timber



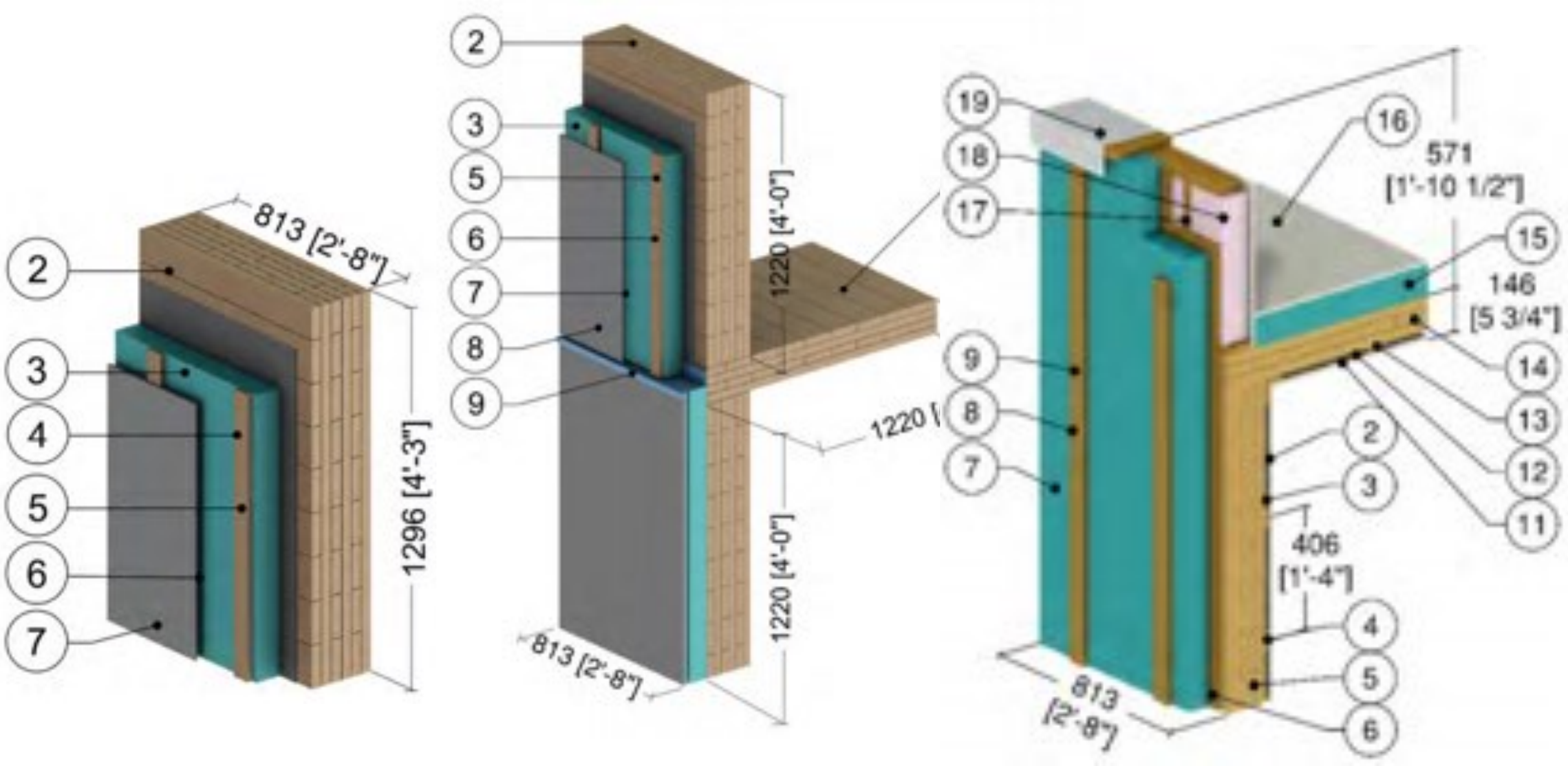
CLT w/exterior wood cladding	
fossil fuel consumption (MJ):	12,395
GWP (tonnes of CO_2 Eq.):	0
Acidification potential (moles PF H+):	210
Human Health Criteria (Kg of 10 micron pm):	7
Eutrophication potential (g of Nitrogen Eq.):	199
Ozone depletion potential (mg of CFH-11 Eq.):	1
Smog potential (Kg of NO_x Eq.):	29



