2019 BCBEC

Balcony Designs For Adaptation And Mitigation

Marc Häberli, Architect AAA, LEED AP BD+C
Cillian Collins, Architect (Ireland) MRIAI, CPHD, LEED AP BD+C

Perkins&Will

RDH
Making Buildings Better™

Agenda

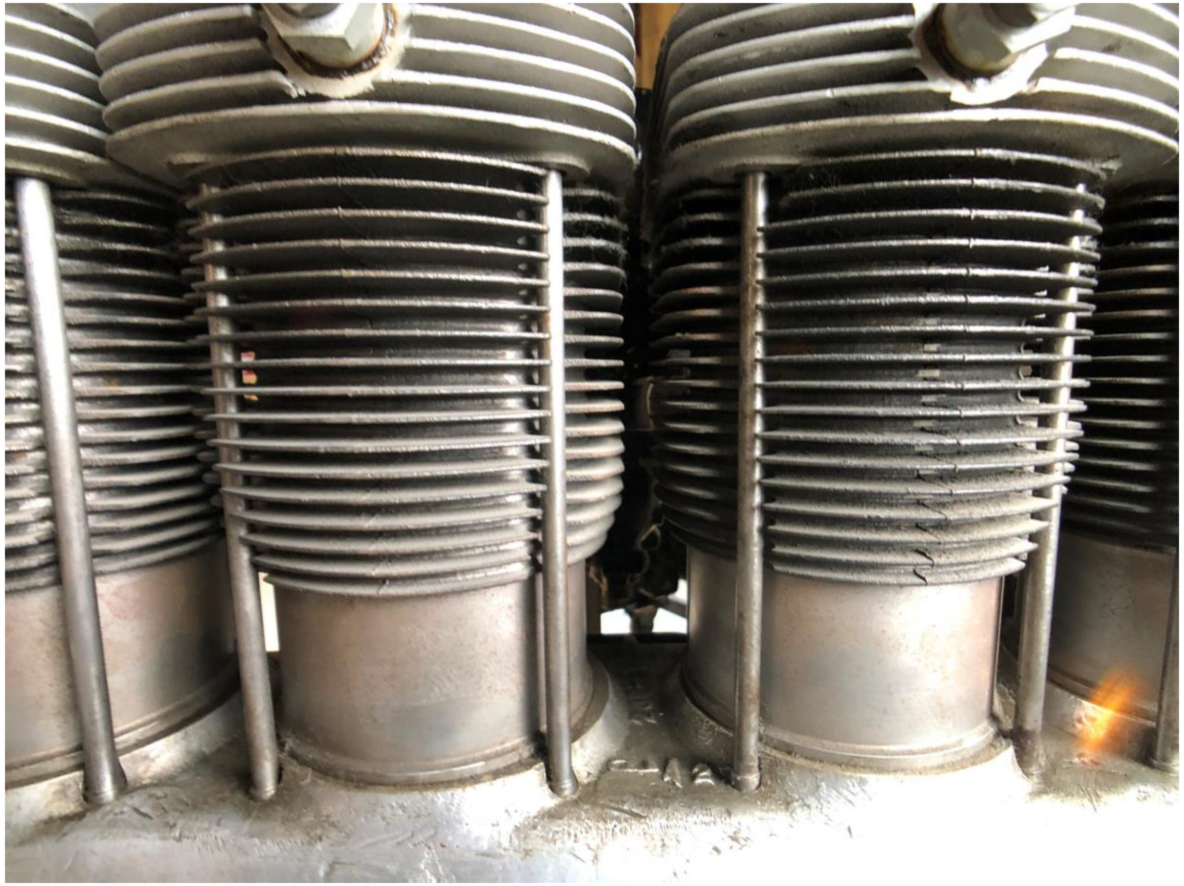
BC HOUSING

Building Excellence Research & Education Grant

Context

A'Beckett Tower – Elenberg Fraser

Current Balcony Construction



“In certain complex assemblies, the research identified facades with as much as a **70% reduction in effective R-value** [because of thermal bridging] ”

Thermal Performance of Facades - 2012 AIA Upjohn Grant Research Initiative Final Report Nov 2014 p. 1

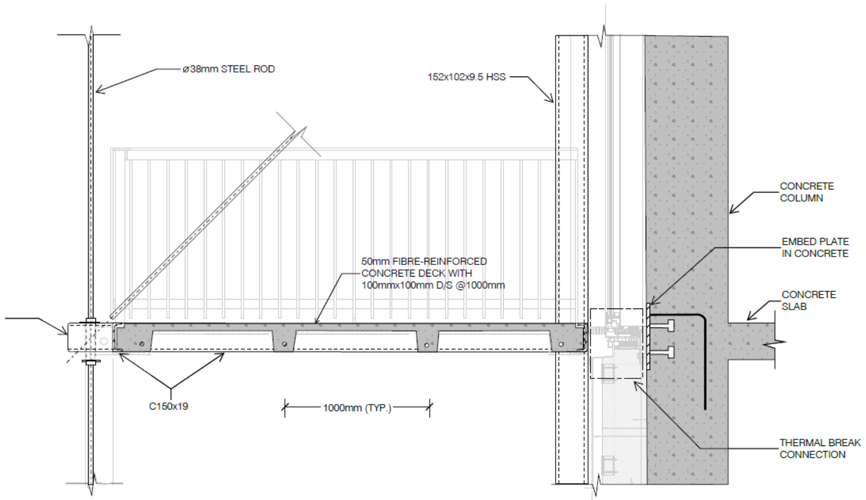
“Building envelope heat loss has historically been simplified due to past difficulties in cost-effectively providing more accuracy. This has generally led to **overly optimistic assessments of building envelope performance** by way of ignoring or underestimating the impact of thermal bridging.”

City of Vancouver Energy Modelling Guidelines [Referenced in the Green Building Rezoning Policy]

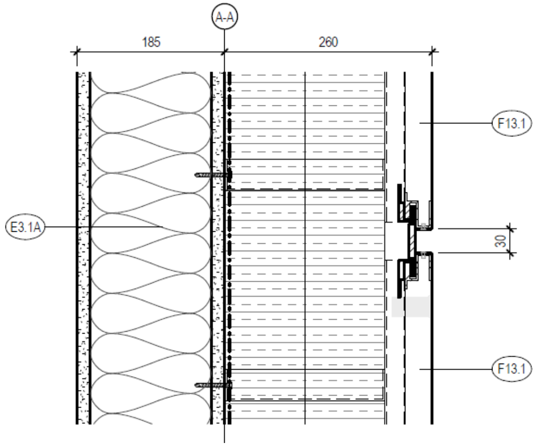
U-value [or R-value] alone is a blunt instrument for gauging the thermal performance of a building

Passive House Plus Magazine [https://passivehouseplus.ie/articles/heating/thermal-bridging, 2011]

Thermal Bridge Connection



Insulation Thickness



Thermal Bridging - Understanding its critical role in energy efficiency – Joseph Little Architects

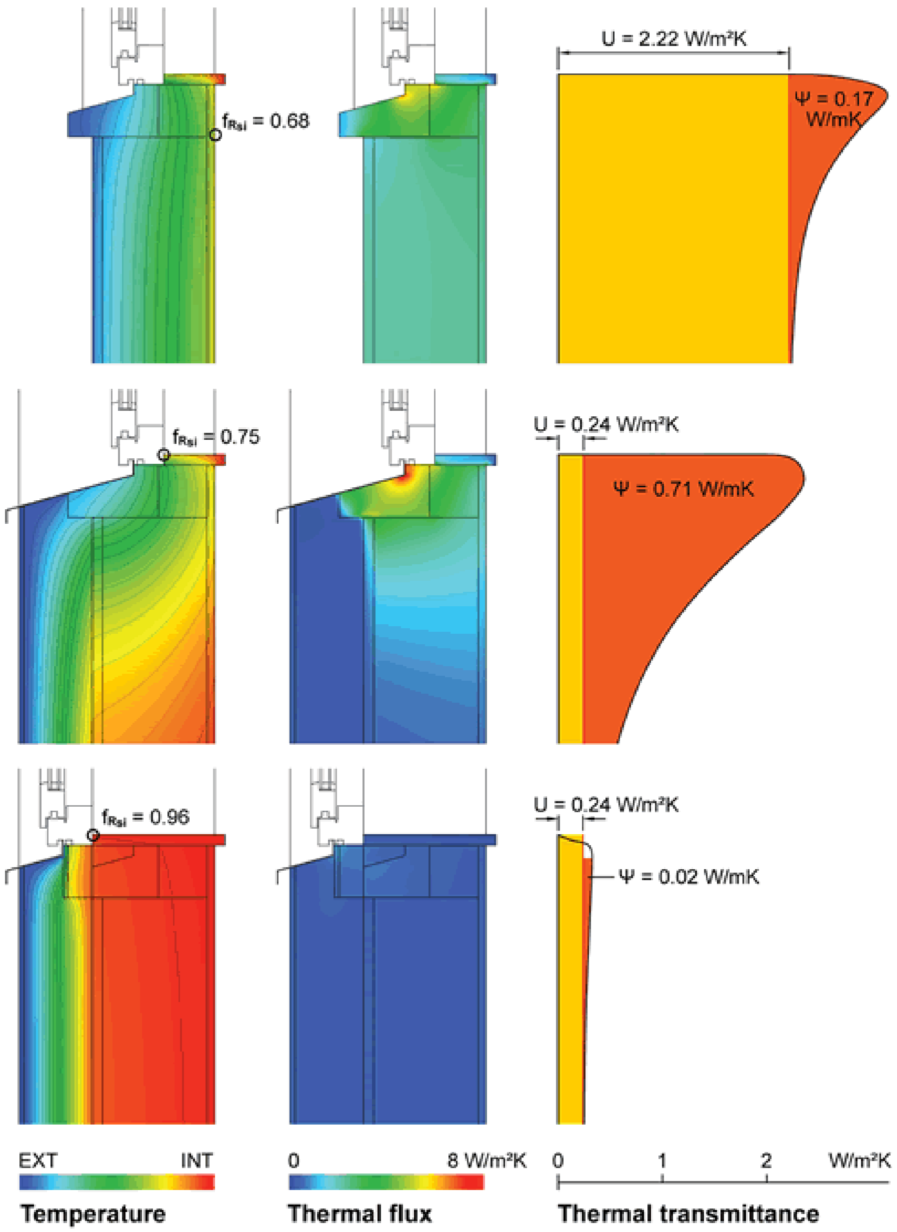


Figure 1: diagrams for an EWI-retrofitted window sill[7]
Top: existing sill; Middle: ill-considered EWI refurb; Bottom: good EWI refurb

Energy standards and codes in BC jurisdictions (BCBC, VBBL, ASHRAE 90.1 and NECB) **do not currently effectively address, or explicitly allow designers to ignore**, major thermal bridges such as slab edges, shelf angles, parapets, window perimeters, etc.

