Project Documentation
Gebäude-Dokumentation

1. Abstract / Zusammenfassung

Passive House PYC Offices, Welshpool

1.1 Data of building / Gebäudedaten

Year of construction/ Baujahr	2018	**Space heating / Heizwärmebedarf**	**14 kWh/(m²a)**
U-value external wall/ U-Wert Außenwand	0.097 W/(m²K)		
U-value floor slab U-Wert Kellerdecke	0.123 W/(m²K)	**Primary Energy Renewable (PER) / Erneuerbare Primärenergie (PER)**	N/A
U-value roof/ U-Wert Dach	0.095 W/(m²K)	**Generation of renewable energy / Erzeugung erneuerb. Energie**	N/A
U-value window/ U-Wert Fenster	0.79 W/(m²K)	**Non-renewable Primary Energy (PE) / Nicht erneuerbare Primärenergie (PE)**	134 kWh/(m²a)

Heat recovery/ Wärmerückgewinnung	77 %	Pressure test n_{50} / Drucktest n_{50}	0.5 h-1
Special features/ Besonderheiten	N/A		

1.2 Brief Description

Passive House PYC Offices, Welshpool

A 220m2 timber frame Passive house certified office, built alongside the house building factory. Both designed and built by PYC Construction in 2018. The Offices consist of a large open plan office area on the first floor, with a smaller office, meeting room, kitchen and toilets on the ground floor. The office is constructed of an Ibeam timber frame superstructure, using Warmcel Cellulose insulation, which sits on a 300mm EPS and concrete raft foundation. The internal and external cladding are locally sourced, within 10 miles of the site.

1.3 Responsible project participants / Verantwortliche Projektbeteiligte

Architect/ Entwurfsverfasser	PYC Construction Ltd www.pycconstruction.co.uk
Implementation planning/ Ausführungsplanung	Jasper Meade, Ben Meade www.pycconstruction.co.uk
Building systems/ Haustechnik	Systemair www.systemair.com
Structural engineering/ Baustatik	Bob Johnson Structural Engineers https://www.bjse.co.uk/
Building physics/ Bauphysik	PYC Construction Ltd www.pycconstruction.co.uk
Passive House project planning/ Passivhaus-Projektierung	PYC Construction Ltd www.pycconstruction.co.uk
Construction management/ Bauleitung	PYC Construction Ltd www.pycconstruction.co.uk
Airtesting	PYC Systems Ltd www.pycsystems.co.uk

Certifying body/ Zertifizierungsstelle	WARM http://www.peterwarm.co.uk/	
Certification ID/ Zertifizierungs ID	6473	https://passivehouse-database.org/index.php?lang=en#d_6473

Author of project documentation / Verfasser der Gebäude-Dokumentation	Passive House Institute Darmstadt www.passiv.de

Date, Signature/ 24/03/2021

Datum, Unterschrift

2. Views of the PYC Offices

Figure 1 - North East and South East Elevations

Figure 2 - South West Elevation

Figure 3 - North West Elevation

Figure 4 - Entrance and exhibition space (Before moving in)

Figure 5 - First floor open plan offices

3. Sectional drawing of the PYC Offices

Typical cross-section through the PYC Offices (See figure 6). A continuous thermal has been provided and the internal airtightness layer is highlighted in red.

