

PassivHaus Project Documentation

The University of Leicester
George Davies Centre



1.0 Abstract

The University of Leicester, George Davies Centre, 15 Lancaster Rd, Leicester LE1 7HA.

Project ID: 5263



Dr Stephen Ball – Director of Sustainability and Certified PassivHaus Designer/Consultant for the University of Leicester, George Davies Centre – Couch Perry Wilkes LLP – (www.cpwp.com).

The George Davies Centre, totalling approximately 12,800m² GIA, brought together three academic departments at the University of Leicester under one roof and now accommodates some 2,400 people within teaching, research, office and social accommodation. It remains the largest single PassivHaus Certified building in the UK.

1.1 Building Data

Year of construction	2014 - 2016
PHPP Space Heating Demand	15kWhr/m² per annum
PHPP Primary Energy Demand	116kWhr/m² per annum
U-value External Wall	0.130W/m ² K
U-value Ground	0.250W/m ² K
U-value Roof	0.130W/m ² K
U-value Window	0.750W/m ² K
Heat Recovery	74.0%
Pressure Test (n ₅₀)	0.34h ⁻¹
Special Features	Rehau Earth Tube – 1.6km Ground to Air Heat Exchanger (GAHE)

1.2 Brief Description

The University of Leicester commissioned the George Davies Centre to enable it to bring together the schools of medicine, health sciences and psychology under a single roof. It also wanted its new building to have very low carbon emissions to help the university achieve its ambition to be recognised for 'environmental and sustainability excellence'.

Accordingly, the university set its design team of engineers Couch Perry Wilkes and Associated Architects, the challenge of designing a building that was inherently low energy in use to achieve an A-rated Energy Performance Certificate (EPC) rating and perhaps more demanding, an A-rated Display Energy Certificate (DEC) rating.

At the very early stages, Dr Stephen Ball convinced the University that if they wanted to achieve their sustainability ambitions and procure a building that was low energy in-use, then they must adopt PassivHaus as a standard and align the development with all the PHPP standards.

The response has been to design a 12,800m² Passivhaus-certified building – still the largest single PassivHaus Certified building in the UK.

The scheme comprises a two-storey podium structure, which houses the main teaching spaces, both a 300-seat and smaller 150-seat lecture theatre, and informal learning spaces. Three linked towers rise up from this podium; these contain a mixture of research laboratories, teaching spaces and cellular offices.

A 3-year soft landings programme has been undertaken to fine-tune the buildings systems to ensure the operational energy demands align with those predicted by the PHPP model.

1.3 Responsible Project Participants

Client: University of Leicester

Building Services Engineer: Couch Perry Wilkes

Architect: Associated Architects

Certified PassivHaus Consultant: Dr Stephen Ball – Couch Perry Wilkes

Structural Engineer: Ramboll

Quantity Surveyors: Gleeds

Project Manager: Bidwells

Main Contractor: Wilmott Dixon

PassivHaus Certifier: WARM and PHI

Certificate ID: 12818_WARM_PH_20160128_PW

2.0 Views of the George Davies Centre (GDC)



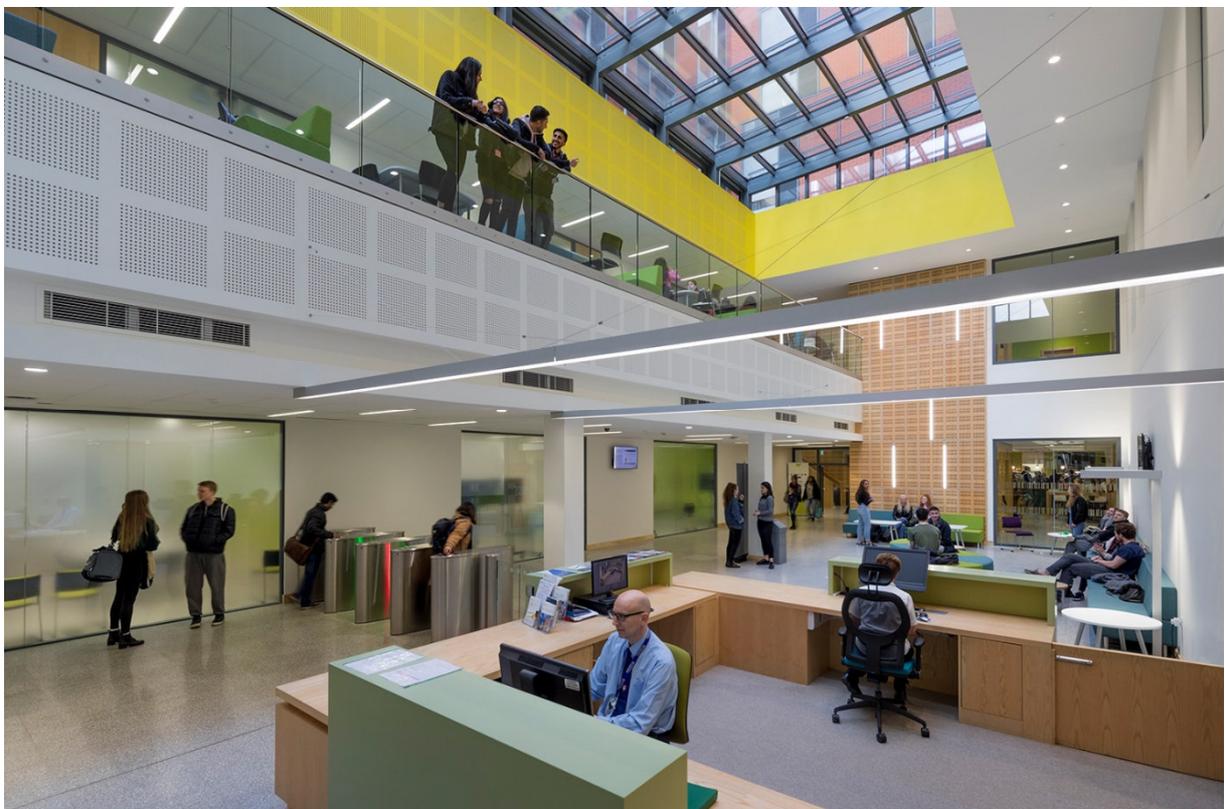
South side of GDC showing colonnade and the 3 linked towers rising up from the podium