Morrison Hershfield, Building Envelope Thermal Bridging Guide (2014), i.

https://www.bchydro.com/powersmart/business/programs/new-construction.html#thermal

A **key to meeting** low thermal energy demand intensity **(TEDI)** for buildings is a **holistic assessment of thermal bridging** for thermal transmittance calculations.

The **biggest impact** … is the **quality of the details** and design teams aggressively **minimizing thermal bridging**.

Guide to Low Thermal Energy Demand for Large Buildings (BC Housing)

After accounting for windows and doors, **exposed concrete slab edges and balconies** can account for the **second greatest source of thermal bridging** in a multi-storey building

The Importance of Slab Edge & Balcony Thermal Bridges [Report #4], 2013 RDH Building Science

The Report

A guide for developers, builders and designers

Identify Balcony Types

Overview of impact balcony design on achieving energy performance targets early in the design process

Mid to high rise concrete residential construction

Balconies as a given

Other Balcony design considerations
- Rainwater
- Wind
- Acoustics
- Solar Shading

Balcony Types

Balcony Types

1. Internal/Inset Balconies

1.1 Continuous Slab

1.2 Pin Connected

2. External Balcony

2.1 Continuous Slab

2.2 Continuous Slab with Intermittent Concrete

2.3 Continuous Slab with Structural Thermal Break

2.4 Continuous Slab with Wrapped Insulation

3. Point Connected Balcony

3.1 Discrete Knife Plate Connection

3.2 Suspended / Compression

3.3 Simply Supported

4. Free Standing Balcony

4.1 Self Supported

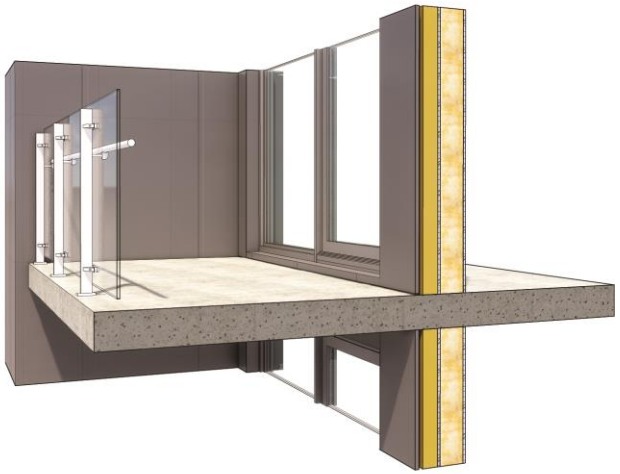
Inset Balconies

External Balcony

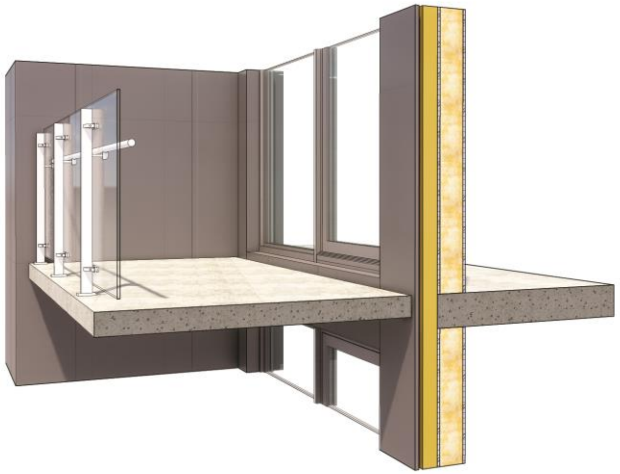
1.0 Internal/Inset Balconies

Riverlight- Rogers Stirk Harbour + Partners

1.0 Internal/Inset Balconies



1.1 Continuous Slab



