

Scaling Up Passivhaus
The Centre for Medicine, University of Leicester

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Overview of the Client Brief:

- Bring together the Schools of Medicine, Health Sciences and Psychology
 - Sensitive to context – ecology and heritage
 - Contribute towards reducing the University's carbon footprint
 - 13,000sqm of teaching, research and support space
 - 2,400 occupants
 - EPC 'A' and DEC 'A'
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- 60% carbon emissions reduction by 2020
 - Develop and refurbish the estate to minimise carbon
 - Increased energy efficiency in operation
 - Improved communication about carbon and energy savings.



Adoption of Passivhaus

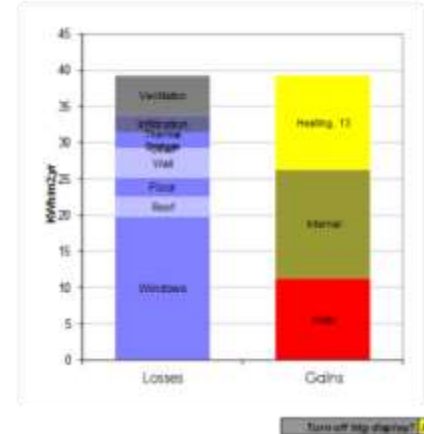
- Proven ability to deliver low energy buildings
- Low base energy demand
- Prioritises user comfort
- Walls 0.13W/m²/k
- Roof 0.13W/m²/k
- Floor 0.13W/m²/k
- Airtightness Target: 1m³/m²/hr @ 50Pa (0.33 ac/h)
- Treated Floor Area: 9700m²
- Exposed thermal mass to regulate internal temperatures
- Ground Air Heat Exchange labyrinth
- District heating
- PV solar renewables

Treated floor area: 9,855 m²

Annual Heat balance kWh/m²

Losses	Gains
Windows	19.8
Roof	2.7
Floor	2.6
Walls	3.9
Other	0.2
Thermal Mass	0.0
Heating	2.1
Cooling	2.3
Internal	5.8
External	11.4
Net	14.9
Total	19.8

Heat losses:

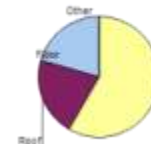


Window breakdown

	Losses W/m ²	Gains W/m ²	Balance W/m ²	Area m ² (% 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	-0.7	721.2 (8.8%)
West	6.2	2.4	-3.8	1,556.5 (19.0%)
Horizontal	1.3	2.4	1.1	232.4 (2.8%)
Total	19.8	12.1	-7.7	4,851.7 (56.7%)

Heat loss form factor

(what is it?)	
Heat loss form factor	
Walls	5.0
Roof	5.5
Floor	5.0
Other	0.0
Total	15.5



Average fabric U value required: 0.277 W/m² K
Average fabric U value of design: 0.232 W/m² K

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 slab	25,222 kWh/a
5 Exterior TB (length/m)	16,388 kWh/a