West side showing extent of green wall



East side showing extent of the main tower



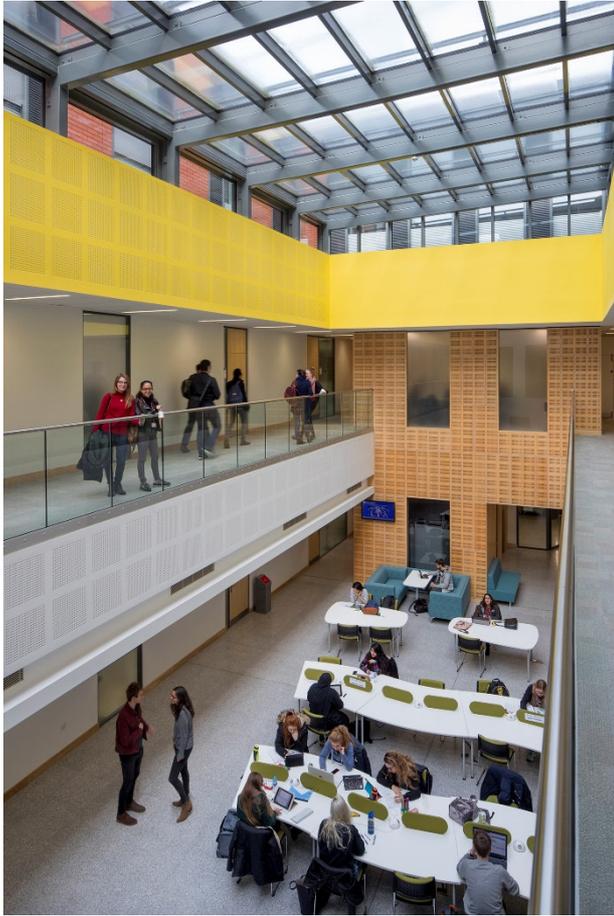
Reception and Entrance Foyer



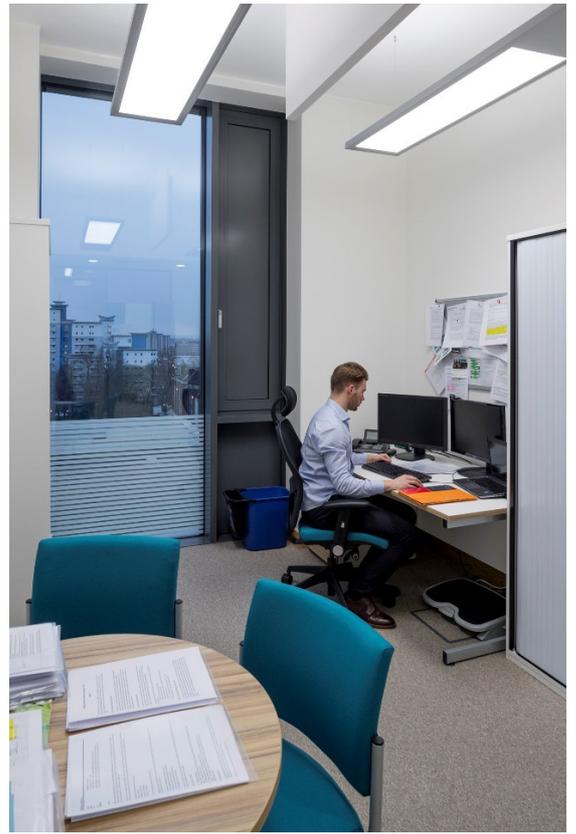
Lecture Theatre



Typical Learning Space



Typical Shared Learning Space



Typical Single Person Office Space

3.0 Sectional Drawing of the George Davies Centre and General Description



Cut-Away Drawing of the George Davies Centre

The project used an in-situ post tensioned concrete frame sitting on piled foundations, post tensioning minimised the amount of concrete required. The concrete frame was exposed internally to a significant degree to provide thermal mass as part of the environmental strategy. The frame also incorporated TABS (Thermally Activated Building Structure) - embedded cooling pipes within the slab close to the exposed soffit of high occupancy teaching spaces. The concrete frame required a high degree of supervision on site to maintain the desired visual appearance.

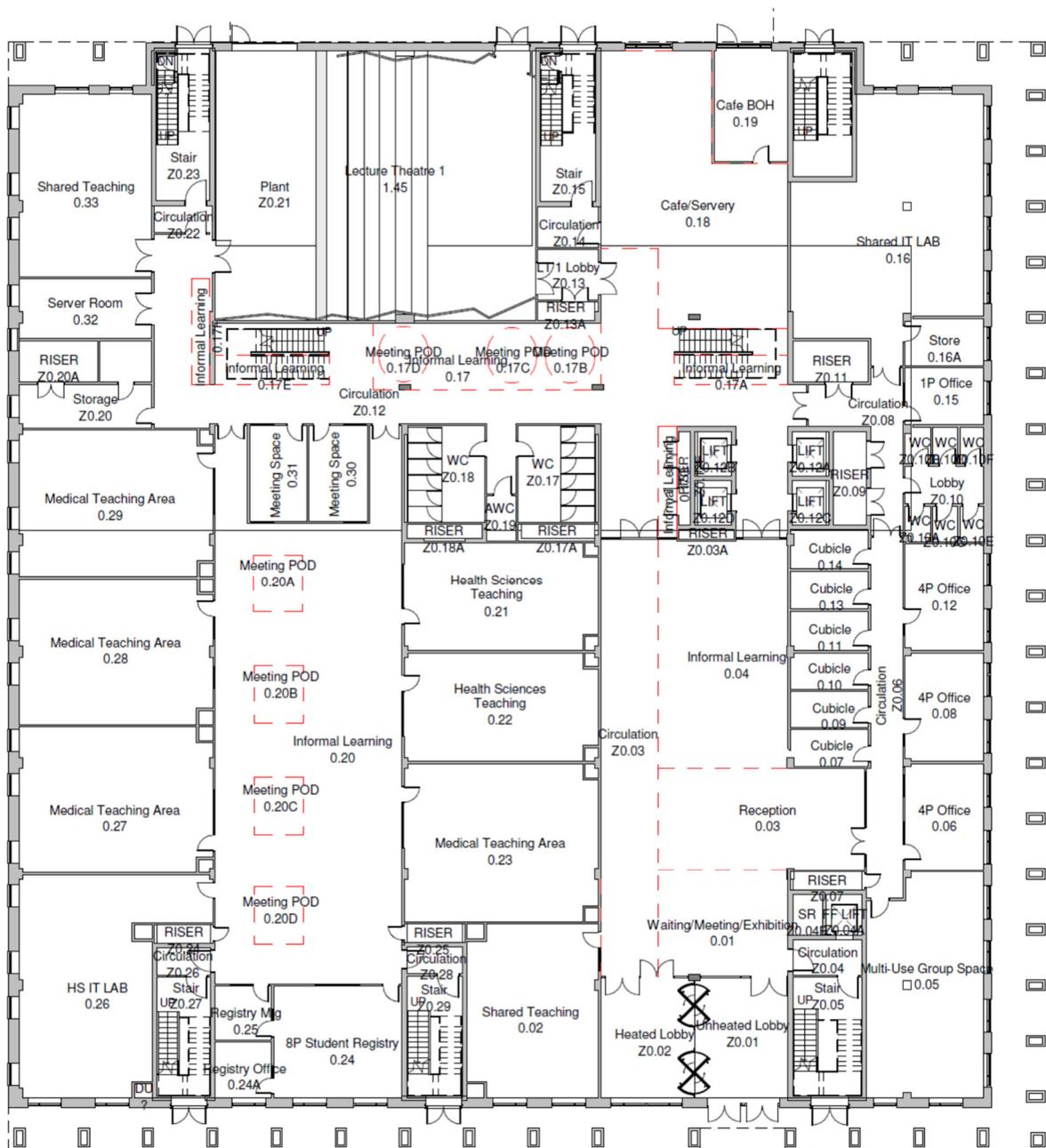
Façade – Lower Floors

The lower two floors were traditional masonry wall construction with a 300mm fully filled cavity and low conductivity wall ties. Two-storey PH certified curtain walling elements infill between the masonry piers. Air tightness was provided by a wet plastered finish to the internal blockwork which sealed against the curtain walling using specialist tapes and membranes.

Façade – Upper Floors

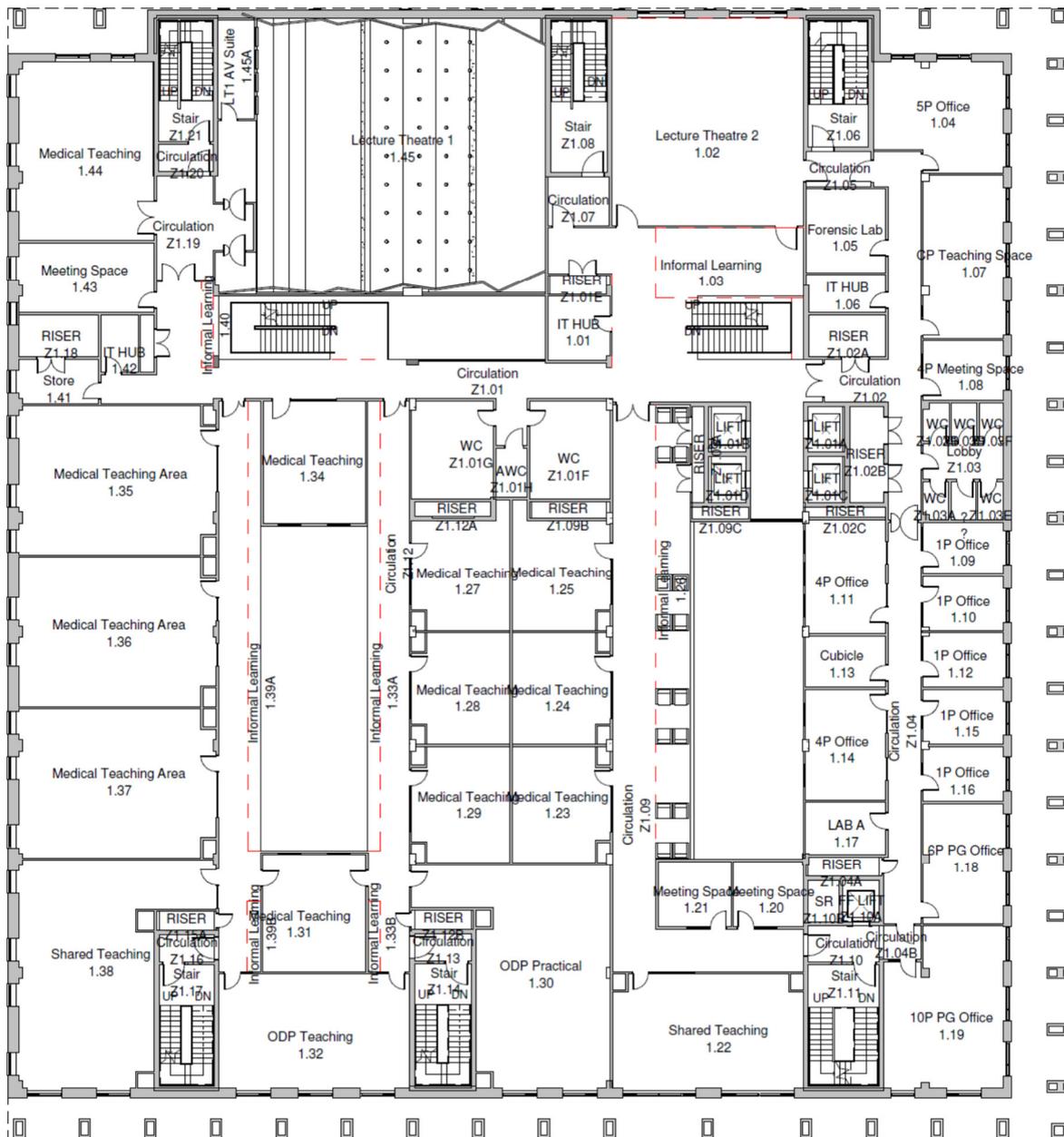
Full curtain walling system with brick slip panels attached to insulated metal spandrel panels. Offsite manufacture and repetitious detailing to ensure quality control procedures for manufacture and installation to ensure high levels of air-tightness.

