Design Tools to Optimize High-Rise Passive House Buildings

Cody Akira Belton, AScT, PTech, CPHD
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MORRISON HERSHFIELD

Agenda

1. How to Increase Productivity in Commercial Buildings
2. Case Study: 825 Pacific Artist Hub
3. Thermal Bridging at Large Buildings
4. Post Construction Research Study
5. Key Takeaways

How to Increase Productivity in Commercial Buildings

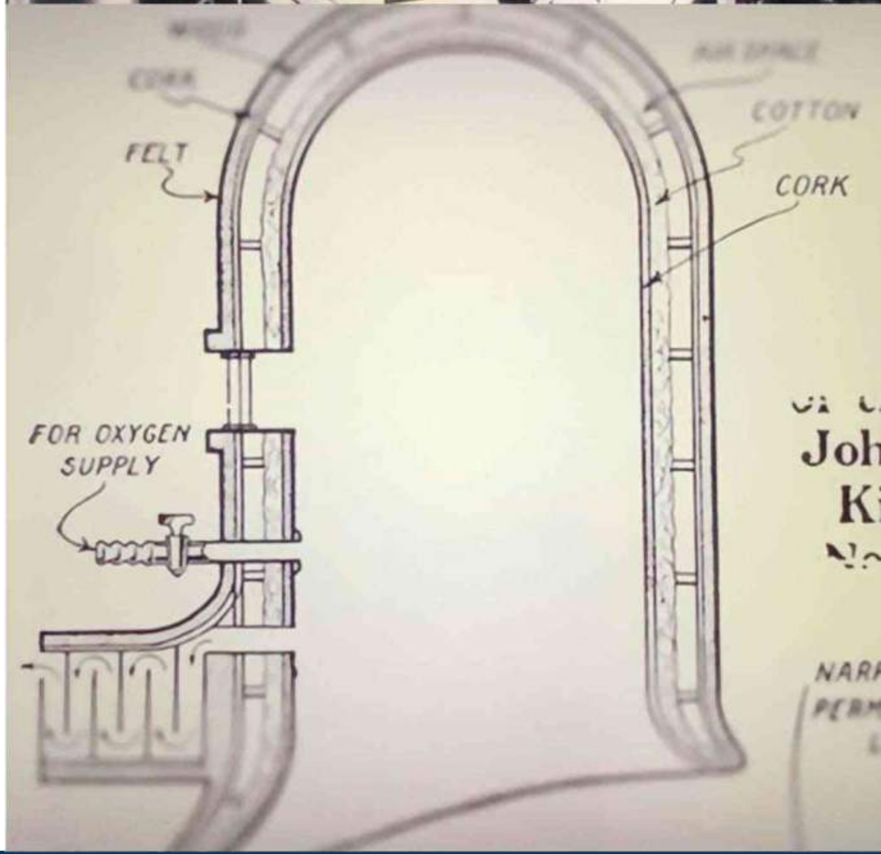
What does it take?

- Less distractions from better soundproofing
  - Reduced street noise
- Better indoor air quality
  - Enhanced cognitive function
  - No mould or condensation exposure on windows
- Enhanced perception of thermal comfort
  - No draughts, no cold spots

What does it take?

All achieved with 'THE ISOLATOR' invention (1925)

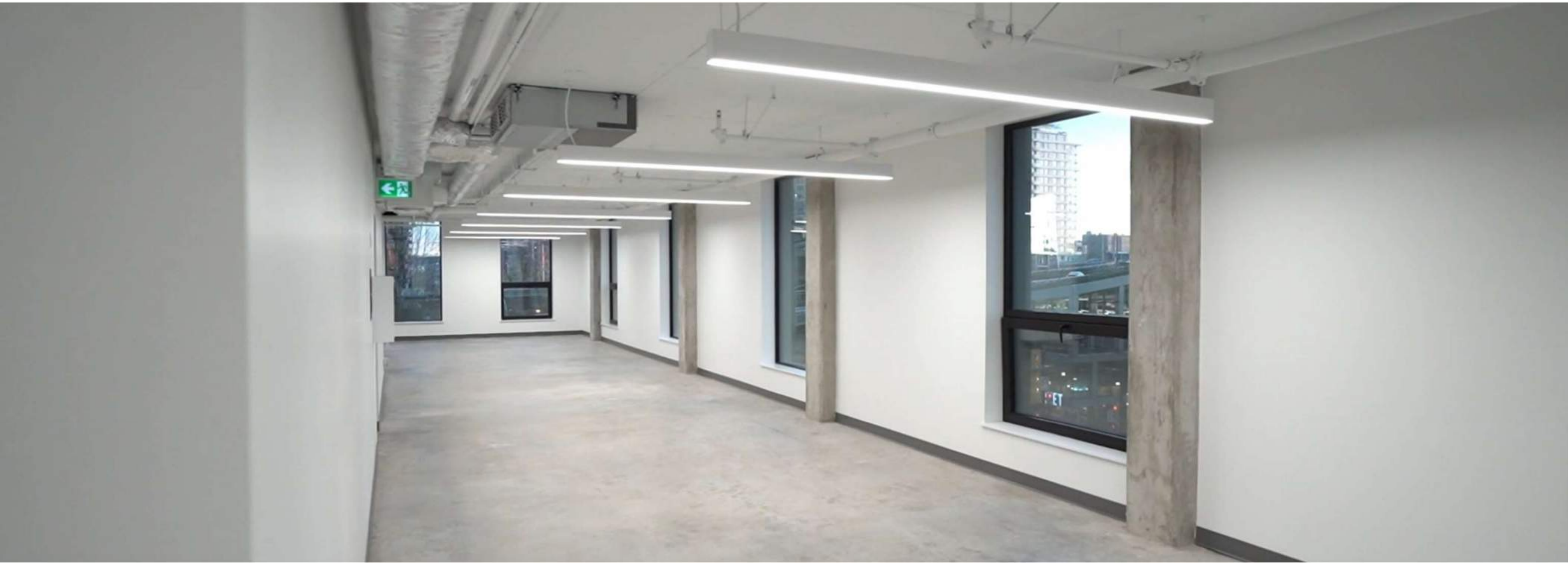
- Thermal insulation / vibration buffers
- High-performance vision area
- Airtight enclosure
- Thermal bridge free design
- Constant/controlled clean air supply



How to Increase Productivity in Commercial Buildings

Alternate option:

- Build a Certified Passive House Passive House Institute
- Convert whole building enclosure into 'THE ISOLATOR'



Case Study

825 Pacific Artist Hub

- **Project Address: 825 Pacific Street, Vancouver, BC**

- **7 Levels + Basement**
- **Treated Floor Area: 1537 m²**
- **Gross Floor Area: 1974 m²**

- **Tallest Certified Passive House Commercial Building in Canada**

Case Study

825 Pacific Artist Hub

- Owned by the City of Vancouver and operated by a not-for-profit affiliate
- The space will contain artist studios, offices and a gallery space on Level 1


N
WEST END
ENGLISH BAY
KITSILANO
SITE
801-819
PACIFIC STREET
YALETOWN
GRANVILLE
ISLAND
FALSE CREEK
Jervis St
Bute St
Thurlow St
Davie St
Burrard St
Hornby St
Howe St
Drake St
Granville St
Seymour St
Richards St
Homer St
Hamilton St
Mainland St
Nelson St
Smithe St
Robson St
Georgia St
Dunsmuir St
Cambie St
Beatty St
Expo Blvd
Pacific St
Beach Ave
Burrard Street Bridge
Granville Street Bridge
Pacific Blvd
Cambie Street Bridge

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Building Enclosure: What did it take?

Windows:

- Uframe-0.88 (mix of operable + fixed)
- Uglazing-0.59 and SHGC 0.27
- Uinstall-0.73 (installed window average)
- Rsi-1.4 effective (installed window average)

Walls Above Grade: Rsi-7.4 effective

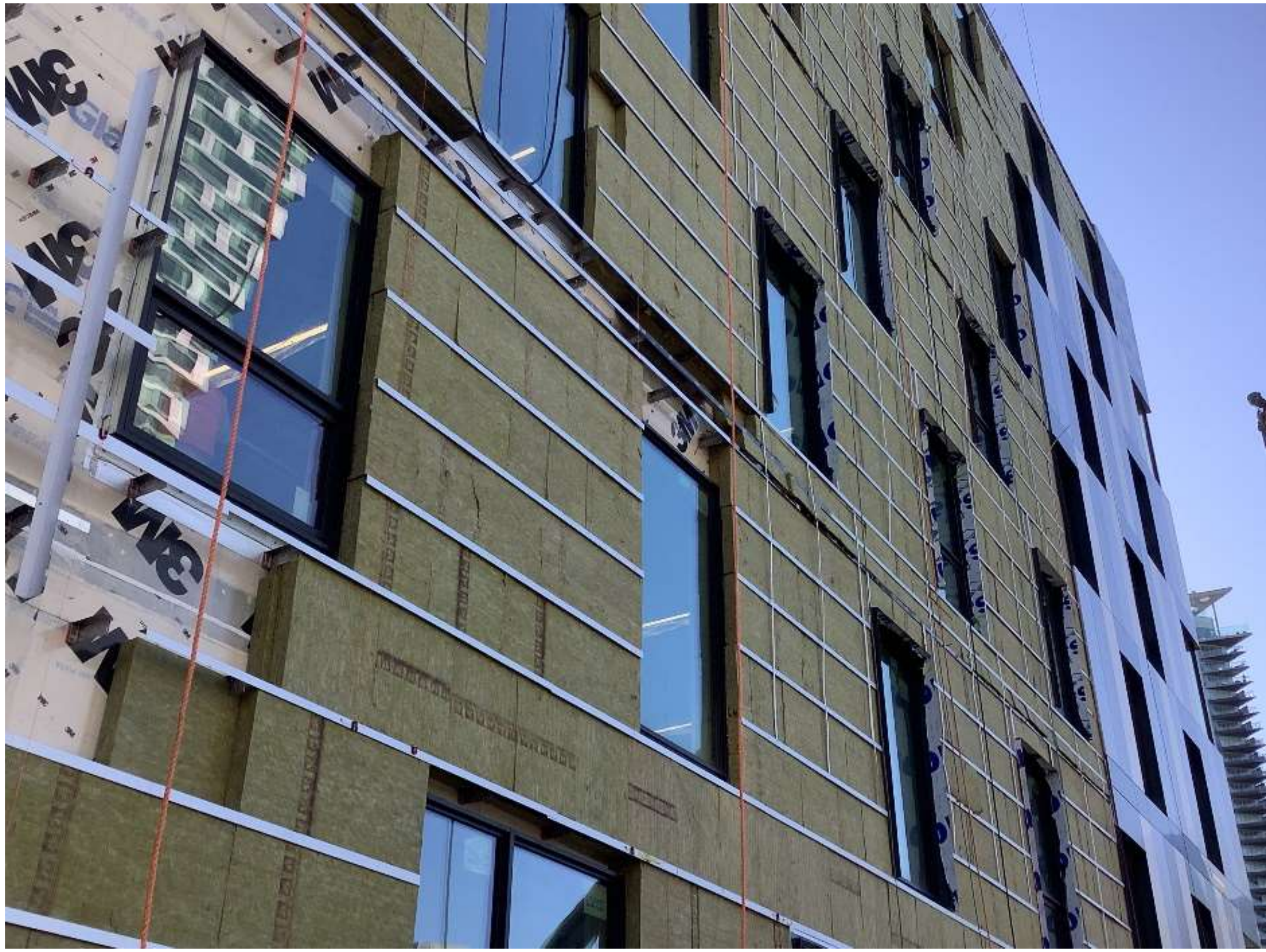
Walls Below Grade: Rsi-4.8 effective

Slab-On-Grade: Rsi-4.8 effective

Roof: Rsi-7.5 effective

Optimized Thermal Bridge Detailing

Airtightness: 0.19 ACH @ 50 Pa



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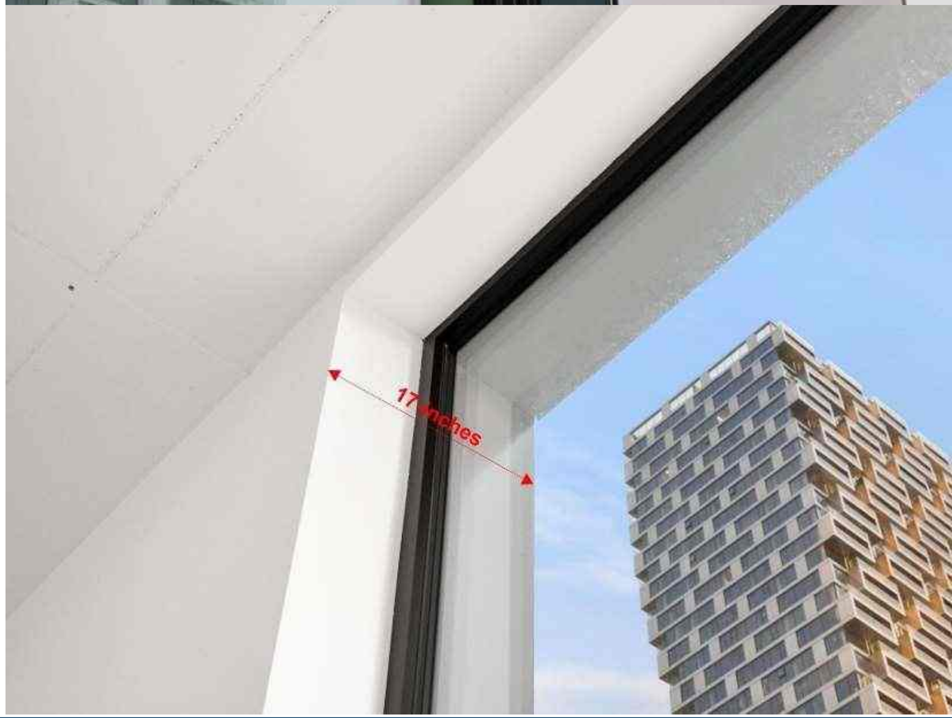
Building Enclosure: What did it take?

Windows: PH certified triple glazed fiberglass windows

- Rsi-1.4 (R-7.8) effective (installed window average)

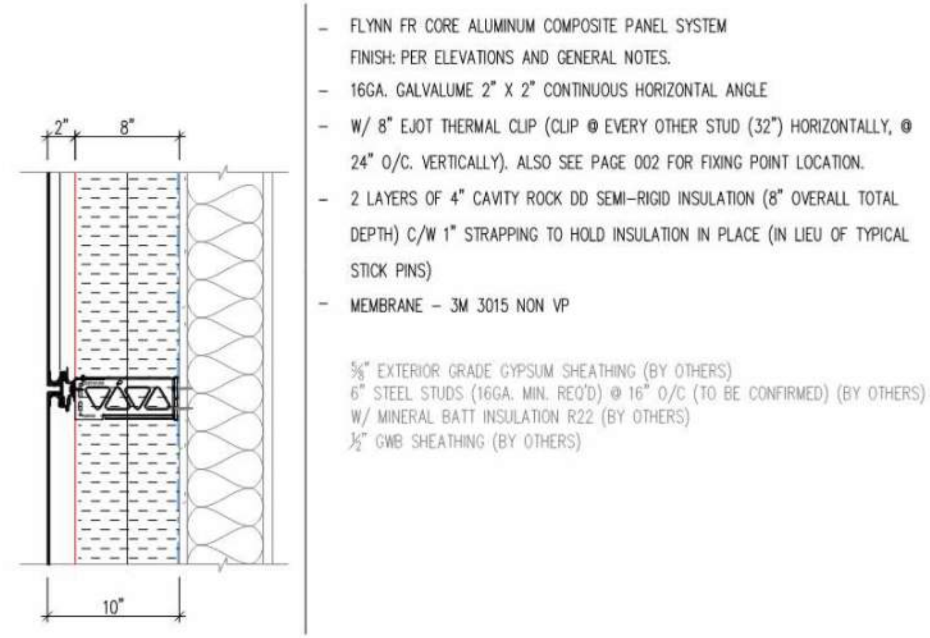
Walls Above Grade: split-insulated steel stud framed wall with 8-inch exterior mineral wool insulation

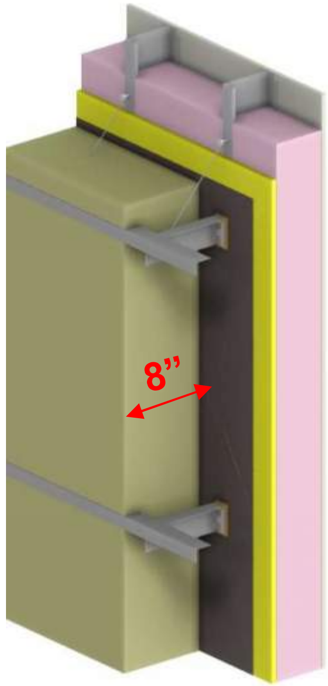
- Rsi-7.4 (R-42) effective
- 17-inch (435 mm) total thickness

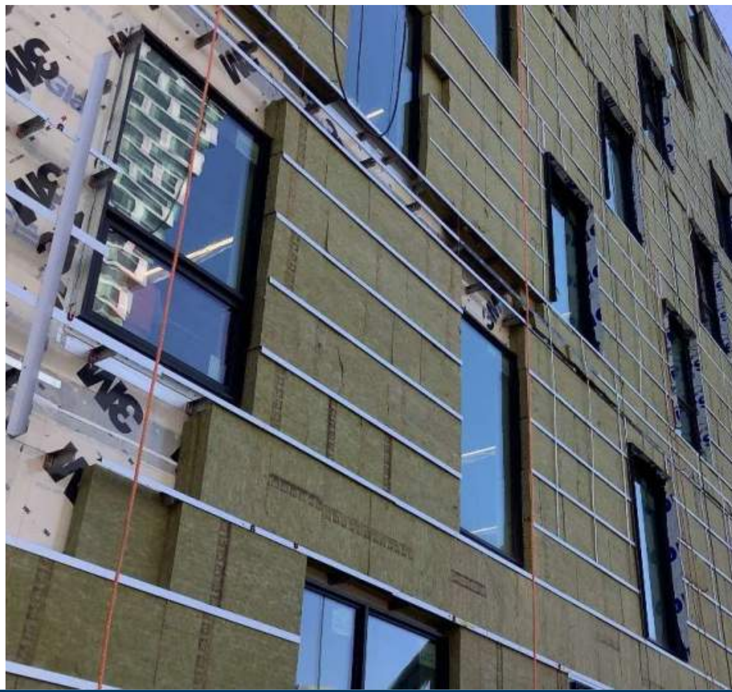


Building Enclosure: Walls Above Grade

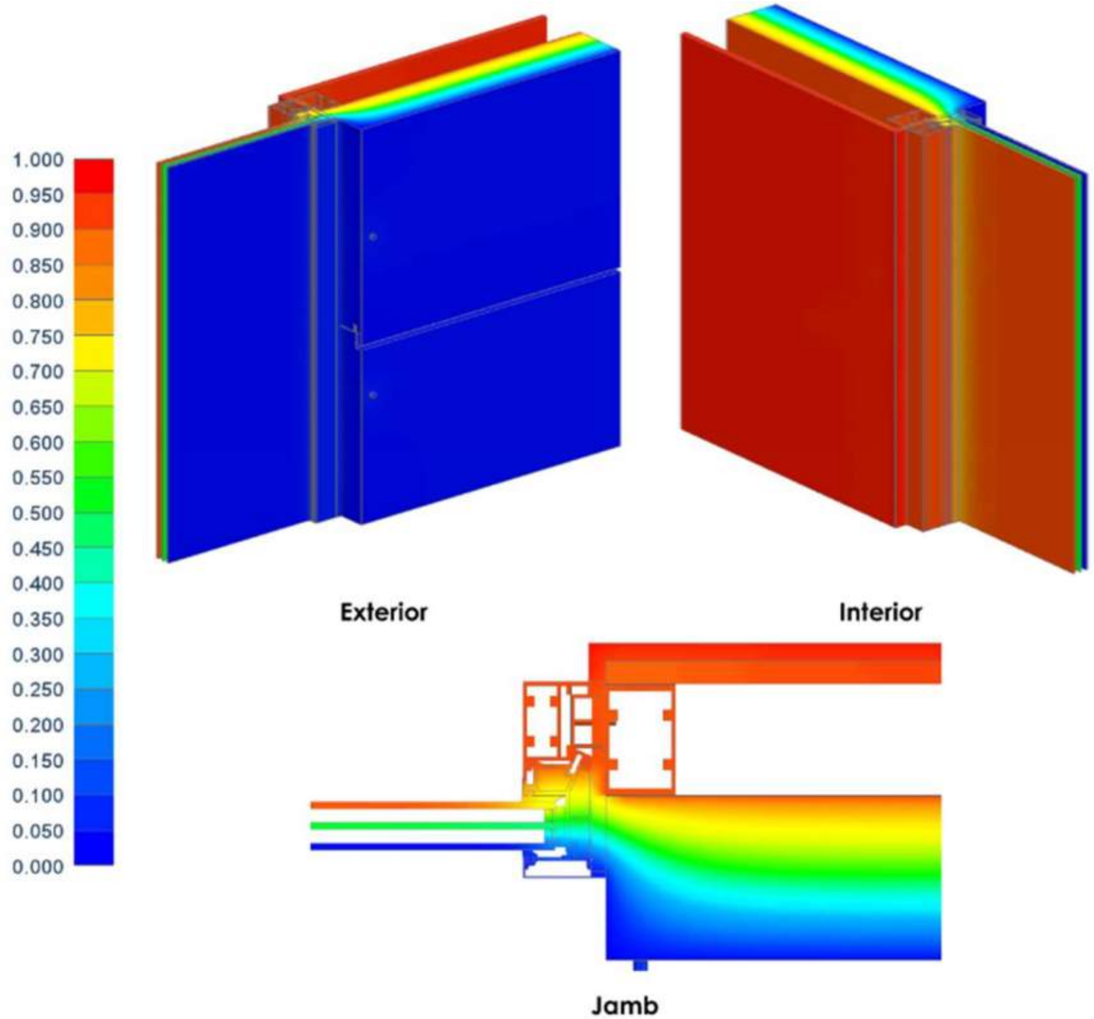
- **Walls Above Grade:** Rsi-7.4 (R-42) effective
- 435 mm (17-inch) total thickness
- Split-insulated steel stud framed wall
- 8-inch exterior mineral wool insulation (Rockwool CavityRock)
- R-22 mineral wool batt insulation (Rockwool ComfortBatt) in steel stud cavities
- 3M 3015 self-adhered membrane on exterior sheathing (primary air barrier)
- EJOT Crossfix w/ horizontal cladding attachment system