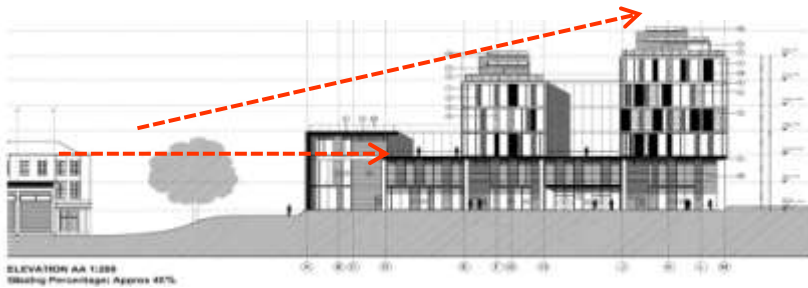
Planning Context

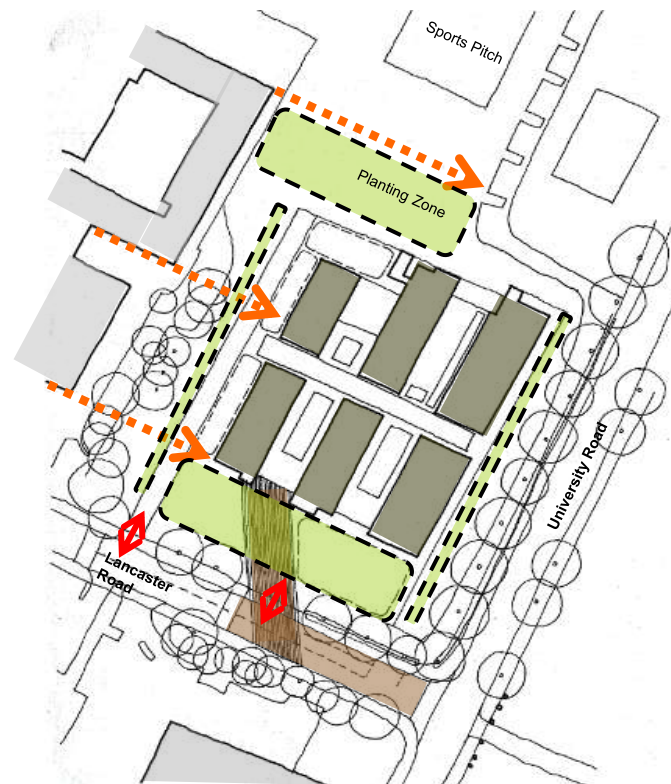
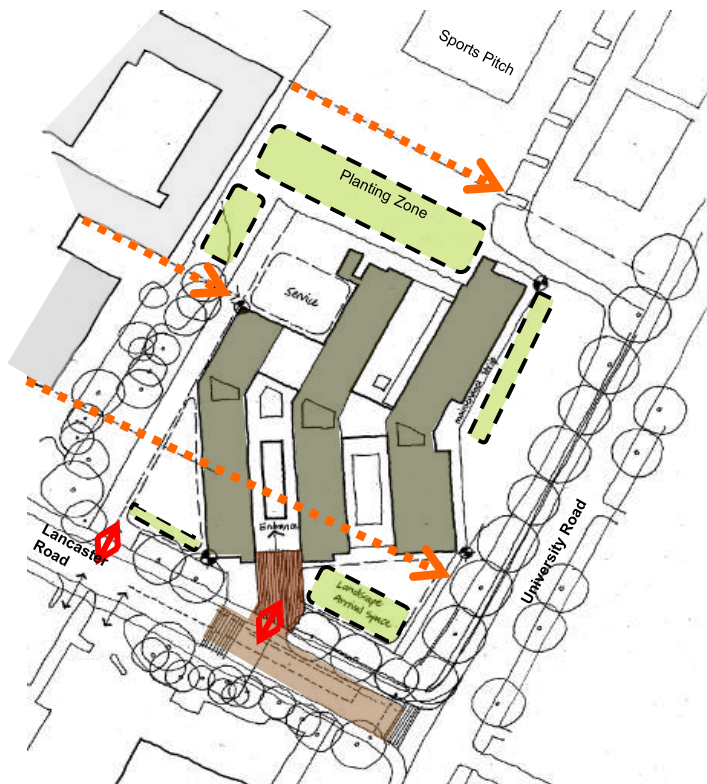
- Adjacent to locally listed building
- Conservation Area
- Listed Fire Station Cottages
- Protected trees on site boundary
- Protected views
- Risk of overshadowing
- Loss of open space & playing fields
- Ecological impact
- Concerns over car parking provision
- Bomb shelter & archaeology



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





Building Form

- 2 Storey plinth
- Deep plan spaces
- Rooflights for daylight
- Narrow floor plates above
- Basement and rooftop plant
- Active solar shading
- Natural ventilation
- Specialist spaces



