

New Build Dwelling: Technical report with drawings

2014489

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1. Introduction

A client has received planning permission to build a new two storey detached residential dwelling with a timber frame construction. A technical report has been produced for the client, explaining the principles that are involved with the timber frame construction. With sketches and reference to the correct regulations, the technical report will consist of information relating to the ground floor construction, first floor construction, eaves detailing and roof covering and the main roof structure (including the advantages and disadvantages of this method). The technical report will also include information on condensation where the causes and sources will be reviewed. whilst also discussing the most appropriate methods of ventilation which will reduce condensation in the new dwelling. Details regarding the new dwelling can be observed in the appendix.

2. House Construction

2.1 Ground Floor Construction

In situ concrete slabs will support the ground floor (figure 1 and 2) with infilled floors that have a floating deck finish. The cavity width must be 50mm and the damp proof course (DPC) must have a minimum distance of 150mm from the exterior ground level.

With floating ground floor decks, the requirement for wet trades can be kept to a minimum (TRADA Technology, 2011). A layer of rigid insulation is placed across the slab's surface and then a wood-based board material deck in order to do this. The density of the insulation, particularly at the edges, will support the floor deck. The building's overall heat loss is lessened, as insulation to the slab is provided by the ground floor decks (TRADA Technology, 2011). The need for edge insulation in order to avoid thermal bridging is also removed.

There may be a risk of condensation on the slab's top surface when, with no ventilation, a layer of insulation is placed between the slab and the floor deck. For new dwellings, the minimum ventilation rate should be not less than 0.3 l/s per m² of internal floor area (Llywodraeth Cymru Welsh Government, 2010). In order to preclude moisture entering the insulation from the dwelling side, a Vapour Control Layer (VCL) should be placed over the layer of insulation, thereby addressing the potential issue of condensation (TRADA Technology, 2011).

It is recommended by (BRE 262, 2002) that between the insulation and floor deck, a 500-gauge (0.12mm) polyethylene VCL is used.

Plywood (type EN636-2) will be used on continuous insulation support for the floating ground floor decks. This should be tongued and grooved, all joints glued and 5mm minimum thickness.

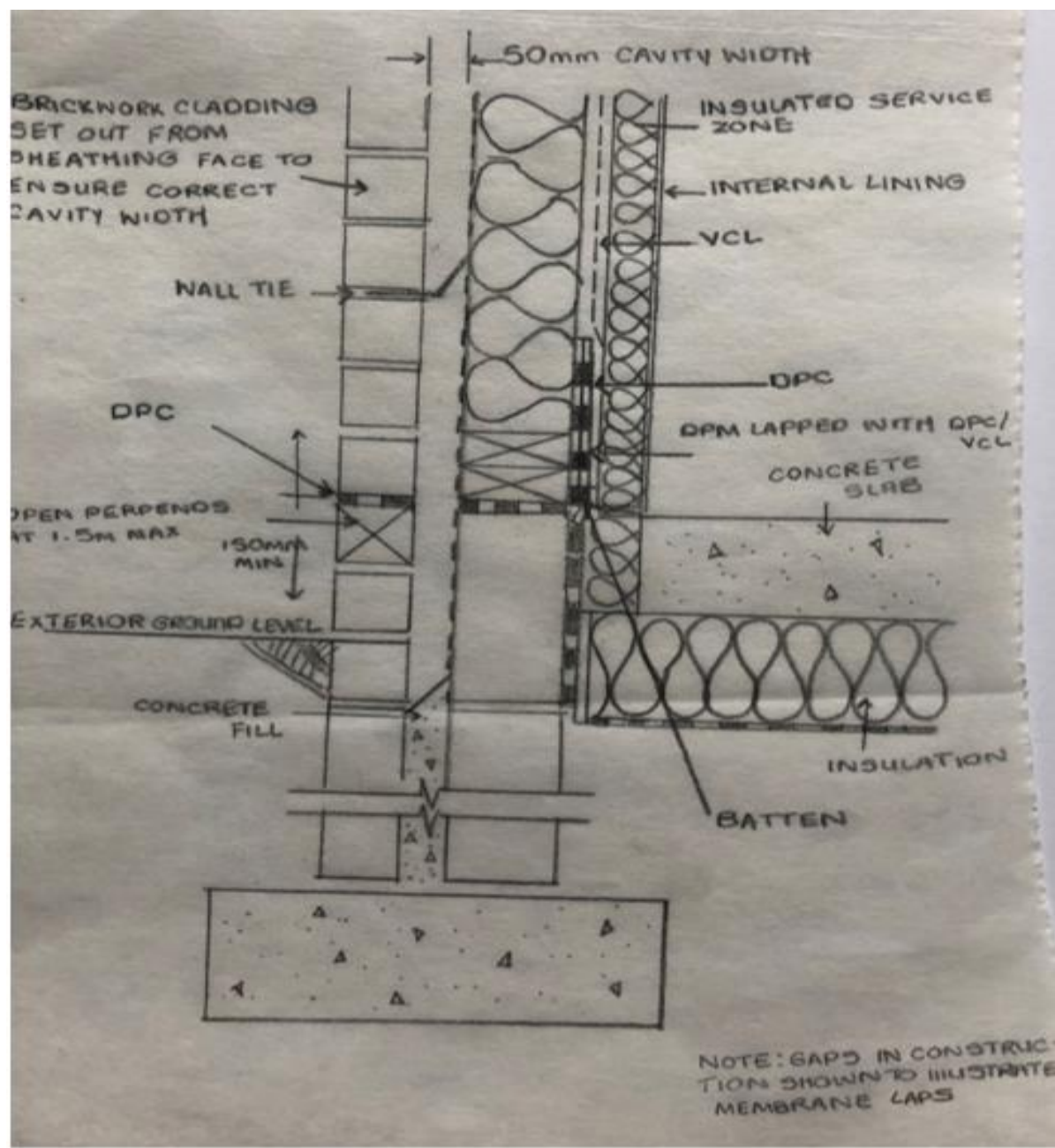


Figure 1: Insulated floor deck and concrete slab (TRADA Technology, 2011).

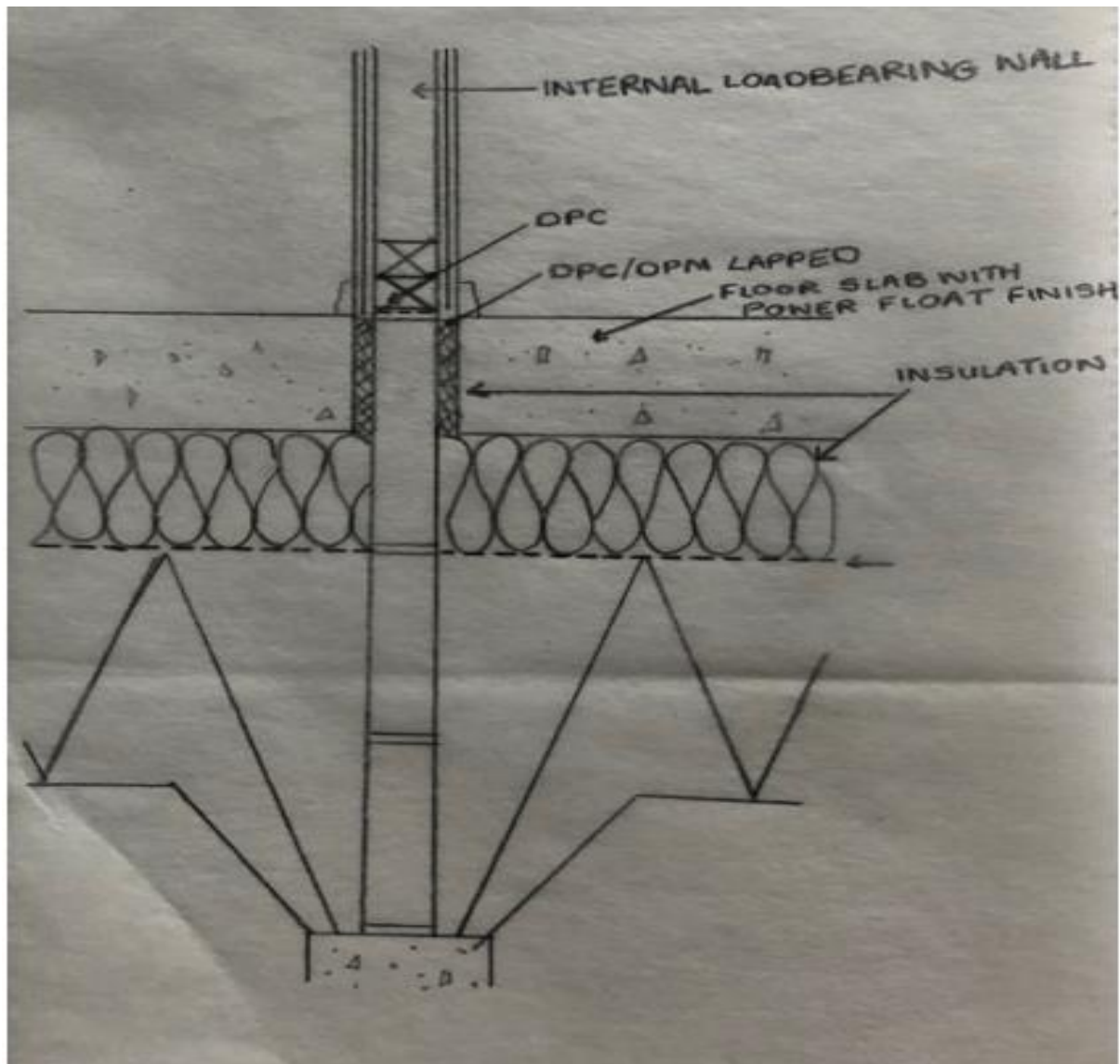


Figure 2: Details of the slab at loadbearing internal wall (TRADA Technology, 2011). Note: Non-loadbearing walls can be built directly from the concrete slab with a DPC beneath the sole plate.