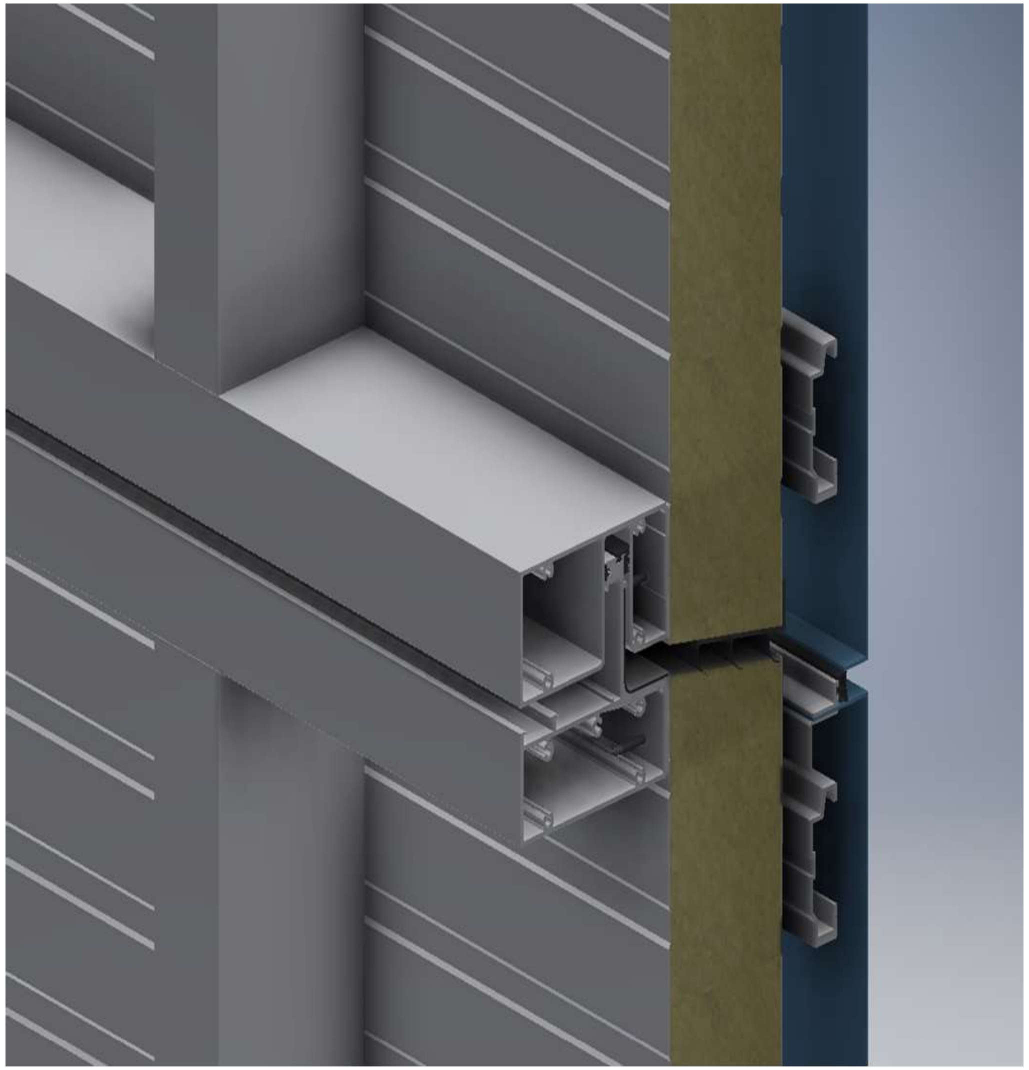






Flynn Speedwall





Credit: Flynn

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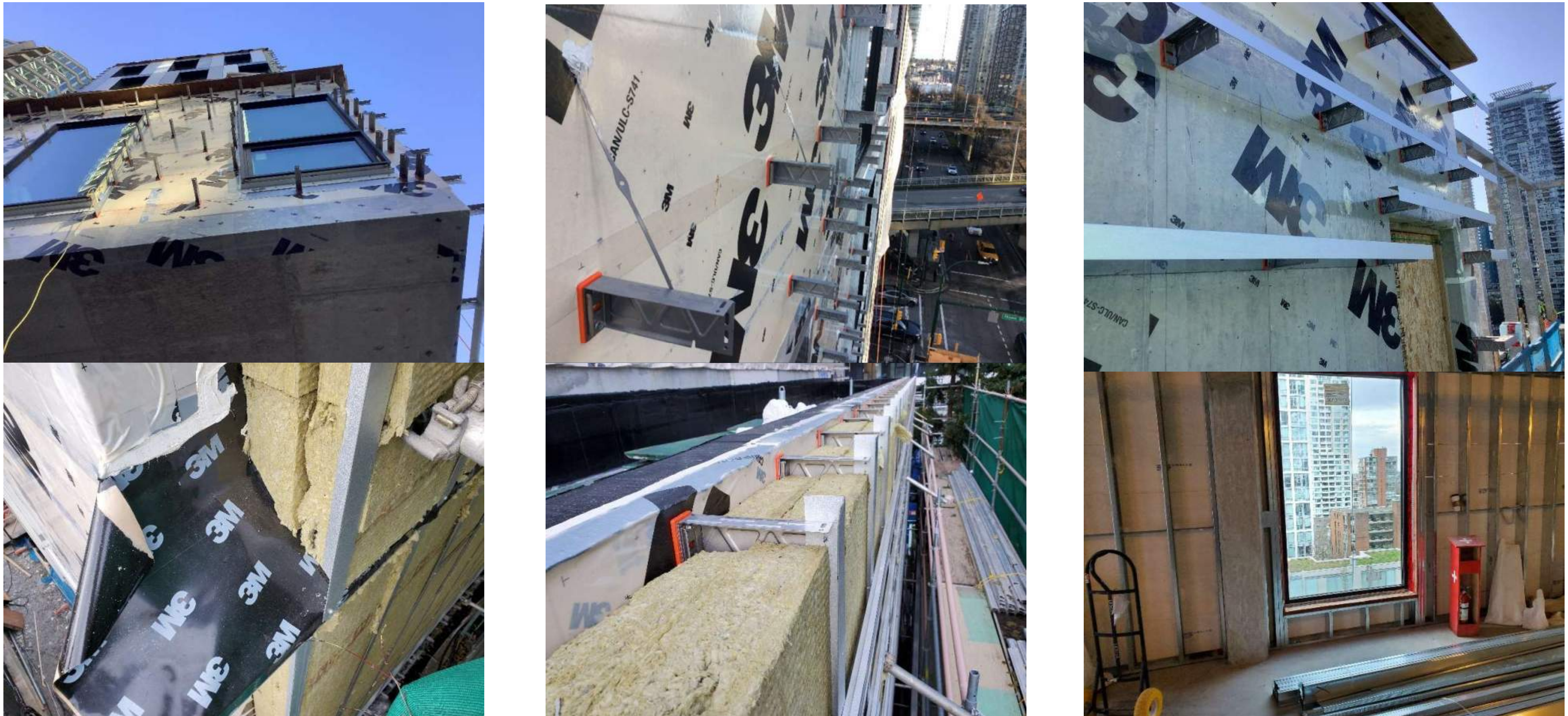
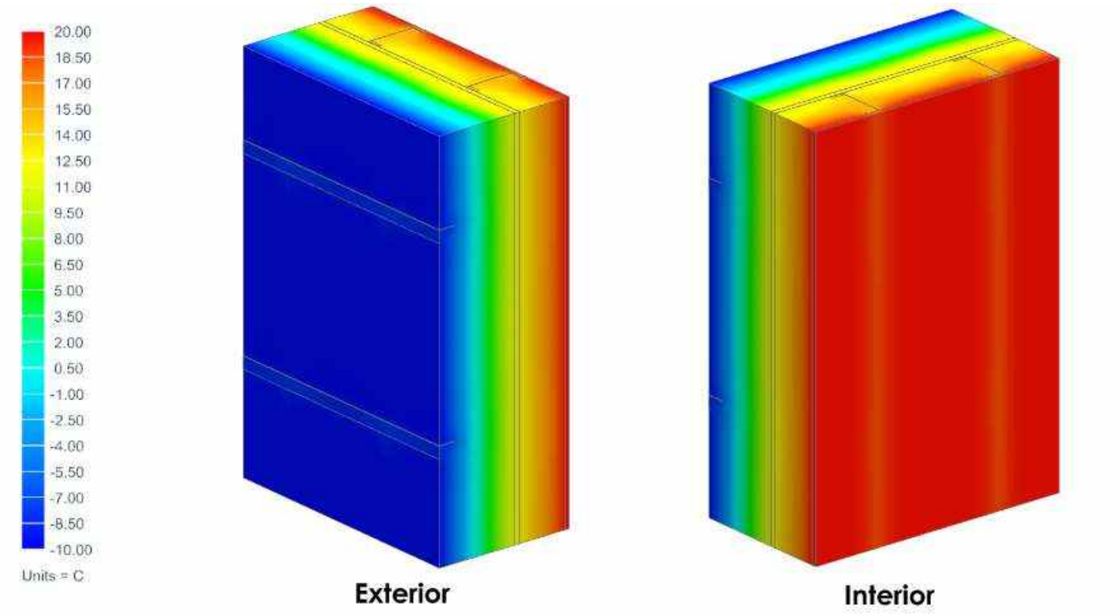
Building Enclosure: Walls Above Grade



Building Enclosure: Walls Above Grade Thermal Analysis

- 3D thermal analysis of clear field wall was required by the Passive House Certifier
- 3D thermal analysis provided accurate R-value needed for the PHPP energy model in support of Passive House Certification
- Difference in between 2D and 3D thermal analysis can be significant to thermal transmittance and surface temperature



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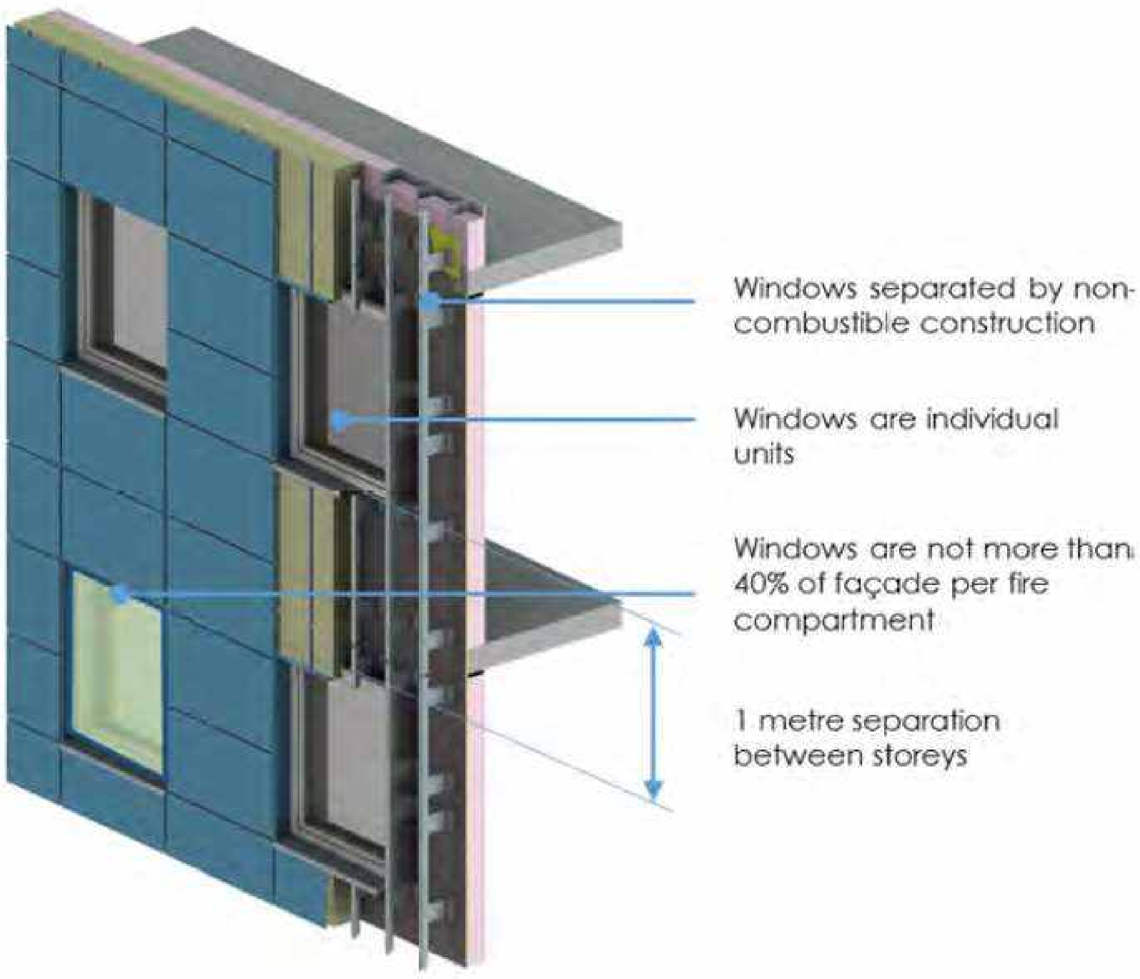
Building Enclosure: Windows

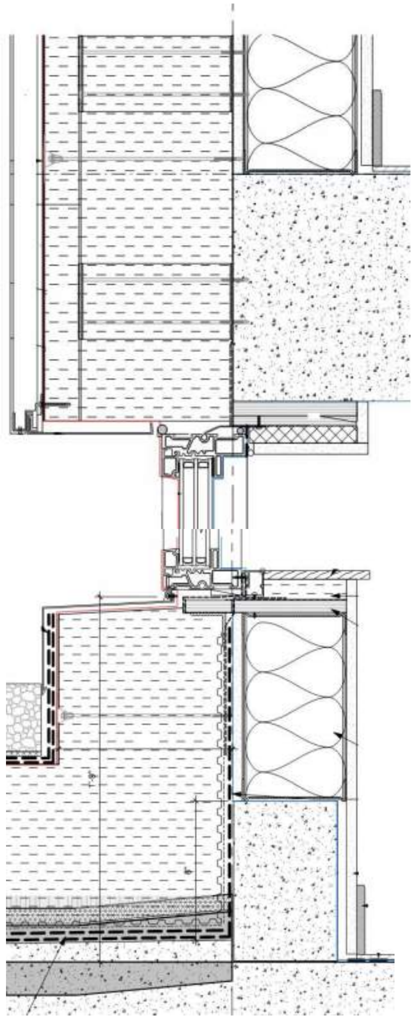
- Mix of operable and fixed PH certified triple glazed fiberglass windows (Cascadia Universal Series PH)
- Rsi-1.4 (R-7.8) effective (installed window average)
- Overheating risk was reduced by changing SHGC from 0.55 to 0.27

Building Enclosure: Windows

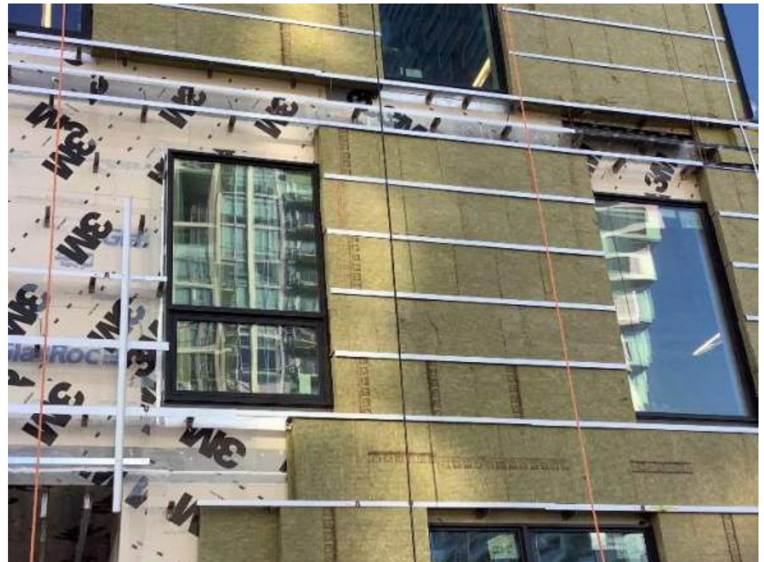
- Non-combustible building
- Combustible window frames are permitted if additional life safety requirements are met
- Refer to NBC Clause 3.1.5.4.(5)
- Provide separation in between windows
- Provide non-combustible insulation surrounding windows
- May not be applicable for all projects, depends on the authority having jurisdiction

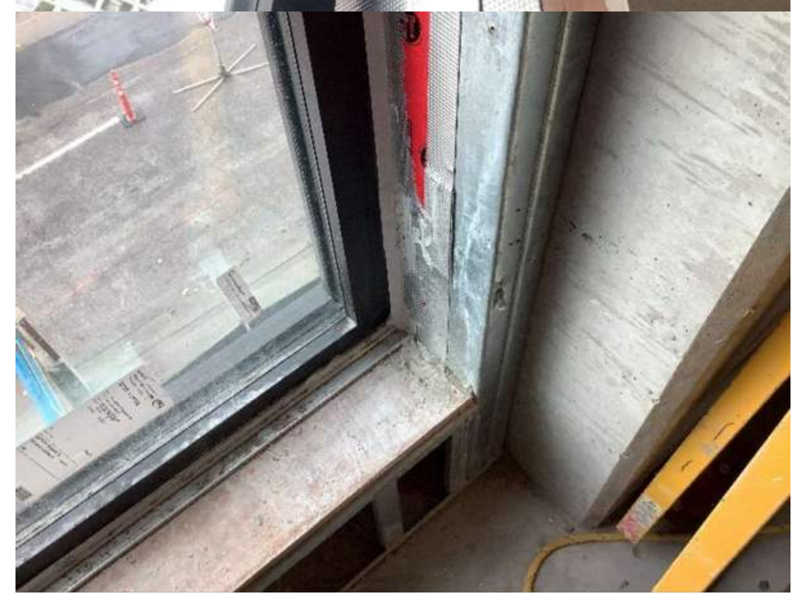


Building Enclosure: Windows



Schematic Detail for
illustrative purposes only





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Building Enclosure: Window-to-Wall Ratio Reduction

Elevation	% Window
North	4.2%
East	31.4%
South	35.2%
West	37.1%

Early Sketch Design

a cd f * architecture | design urbain | intérieur

As-Built

IBI

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Building Enclosure: Window-to-Wall Ratio Reduction

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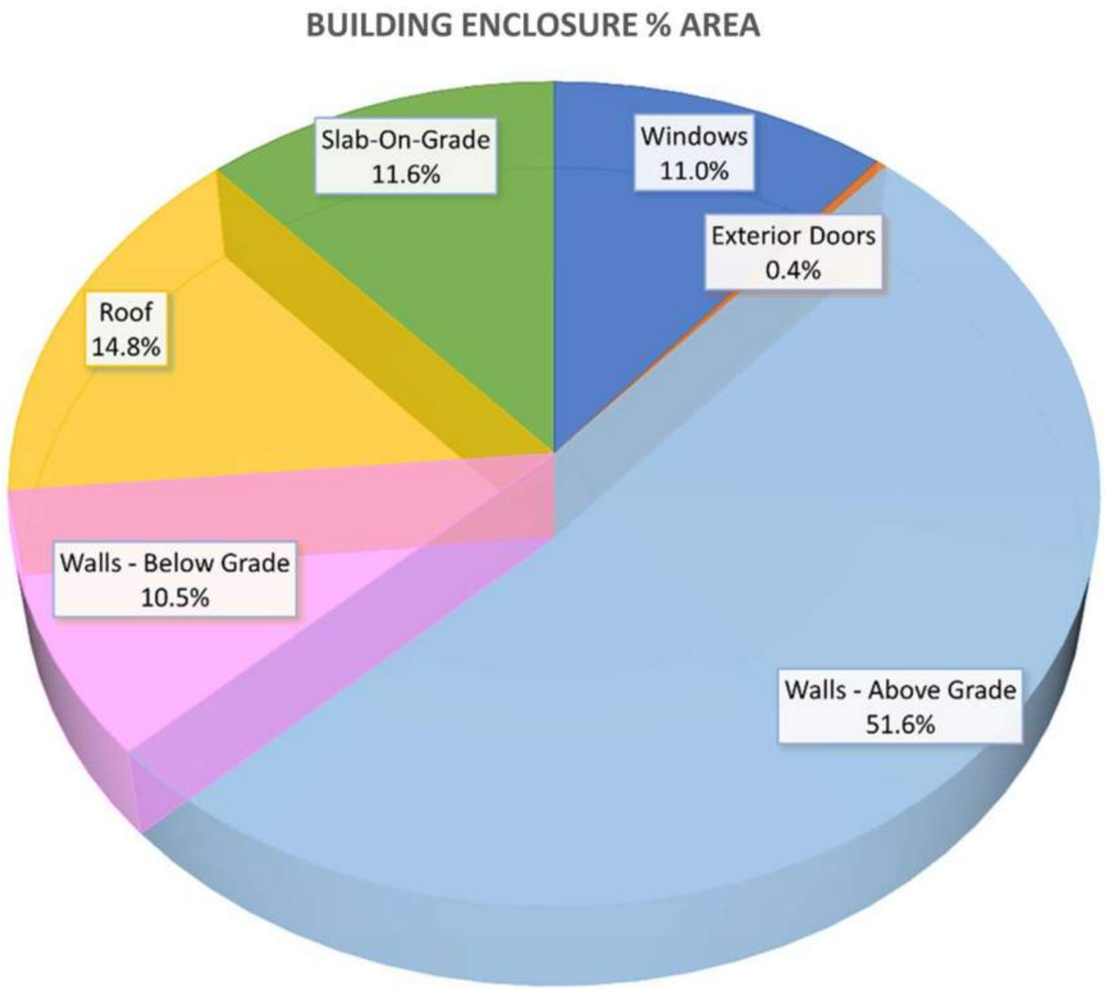

