University of Leicester

AssociatedArchitects

Jon Chadwick

Scaling Up Passivhaus

THE CENTRE FOR MEDICINE, UNIVERSITY OF LEICESTER

ukpassivhaus conference 2014

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Predicted Performance

Specific building demands with reference to the treated floor area

				Requirements		Fulfilled?*
	Treated floor area	9655.0	m²			
Space heating	Heating demand	**12.11**	**kWh/(m²a)**	15	kWh/(m²a)	**yes**
	Heating load	**10**	**W/m²**	10	W/m²	**yes**
Space cooling	Overall specif. space cooling demand		**kWh/(m²a)**	15	kWh/(m²a)	**yes**
	Cooling load		**W/m²**	-		**-**
	Frequency of overheating (> 25 °C)		%	-		**-**
Primary energy	Heating, cooling, auxiliary electricity, dehumidification, DHW, lighting, electrical appliances	**119**	**kWh/(m²a)**	120	kWh/(m²a)	**yes**
	DHW, space heating and auxiliary electricity	54	kWh/(m²a)	-		**-**
	Specific primary energy reduction through solar electricity		kWh/(m²a)	-		**-**
Airtightness	Pressurization test result n_{50}	**0.3**	**1/h**	0.6	1/h	**yes**

* empty field: data missing; '-': no requirement

U-values: *Walls 0.13W/m²/k*

Roof 0.13W/m²/k

Floor 0.13W/m²/k

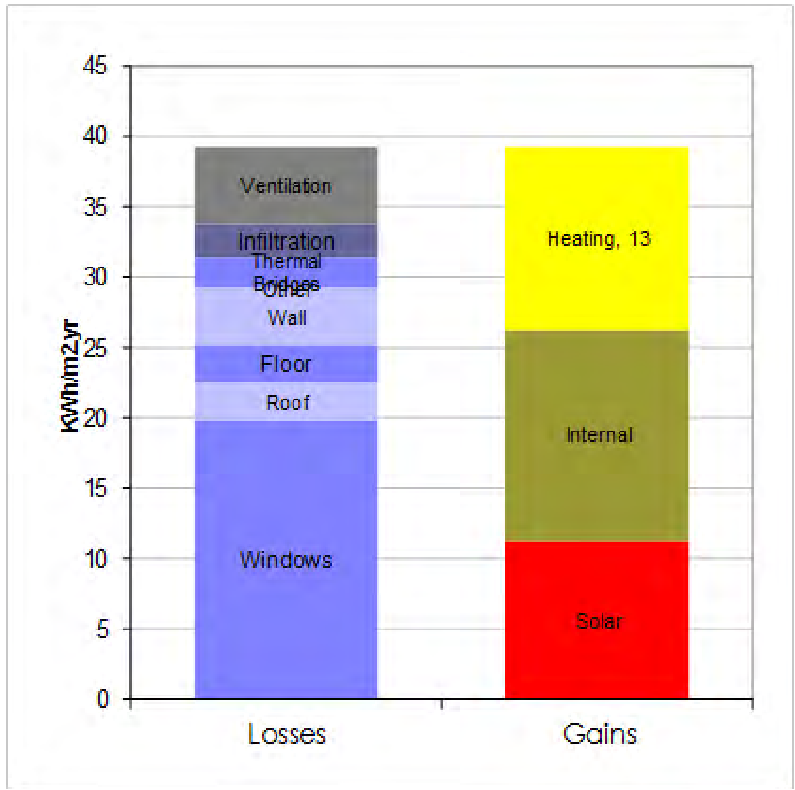
Airtightness: *1m³/m²/hr @ 50Pa*

Equates to: *0.33 ac/h*

Treated floor area: 9,655 m²

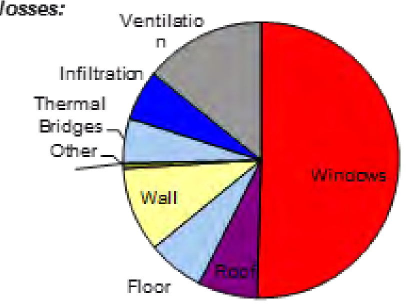
Annual Heat balance kWh/m²

	Losses	Gains
Windows	19.8	
Roof	2.7	
Floor	2.6	
Wall	3.9	
Other	0.2	
	0.0	
Thermal Brid	2.1	
Infiltration	2.3	
Ventilation	5.6	
Solar		11.4
Internal		14.9
Heating		13.0
Totals	***39.3***	***39.3***



Turn off htg display? No

Heat losses:

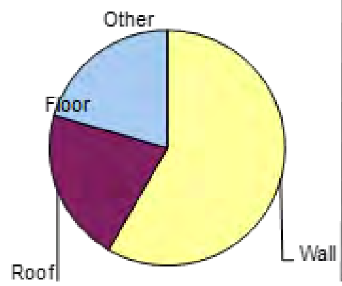


Window breakdown

	Losses kWh/m²	Heat gains kWh/m²	Balance kWh/m²	area m² (% of wall)
North	2.8	1.0	-1.8	715.5 (8.7%)
East	6.7	4.1	-2.6	1,658.5 (20.2%)
South	2.9	2.2	-0.8	721.2 (8.8%)
West	6.2	2.4	-3.7	1,556.5 (19.0%)
Horizontal	1.3	2.4	1.1	232.4 (2.8%)
Total	19.8	12.1	-7.8	4,651.7 (56.7%)

Heat loss form factor
(what is it?)

Heat loss form factor	
Wall	0.8
Roof	0.3
Floor	0.3
Other	0.0
Total	***1.52***



Average fabric U value required	0.277 W/m2.yr
Average fabric U value of design	0.232 W/m2.yr

Heat Losses

1	Windows	191,576 kWh/a
2	Exterior wall - Ambient	31,731 kWh/a
3	Roof/Ceiling - Ambient	26,395 kWh/a
4	Floor slab / Basement ceili	25,222 kWh/a
5	Exterior TB (length/m)	16,388 kWh/a

The Design Team

University of Leicester

Client

Pre Contract

BIDWELLS

Project Managers

gleeds

Cost Consultants

AssociatedArchitects

Architect and Lead Consultant

couchperrywilkes engineering change

M+E Engineers

Passivhaus Designers

RAMBØLL

Structural and Civil Engineers

Post Contract

Clientís Retained Consultants

BIDWELLS

Project Managers

gleeds

Cost Consultants

AssociatedArchitects

Design Advisor

couchperrywilkes engineering change

Technical Advisor

WILLMOTT DIXON SINCE 1852

Main Contractor

Passivhaus Designers

Contractorís Design Team

AssociatedArchitects

Architect and Lead Consultant

NG Bailey

M+E Subcontractor

WARM:

Passivhaus Consultants

RAMBØLL

Structural and Civil Engineers

An Overview of the 2011 Client Brief:

ï Bring together the Schools of Medicine, Health Sciences and Psychology

ï Adjacent to the existing medical building

ï Sensitive to context ñ ecology and heritage

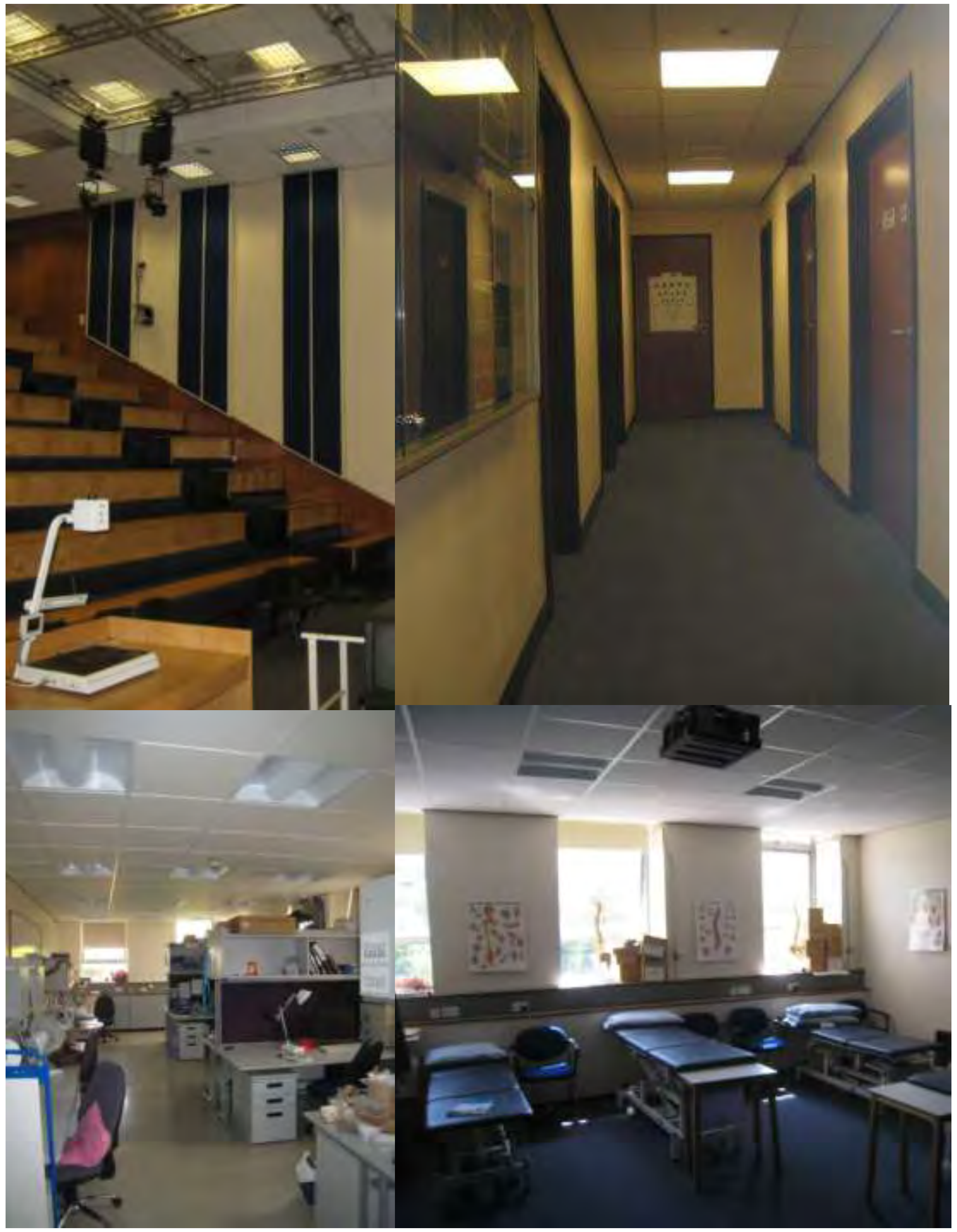
ï Contribute towards reducing the Universityís carbon footprint ñ passive design

