

Fundamentals of Construction Technology

Module Code: ACBA4001

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Introduction

The purpose of this report is to solve and present construction details for a single two storey detached domestic building as presented in original brief drawings which can be seen in Appendix A

[Inset drawings into Appendix A]

- NW and SW elevations - proposed
- Ground/first floor/second floor plans - proposed
- Roof plans - proposed

Table 1 (see below) summarises data given at the outset of the brief and initial assumptions made prior to producing detailed drawings which are located in Appendix B; accompanying explanations for these will follow in Sections 1-4.

Summary Table 1 - Given brief data:

Structural Element& details to be solved	Data Given	Assumptions /other comments
Ground Site/Floor, to solve: Construction, detailing and junctions with external walls.	Built on level greenfield site: 450 mm of topsoil above firm soil/low clay/above water table.	Negligible Radon Level
Wall Construction, to solve:	Standard Cavity Wall/Block and Block/Partial Fill	Note the 'Random rubble' facing to the gable wall of the NE Elevation and use of this material for the

Construction, detailing and junctions with external walls	Smooth Render externally	plinths: mitigation measures will be required to accommodate these finishes.
Plinths/Openings, to solve: Solutions for lintels, sills and jambs.	Soldier courses, over all openings. Porch Pillars to be natural sandstone. Random rubble stone plinth course	Random rubble stone is unlikely to be cropped to a regular 100mm width and, since there is no backing wall, needs a solution to ensure a clear cavity is maintained.
Floors, to solve: Construction, detailing, junctions with external walls and restraints.	Suspended timber floor: Ground Floor. Upper Floors: Traditional Solid Timber with solid tongue and groove flooring.	On the ground floor, there may be requirements for several different floor finishes, in accordance with designated room use: E.g. tiles for the Utility and W/C area - possible wet room requirements. Tiling/engineered timber boarding for kitchen area; engineered timber boarding /Carpet finish for Lounge/Study/Hall areas. Therefore, it would make sense that the joists are overlaid with a structural ply/OSB board floor, to provide a working

		platform, without risk of damaging final finishes. It would also provide a suitable substrate for a variety of different floor finishes, bearing in mind utility, WC and kitchen areas would require moisture resistant boarding. Consequently, a dead load of up to 0.5 kN/m² has been allowed for in selecting the joist size from Trada span tables
Windows and external doors, to solve: Solutions for lintels, sills and jambs.	Light Oak effect uPVC with sealed double-glazed units.	Will need to consider height and position of glazing in critical locations wrt to Approved Doc Building Regs N, to determine correct specification/standard for glazing.
Roof/Eaves, to solve; Construction, detailing, fixing (including utility single story roof as per tutor guidance).	Trussed Rafters at 40° pitch with natural slate covering and close eaves.	Tutor has stated that the roof is to be a warm roof, rather than sealed. It may have been considered sufficient to have opted for a sealed roof solution entirely but the warm roof solution has been presented as instructed.

Eaves detailing and roof covering: appropriate weathering, fixing, laps.		
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Additionally, following a discussion with E. Kincaid [April 2020)] permission with respect to using 'Vectorworks' to present some of the assignment drawings (as part of C.A.D. training being undertaken during ongoing work shadow placement, at the 'Living Design': local design studio) the following sections and plans were produced:

[Citation: Kincaid, E.P. (2020) Conversation L Zanoni, 21st April]

- Section A-A [Section to show arrangement and roof truss specifications for main roof]
- Section B-B [Section to show King post truss to intersecting roof- T section]
- Section C-C [Section to show Fink Truss over single storey]

These are presented in Appendix B

Rudimentary 2D plans were also produced (See Appendix B) to illustrate ground floor/first floor and roof plans. Reference to all the above will be made in the subsequent sections, in conjunction with manufacturer's information and/other diagrams, where required to describe the solutions presented.

The detailed section drawings were hand drawn but then scanned and annotated in Vectorworks for clarity; these are also located in Appendix B.

Section One

Ground Floor: Construction, detailing and junctions with external walls:

With reference to Approved Document A (2017) and BS 8004 (2015), a strip foundation design is proposed as shown in Diagram 4: Door threshold/ground floor detail and Diagram 7, Ground Floor -detail (see Appendix B).

In order to provide a context for the ground floor detailing (although outside of the scope of this assignment) an explanation for the basis of the proposed substructure-strip foundation design, with accompanying calculation and summary table can be found in Appendix C (see below)

Substructure: Walls below ground and Suspended Timber Floor:

To maintain continuity between the sub and superstructures a filled cavity wall detail was chosen for the ground wall(substructure) the fundamental detailing of which is shown in Diagram 7, Ground Floor-details (Appendix B) and was arrived at using general guidance from Approved Document A,(2017) and BS 8004(1986); in this solution a weak mix concrete fill is made up to ground level, to prevent the inner and outer leaves of the cavity wall structure from buckling under the proposed building load.

The general structure for the cavity wall (superstructure), as shown in Diagram 3, Door head/intermediate floor detail,(see Appendix B) using guidance in Approved Document A,(2017,p.20-31) a part cavity fill structure, will be used, comprising of concrete block, inner and outer leaves with rigid insulation attached to the inner leaf and a partial air gap alongside the external leaf, required to break the capillary path of moisture and/or inner cavity condensation across into the building.

Approved Document A (2017, p..20) also advises that 'All cavity walls should have leaves at least 90mm thick and cavities at least 50mm wide'. From the dimensions

given (see drawings in Appendix A), it can be seen that the external walls are 335mm overall in width.

Assuming 100mm dense concrete block inner and outer leaves, and a 50mm residual cavity, the construction is proposed to be as summarised in **Table 3** below:

Summary Table 3: Cavity Wall (superstructure) detailing:

Construction Detail	Dimensions/other comments	Manufacturer Specification
100mm concrete block inner leaf /outer leaf	225 mm high (215 mm block + 10 mm mortar joint)	Dense Concrete Blocks; Aggregate blocks with a solid density range of 1850 - 2300kg/m³ (insert data sheet in Appendix D) https://www.edenhall.co.uk/documents/brick-technical-info/edenhall-data-sheet-btb10-1063.pdf (see Appendix D for data sheet for Dense concrete blocks)
85mm partial fill cavity insulation	Rigid board type - Phenolic foam with foil facings	Kingspan KoolTherm K108 Cavity board; (Kingspan insulation 22117: (2017, p.5) (Kingspan insulation 48492: (2017, p.5-6)
50 mm cavity	N/a	N/a

Wall ties are used to provide lateral restraint to the leaves of cavity walls (BS 5628-3:2005, Section 5.3.5) as shown in Diagram 3, Door head/intermediate floor detail, (see Appendix B). Approved Document A (2017, p.20) specifies ‘The wall ties should have a horizontal spacing of 900mm and a vertical spacing of 450mm, which is equivalent to 2.5 ties per square metre. It is also advised that wall ties should be spaced ‘not more than 300mm apart vertically, within a distance of 225mm from the vertical edges of all openings, movement joints and roof verges.’

It is proposed to use Type 2 wall ties as per recommendations made in *tables 9 & 10 in* (PD 6697: Recommendations for the design of masonry structures to BS EN 1996-1-1 and BS EN 1996-2(2019, p.33-34).

Further guidance regarding selection of wall ties for certain cavity width values can be found *Table 5* Approved Document A, (2017, p.29). Summary Table 4 below summarises relevant British standards for guidance on masonry units, wall ties and restraints and thermal insulation.

Summary Table 4: Standards for masonry units, wall ties and thermal insulation:

Structural element	Codes
Masonry Units	Clay bricks to BS 3921:1985 or BS 6649:1985. Concrete blocks to BS EN 771-1; Concrete bricks or blocks to BS 6073-1:1981 or BS EN 771-3 or -4; Random rubble natural stone - no dimensional requirements described in BS EN 771-6 or BS 5628-3:2001, but would need to be cropped to 100mm bed width;
Wall Ties	BS 1243, DD 140, or BS EN 845- 1 and should be material references 1 or 3 in BS EN 845 Table A 1 austenitic stainless steel

	PD 6697:2019 Recommendations for the design of masonry structures to BS EN 1996-1-1 and BS EN 1996-2
Thermal Insulation	The λ -values (thermal conductivity) detailed are quoted in accordance with BS EN 13166: 2012 + A2: 2016 (Thermal insulation products for buildings. Factory made phenolic foam (PF) products. Specification)

Thermal Insulation Elements:

Solutions for thermal insulation required by cavity walls, suspended timber floor, and the roof, were researched by reference to guidance from *Approved Document part L:2014 L1A* (2018, p.46) and BS 5250:2011 Code of practice for control of condensation in buildings.

Determination of constructions with respect to thermal performance:

Using the Elemental specification for Target Emission Rate (TER), from guidance in Section Four Approved Document part L:2014L1A(2018, p.20-21) and Appendix B(p40(?)the following elemental U-values are required:

- External walls: 0.18W/m²/K
- Ground floor: 0.13W/m²/K
- Roof: 0.13W/m²/K

Cavity Wall:

For external cavity wall insulation, Phenolic foam was chosen over polyisocyanurate foam board as its lower thermal conductivity (0.018 as opposed to 0.022W/mK)

permits use of dense concrete blocks, which have a better loadbearing capacity, and are more economical [see Diagram 3, Door head/intermediate floor detail, to see the application of the 80 mm Kingspan K108 wall insulation board, with positioning of ties, retaining clips (see Appendix B)

Assuming standard dense concrete block construction, a U-value of 0.18W/m2K is achieved using 75mm Kingspan K108 Cavity board see fig 1, extract from: Kingspan Insulation: K108 Cavity Board PARTIAL FILL CAVITY WALL INSULATION 3rd issue October 2017.

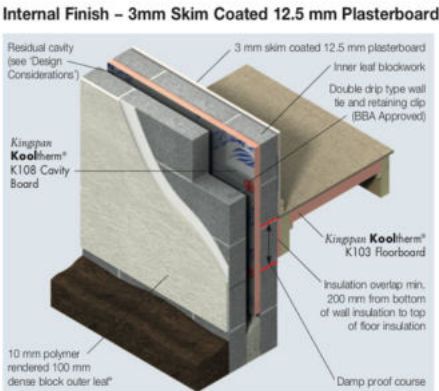


Figure 2

U-values (W/m²·K) for Various Thicknesses of Kingspan Kooltherm® K108 Cavity Board				
Insulant Thickness (mm)	Inner Leaf Blockwork Density and λ-value (W/m·K)			
	Dense (1.13)	Medium (0.51)	Lightweight (0.15)**	Aerated (0.11)**
20	X	X	0.35	0.33
25	X	X	0.32	0.30
30	X	0.32	0.29	0.28
35	0.31	0.30	0.27	0.26
40	0.28	0.28	0.25	0.24
45	0.26	0.26	0.23	0.22
50	0.24	0.24	0.22	0.21
55	0.23	0.22	0.21	0.20
60	0.22	0.21	0.20	0.19
65	0.20	0.20	0.19	0.18
70	0.19	0.19	0.18	0.17
75	0.18	0.18	0.17	0.16
80	0.18†	0.18†	0.17†	0.16
90	0.16	0.16	0.15	0.14
100	0.15	0.15	0.14	0.14
110	0.14	0.14	0.13	0.13
120	0.13	0.13	0.12	0.12

* Calculations assume dense block outer leaf of λ-value (1.13 W/m·K).