4.0 Floor Plans of the George Davies Centre



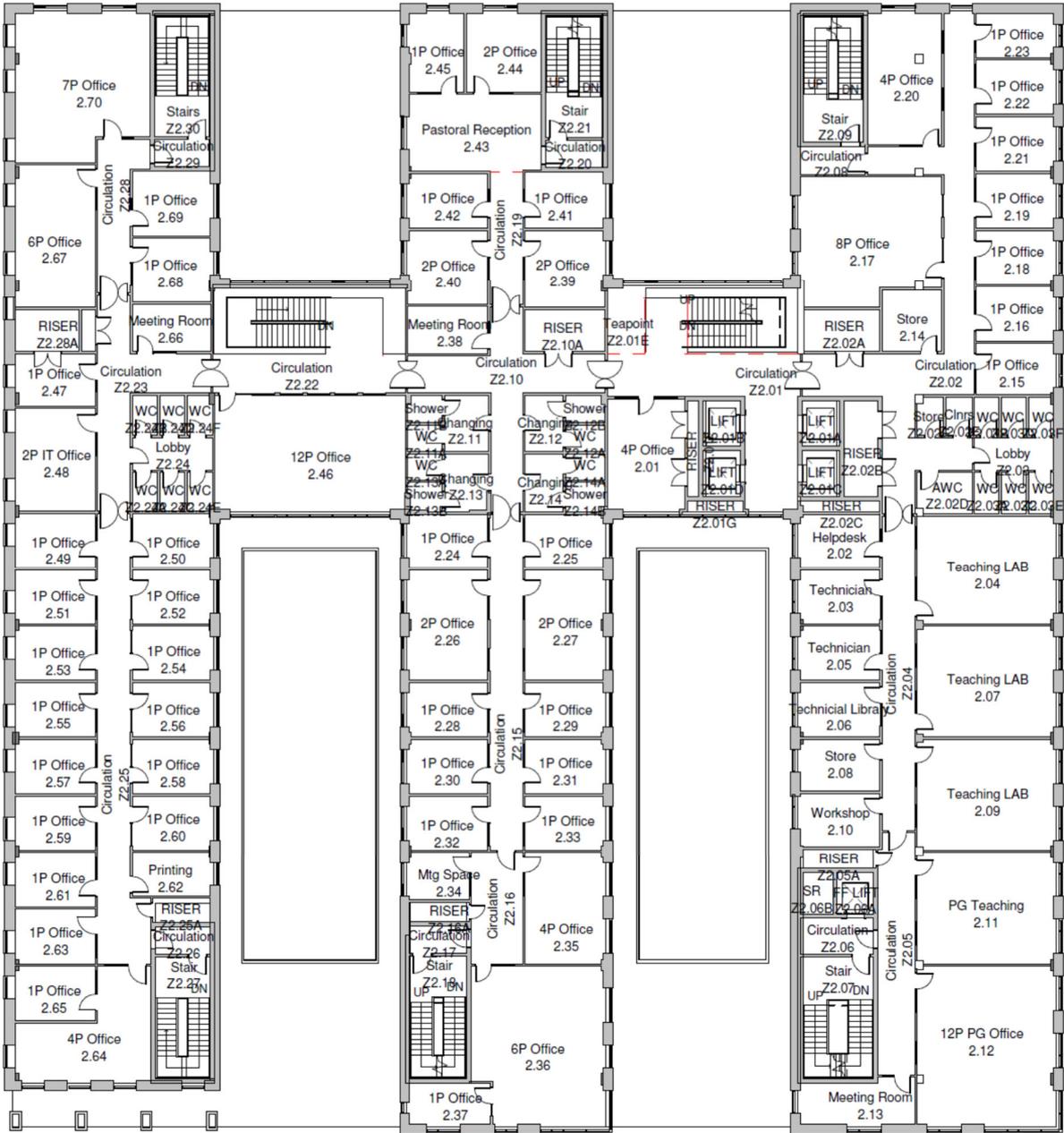
Ground Floor

The entrance to the building on the south side is through a staggered lobby to help maintain airtightness. This leads to the main reception and large circulation space with informal learning. To the east are a series of 1 to 4 person offices. There is a large 300-seat lecture theatre (with dedicated AHU plant underneath the raked seating), cafeteria/servery and shared IT lab to the north of the ground floor. Toilets, lifts and rises are in the central core of the building surrounded by more large teaching space and meeting pods. The west of the ground floor is dominated by specialist medical teaching facilities and a further IT lab.



First Floor

The perimeters of the first floor are dominated on the east side by office space, both shared and single person occupancy. The south and west of the first floor contain shared teaching and specialist medical teaching facilities. The core continues with toilets, lifts and further medical teaching space as well as informal learning and meeting facilities for students. The upper tiers of the 300-seat lecture theatre continue to the north of the building, adjacent to a smaller lecture theatre and IT hub.



Second Floor

The second floor is dominated by 1 and 2 person offices arranged around the 3-pillars that rise up from the ground and first floor 'plinth'. There is some larger shared office accommodation distributed around this floor as well as some teaching labs on the east tower. Toilets and lifts to the core.



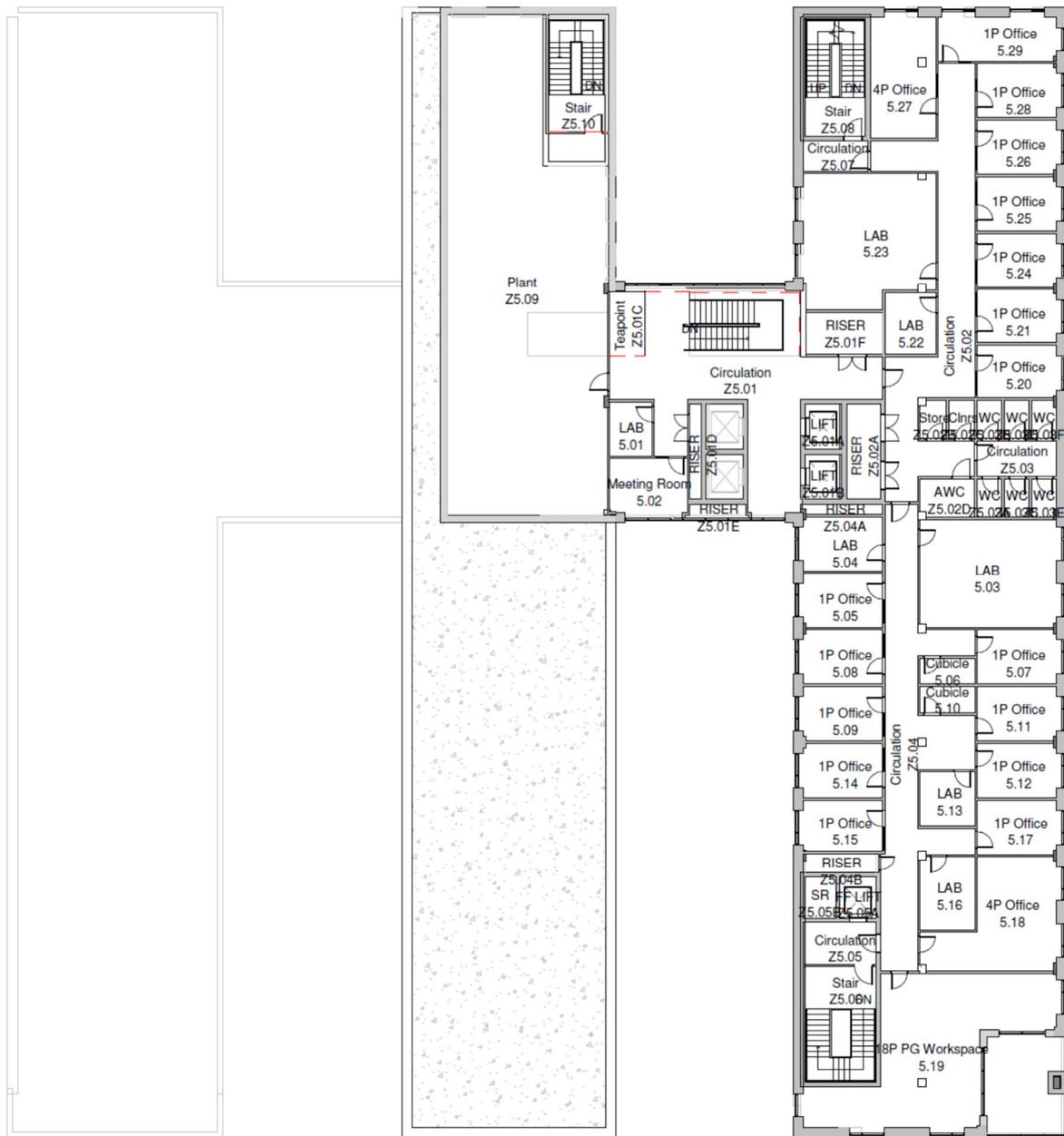
Third Floor

As the building rises through the third floor, now 2-pillars remain, dominated by single person offices with some larger shared office accommodation distributed around this floor. Toilets and lifts to the core.