ï Allow the existing building to be upgraded in the future

ï 13,000sqm of teaching, research and support spaces for 2,400 occupants

ï Range of flexible teaching spaces with potential for conference use

ï Deliver the building by September 2015



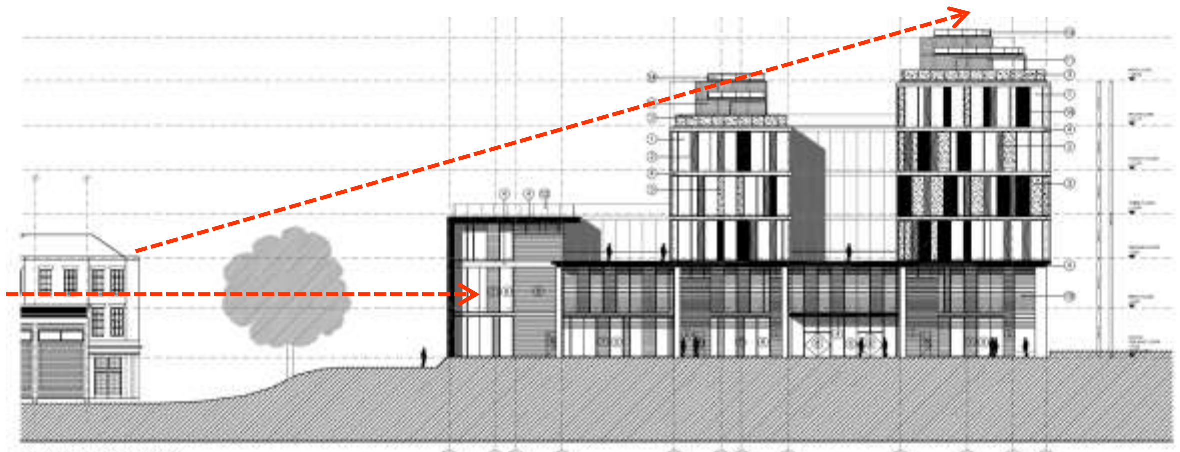
Background Site Information – Regent College Site

Planning Issues

- Locally listed building (Regent College)
- ëConservation Areaí and listed ëFire Station Cottagesí
- Protected trees on site boundary
- Protected views towards the War Memorial
- Risk of overshadowing adjacent buildings
- Loss of open space & playing fields
- Ecological impact
- Concerns over car parking provision
- Bomb shelter & potential archaeology

Design Approach

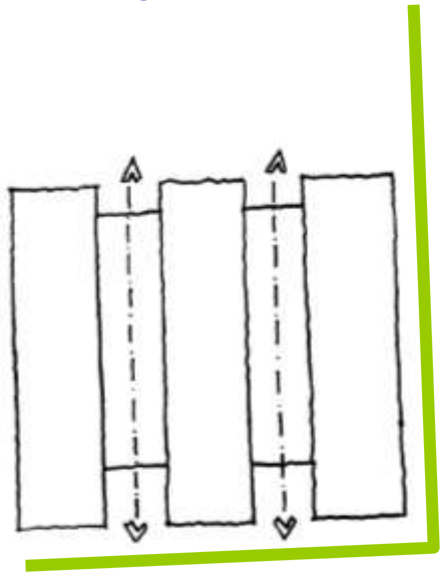
- Demolish bomb shelter - provide new football pitch
- Increase site biodiversity
- Respect Regent College
- Face the University and mark the start of the campus
- Provide an efficient plan form
- Maximise passive measures



ELEVATION AA 1:200
Glazing Percentage: Approx 45%

Concept ñ Plan Form

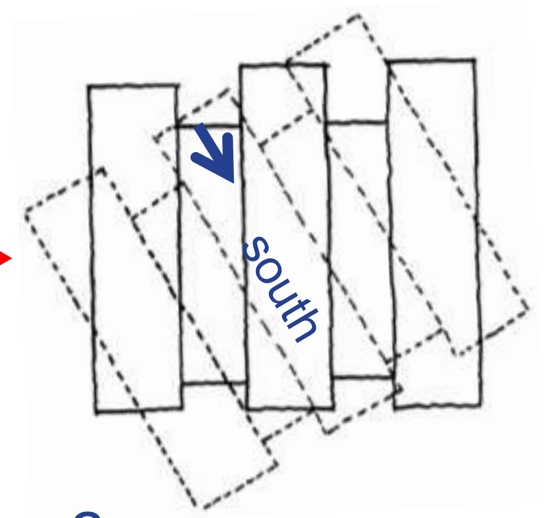
Finger Blocks



1.

- Square block responds to site boundaries.
- Split block up allowing views through into site.
- Narrow floor plate to max daylight.
- Landscape planted through building gaps.
- Stepped heights of blocks high to Uni Rd.

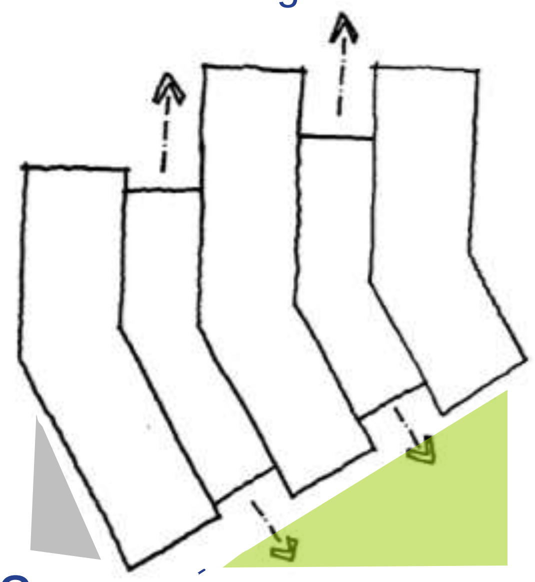
Rotate 45 Degrees



2.

- Rotate blocks to face directly south.
- Orientation best to control solar gain.
- Building faces the corner legible entrance!

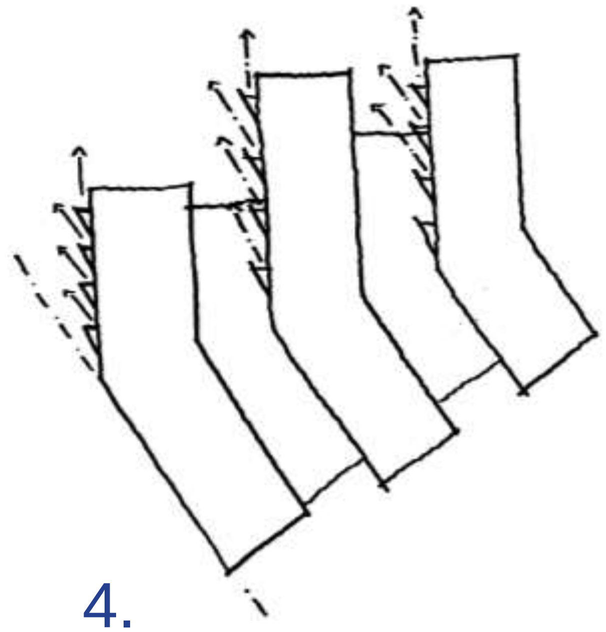
Aligned to South & College



3.

- Blocks turn back on College grid into site responding to context.
- Rotation provides a pedestrian arrival space and separate service zone.

Façade Respond to Sun

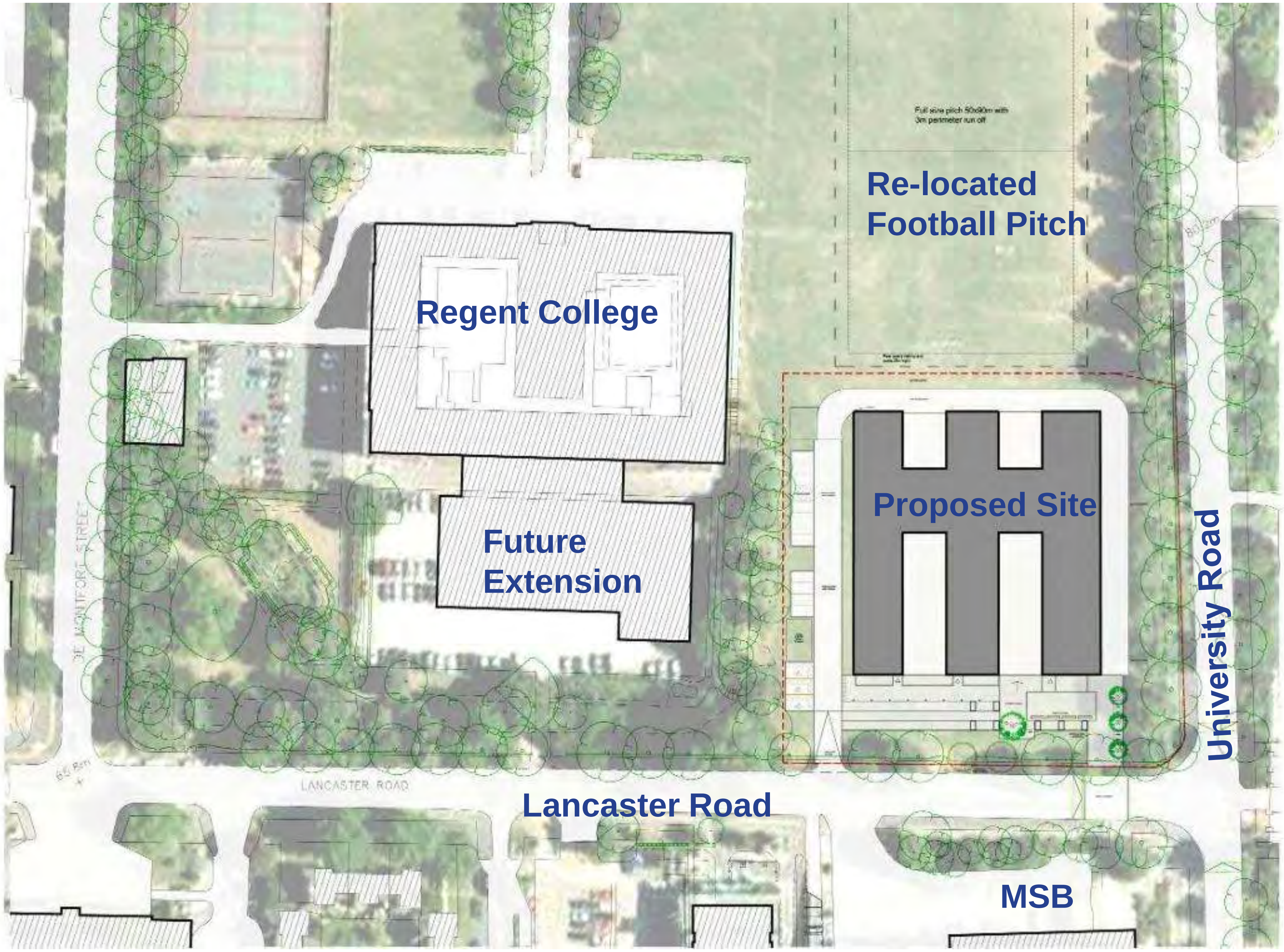


4.

- Prickly façade animates building protection from solar gain.