Atria



Atria



Specialist Spaces

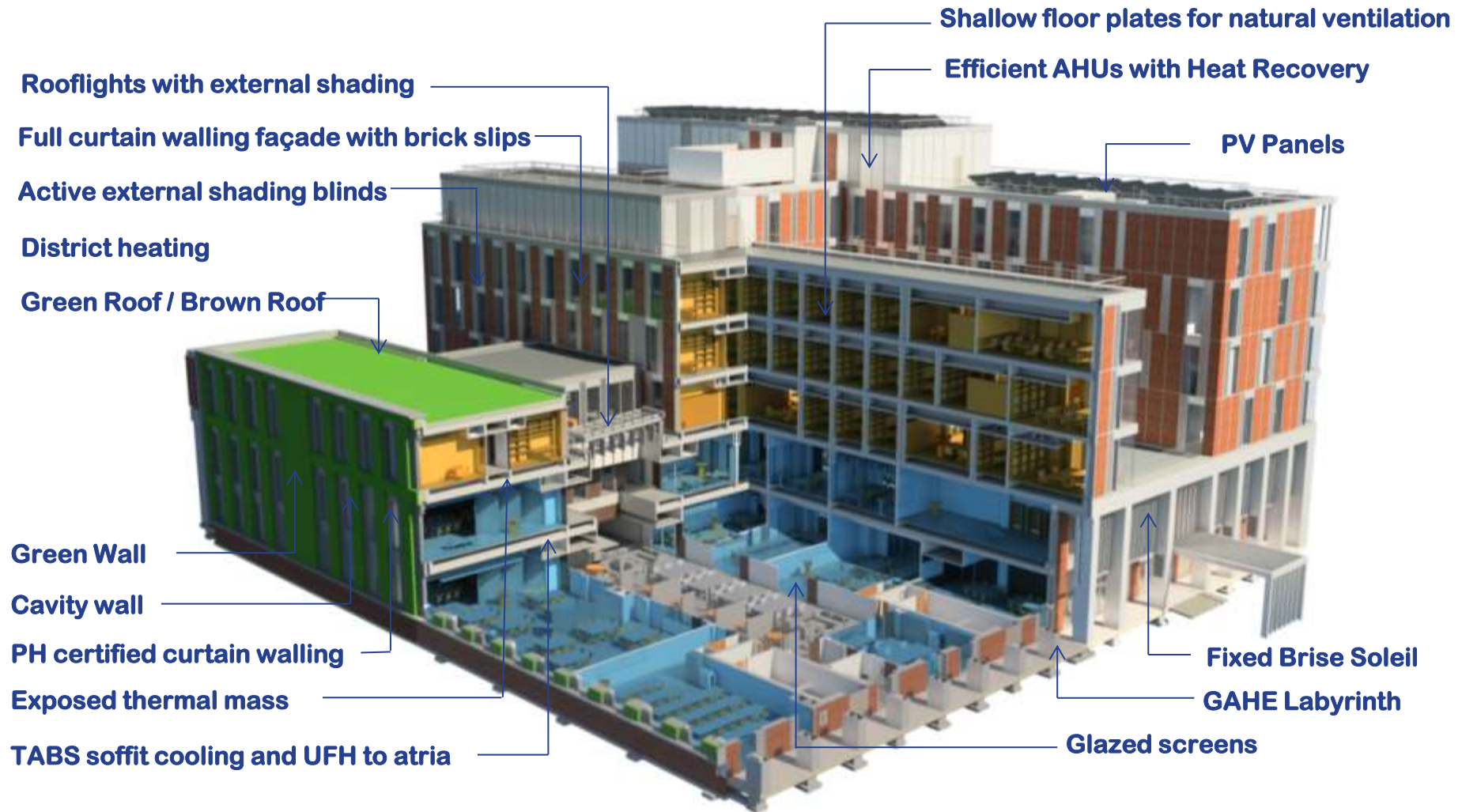


Teaching Spaces



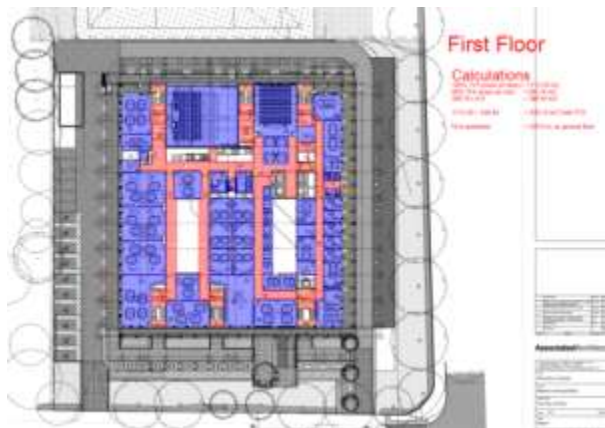
Teaching Spaces



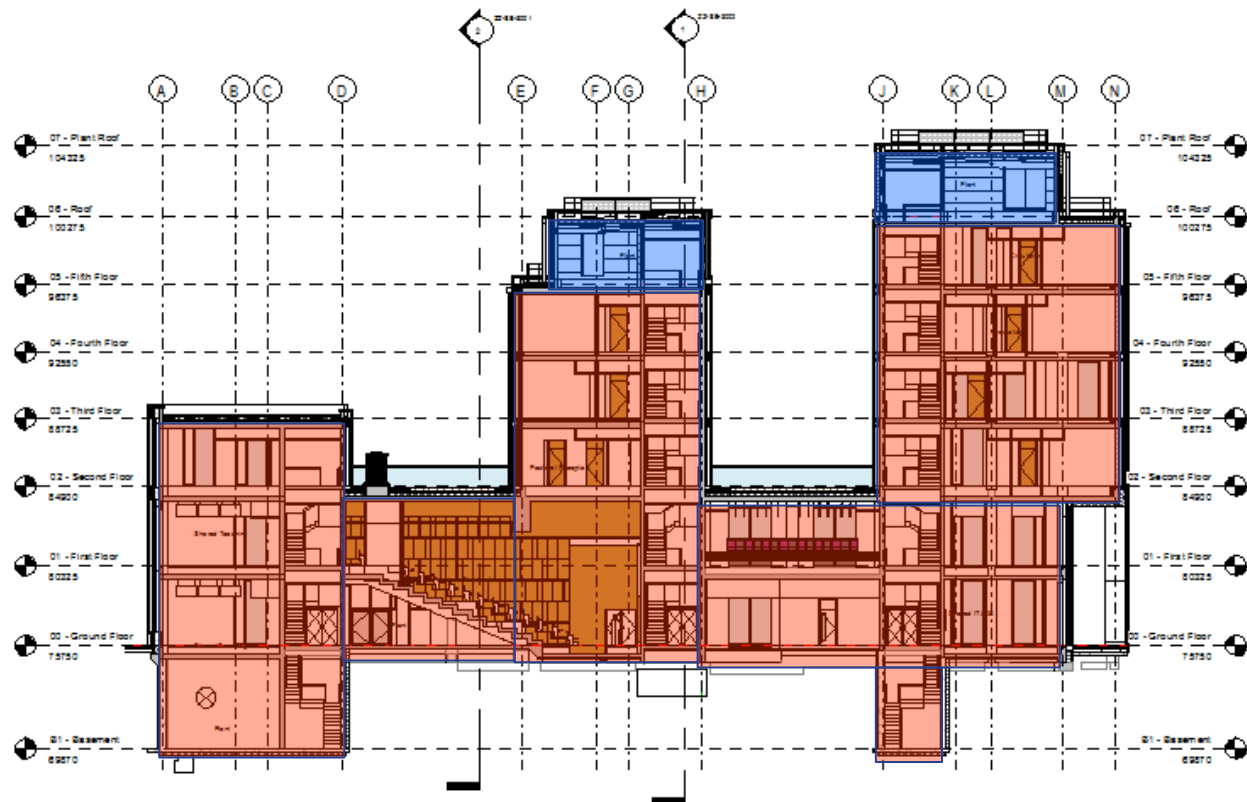


Post tender design development

All plant rooms brought inside thermal envelope