** A 6.6% thermal bridging factor has been assumed for the effect of mortar joints.

† U-values with a 40 mm cavity are 0.01 W/m²·K lower (better) than those shown.

NB Refer to local distributor or Kingspan Insulation price list for current stock and non-stock sizes.

Figure 1: Cavity wall U-values

Ground floor construction:

Considering guidance from Anderson (2006, p23) the u value for the ground floors were calculated using the 'Perimeter/ Area ratio' (perimeter measured to inside face of external walls

From the dimensions given;

$$P = 43.5\text{m}$$

$$A = 94.7\text{m}^2$$

$$P/A = 0.46$$

From Kingspan manufacturer's tables:

For a perimeter / area ratio of more than 0.2, the maximum U-value achievable is 0.14W/m²K using 75 + 100mm layers of K103 Foil faced Phenolic foam insulation board, (assuming a 25 x 25mm batten support and a joist depth of 200mm). For 220mm depth joists, or 200mm depth joists using support clips or battens underneath the joists, it is assumed that calculation is likely to show that 100+100mm achieves 0.13W/m²K.

200mm foil faced PIR insulation board between joists as above (conductivity 0.022 W/mK) achieves a U-value of 0.13W/m²K - determined using the Celotex calculator (Celotex Therefore, 200mm, or 100 + 100mm Kingspan K103 will meet the requirement (See Fig 2 below)

A perimeter insulation strip is installed, to prevent linear thermal bridging between joist and external wall, to extend full depth of joist. Cavity wall insulation is to extend min 200mm below floor level; see Diagram 4, Door threshold/ground floor detail, (Appendix B)

Suspended Timber Ground Floors

Insulation Between Joists

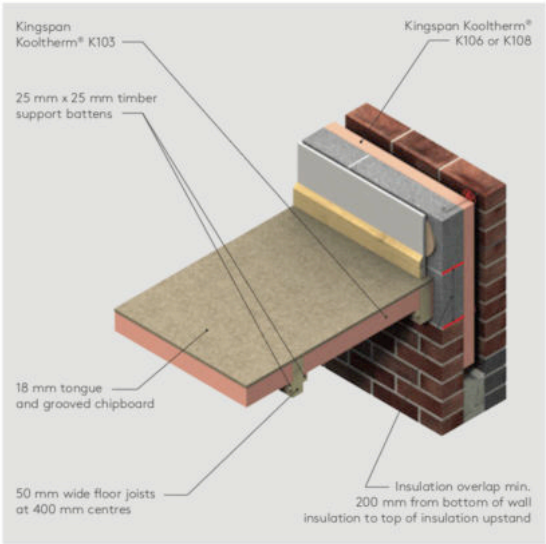


Figure 4

U-values (W/m²K) for Various Thicknesses of Kingspan Kooltherm® K103 Floor Perimeter / Area Ratios						
Insulant Thickness (mm)	Perimeter / Area (m⁻¹)					
	0.2	0.3	0.4	0.5	0.6	0.7
45	X	X	X	X	X	X
50	X	X	X	X	X	X
60	0.24	X	X	X	X	X
70	0.22	0.25	X	X	X	X
75	0.22	0.24	0.25	X	X	X
80	0.21	0.23	0.24	0.25	X	X
90	0.20	0.21	0.23	0.23	0.24	0.24
100	0.18	0.20	0.21	0.22	0.22	0.23
110	0.17	0.19	0.20	0.20	0.21	0.21
120	0.17	0.18	0.19	0.19	0.20	0.20
125	0.16	0.17	0.18	0.19	0.19	0.19
130	0.16	0.17	0.18	0.18	0.18	0.19
140	0.15	0.16	0.17	0.17	0.17	0.18
150	0.14	0.15	0.16	0.16	0.17	0.17
80 + 80	0.14	0.15	0.15	0.15	0.16	0.16
80 + 90*	0.13	0.14	0.14	0.15	0.15	0.15
75 + 100***	0.13	0.14	0.14	0.14	0.15	0.15

* Where multiple layers of insulation of different thicknesses are used, the thickest layer should be installed as the outermost layer in.

** Suspended timber ground floor joists are typically 200 mm deep and, therefore, U-values have been calculated with a maximum insulation thickness of 175 mm, in order to accommodate 25 x 25 mm timber support battens.

NB Refer to local distributor or Kingspan Insulation price list for current stock and non-stock sizes.

Figure 2: Suspended timber floor U-values

Substructure: Suspended Timber Floor:

In summary Table 1, the given data stipulated that the ground floor is to be a suspended timber floor also known as a 'hollow' floor). Diagram 14; Ground Floor Joist Plan (Appendix B) shows suggested positioning for the floor joists and shows the key requirements to construct and restrain the suspended floor, with reference to the concepts shown in diagrams 5 and 6 of Approved Document C (2017, p 38-39), these are as follows:

A floor void structure, which serves to ventilate the timber joists, traditionally suspended from galvanised mild steel, timber to masonry type joist hangers to prevent rotting of the joist ends [e.g. Simpson Strong-Tie SFH - Safety Fast Masonry Restraint Hanger] Approved Document C (2017, p.38) states that the ventilation space should measure 75 mm from ground to underside of wall plates and at least 150 mm to the underside of the suspended joists.

'Sleeper walls' , as shown in Diagram 14;Ground Floor Joist plan (Appendix B) which support the timber joists and for this design, continue as load-bearing partitions either side of the stairwell and to 2nd floor level providing support for both ground and first floor joists. At void level, these are built in a 'honey combed' arrangement (missing bricks to provide gaps for air circulation). The joists are either lapped over the wall and fixed to 100x 50mm softwood wall plates, with damp proof course fixed between plate and sleeper wall to prevent rot, or hung on 'straddle' type joist hangers with a damp-proof course membrane laced below the joist level.

These bearer walls are borne off an 'oversite' layer of concrete see Diagram 4: Door Threshold/ground floor detail(Appendix B) in 100 or 50 dense concrete as in (BS 8500-1,2002) on a polyethylene damp proof membrane of 1000g, as in (BS 6515,1984) this is laid over 150 mm clean hardcore. the walls The total dead and imposed loads from these internal loadbearing walls are calculated to be as 31kN/m (see Appendix C), requiring foundations of 300 x 150mm as suggested in Approved Document A, Table 10 (2017).

Ventilation in the cavity walls is achieved by vents placed in line with the air flow through the sleeper walls; Approved Document C (2017,p.38) states that 'If floor levels need to be nearer to the ground to provide level access sub-floor ventilation

can be provided through offset (periscope) vents, the latter are proposed for this reason (e.g. Manthorpe Building Products G965 Dual Extended Telescopic Underfloor Void Ventilator and G930 Combination Airbrick, see manufacturer's notes in Appendix D)

A polypropylene panel, see fig 3 below (e.g. 'SureCav 50' panel cavity protection system) is proposed as a solution to facilitate construction of the plinth from random rubble stone, as per brief drawings (see Appendix A). This system allows all voids to be filled in the narrow 100mm leaf of plinth stonework without risk of bridging the cavity, and could also be used for the facing to the northeast gable to eliminate the backing blockwork, reducing the overall outer leaf dimension to 100-150mm and simplifying lintel and sill details in this wall.

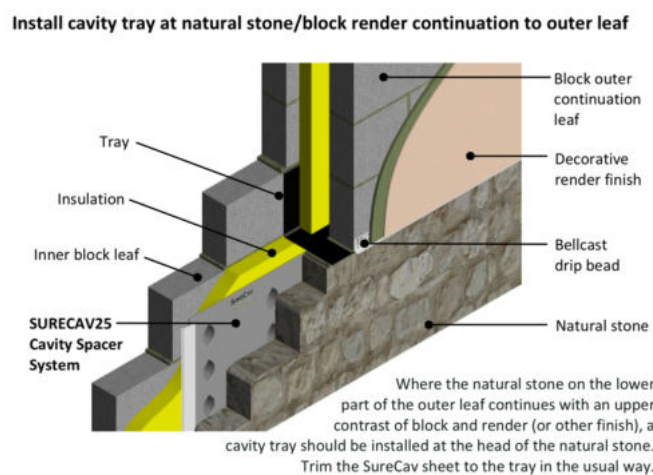


Figure 3: SureCav Ltd., 2018, p.25

In accordance with guidance from Approved Document A, Section 2B1, (2017,p.17) joist sizes were determined with reference to the Eurocode 5 Span Tables, 4th ed (Trada,2014)

For the ground floor (dead load greater than 0.25kN/m²): 220 x 47 C16 softwood timber joists at 400 mm centres were chosen, as shown in Diagram 14(Appendix B) Although a higher strength grade would have permitted the use of 200 x 47mm joists, the depth of insulation required is 200mm, and a 220mm joist allows a batten to be fixed to retain the floor insulation.

It is assumed that there will be secondary internal floor finishes (Carpet/ timber board/ tile/ vinyl etc), and a structural floor of either 18mm Plywood or T & G Chipboard is proposed. If ceramic or stone tile finishes are to be considered, the sub-floor should be of plywood, and strengthened to minimise deflection by spacing joists at 300mm centres, and introducing additional noggins at 300mm centres. If tiling is not proposed, and chipboard may be used, Approved Document C requires in section 4.15, (2017, p.39) that “In areas such as kitchens, utility rooms and bathrooms where water may be spilled, any board used as a flooring, irrespective of the storey, should be moisture resistant. In the case of chipboard, it should be of one of the grades with improved moisture resistance specified in BS 7331:1990 or BS EN 312 Part 5:1997. Plywood should be specified to EN314-2, class 2 (bonding quality) & EN 636 - class 2 (durability) <https://elliotts.uk/plywood-classes-explained> It should be laid, fixed and jointed in the manner recommended by the manufacturer. Any softwood boarding should be at least 20mm thick and from a durable species, or treated with a suitable preservative.”