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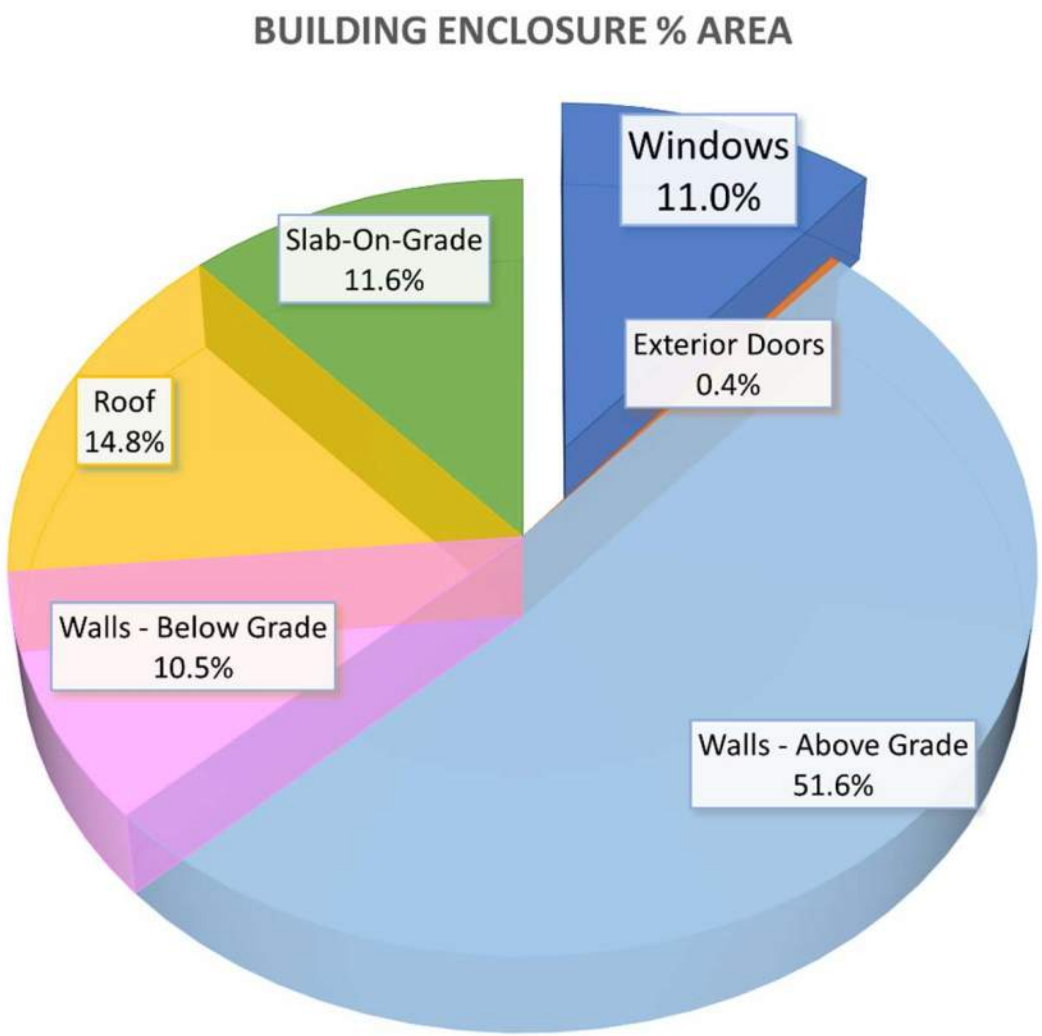
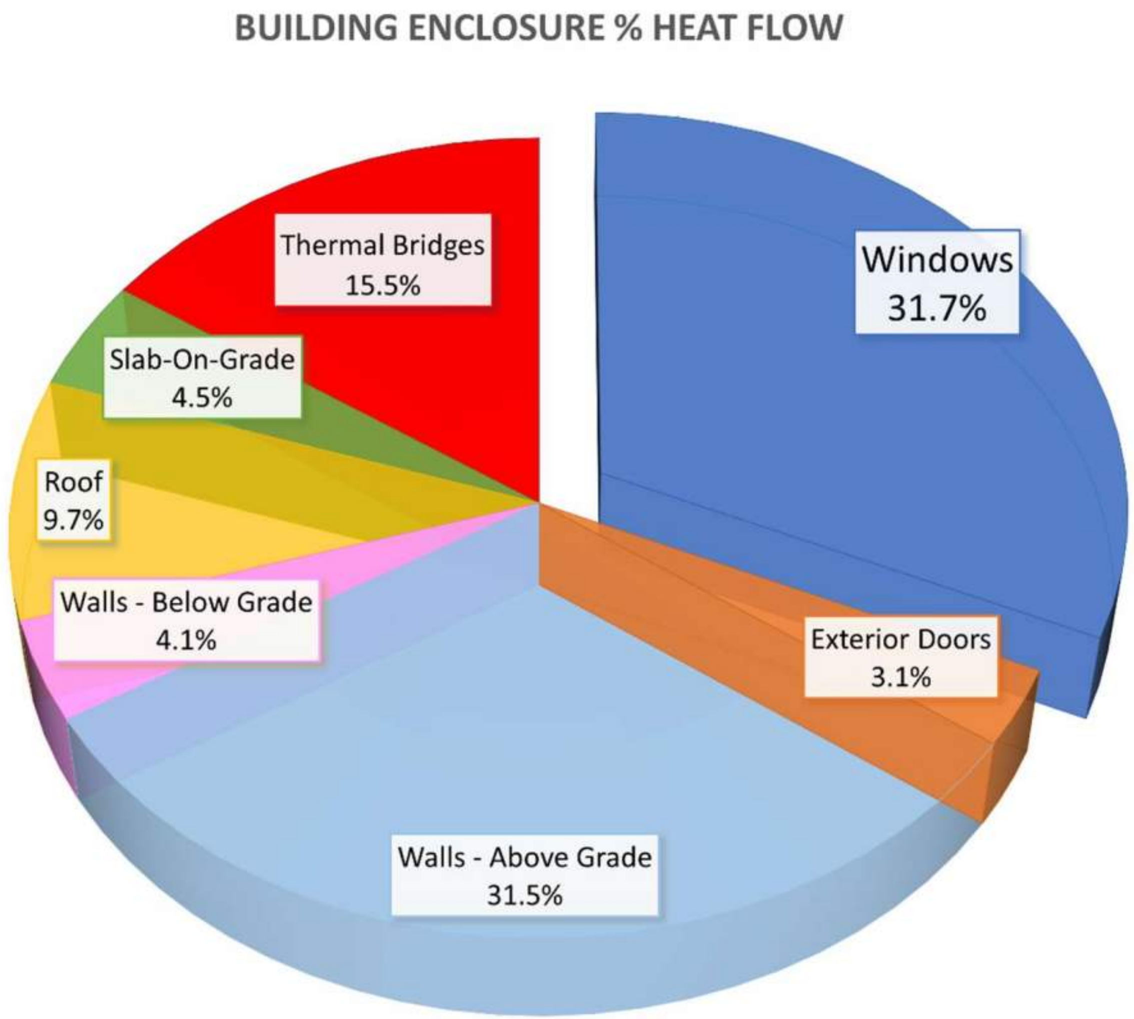
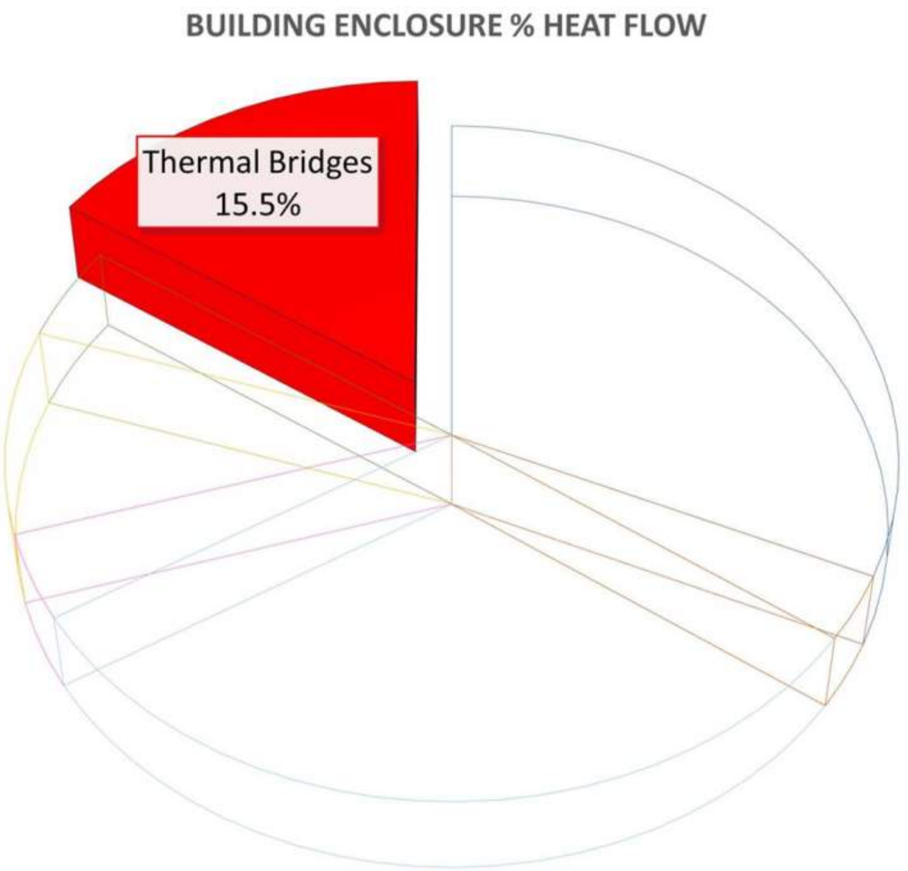




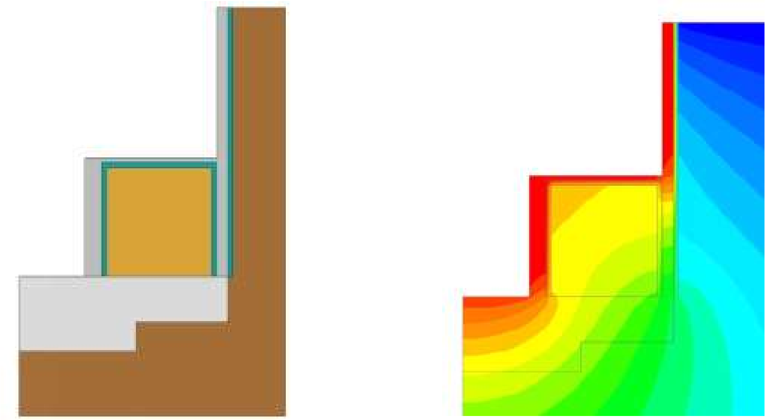
Building Enclosure: Thermal Bridging Heat Loss

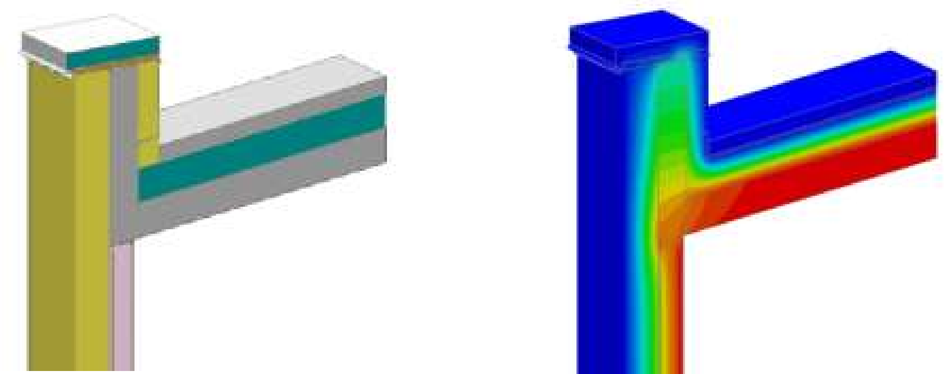
- Thermal Bridges account for 15% of heat loss through building enclosure

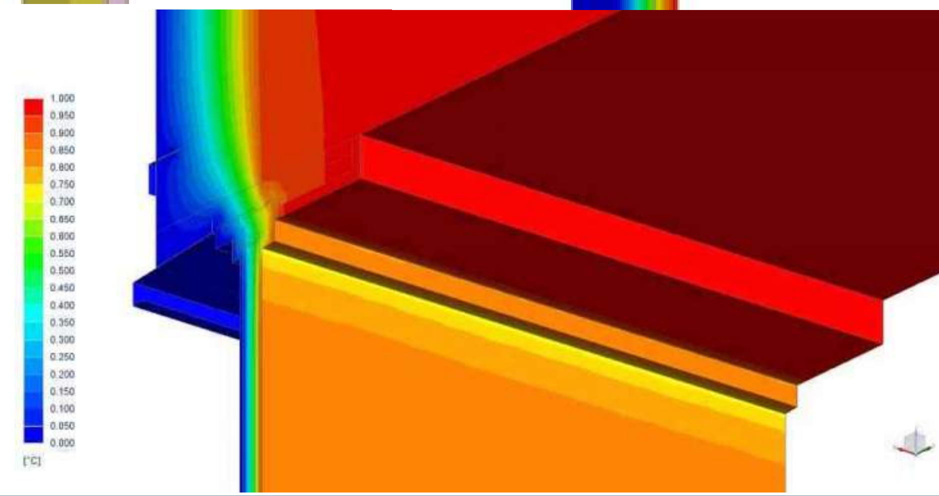


Building Enclosure: Thermal Bridging Heat Loss

- Accurate determination of thermal bridge values (combination of 3D and 2D) for Passive House Planning Package (PHPP) energy model was a significant factor to overall building design in support of Passive House Certification
- Inaccurate thermal bridge values may unjustly inflate Space Heating/Cooling and Primary Energy Renewable (PER) Demand







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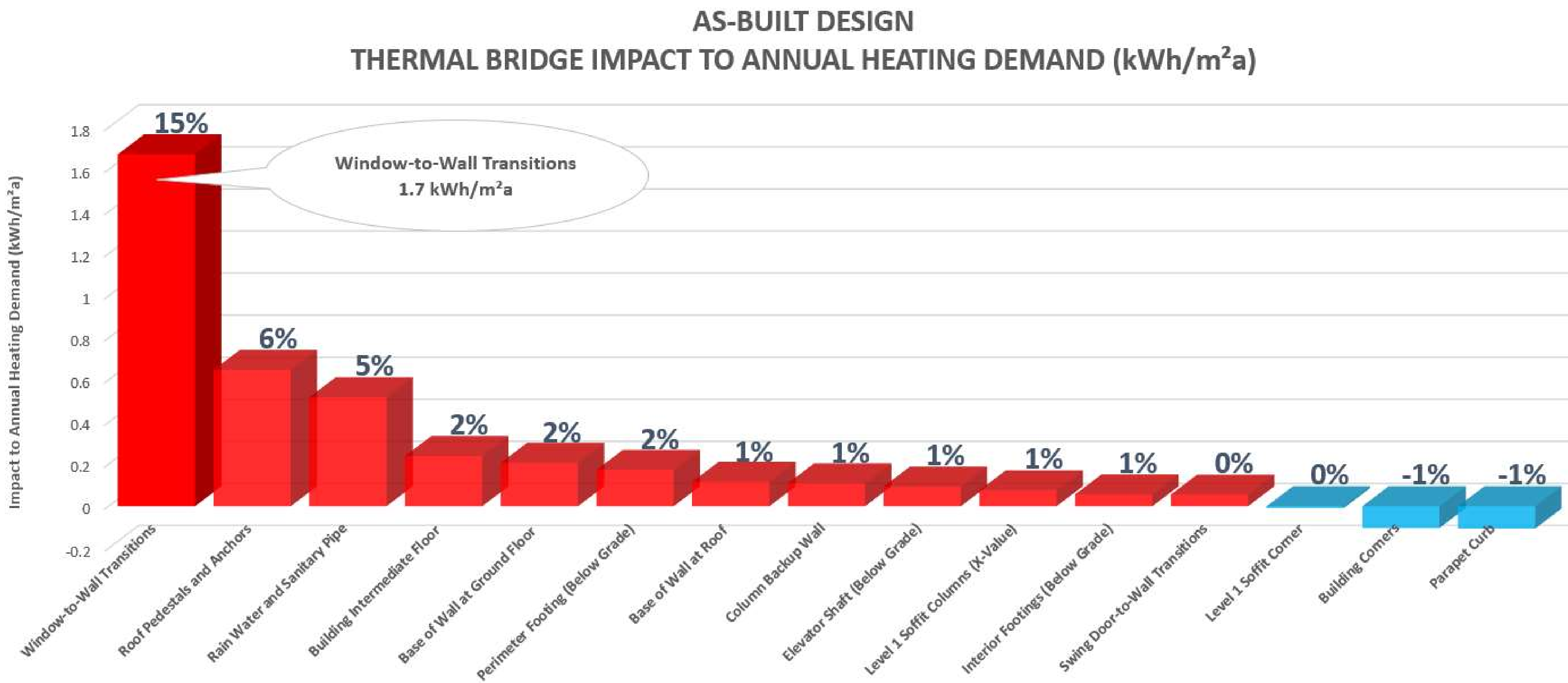
Building Enclosure: Thermal Bridging Heat Loss

- Where are the high impact thermal bridges?



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Building Enclosure: Thermal Bridging Heat Loss

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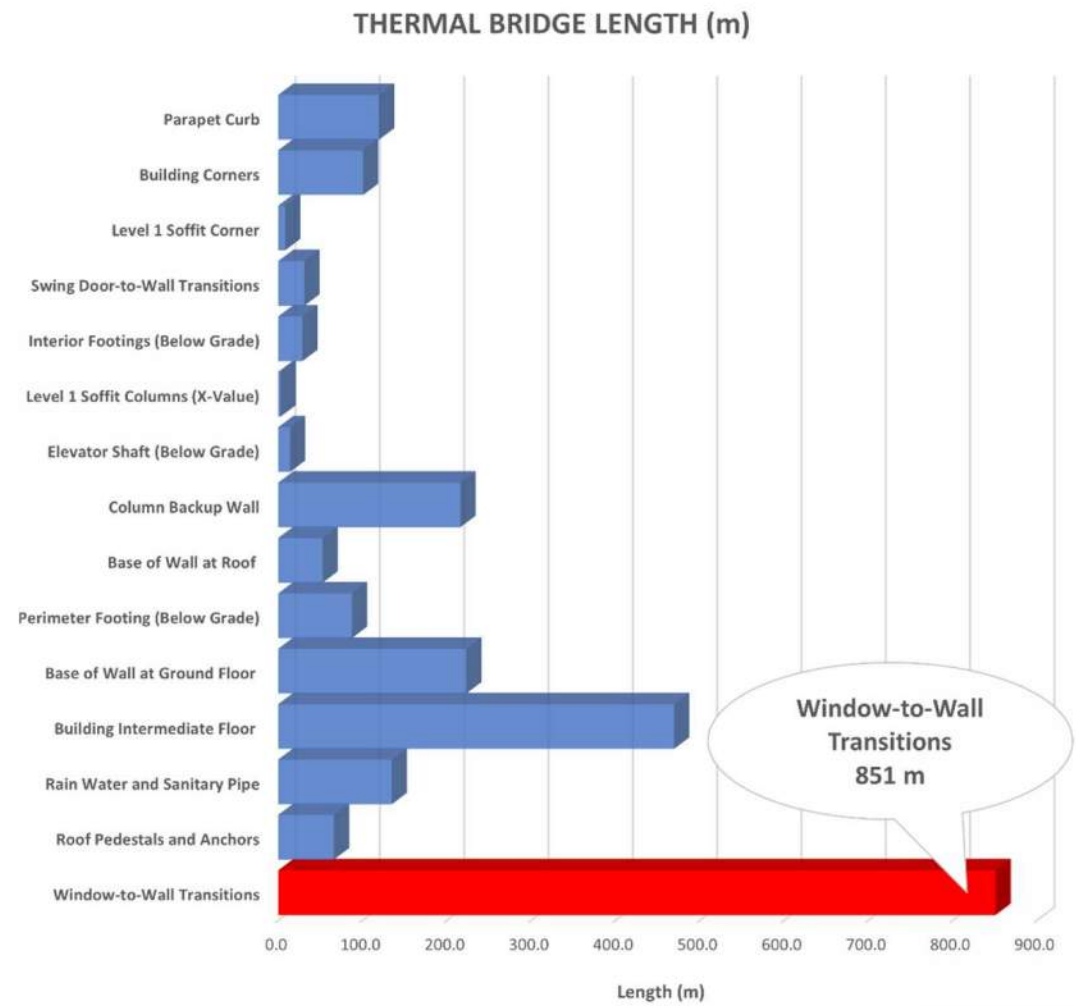

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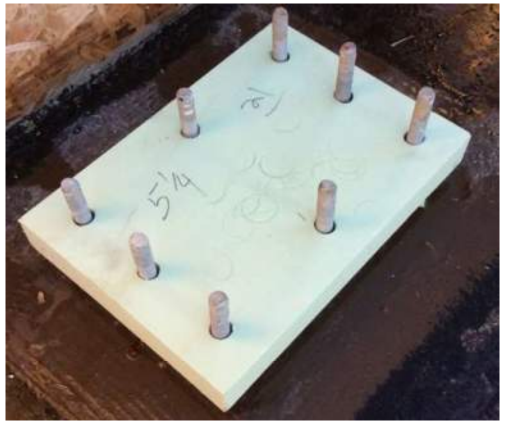
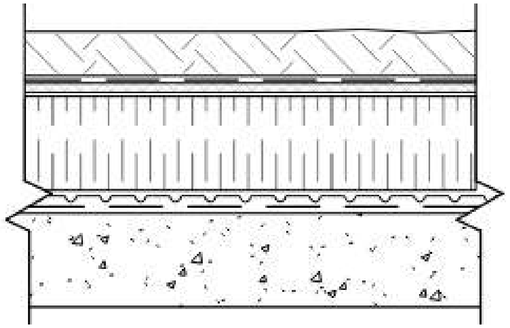
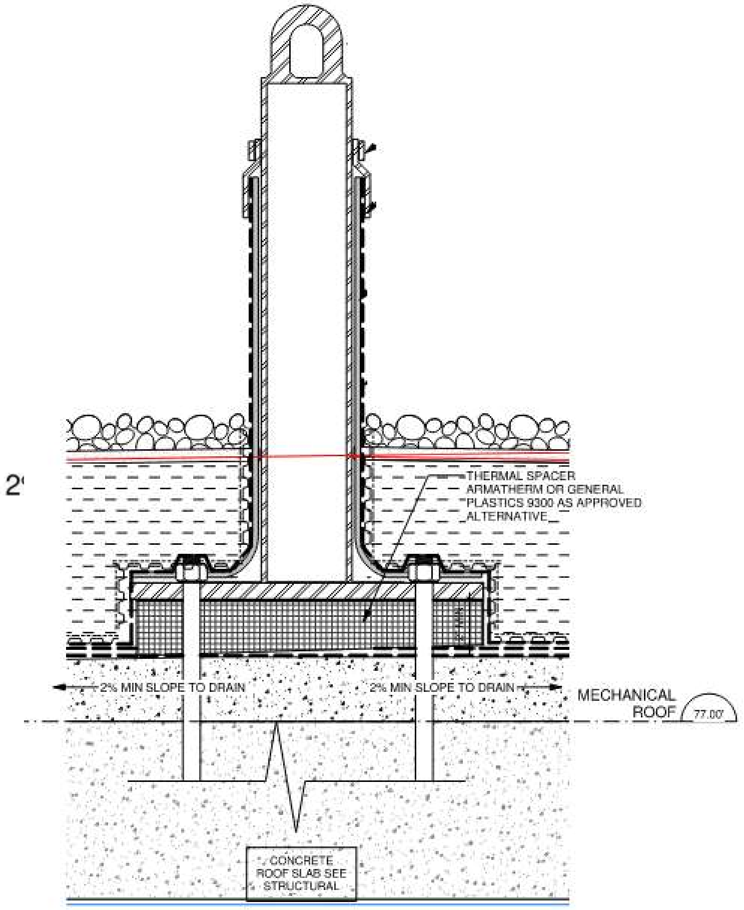
Building Enclosure Approach: Roof