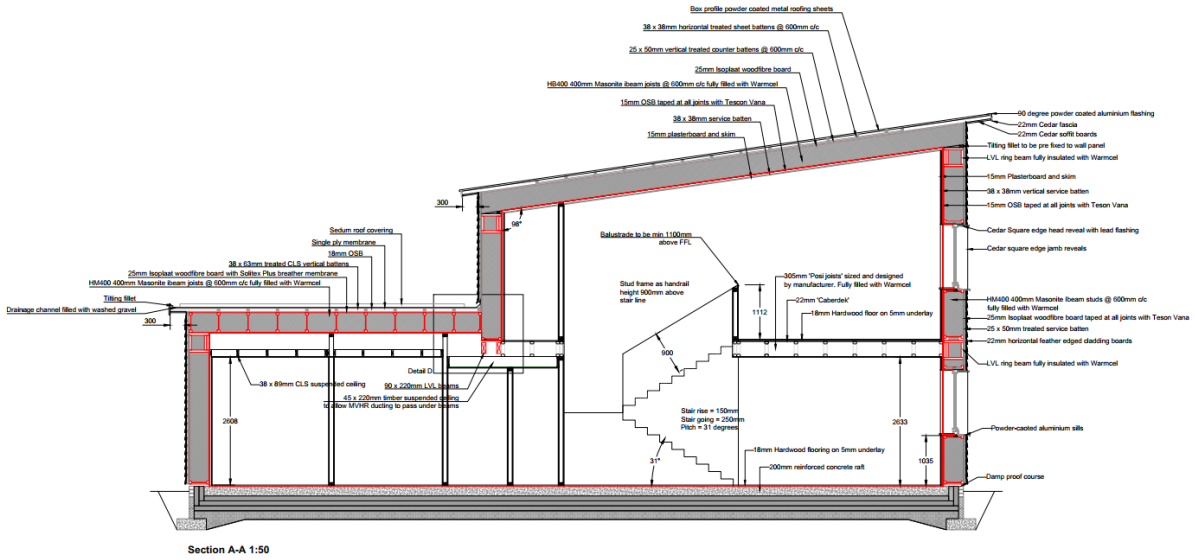


Figure 6 – Typical section through the PYC Offices

4. Floor plans for the PYC Offices

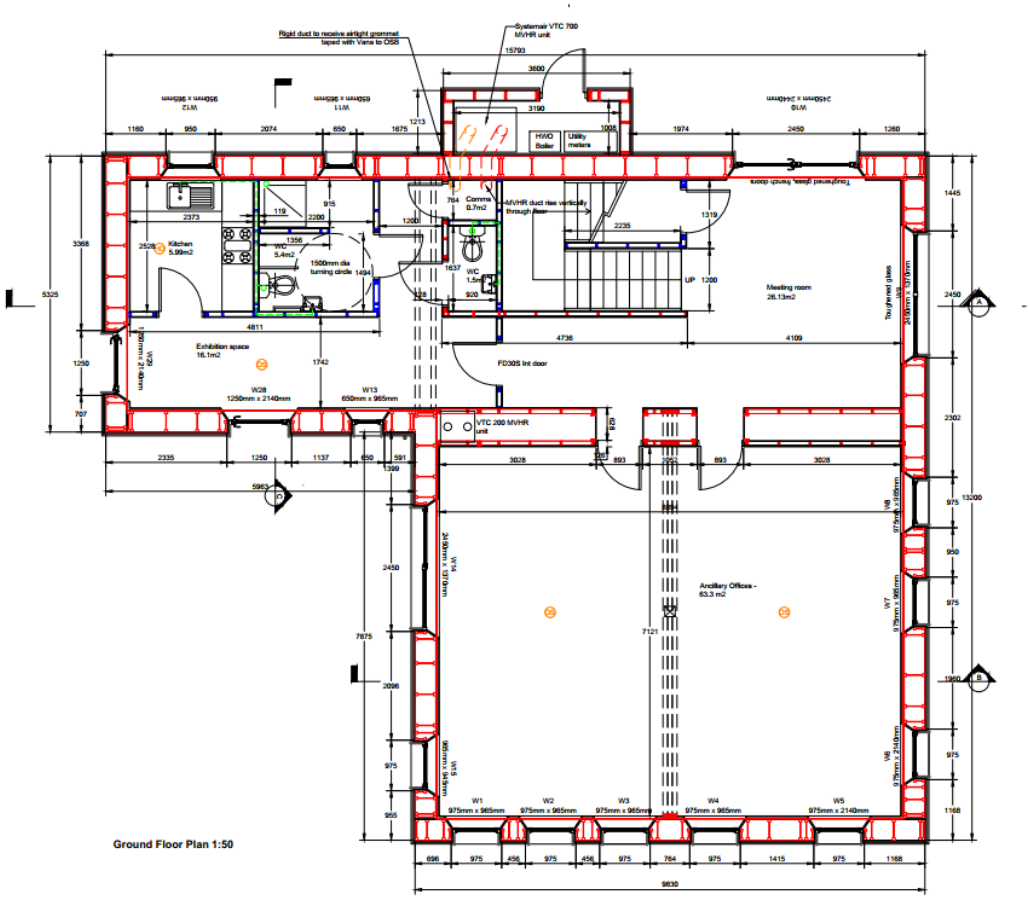


Figure 7 – Ground floor plan

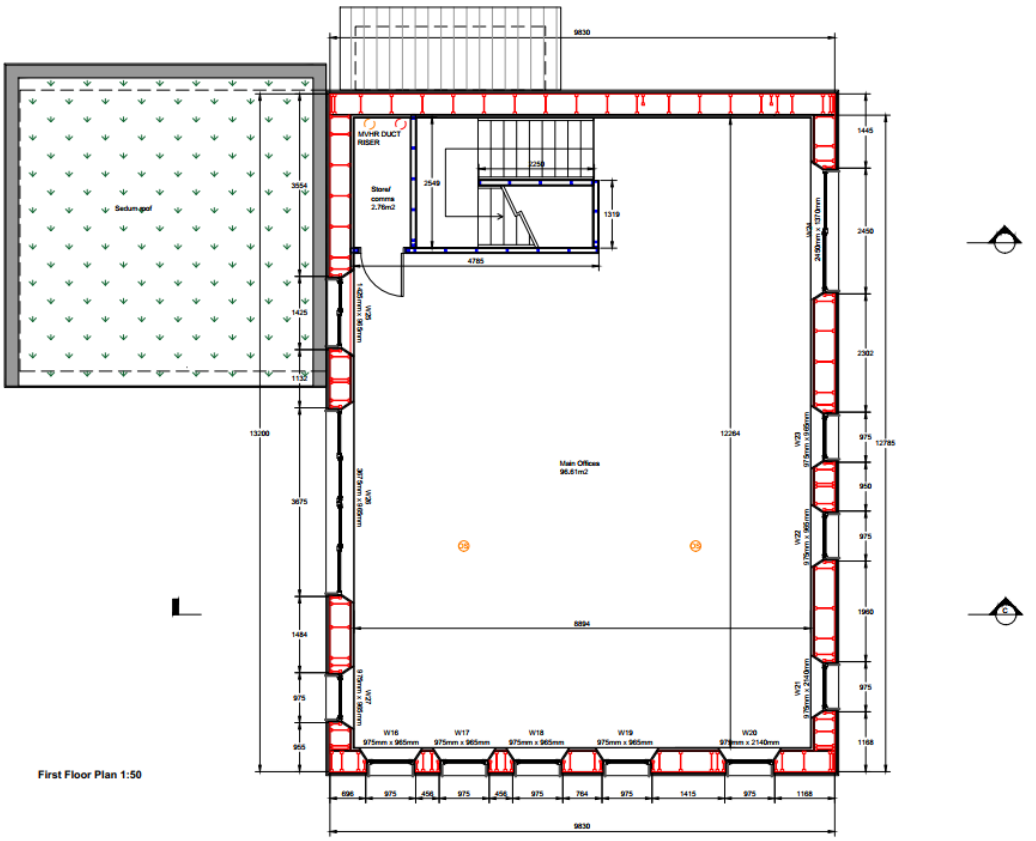


Figure 8 – First floor plan

5. Construction details of the thermal envelope for the PYC Offices

5.1 External wall to foundation detail

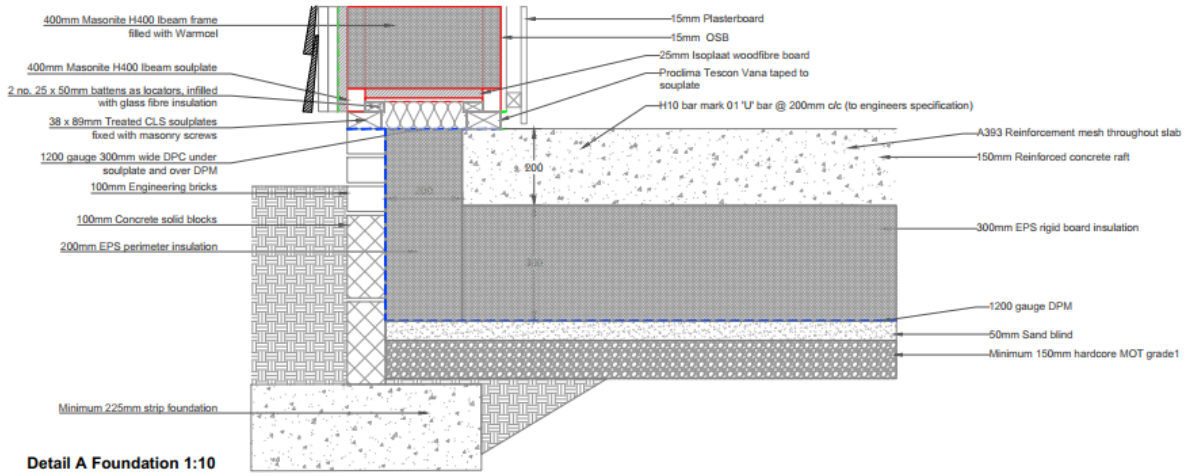


Figure 9 – External wall to foundation detail

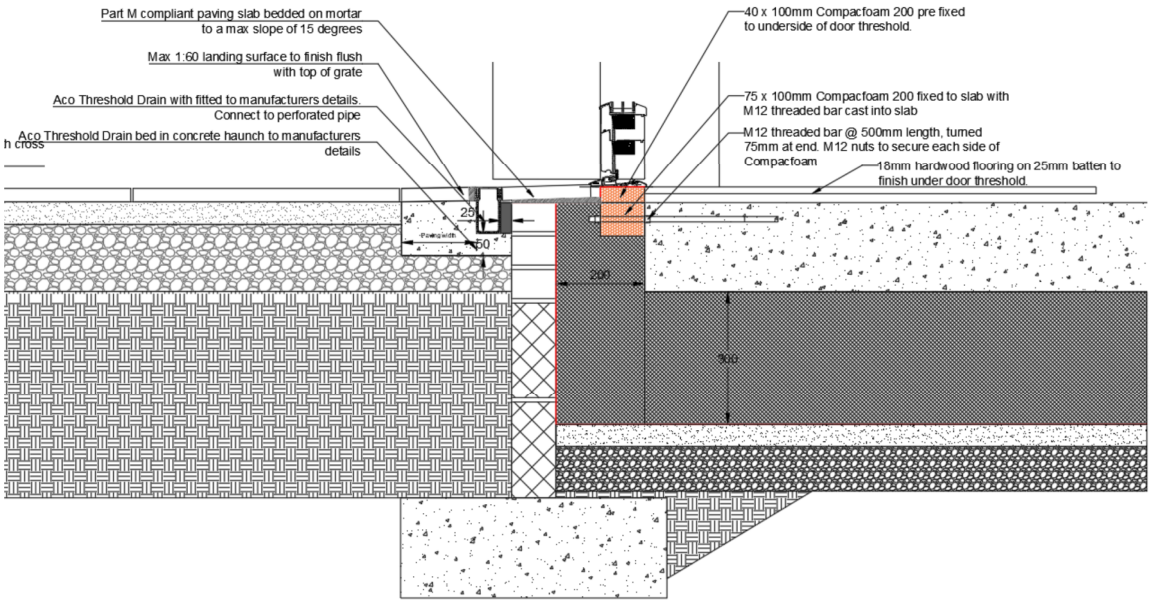


Figure 10 – Door threshold detail

The ground floor is constructed from a 200mm reinforced concrete slab poured over 300mm of EPS insulation. 200mm EPS insulation wraps around the edge of the slab to reduce the thermal bridging at the perimeter junction. Double timber soleplates were provided for fixing the timber frame panels (See figure 11). Insulation was fitted between the soleplates to reduce the thermal bridging (See figure 9). To reduce the thermal bridging to door thresholds Compacfoam (0.47 W/mk) was installed (See figure 10).