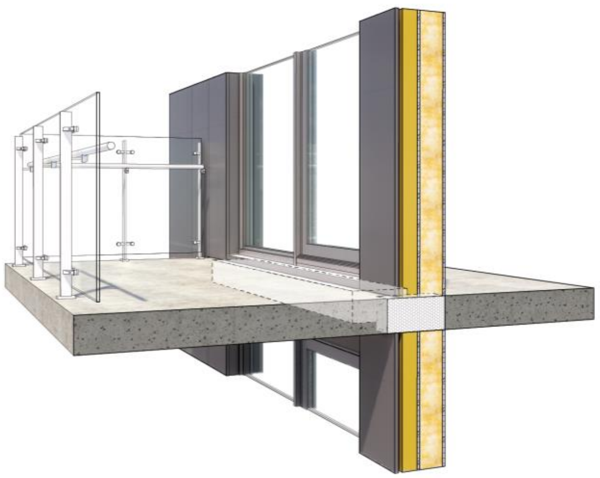
1.2 Point Connection

2.0 External Balconies

New'R - Hamonic and Masson

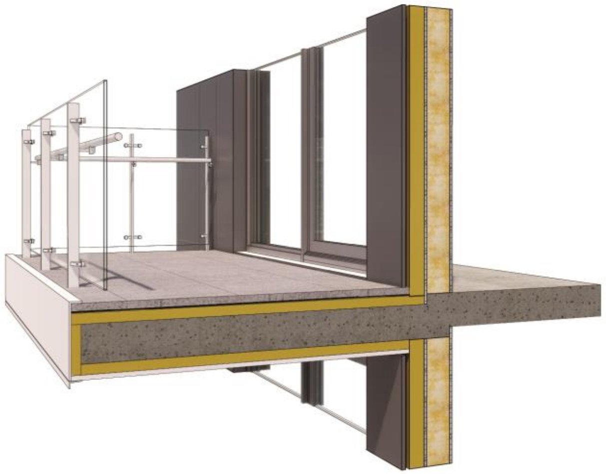
2.0 External Balconies

2.1 Continuous Slab



2.2 Intermittent Concrete

2.3 Structural Thermal Break

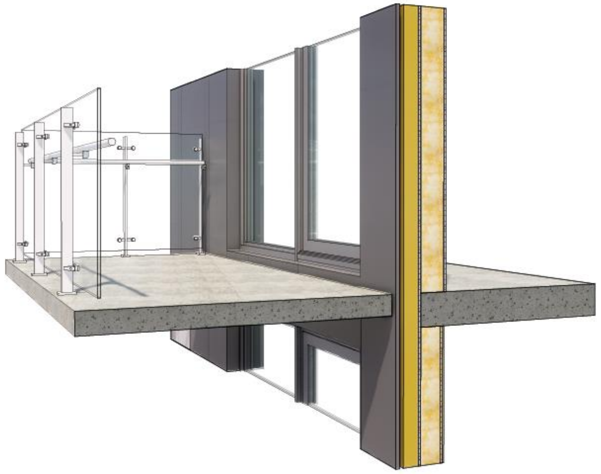


2.4 Wrapped Insulation

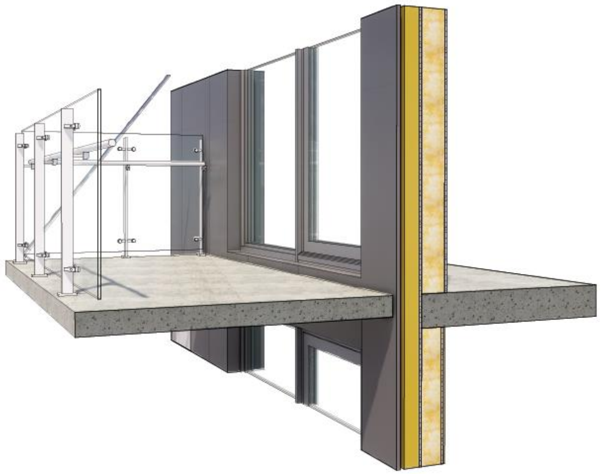
3.0 Point Connected Balconies

The Silo - COBE

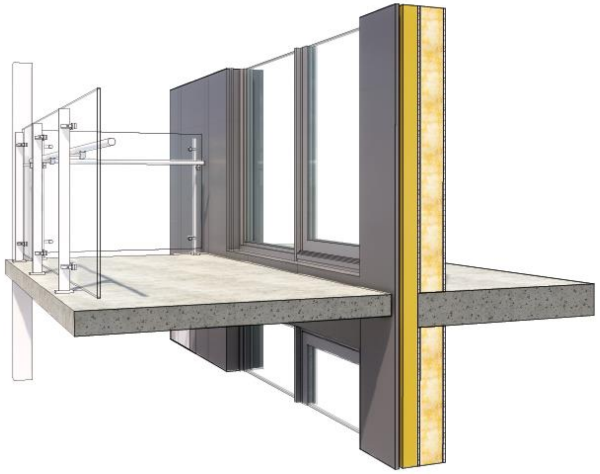
3.0 Point Connected Balconies



3.1 Discrete Moment Connection

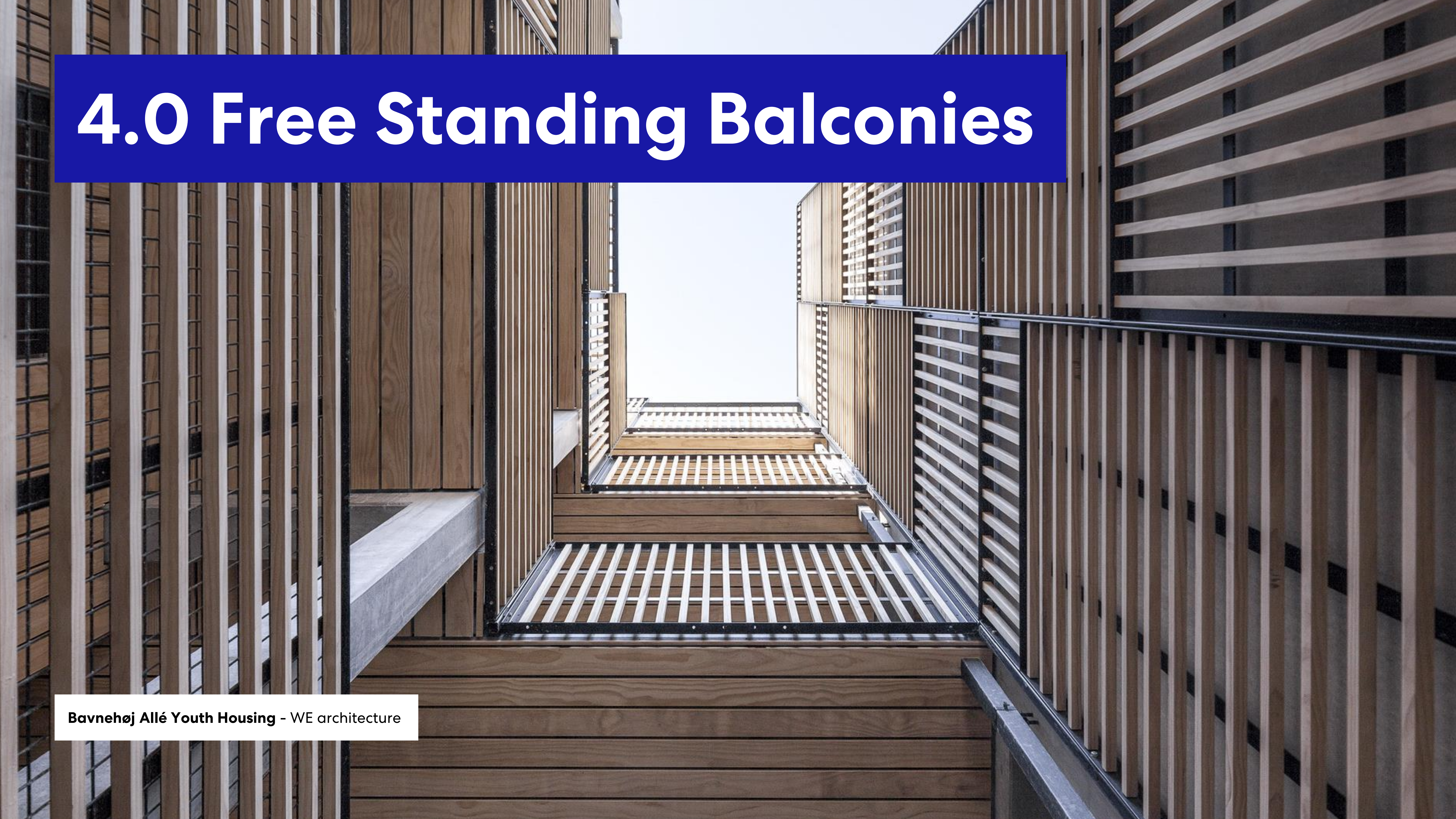


3.2 Suspension / Compression



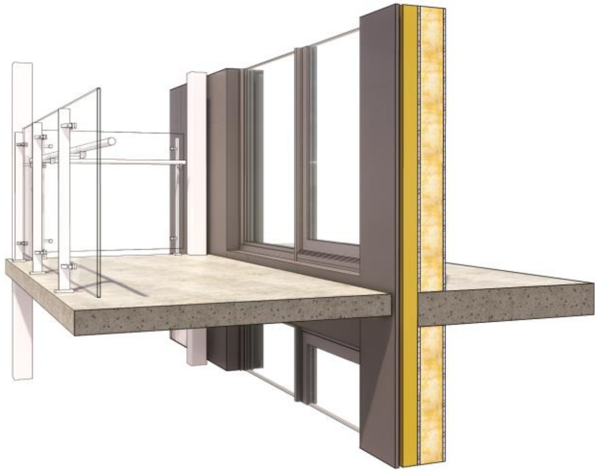
3.3 Simply Supported

4.0 Free Standing Balconies



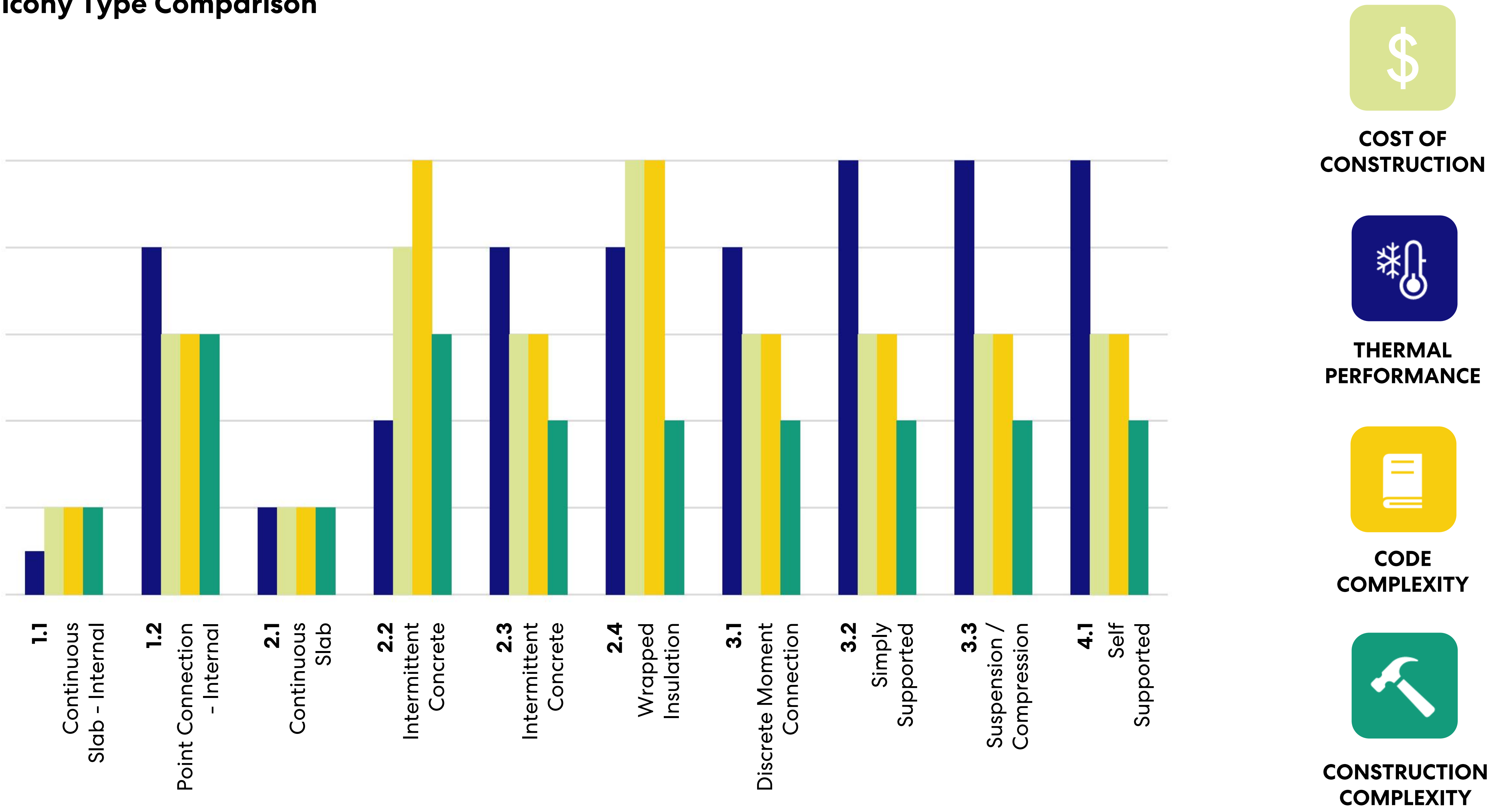
Bavnehøj Allé Youth Housing - WE architecture

4.0 Free Standing Balconies



4.1 Self Supported

Balcony Type Comparison



Case Study

DYEJI – Costa Lopes

How does this impact our buildings and energy targets?

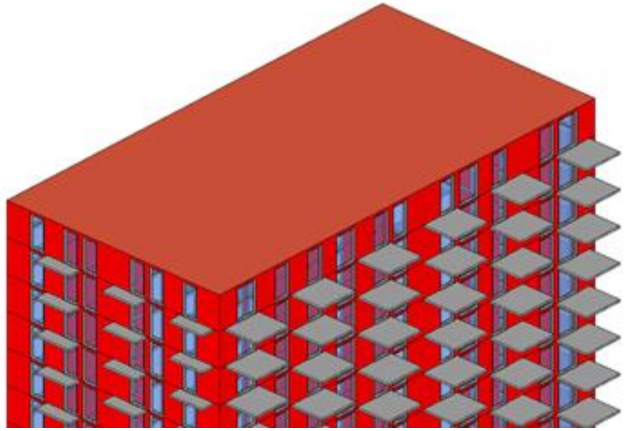
Case Study – 5055 Joyce Street

City of Vancouver *Land Use and Development Policies and Guidelines*
Planning, Urban Design and Sustainability Department
453 West 12th Avenue, Vancouver, BC V5Y 1V4 | tel: 3-1-1, outside Vancouver 604.873.7000 | fax: 604.873.7100
website: vancouver.ca | email: planning@vancouver.ca | app: VanConnect

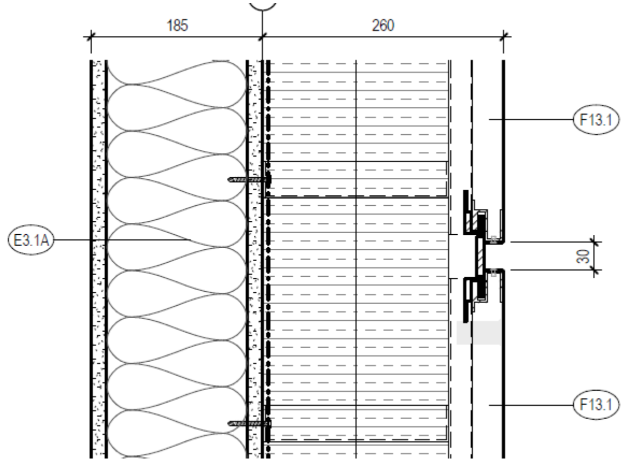
GREEN BUILDINGS POLICY FOR REZONINGS

Performance Limits Buildings Not Connected to a City-recognized Low Carbon Energy System			
Building Type	TEUI (kWh/m^2)	TEDI (kWh/m^2)	GHGI ($kgCO_2/m^2$)
Residential Low-Rise (< 7 storeys)	100	15	5
Residential High-Rise (7+ storeys)	120	30	6
Office	100	27	3
Retail	170	21	3
Hotel	170	25	8
All Other Buildings	EUI 35% better than Building By-law energy efficiency requirements, Section 10.2, in effect at the time of rezoning application		