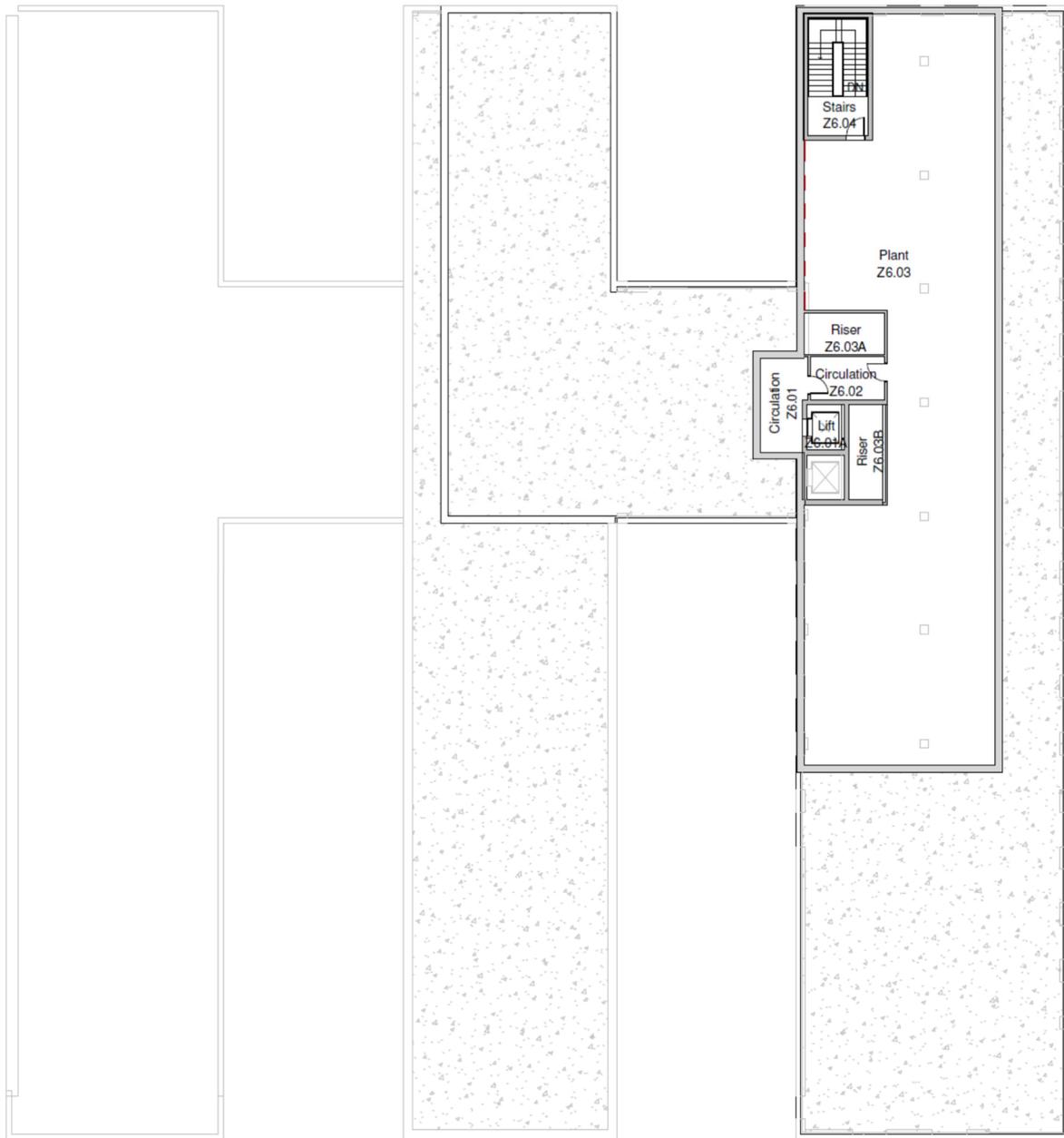
Fourth Floor

This floor is again dominated by single person offices with some larger shared office accommodation for Ph.D students distributed around this floor. Toilets and lifts to the core.



Fifth Floor

At the fifth floor, a single pillar remains to the east, again dominated by single person offices with some larger shared office accommodation distributed around this floor. Toilets and lifts to the core. The rooftop plant area is also shown on top of what was the middle tower.



Sixth Floor

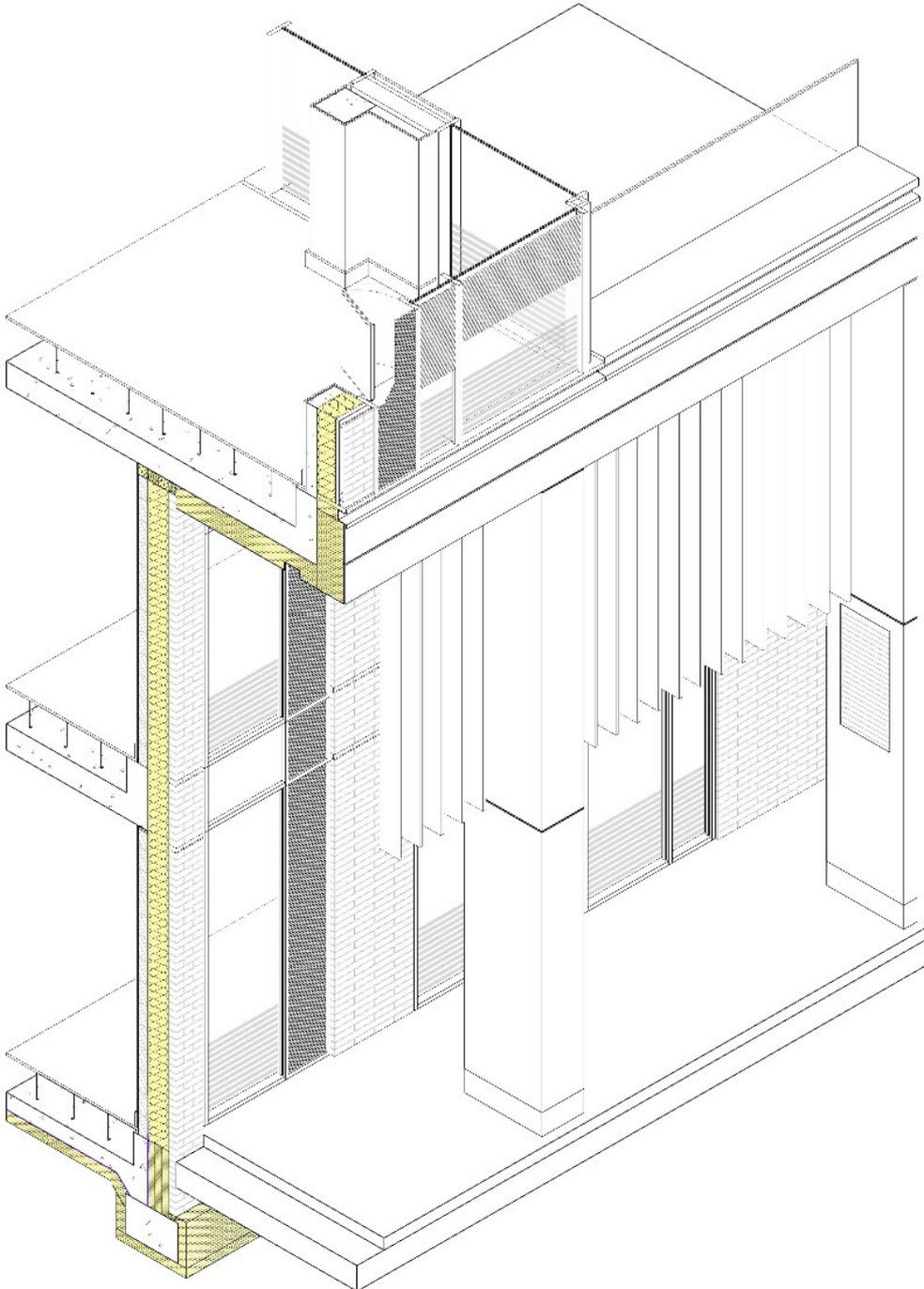
At the sixth floor, rooftop plant is shown located on top of the eastern most tower.