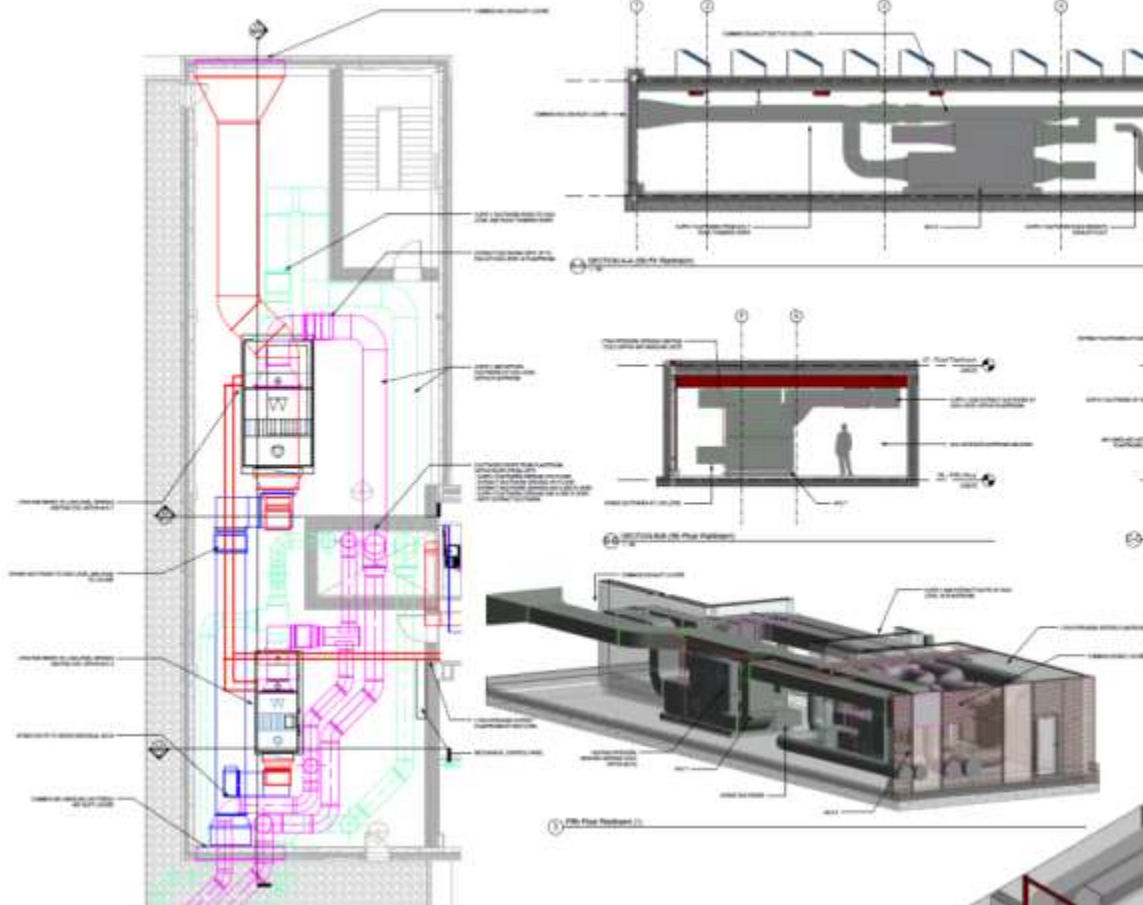


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Post tender design development

Plant room layouts revised to minimise cold duct-runs within envelope



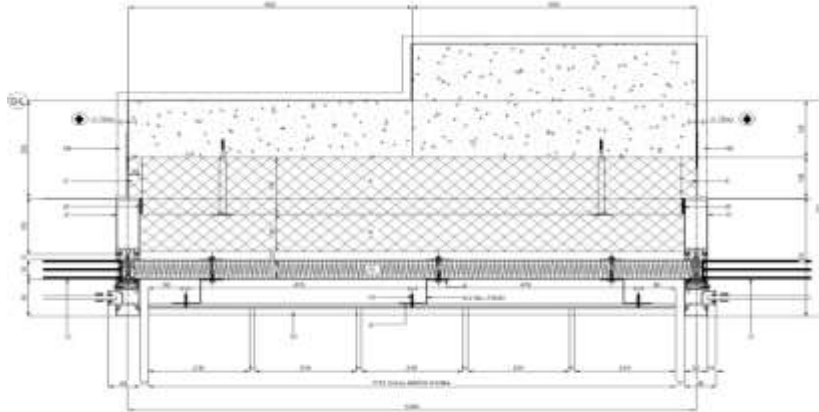
Masonry Cavity Construction



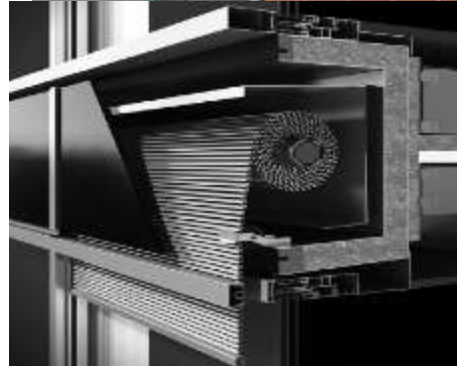
- 300mm cavity with full fill insulation
- Low conductivity brick ties
- Wet plaster as internal airtightness line
- Windows formed from curtain walling
- Windposts required due to size of openings