Case Study – 5055 Joyce Street

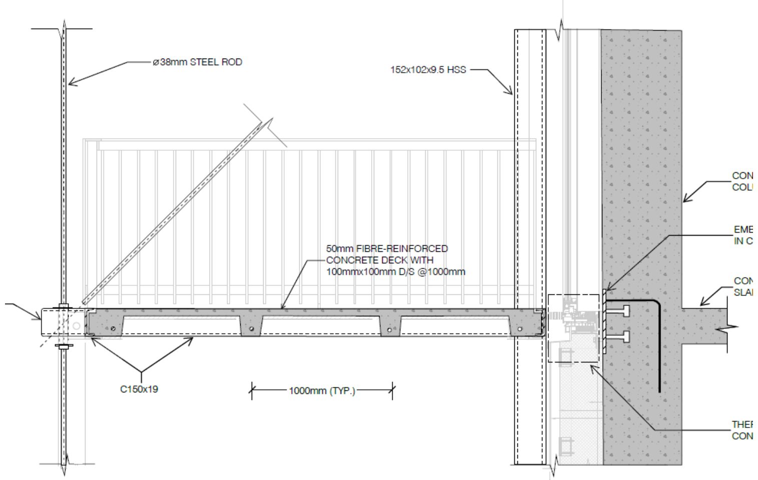


FORM / ARTICULATION



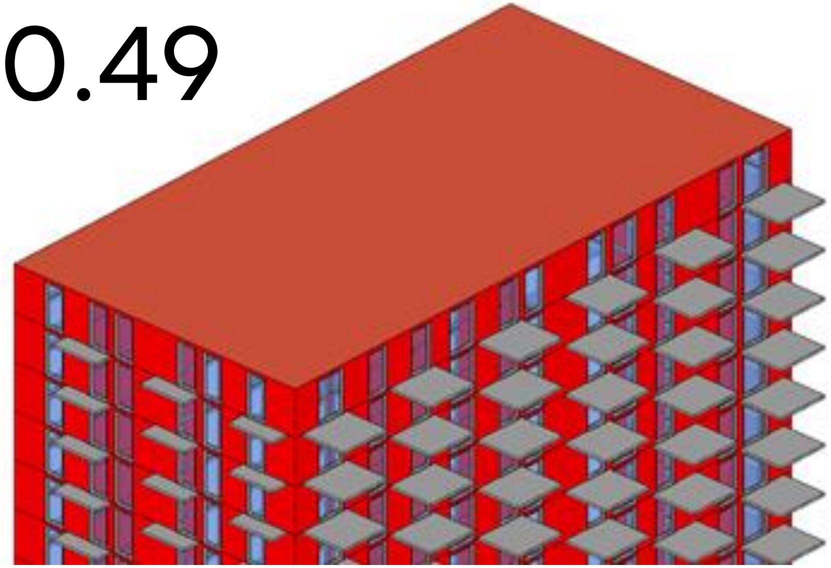
COMPONENT SPECIFICATION

WINDOW-WALL RATIO



THERMAL BRIDGING

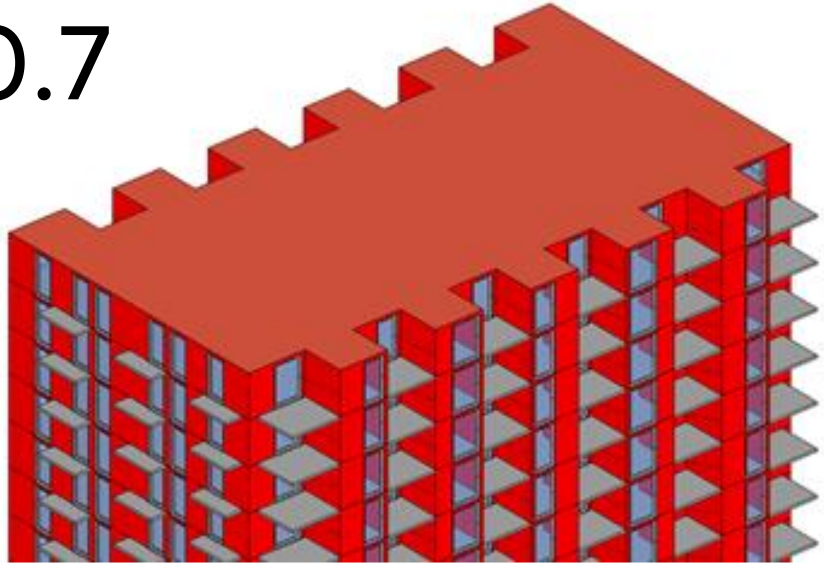
0.49



TFA: 17,400m^2 WWR: 45%
WALL: 5320m^2 TB: 1,634m

TEDI – 28.7 kWh/m^{2}a

0.7

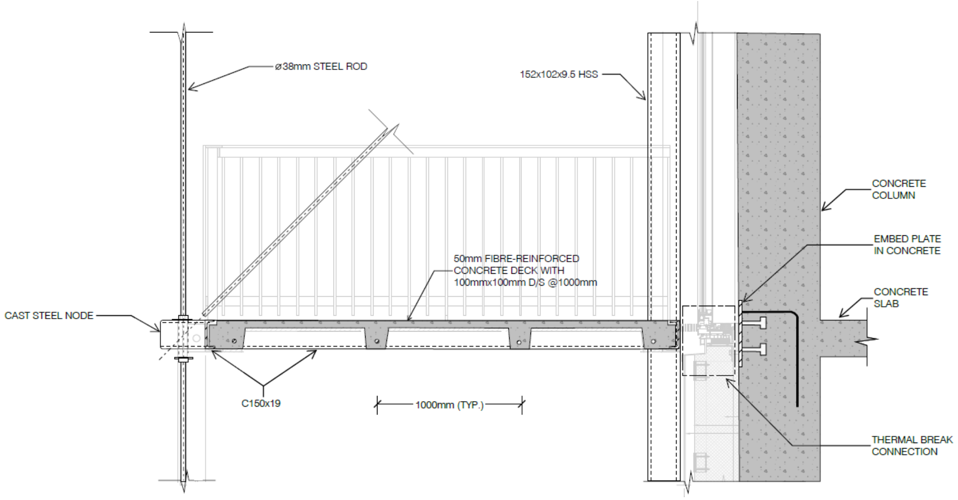


TFA: 17,400m^2 WWR: **32%**
WALL: **9835m^2** TB: **3,145m**

TEDI – 34.0 kWh/m^{2}a

Baseline – R15 Effective Assembly

Thermal Bridge Connection

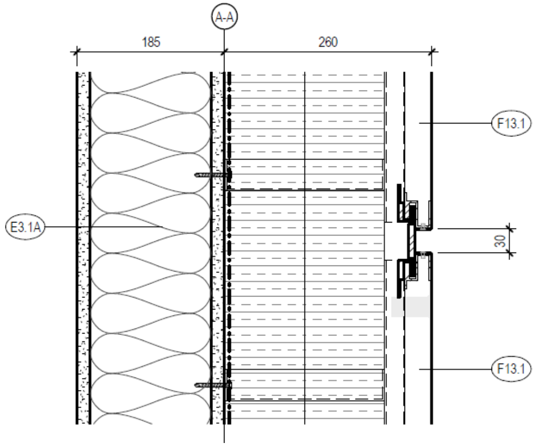


3.1 Discrete Point Connected Knife/Pin/Isokorb

χ = ~0.3 W/K

3m balcony, 17 per floor, 30 floors

Insulation Thickness



6” Mineral Wool (R22)

Thermally efficient clips

Window-Wall Ratio

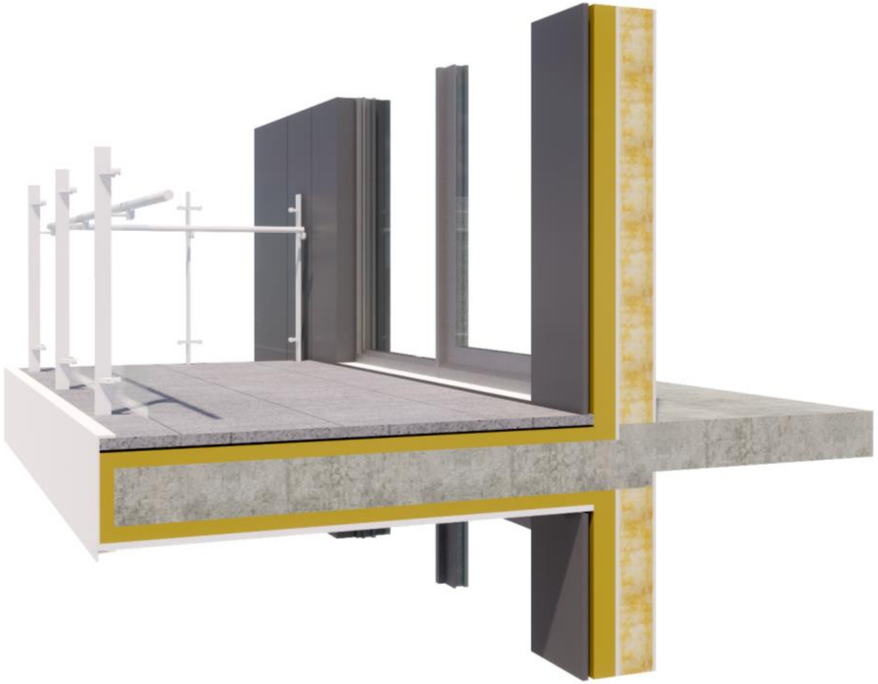
Baseline WWR = 45%

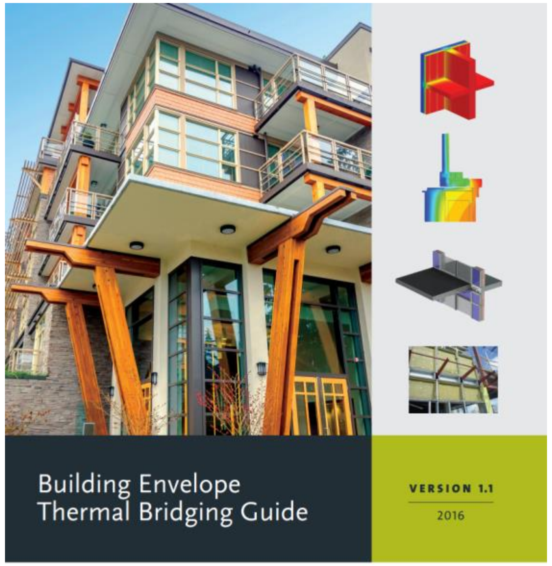
Triple Pane fixed glazing
Double Pane operable