5.0 Construction Details

Ground Floor (typical construction)

22mm terrazzo tiles on decoupling mat, on 70mm floating screed, on 30mm Knauf Polyfoam Floorboard Eco Extra Insulation, 150mm ground bearing TC concrete slab on 65mm Knauf Polyfoam C350SE insulation.

Average U-value 0.250W/m²K



Drawing showing ground floor/wall connection and upper floor/wall connection

Walls

Lower Floors

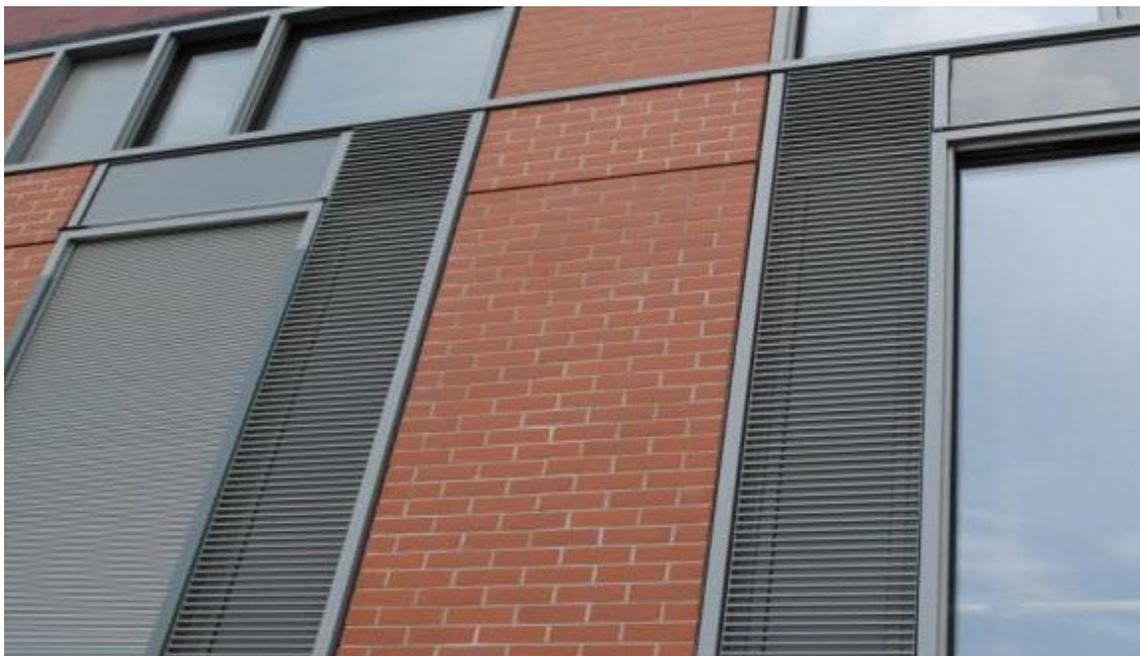
The lower two floors were traditional masonry wall construction with a 300mm fully filled cavity and low conductivity wall ties. Two-storey PH certified curtain walling elements infill between the masonry piers. Air tightness was provided by a wet plastered finish to the internal blockwork which sealed against the curtain walling using specialist tapes and membranes.



103mm Ibstock Red brickwork externally, followed inside by 300mm cavity with Knauf Earthwool Dritherm 32 Ultimate mineral wool insulation, 140mm medium density blockwork, 13mm wet plaster internally. TeploTies to cavity masonry. Foamglass loadbearing insulation to base of masonry.

Upper Floors

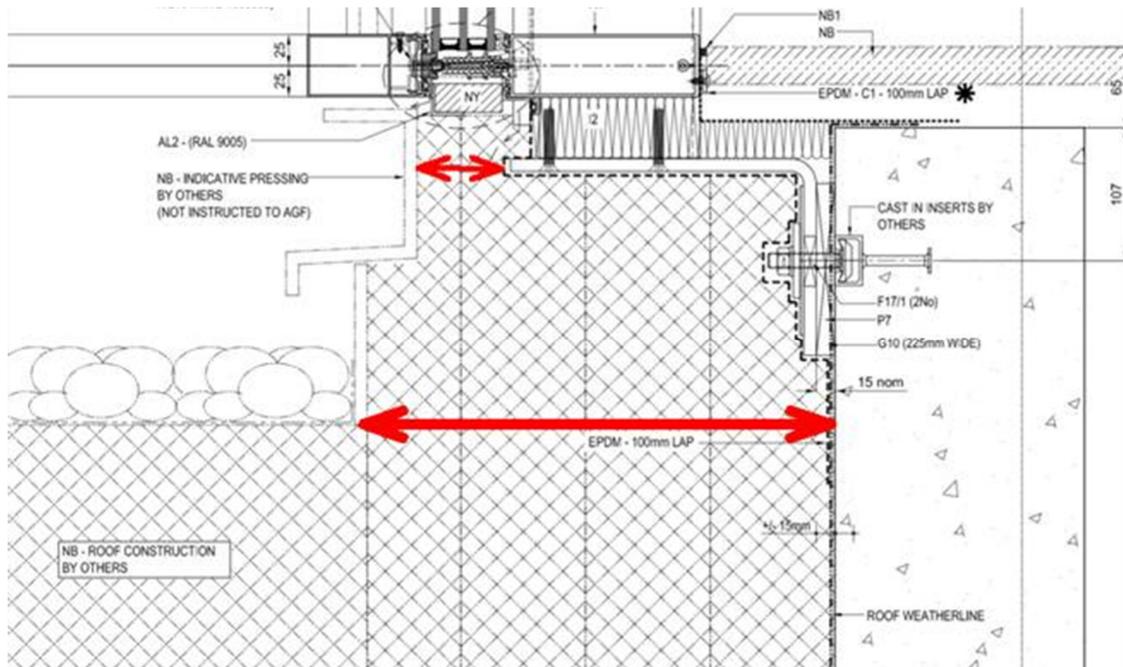
Full curtain walling system with brick slip panels attached to insulated metal spandrel panels. Offsite manufacture and repetitious detailing to ensure quality control procedures for manufacture and installation to ensure high levels of air-tightness.



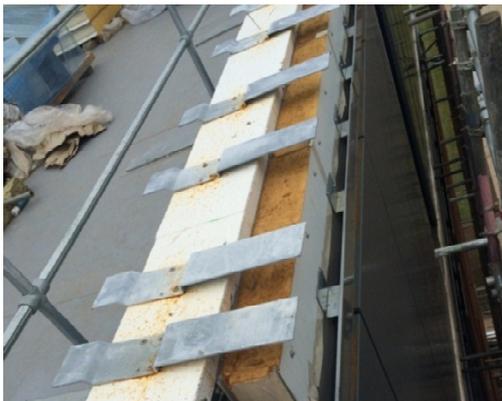
Roof (typical construction)

Paving slabs on spacers/pebble ballast, on separation layer, on 270/410mm Jablite Premium Flat Roof inverted insulation, on hot melt roof waterproofing, on 250mm RC concrete slab.

Average U-value 0.130W/m²K



Roof/Wall detail



Images showing installation of continuous insulation on roof/wall parapet

Glazing

Schüco PH certified triple-glazed curtain walling with argon filling (System Window: Schüco AWS 90. SI, System Façade: Schüco FW 50+. SI).

Overall U-value 0.750W/m²K

Frame U_f value 0.830W/m²K

Glazing U_g value 0.580W/m²K

Glass g- Value 0.48

PH certified Lamilux PR60energysave tripled glazed glass roofs to east and west atria.