2.2 First Floor Construction

Traditionally, the upper floors of dwellings have been of timber and provided many advantages such as a void space where services such as electrical cables or central heating pipes may be located. There are few component parts - a boarded covering, joists, and on occasion, in order to prevent warping, there will be herringbone strutting between the joists (Riley & Cotgrave, 2018). Joists should be carried on the supported wall by joist hangers in accordance with BS EN 845-1; should have 75mm bearing at each end on a timber wall-plate or at least 90mm bearing on the supported wall and are at not more than 1.2m centres (Llywodraeth Cymru Welsh Government, 2010). The inner skin of the external cavity wall which is in blockwork, is where the floor joists should rest (figure 3). This figure also illustrates an alternative of placing the joists on steel joist hangers. The joists can fit into joist hangers or rest on walls when internal walls are used to support the joists. Joists can be susceptible to buckle and movement near the middle because they are secured at the ends (figure 4). They can be made stable by cutting and wedging short lengths of joists called noggins between the joists (figure 5) (Riley & Cotgrave, 2018). Through the principle of 'lateral restraint', timber upper floors considerably help the stability of the house walls (Riley & Cotgrave, 2018). In order to provide this restraint, between the floor joists and house wall, steel straps are attached, as illustrated in figure 6.

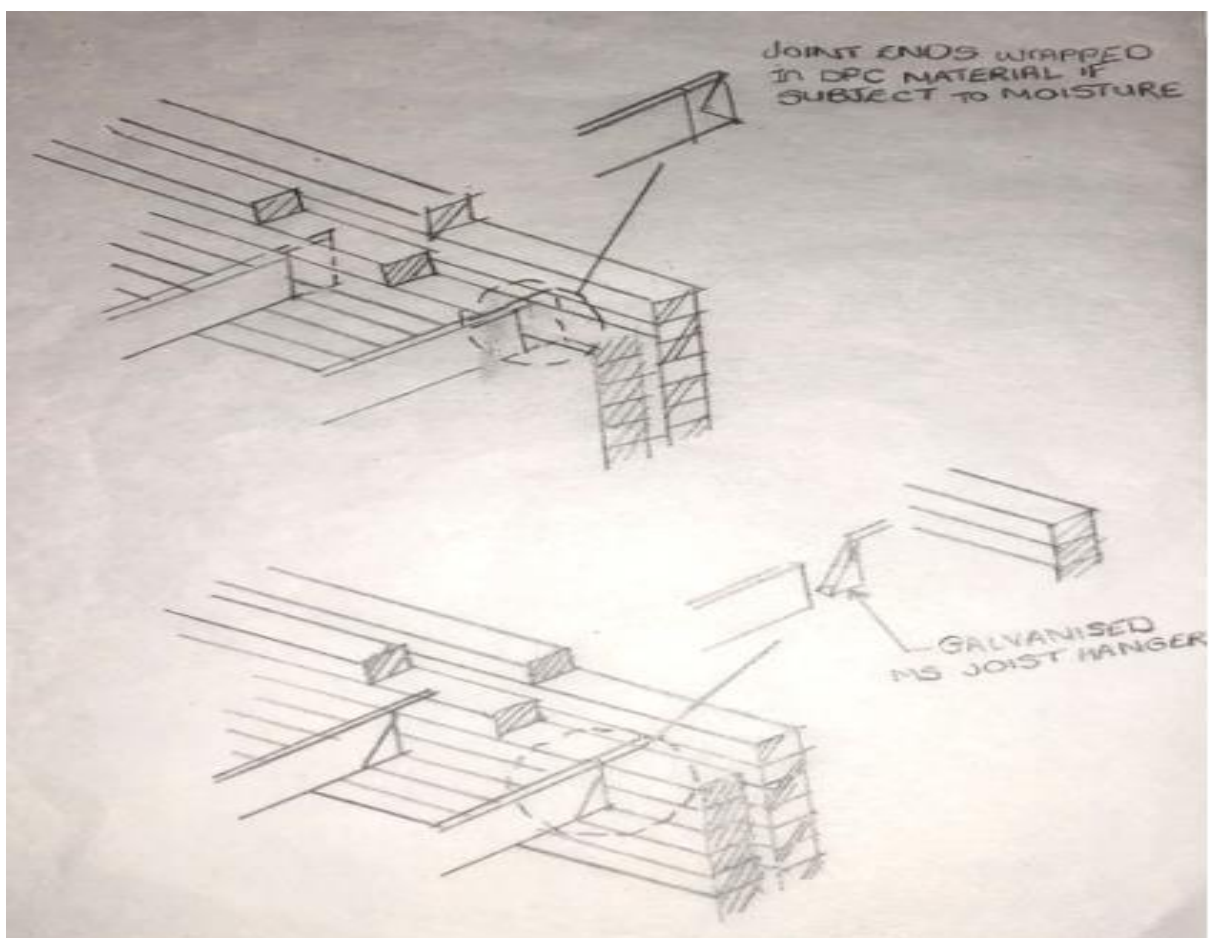


Figure 3: Joist end support (Riley & Cotgrave, 2018).

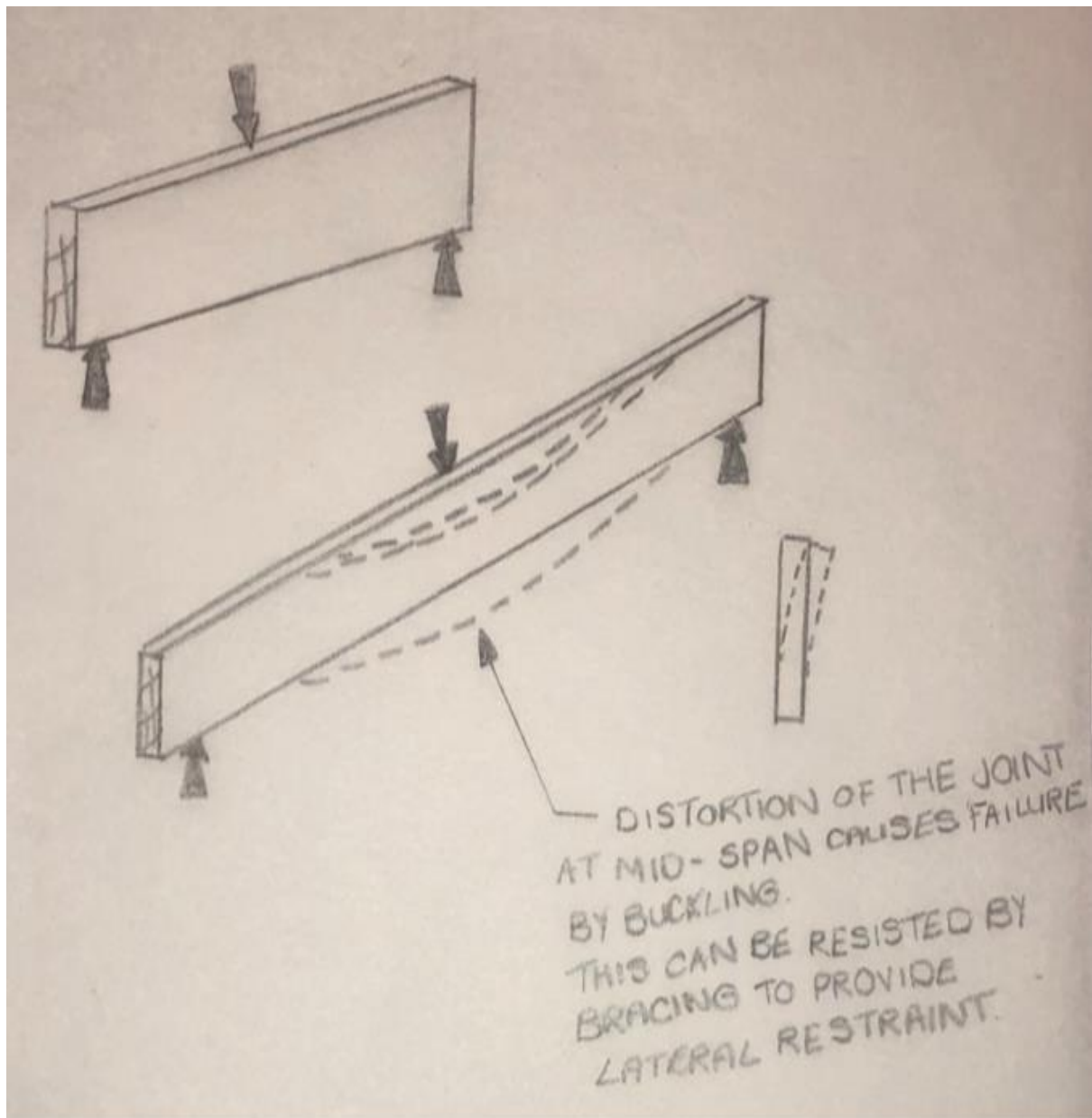


Figure 4: Distortion of joists under load (Riley & Cotgrave, 2018).