Table 5 summarises relevant British standards for further guidance on Timber/ other material use for Floors and Roof structures. as referenced in Approved Document A (2017, p.17). As the joists span over 2.5m, strutting is required at mid span, in accordance with BS8103-3:2009 (section 6.2.3, p.14-18). This could either be proprietary herringbone struts, or 38mm timber strutting (solid or herringbone), however, since the joists are infilled with rigid foam board, full-depth solid strutting is chosen to maintain continuity of insulation.

Ground floor construction summary:

- 18mm plywood or moisture resistant T & G particleboard type P5 to BS EN 312 Part 5:1997
- 200 x 47mm C16 SW treated timber joists at 400mm centres
- Kingspan K103 Foil-faced Phenolic foam board insulation; 100 + 100mm between joists, on 20 x 20mm SW treated battens
- Full depth solid SW strutting at mid-span
- U-Value = 0.13 W/m²K

Summary Table 5: Standards for Timber Floors and Roof structures:

Substructure element	Codes
All	BS 5268-2:2002 Code of practice for permissible stress design, materials and workmanship
Trussed Rafter roofs	BS 5268-3:1998, Code of practice for trussed rafter roofs
Floors and Roofs	BS 8103-3:1996 Structural design of low-rise buildings, Code of Practice for timber floors and roofs for dwellings.

Section Two:

First Floor - Construction, detailing, junctions with external walls and restraints

The proposed arrangement of floor joists is shown in Diagram 13: First Floor Joist Plan (Appendix B) drawings for each floor in appendix A.

Structural sizing

Although SW boarding is specified as a finished floor, there could still be secondary internal floor finishes of ceramic or stone tile finishes, and a dead load of 0.5kN/m² is assumed in order to allow for this, (and for the en-suite bathroom and partitions). The floor would need to be strengthened to minimise deflection under tiled finishes as stated in section 1.

From TRADA span table 4.1 (Eurocode 5 span tables for solid timber members, p.21), 220 x 47 C16 softwood timber joists at 400 mm centres have a maximum permissible span of 4.36m for a dead load of 0.5kN/m², so are suitable in this instance. Two additional joists are required under lightweight non-loadbearing first floor partitions (between bedroom 2 & 3).

Even if a lower dead load of 0.25kN/m² were to be specified, the maximum span of 4.62m for 220 x 47mm C16 timber in this case would need to be reduced by 10% to 4.16m, as per advice (Section 4.1.5, p.19) wherever lightweight partitions run at right-angles to the direction of joists (in bedroom 1 & 3). Taking a lower joist size of 195 x 47mm would result in an effective maximum span of 4.10 less 10% = 3.69m, which is less than the required span of 3.915m.

BS8103-3:2009, Tables 11-14 and figure 12, give guidance on sizing for trimmers supporting floors without partitions (BS8103-3:2009 Structural design of low-rise buildings – Part 3: Code of practice for timber floors and roofs for housing, p.38-45). The clear span of the trimmer to the stairwell is 3m, and it supports a loaded length of 1.075m. Table 12 gives a permissible span of 4.79m for double members with an overall timber size of 94 x 220mm, and a loaded length of 1m, and Table 11 allows 3.662m span for a single member of 47 x 220mm, so 1nr 47 x 220mm C16 joist could be assumed to be sufficient, however, increasing the width to 76mm would provide a more secure fixing for balustrades and newels.

As shown in Diagram 3: Door head/intermediate floor detail (Appendix B) sound insulation is provided by a ceiling finish of single layer of plasterboard, minimum mass per unit 10kg/m², with an absorbent layer of mineral wool (minimum thickness 100mm, minimum density 10kg/m³) laid in the cavity. (Para. 5.23 p.113, Approved Document E)

Also shown are the lateral restraint straps as per guidance in Approved Document A, (Sections 2C34-36, p. 36-37):

‘Walls should be strapped to floors above ground level, at intervals not exceeding 2m and as shown in Diagram 15 by tension straps conforming to BS EN 845-1’.

Further guidance for gable walls is given in *Section 2C36, p. 37 and advise for support for walls is given in Table 9 (p. 37):*

‘Roof or floor lateral support [to internal loadbearing walls] at the top of each storey

Floor lateral support [to solid or cavity external walls greater than 3m length] by every floor forming a junction with the supported wall'

Section Three:

As per guidance in both Approved Documents A and C and L:2014 L1A, a solution for jambs and window openings was arrived at as shown in Diagram 8: Jamb Detail (Appendix B), note the Kingspan Kooltherm K108 Cavity closer, to prevent thermal bridging and the air barrier flexible membrane. Also shown is a damp-proof cavity tray over the lintel ensures that in extreme exposure areas any moisture penetrating the outer leaf is directed out through weep holes immediately above the cavity tray. The Catnic Thermally broken lintel range comprises two separate pressed steel lintels for inner and outer leaf, bonded to a rigid insulation core, which results in very low thermal transmittance 0.05 W/mK or less. The square edge of the inner part of the insulation core ensures better continuity with the cavity insulation.

In Diagram 2: Sill detail (Appendix B), since the UPVC frame is shown set back the full width of the outer leaf, a separate concrete sub sill is proposed below a 90 mm 'stub' pvc sill. The damp proof cavity tray beneath the sub sill ensures that moisture draining through the frame profile cannot run off either side of the sill within the cavity. An additional section of insulation board is placed behind the sub sill to minimise thermal bridging at this point.

In critical location, as defined in Approved Document N glazing will need to be toughened to Class C of BS 6206. For this project, such locations include the patio door leaves, glazing to the utility external door, and the sidelight and door glazing to the front entrance. Roof windows will have an outer toughened laminated pane.

Section Four:

Main Roof Structure: Construction, detailing and fixing

The main roof structure (diagram 9, Appendix B) comprises Attic type trusses. These are a combination of the Queen post type truss, omitting the strainer beam at the top of the posts, and adding a raised tie section to allow for greater headroom. Since the bottom chord of this truss will be required to carry floor loads, a deeper and wider timber section has been assumed (197 x 47mm), and a narrower spacing of 400mm centres.

Where roof window openings and floor voids interrupt the structure, pairs of trusses will be fixed together to form a compound truss either side of the opening, and infill rafters will be supported by girder trusses or purlins spanning between the compound trusses – see fig.4 below:

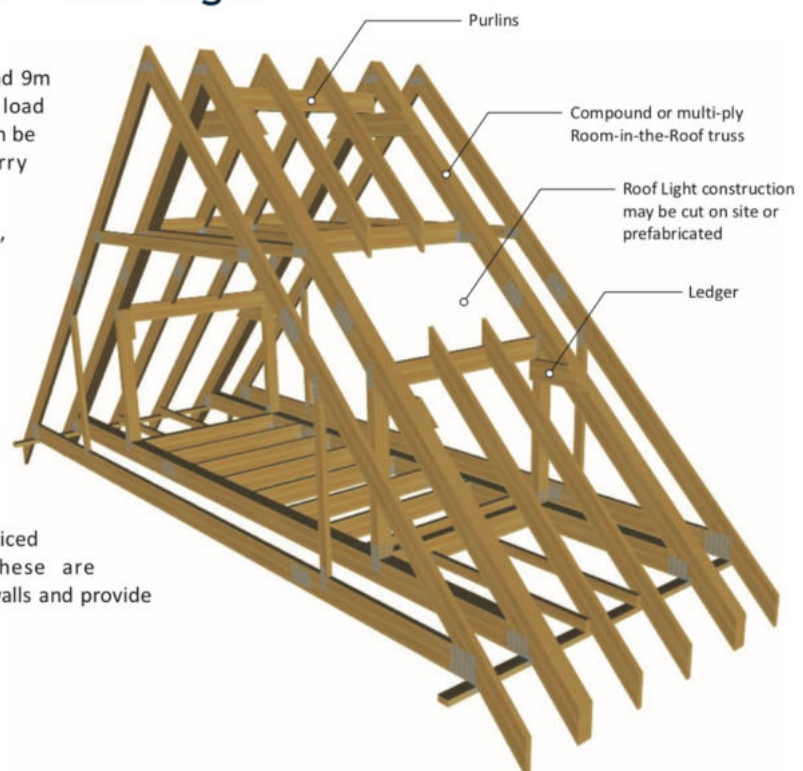
Room in the Roof - Roof Light

For normal roof spans, up to around 9m and larger spans with internal load bearing walls the truss members can be economically designed to carry domestic loading.

For typical dormer windows, traditional purlins supported on multi-ply trusses carry the intermediate infilling over the dormer.

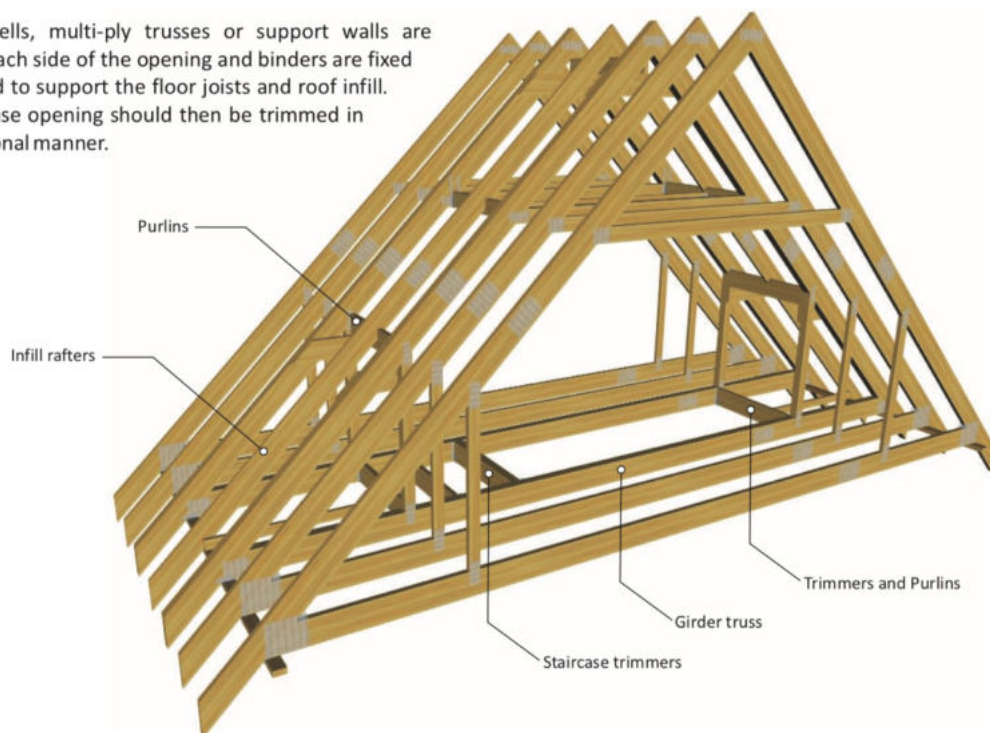
The rafters and extension ceiling ties are nailed on, to form the flat roof over the dormer window.