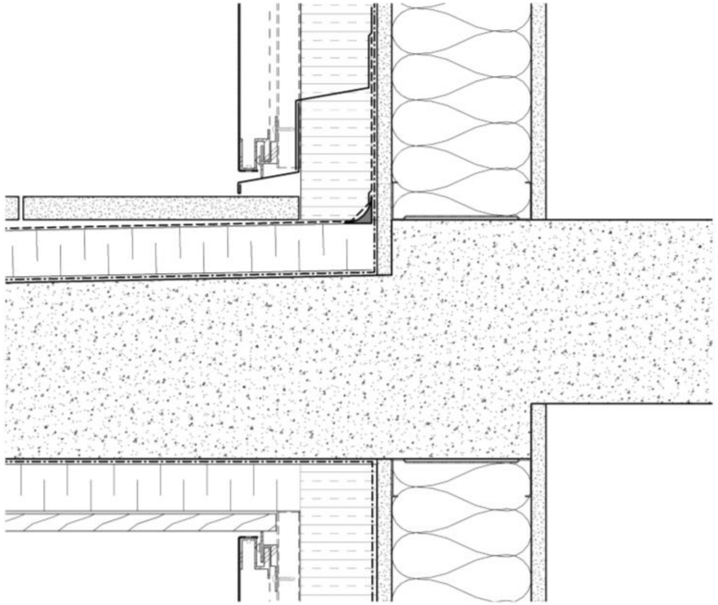
Case Study - 5055 Joyce Street

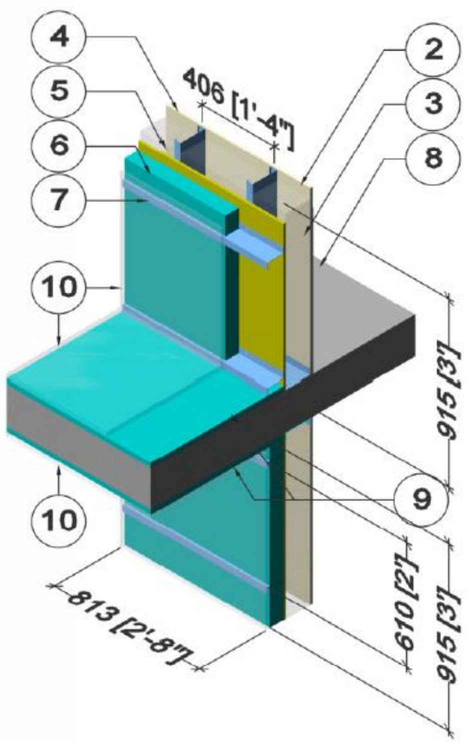
Effective R-Value? R?