High Level View from the Roof of MSB

Proposed Site Layout



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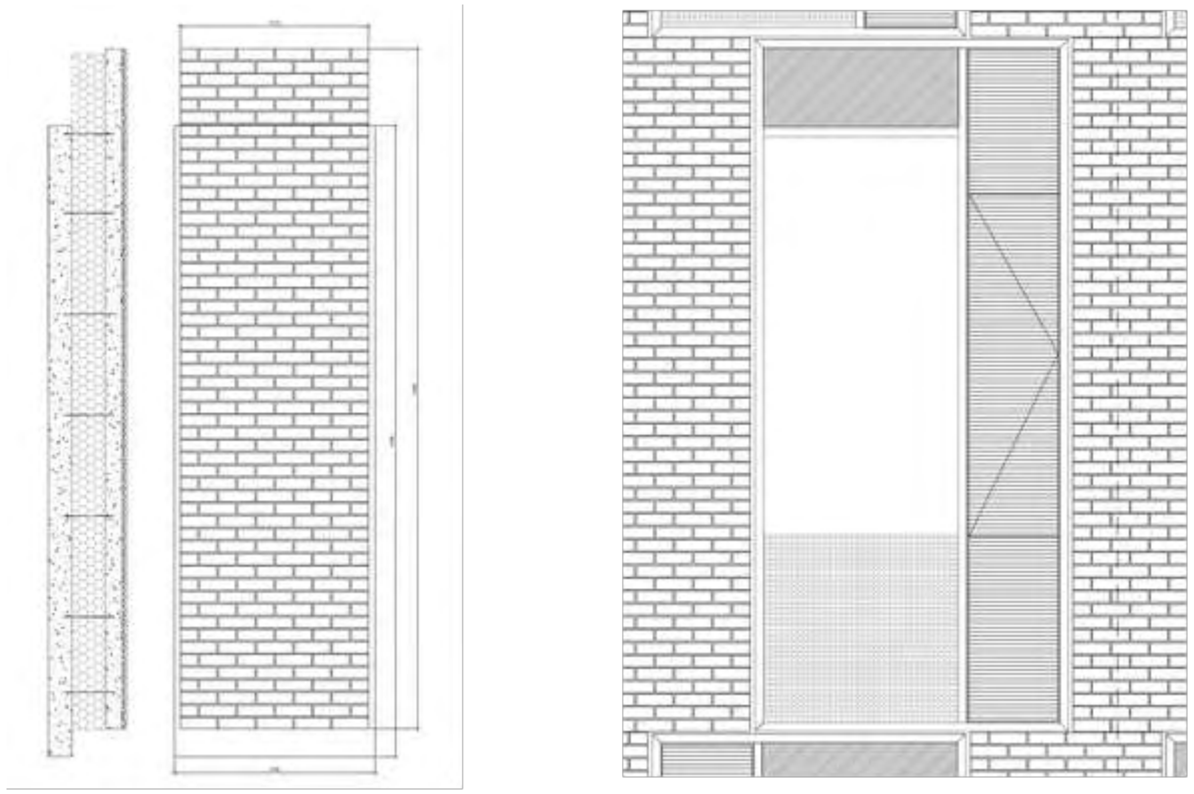
Contractor's Proposals – Environmental

Tender: Precast Concrete Sandwich Panel



ï Unitised curtain walling windows between precast brick slip clad panels

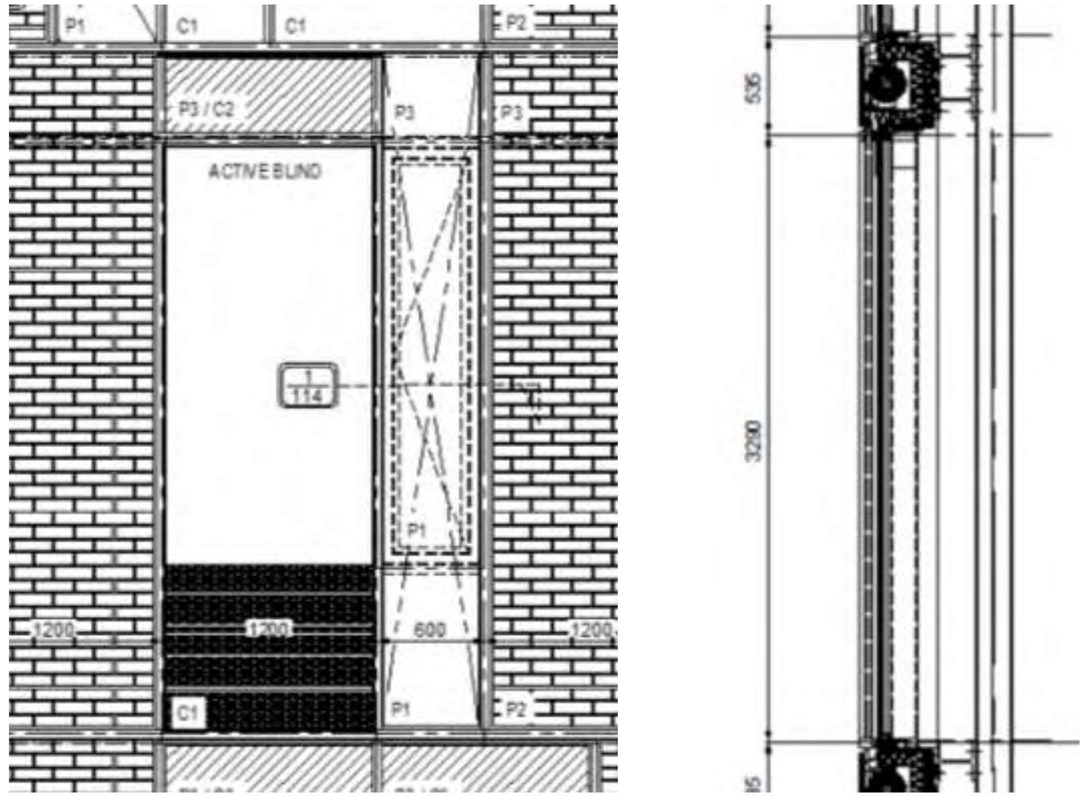
ï Air seals on all four sides

ï Opening vent panel behind fixed louvre

ï Individual blind box for each window

ï Thermal mass

CPs: Full Curtain Walling with Brick Slips



ï Full curtain walling faÁade ñ storey height screens

ï Brick slip panels fixed to insulated metal panels

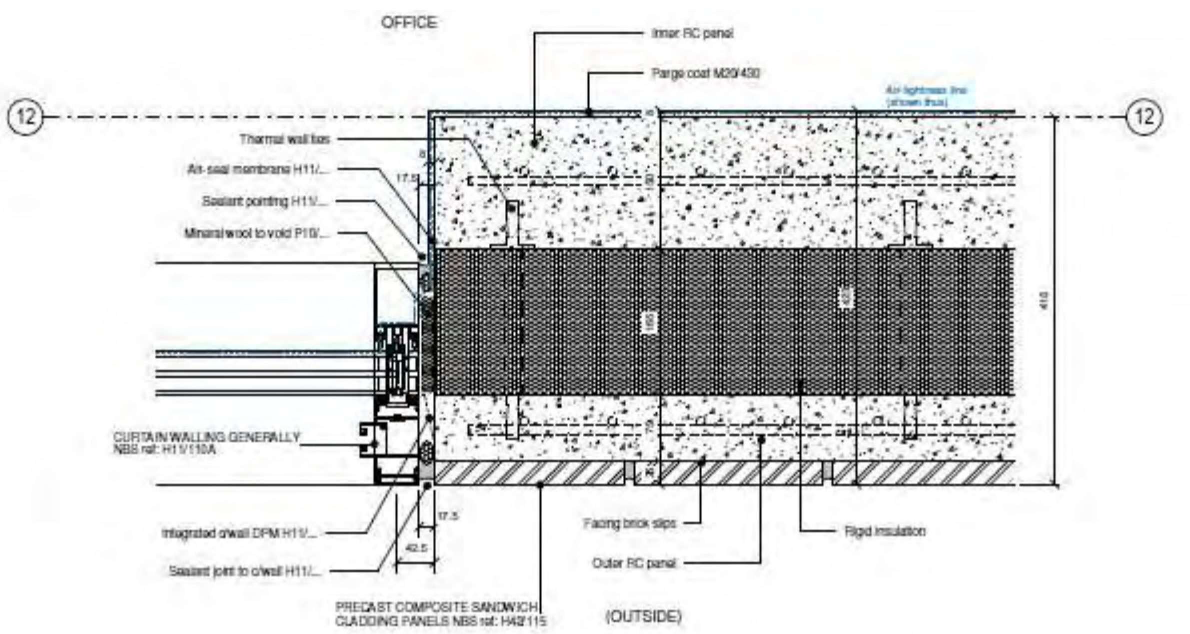
ï Reduced requirements air seals

ï Opening vent panel behind fixed louvre

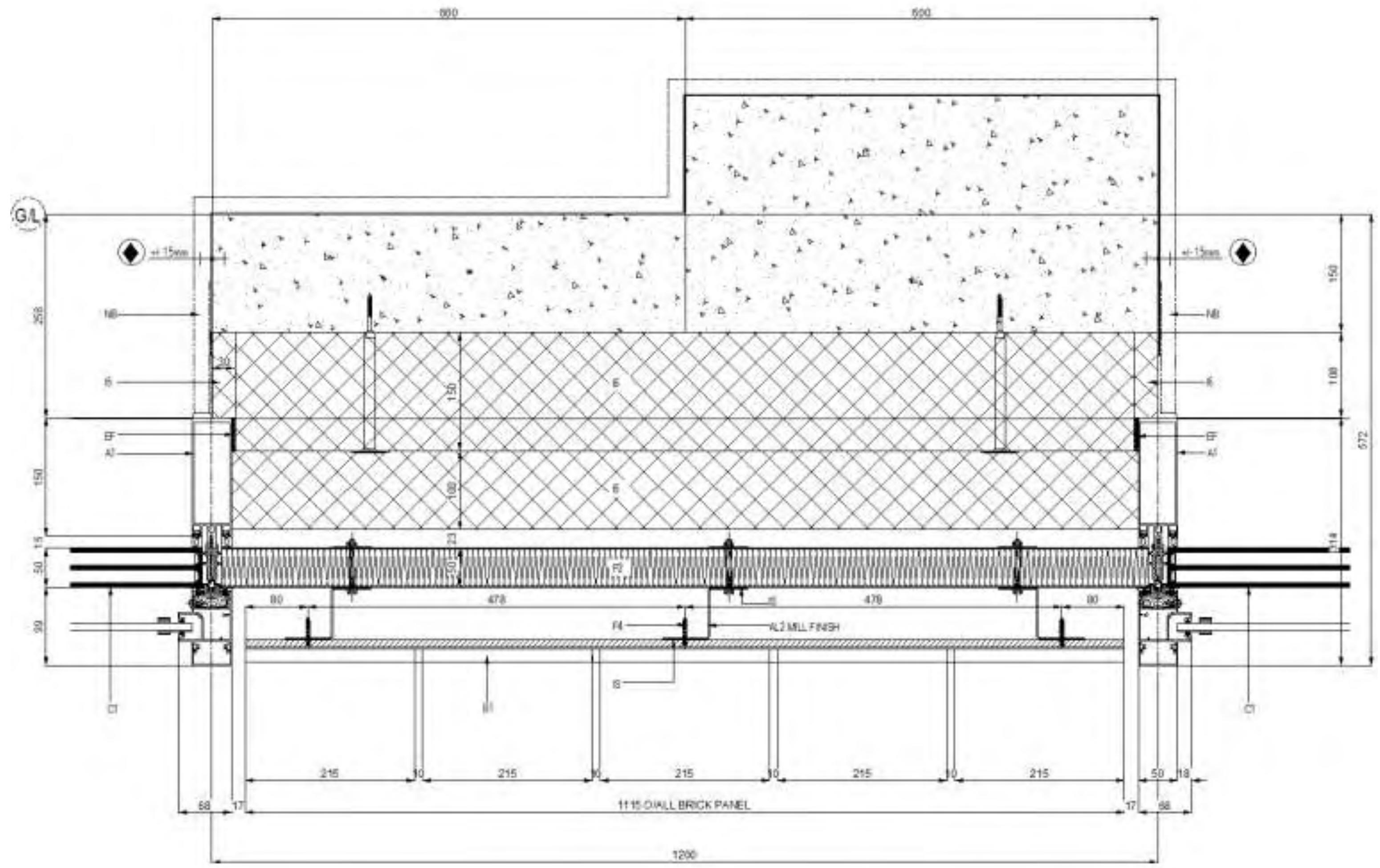
ï Continuous blind box around slab perimeter