C/Walling with Brick Slips



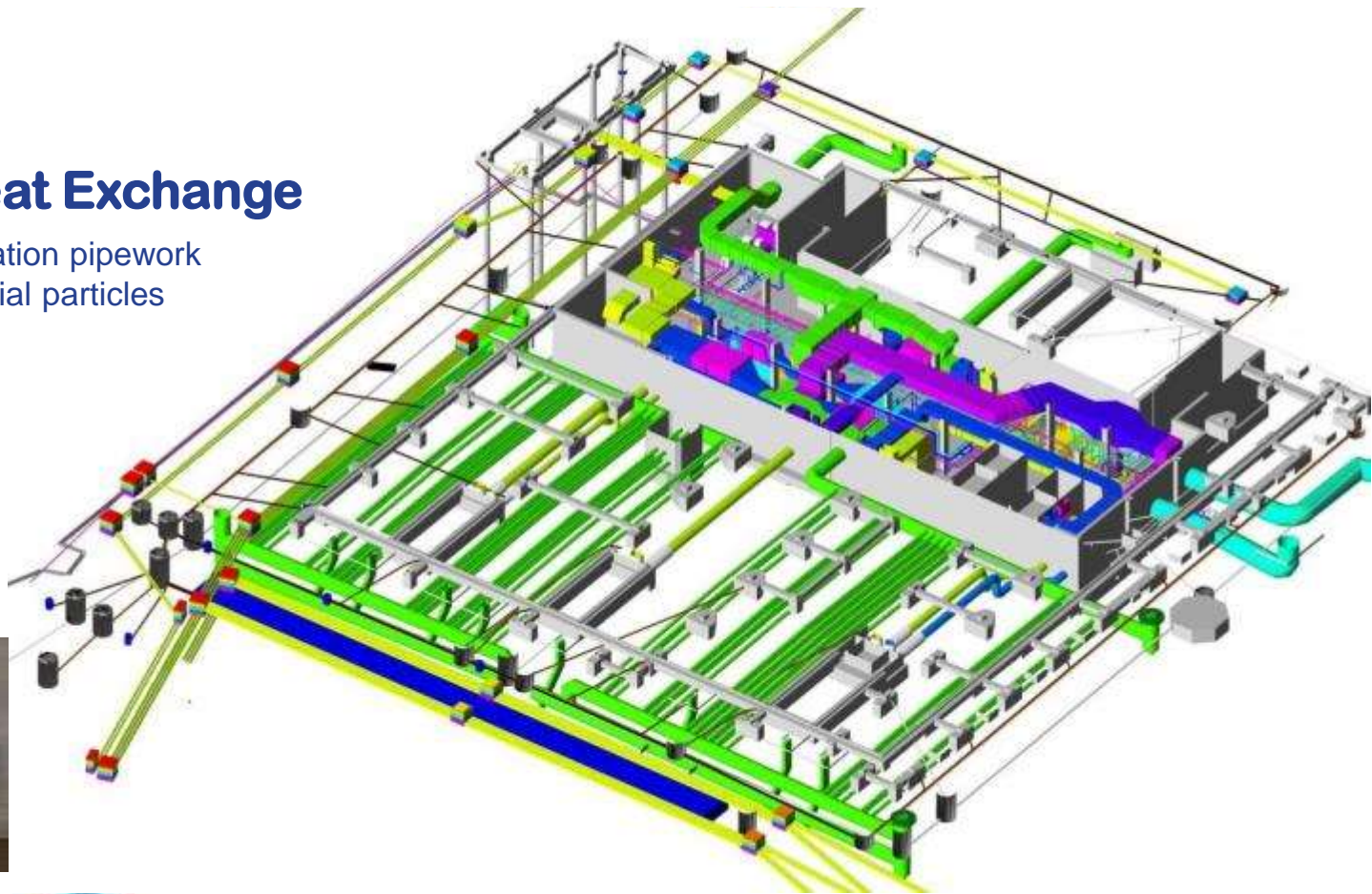
- Single subcontractor responsibility
- Faster construction programme
- Tighter tolerances
- PH certified products
- Incorporates vent panels and external shading blinds



Building component	U value (W.m²K)
Masonry	0.11
Glazing	0.57
Roller blind boxes	0.4
Opening panels	0.4
Brick cladding	0.1
CW frame	0.85
Roof	0.13
Ground	0.13

Ground Air Heat Exchange

1.6 Kilometers of ventilation pipework
lined in silver antibacterial particles



Contractor's Challenges

Design and Procurement Stage

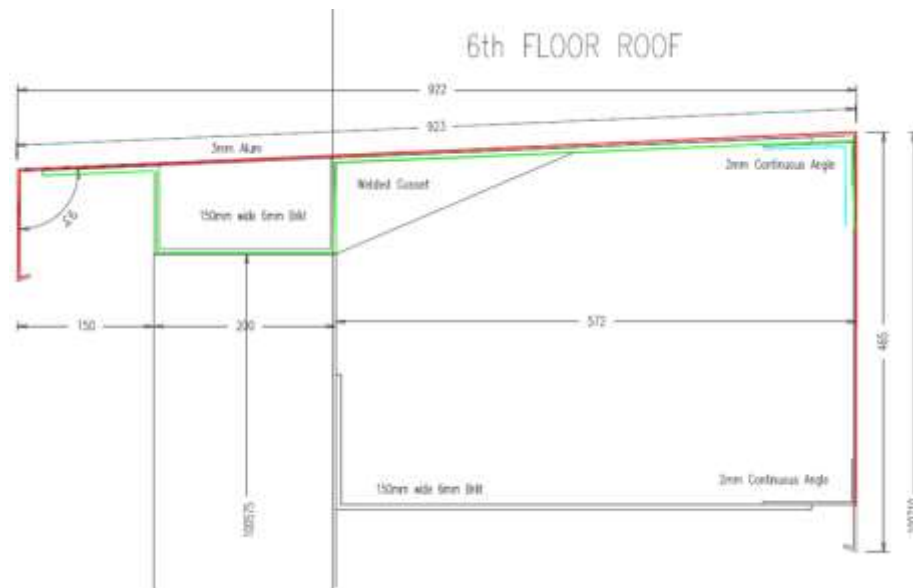
- » Main contract procurement route – Single stage D&B ?
- » Sub-contractor procurement – design responsibility and timing ?