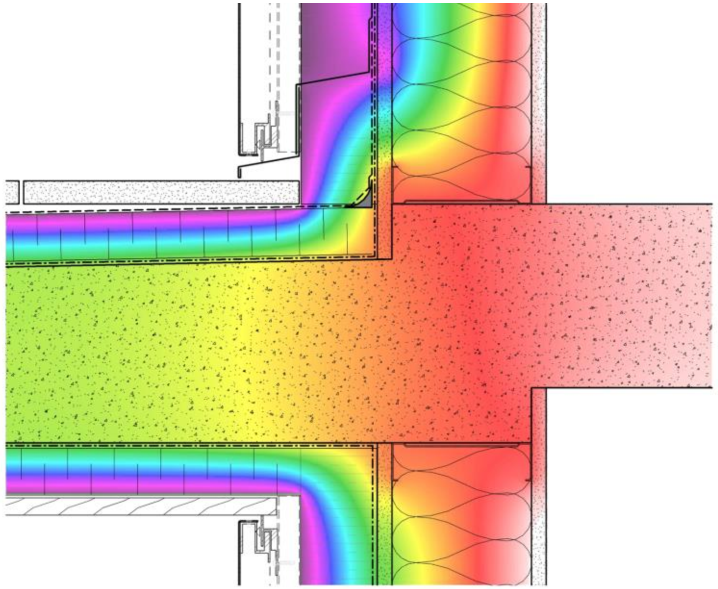
2.4 Wrapped Insulation





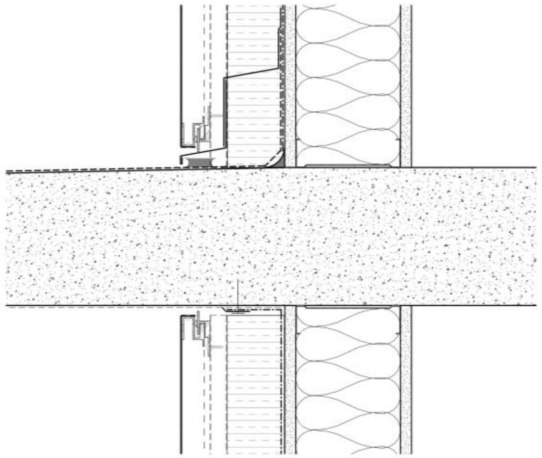


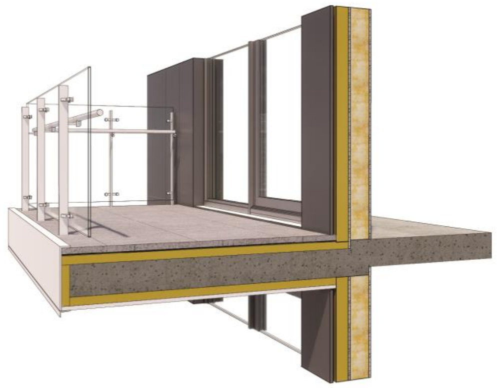




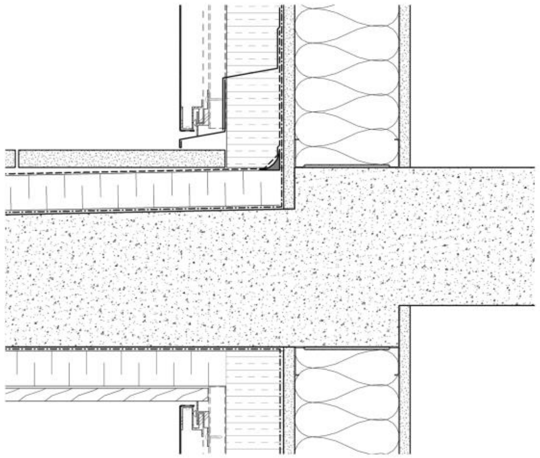
$\Psi = 0.496$ W/mK

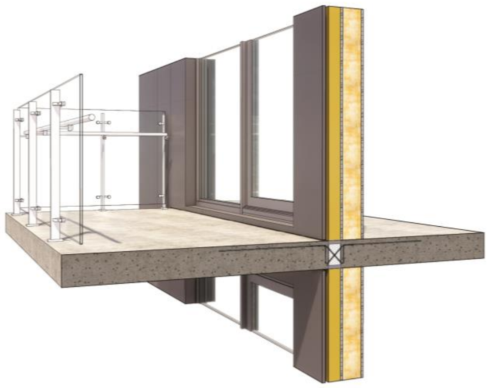
2.1
CONTINUOUS SLAB



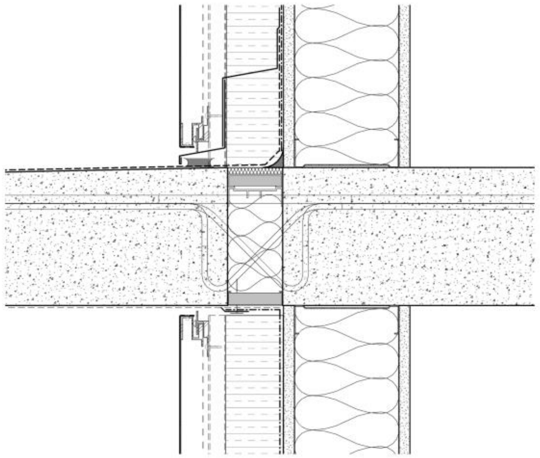


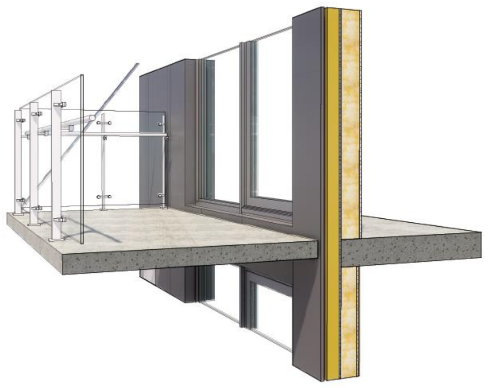
2.4
WRAPPED INSULATION



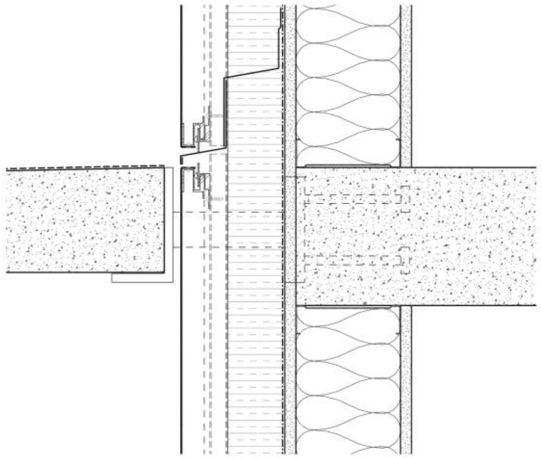


2.3
STRUCTURAL BREAK

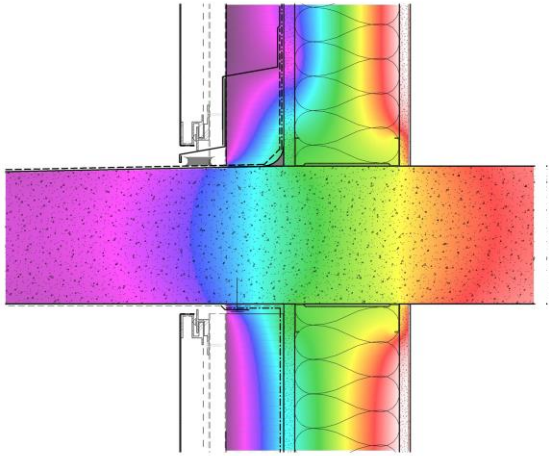


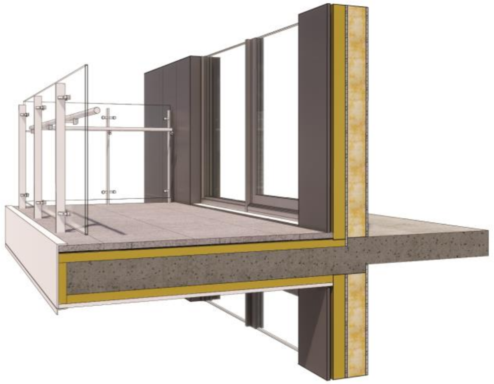


3.2
PIN CONNECTION

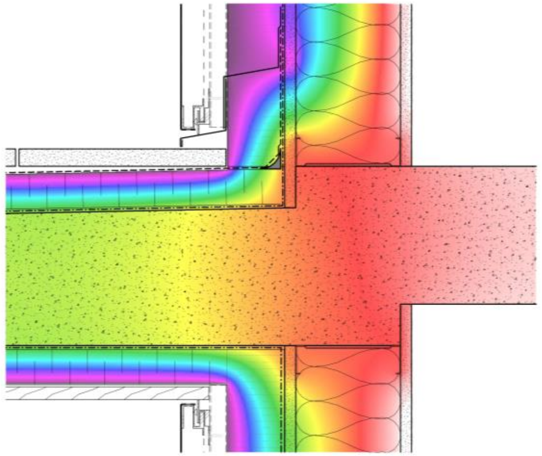


Ψ = 1.059 W/mK

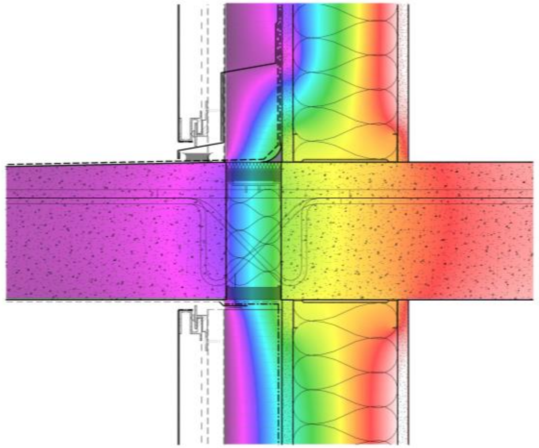


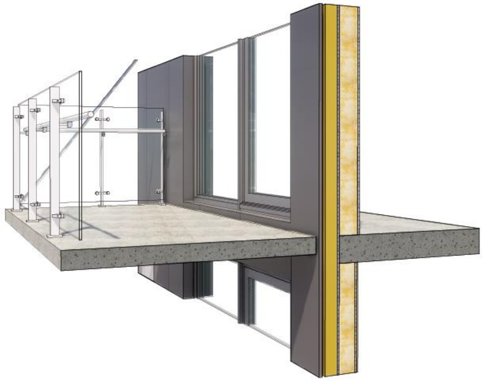


Ψ = 0.496 W/mK

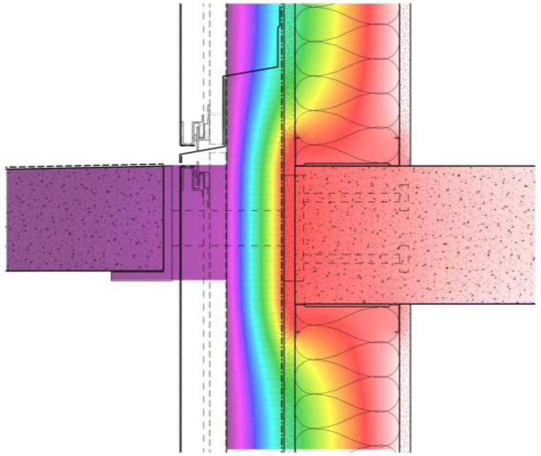


Ψ = 0.252 W/mK





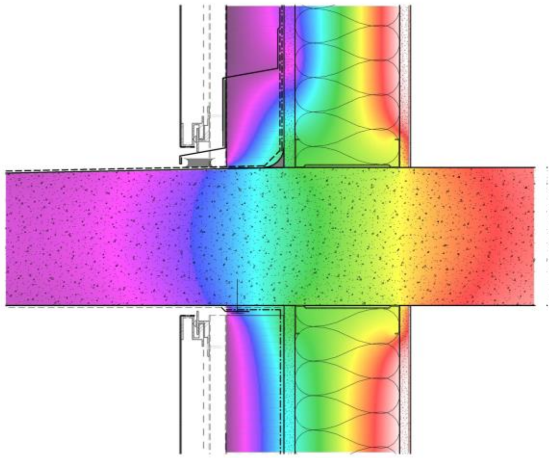
Ψ = 0.089 W/mK

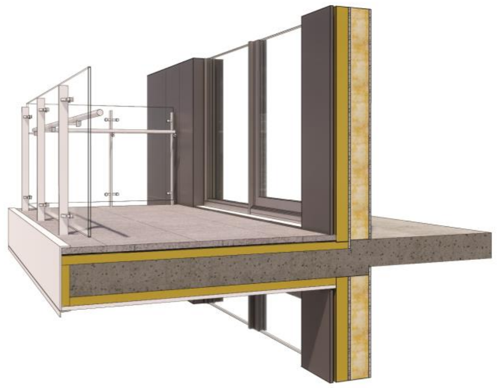


R9.1 (R22)

51% Heat Loss

$\Psi = 1.059$ W/mK

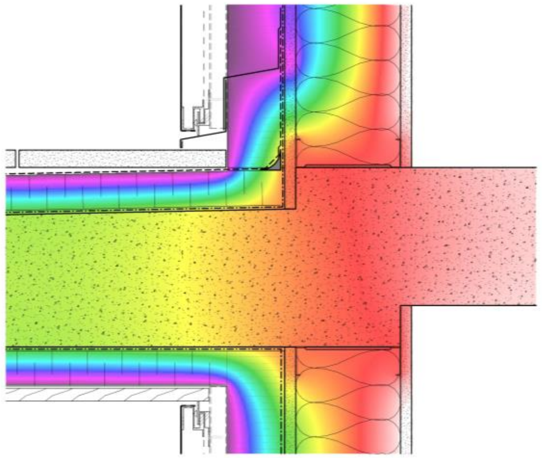


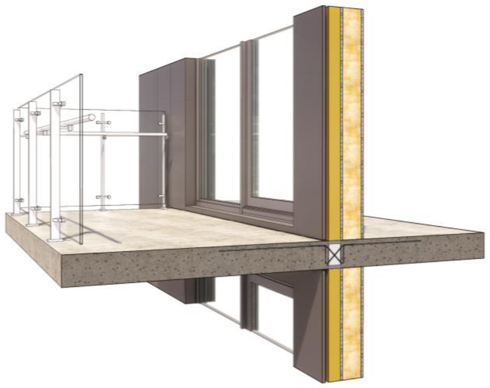


R12.6 (R22)

34% Heat Loss

$\Psi = 0.496$ W/mK

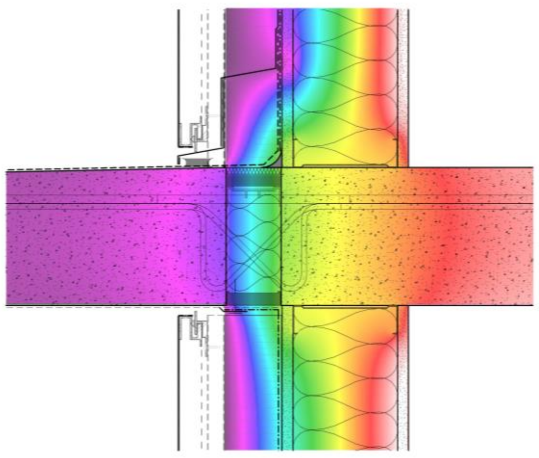


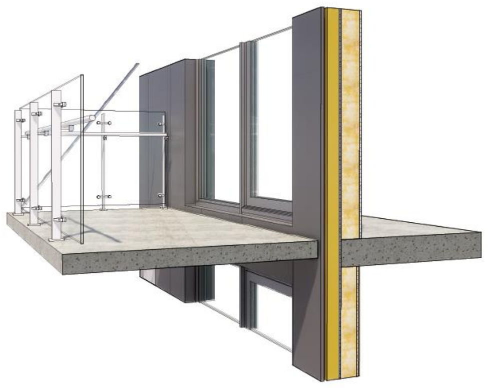


R15.1 (R22)

21% Heat Loss

$\Psi = 0.252$ W/mK

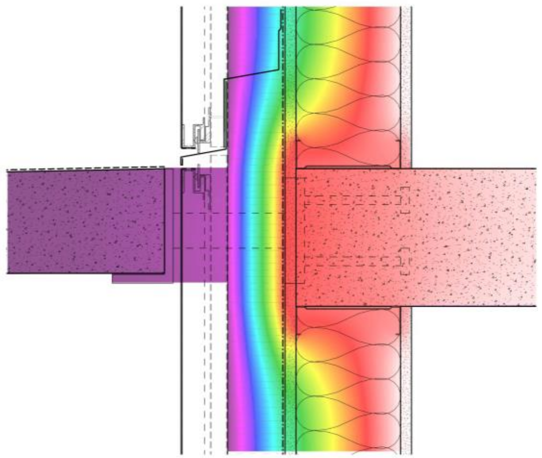




R17.5 (R22)