Figure 11 - Shows soleplate installation detail to the concrete slab

Figures 12 & 13 show the construction build-ups and U-values for the ground floor slab and external walls from the PHPP calculations

Assembly no.	Building assembly description	Interior insulation?
01ud	Floor slab	

Heat transmission resistance [m²K/W]

Orientation of building element: 3-Floor — interior R_{si}: 0.17

Adjacent to: 2-Ground — exterior R_{se}: 0.00

Area section 1	λ [W/(mK)]	Area section 2 (optional)	λ [W/(mK)]	Area section 3 (optional)	λ [W/(mK)]	Thickness [mm]
Slab	2.100					200
EPS	0.038					300

Percentage of sec. 1: 100% — Percentage of sec. 2 — Percentage of sec. 3 — Total: 50.0 cm

U-value supplement: W/(m²K)

U-value: 0.123 W/(m²K)

Figure 12 – Floor slab U-value calcs from PHPP

5.2 External wall construction

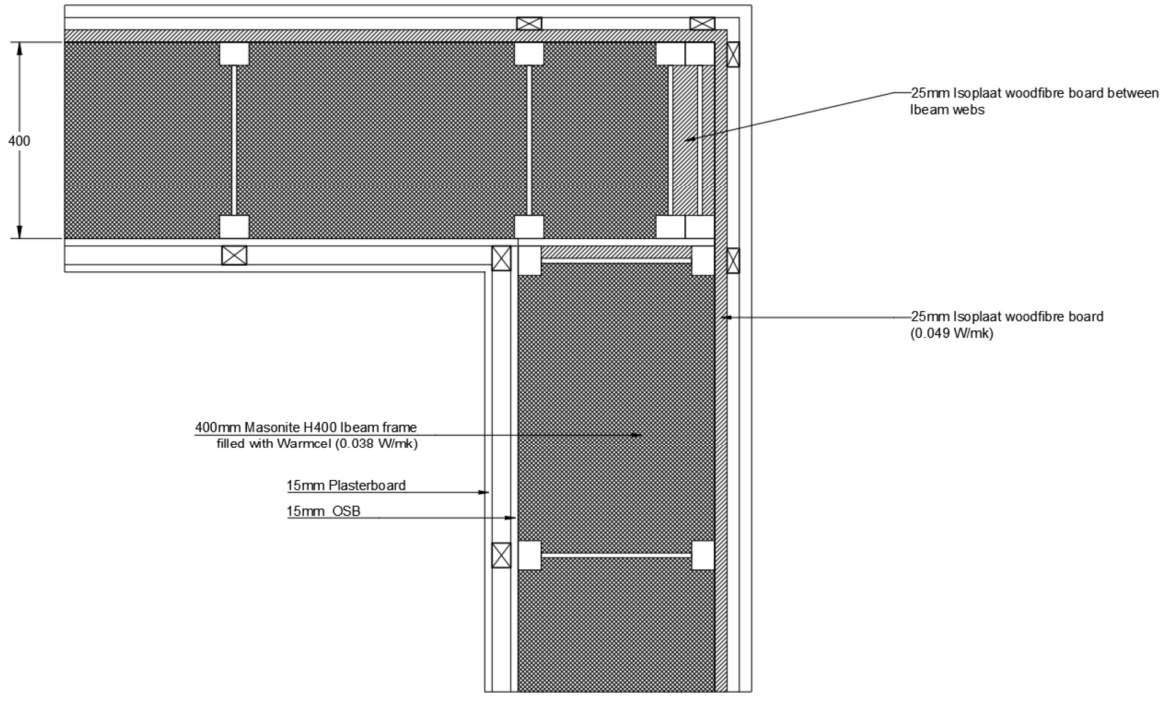
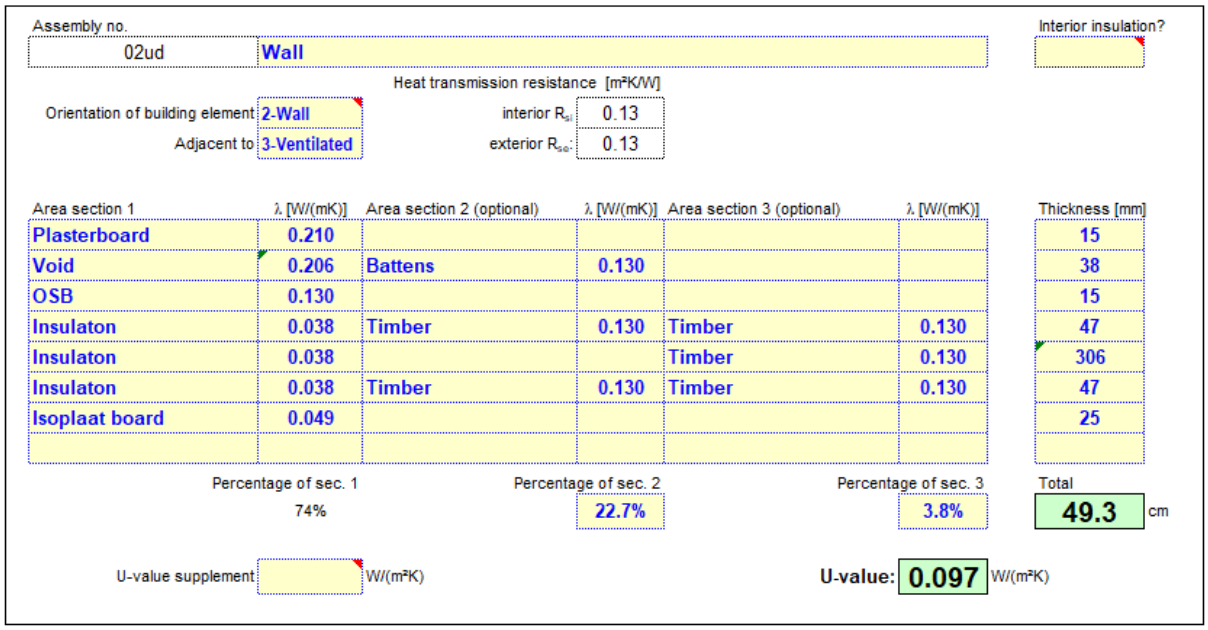


Figure 13 – External wall corner detail

The external wall was constructed from 400mm Ibeams, fully filled with Warmcel cellulose insulation. 15mm OSB was fixed to the insde of the studs and taped at all joints with Pro Clima Tescon Vana to act as the airightness layer. 25mm woodfibre was fitted externally to reduce the thermal bridging through the studs and a breather membrane was provided for wind protection. 25mm Battens were fitted over the woodfibre to provide a ventilated cavity. Where the Ibeams butt together these were fitted with woodfibre board.