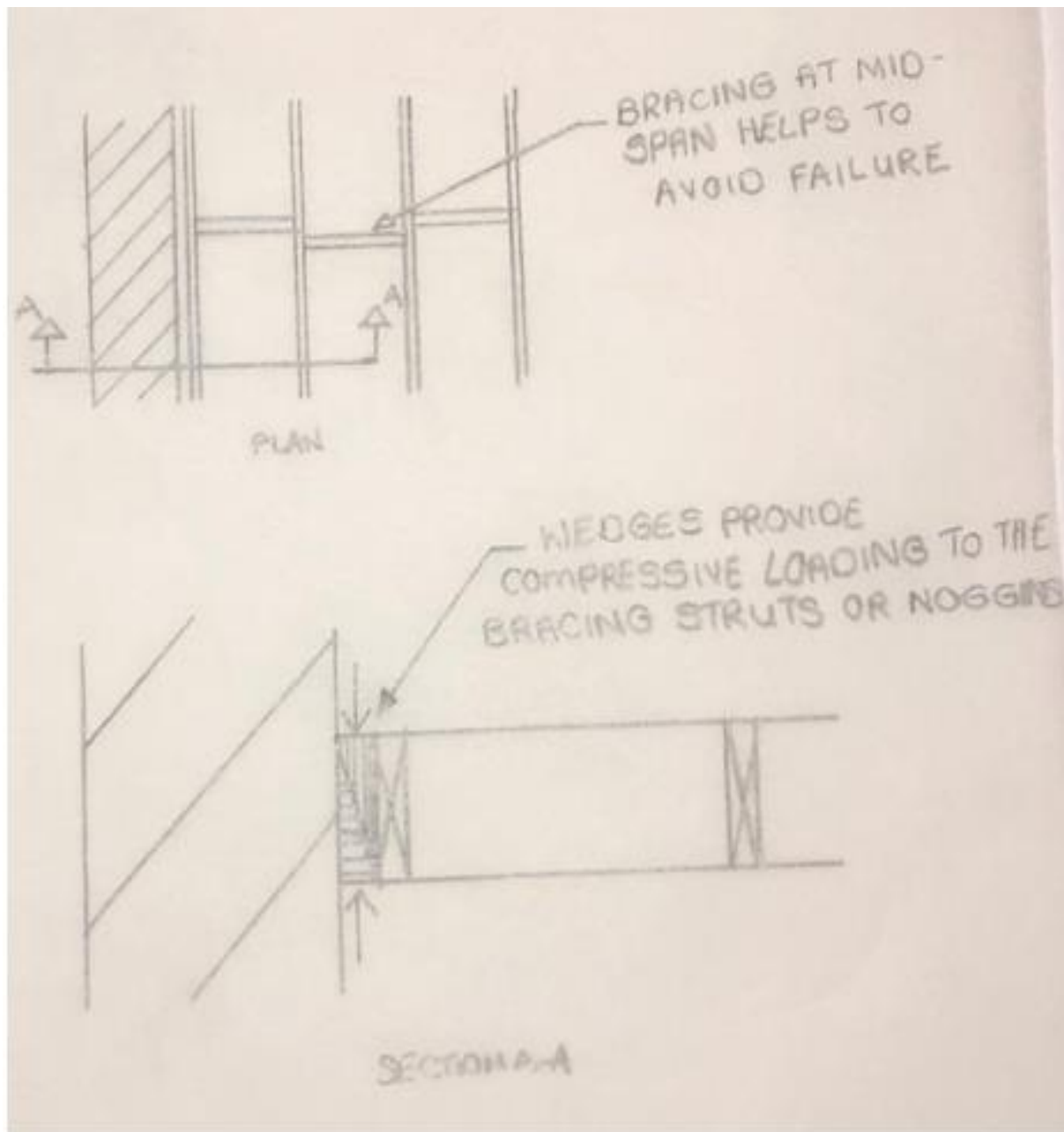


Figure 5: Noggins for stability (Riley & Cotgrave, 2018).

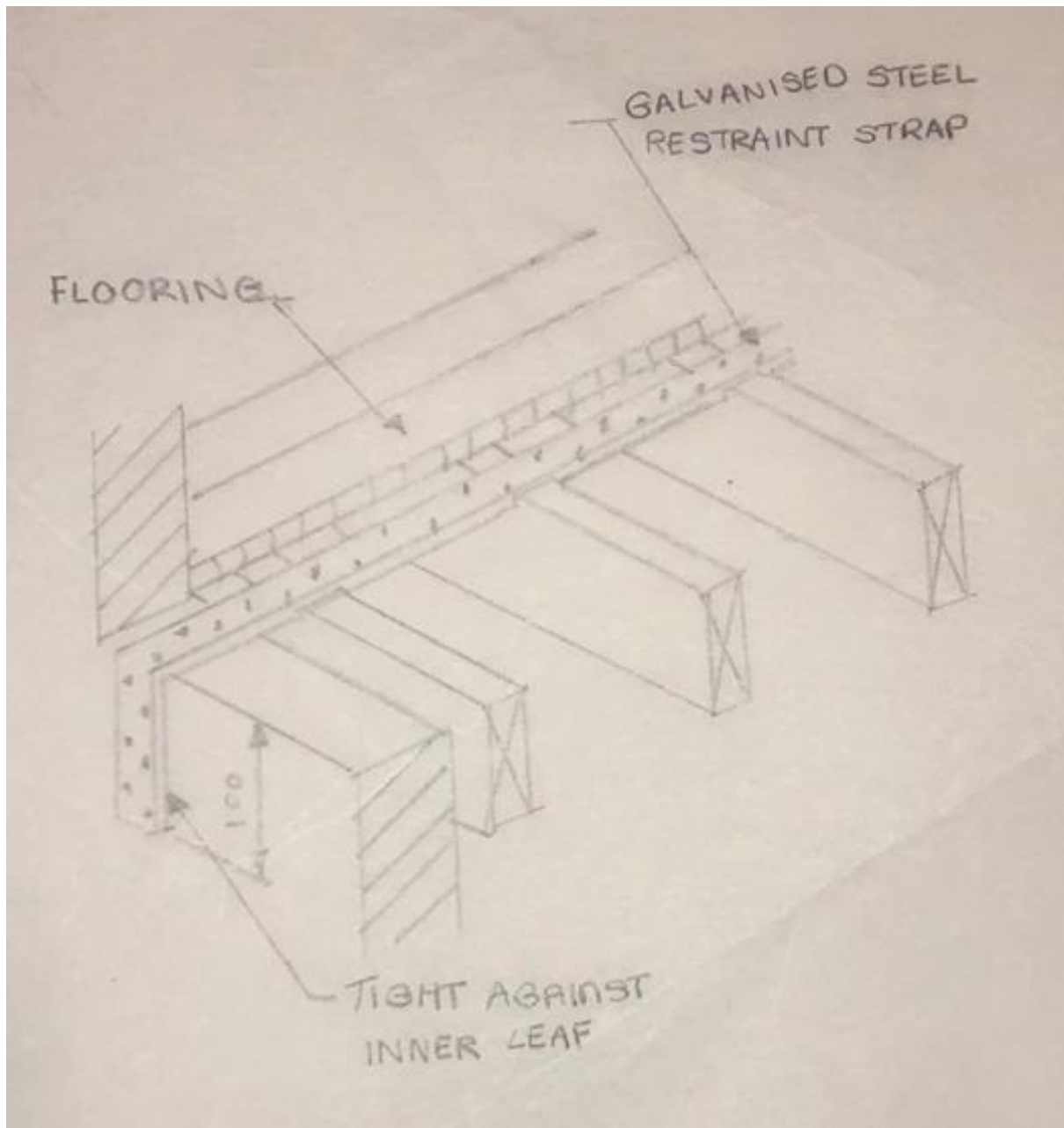


Figure 6: Lateral restraint straps between upper floor and wall (Riley & Cotgrave, 2018).

Flooring grade chipboard and tongue and grooved softwood floorboarding are used as coverings to upper floors (figure 7).