- Roof: U-0.134 (Rsi-7.5 effective)
- 8-inch XPS rigid insulation





ROOFING WP SYSTEM
CONSTRUCTED IN COMPLIANCE TO ANSI/SPRI VF-1
4" GROWING MEDIUM
FILTER FABRIC / DRAINMAT
R40, 8" THICK RIGID INSULATION
DRAINMAT
WATER PROOFING MEMBRANE
CONCRETE STRUCTURAL SLAB, SLOPE TO DRAIN MIN. 2



Schematic Detail for illustrative purposes only

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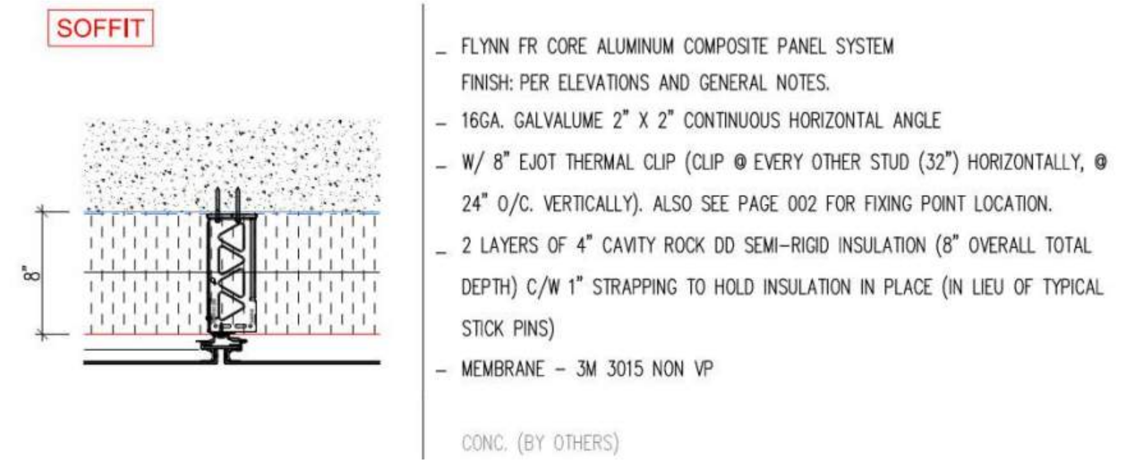
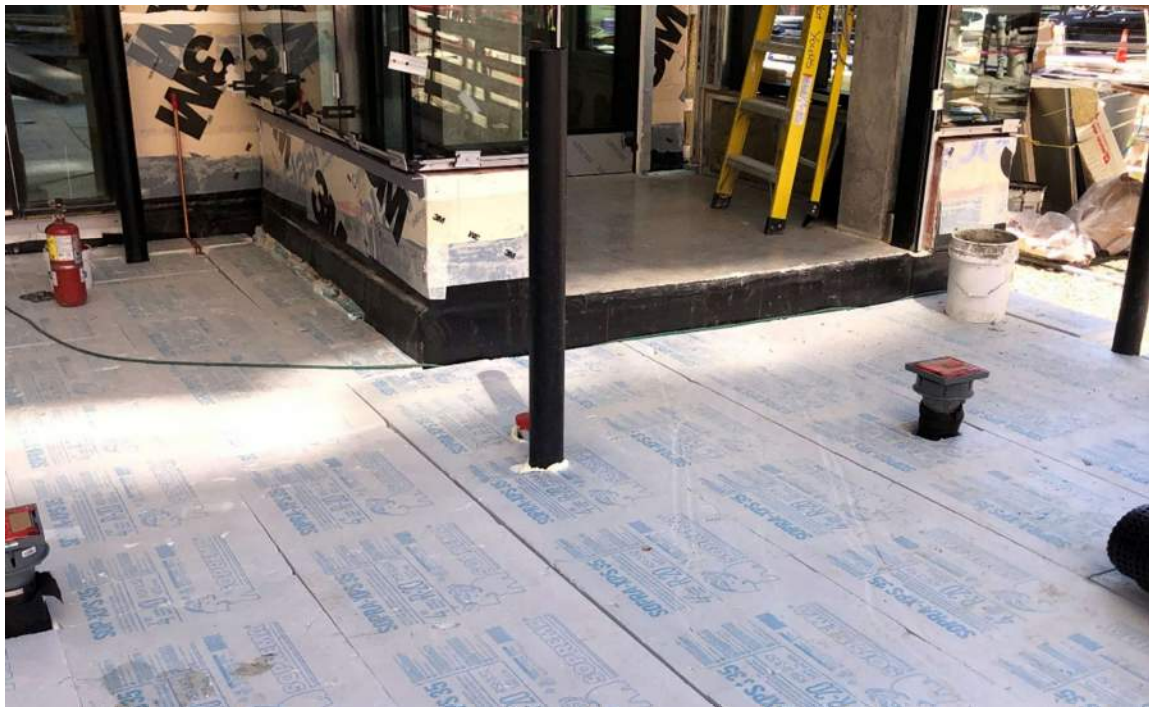
Building Enclosure Approach: Vestibule

- Vestibule is outside the conditioned thermal boundary
- Vestibule curbs and integral interior slab is placed over the 8-inch XPS roof insulation above the heated basement





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Building Enclosure Approach: Airtightness

- Mid-Construction Airtightness (L7): 0.52 ACH @ 50 Pa
- Final Airtightness: 0.19 ACH @ 50 Pa
- Equivalent leakage area @ 50 Pa: 0.054 m² (0.58 ft²)
- Passive House Criterion: ≤ 0.60 ACH @ 50 Pa
- Equivalent leakage area @ 50 Pa: 0.054 m² (0.58 ft²)
- Total building enclosure surface area: 3031.2 m2

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Building Enclosure Approach: Detail Thermal Performance

- Typical Footing
- 2D Thermal Analysis

Table 4.2: Thermal Performance Results for Detail 1: Typical Footing

Detail #	Thermal Bridging Type	Ψ-Value W/m.K (BTU/hr.°F.ft)
Detail 1: Typical Footing	Linear Transmittance	0.139 (0.080)

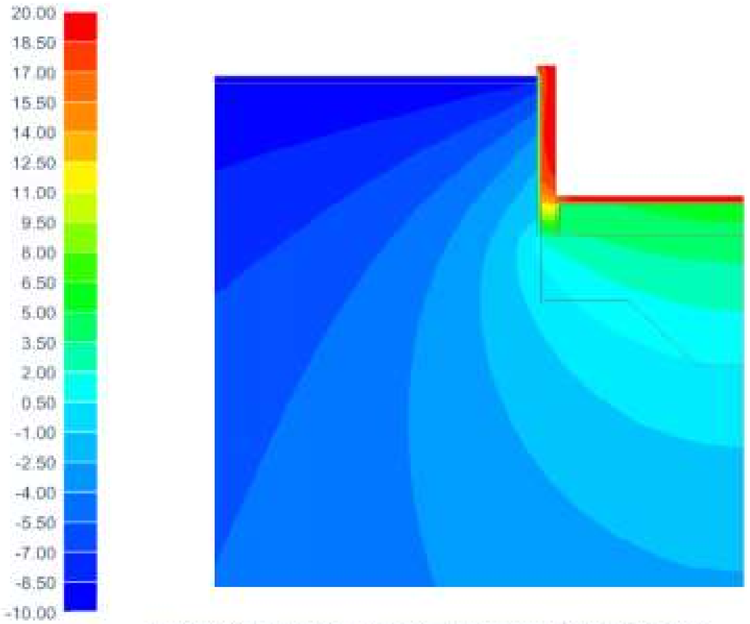
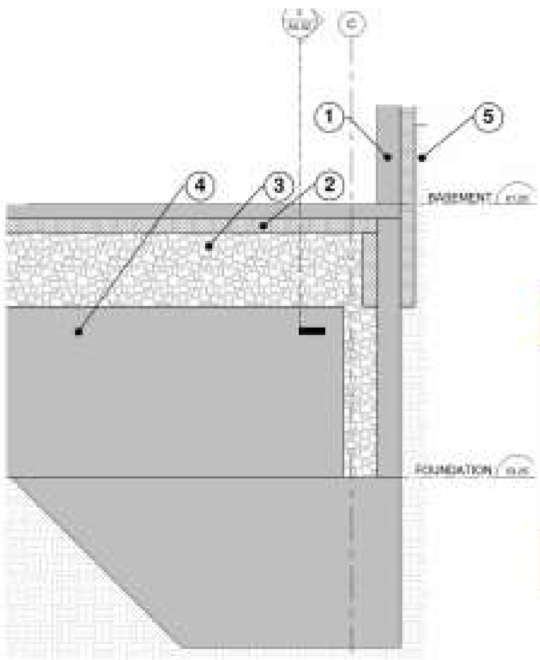
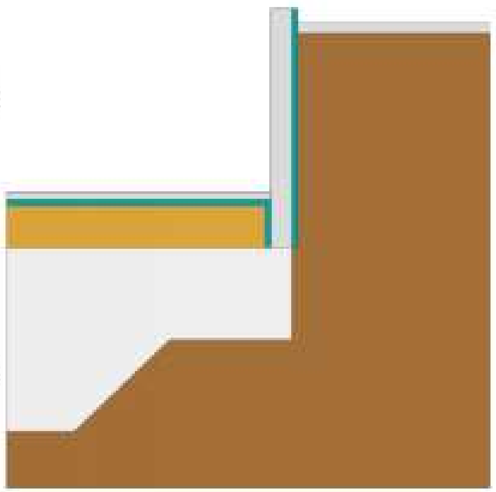


Figure 4.3: Temperature Profile for Detail 1: Typical Footing



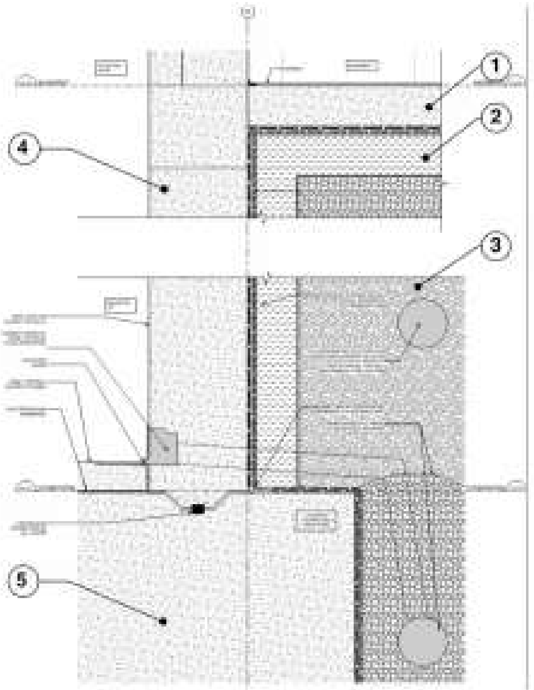


Building Enclosure Approach: Detail Thermal Performance

- Elevator Shaft
- 2D Thermal Analysis

Table 5.2: Thermal Performance Results for Detail 2: Elevator Shaft

Detail #	Thermal Bridging Type	Ψ-Value W/m.K (BTU/hr.°F.ft)
Detail 2: Elevator Shaft	Linear Transmittance	0.462 (0.267)



e 5.1: Reference Detail 2/A7.01 for Detail 2: Elevator Shaft

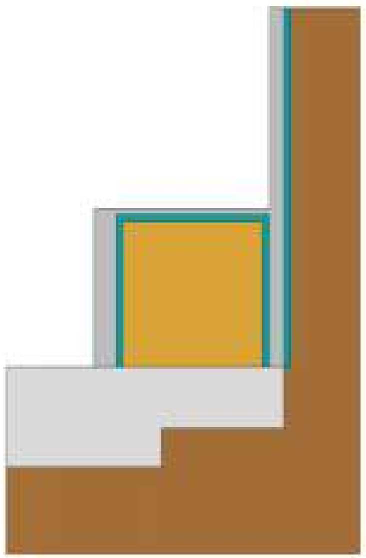


Figure 5.2: Modelled Assembly for Detail 2: Elevator Shaft

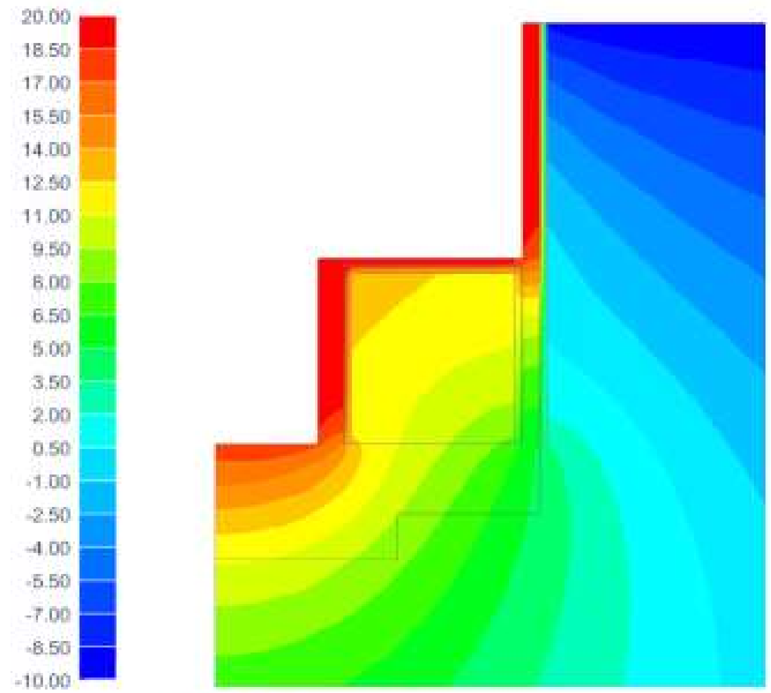


Figure 5.3: Temperature Profile for Detail 2: Elevator Shaft

Building Enclosure Approach: Detail Thermal Performance

- Ground Floor Base of Wall
- 2D Thermal Analysis

Table 6.2: Thermal Performance Results for Detail 3: Ground Floor Base of Wall

Detail #	Thermal Bridging Type	Ψ-Value W/m.K (BTU/hr.°F.ft)
Detail 3: Ground Floor Base of Wall	Linear Transmittance	0.065 (0.037)

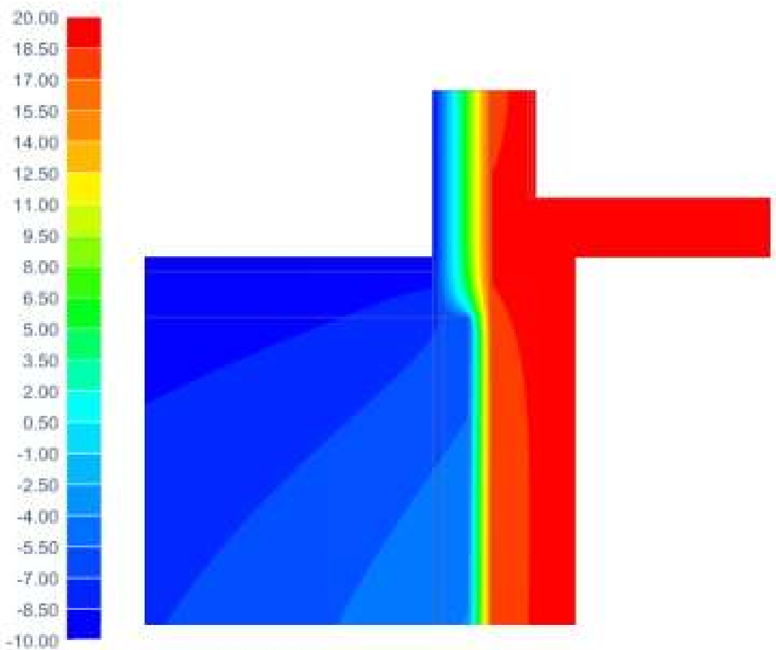


Figure 6.3: Temperature Profile for Detail 3: Ground Floor Base of Wall

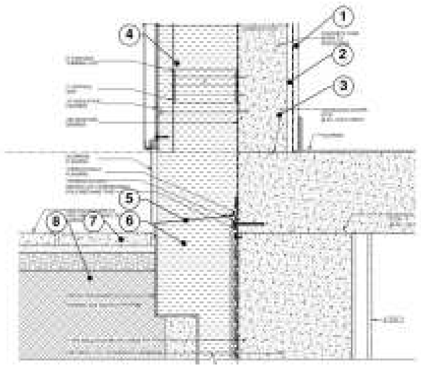


Figure 6.1: Reference Detail 1/A7.01for Detail 3: Ground Floor Base of Wall

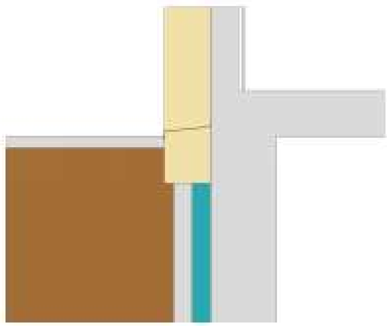


Figure 6.2: Modelled Assembly for Detail 3: Ground Floor Base of Wall

Building Enclosure Approach: Detail Thermal Performance

- Roof Parapet Wall
- 3D Thermal Analysis

Table 7.2: Thermal Performance Results for Detail 4: Parapet

Detail #	Thermal Bridging Type	Ψ-Value W/m.K (BTU/hr.°F.ft)
Detail 4: Parapet	Linear Transmittance	-0.026 (-0.015)

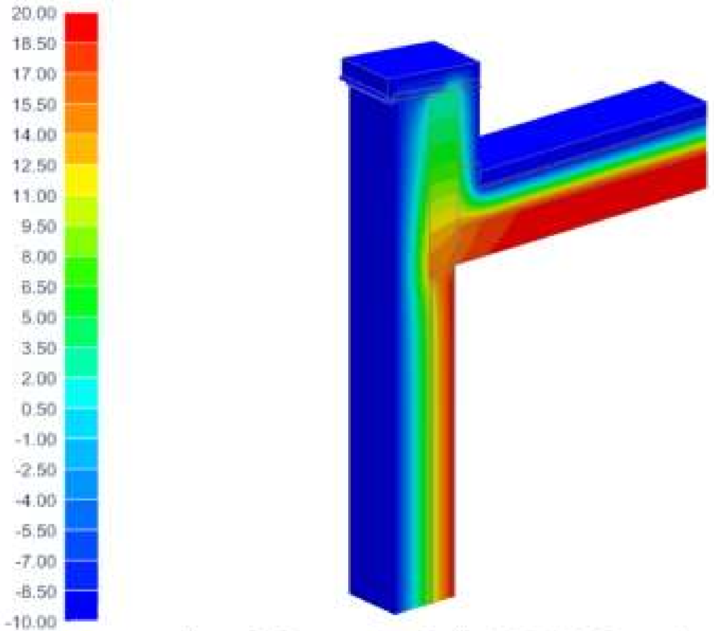


Figure 7.3: Temperature Profile for Detail 4: Parapet

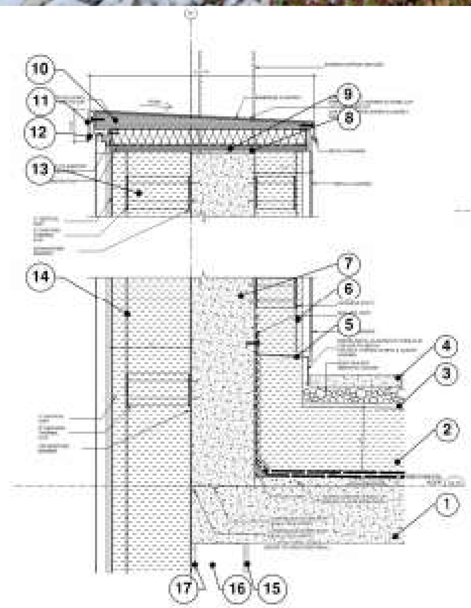


Figure 7.1: Reference Detail 2/A7.04 for Detail 4: Parapet

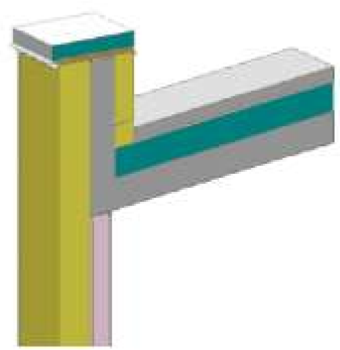


Figure 7.2: Modelled Assembly for Detail 4: Parapet

Passive House Verification: Final Results

- Fulfilled all Passive House Certification Criteria!

GROSVENOR

CITY OF VANCOUVER

What is Thermal Bridging?

Morrison Hershfield

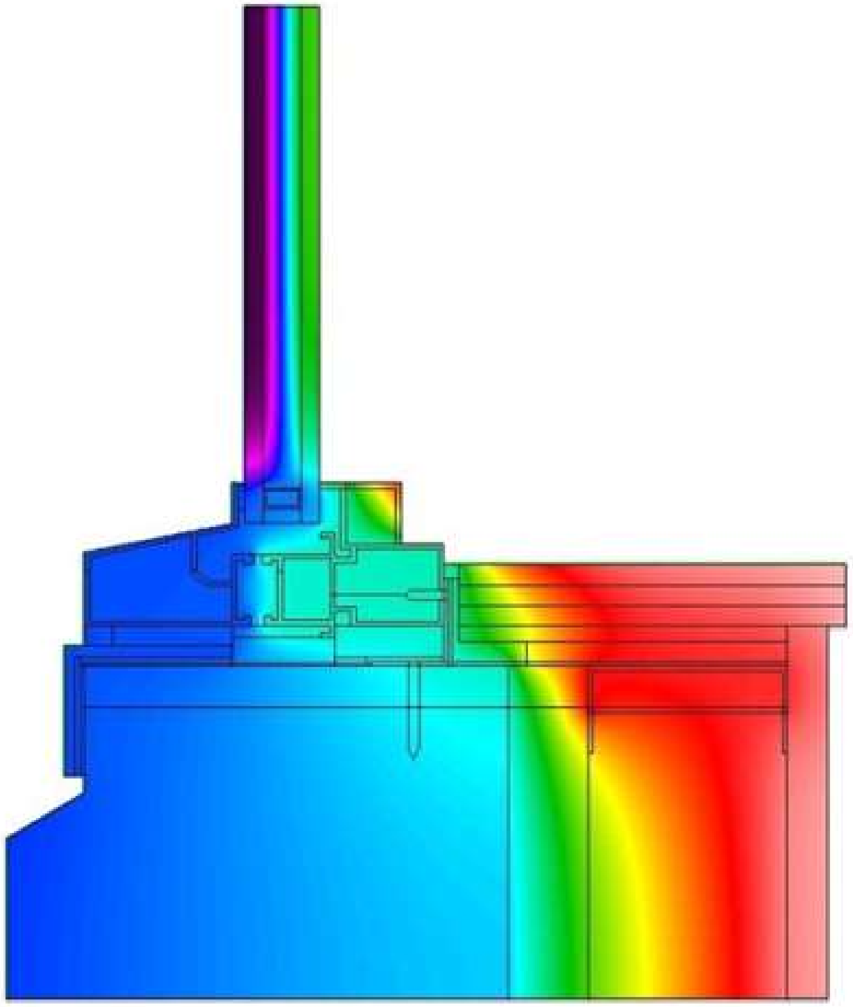
What is a Thermal Bridge?