ï Thermal mass replaced by non-structural infill

Tender: Precast Concrete Sandwich Panel



CPs: Full Curtain Walling with Brick Slips



Pros:

- Single subcontractor responsibility
- Easier construction
- Faster programme
- Tighter tolerances

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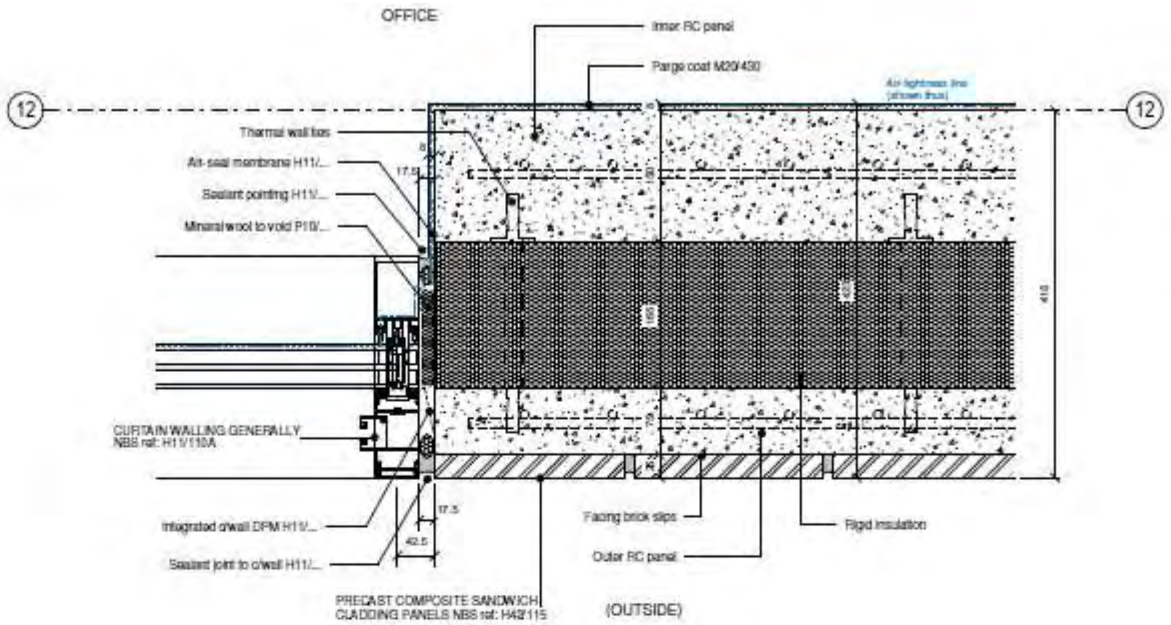
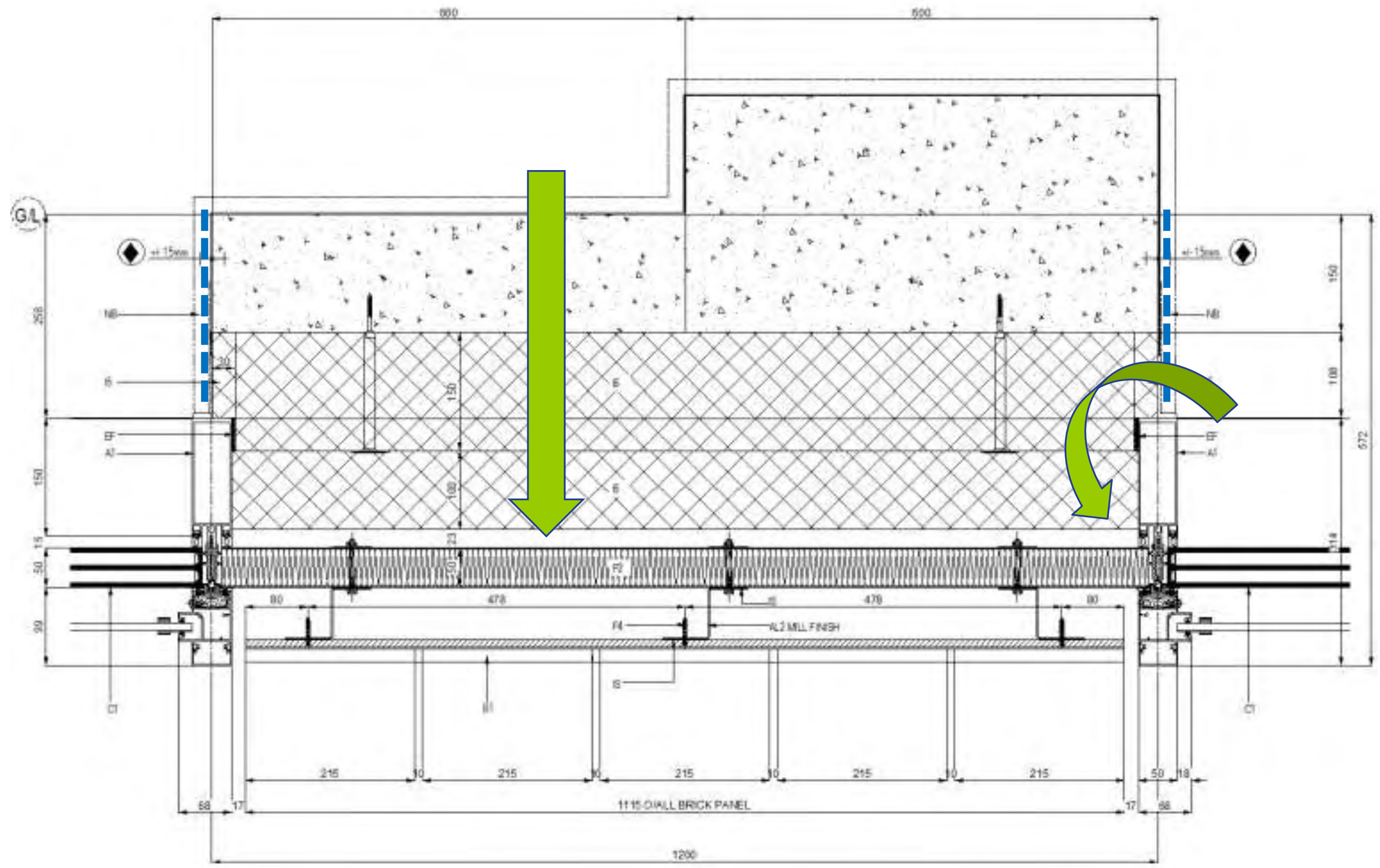
Tender: Precast Concrete Sandwich Panel



CPs: Full Curtain Walling with Brick Slips



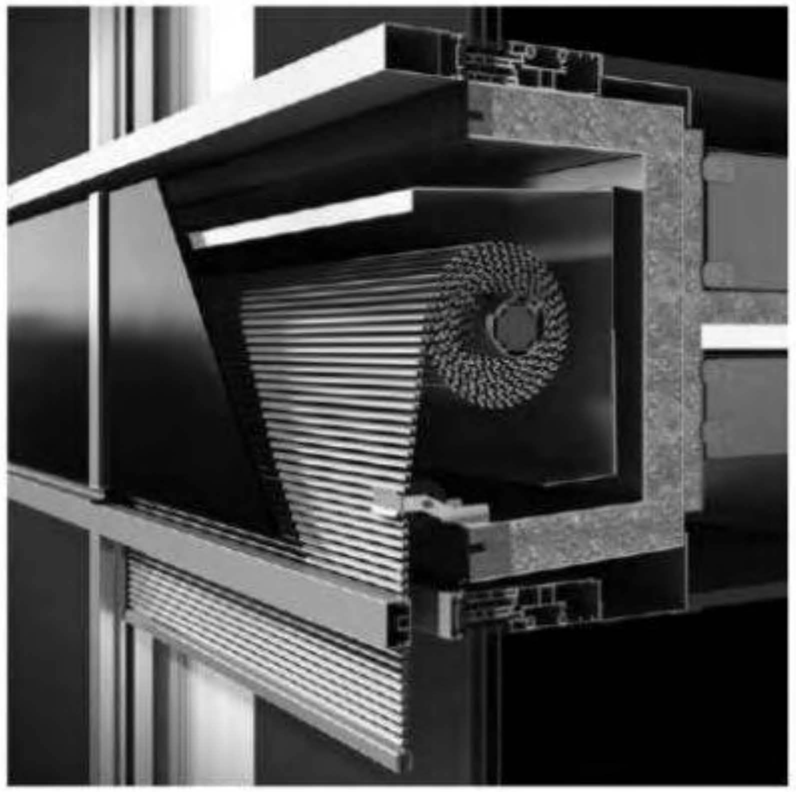
Cons:

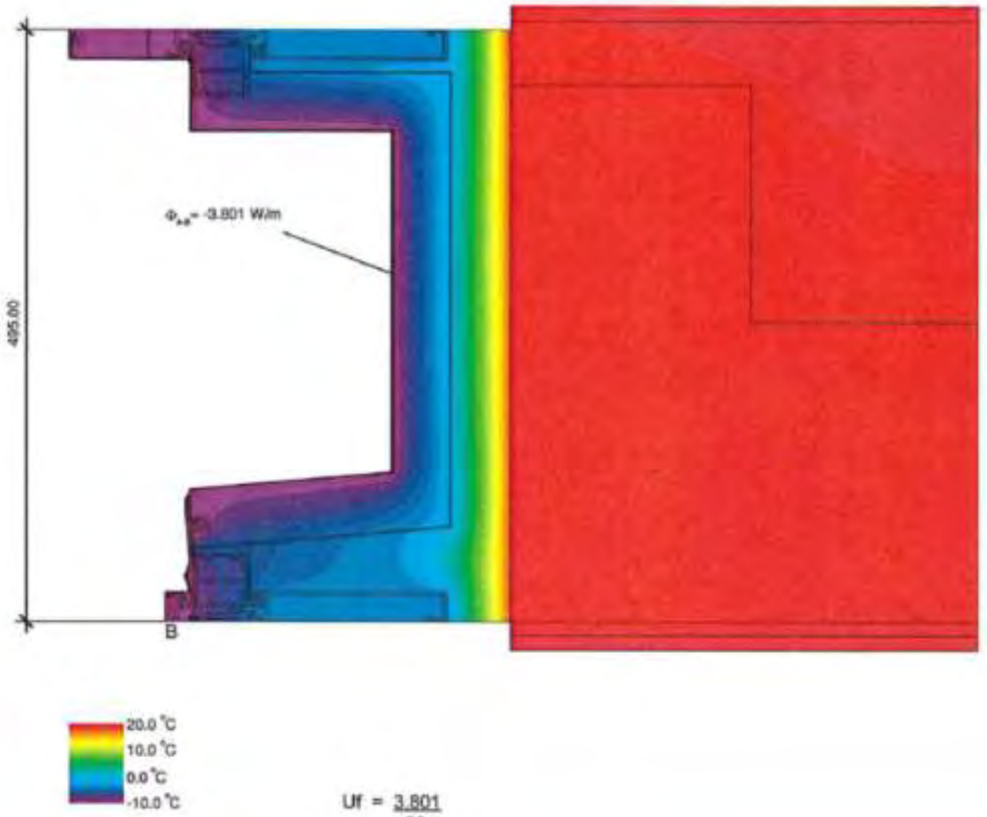
- Planning risk
- Additional movement joints
- Risk of interstitial condensation
- Additional seals / VCLs required
- Overall faÁade zone increased ~150mm
- Greater coordination with PT frame

SCHÜCO

External Shading Blinds

- CTB blinds - not used before in UK
- UoL nervousness about maintenance
- Automatic operation ñ linked to BMS
- Automatically retract in high winds
- Tender design - small sections
- Contract - continuous ëribboní
- Blind box - thermal weak link

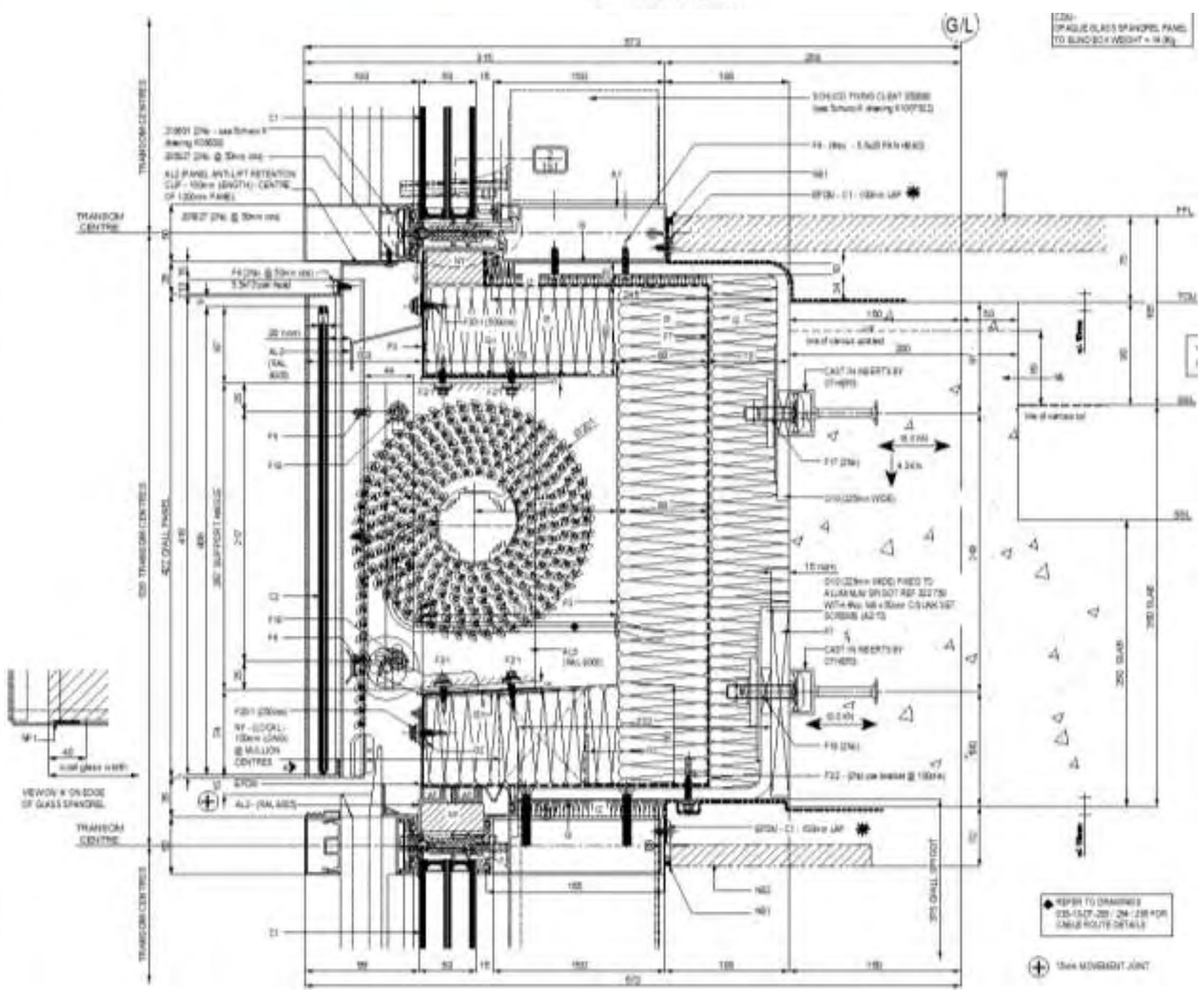


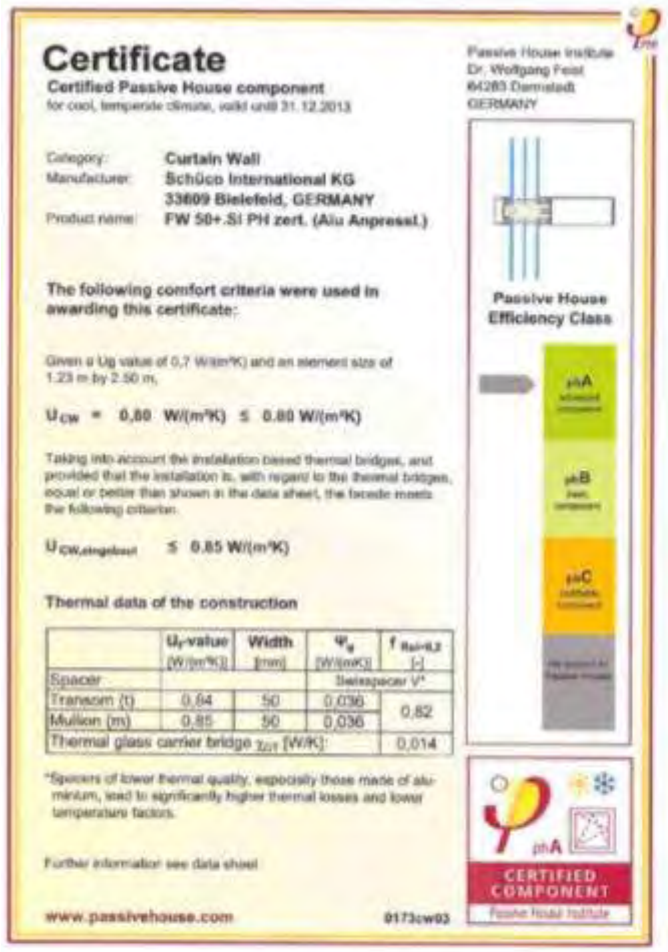


Uf = $\frac{3.801}{30}$

= $\frac{0.128}{0.495}$

Uf = 0.256 W/m²K





Certificate

Certified Passive House component

for cool, temperate climate, valid until 31.12.2013

Passive House Institute
Dr. Wolfgang Feist
64283 Darmstadt
GERMANY

Category: Curtain Wall

Manufacturer: Schüco International KG, 33609 Bielefeld, GERMANY

Product name: FW 50+.SI PH zert. (Alu Anpressl.)

The following comfort criteria were used in awarding this certificate:

Given a Ug value of 0,7 W/(m²K) and an element size of 1.23 m by 2.50 m,

U_{CW} = 0,80 W/(m²K) ≤ 0.80 W/(m²K)

Taking into account the installation based thermal bridges, and provided that the installation is, with regard to the thermal bridges, equal or better than shown in the data sheet, the facade meets the following criterion:

$U_{CW,eingebaut}$ ≤ 0.85 W/(m²K)

Passive House Efficiency Class

phA advanced component

phB basic component

phC certifiable component

Thermal data of the construction

	U_f-value [W/(m²K)]	Width [mm]	Ψ_g [W/(mK)]	$f_{Rsi=0,25}$ [-]
Spacer			Swisspacer V*	
Transom (t)	0.84	50	0.036	0.82
Mullion (m)	0.85	50	0.036	
Thermal glass carrier bridge χ_{GT} [W/K]:				0.014

*Spacers of lower thermal quality, especially those made of aluminium, lead to significantly higher thermal losses and lower temperature factors.