Assembly no.						Interior insulation?
02ud	Wall					

Heat transmission resistance [m²K/W]

Orientation of building element: 2-Wall — interior R_{si}: 0.13

Adjacent to: 3-Ventilated — exterior R_{se}: 0.13

Area section 1	λ [W/(mK)]	Area section 2 (optional)	λ [W/(mK)]	Area section 3 (optional)	λ [W/(mK)]	Thickness [mm]
Plasterboard	0.210					15
Void	0.206	Battens	0.130			38
OSB	0.130					15
Insulaton	0.038	Timber	0.130	Timber	0.130	47
Insulaton	0.038			Timber	0.130	306
Insulaton	0.038	Timber	0.130	Timber	0.130	47
Isoplaat board	0.049					25

Percentage of sec. 1	Percentage of sec. 2	Percentage of sec. 3	Total
74%	22.7%	3.8%	49.3 cm

U-value supplement: W/(m²K)

U-value: 0.097 W/(m²K)

Figure 14 – Externa wall U-value calcs from PHPP

5.3 Eaves detail

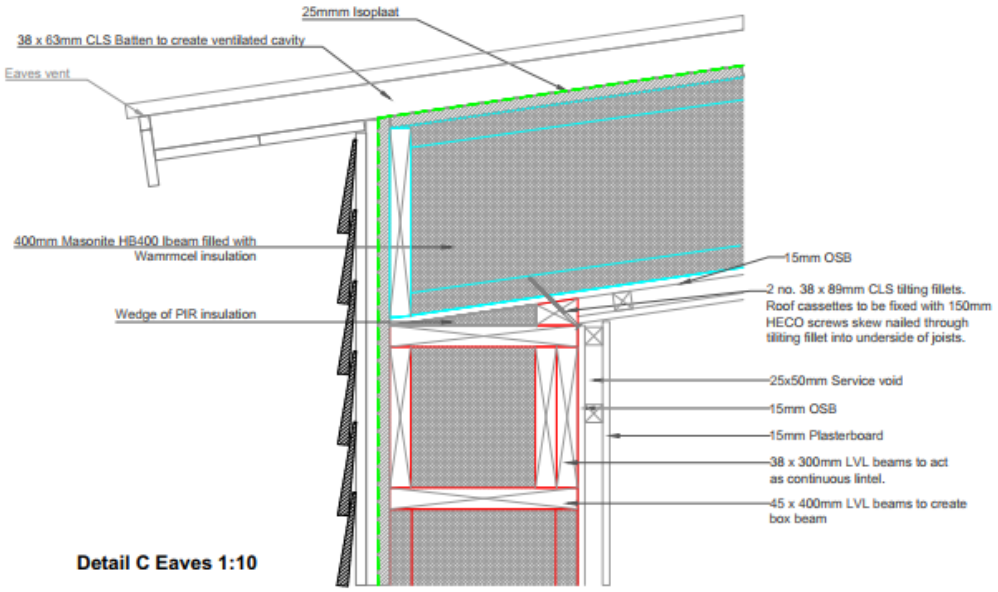


Figure 15 – Eaves detail

The roof for the PYC Offices was constructed from 400mm timber Ibeam rafters, fully filled with Warmcel Cellulose insulation. 15mm OSB was fixed to the insde of the rafters and taped at all joints with Pro Clima Tescon Vana to act as the airightness layer. 25mm woodfibre was fitted over the rafters to reduce the thermal bridging through the rafters and a breather membrane was provided for wind protection. 63mm Battens were fitted over the woodfibre to provide a ventilated cavity.

A timber box beam was contructed into the head of the panels to provide a continuous structural support. This method was chosen over standard lintels as there were many small windows and this option reduced the number of cripples studs, and therefore, the timber fraction (See figure 15).

Figure 16 shows the roof build-up and U-value from the PHPP calculations.

Assembly no.						Interior insulation?
03ud	Roof all					

Heat transmission resistance [m²K/W]

Orientation of building element	1-Roof	interior R_{si}	0.10
Adjacent to	3-Ventilated	exterior R_{se}	0.10

Area section 1	λ [W/(mK)]	Area section 2 (optional)	λ [W/(mK)]	Area section 3 (optional)	λ [W/(mK)]	Thickness [mm]
Plasterboard	0.210					15
Void	0.306	Battens	0.130			38
OSB	0.130					15
Insulaton	0.038	Timber	0.130	Timber	0.130	47
Insulaton	0.038			Timber	0.130	306
Insulaton	0.038	Timber	0.130	Timber	0.130	47
Isoplaat board	0.049					25

Percentage of sec. 1	Percentage of sec. 2	Percentage of sec. 3	Total
82%	15.0%	3.0%	49.3 cm

U-value supplement W/(m²K)

U-value: 0.095 W/(m²K)

Figure 16 – Roof U-value calcs from PHPP

Figure 17 – Timber wall panels being constructed in the factory

Figure 18 – First floor panels erected, showing eaves detail

Figure 19 – Roof panels being erected

5.4 Lower roof to external wall abutment detail

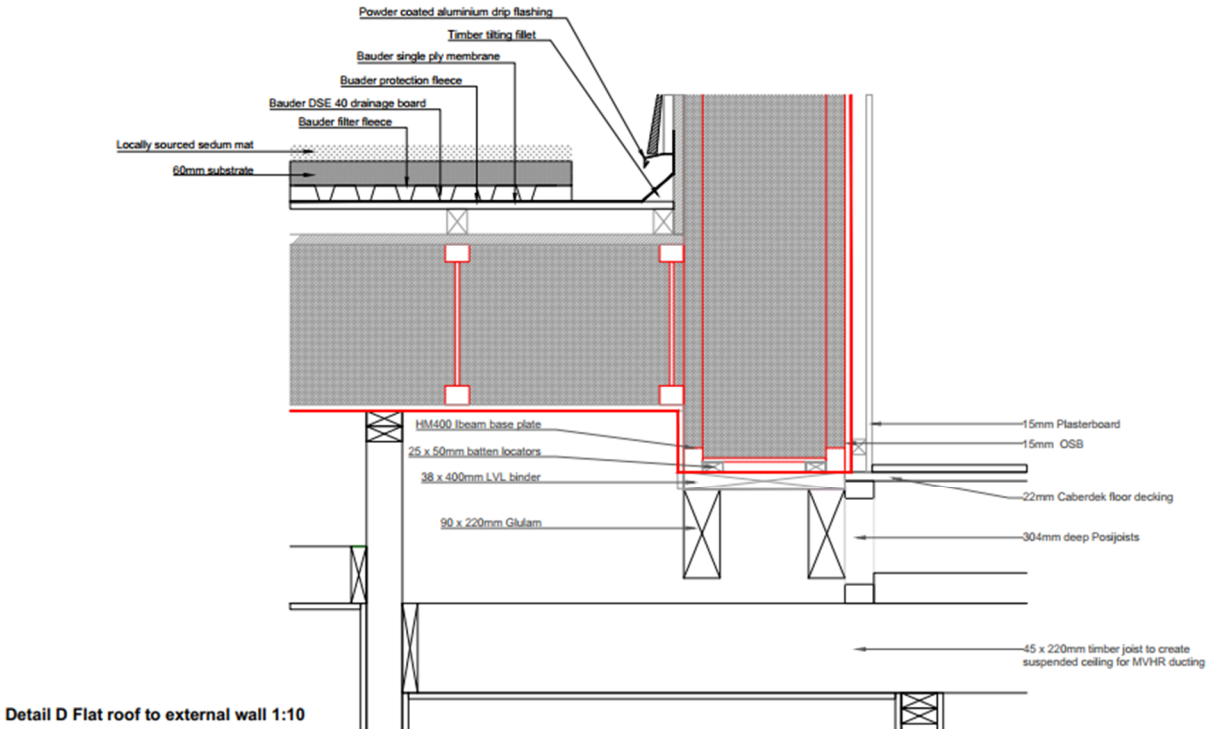


Figure 20 – Lower roof to first floor external wall abutment

Figure 20 shows where the lower roof abuts the first floor external walls. The roof construction is as per Figure 16 and the external wall construction is as per Figure 14. The first floor walls were supported on 2no. glulam beams. Pro Clima Intello membrane was pre-placed under the panels to ensure a continuous airtight layer. Figure 20 shows the airtightness line highlighted in red.