Short answer:

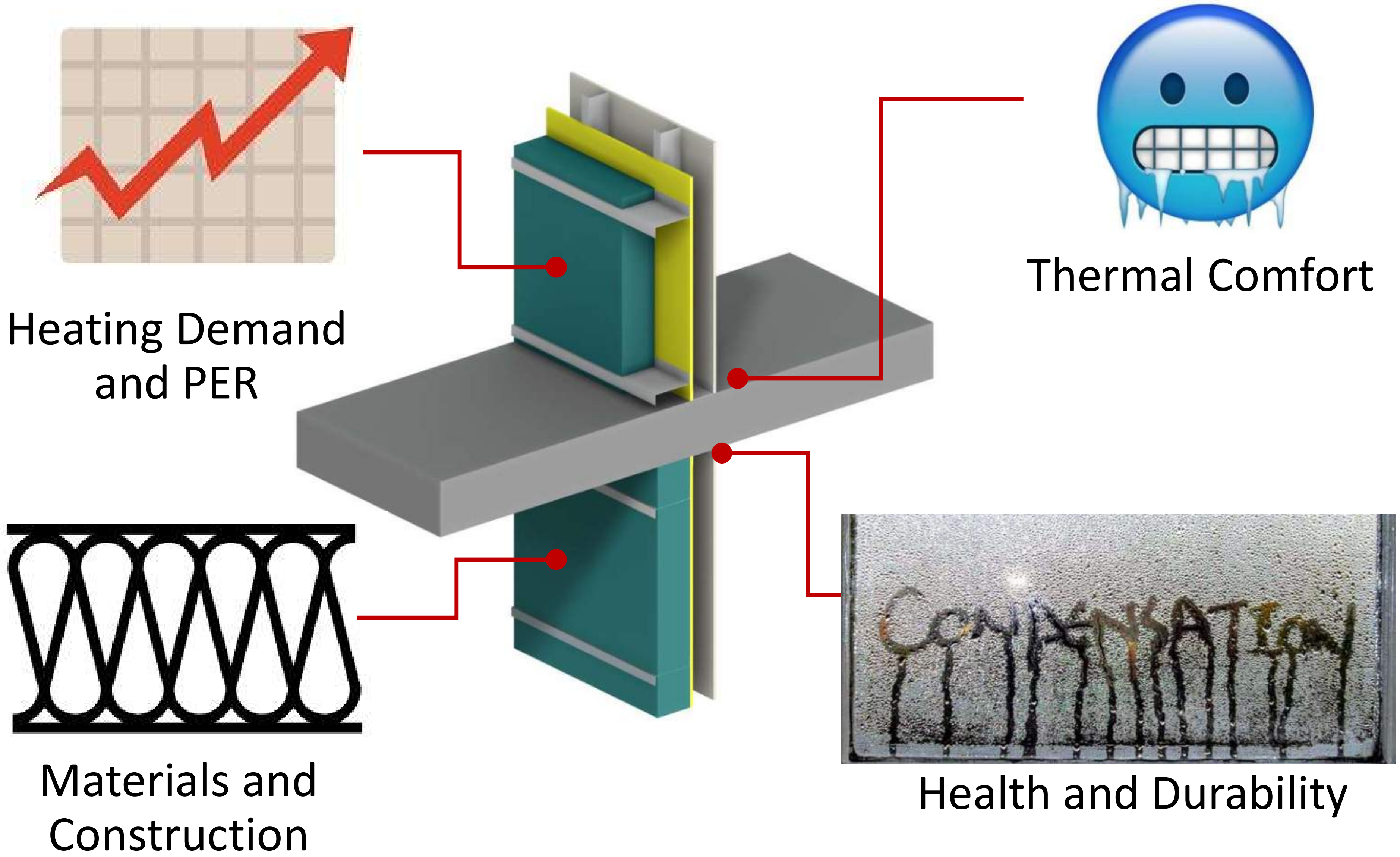
A discontinuity in the thermal envelope

Types of discontinuities include:

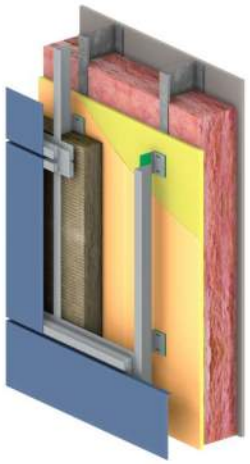
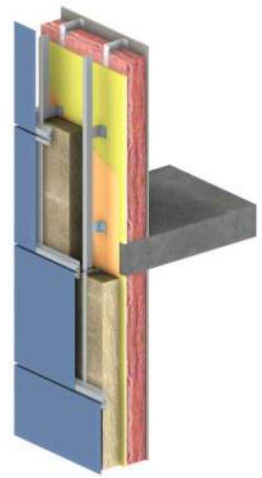
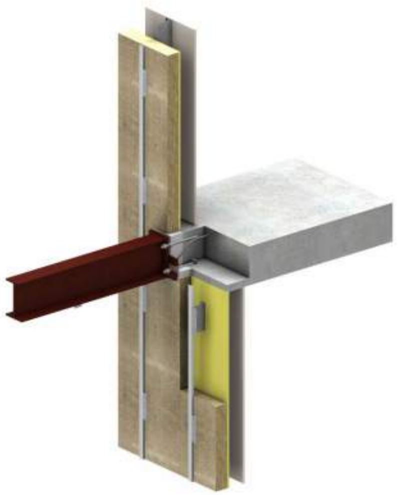
- Repetitive bridges
- Material changes
- Penetrations
- Assembly junctions
- Corners



Impact of Thermal Bridging

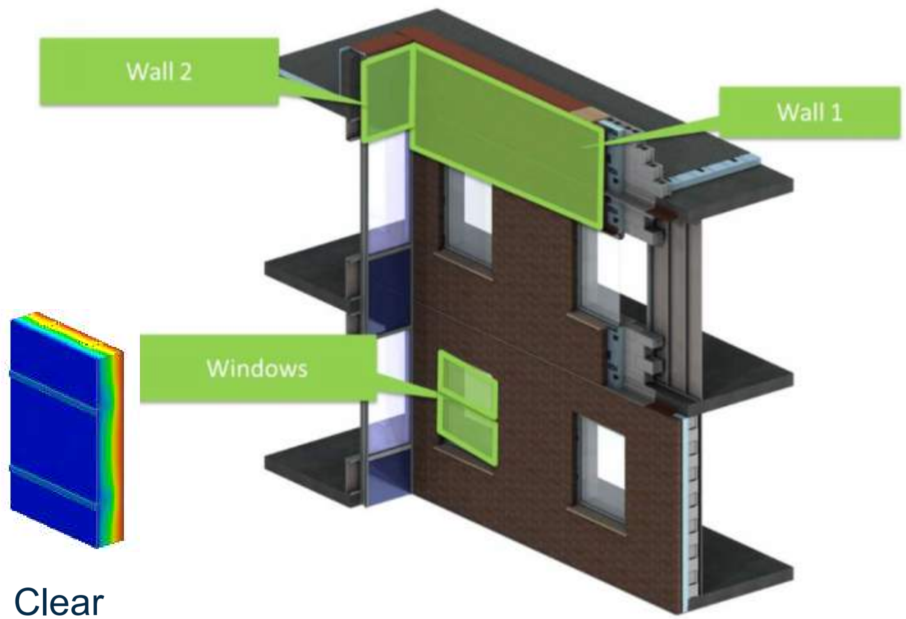


Whole Building Enclosure Approach: Accounting Thermal Bridges

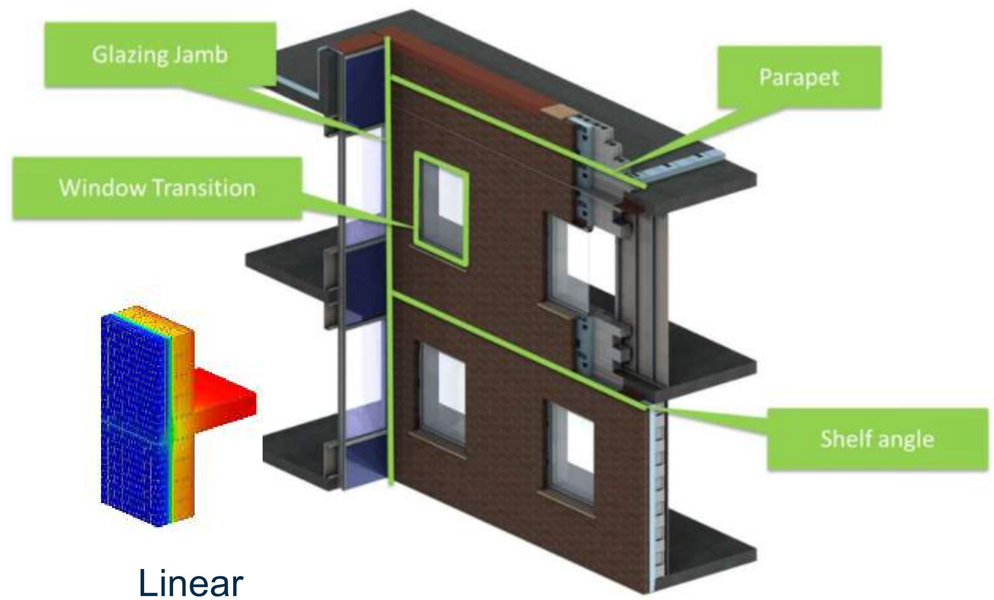
Clear Field	Linear	Point
		
U_o	Ψ	χ
wall, floor, or roof assembly	window to wall, roof to wall, intermediate floor	beam penetration, roof anchor

Overall Building Performance

Whole Building Enclosure Approach: Accounting Thermal Bridges



Clear Field

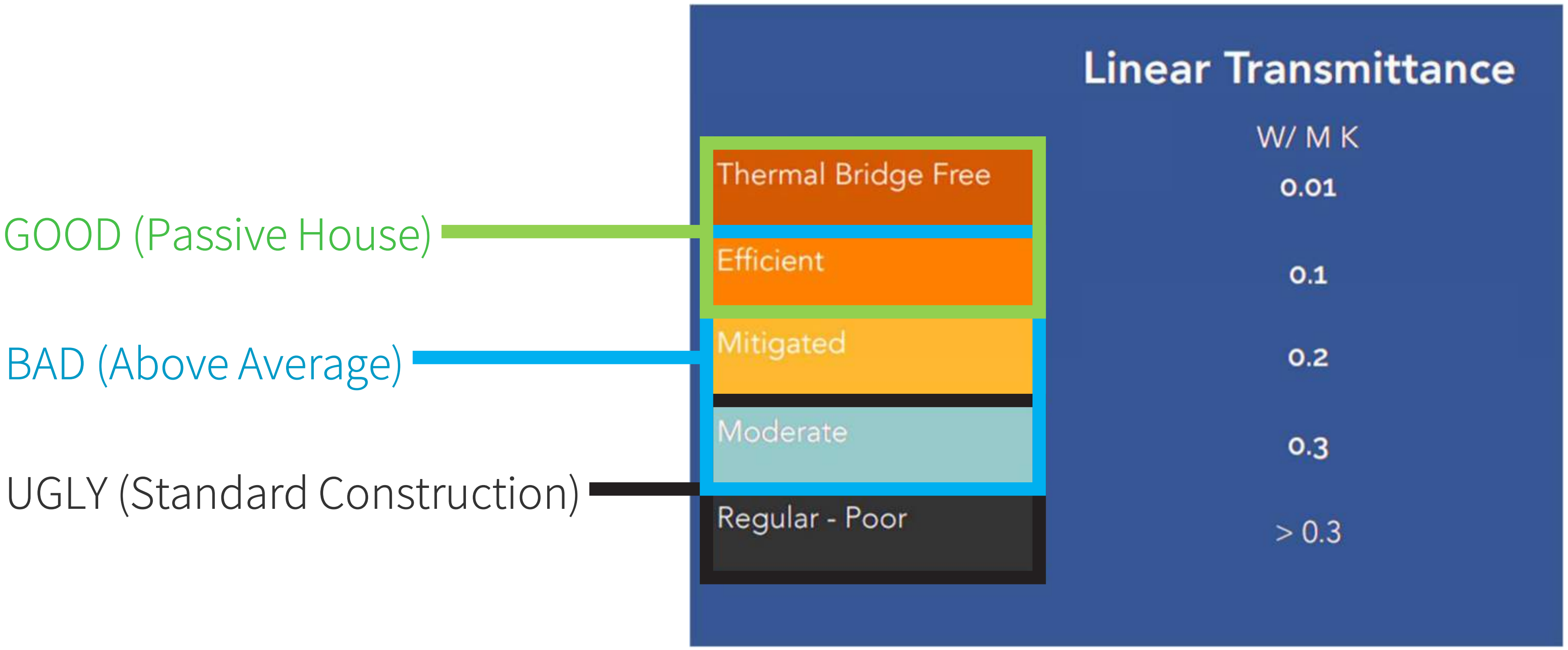


Linear

Total Heat loss = heat loss due to clear field + Heat loss due to interface details

Overall Building Performance

Whole Building Enclosure Approach: Accounting Thermal Bridges



Thermal Bridging at Large Buildings

Morrison Hershfield

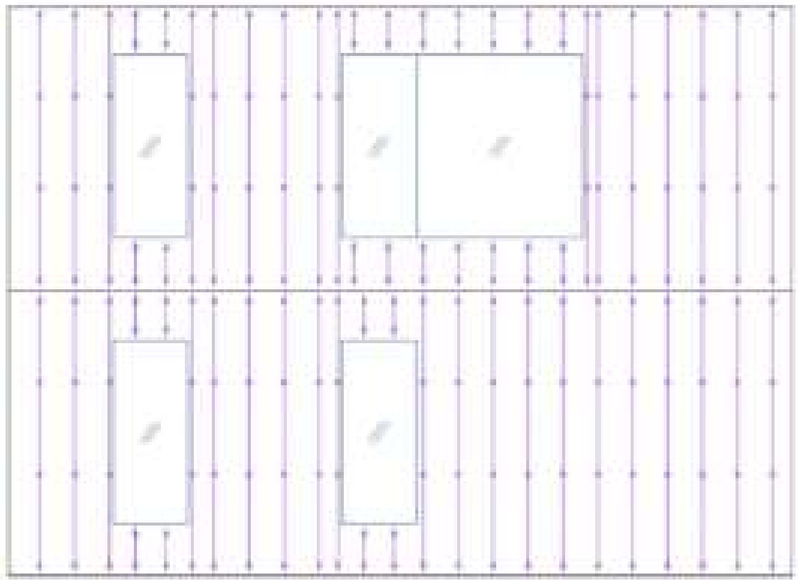
Part 3 Building Construction

- Higher structural loads
- More stringent requirements for code and life safety
- More non-combustible metal components
- Different detailing

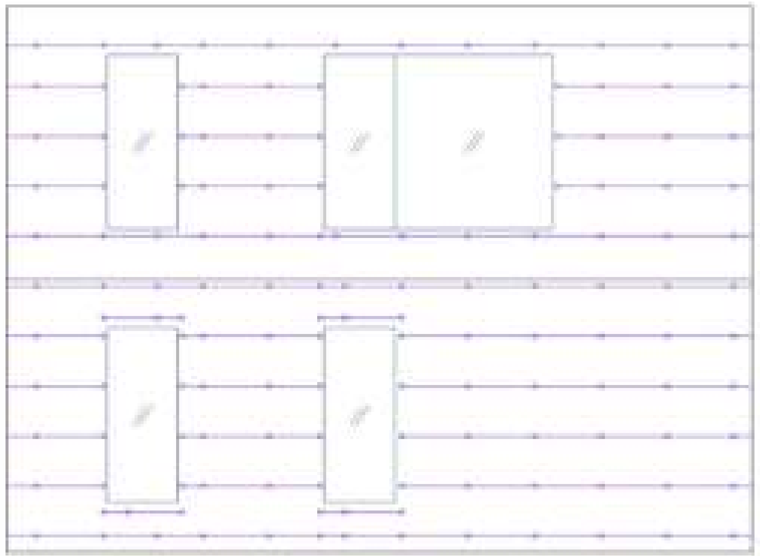
Cladding Attachment Systems

- Reduce thermal bridging
- Support structural loads
  - Cladding dead load
  - Wind load
- Considered as secondary structures with influence on thermal performance
  - Evaluate based on structural and thermal performance

Cladding Attachment Systems



16" x 42" Vertical Layout



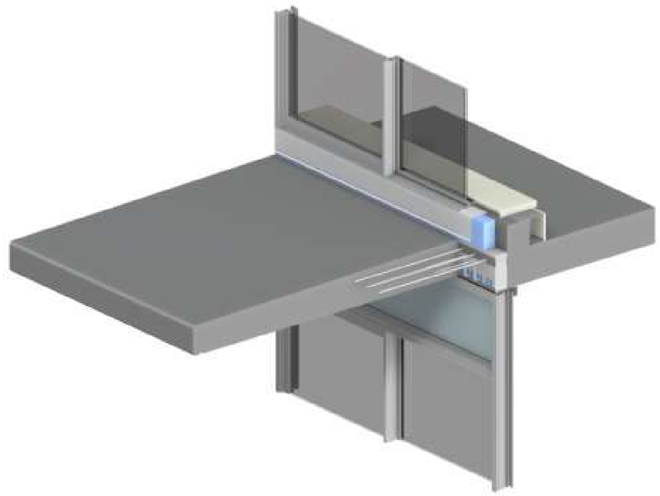
32" x 24" Horizontal Layout

Rail Orientation	Bracket Spacing	Total Rail Length	Number of Brackets	Clear Field Effective R-value	Effective R-value Percent Difference
Vertical	16" x 42"	425 ft (129.5 m)	196	R-24.1 (RSI-4.24)	-
Horizontal	16" x 48"	161 ft (49.1 m)	134	R-25.4 (RSI-4.47)	6%
	32" x 24"	279 ft (85.0 m)	141	R-25.1 (RSI-4.42)	4%