Overall U-value 0.820W/m²K

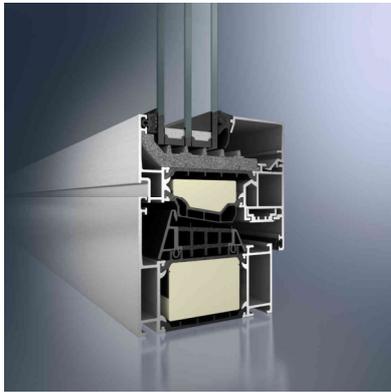
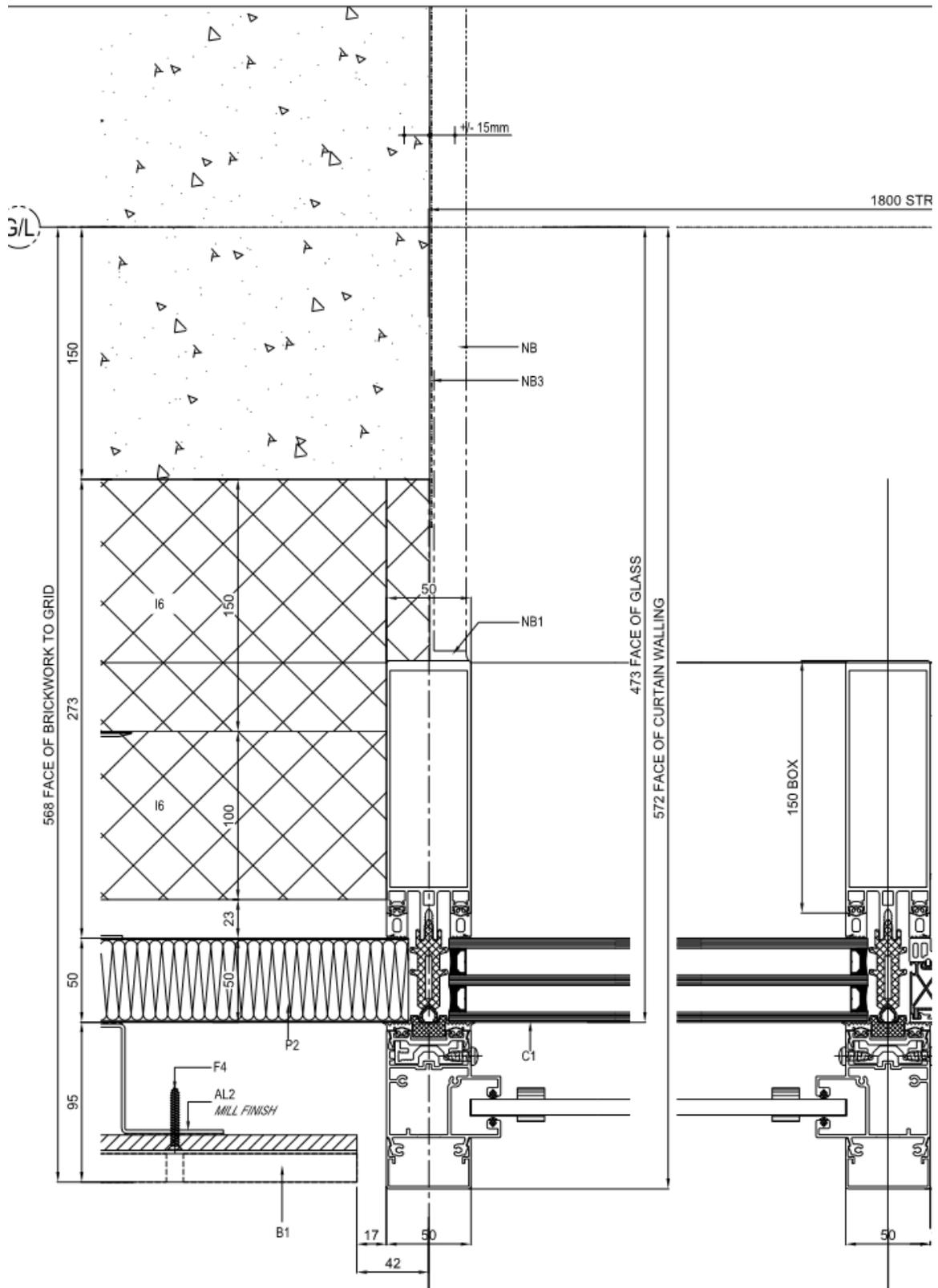


Image of Schüco AWS 90.SI window



Image of frame/window/wall installation



Window/Wall detail

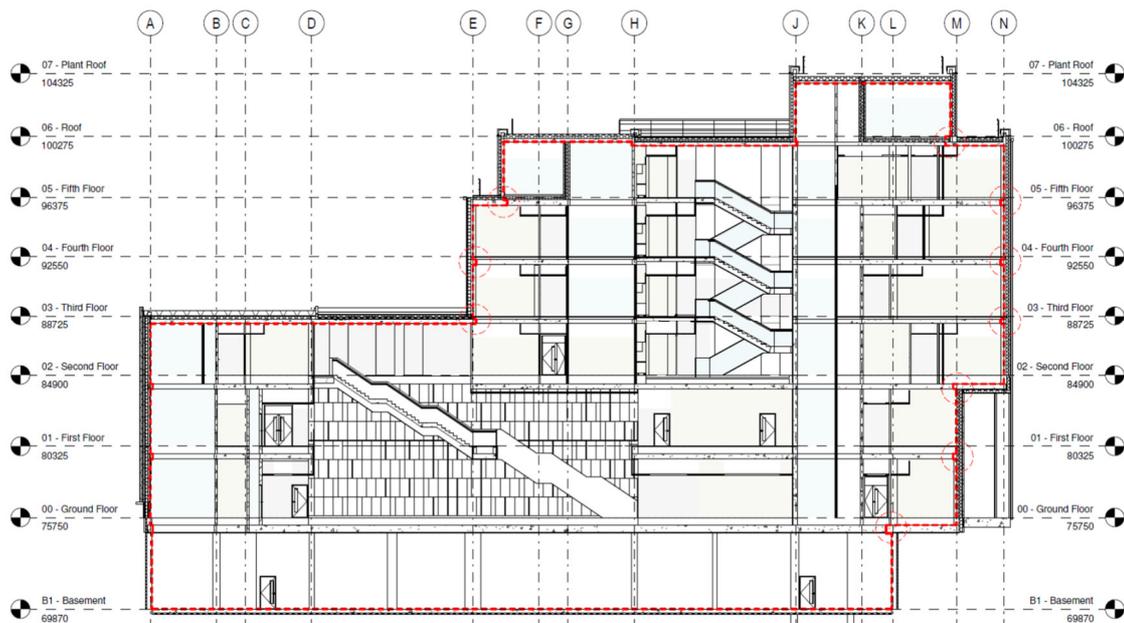
6.0 Description of Airtight Envelope and Documentation of the Pressure Test Result

Care was taken at every stage of the design to ensure an air-tight building could be achieved on this scale from the staggered entrance lobby all the way through the building to the mock-ups that were tested off-site prior to installation and sign off.

The typical process and gateways are show below:



Tool-box talks and guidance was given to every site worker to ensure they understood and appreciated the importance of maintaining the air-tight line around the building and where that air-tight line was.



Cross-section showing continuous air-tightness line at early stage

On the lower floors the internal blockwork was finished with a wet-applied plaster to provide an airtight solution. Between the masonry elements infill sections of Passivhaus-certified curtain wall were used; all sealed to the wall using specialist tapes and membranes to prevent any air leakage.

On the upper floors, a PassivHaus certified full curtain walling system with brick slip panels attached to insulated metal spandrel panels was used. Offsite manufacture was employed to ensure repetitious detailing for quality control procedures for manufacture and installation to promote high levels of airtightness.

The sub-contractor also went to the extent of developing and testing a mock-up of the proposed installation for air-tightness and water ingress as shown below:



Envelope Mock-up, Testing and Inspection for Air-tightness and Water at Wind-Techs Facility

The final airtightness test was undertaken by HRS Services Ltd with results shown as follows:

Two tests were carried out:

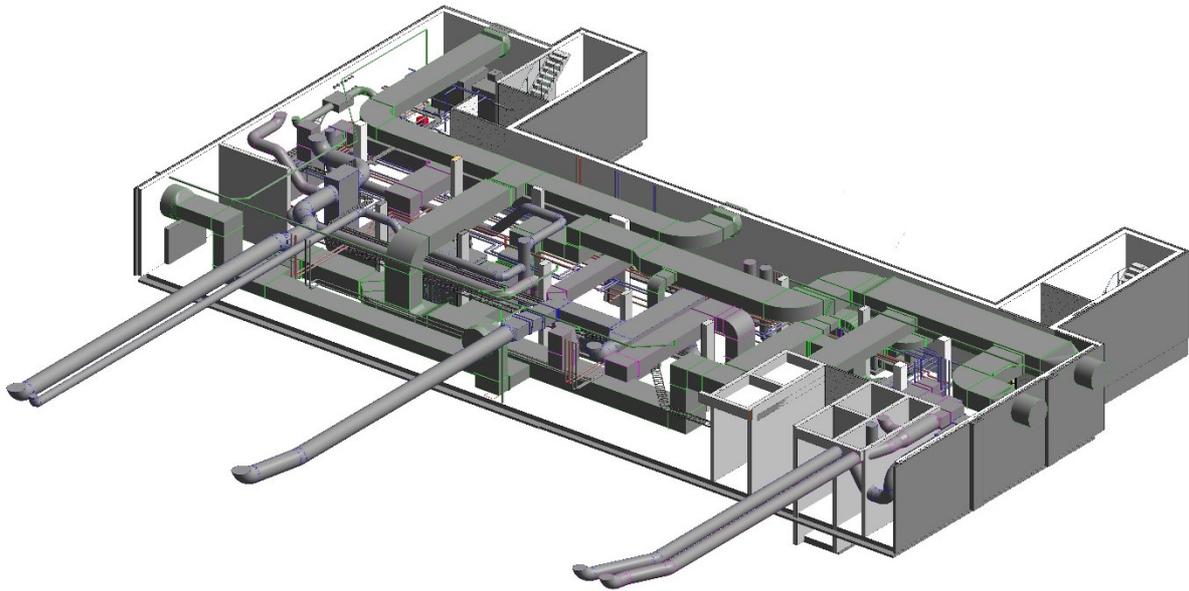
Under pressurisation, the building achieved a result of $1.10\text{m}^3/(\text{h.m}^2)$.