Figure 21 – Glulam beams supporting first floor roof (abutment)

5.5 Window details

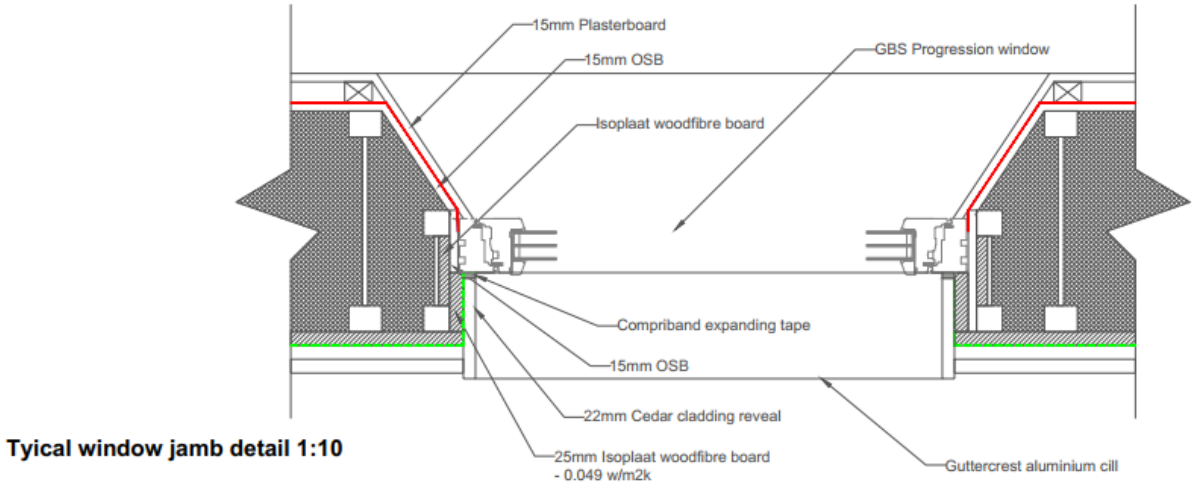


Figure 22 – Window jamb detail

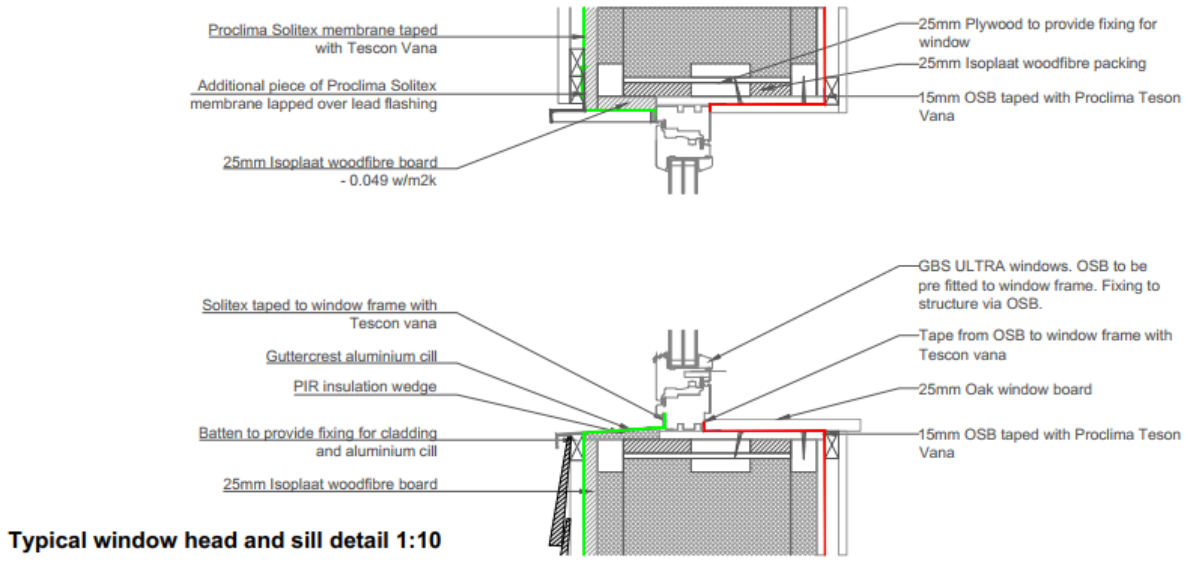


Figure 23 – Window head and sill detail

The windows and external doors for the PYC Offices are the Green Building Store Ultra window range. The frames are solid timber and the glazing comprises of 4.E-20-4-20-4.E Low E standard clear glass. Figure 24 shows the figures for each window and door types. The window incorporated chanferred window reveals to allow more light into the building. Woodfibre was wrapped into the window frame to reduce the installed thermal bridge. The Ug value was 0.53 W/m^{2}k and the g-value was 52%.

Window frames — Window frames

ID	Description	U_f-Value left	U_f-Value right	U_f-Value bottom	U_f-Value above	Frame width left	Frame width right	Frame width bottom	Frame width above	Glazing edge thermal bridge left	Glazing edge thermal bridge right	Glazing edge thermal bridge bottom	Glazing edge thermal bridge top	Installation thermal bridge left	Installation thermal bridge right	Installation thermal bridge bottom	Installation thermal bridge top	Curtain wall facades: χ_{cc}-value Glass carrier
		W/(m²K)	W/(m²K)	W/(m²K)	W/(m²K)	m	m	m	m	W/(mK)	W/(mK)	W/(mK)	W/(mK)	W/(mK)	W/(mK)	W/(mK)	W/(mK)	W/K
01ud	GBS Ultra fixed (Swisspacer Ultimate)	0.80	0.80	0.79	0.80	0.088	0.088	0.109	0.088	0.022	0.022	0.023	0.022	0.040	0.040	0.040	0.040	
02ud	GBS Ultra T&T	0.86	0.86	0.83	0.86	0.102	0.102	0.150	0.102	0.022	0.022	0.023	0.022	0.040	0.040	0.040	0.040	
03ud	GBS Ultra Double Doorset Softline IV98 (Swisspacer Ultim	0.95	0.91	1.36	0.95	0.164	0.097	0.181	0.164	0.020	0.022	0.023	0.020	0.040	0.040	0.080	0.040	
04ud	GBS Ultra Entrance Door Softline IV98 Opaque	0.79	0.79	1.51	0.79	0.160	0.160	0.230	0.160	0.020	0.022	0.023	0.020	0.040	0.040	0.080	0.040	

Figure 24 – Window and external door data from PHPP

5.6 Description of the airtight envelope

The airtightness layer for the external walls and roof was provided by 15mm OSB and taped at all joints with Pro Clima Tescon Vana (See figure 25). Pro Clima Intello Membrane was used where the airtightness layer needed to be pre-placed to ensure a continuous airtight layer, for example, at the lower roof to first floor external wall junctions. The PYC Offices achieved an airtest result of 0.5 ACHR @ 50 Pa. Figures 26 and 27 show the pressurization and depressurization graphs from the final airtest.