2x4 STUD w/exterior wood cladding	
fossil fuel consumption (MJ):	12,456
GWP (tonnes of CO_2 Eq.):	1
Acidification potential (moles PF H+):	215
Human Health Criteria (Kg of 10 micron pm):	9
Eutrophication potential (g of Nitrogen Eq.):	218
Ozone depletion potential (mg of CFH-11 Eq.):	1
Smog potential (Kg of NO_x Eq.):	26

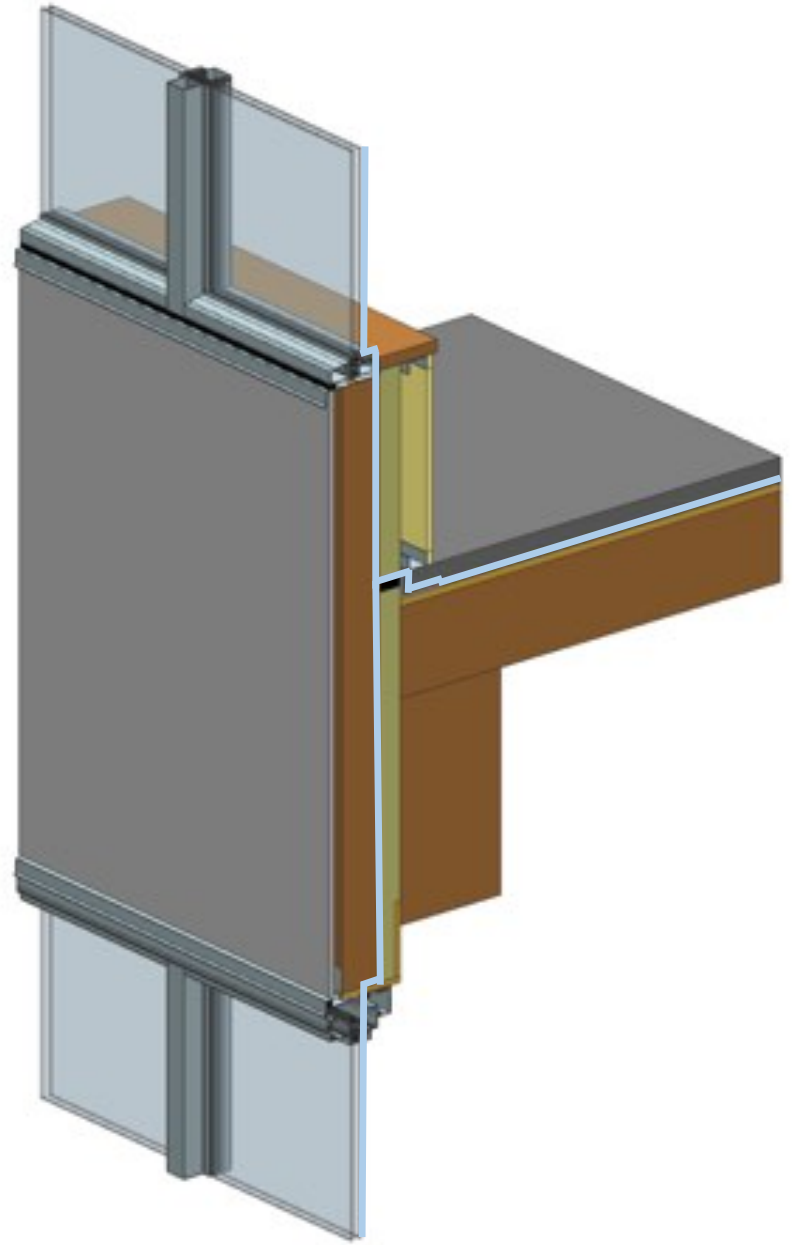
Image: Susan Jones- Atelier Jones

Exterior Insulated Cross Laminated Timber (CLT) Wall

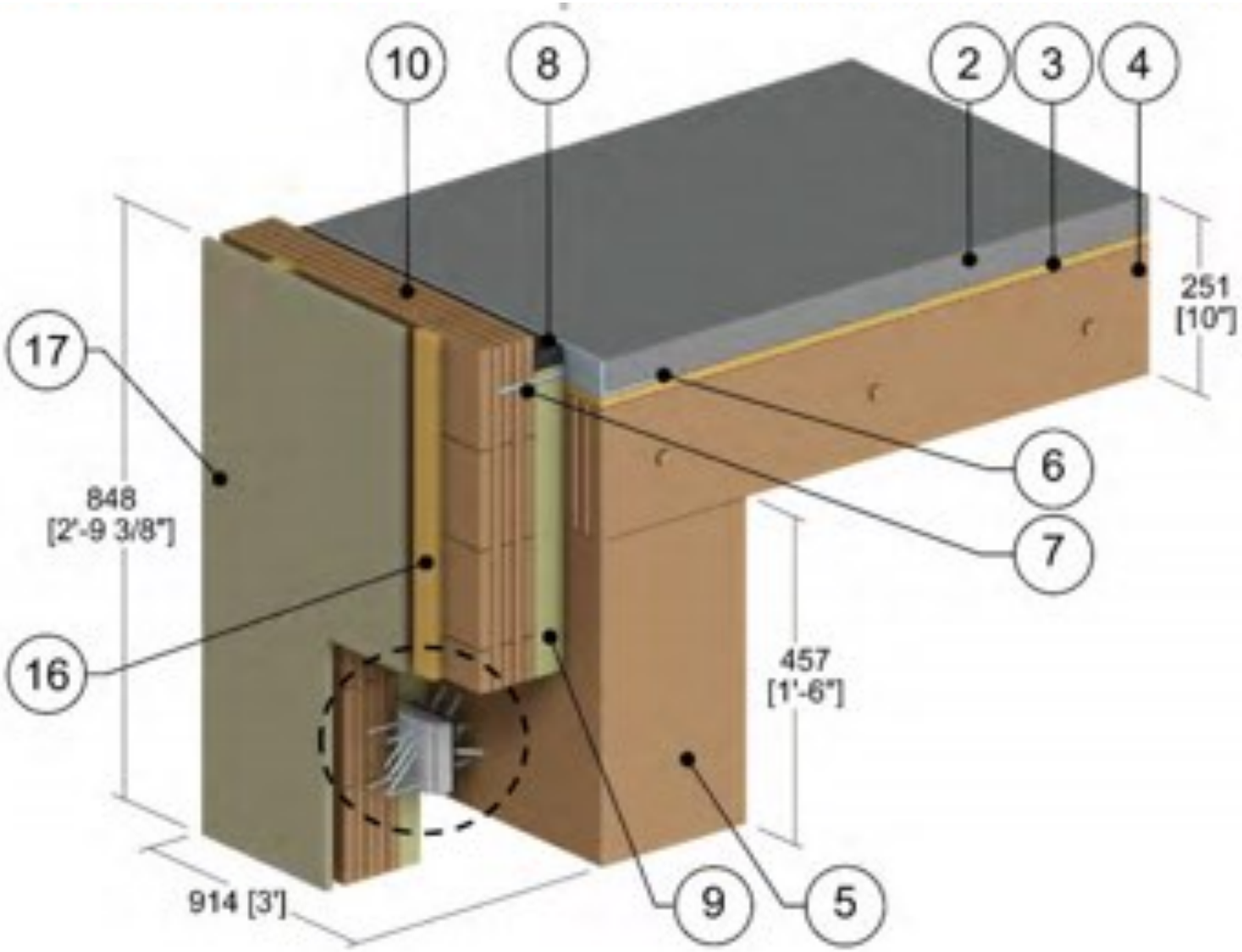


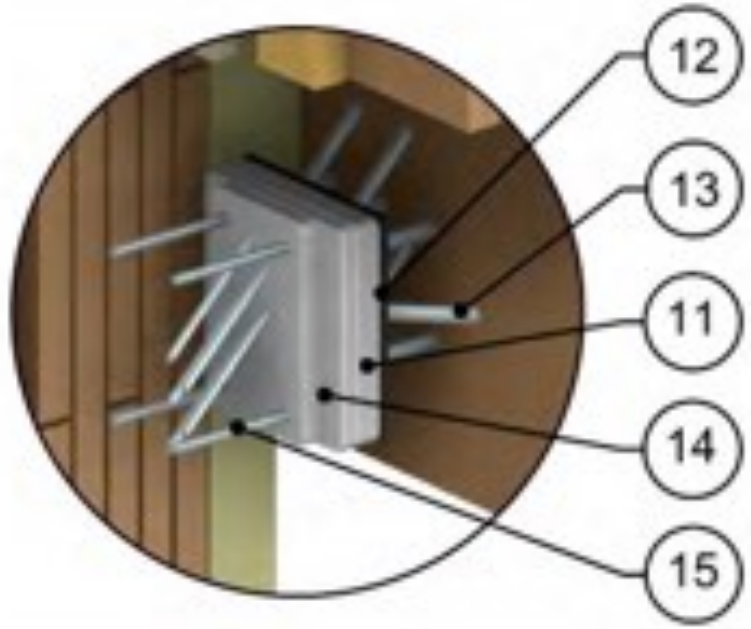
Interior Insulated CLT Facade

- Minimizes/eliminates thermal bridges :
  - No need for deflection header (CLT panel is the deflection header!) means reduced length of linear thermal transmittance
  - Eyebrows (complete thermal break)
  - Corners (negative thermal bridge – credit back in PH model)
  - Shelf angle at brick transition to other cladding becomes intermittent point TB
  - No balcony attachment thermal bridge or need for thermally broken connectors, balcony is secured by same structural connection as CLT panel…2 birds with 1 stone
  - Careful! Above is not true of exterior insulated "CLT curtain wall" systems
- Air barrier is on inside
- SAM (pre-stripped) is best most reliable method for CLT airsealing
- Panel to panel connections happen at sill heights. (When pre-fabbed, window gets carried on upper panel.)