For larger spans and those with intensive trimmed openings, latticed purlin beams are required. These are supported on end and transverse walls and provide maximum floor space.



Room in the Roof - Staircase Trimming

For stairwells, multi-ply trusses or support walls are required each side of the opening and binders are fixed as required to support the floor joists and roof infill. The staircase opening should then be trimmed in the traditional manner.



ITW ALPINE : TRUSSED RAFTER GUIDE

Figure 4: ITW Alpine Trussed Rafter Guide, p.12

At the intersection with the smaller span of the projecting gable, which utilises a simpler King post truss structure, the attic trusses will be supported by a steel beam using joist hangers fixed to timber packers fitted into the web of the beam section, and strapped over a timber plate bolted to the upper flange of the beam.

Diminishing truss frames are fixed over the main attic trusses, and supported by 'thrust' batens to form the roof intersection and valley (see fig. 5 below).

Valley Construction

The construction of valleys using prefabricated reducing valley trusses allows the formation of roof intersections with minimum of site-cut infill. The valley trusses are aligned and the topmost braced back to the supporting trusses; diagonal bracing is then fixed and a longitudinal tie at the apex node. Ideally, the lower edge of the bottom chord of the valley frames is bevelled to suit the roof slope of the supporting trusses or fixing thrust batens cut from one piece of timber for economy. Sarking, tiling battens and tiling can then be carried out to line in with the supporting roof.

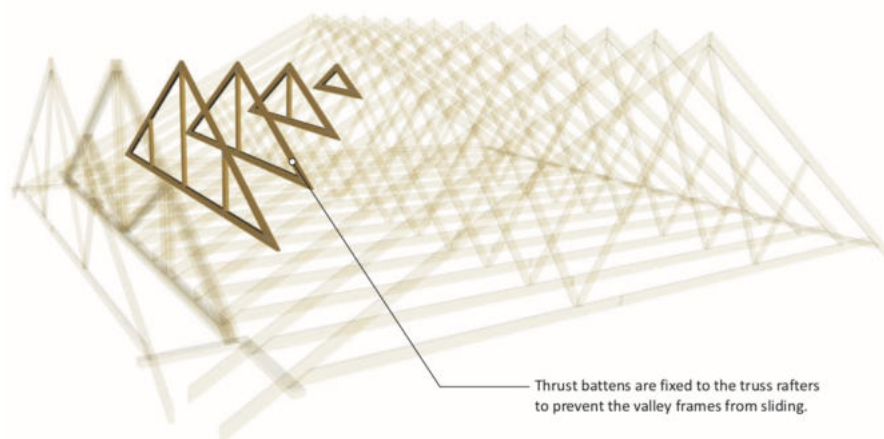


Figure 5: ITW Alpine Trussed Rafter Guide, p.4

The Utility Roof is not required to support any floor load, and a standard 'Fink' type truss (see diagram 11, section C-C, Appendix B) will be suitable for the span, using smaller timber sections (typically 97 x 35mm rafters and bottom chord, and 72 x 35mm struts).

All trusses are to be fixed to timber wallplates using truss clips, and bracing is required in accordance with BS 5268-3:1998, Code of practice for trussed rafter roofs. This is achieved by means of longitudinal bracing timbers fixed to the

underside of rafters. Attic trusses will need to include bracing with plywood or OSB panels between or under the sloping ceiling sections.

An adapted detail based on Velux manufacturer's installation drawings for recessed installation into slate coverings is shown in diagrams 5 & 6, Appendix B, with annotations showing position of additional support timbers for warm roof insulation.

The warm roof insulation layer is fixed using 50 x 25mm counterbattens parallel to the trussed rafters. These are fixed through insulation to rafters with stainless steel helical nails, 35mm embedment into rafters; Helifix InSkew 140mm at 300mm fixing centres along counterbatten, 8.3nr fixings/m²

Using Kingspan calculator at <https://www.uvalue-calculator.co.uk/calculator/>

A U-value of 0.13W/m²K is achieved using two layers of Kingspan K7 Pitched roof board; 80mm between, 80mm over rafters.

Roof structure summary:

- 3mm skim coated 12.5mm plasterboard
- Timber stop batten
- Kingspan K7 Pitched roof board; 80mm between, 80mm over rafters
- Breathable underslating membrane
- 38 x 38mm counterbatten
- 50 x 25mm slating batten
- Natural slates

If all insulation is required to be above rafters, a depth of 150mm foil faced PIR insulation board is required (determined using Celotex calculator at <https://www.celotex.co.uk/member/u-value-calc>)

No Sarking Board

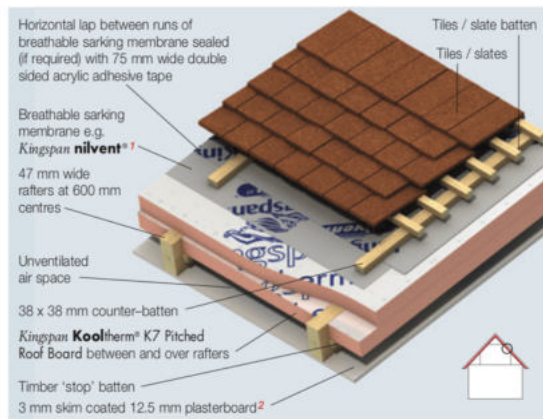


Figure 3a

U-values (W/m ² ·K) for Various Thicknesses of Kingspan Kooltherm® K7 Pitched Roof Board and Different Rafter Depths			
Thickness of Kingspan Kooltherm® K7 Pitched Roof Board (mm)	Rafter Depth (mm)		
	100	125	150
35 + 35	X	X	X
35 + 40*	0.25	0.25	0.25
40 + 40	0.24	0.24	0.24
50 + 50	0.19	0.19	0.19
60 + 60	0.16	0.16	0.16
70 + 70	0.14	0.14	0.14
75 + 75	0.14	0.13	0.13
80 + 80	0.13	0.13	0.13
90 + 90	0.12	0.11	0.11
100 + 100	0.11	0.10	0.10
100 + 110*	0.11	0.10	0.10

* First thickness refers to thickness between rafters, second thickness over rafters.
The thermal resistance of the over rafter layer of insulation must be ≥ that of the between rafter layer so as to avoid condensation.

NB Refer to local distributor or Kingspan Insulation price list for current stock and non-stock sizes.

Figure 6: Roof U-values

Roof covering:

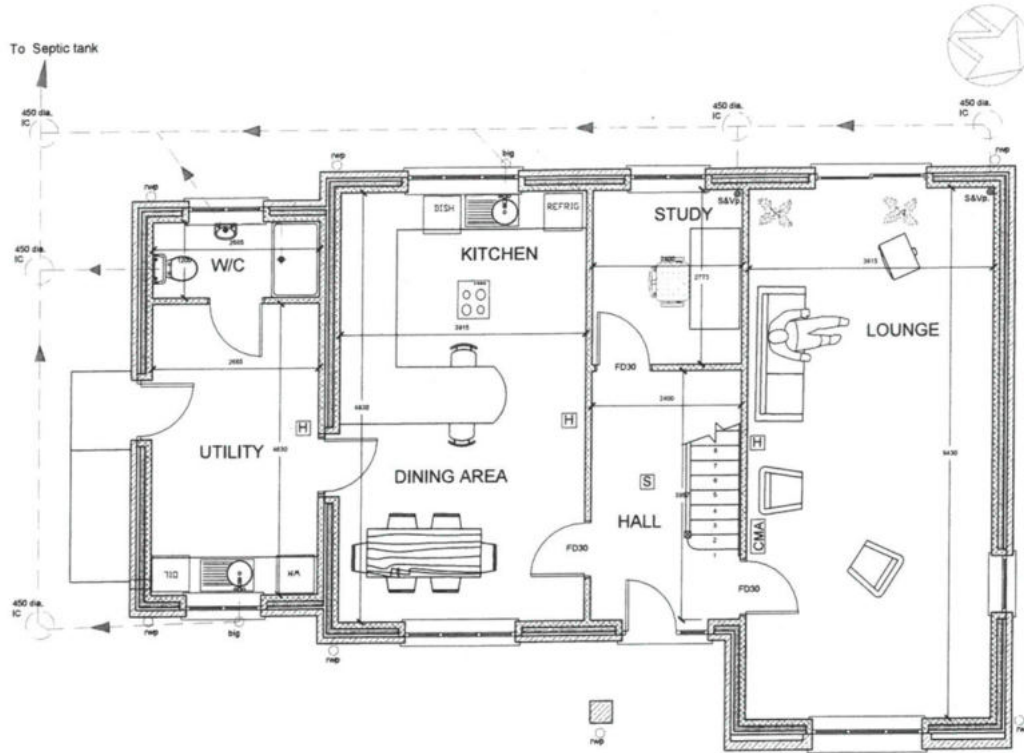
500 x 250mm Natural slate fixed in accordance with Code of Practice BS 5534 'Slating and Tiling' to 40 degree pitch, slates not less than 4mm thick, 80mm laps, fixing with copper nails to BS 1202 to 50 x 25mm SW treated slating battens at 210mm centres, nails to penetrate battens by min. 15mm

To prevent potential build-up of moist air between the underside of slate and the breathable membrane, an Eaves fascia ventilator strip is required to ventilate the batten space. For natural slate, the covering is deemed to be sufficiently 'air open' to allow dispersal between the slates.