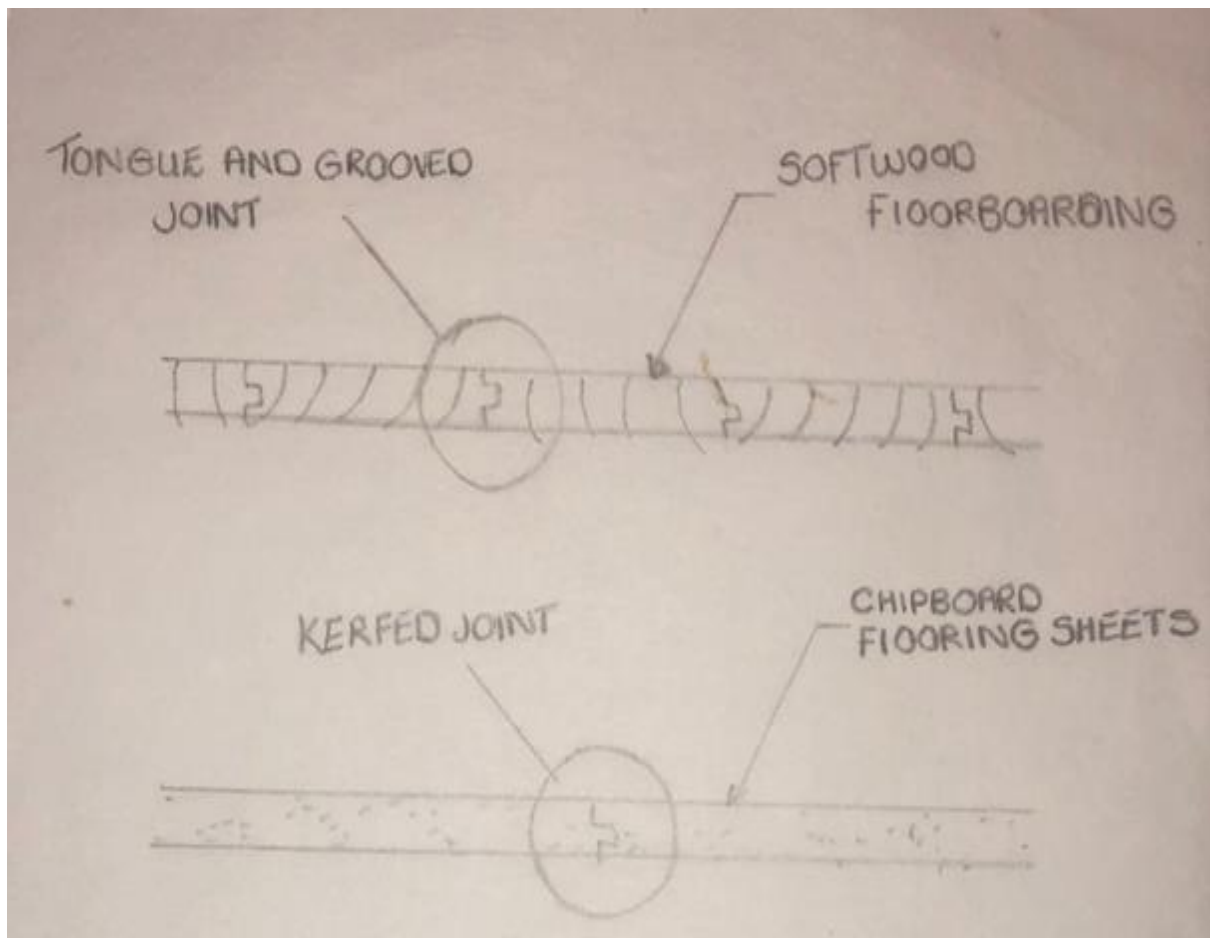


Figure 7: Chipboard flooring sheets and joists to floorboards (Riley & Cotgrave, 2018)

Partitions must be supported off the suspended upper floor (Riley & Cotgrave, 2018) (figure 8). With a timber stud partition, because the load is spread across several joists, there is no requirement to take any particular action where a partition runs perpendicular to floor joists. However, support must be provided exactly beneath when partitions run parallel to the floor joists (Riley & Cotgrave, 2018). The studs for partitions will be placed at 600mm centers and will be in accordance with BS EN 336.

Both upper and ground floor construction will generate a U value of $0.13 \text{ W/m}^2\text{k}$ (Llywodraeth Cymru Welsh Government, 2010).

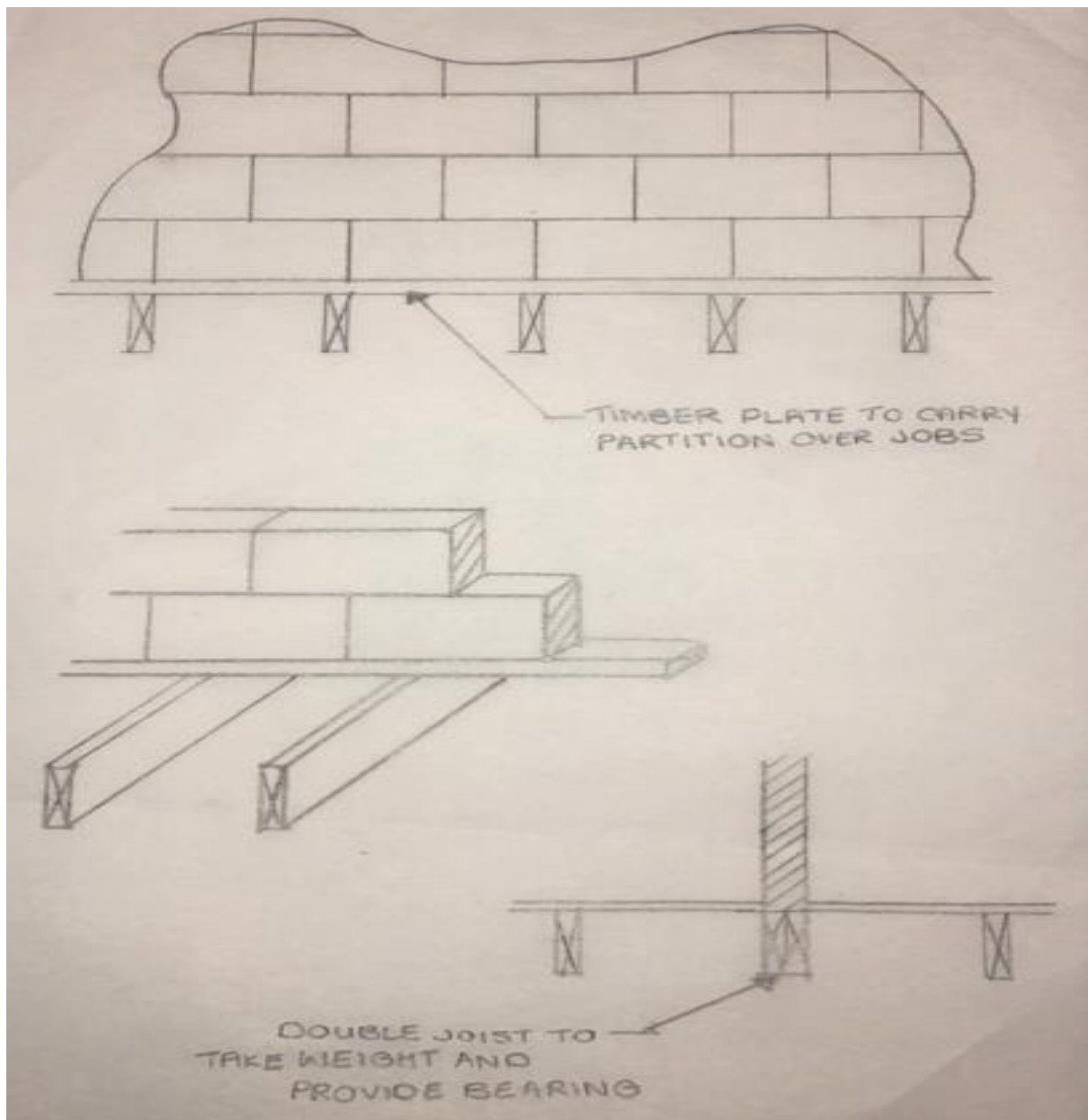


Figure 8: Support to partitions (Riley & Cotgrave, 2018).

2.3 External Walls

Constructing external walls correctly is just as important as constructing the first and ground floors in the correct way. Acting on the structure and transmitting to the foundations, external walls of timber frame are necessary to allow the imposed and dead loads, including wind loads, to be carried. In order to withstand a little failure or damage, all buildings must be suitably robust.

External walls should have relevant thermal performance levels to meet the requirements. They should provide enough support for the cladding materials to be used, durability is vital, as is the necessary fire resistance (Llywodraeth Cymru Welsh Government , 2010).

Table 1: The surface linings of walls should meet the classifications below for each room
(Llywodraeth Cymru Welsh Government , 2010).

Location	Classification
Small Rooms of area no more than 4m ²	3
Domestic Garages of area no more than 40 m ²	3
Other rooms (including garages)	1
Circulation spaces within dwelling houses.	1

Outer cladding and a loadbearing timber frame constitutes the external wall, this cladding is attached to the timber frame and is lightweight (TRADA Technology, 2011). Figure 9 shows a slab foundation bearing the timber frame external wall and an outer cladding of brick, built to fit in with the new dwelling's first and ground floors. Some principles included with the wall construction are open perpend to drain and cavity spaced at max 1.5m centres, VCL, breather membrane, DPC and a steel lintel. The steel lintel will have a minimum end bearing of 150mm, levelled along its length and across its width while bedded on mortar. It is important that the lintel is installed correctly and insulated which will avoid thermal bridging. This will be ensured by building the lintel in accordance with BS EN1996-2:2006. The external wall construction will have a U-value of 0.18 W/m²k (Llywodraeth Cymru Welsh Government, 2010).