Interior Insulated Cross Laminated Timber (CLT) Wall

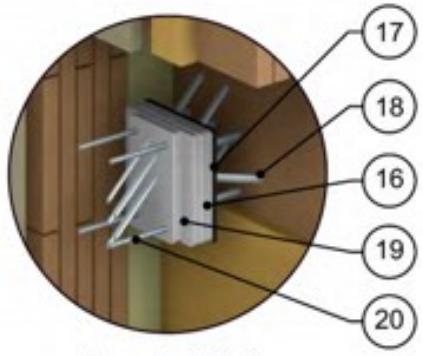




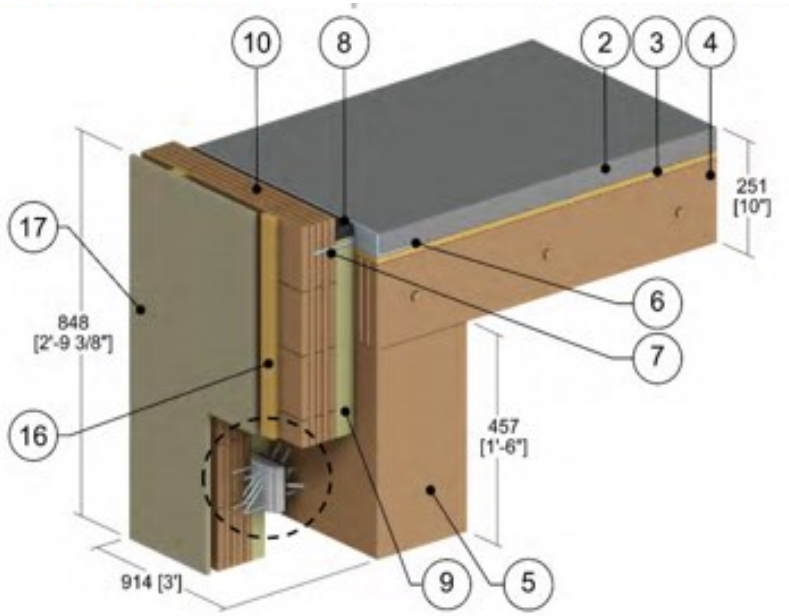
Connector Detail

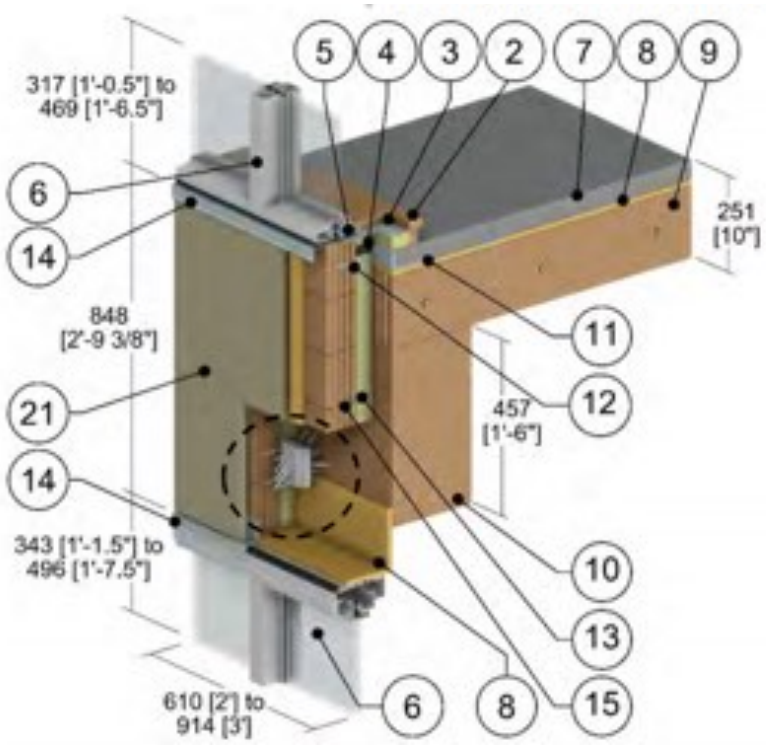
Interior Insulated Cross Laminated Timber (CLT) Wall

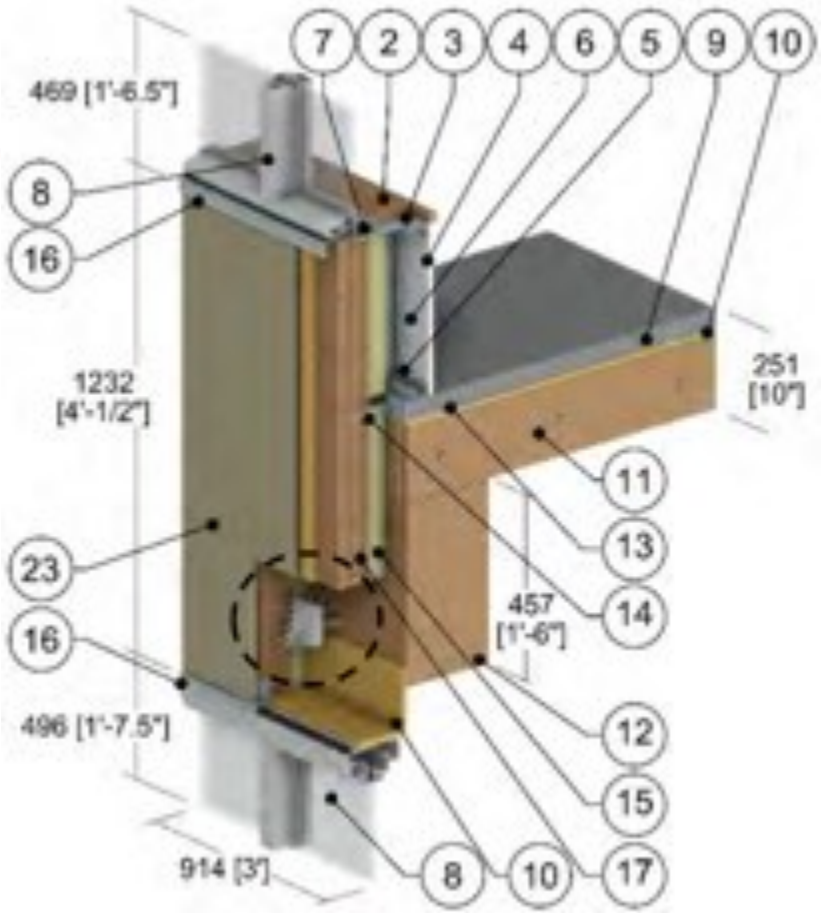
Interior Insulated Cross Laminated Timber (CLT) Spandrel at Window and Dowel Laminated Timber (DLT) – Intermediate Floor Intersection with Edge of Floor and Glulam Beam Aligned



Connector Detail







Thanks for your attention!

Questions?

Prudence Ferreira, CPHC
Passive House Practice Lead
pferreira@morrisonhershfield.com
www.MorrisonHershfield.com