Figure 25 – Airtightness layer via OSB baord and airtight tape

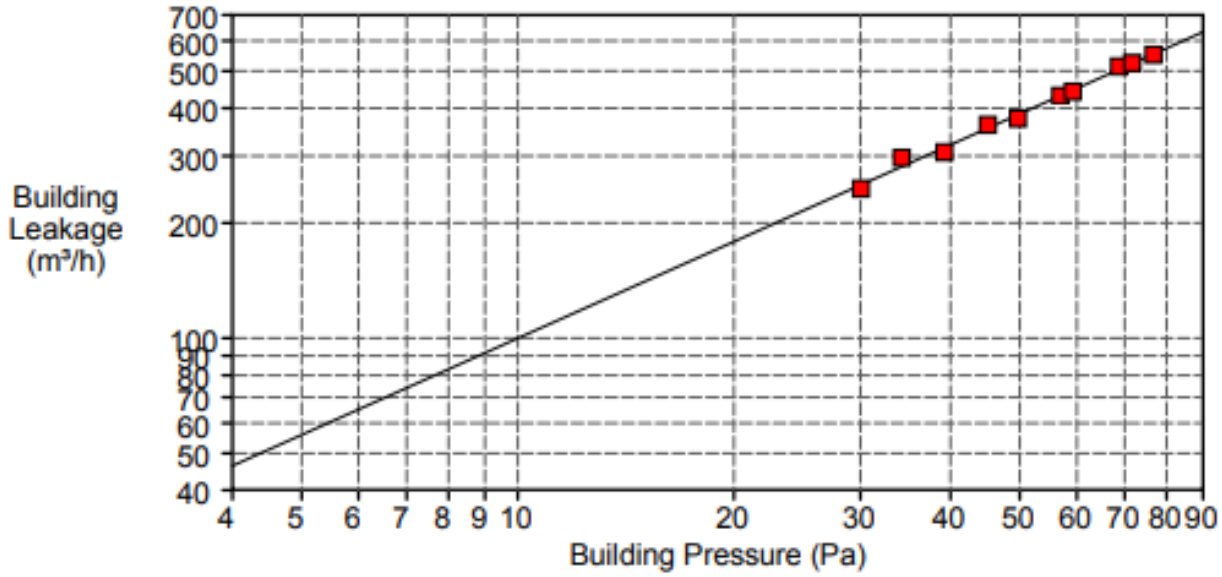


Figure 26 – Pressurization test graph

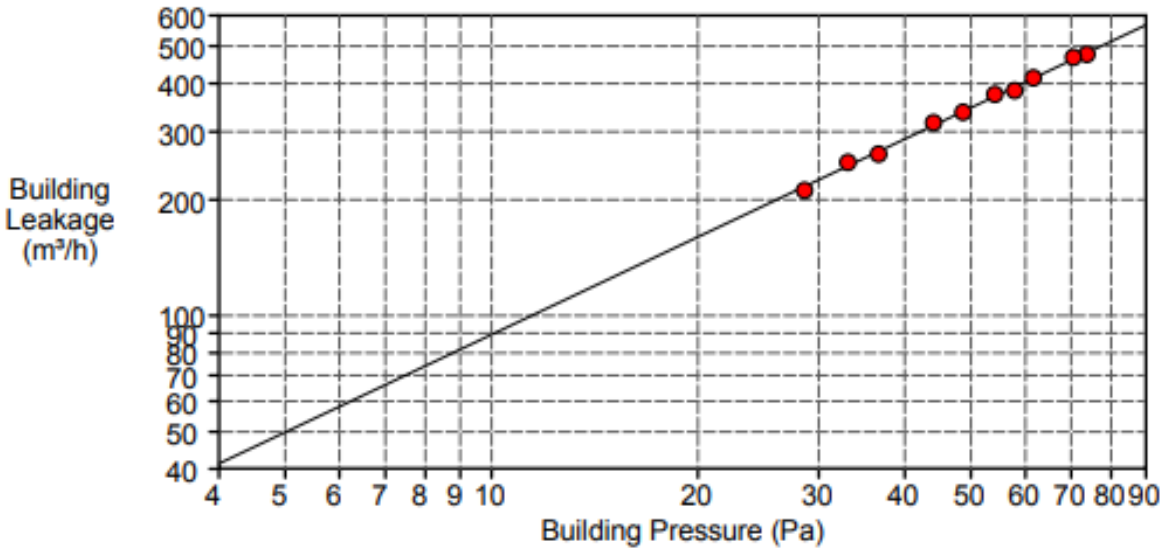


Figure 27 – Depressurization test graph

6. Ventilation design

The PYC Offices incorporated two MVHR units, a large unit located in a plant room outside the thermal envelope, but with an insulated room, and a smaller unit located inside the thermal envelope which only supplied air to one of the downstairs meeting rooms. The larger unit was a Systemair VTC 700 and the smaller unit was a Systemair VTC 200. The effective heat recovery efficiency is 74% for the VTC 700 and 81% for the VTC 200. This gives an overall effective efficiency of 76%. The electrical efficiency is 0.22 for the VTC 700 and 0.34 Wh/m^3 for the VTC 200 Wh/m^3. Both systems were installed and commissioned by PYC Systems.

Both units were located close to the thermal envelope to make the exhaust air ducts as short as possible. The exhaust ducting were insulated with 25mm Armaflex insulation to reduce heat loss via the ducting (See figure 31).

The design utilised steel spiral wound ducting throughout and incorporated sound attenuators where necessary. The ducting supplying the ground floor rooms were built into the first floor construction and used ceiling mounted vents, whereas the first floor open plan office used exposed ducting with side mounted vents (See figure 32).

The supply air (Red) were installed in the office spaces and meeting room. The extract ducts (orange) were installed in the kitchen, WCs and office spaces. In the offices the supply ducts were located on one side of the room and the extract

ducts on the other using cascade primciples. The air trasnfer paths were formed by undercutting the doors.