Under depressurisation, the building achieved a result of $0.98\text{m}^3/(\text{h.m}^2)$.

This calculates as an average of $1.04\text{m}^3/(\text{h.m}^2)$.

7.0 Planning of Ventilation Ductwork

In order to reduce pipework and duct runs over which is a very large building, the scheme includes a total of 10 air handling units (AHUs): five in the basement plant room, two in each of the two plantrooms situated on top of the towers, and one – supplying the main 300-seat lecture theatre – located in a dedicated plantroom beneath its raked seating. (The local low level supply and high level extract ventilation for the rooms is illustrated in the next section).



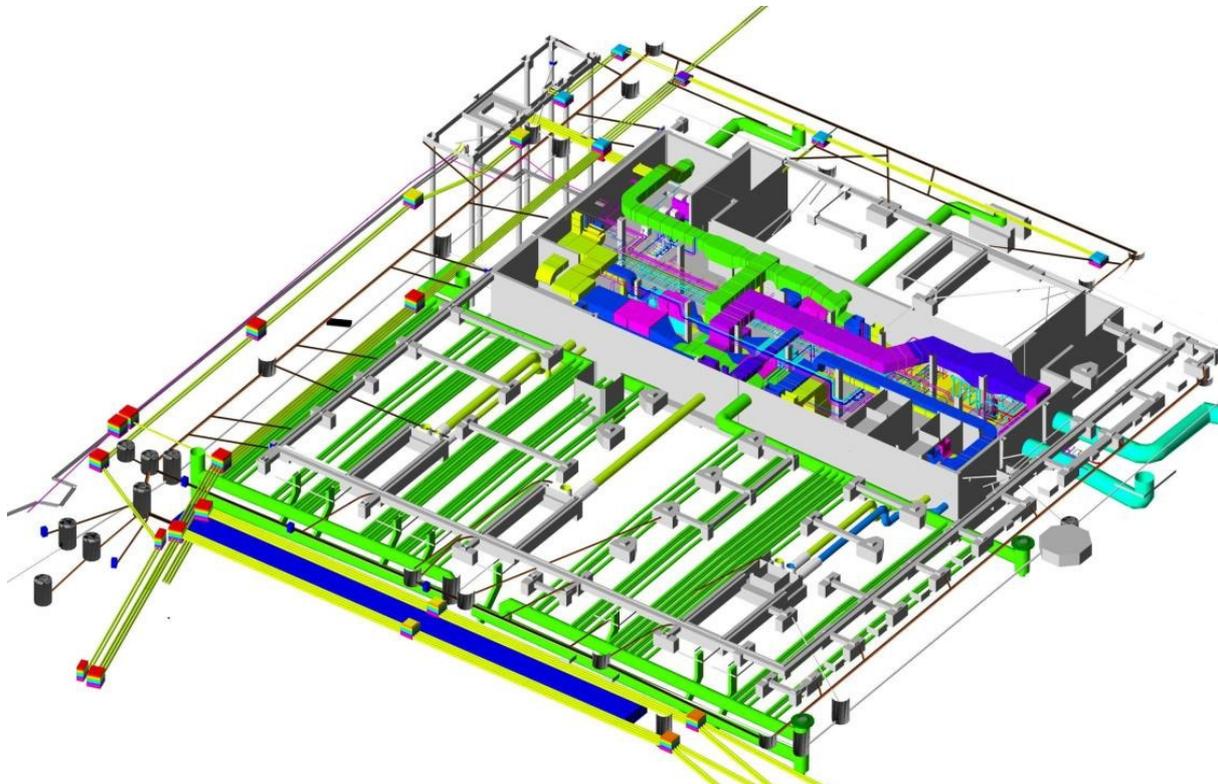
Schematic of basement AHU layout

All of the AHUs incorporate a thermal wheel to recover heat from the air before it is exhausted. The units are bespoke Barkell AHUs with heat recovery, tested independently by BSRIA, at 74% efficiency and electrical efficiency of 0.39Wh/m^3 .



AHU installation in basement plantroom

AHUs located in the basement serving the densely occupied teaching and lecture theatres, can take air through a ground-to-air heat exchanger (GAHE) of 1.6km total length. The GAHE tempers all of the fresh air supply to the basement AHUs by pre-cooling it in summer and preheating it in winter. This fresh air supply of 34,200m³ per hour represents approximately 30% of the total fresh air entering the building.



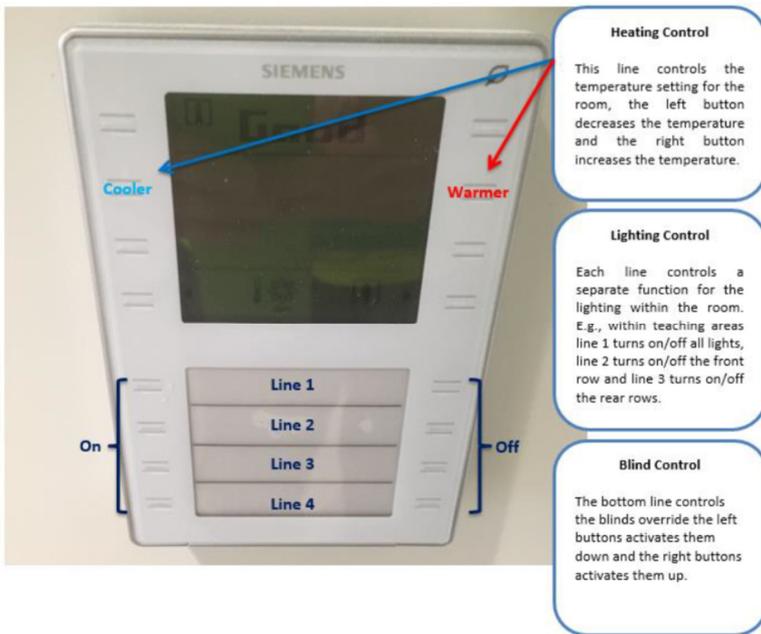
GAHE schematic and scale of ductwork shown above

The GAHE labyrinth was located beneath the building and co-ordinated around foundations and drainage. A clever feature was to integrate the air intakes to the GAHE within the colonnade of the building, as shown below:

**GAHE – Air Intakes
in Colonnade**



Image of GAHE air intake within colonnade



Room Controller

Further extracts from the building user guide (below) show where everything is and what things do.



Typical room layout showing controller and what it does

9.0 PHPP Calculations

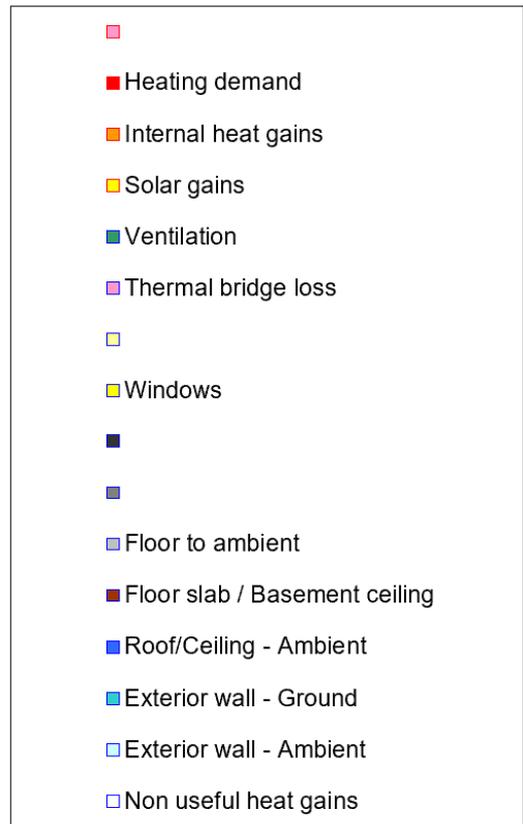
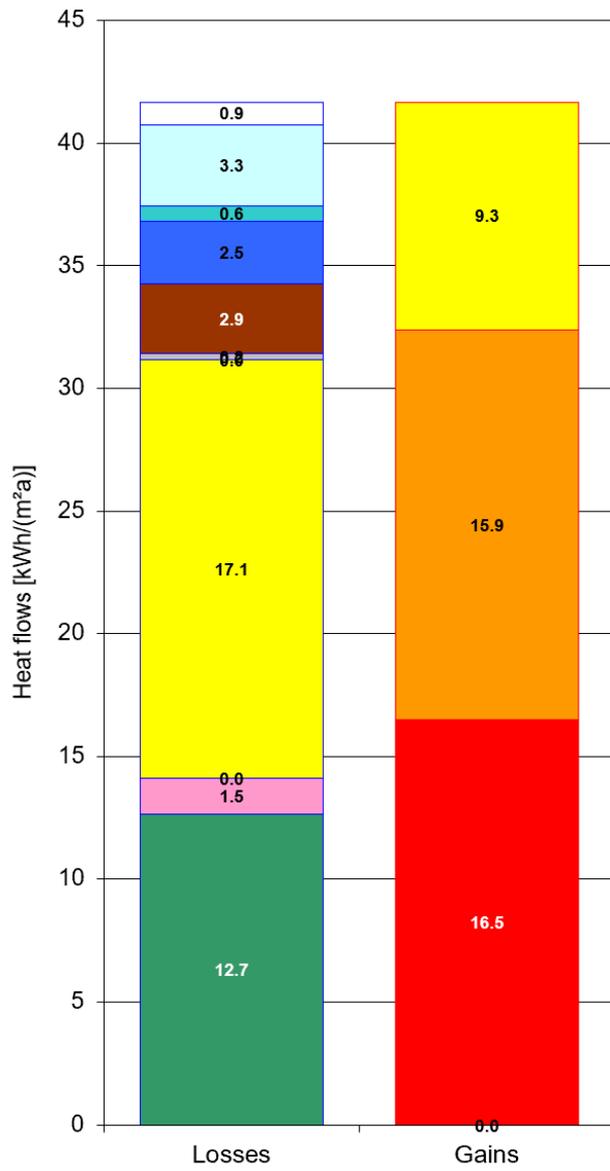
The final PHPP model was signed off by Certifiers WARM. Extracts from the 'Verification Tab' are shown below and confirm a 'yes' against each of the verification criteria.