Contractor's Challenges

Design and Procurement Stage

- » Simplicity of design and detailing needed
- » Structural materials choices for air-tightness and thermal bridging



Contractor's Challenges

Design and Procurement Stage

- » Integration of insulation to the slab/foundations for multi-storey structures



Contractor's Challenges

Construction Stage

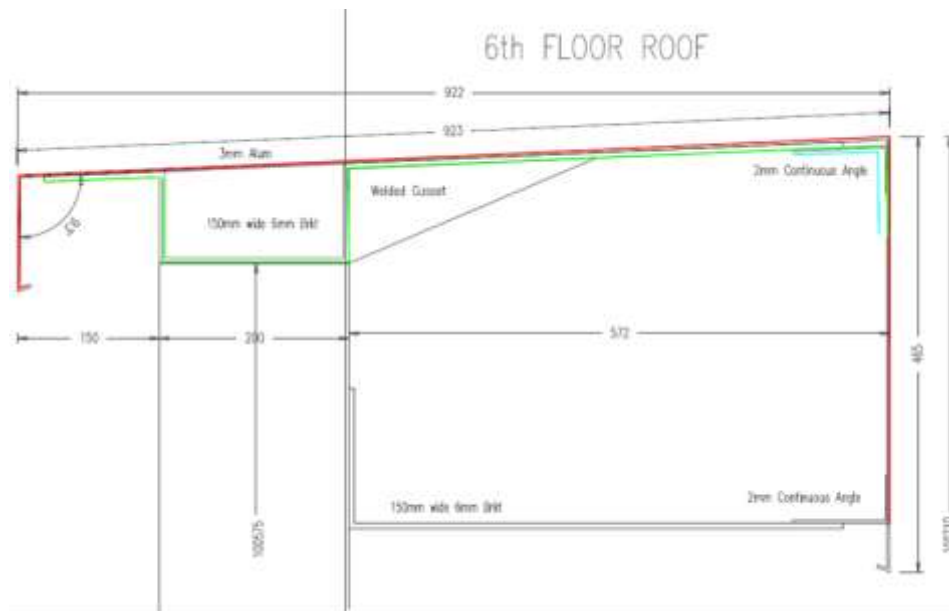
- » Programme challenges with ground ducts and piled foundations

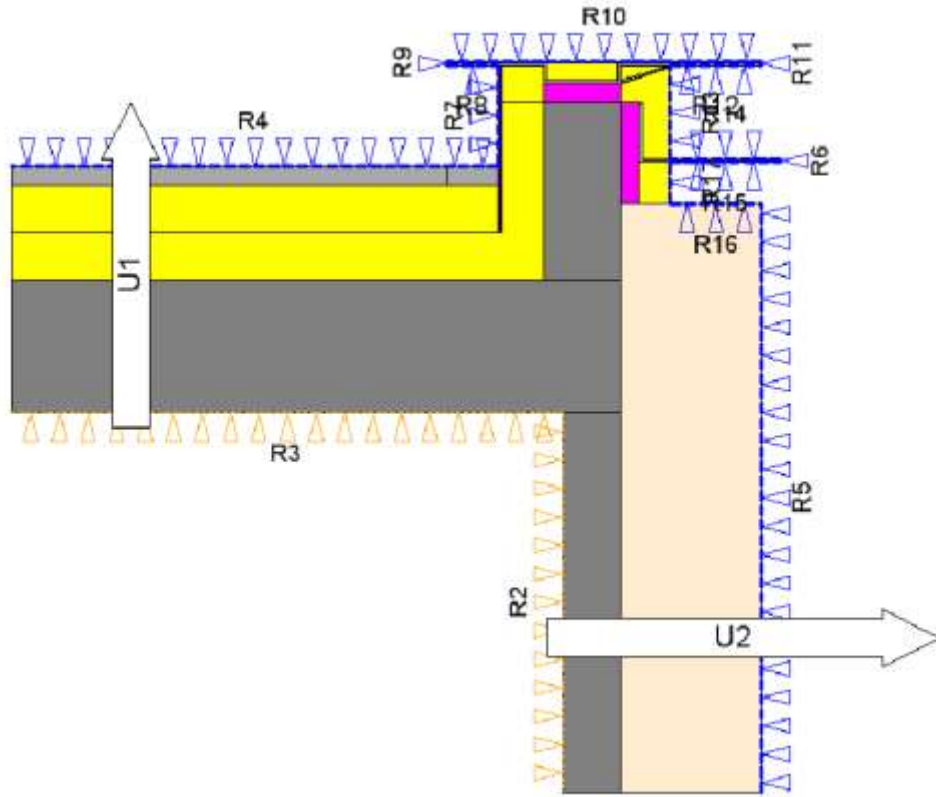


Contractor's Challenges

Construction Stage

- » Resources required for specialist PH designer support throughout the project
- » Late design changes impacting on PHPP margins