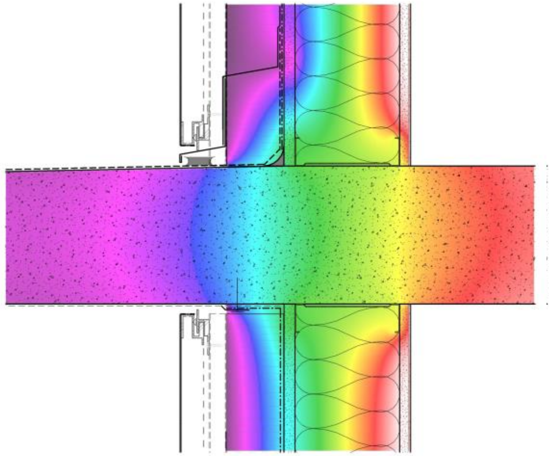
8% Heat Loss

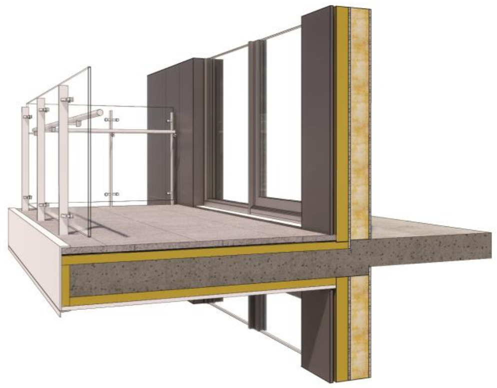
$\Psi = 0.089$ W/mK



TEDI – 33.4 kWh/m^{2}a

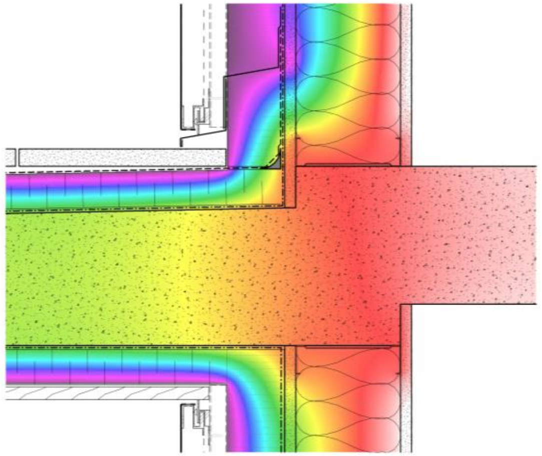
R9.1 (R22)
51% Heat Loss
Ψ = 1.059 W/mK

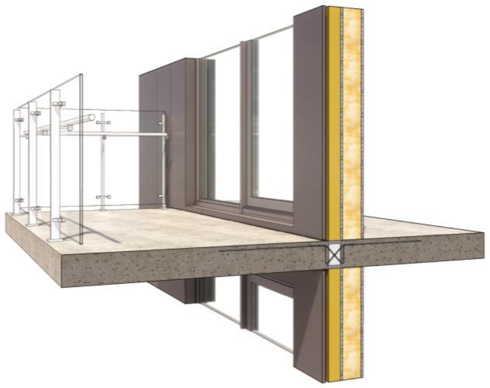




TEDI – 30.5 kWh/m^{2}a

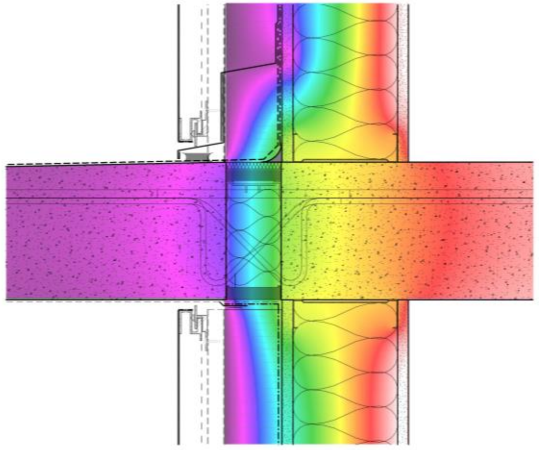
R12.6 (R22)
34% Heat Loss
Ψ = 0.496 W/mK

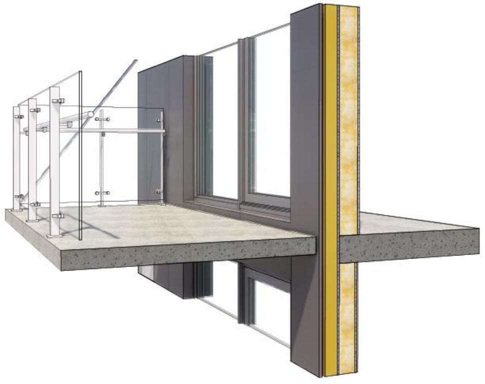




TEDI – 28.7 kWh/m^{2}a

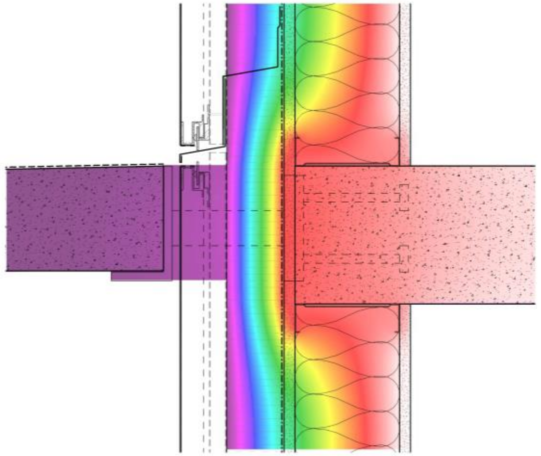
R15.1 (R22)
21% Heat Loss
Ψ = 0.252 W/mK

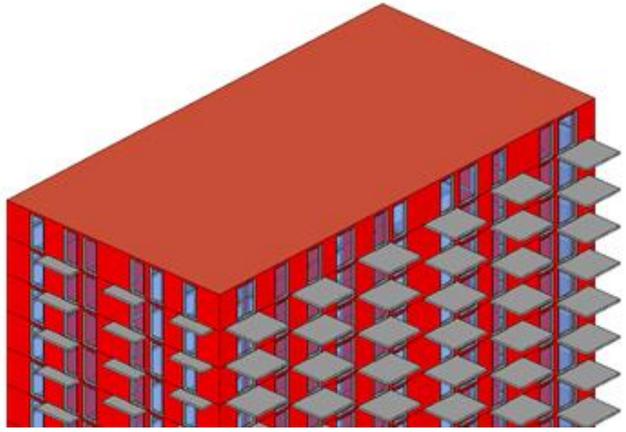




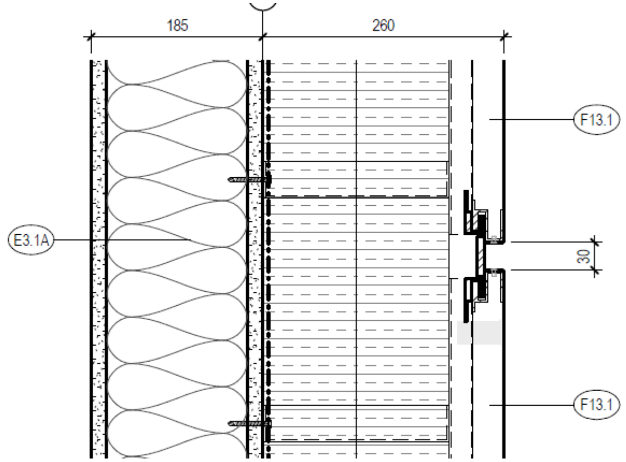
TEDI – 27.6 kWh/m^{2}a

R17.5 (R22)
8% Heat Loss
Ψ = 0.089 W/mK



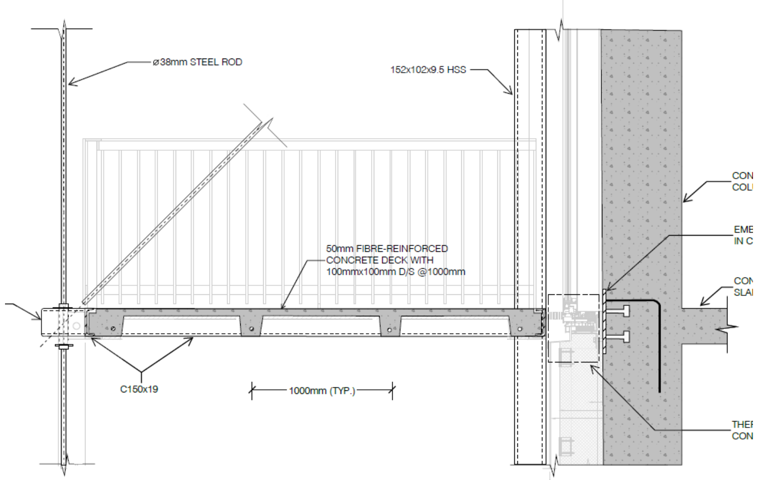


FORM / ARTICULATION



COMPONENT SPECIFICATION

WINDOW-WALL RATIO



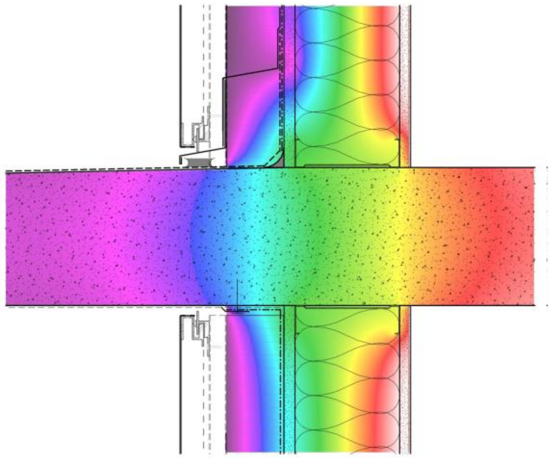
THERMAL BRIDGING

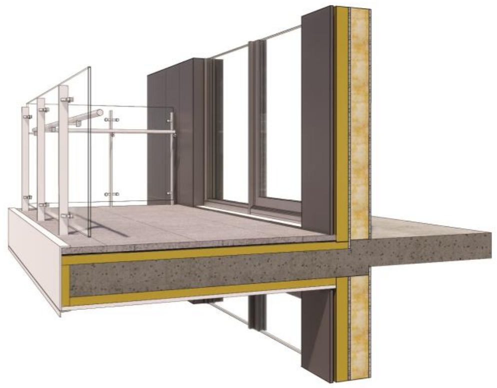
Ψ = 1.059 W/mK

R-190 !! (R15)

45% WWR

TEDI – 28.7 $\mathrm{kWh/m^2a}$



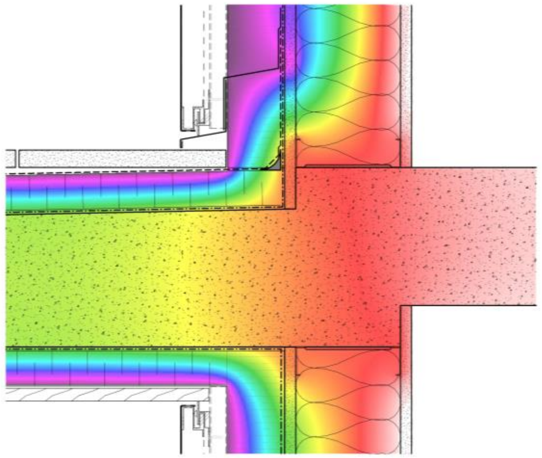


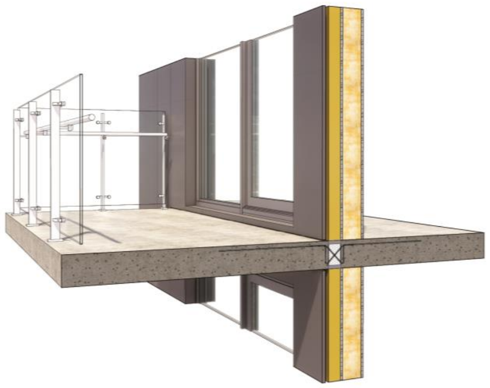
Ψ = 0.496 W/mK

R-31 (R15)

45% WWR

TEDI – 28.7 $\mathrm{kWh/m^2a}$



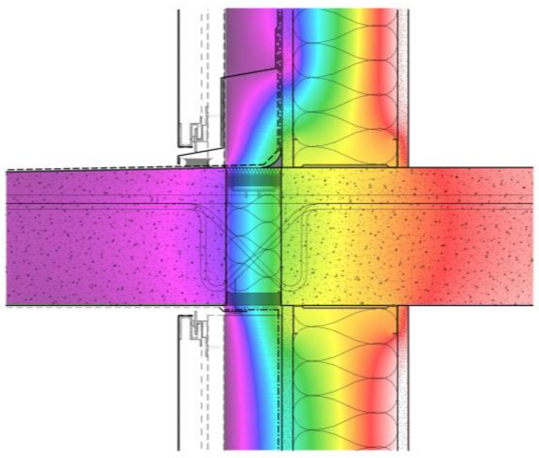


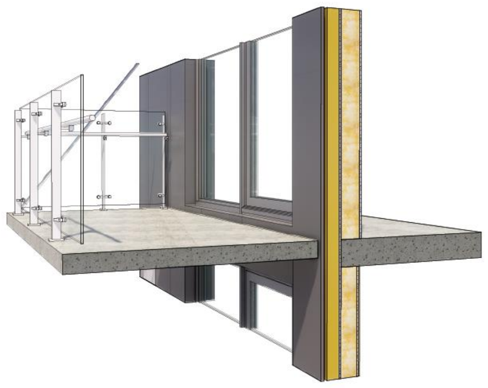
Ψ = 0.252 W/mK

R-22 (R15)