Balconies

Uninsulated

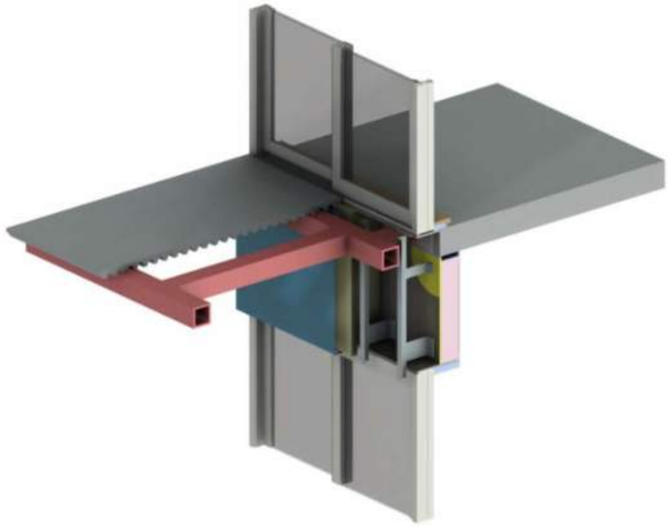
Ψ > 1.0 W/mK



Thermally Broken

Ψ ~ 0.39 – 0.74 W/mK

50% -74% improvement

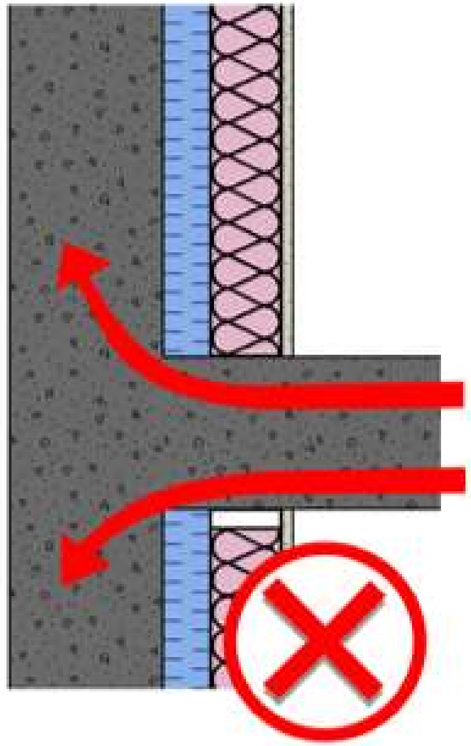


Intermittently Attached

Ψ ~ 0.046 W/mK

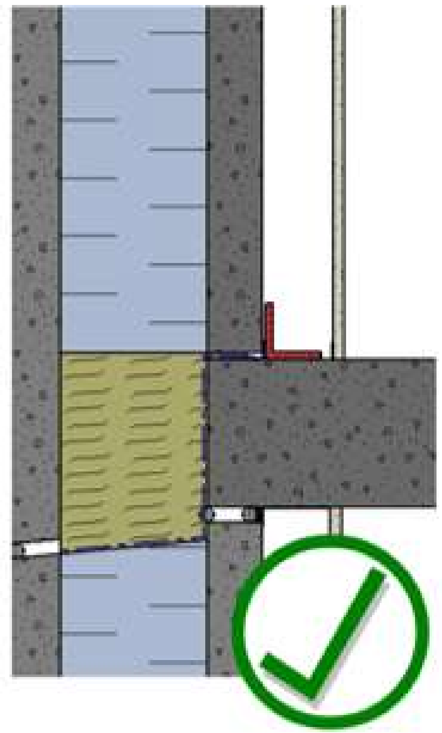
97% improvement

Intermediate Floors



Interior Insulated Concrete

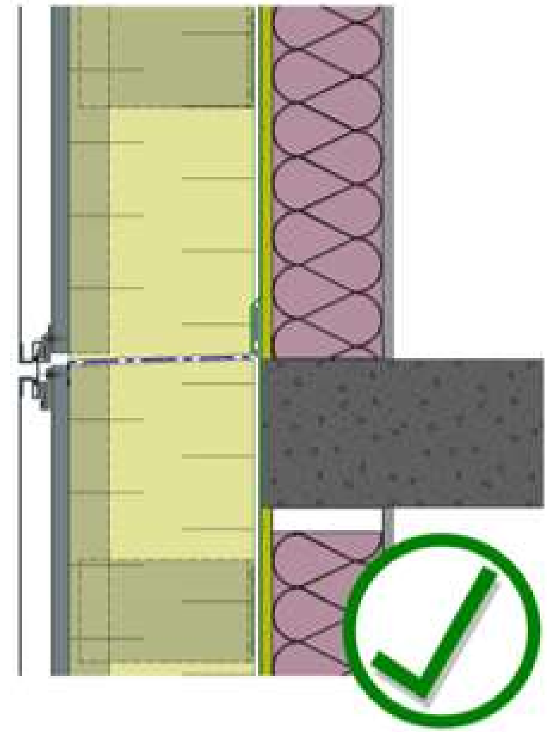
Ψ 0.773 W/mK



Precast Concrete Panels

Ψ 0.022 W/mK

97% improvement

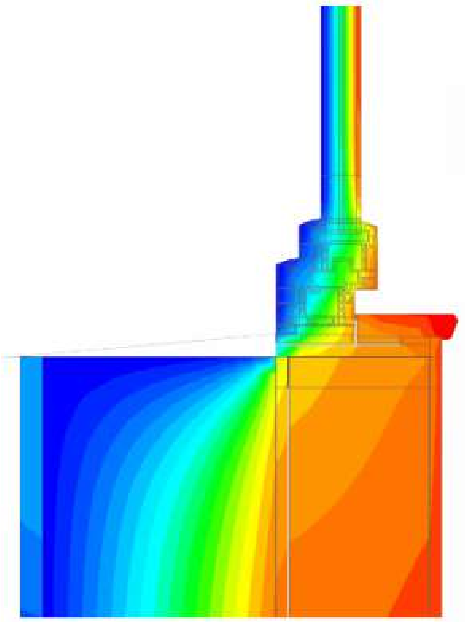


Exterior Insulated Walls

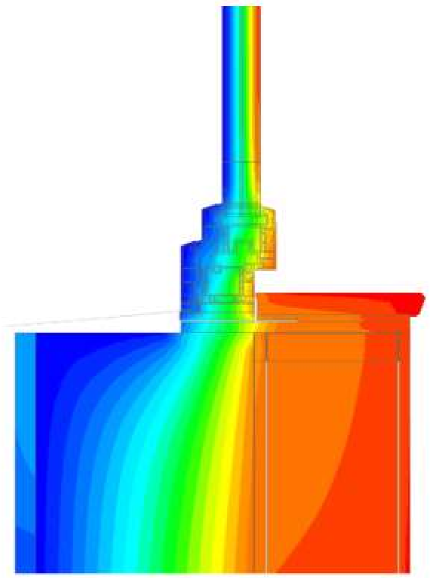
Ψ 0.015 W/mK

98% improvement

Window-to-Wall

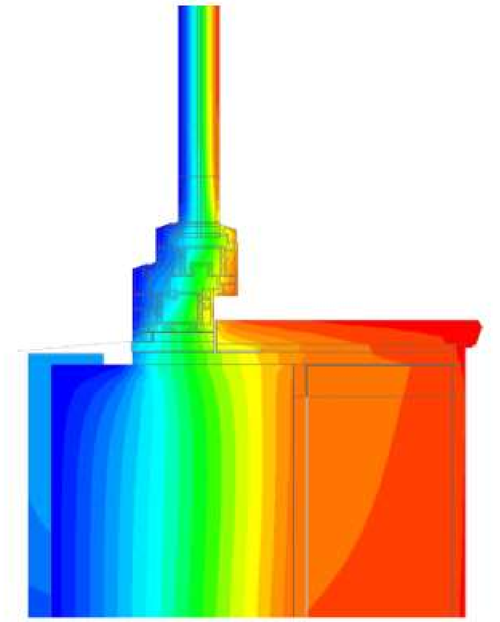


Window aligned with steel framing, air in stud cavity



Window aligned with edge of insulation, without support angle, air in stud cavity

30% improvement



Window aligned with insulation, without support angle, air in stud cavity

62% improvement

Thermal Bridging Analysis

MORRISON HERSHFIELD

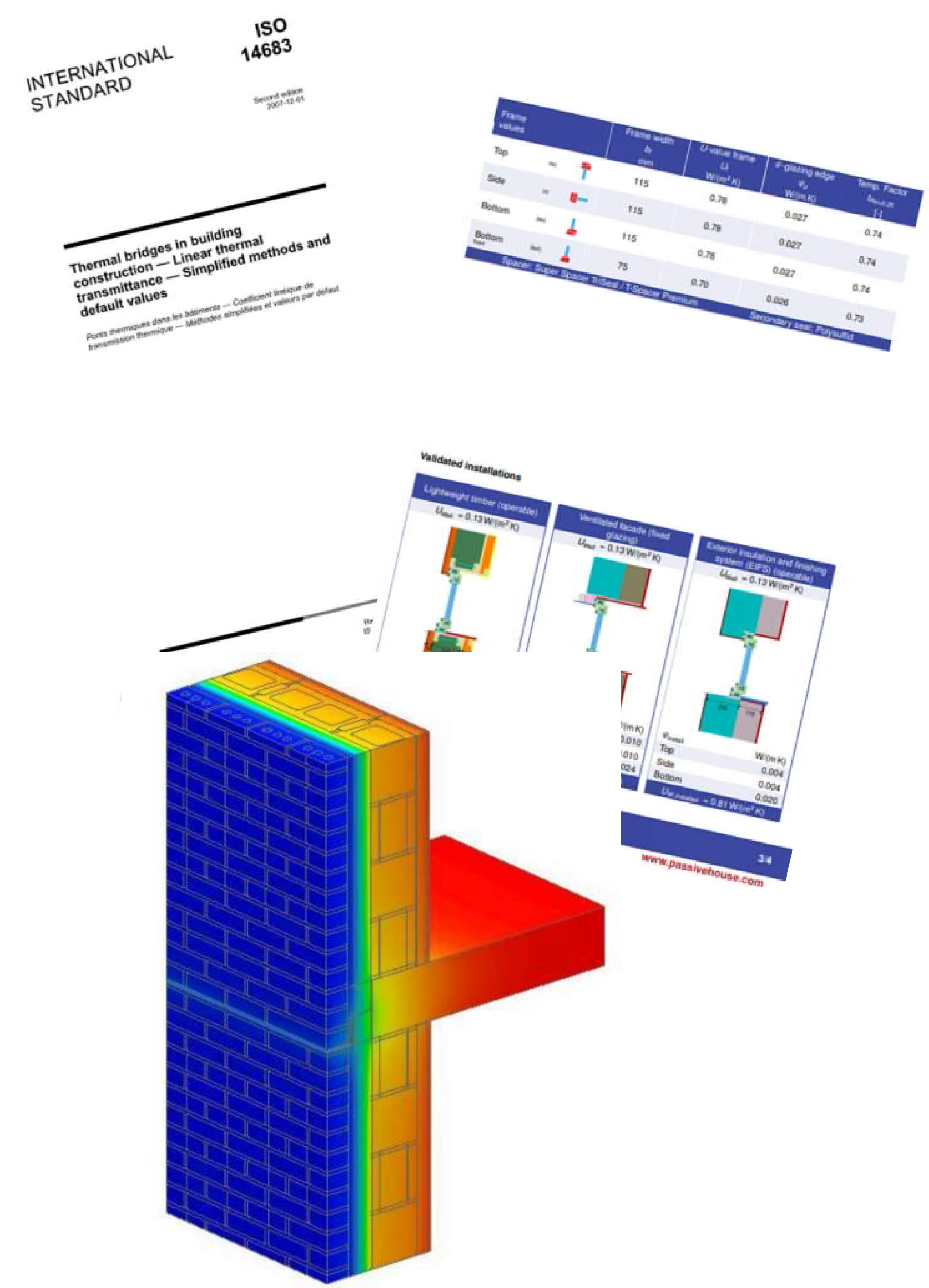
Thermal Simulations

Determination of Thermal Bridge Values

Thermal bridge determination methods are **not** enforced by current building codes in Canada or by Passive House Institute (PHI)

Methods available:

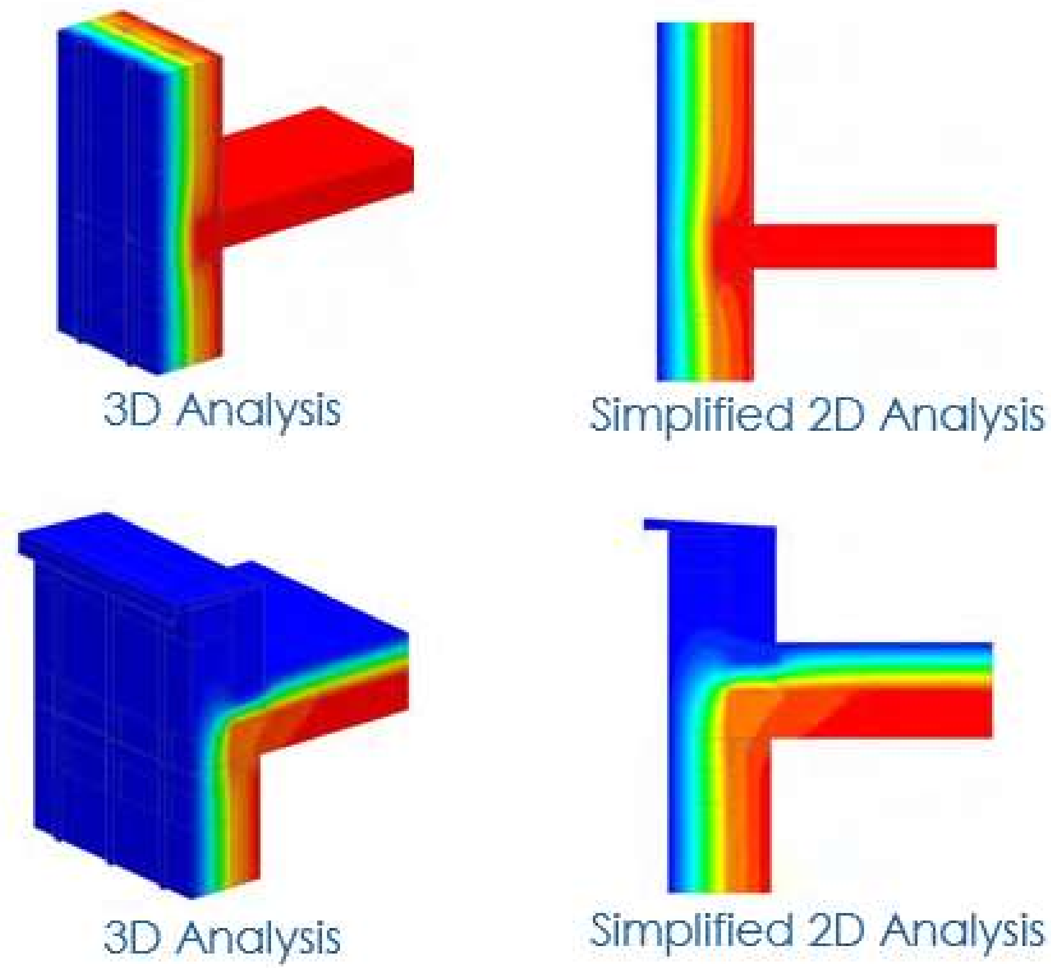
- Conservative assumption (highly variable accuracy)
- Default values in ISO 14683 (typical accuracy 0% to 50%)
- Comparison to generic details from catalogue (typical accuracy ±20%)
- Thermal simulation of specific details (typical accuracy ±5%)



Thermal Simulations

When to model in 3D

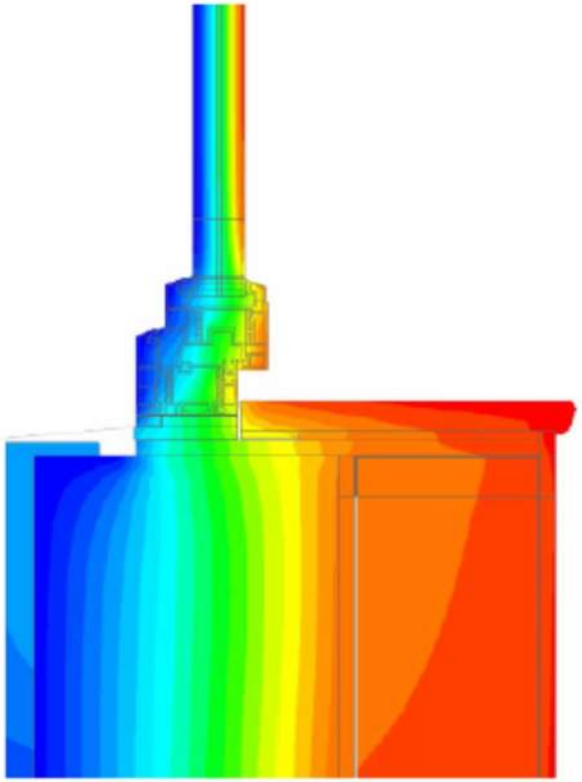
- Difference in between 2D and 3D thermal simulation can be significant to thermal transmittance and surface temperature
- Difference is dependent on how the wall, roof, or floor construction is simplified in a 2D model and if heat flow paths exist in multi-directions
- Multi-directional heat flow paths can result in ±60% difference in thermal transmittance values when comparing 2D and 3D
- Use the right tool for the right job (2D vs. 3D)

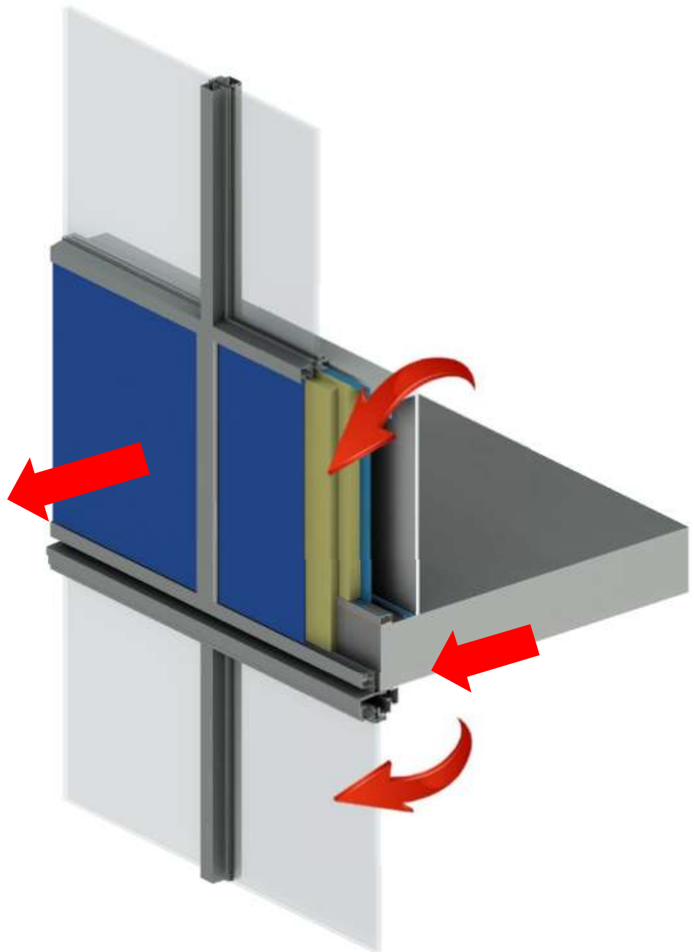


Thermal Simulations

When to model in 3D

- 3D Thermal Simulation
  - Discrete/non-continuous components
  - Complex heat flow paths
- 2D Thermal Simulation
  - Intermediate floors
  - Window transitions
  - Corners
  - Parapets



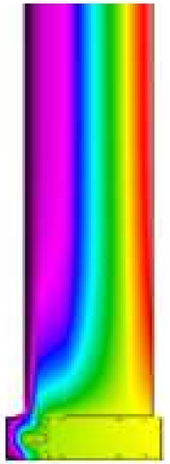


Thermal Simulation

2D vs. 3D Accuracy

Hotbox Lab Measurement

3D Analysis



2D Analysis

Approach	Thermal Transmittance W/m²K (BTU/ft²hr°F)	Effective R-value m²K/W (ft²hr°F/BTU)	Percent Difference Compared to Hotbox Measurement
Hotbox Measurement	**0.87 (0.153)**	**1.2 (6.5)**	**-**
3D Analysis	0.87 (0.153)	1.2 (6.5)	0%
2D NFRC-100	0.63 (0.111)	1.6 (9.0)	32%
2D NFRC Modified	0.68 (0.120)	1.5 (8.3)	24%

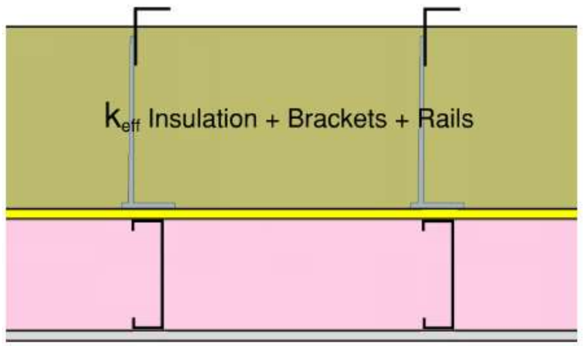
Thermal Simulations

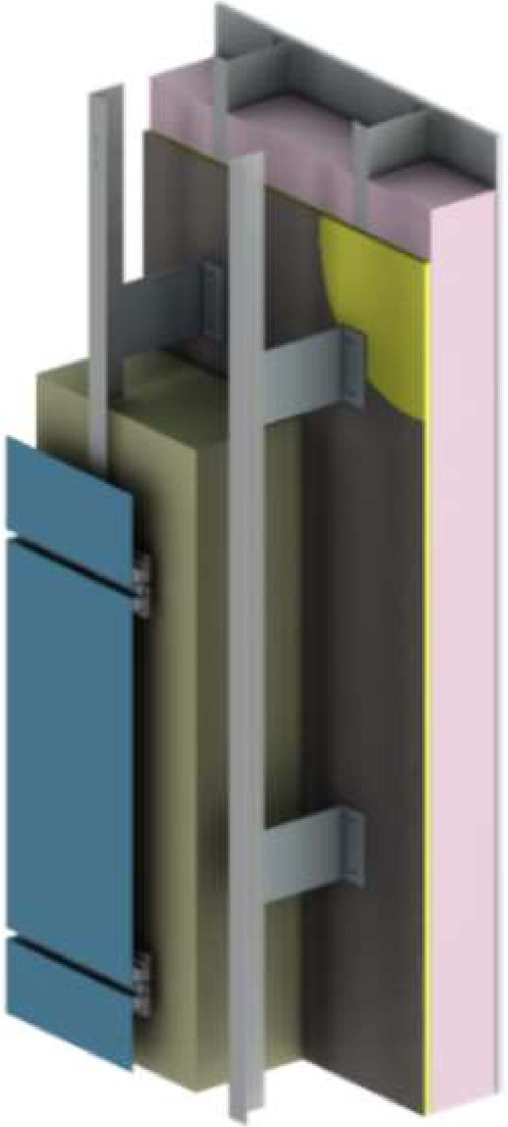
2D vs 3D Accuracy

Example: Bracket and Rail Cladding Attachment System

- Intermittent brackets
- Steel studs
- Two types of thermal bridges in one direction
- Single 2D section cannot fully represent the heat flow through the assembly for the intermittent bracket

How can we calculate the effective clear field R-value of this wall?





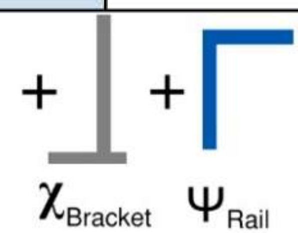
Thermal Simulations

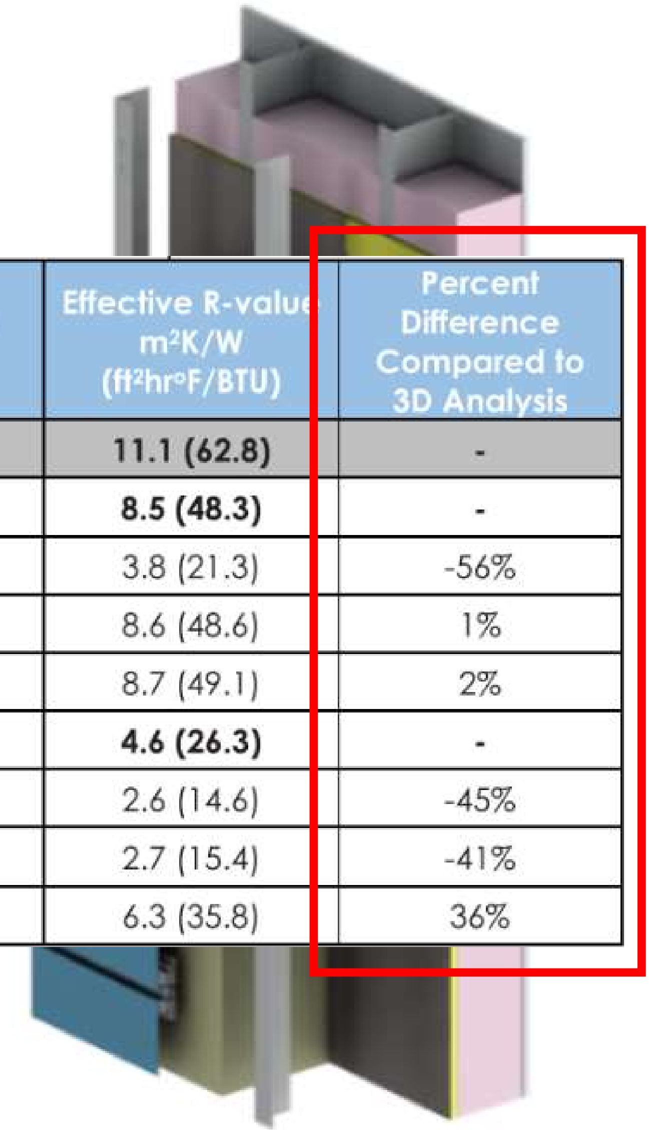
2D vs 3D Accuracy

Determination of effective R-value at clear field using 2D:

1. Average Volume: Exterior assembly conductivity averaged based on volume of components
2. Equivalent Conductivity: Conductivity of bracket based on area weighted average of bracket and insulation
3. Linear and Point Transmittance: Bracket and rail modelled separately as 2D models and combined with 2D clear field assembly