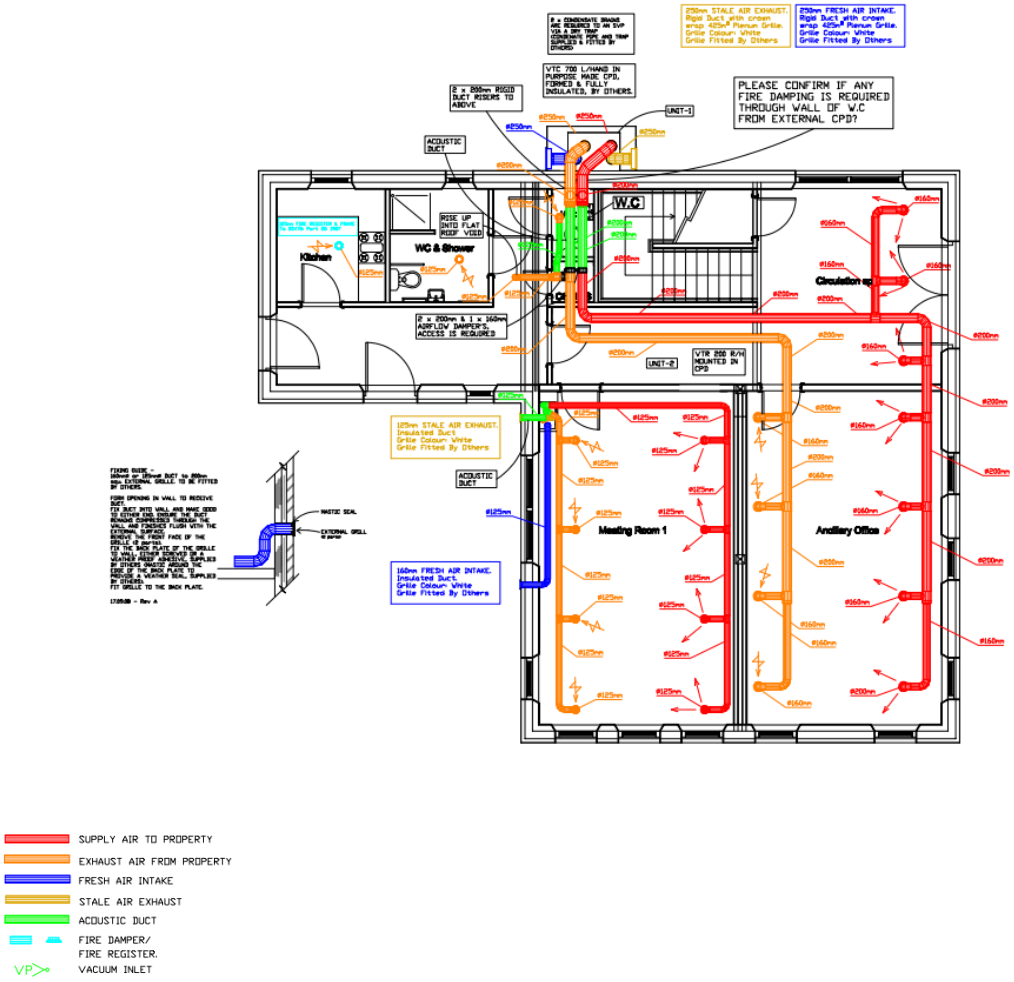


Figure 28 – Ground floor ventilation design

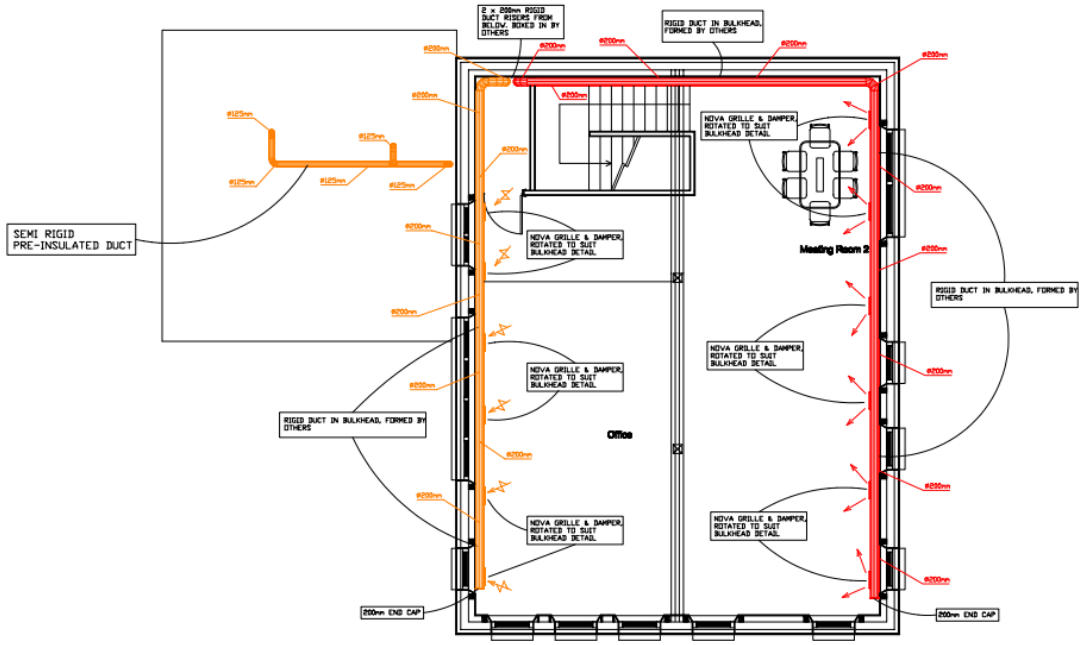


Figure 29 – First floor ventilation design

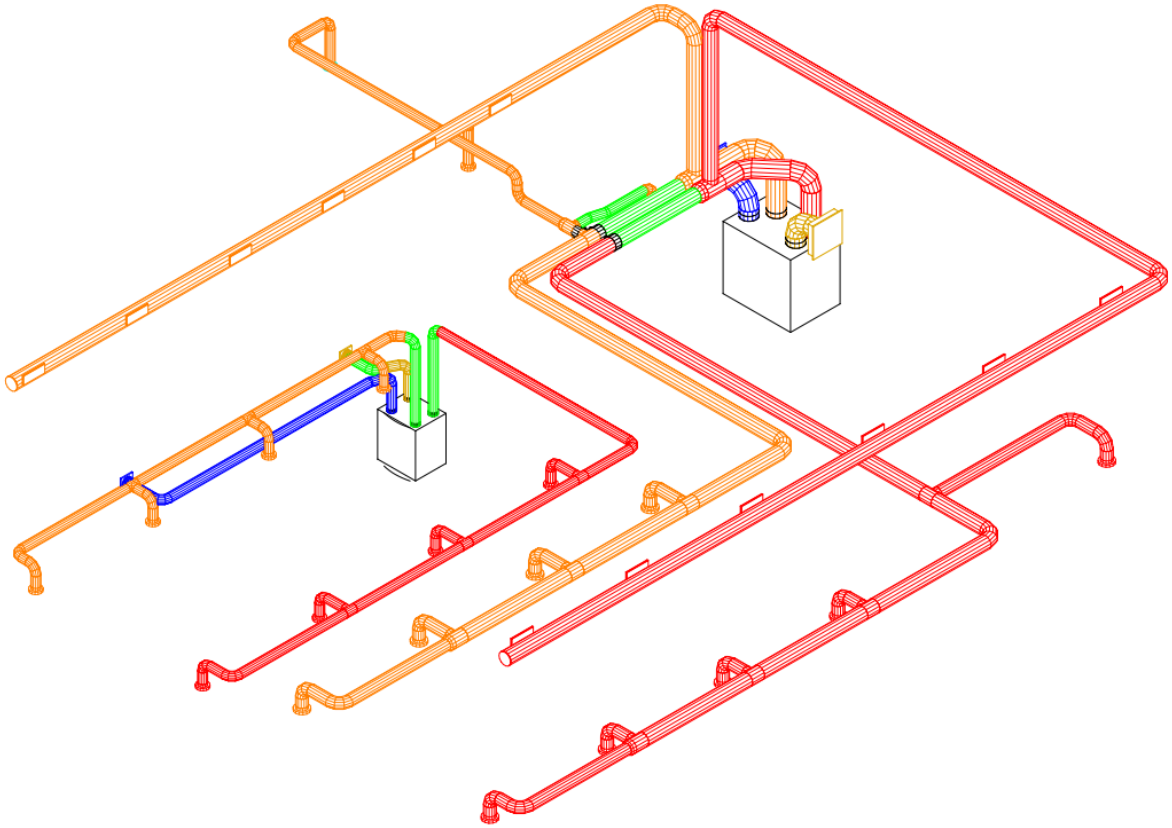


Figure 30 – Isometric drawing of ventilation design

Figure 31 – Insulation to MVHR exhaust ducts

Figure 32 – Steel spiral wound ducting to first floor office

7. Domestic hot water and space heating systems

The hot water demand is reletively low, as the building is an office, and therefore, is provided by a localised instantaenuous water heater (See figure 33). This is located under the kitchen units and supplies the kitchen sink and WC basins. The shower is electric.