45% WWR

TEDI – 28.7 $\mathrm{kWh/m^2a}$



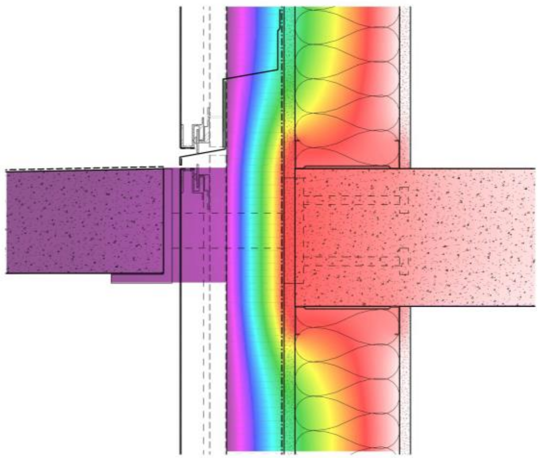


Ψ = 0.089 W/mK

R-18

45% WWR

TEDI – 28.7 $\mathrm{kWh/m^2a}$

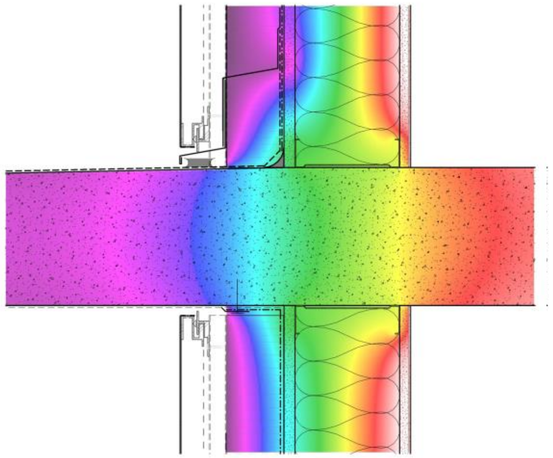


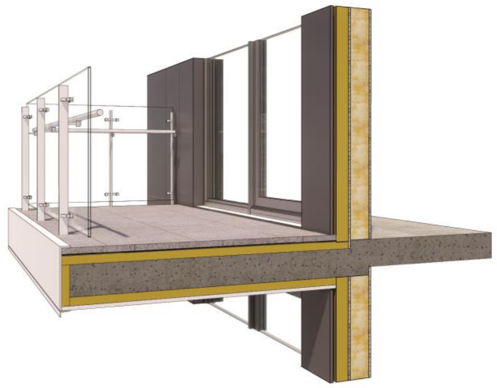
Ψ = 1.059 W/mK

R-9 (R22)

30% WWR

TEDI – 28.7 kWh/m^2a



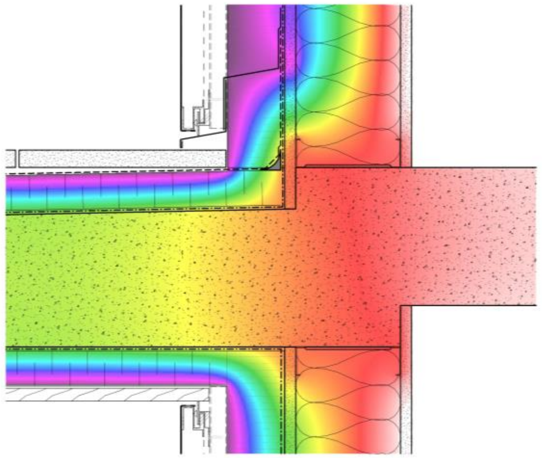


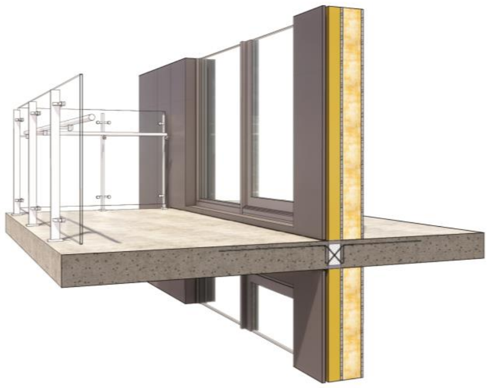
Ψ = 0.496 W/mK

R-12 (R22)

40% WWR

TEDI – 28.7 kWh/m^2a



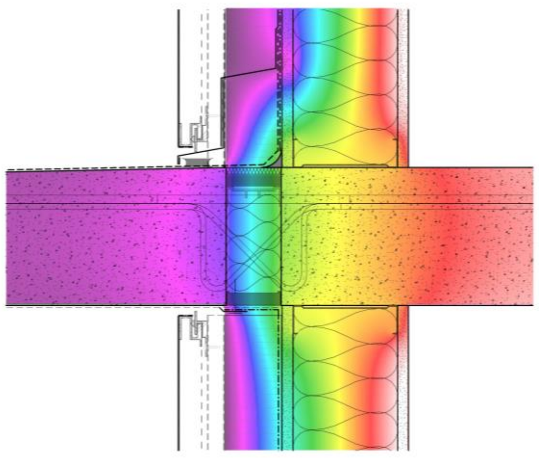


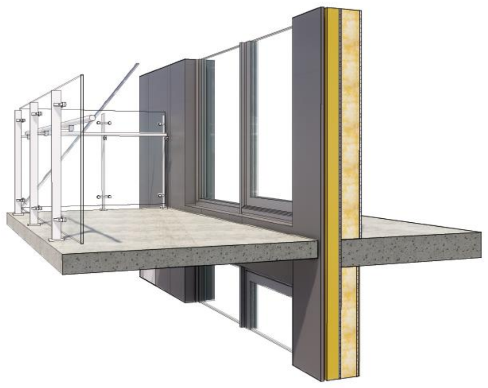
Ψ = 0.252 W/mK

R-18 (R22)

45% WWR

TEDI – 28.7 kWh/m^2a



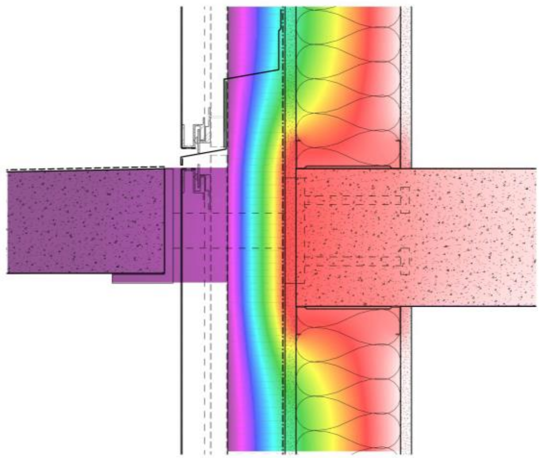


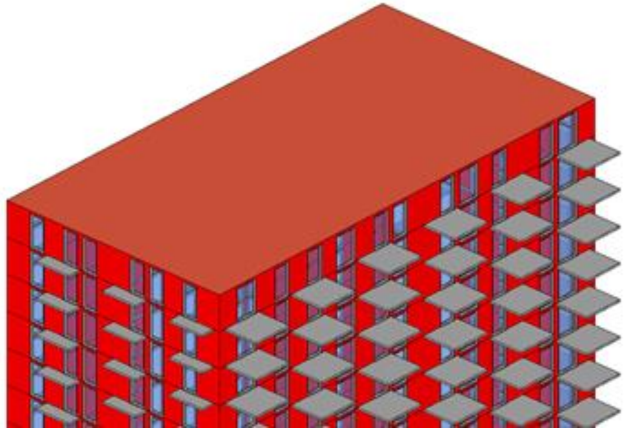
Ψ = 0.089 W/mK

R-18 (R22)

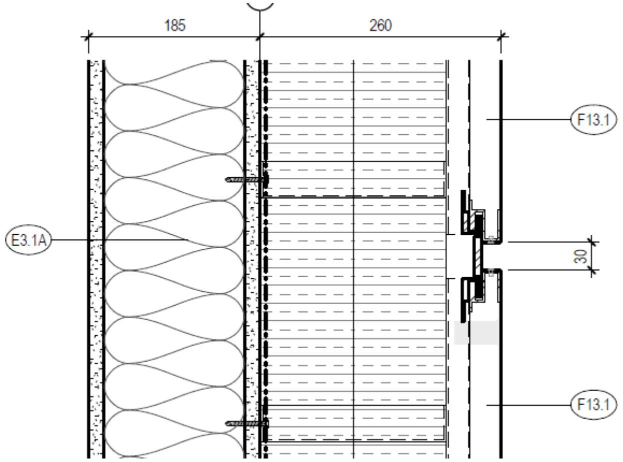
50% WWR

TEDI – 28.7 kWh/m^2a



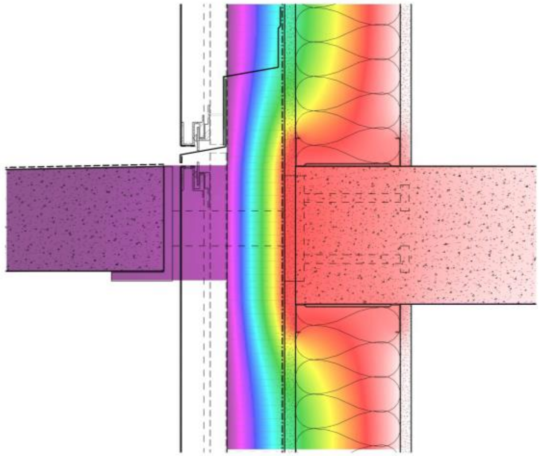


FORM / ARTICULATION



COMPONENT SPECIFICATION

WINDOW-WALL RATIO



THERMAL BRIDGING

Key Findings

VM House – BIG

Key Findings

- Its all about area of energy transfer
  - Thickness of slab
  - Length of Balcony
  - Length of Thermal Bridge
- Less mass = less thermal bridging
- Residential ventilation and ducting strategies
- Accessibility
- Fire protection detailing
- One part of a holistic approach

Thanks for attending

Perkins&Will