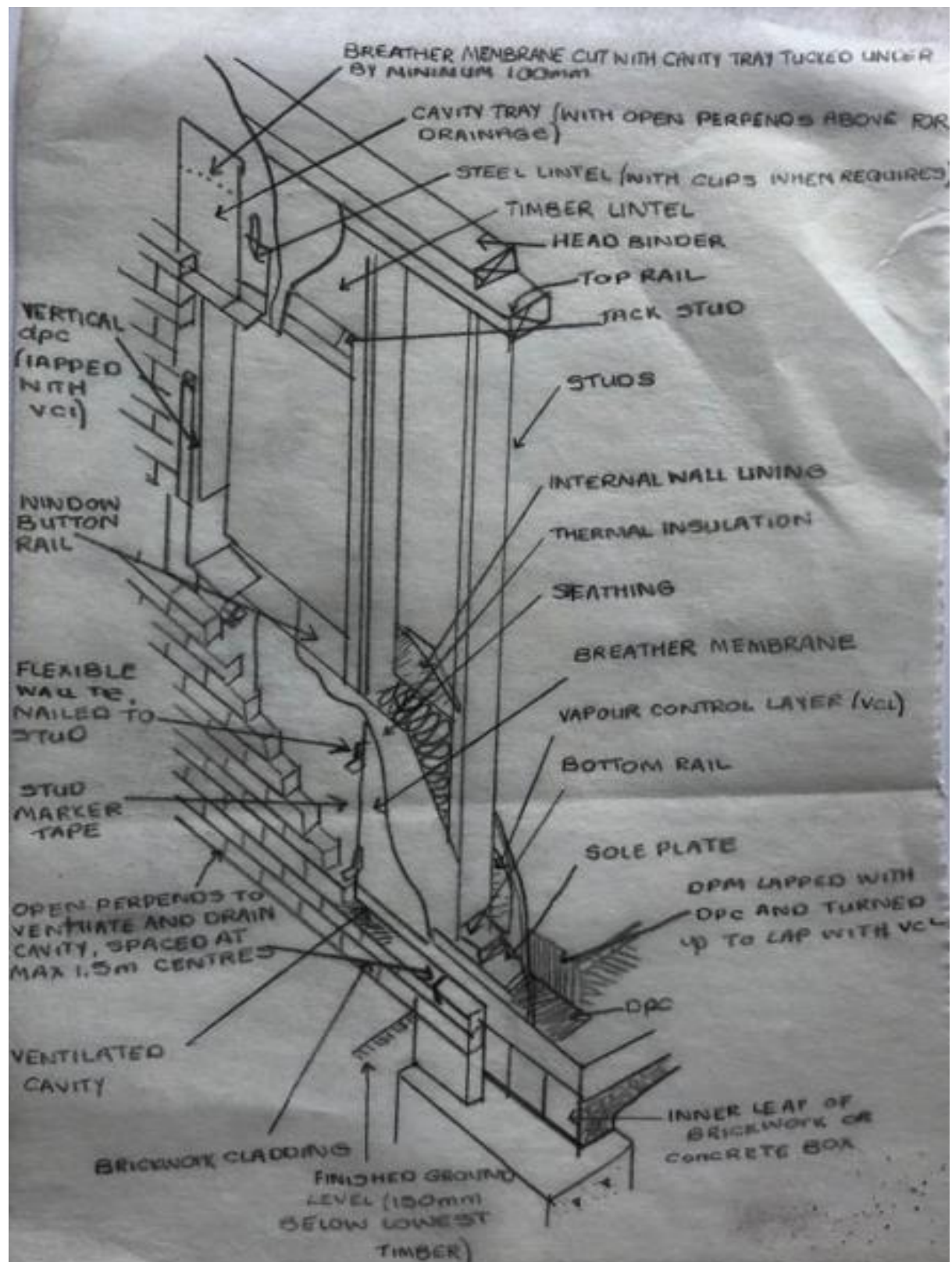


Figure 9: Slab foundation bearing the timber frame external wall and an outer cladding of brick.

2.4 Eaves detailing and roof covering

In relation to constructing an eave, considerations need to be made as highlighted below;

- Through soffit or proprietary over-eave vents, provide ventilation to the roof space.
- Maintain the tile line by sufficiently tilting eave tiles.
- Appropriate type of unsupported roof membranes, able to resist wind uplift and extend into the gutter.
- A suitable cavity barrier is fitted at the top between the timber frame wall and cladding.
- Roof ventilation is not affected by roof ceiling insulation, nor initiate thermal bridging at the edge of the ceiling through leaving any gaps.

The soffit level, the projection needed and roof pitch determine the detail of the eave that can vary and may also be dependent upon the level of the window head (TRADA Technology, 2011). Figure 10 shows a clipped eave, but they can also be boxed.

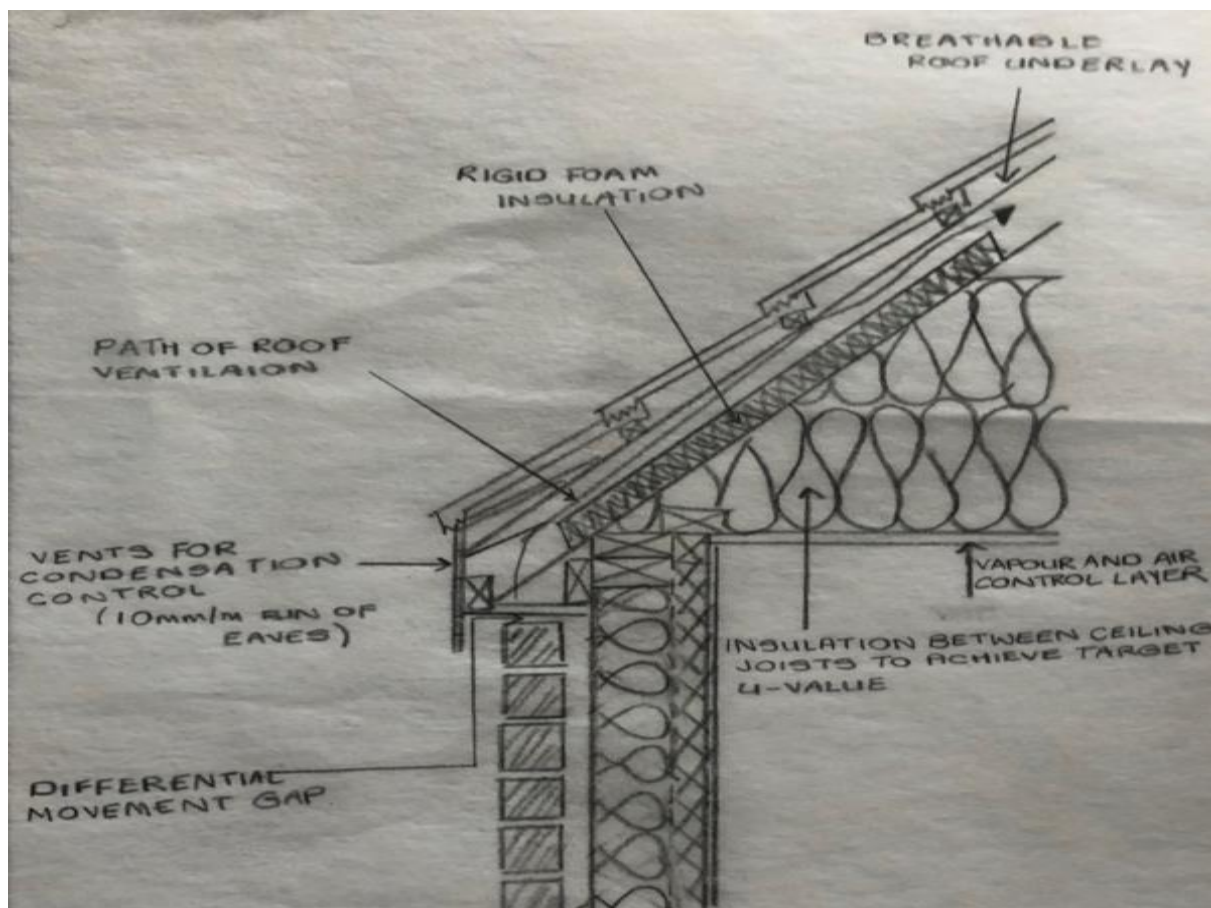


Figure 10: Clipped eaves construction (TRADA Technology, 2011).

Slate is used to cover the pitched roof and comes in various sizes such as 300mm and 600mm. In order to be nailed to the battens on timber roofs, every slate must be holed centrally with two holes. This is known as a centre nailed slate (Riley & Cotgrave, 2018). If extensive exposure to rain and wind is anticipated, this technique provides strength (Riley & Cotgrave, 2018) (figure 11).