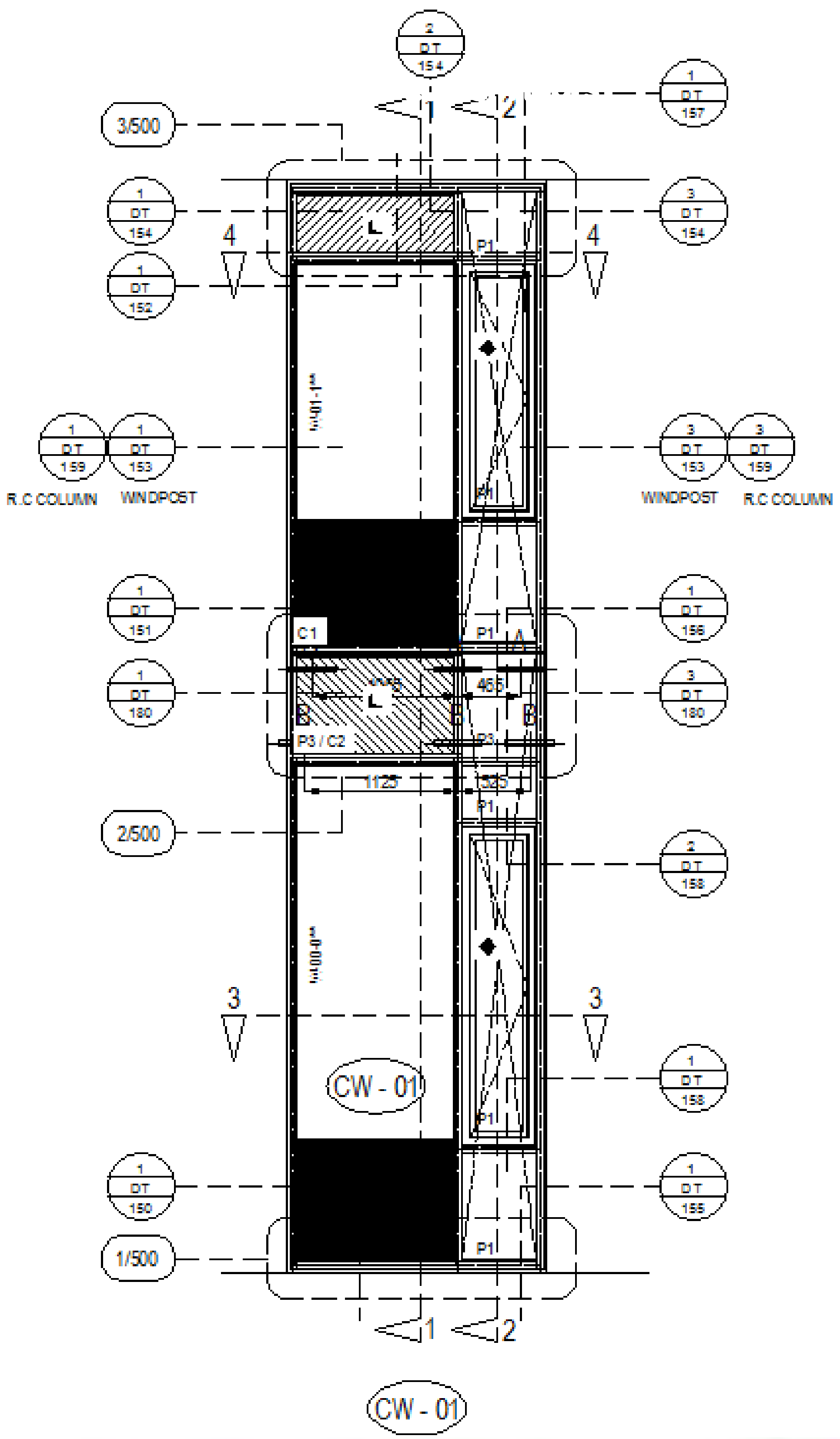
Further information see data sheet

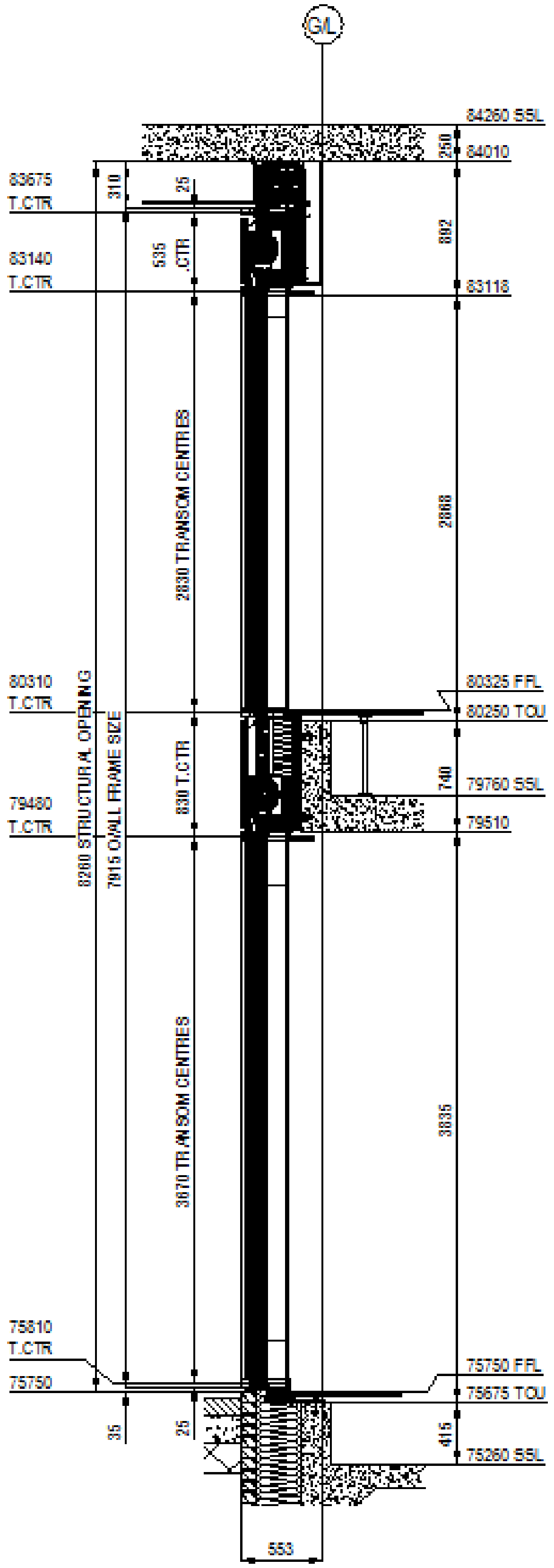
www.passivehouse.com 0173cw03

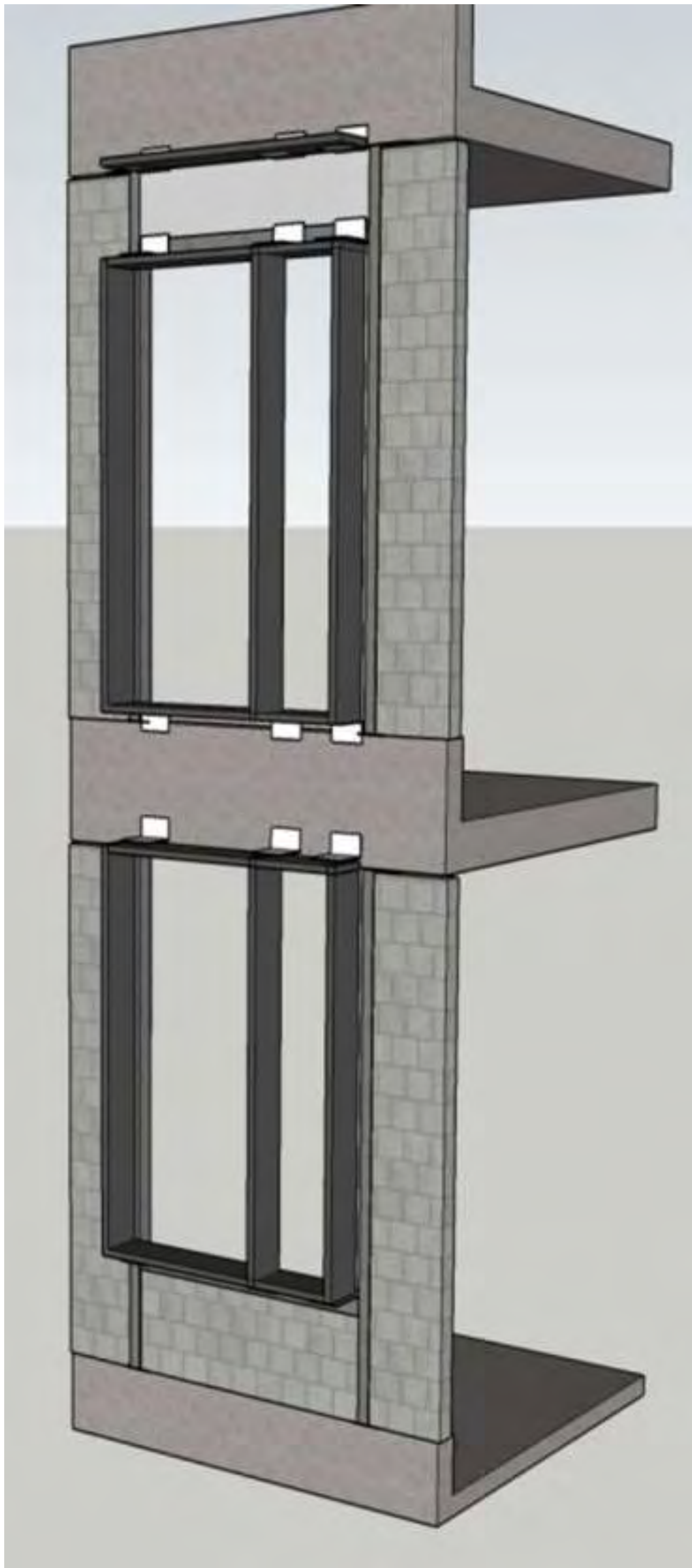
CERTIFIED COMPONENT
Passive House Institute