Figure 33 – Instantaneuous water heater for hot water

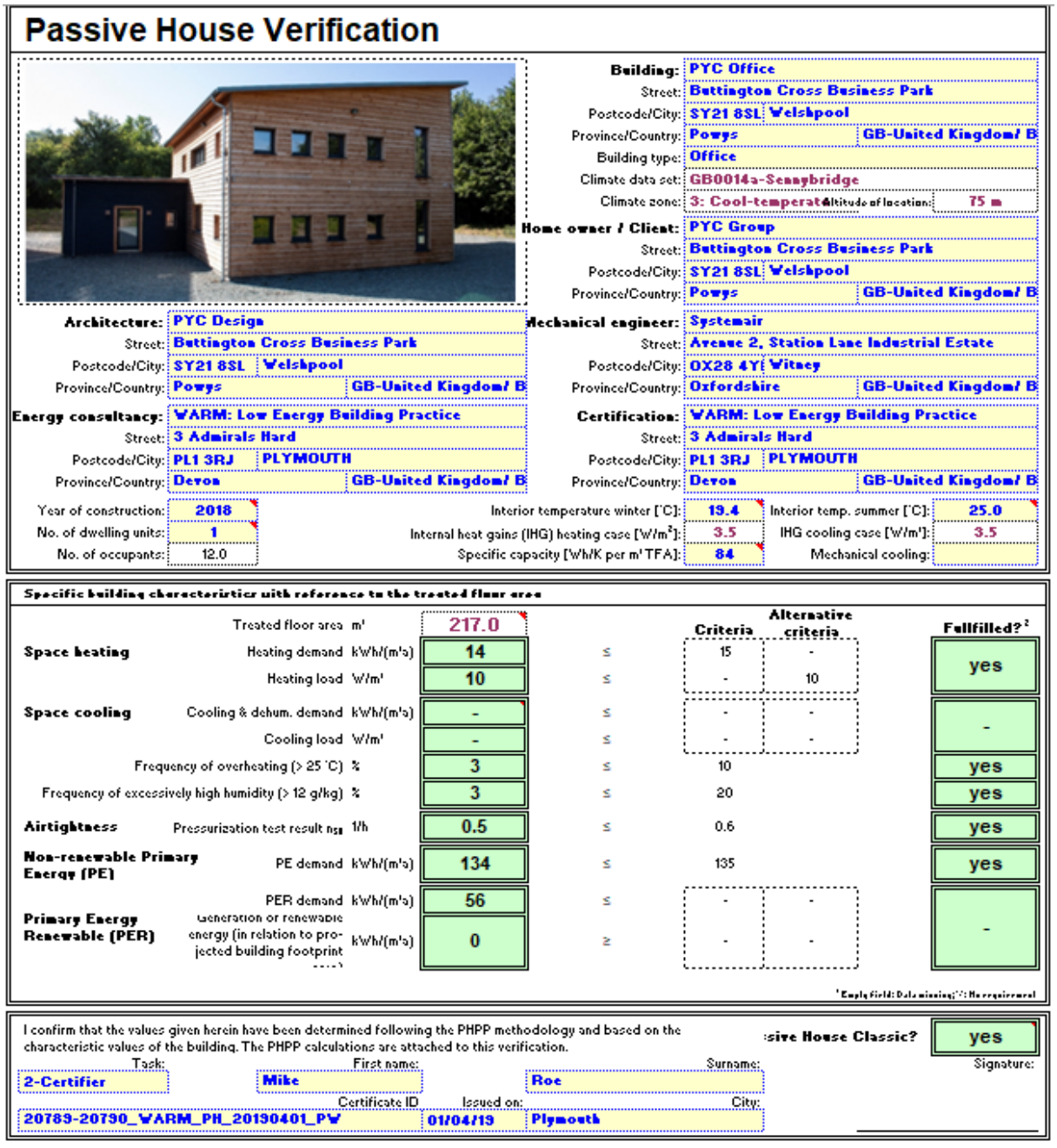
Figure 34 – Instantaneuous water heater in location

The PHPP calculations demonstrated that the building could solely be heated via the MVHR system as the heat load was low. However, the design has incorporated moveable electric heaters, to provide space heating in certain areas which are being used, when the building has been empty and the internal temperature has dropped (See fig 35 & 36).

Fig 35 – Moveable electric heaters

Fig 36 – Moveable electric heaters

8. PHPP calculations



Passive House Verification

Building:	PYC Office		
Street:	Buttington Cross Business Park		
Postcode/City:	SY21 8SL	Welshpool	
Province/Country:	Powys	GB-United Kingdom/ B	
Building type:	Office		
Climate data set:	GB0014a-Sennybridge		
Climate zone:	3: Cool-temperat	Altitude of location:	75 m
Home owner / Client:	PYC Group		
Street:	Buttington Cross Business Park		
Postcode/City:	SY21 8SL	Welshpool	
Province/Country:	Powys	GB-United Kingdom/ B	
Architecture:	PYC Design		
Street:	Buttington Cross Business Park		
Postcode/City:	SY21 8SL	Welshpool	
Province/Country:	Powys	GB-United Kingdom/ B	
Mechanical engineer:	Systemair		
Street:	Avenue 2, Station Lane Industrial Estate		
Postcode/City:	OX28 4YF	Witney	
Province/Country:	Oxfordshire	GB-United Kingdom/ B	
Energy consultancy:	WARM: Low Energy Building Practice		
Street:	3 Admirals Hard		
Postcode/City:	PL1 3RJ	PLYMOUTH	
Province/Country:	Devon	GB-United Kingdom/ B	
Certification:	WARM: Low Energy Building Practice		
Street:	3 Admirals Hard		
Postcode/City:	PL1 3RJ	PLYMOUTH	
Province/Country:	Devon	GB-United Kingdom/ B	

Year of construction:	2018	Interior temperature winter [°C]:	19.4
No. of dwelling units:	1	Internal heat gains (IHG) heating case [W/m²]:	3.5
No. of occupants:	12.0	Specific capacity [Wh/K per m² TFA]:	84
		Interior temp. summer [°C]:	25.0
		IHG cooling case [W/m²]:	3.5
		Mechanical cooling:	

Specific building characteristics with reference to the treated floor area

					Criteria	Alternative criteria	Fullfilled?
	Treated floor area	m²	217.0				
Space heating	Heating demand	kWh/(m²a)	14	≤	15	-	yes
	Heating load	W/m²	10	≤	-	10	
Space cooling	Cooling & dehum. demand	kWh/(m²a)	-	≤	-	-	-
	Cooling load	W/m²	-	≤	-	-	
	Frequency of overheating (> 25 °C)	%	3	≤	10		yes
	Frequency of excessively high humidity (> 12 g/kg)	%	3	≤	20		yes
Airtightness	Pressurization test result n_{50}	1/h	0.5	≤	0.6		yes
Non-renewable Primary Energy (PE)	PE demand	kWh/(m²a)	134	≤	135		yes
Primary Energy Renewable (PER)	PER demand	kWh/(m²a)	56	≤	-	-	-
	Generation of renewable energy (in relation to projected building footprint)	kWh/(m²a)	0	≥	-	-	

¹ Empty field: Data missing; ² No requirement

I confirm that the values given herein have been determined following the PHPP methodology and based on the characteristic values of the building. The PHPP calculations are attached to this verification.

:sive House Classic? yes

Task:	First name:	Surname:	Signature:
2-Certifier	Mike	Roe	

Certificate ID	Issued on:	City:
20789-20790_WARM_PH_20190401_PW	01/04/19	Plymouth

Figure 37 – Verifcation sheet from final PHPP calculations

9. Building costs

The cost was approximately £1600/m2 of useable floor area (TFA)

10. Measured results of the inhabited Passive House

10.1 Measured energy consumption values

The offices and factory share an electricity meter which means that its difficult to separate the electrical consumption from the factory. Energy bills are estimate, based on PHPP calculations. All space heating, hot water and non-residential (household) electricity is met via mains electric. This is with the intention of introducing a large array of PV panels which will provide all the power required to make the offices off-grid.

Total space heating demand of 3024 kWh/a and is met via direct electric.

Hot water of 2584 kWh/a and is met via an instantaneous electric water heater water heater.

Non-residential electric of 3233 kWh/a

Total energy demand – 8841 kWh/a

Currently with an electric tariff of 18.8p per kWh this would provide an estimated annual electric bill of £1,662 of which £568 would be for the space heating (Not including standing charges).

10.2 User satisfaction, user behaviour

“Our new offices are great to work in. The internal temperature is very consistent, with minimal heating easily maintaining above 18 degrees in the winter and not overheating too much in the summer. The air quality is very good with the MVHR units. Despite being in an industrial park near a very busy road we find one of the biggest things is how quiet it is in the offices, triple glazed windows along with the dense pack Warmcel cellulose fibre insulation in the walls give great sound reduction. I find as the building owner, the low running costs and most importantly the comfort benefits make this a very productive work space” Jasper Meade, Director PYC Group Ltd