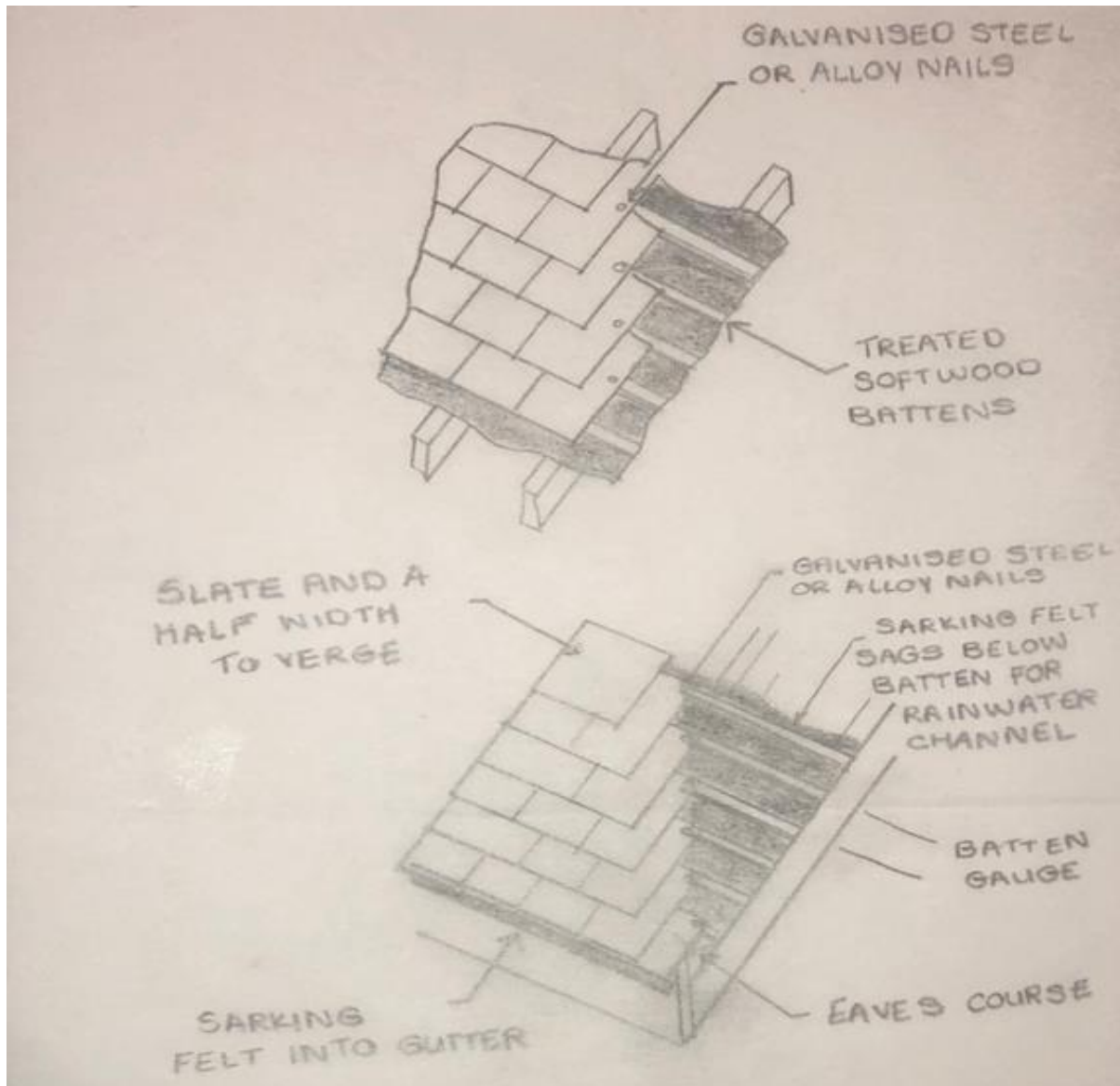


Figure 11: Head nailed and Centre nailed slates (Riley & Cotgrave, 2018)..

To prevent any entry by rain, bonding is important as demonstrated in figure 12. The illustrations show there is usually a double thickness of slate over the whole roof, but in the lap position a triple thickness, each slate being overlapped 3 times (Riley & Cotgrave, 2018). The gauge is centre-to-centre spacing of the fixing battens and the method of lapping, part of the process of water proofing (Riley & Cotgrave, 2018). Additionally, the roof must have a slope of 1:80 and waterproofing should extend up the adjacent walls at a minimum of 150 mm from the surface of the roof. The roof covering must include ventilation (Llywodraeth Cymru Welsh Government, 2010).

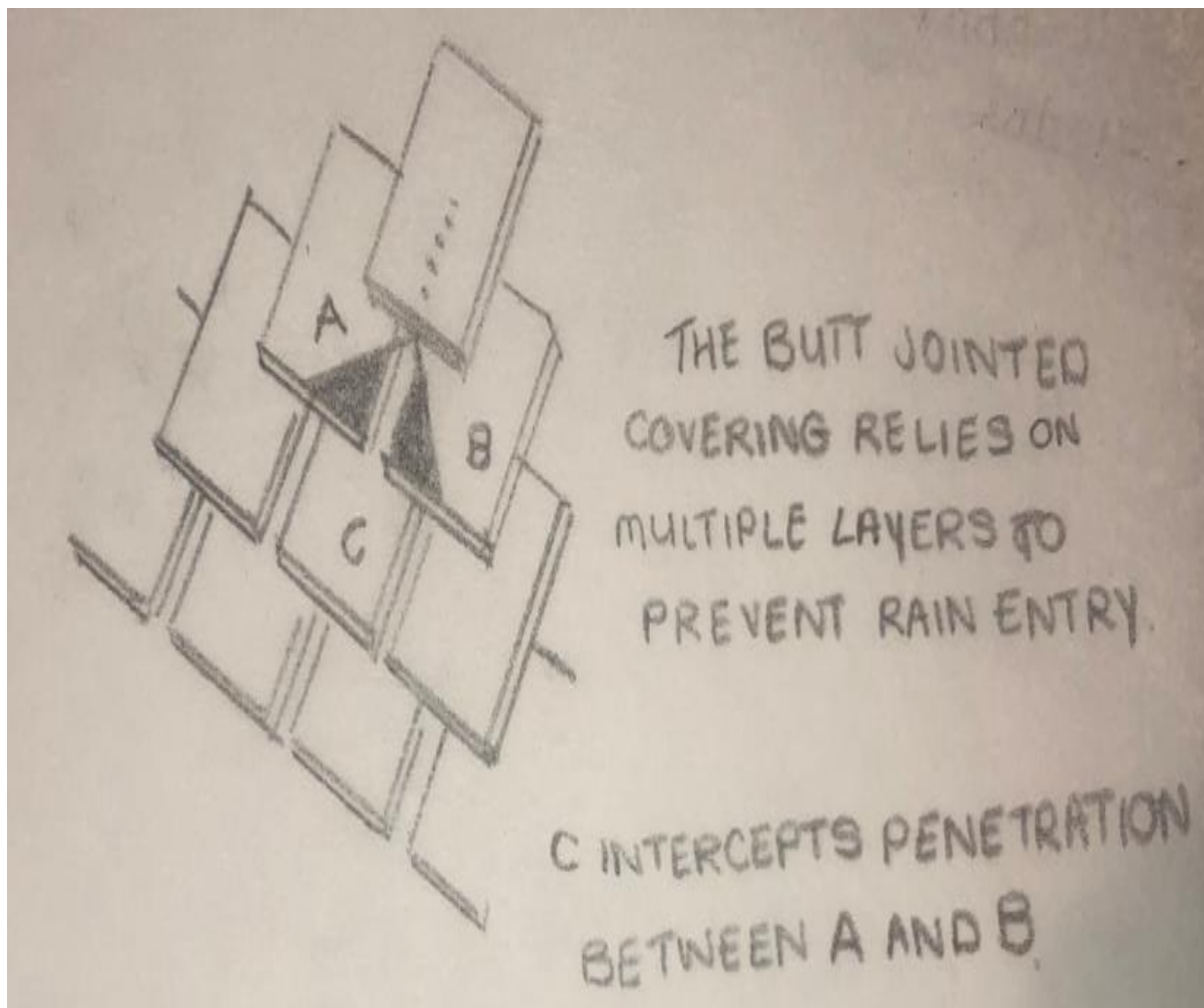


Figure 12: Prevention of the entry of rainfall using butt jointed roof coverings – multiple layer coverings (Riley & Cotgrave, 2018).

2.5 Roof Structure

A trussed rafter is used for the pitched roof - this being the detail combining ceiling joists and rafter (figure 13). Removing the heavy purlin and instead using internal bracing, the trussed rafter also replaces the ridge board by using a gang nail plate (Riley & Cotgrave, 2018). Both the horizontal ceiling joists and rafter sections create the basic triangle of component parts which remains a tie member in tension, as per the original rafter and purlin roof. The prefabricated trussed rafters can be raised into place and fixed at 600mm after the positioning the wall-plate on the top of the wall (figure 14) (Riley & Cotgrave, 2018). Using proprietary truss fixing clips, trussed rafters are fixed to the top timber and the members bearing the trussed rafters must be at least 75mm wide (Riley & Cotgrave, 2018). The trussed rafter has a fink profile.

Whilst all other members are struts in compression supporting the rafter, supporting the horizontal ceiling joists and meeting the apex of the detail, the two internal members are always tied in tension. Providing anchorage to space them apart, other timbers can be perceived to run horizontally, but only after the basic trussed rafters have been assembled, spaced at 600mm (Riley & Cotgrave, 2018).