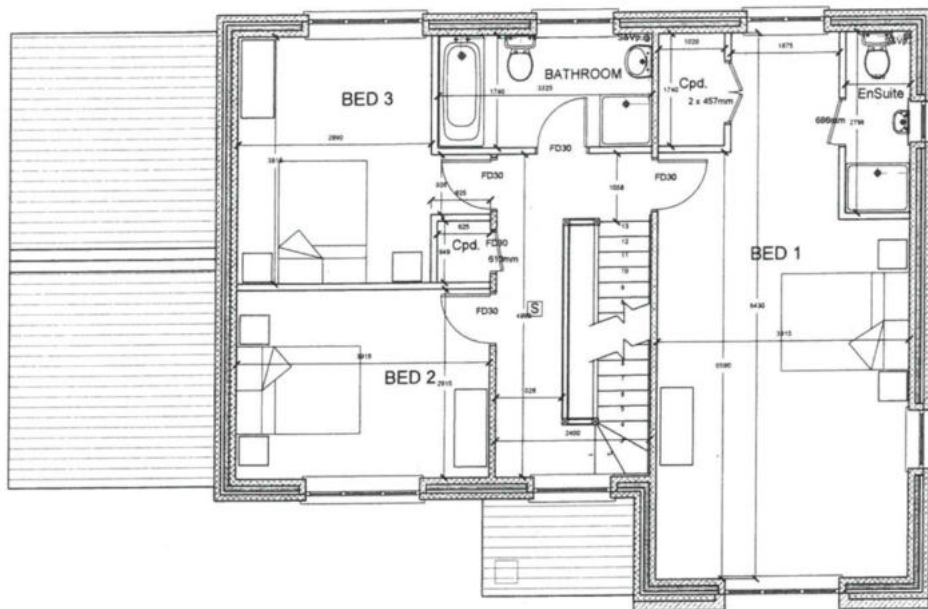
Appendix A:

Drawings as proposed (included in assignment brief)

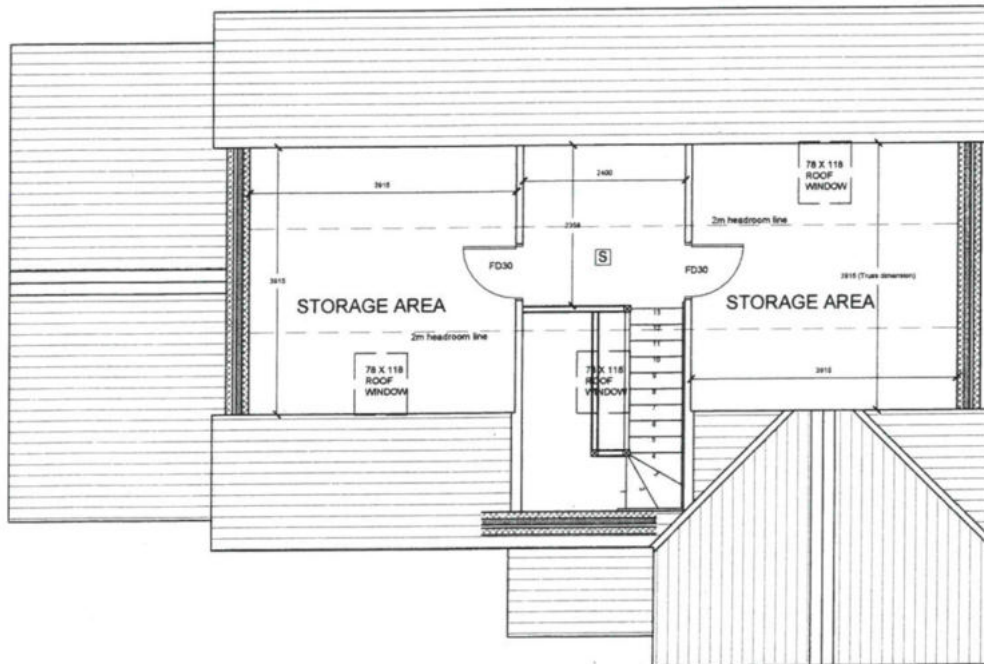
Note: Indicative sewer layout - Exact layout to be agreed on site with building control officer.



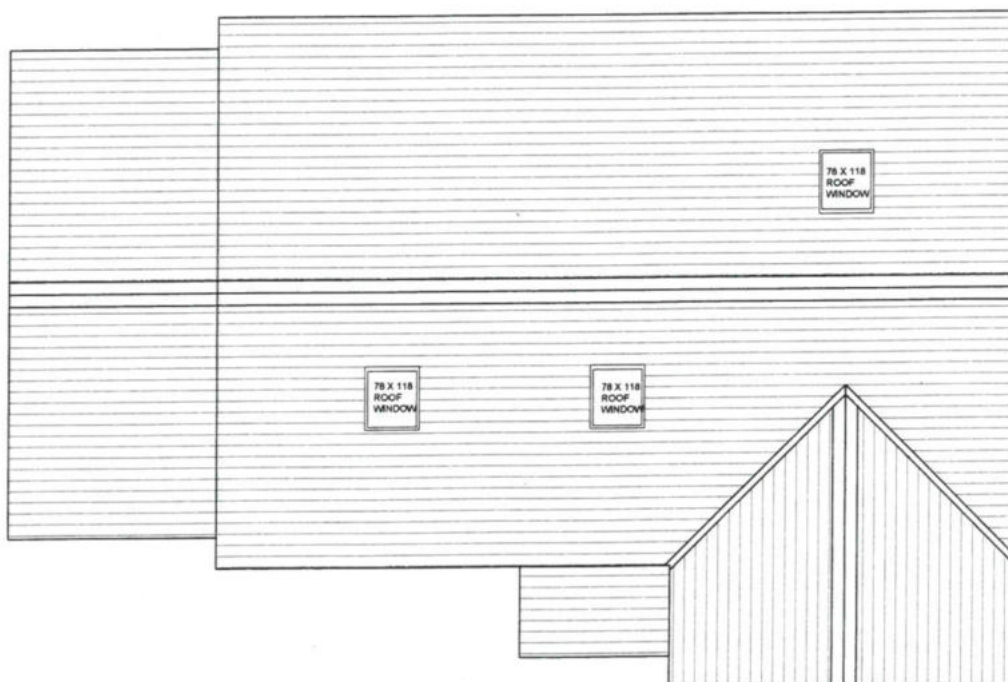
PROPOSED GROUND FLOOR PLAN 1/50



PROPOSED 1st. FLOOR PLAN 1/50



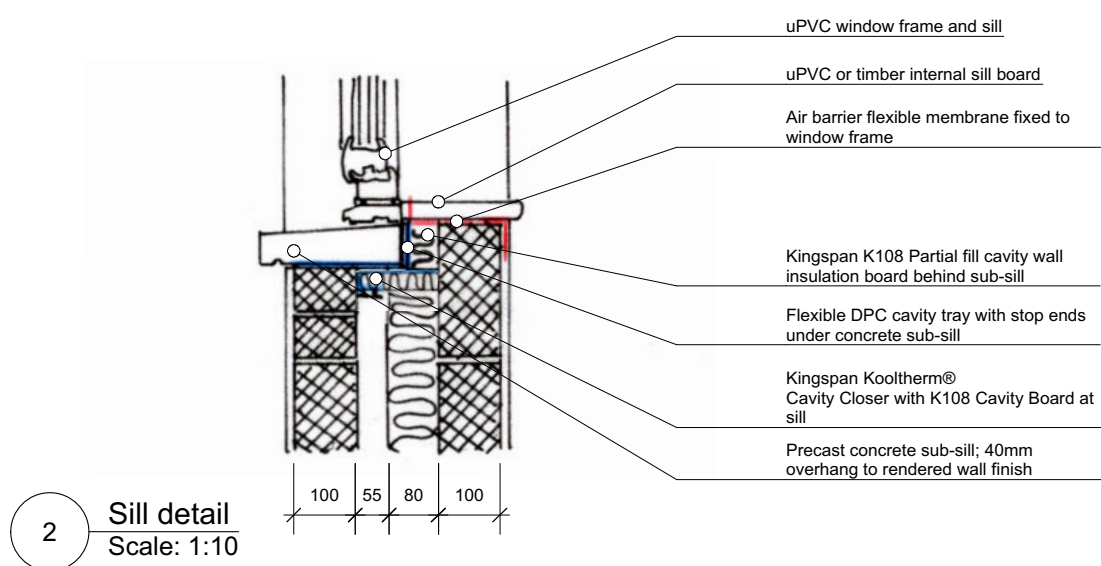
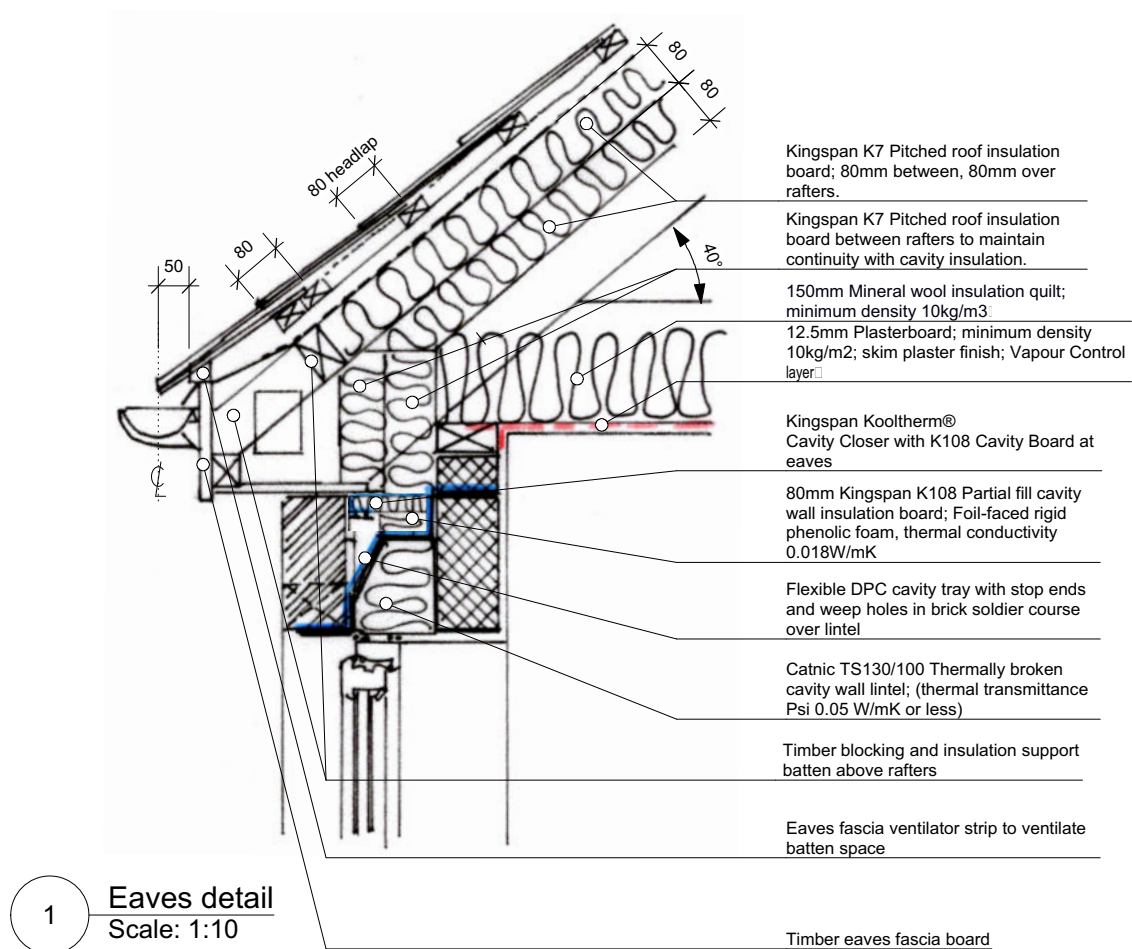
PROPOSED 2nd. FLOOR PLAN 1/50