Bracket Material	Approach	Thermal Transmittance W/m²K (BTU/ft²hr°F)	Effective R-value m²K/W (ft²hr°F/BTU)	Percent Difference Compared to 3D Analysis
	1D Nominal	**0.090 (0.016)**	**11.1 (62.8)**	-
FRP	**3D Analysis**	**0.118 (0.021)**	**8.5 (48.3)**	-
	Average Volume	0.267 (0.047)	3.8 (21.3)	-56%
	Equiv Conductivity	0.117 (0.021)	8.6 (48.6)	1%
	Point & Linear	0.116 (0.020)	8.7 (49.1)	2%
Aluminum	**3D Analysis**	**0.216 (0.038)**	**4.6 (26.3)**	-
	Average Volume	0.390 (0.069)	2.6 (14.6)	-45%
	Equiv Conductivity	0.368 (0.065)	2.7 (15.4)	-41%
	Point & Linear	0.159 (0.028)	6.3 (35.8)	36%

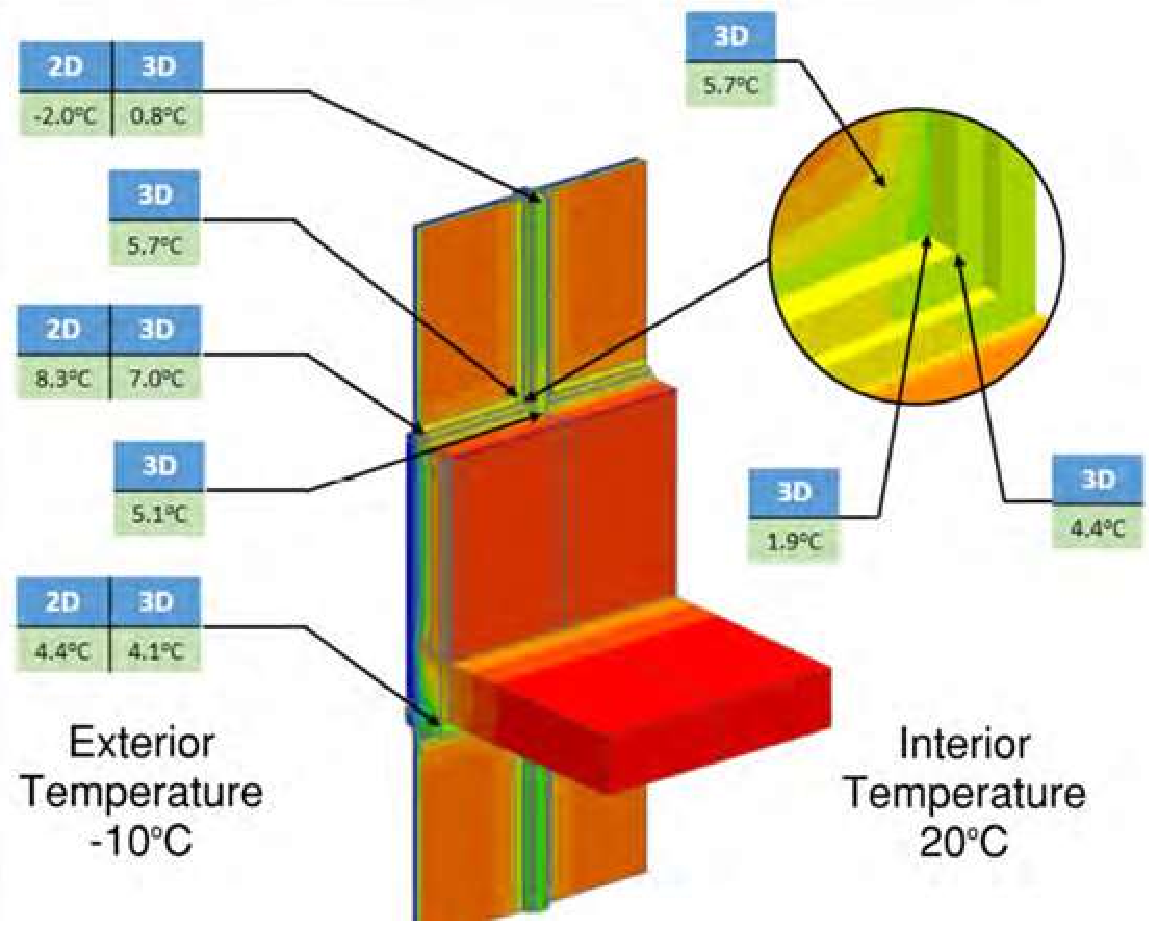




Thermal Simulations

Surface Temperatures and Condensation Risk Assessment

- 3D analysis captures lateral heat flow and will often show different temperatures compared to 2D analysis
- 2D analysis calculates average temperatures at best, but the coldest temperature is what counts for evaluating the risk of condensation
- 3D analysis better reflects reality



Thermal Simulations

Thermal Simulation Standards

- Outlines requirements for thermal simulation

- ISO 10211 (referenced by PHI)
  - Modelling procedures
  - Specifies how to calculate Ψ,χ
  - No guidance when to use 2D vs. 3D

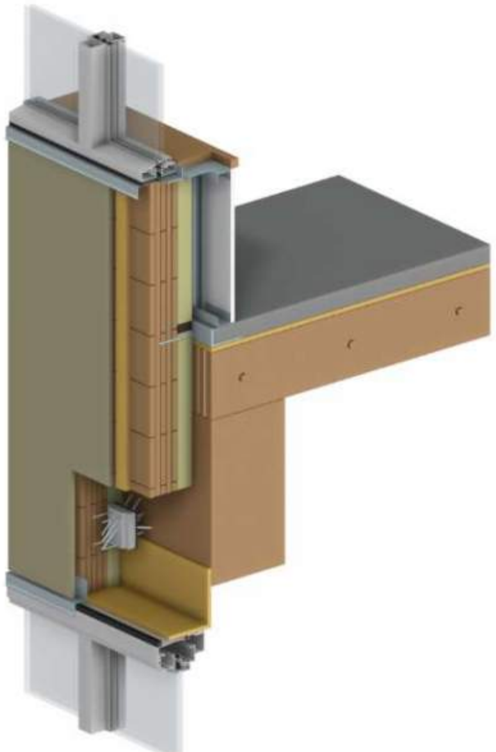
- CSA Z5010
  - Modelling procedures
  - Specifies how to calculate Ψ,χ
  - Specifies general guidance when to use 2D vs. 3D

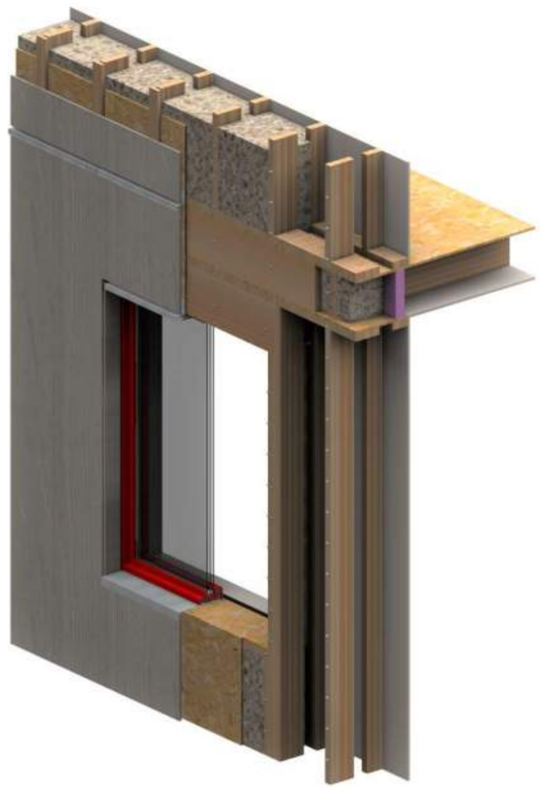
Thermal Bridging Resources

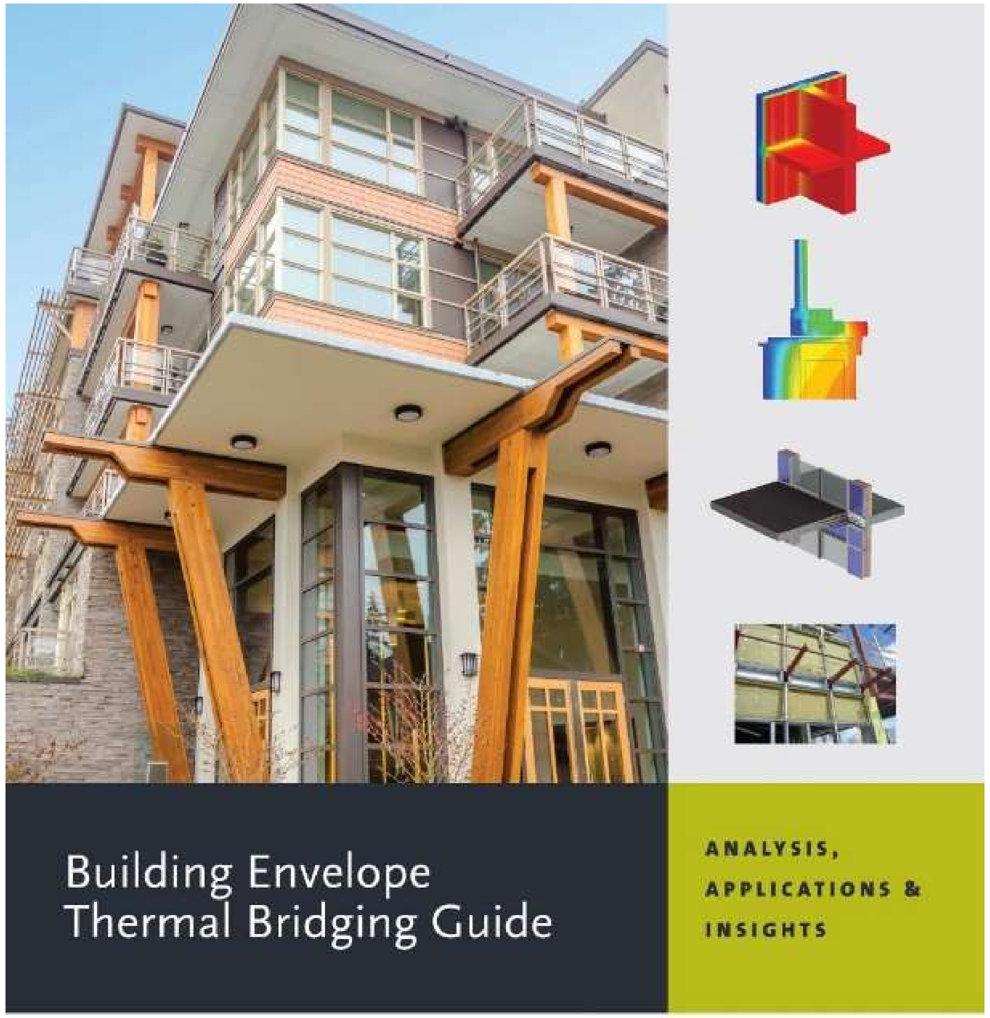
Morrison Hershfield

Thermal Bridging Resources

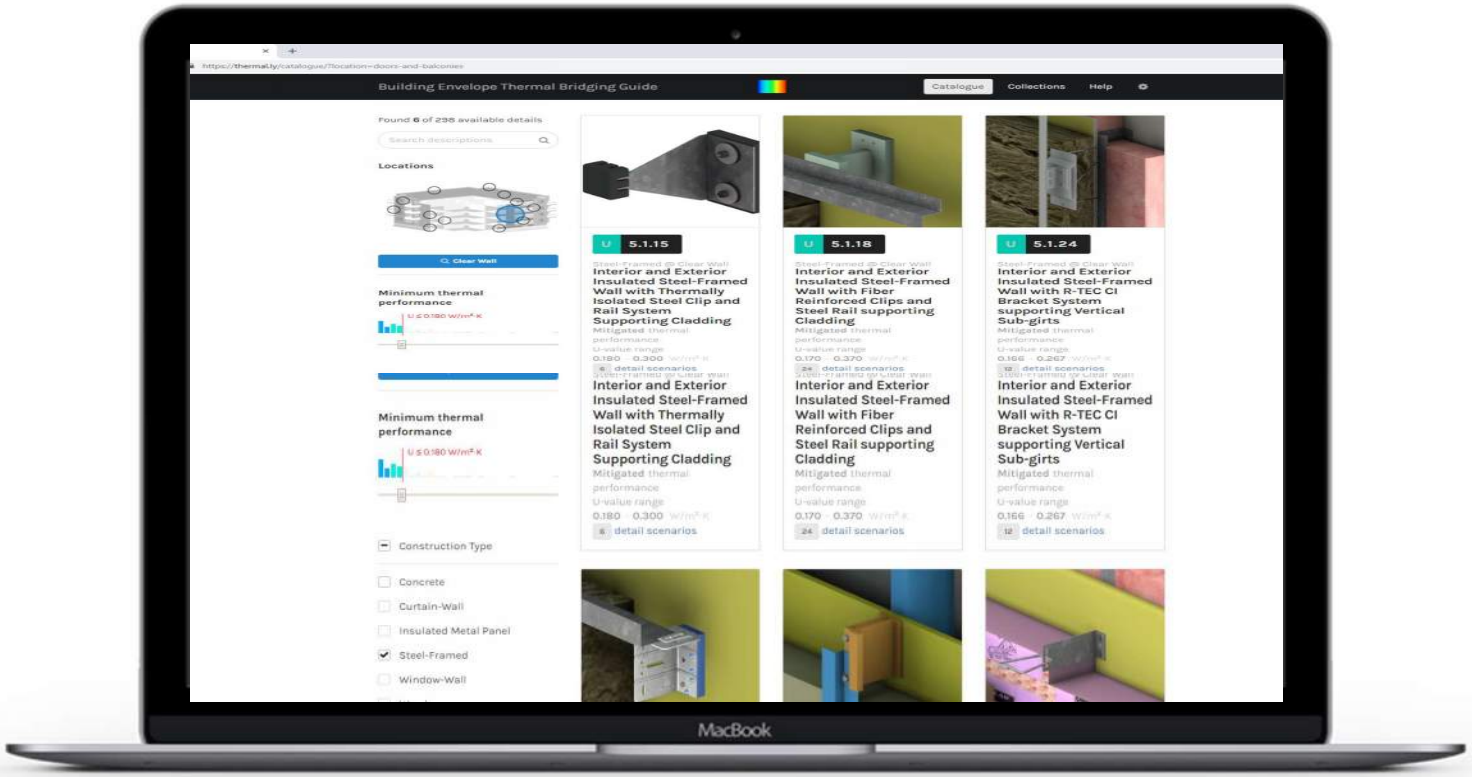
Over 600 building details with thermal performance information and detailing approaches







Thermal Bridging Resources



Thermalenvelope.ca

- Search and compare details
- Integrated calculator
- Education resources
- Passive House library
- Clear wall estimator

Thermal Bridging Resources

CERTIFICATE

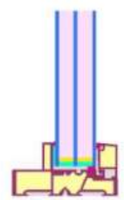
Certified Passive House Component

Component-ID 1256fx03 valid until 31st December 2023

Passive House Institute
Dr. Wolfgang Feist
64283 Darmstadt
Germany

Category: **Fixed window**
Manufacturer: **Cascadia Windows & Doors, Langley, BC, Canada**
Product name: **Cascadia Fixed Window PH**

This certificate was awarded based on the following criteria for the cool, temperate climate zone



Comfort $U_W = 0.77 \leq 0.80\ W/(m^2 \cdot K)$
$U_{W,installed} \leq 0.85\ W/(m^2 \cdot K)$
with $U_g = 0.70\ W/(m^2 \cdot K)$

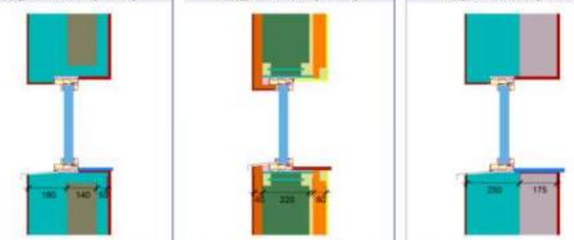
Hygiene $f_{Rsi=0.25} \geq 0.70$

cool, temperate climate
phA
CERTIFIED COMPONENT
Passive House Institute

Passive House efficiency class: phE phD phC phB phA

www.passivehouse.com

Validated installations



$\Psi_{install}$ W/(m · K)	Formwork blocks (fixed) $U_{Wall} = 0.15\ W/(m^2 \cdot K)$	Lightweight timber (fixed glazed) $U_{Wall} = 0.13\ W/(m^2 \cdot K)$	Exterior insulation and finishing system (EIFS) (fixed glazed) $U_{Wall} = 0.13\ W/(m^2 \cdot K)$
Top	0.012	0.018	0.008
Side	0.012	0.018	0.008
Bottom	0.019	0.020	0.016
$U_{W,installed}$	$= 0.81\ W/(m^2 \cdot K)$	$= 0.83\ W/(m^2 \cdot K)$	$= 0.80\ W/(m^2 \cdot K)$

Frame values		Frame width b_f mm	U-value frame U_f $W/(m^2 \cdot K)$	Ψ-glazing edge Ψ_g W/(m · K)	Temp. Factor $f_{Rsi=0.25}$ [-]
Mullion Fixed	(8M1)	99	0.81	0.021	0.75
Bottom Fixed	(FB1)	58	0.81	0.020	0.75
Top Fixed	(FH1)	58	0.81	0.020	0.75
Lateral Fixed	(FJ1)	58	0.81	0.020	0.75

Spacer: Super Spacer Premium   Secondary seal: Butyl

Component-ID: 1256fx03   3/4

www.passivehouse.com

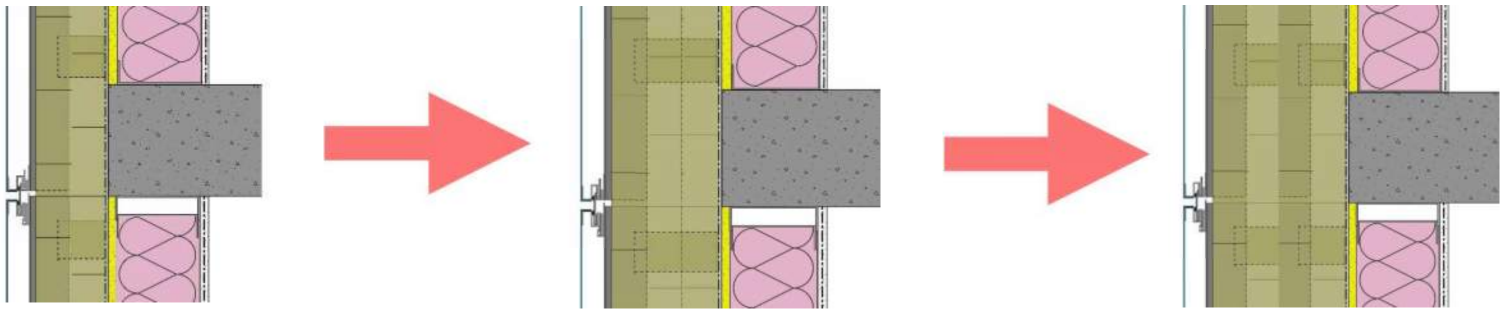
Post Construction Research Study:

Optimized High Impact Thermal Bridges
at 825 Pacific Artist Hub

The Problem: Common Energy Conservation Measure (ECM)

Adding excessive insulation to external walls to compensate for heat loss borne from high impact thermal bridges – is this the best ECM approach?

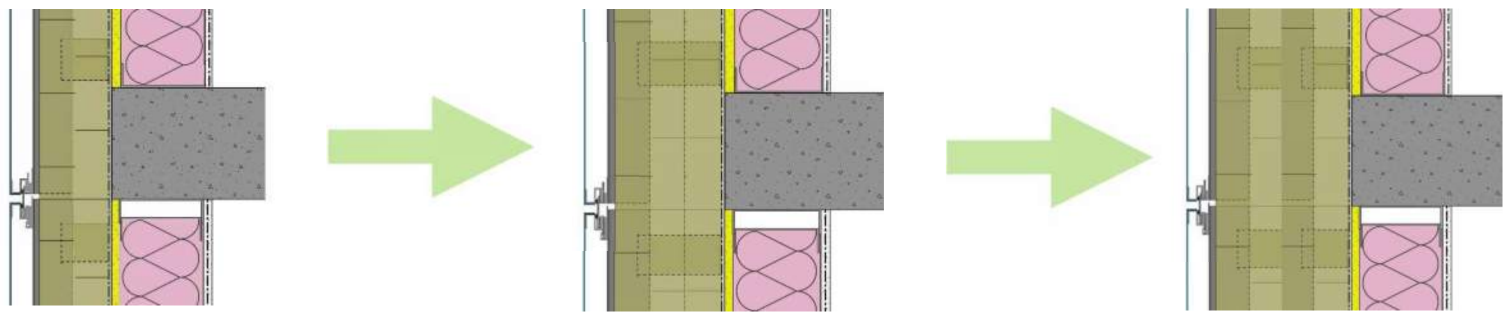
- Lowering operational carbon, while increasing embodied carbon
- Diminishing marketable floor area due to thicker walls



The Solution: Effective Energy Conservation Measure (ECM)

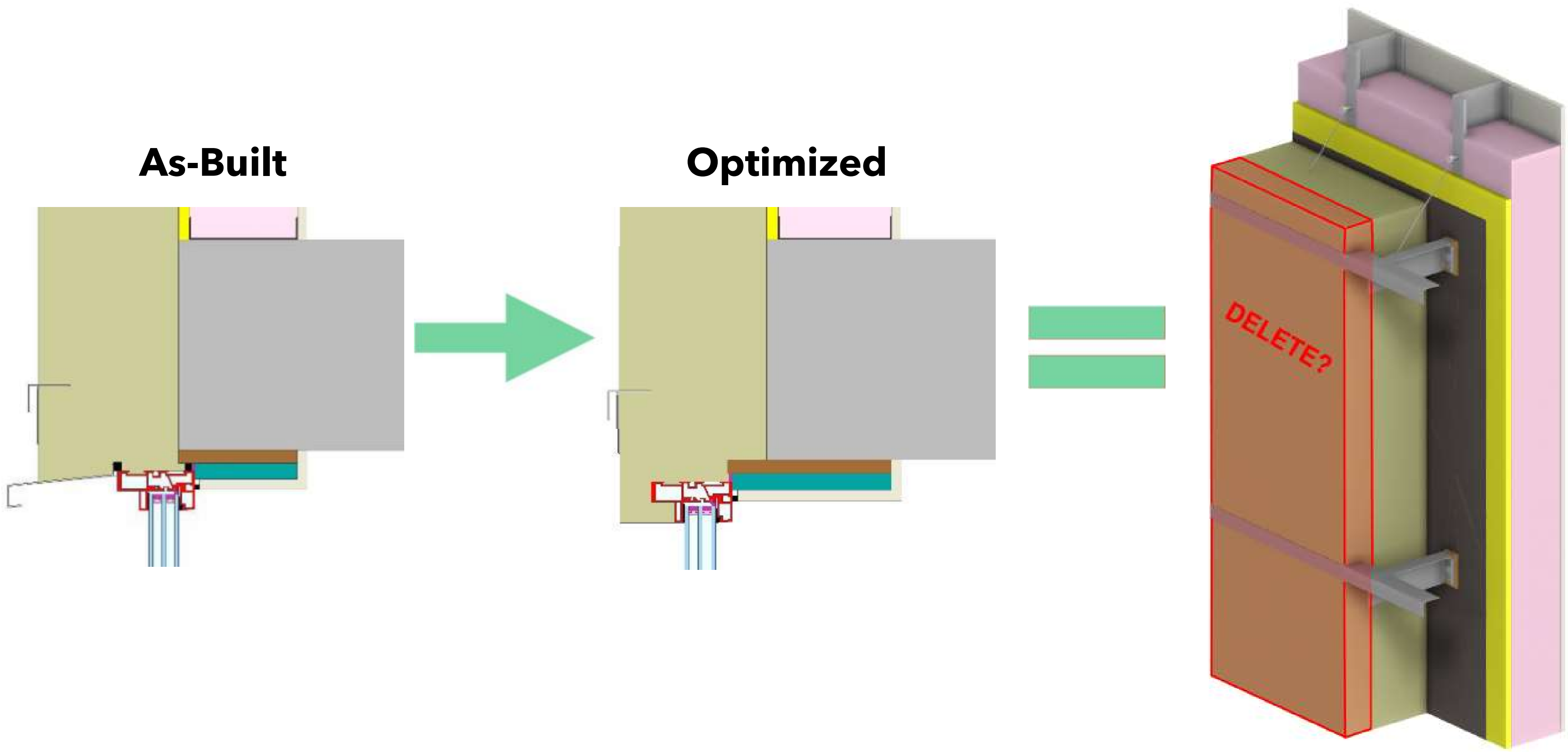
How to make high-rise Passive House walls thinner:

- Eliminate conservative assumptions at high impact thermal bridges
- Allocate resources to optimize high impact thermal bridges



Objective

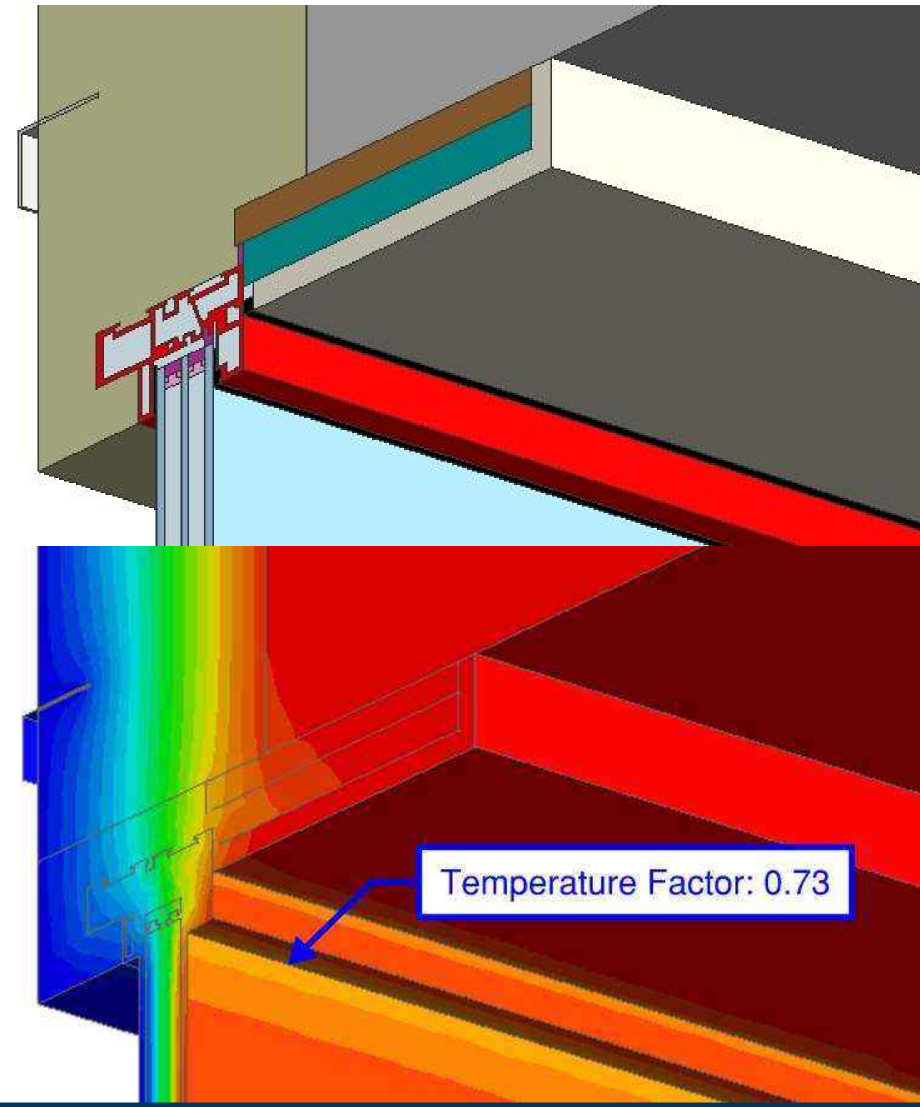
Determine if the high impact thermal bridges at window-to-wall transitions can be optimized to provide a trade-off opportunity with the external walls to reduce its 17-inch thickness



Optimized Window Install

Recommended procedure for window install design:

1. Do all install options fulfill PHI requirements?
   - Hygiene Criterion
   - Thermal Comfort Criterion
2. How much does the install option impact the energy performance?
3. Can optimized install provide more design flexibility?



Optimized Window Install

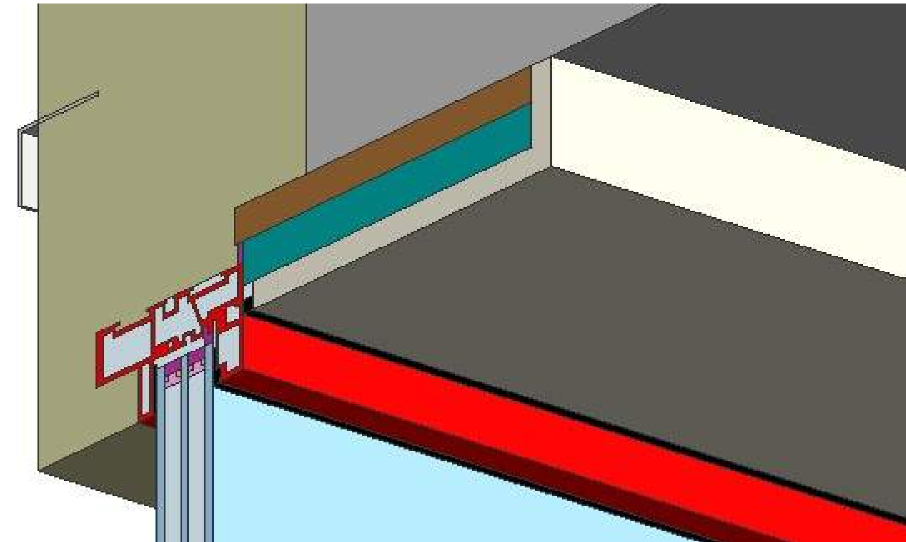
Recommended procedure for window install design:

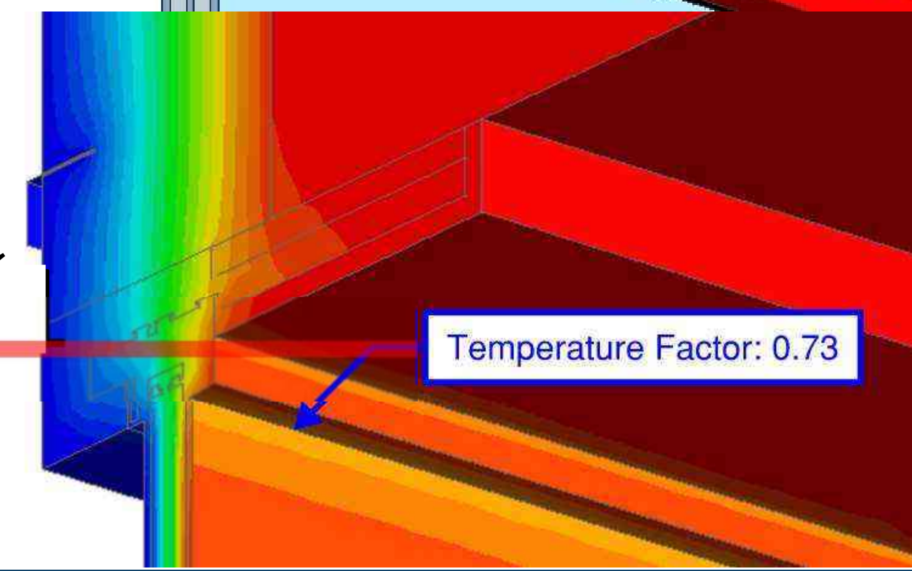
1. Do all install options fulfill PHI requirements?
   - Hygiene Criterion

$$F_{RSI} = \frac{(inside\ surface\ temp - outside\ surfa}{inside\ temp - outside\ temp}$$

Table 6 Criteria for moisture protection

Climate zone	Min. temperature factor $f_{Rsi=0.25\ m^2K/W}$ []
Arctic	0.80
Cold	0.75
Cool-temperate	0.70
Warm-temperate	0,65
Warm	0.55
Hot	-
Very hot	-



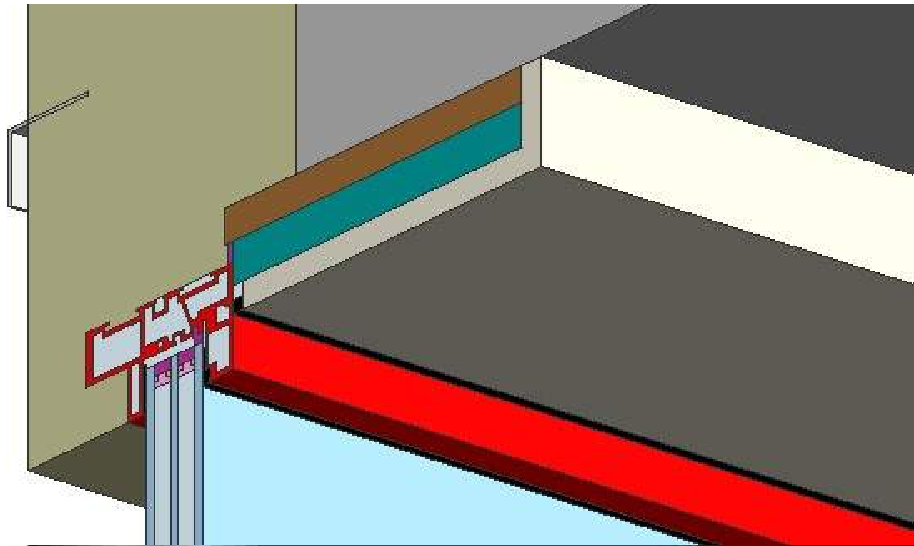


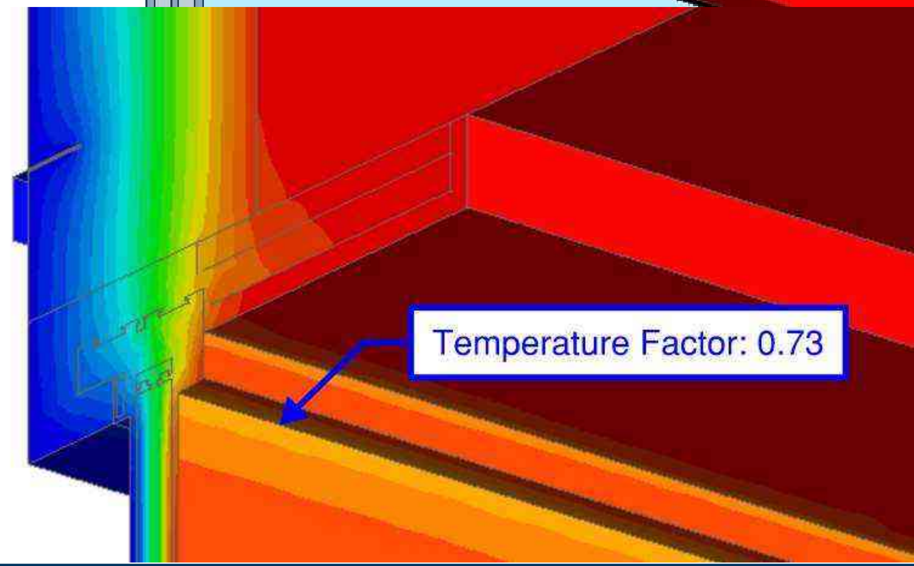
Optimized Window Install

Recommended procedure for window install design:

2. How much does the install option impact the energy performance?
3. Can optimized install provide more design flexibility?

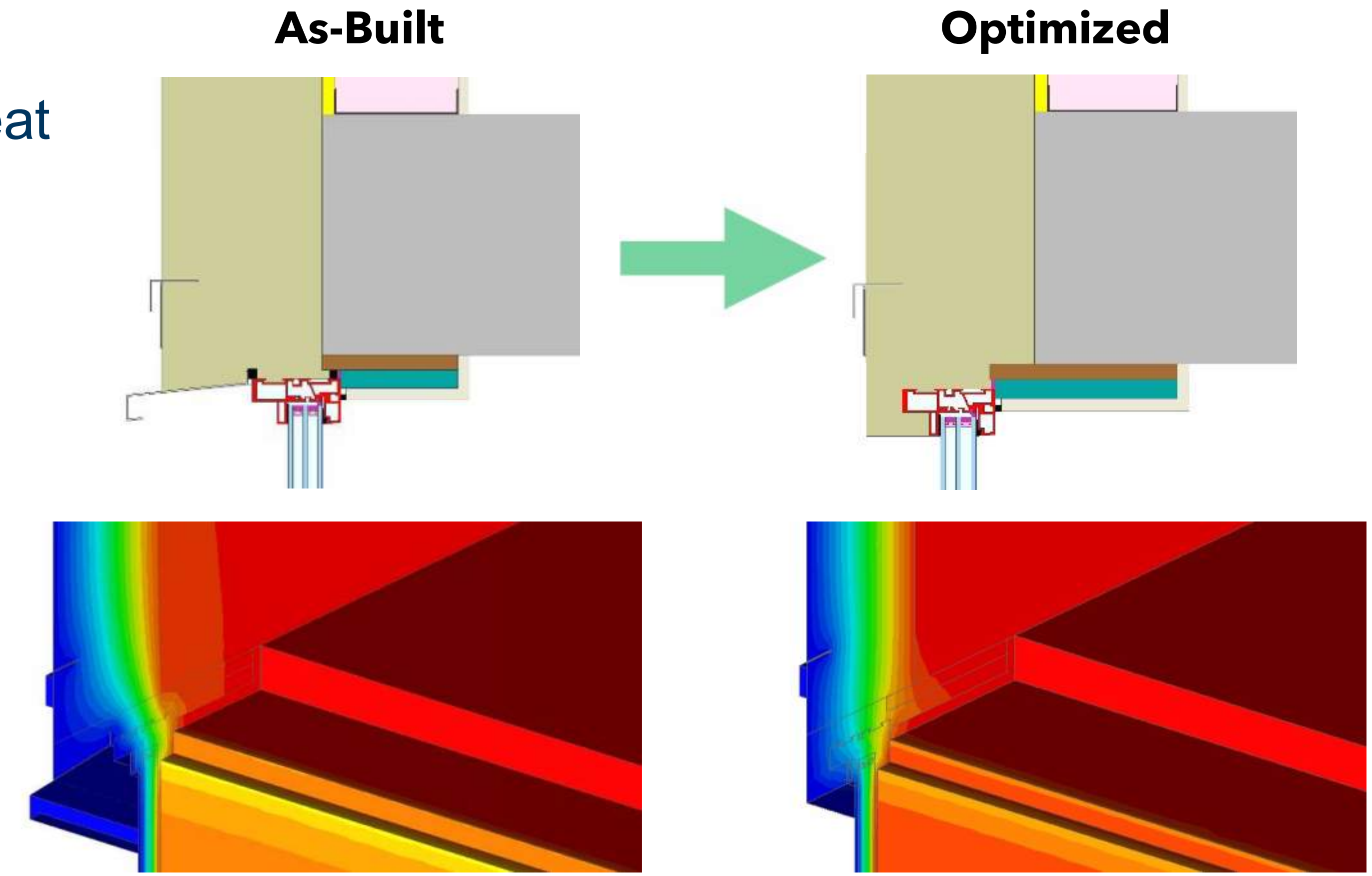
Ψ - value?





Optimized Window Install: Thermal Bridging Heat Loss Effect

- Reduced window install thermal bridge heat loss by 35% compared to as-built install



Optimized Window Install: Thermal Bridging Heat Loss Effect

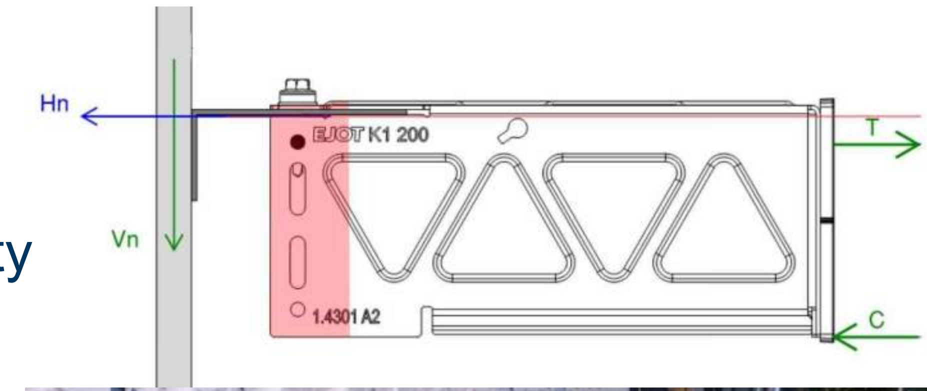
- Reduced window install thermal bridge heat loss by 35% compared to as-built install
- Energy conservation savings (buffer) = more design flexibility

Table 1: Effect to Energy Performance by Optimizing Window Installation Details Only (No Change to Opaque Walls)

Scenario	PER Demand Effect compared to As-Built (kWh/m^2a)	Space Heating Demand Effect compared to As-Built (kWh/m^2a)	Space Heating Load Effect compared to As-Built (W/m^2)	Space Cooling & Dehum. Demand Effect compared to As-Built (kWh/m^2a)	Space Cooling Load Effect compared to As-Built (W/m^2)	Window Energy Balcance compared to As-Built (kWh/a)
Optimized window install only	-0.45	-0.88	-0.30	-0.30	0.32	-1667

Optimized Window Install: Thermal Bridging Heat Loss Effect

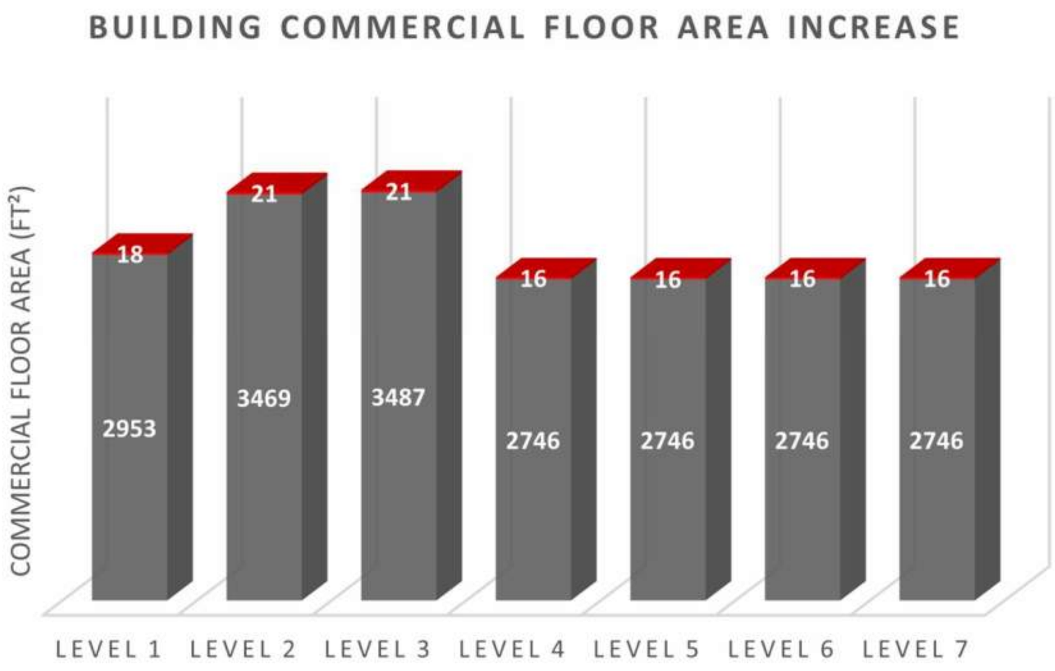
- Reduced window install thermal bridge heat loss by 35% compared to as-built install
- Energy conservation savings (buffer) = more design flexibility
- Alternate wall design with reduced insulation potential benefits:
  - Decrease wall thickness
  - Increase cladding attachment options
  - Decrease embodied carbon emissions
  - Decrease wall construction costs



Post Construction Research Study: Optimized High Impact Thermal Bridges at 825 Pacific Artist Hub

Optimized Window Install: Thermal Bridging Heat Loss Effect

- Decrease external wall thickness → min. 1-inch (25 mm)
- Decrease exterior wall insulation and cladding bracket size → approx. $29K value
- Decrease embodied carbon → 2.7 metric tonnes of carbon dioxide equivalent
- Increase interior floor area opportunity → 123 ft² (11.4 m²) (+0.6%)



Conclusions & Recommendations

Morrison Hershfield

Conclusions & Recommendations

Modelling Tools

- Leverage energy models in design
  - Help identify high impact thermal bridges

- Leverage custom thermal simulations to optimize high impact thermal bridges
  - Improve thermal performance and resistance to mould & condensation
  - Decrease external wall thickness → increase interior floor area opportunity
  - Decrease embodied carbon → less building materials needed

Conclusions & Recommendations

Key Takeaway

- Consider thermal bridging early in design
- Request for Proposal (RFP) define thermal bridge simulation requirements in scope of work
  - Reference CSA Z5010 standard and define thermal simulation requirements (2-D vs. 3-D)
  - Identify anticipated high impact thermal bridges (key details) that require thermal simulation

Conclusions & Recommendations

Key Takeaway

OPTION #1 (STATUS QUO)

not defining thermal bridge determination requirements for energy model

VS.

OPTION #2 (RECOMMENDED)

requiring thermal simulation at high impact thermal bridges for energy model

Thank You

Cody Akira Belton, AScT, PTech, CPHD
cbelton@morrisonhershfield.com

Morrison Hershfield

Questions?