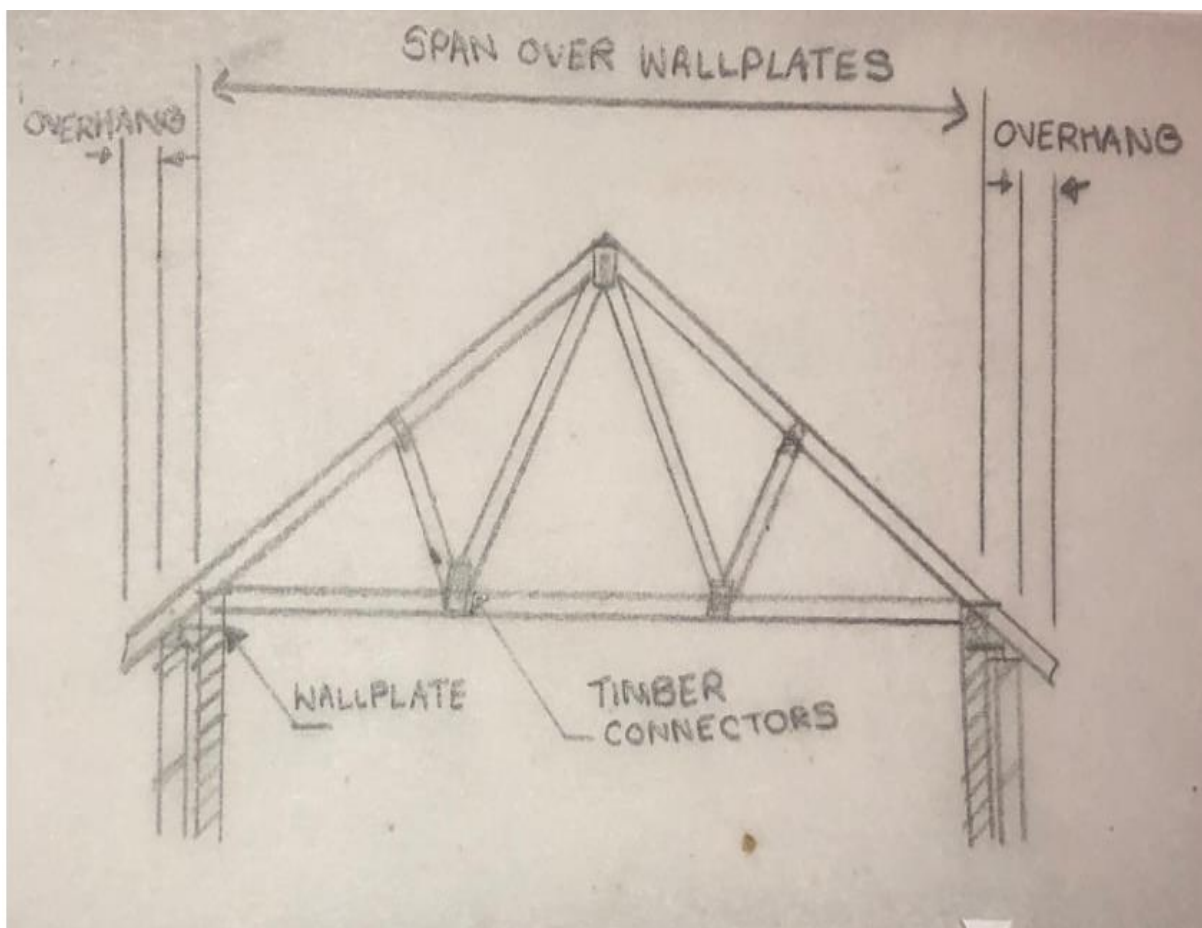


Figure 13: A trussed rafter with a fink profile (Riley & Cotgrave, 2018).

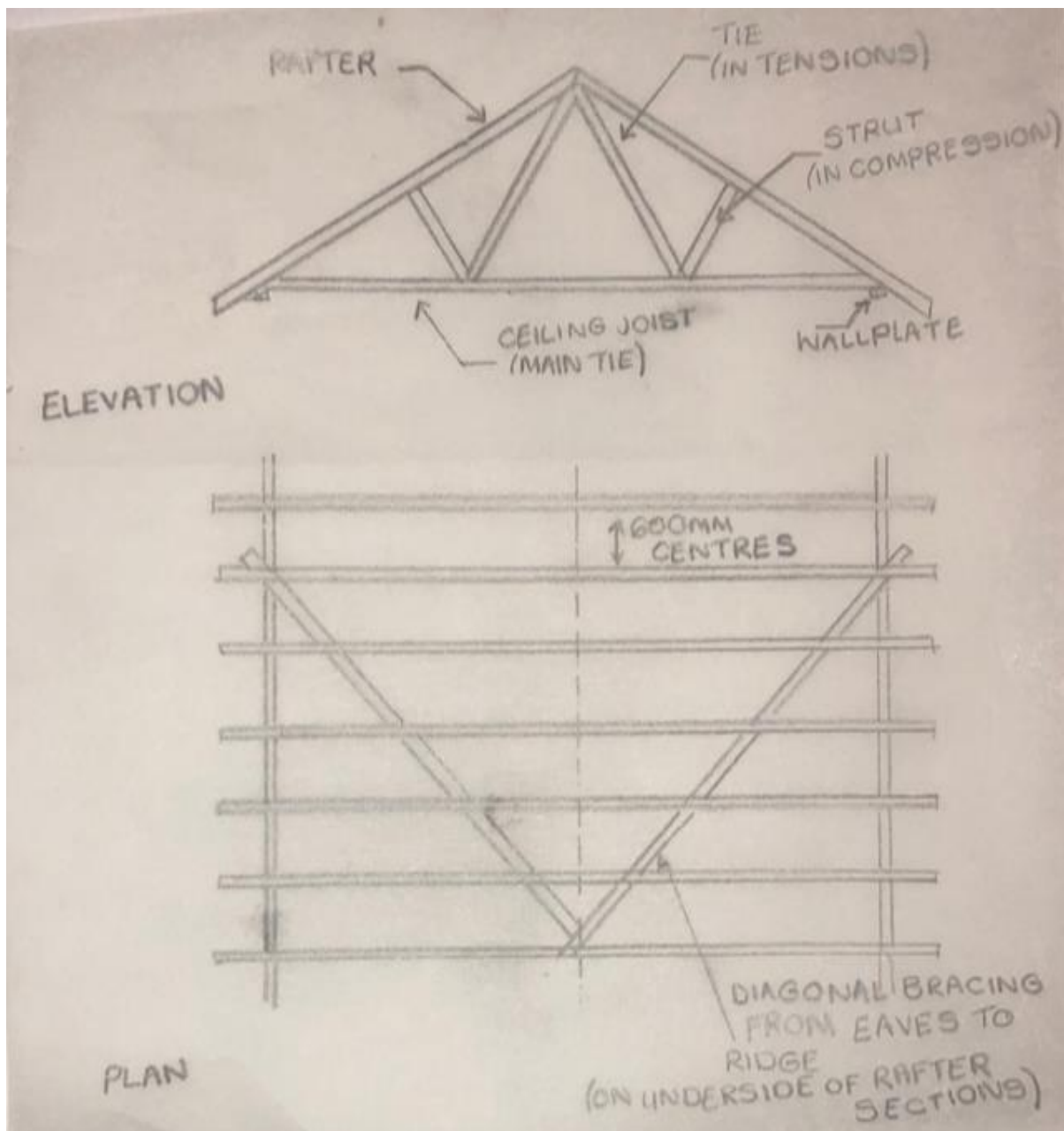


Figure 14: Component parts of the trussed rafter with a fink profile (Riley & Cotgrave, 2018).

The timbers used to prevent collapse due to the pressure of the wind is another key feature; the bracing running diagonally up to the roof's apex from the wall-plate attached to the underside of the rafter (Riley & Cotgrave, 2018) (figure 15). Moreover, the construction of the roof will have a U value of $0.13 \text{ W/m}^2\text{k}$ (Llywodraeth Cymru Welsh Government, 2010).