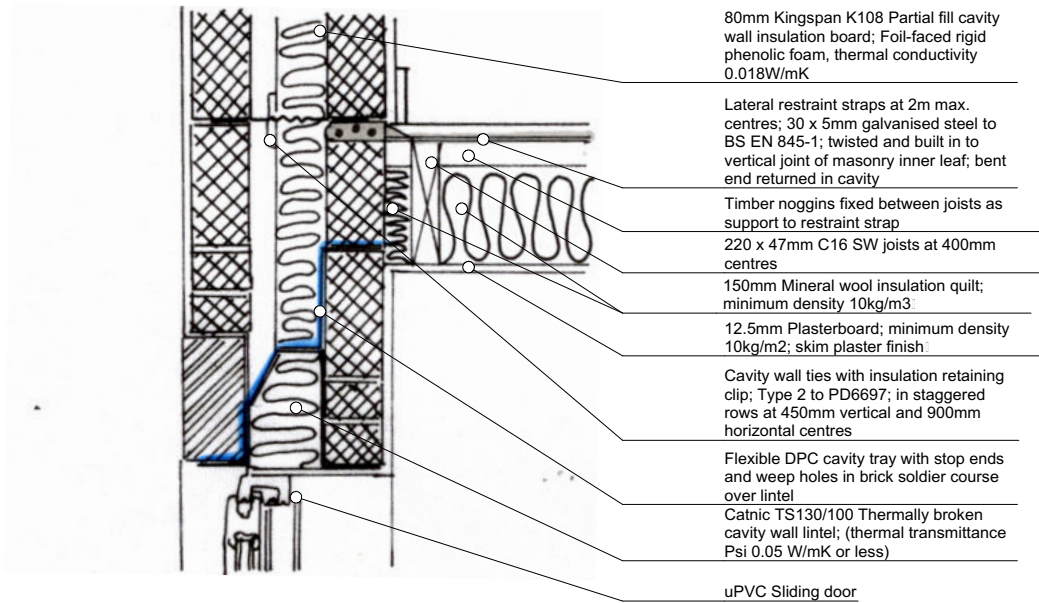


ROOF PLAN 1/50

Appendix B:

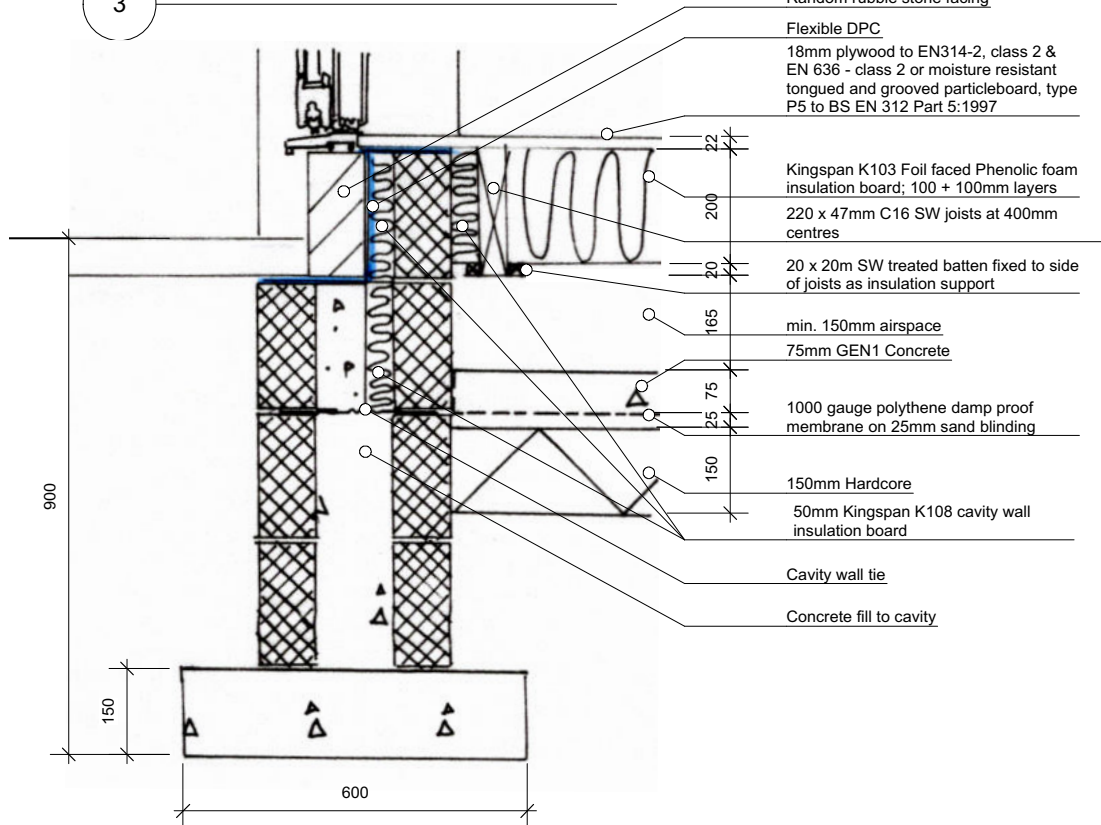
Construction details





3

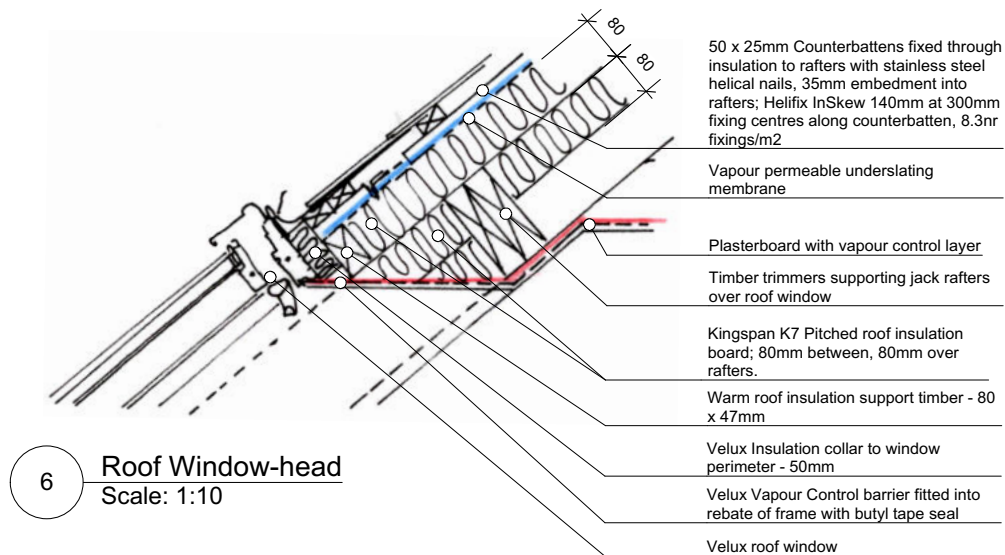
Door head/ intermediate floor detail



4

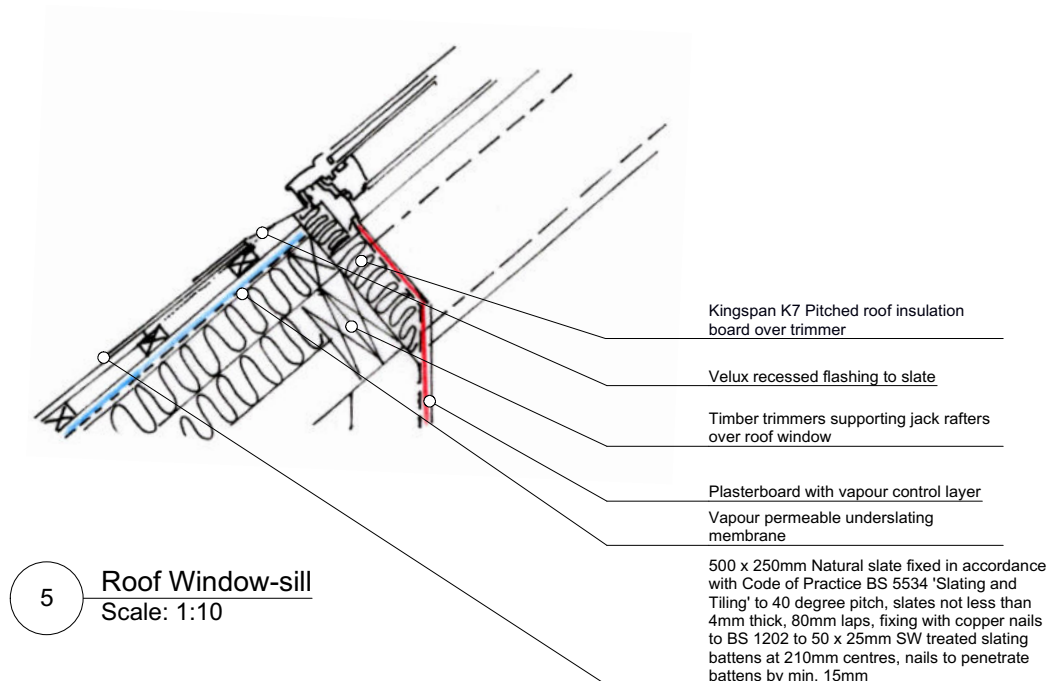
Door threshold/ ground floor detail

Scale: 1:10



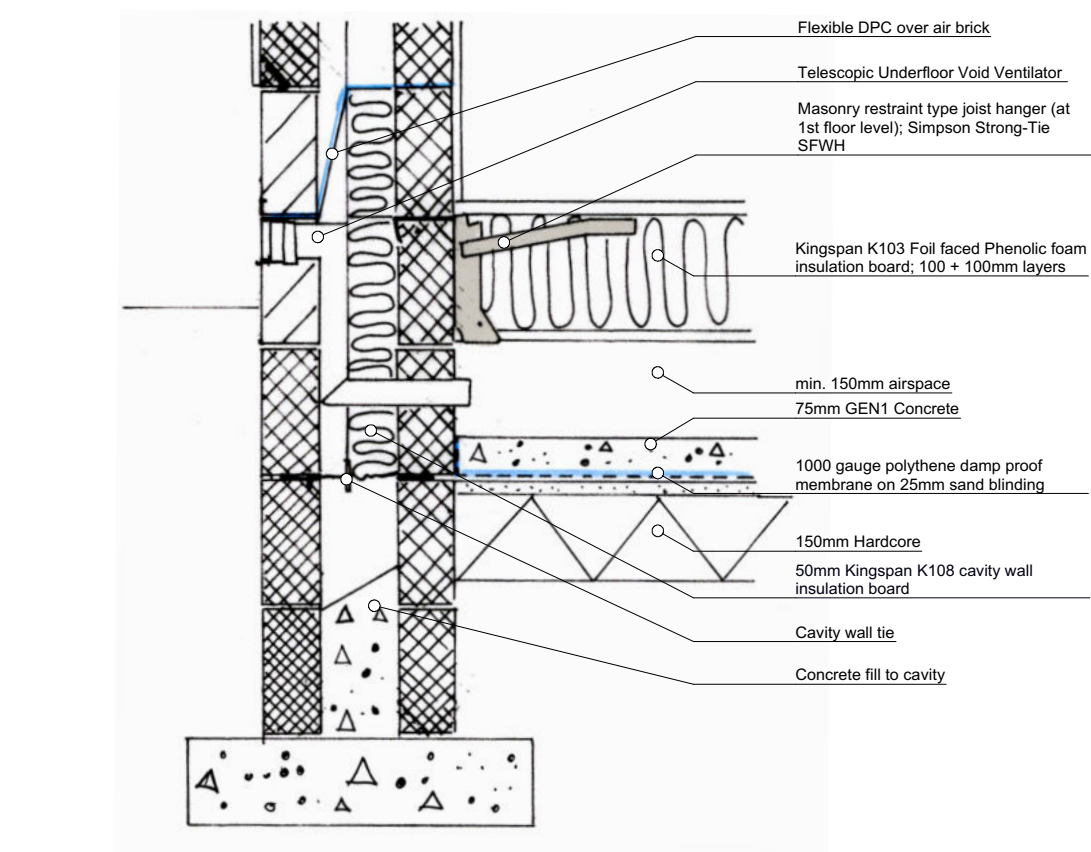
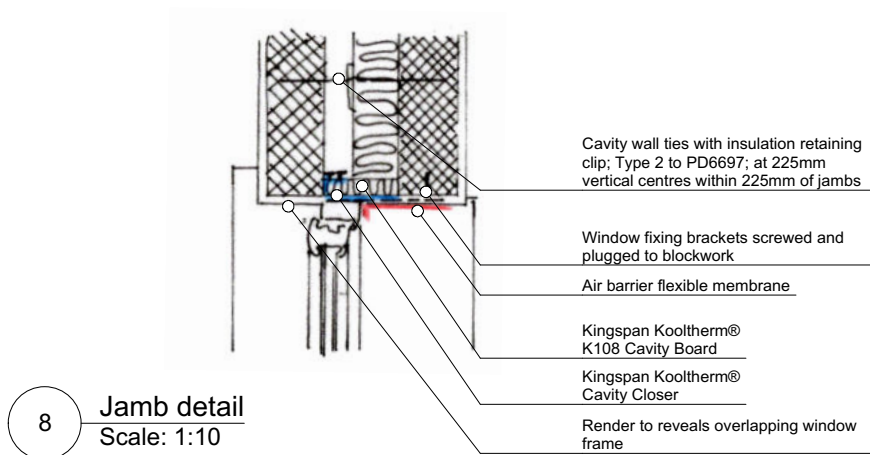
6

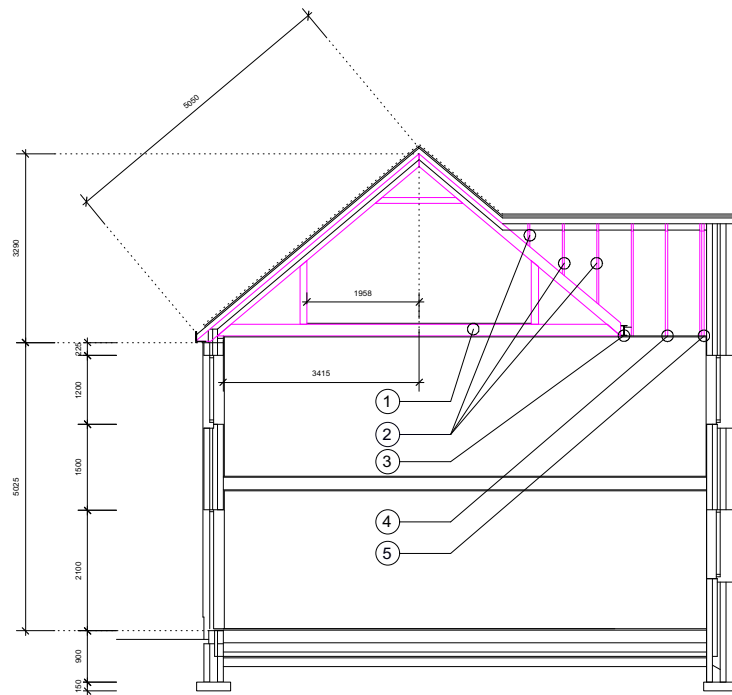
Roof Window-head
Scale: 1:10



5

Roof Window-sill
Scale: 1:10

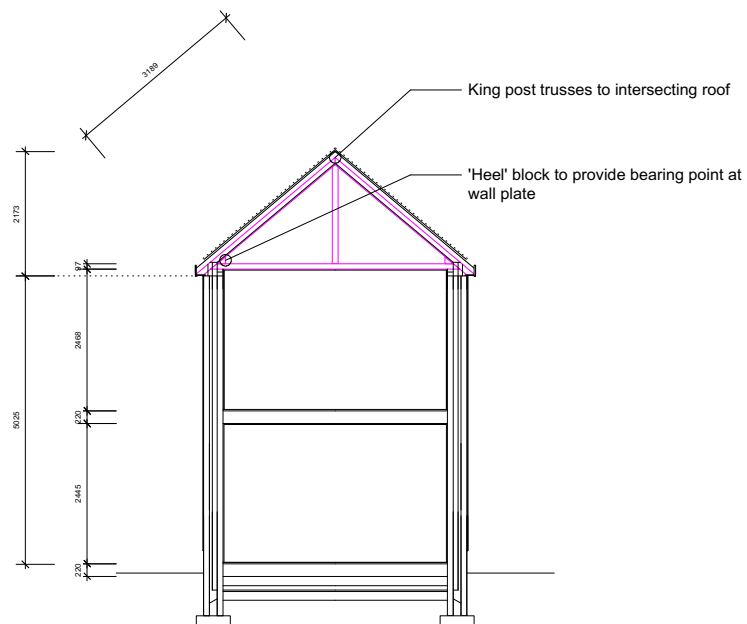




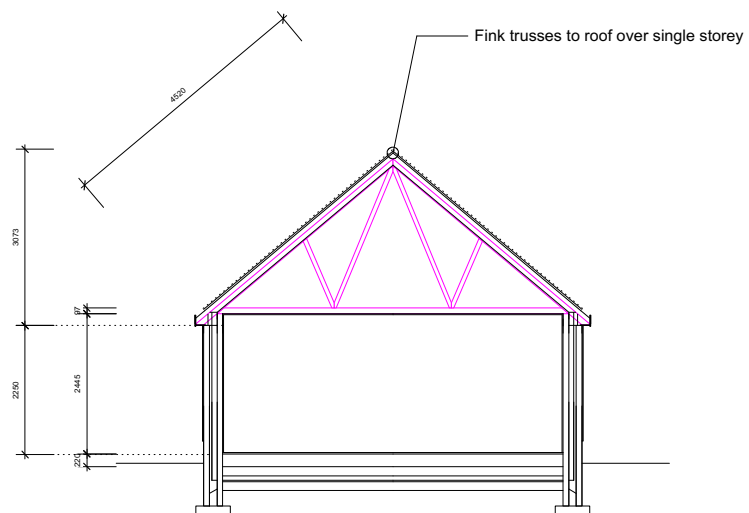
9 Section A-A
Scale: 1:100

Notes

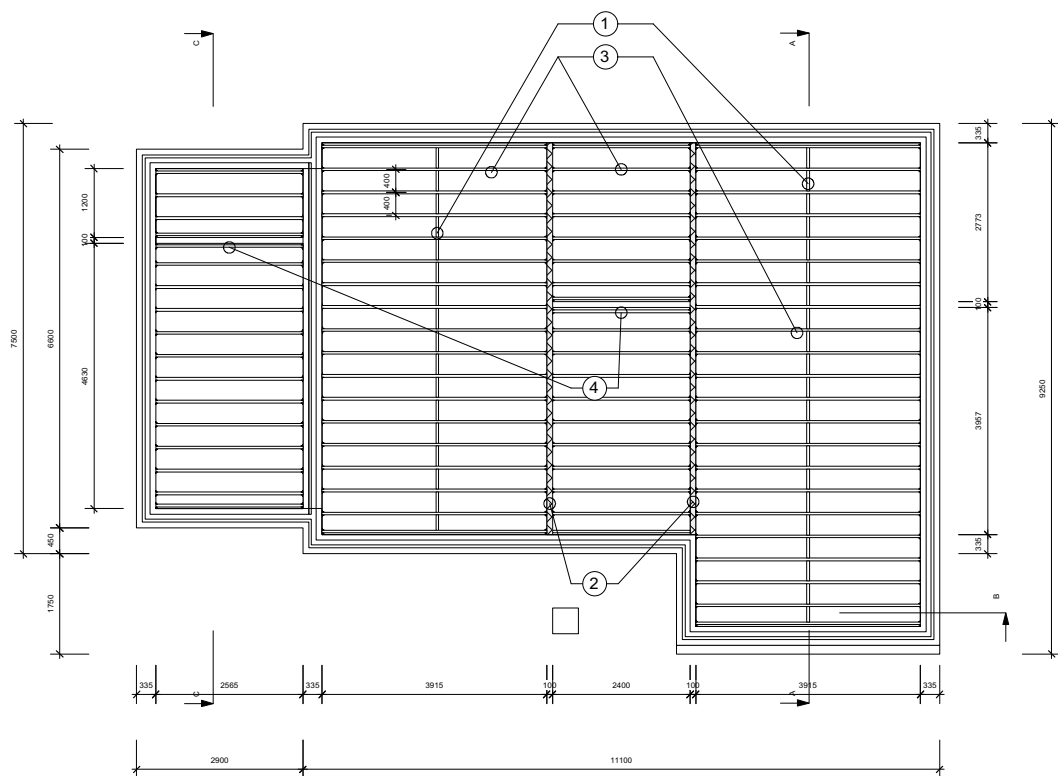
1. Attic trusses at 400mm centres supported by steel beam at intersecting roof
2. Diminishing trusses fixed to Attic trusses at intersection
3. Steel beam supporting Attic trusses at intersecting roof
4. King post trusses - ref dwg nr 10; Section B-B
5. Verge rafter/ gable ladder