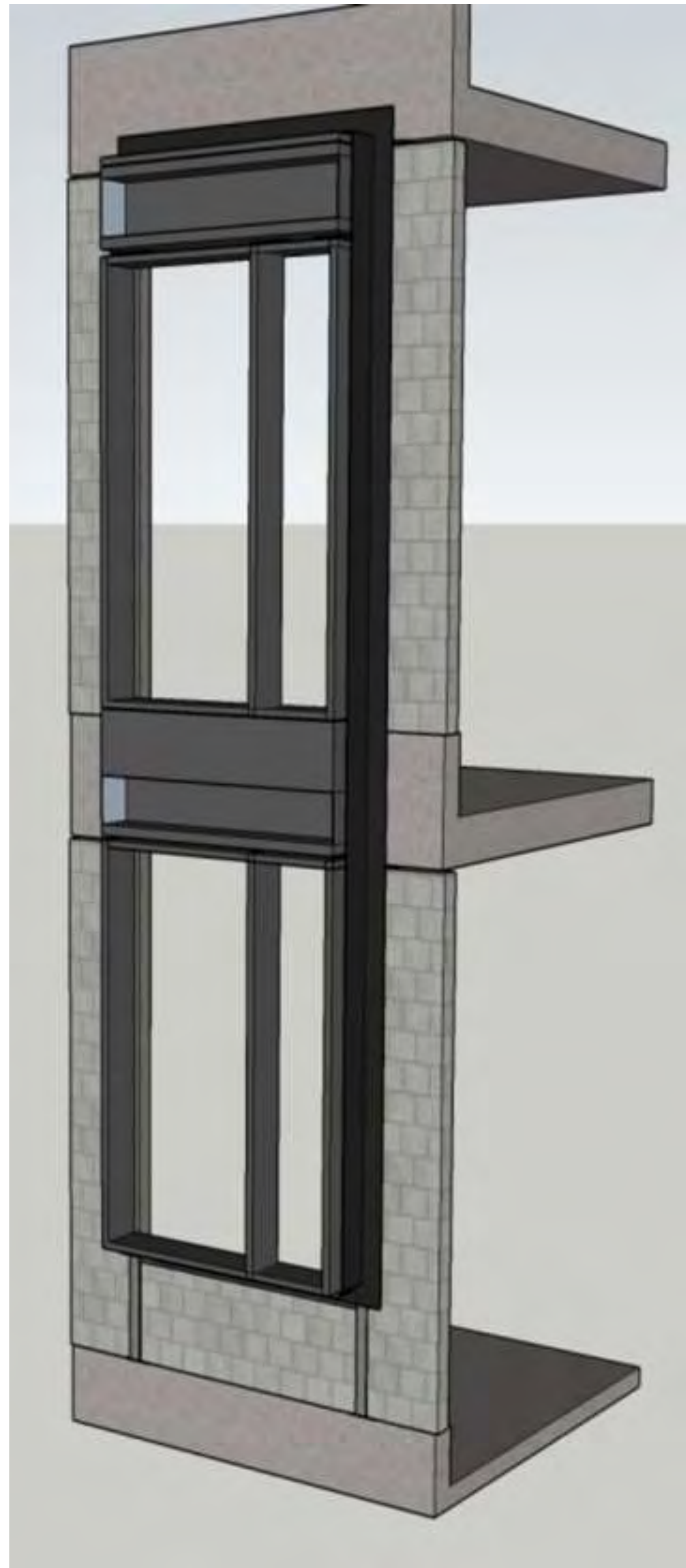
University of Leicester

AssociatedArchitects









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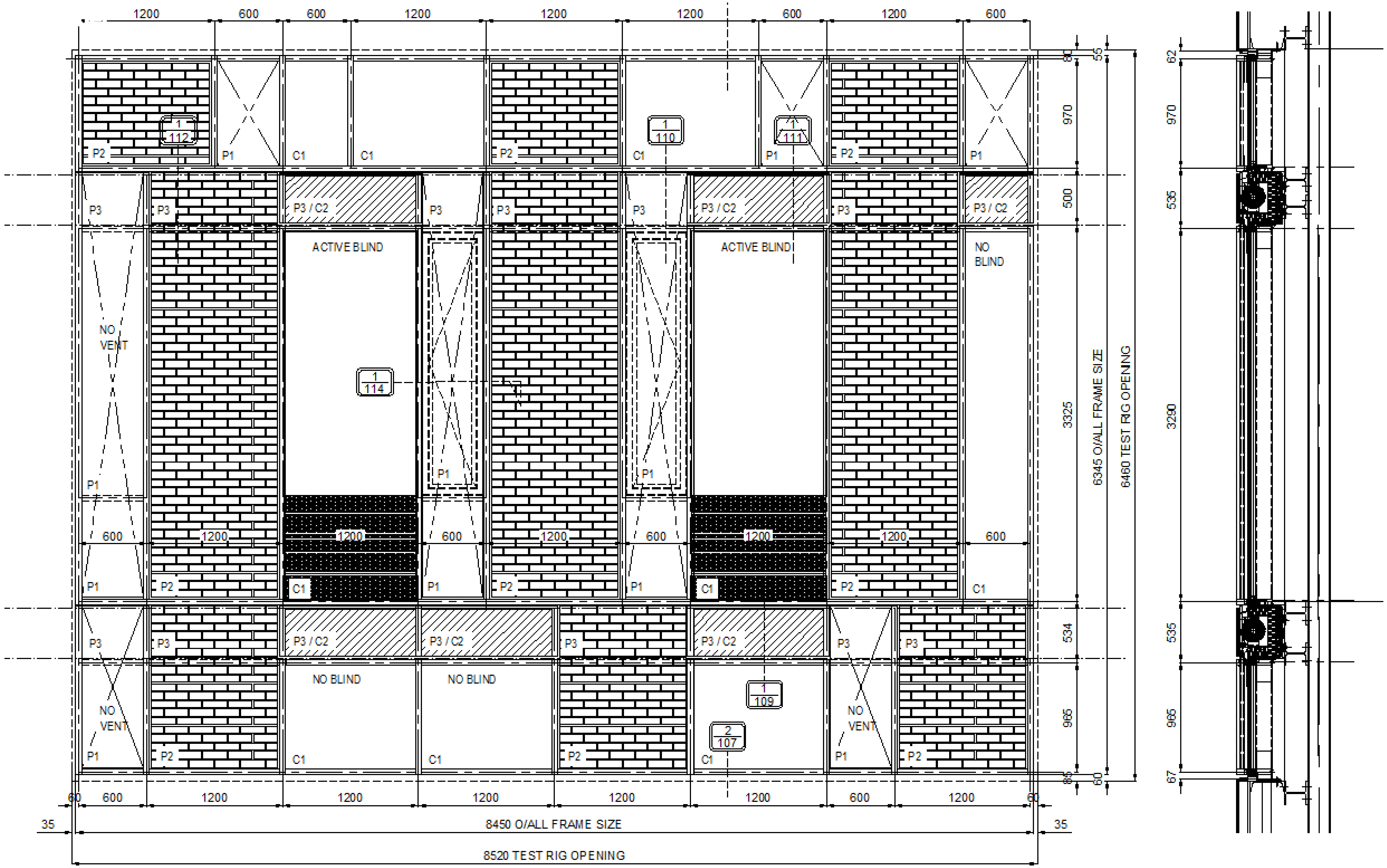

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Façade Mock-Up Panel

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Thermal Envelope

Tender:

Roof top plant rooms outside thermal envelope

Basement plant room inside the thermal envelope

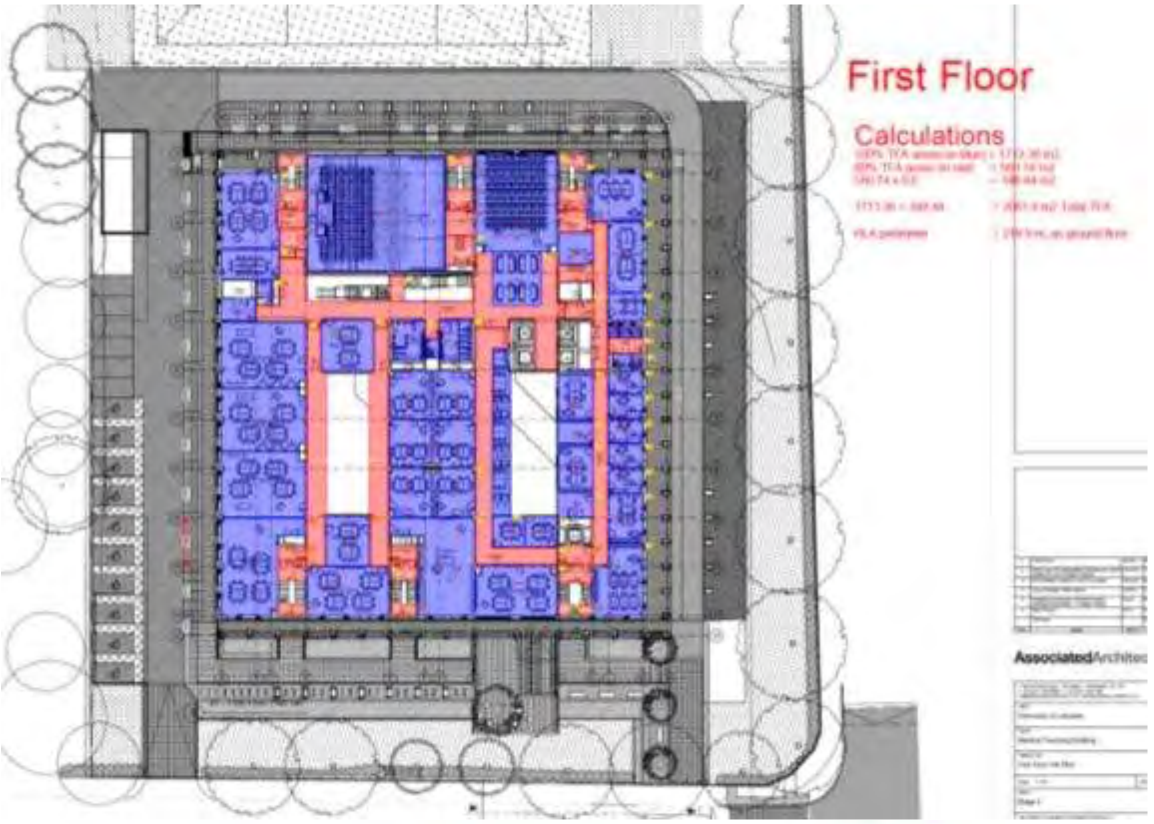
Contract:

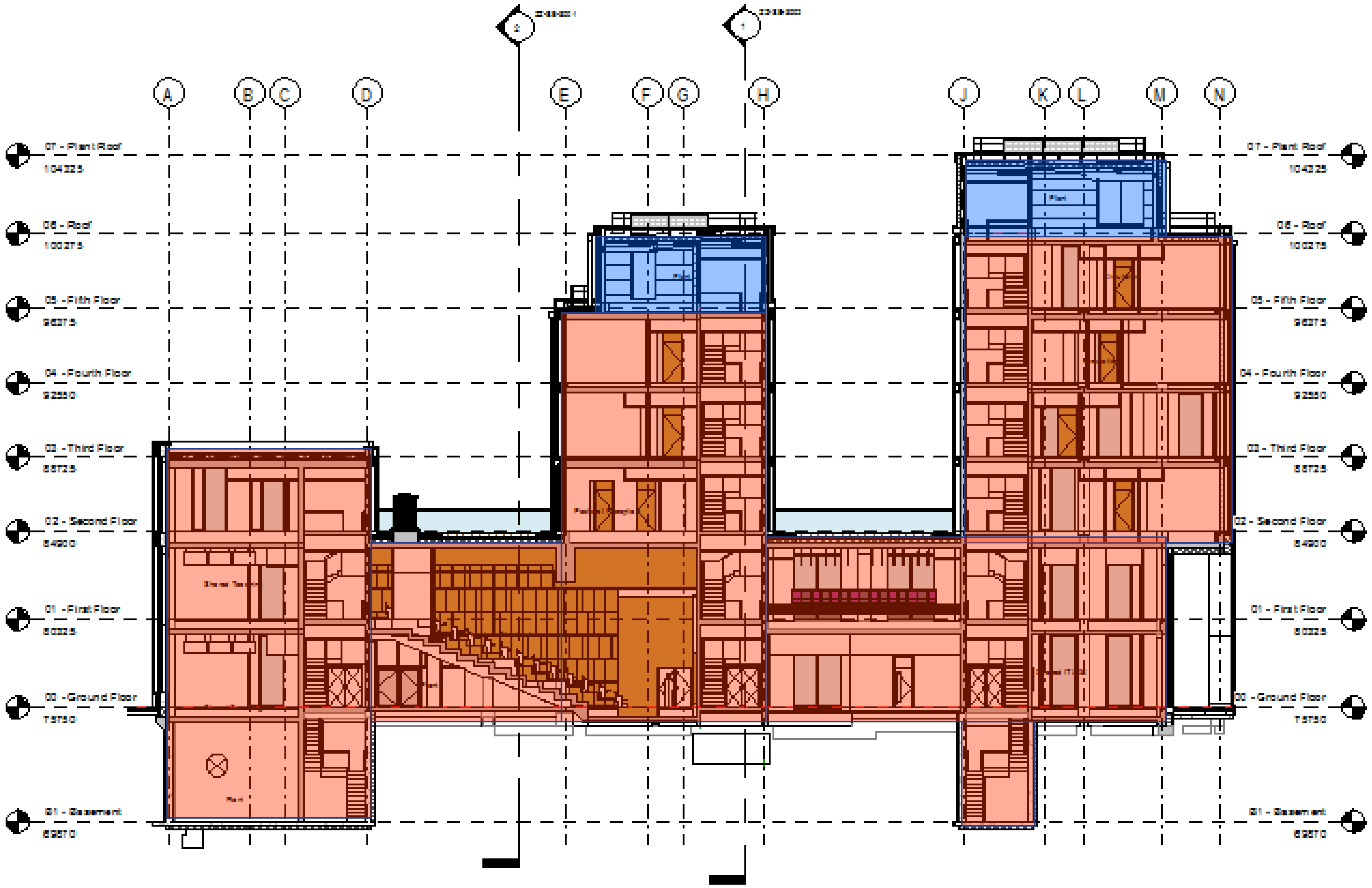
All plant rooms inside thermal envelope

Increased ëTreated Floor Areaí

Ventilation duct runs ñ inside thermal envelope

Simplification of scheme



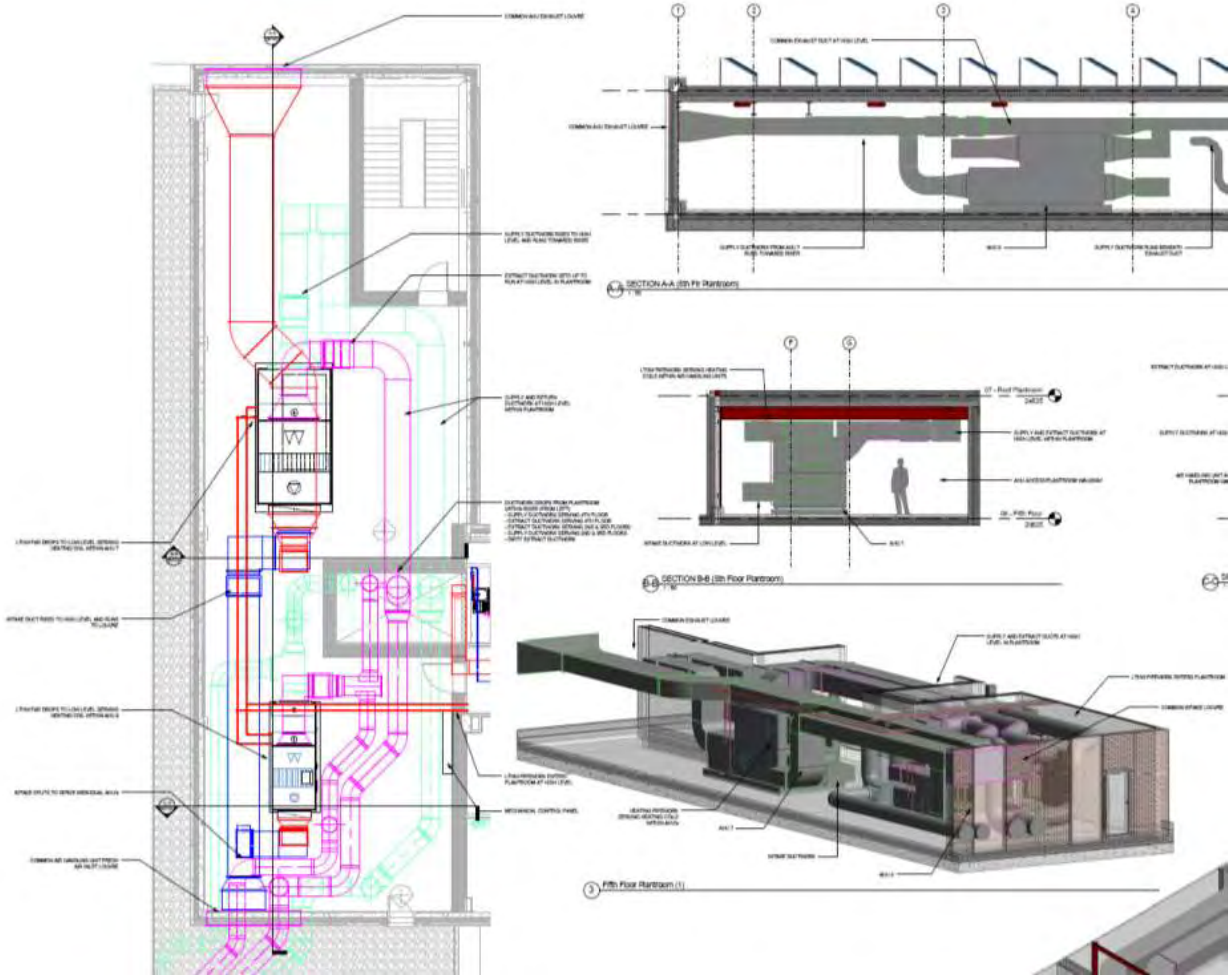


Cold Duct Runs

ïExtensive cold duct runs within envelope

ïPlant room layouts changed to minimise cold duct runs

ïSuitable AHUs ñ not available as PH certified products



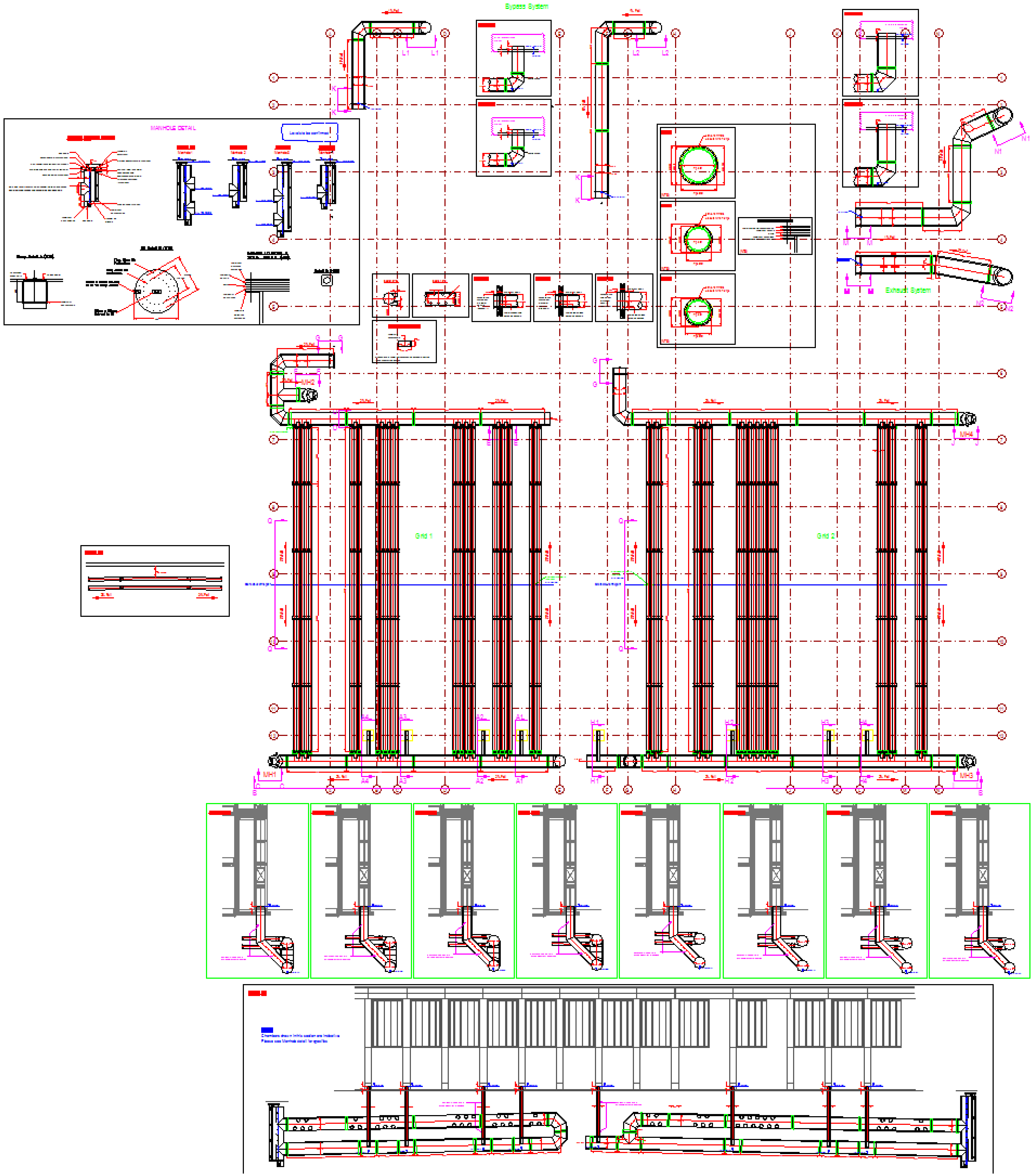
Thermal Bridging

- Minimising thermal bridging is crucial
- Couldnít all be eradicated or calculated prior to contract
- Schedule of thermal bridges compiled
- WDES did thermal modelling
- Pile caps insulated on all sides, piles not insulated
- Thermal pads included on all steelwork connections
- GRC cladding changed to insulated render

	Base 2A estimate		WD proposal	
Thermal bridge description	Ψ W/(mK)	% losses	Ψ W/(mK)	% losses
Balustrade/mansafe fixings	0.000		0.000	
Parapet wall	0.150	1.5%	0.100	1.5%
Plant room upstands for walls	0.200	0.7%	0.200	
Plantroom to internal space	0.000		0.000	
Rooflight upstands - will be insulated			0.200	
Wall-roof with ballustrade	0.200	0.1%	0.100	0.0%
W 13 Inverted wall-roof junction	0.200	1.0%	0.048	0.3%
Rooflight-wall junction	0.300	0.6%	0.300	0.7%
Thresholds…	0.200		0.200	
Wall-window junction	0.070		0.070	
shade support fixings				
structure (columns & floors) into walls	0.000		0.000	
W 14 Collonade soffit to wall beneath	0.050	0.1%	0.075	0.2%
Cladding support to collonade soffit & wall - e	0.100	0.7%	0.100	
Collonade CONC soffit to support column	4.000	1.9%	4.000	2.2%
Collonade STEEL soffit to support column	4.000	1.6%	0.650	0.3%
Windposts			0.000	
Ground pile caps in basement - various configur	1.500	0.8%	1.500	0.9%
Ground floor single piles in centre of floor	1.500	1.4%	1.500	1.4%
Ground floor single piles at perimeter	1.000	0.5%	0.770	0.2%
Perimeter ground beam	0.100	0.2%	0.000	
		10.9%		7.7%

Ground-Air Heat Exchanger

- Redesigned to ease construction
- GAHE located beneath the building
- Extensive coordination ñ design period increased
- Vent towers integrated into ëdummyí columns
- Verifying the efficiency of the system to suit PHI
- Very deep excavations
- Installation took longer than anticipated



08 September 2014

Conclusions

- On track - September 2015 and Passivhaus certification
- Difficulties sourcing products to suit the aesthetic
- Lack of Passivhaus knowledge and experience amongst contractors
- PHPP proved a useful design tool
- Effective communication of key design requirements - ?
- Site supervision - ?
- Increased capital costs for Passivhaus have fallen
- Achieving DEC A will be a challenge