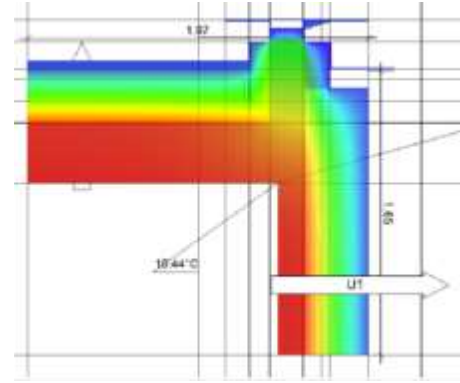


Foamglass block $\lambda = 0.041 \text{ W/(m}\cdot\text{K)}$

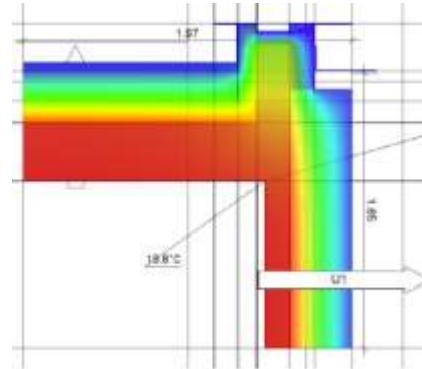


Final design:
Standard roof Insulation
 $\lambda_D = 0.038 \text{ W/(m}\cdot\text{K)}$

During construction continuity of
insulation was checked and rectified



$\Psi = 0.210 \text{ W/m.K}$



$\Psi = 0.105 \text{ W/m.K}$

Contractor's Challenges

Construction Stage

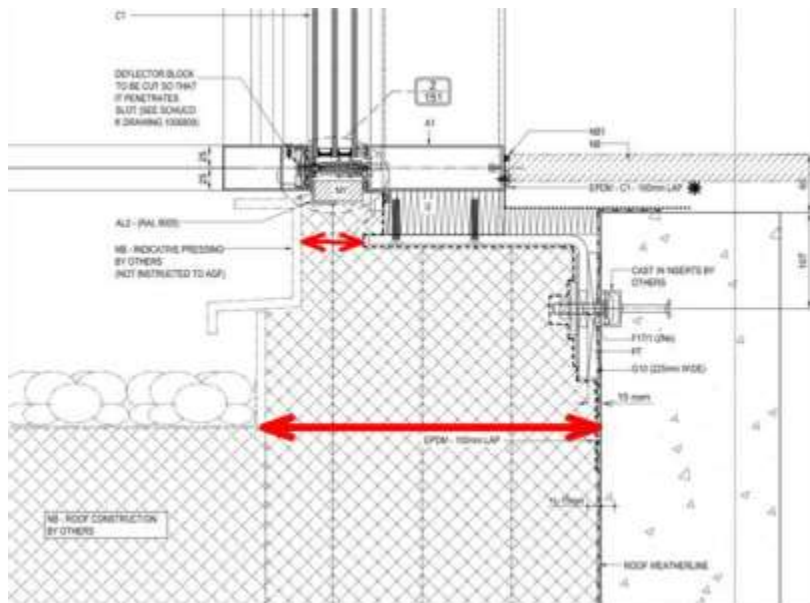
- » Sectional air permeability testing in a large/complex building



Contractor's Challenges

Construction Stage

- » Achieving Passivhaus standard on build quality control measures
- » Procurement limitations and PHPP design penalties on large-scale AHUs



Key Lessons Learned

On track for November 2015 completion and Passivhaus certification...

Designed in 2010 – some difficulties sourcing products to suit the aesthetic – greater range available now

Lack of Passivhaus knowledge and experience amongst contractors during tender period at the time

PHPP proved a useful design tool – testing impacts of ‘what if’ scenarios

Individual components have less impact on larger schemes – able to trade off performance in some areas

But.... don't get complacent! Constant monitoring of progress is required – ‘death by 1000 cuts!’

Effective communication of key design requirements is more difficult to achieve on larger sites

Good intentions to do early phased air tests was not possible – but air testing of sample rig was vital.

PH certification won't be achieved until after practical completion but is a requirement of the contract

Increased capital costs for Passivhaus relative to ‘Part L’ are believed to have fallen based upon QS research

Achieving DEC A will be a significant challenge - three year soft landings period will be vital

Questions?