10 Section B-B
Scale: 1:100



11 Section C-C
Scale: 1:100

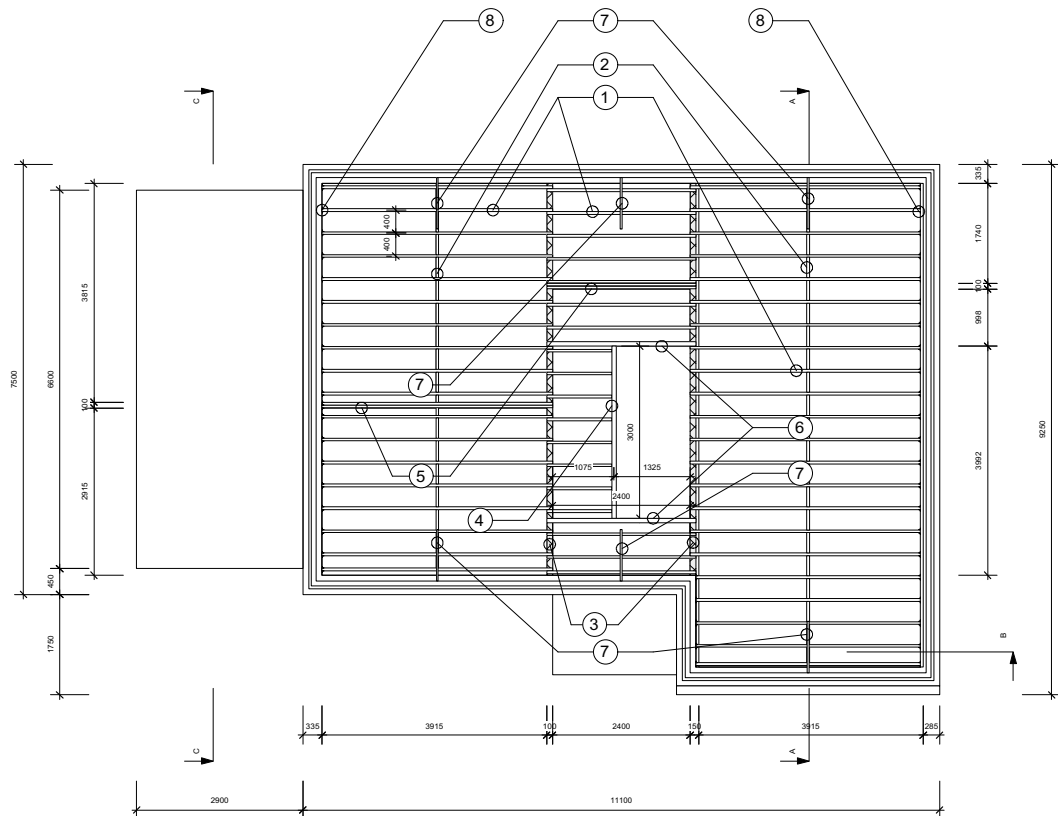


14

Ground Floor Joist Plan
Scale: 1:100

Notes

1. Solid timber strutting at mid-span to full depth of joists
2. 'Honeycomb' openings in loadbearing walls below joist level to provide cross ventilation to void under hallway floor; 'Straddle' type double joist hangers to floor joists fixed inline either side of blockwork.
3. 220 x 47mm C16 SW Joists at 400mm centres
4. Additional joists either side of non-loadbearing blockwork partitions
5. N/A
6. N/A
7. N/A
8. N/A
9. N/A



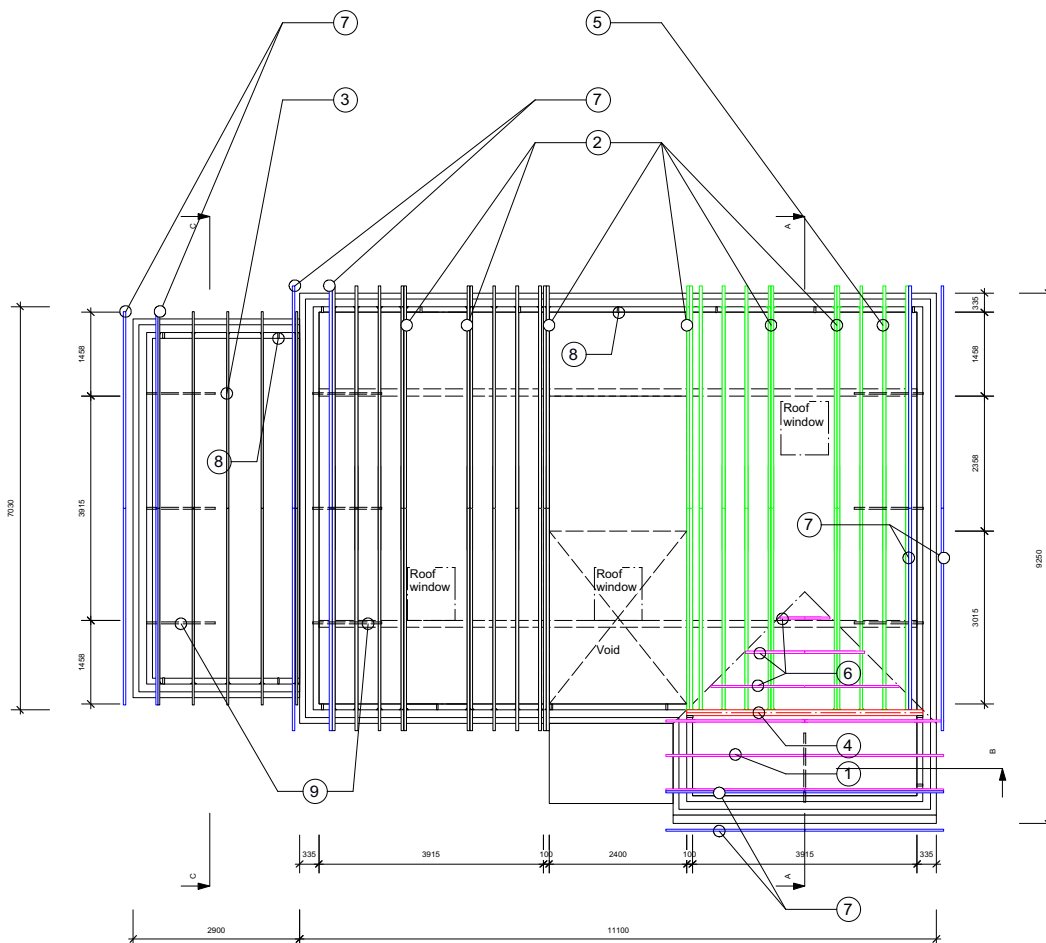
13

First Floor Joist Plan

Scale: 1:100

Notes

1. 220 x 47mm C16 SW Joists at 400mm centres
2. Solid timber strutting at mid-span to full depth of joist
3. 100mm Loadbearing blockwork walls below
4. 220 x 76mm C16 SW Joists as trimmer to landing
5. 2nr 220 x 47mm C16 SW Joists under partitions
6. 220 x 76mm C16 SW trimming joists supporting landing trimmer
7. Lateral restraint straps at max. 2m centres, supported by solid strutting between joists
8. Lateral restraint type joist hangers at max. 1.2m centres along external walls



12 **Roof Framing Plan**
Scale: 1:100

Notes

1. King post trusses - ref dwg nr 10; Section B-B
2. 2nr Attic trusses (ref dwg nr 9; Section A-A) either side of roof openings with purlins or girder trusses spanning between to support infill rafters (not shown).
3. Fink trusses (ref dwg nr 11; Section C-C) to single storey at 600mm centres
4. Steel beam supporting Attic trusses at intersecting roof
5. Attic trusses at 400mm centres supported by steel beam at intersecting roof
6. Diminishing trusses fixed to Attic trusses at intersection
7. Verge rafter/ gable ladder
8. Vertical restraint straps fixed to wallplate and screwed to blockwork walls at max. 2m centres
9. Horizontal restraint straps fixed across rafters and ceiling ties, and turned into cavity of masonry walls at max. 2m centres.

Appendix C:

Foundation load calculation

Substructure - Strip Foundation:

Loads were assessed with reference to an example calculation (Chudley and Greeno, 2016, p260-261), which provided dead and imposed load data for a house of similar scale and construction, and to (BS EN 1991-1-1,2002), and (Approved Document A,2017, p.10)

The full calculation is included in Table 1A, Calculation1, (see below) and the maximum load shown to be 45 kN/m.

From tables in Chudley and Greeno,(2016,p.261) and Table 10 of Approved Document A, (2017,p.46) a foundation width of 500mm is indicated for the given soil spec: Clay/sandy clay (Type 2).

As there is also a gable extending out from the front facing NE elevation, with an additional facing of stone, (see Diagram 9, Section A-A, Note 3, Appendix B)it was considered prudent to use 600 x 150mm for the strip foundation dimensions, in support of the proposed cavity wall structure The wider foundation would also help to support the spread of load imposed by the steel beam proposed to support the attic truss roof structure at the 'T' intersection of the projecting gable shown in Diagram 9, Section A-A, Note 3,(Appendix B)

Further guidance on assessing dead and imposed loads can be found in the following standards, as listed in Approved Document A, (2017, p31) (see Table 2 below)

Summary Table 2: Standards for Foundations and Dead and imposed Loads:

Substructure element	Codes
Dead and imposed loads	BS 6399-2:1997 Loading for buildings.
Imposed roof loads	BS 6399-3:1998 Loading for buildings. Code of practice for imposed roof loads
Foundation	BS 8004:1986 Code of practice for foundations.

Appendix D

Manufacturer Data Sheets:

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Kingspan Insulation: K108 Cavity Board PARTIAL FILL CAVITY WALL INSULATION 3rd issue October 2017).

[TRADA 2014 Trada technology Ltd (for Citation reference - available from Chiltern House, Stocking Lane, Hughenden Valley, High Wycombe, Bucks HP14 4ND), as follows: Eurocode 5 span tables for solid timber members]

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Riley, M.and Cotgrave, A.(2018) *Construction technology 1: House Construction 4 th Ed.* London:Palgrave

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The Building Regulations(2010) *Approved Document C: Resistance to contaminants and moisture. 2017 Edition*.

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