		Treated floor area	9863.1 m ²	Requirements	Fulfilled?*
Space heating	Heating demand	15 kWh/(m²a)		15 kWh/(m ² a)	yes
	Heating load	11 W/m²		10 W/m ²	-
	Primary energy <small>Heating, cooling, dehumidification, DHW, auxiliary electricity, lighting, electrical appliances</small>	116 kWh/(m²a)		120 kWh/(m ² a)	yes
	DHW, space heating and auxiliary electricity	56 kWh/(m ² a)		-	-
	Specific primary energy reduction through solar electricity	6 kWh/(m ² a)		-	-
Airtightness	Pressurization test result n ₅₀	0.3 1/h		0.6 1/h	yes

The following page shows the 'Energy Balance Heating' graph from the 'Annual Heating' tab. It can be seen that windows account for almost half the heat losses, with ventilation accounting for just under a third.

Just over a third of the heat losses are compensated for by internal gains, with solar gain offsetting just under a quarter of the losses.



10.0 Construction Costs

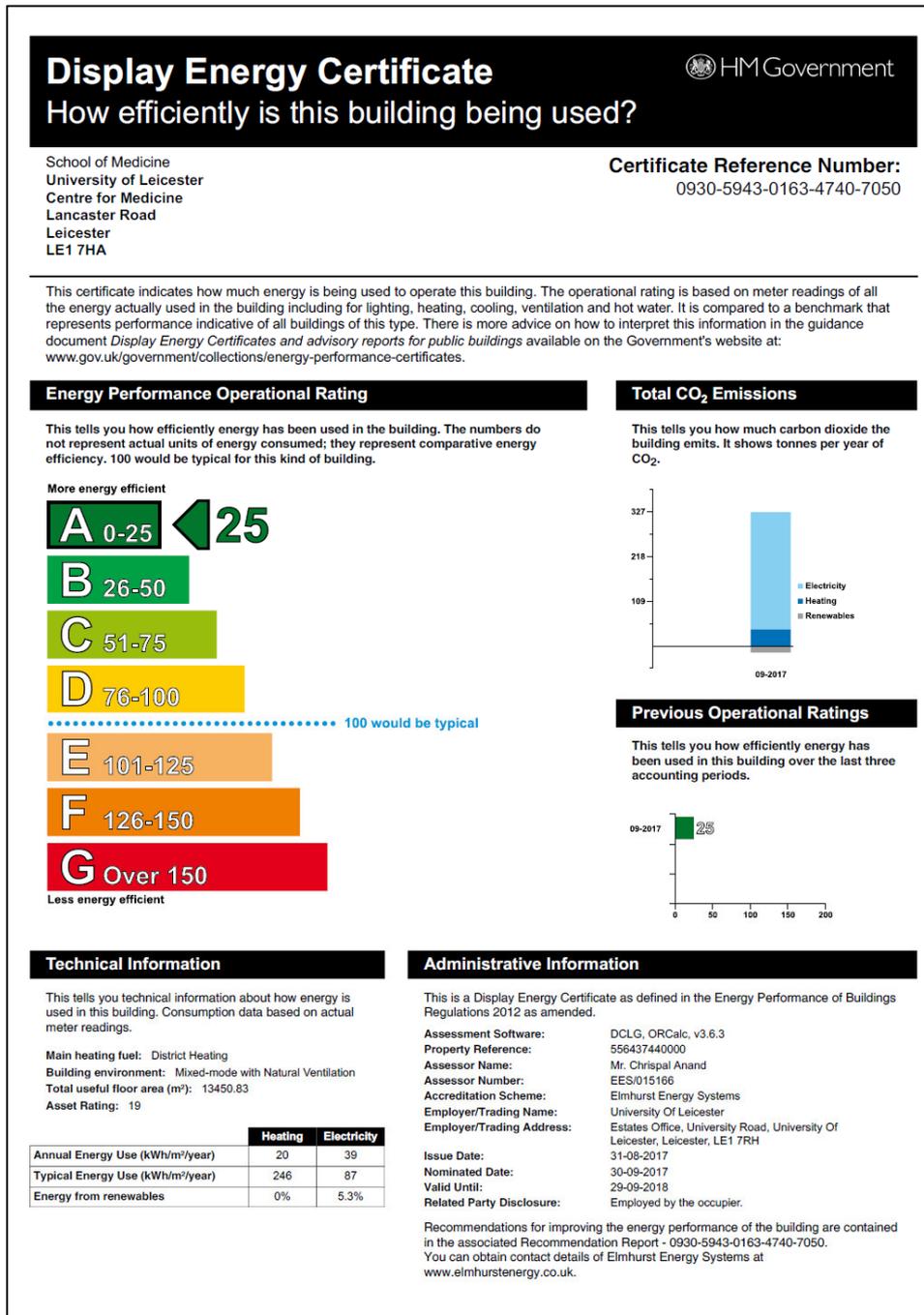
The construction costs were approximately £29m.

The total costs including VAT, fixtures, fittings and equipment, AV/IT, fees and landscaping were approximately £42m.

11.0 Measured Results

A 3-year soft landings programme has been undertaken to fine-tune the buildings systems to ensure the operational energy demands align as close as possible with those predicted by the PHPP model and to respond to questions from building users.

The results of the work are show below in the form of an A-rated Display Energy Certificate (DEC) and an A-rated Energy Performance Certificate (EPC) – showing the building is a sector leader.



A-rated DEC

Energy Performance Certificate

Non-Domestic Building



University of Leicester
Centre For Medicine
University Road
LEICESTER
LE1 7RH

Certificate Reference Number:
0580-0036-8719-9800-6092

This certificate shows the energy rating of this building. It indicates the energy efficiency of the building fabric and the heating, ventilation, cooling and lighting systems. The rating is compared to two benchmarks for this type of building: one appropriate for new buildings and one appropriate for existing buildings. There is more advice on how to interpret this information in the guidance document *Energy Performance Certificates for the construction, sale and let of non-dwellings* available on the Government's website at www.gov.uk/government/collections/energy-performance-certificates.

Energy Performance Asset Rating

More energy efficient

A+

Net zero CO₂ emissions

A 0-25

19

This is how energy efficient the building is.

B 26-50

C 51-75

D 76-100

E 101-125

F 126-150

G Over 150

Less energy efficient

Technical Information

Main heating fuel:	District Heating
Building environment:	Heating and Mechanical Ventilation
Total useful floor area (m ²):	11673
Building complexity (NOS level):	5
Building emission rate (kgCO ₂ /m ² per year):	10.5
Primary energy use (kWh/m ² per year):	Not available

Benchmarks

Buildings similar to this one could have ratings as follows:

41

If newly built

111

If typical of the existing stock

A-rated EPC

The overall metered energy consumption worked out to be c. 59kWh/m² per annum.

This compared to a similar building next door to the George Davis Centre operating at over 500kWh/m² per annum.

The client is delighted with the reduction in running costs as well as the fact that the building provides a healthy environment for students and staff to study and work.

The George Davies Centre was awarded CIBSE Building of the Year – Public Use in 2018 and was recognised as most effectively demonstrating high levels of user satisfaction and comfort whilst delivering outstanding measured building performance.