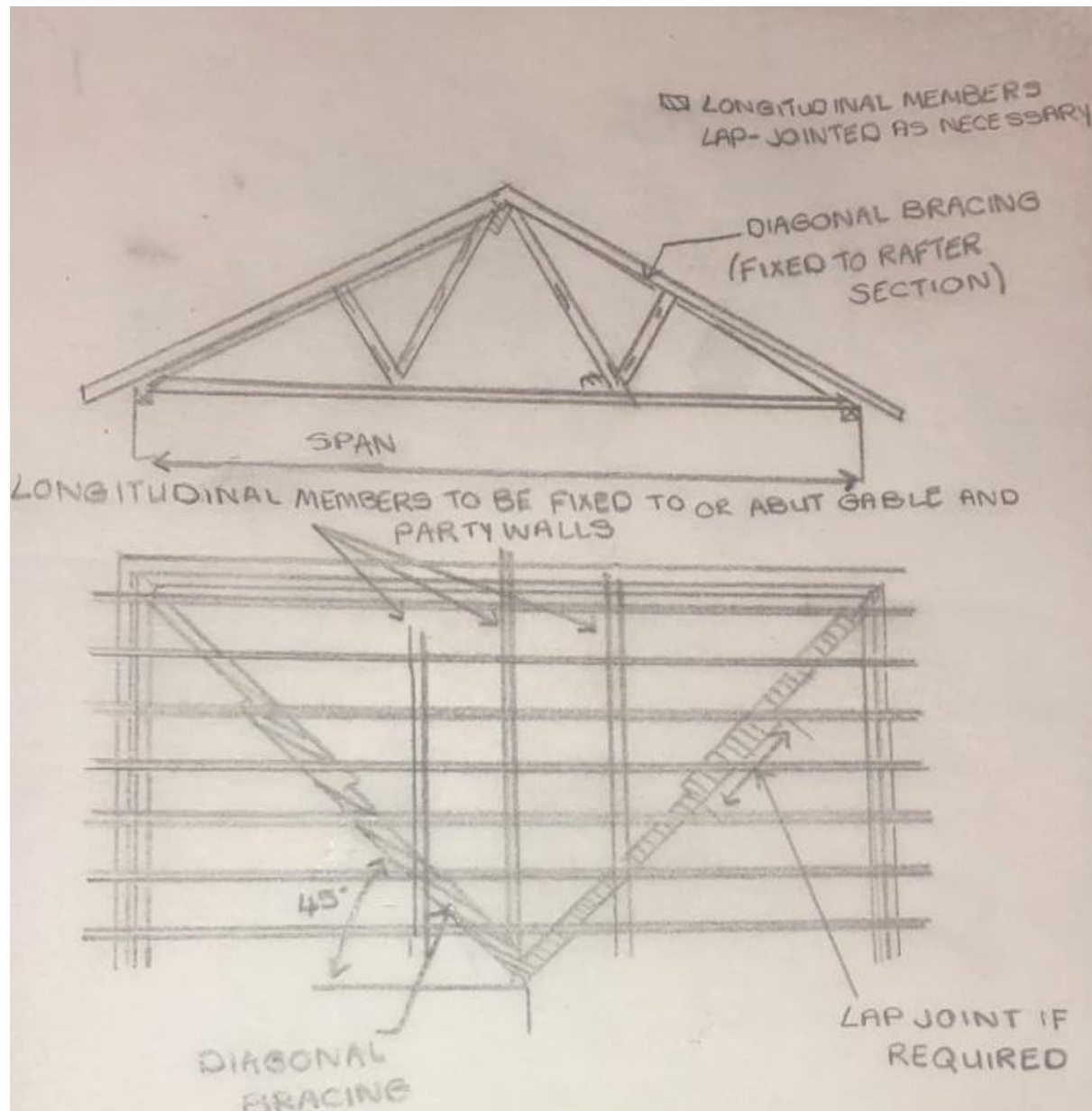


Figure 15: Diagonal wind bracing and longitudinal bracing (Riley & Cotgrave, 2018).

3. Advantages and Disadvantages of a Trussed Rafter

Table 2 provides a summary of the advantages/disadvantages of using a trussed rafter for a pitched roof.

Table 2: Advantages and disadvantages of using a trussed rafter for a pitched roof.

<i>Advantages</i>	<i>Disadvantages</i>
Construction quicker as roof designs simple.	Due to unsatisfactory handling, delivery and storage, material could not achieve its normal standard of performance.
There is minimal waste.	Before internal partitions are installed, the roof needs to be loaded by the covering.
Decreased requirement for intermediate load bearing internal walls	Trussed rafters all must be plum, spaced at even distance and fitted correctly.
Spans are large.	The span cannot be modified if variations occur to rain, snow or wind loads, loading of covering or span, because design is based upon these.
Reduction in intensity of workforce as materials are prefabricated.	Roof space available can be limited. Where roof changes direction, careful consideration is necessary.

4. Ventilation

4.1 Causes and sources of condensation and the impacts of condensation on building fabric

When moisture vapour in the air is released in the form of droplets of liquid, frequently onto cold surfaces within the building, condensation occurs. The critical temperature at which this release happens is known as the dew point and depends upon both humidity and temperature (Riley & Cotgrave, 2018). During winter, on the windows internal glass surface, condensation occurs, whilst in the body of the element - within the wall or roof - interstitial condensation occurs when the critical dew point temperature is achieved (figure 16) (Riley & Cotgrave, 2018). The growth of mould caused by condensation has an impact on the fabric of the building. An environment for the development of mildew and mould is created by humidity combined with temperature and causes staining of the walls. This leads to the decay and corrosion of the building fabric, thereby having a detrimental effect on the thermal performance of the building.

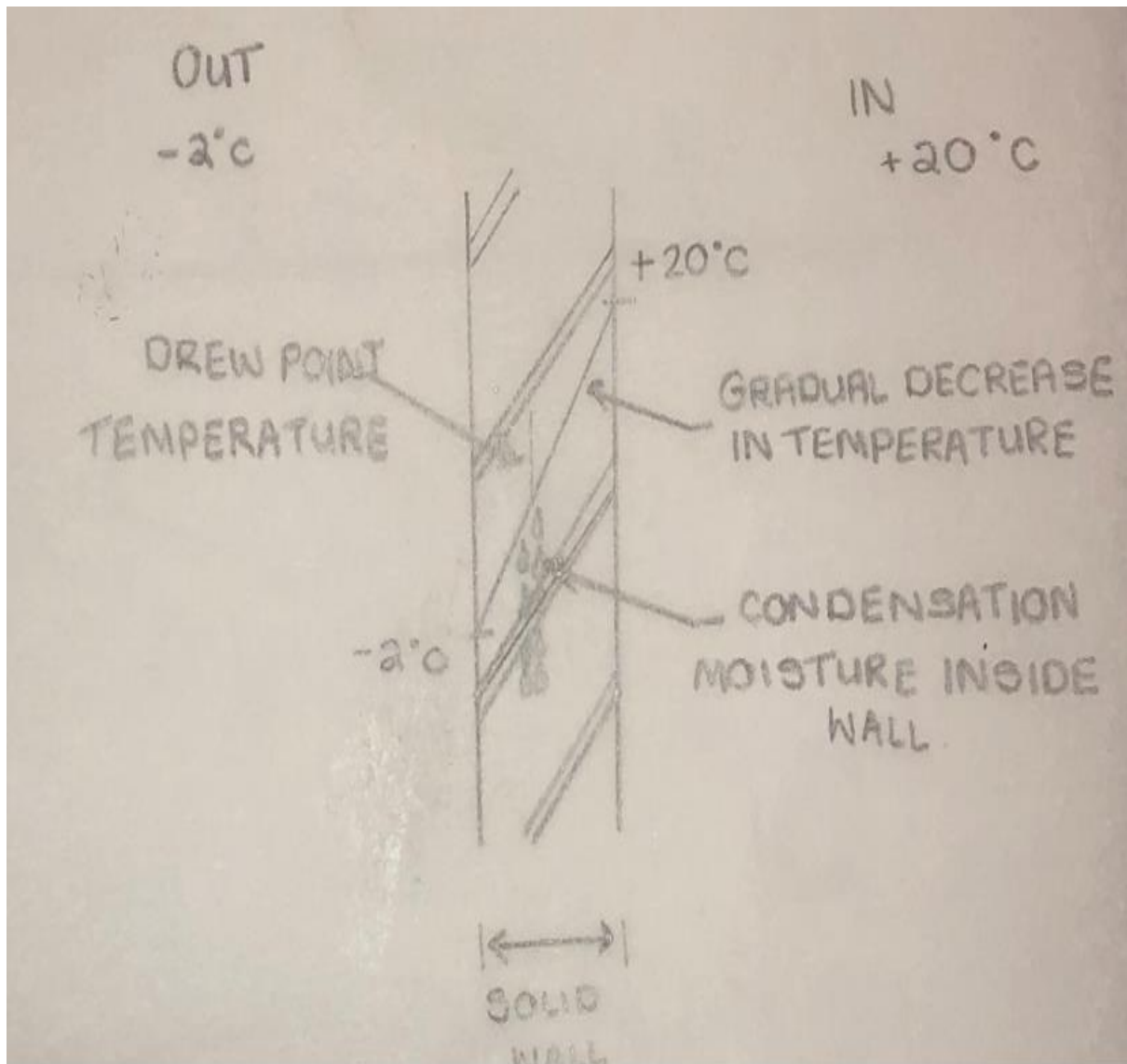


Figure 16: Condensation (interstitial) within a wall (Riley & Cotgrave, 2018).

4.2 Ventilation Methods

In order to remove moisture vapour held in the air, air changes and ventilation are essential. A ventilation strategy for dwellings which is 3-pronged is recommended summarised as follows :

- In 'wet' rooms such as toilets, kitchens and bathrooms, target the of extract ventilation (Llywodraeth Cymru Welsh Government , 2010).
- To reach an appropriate air change rate, enough fresh air from the outside is provided through efficient 'whole house' ventilation (Llywodraeth Cymru Welsh Government , 2010).
- To help with the occurrence of high levels of contamination or vapour, such as removing smoke from a kitchen, use 'purge' ventilation (Llywodraeth Cymru Welsh Government , 2010).

The minimum ventilation rate should not be less than 0.3 litres/second per m² of internal floor area (Llywodraeth Cymru Welsh Government , 2010). To guarantee that ventilation is satisfactory and in line with the above, the methods that can be used are outlined in table 3.

Table 3: Ventilation method with description.

Ventilation Method	Description
Cross Ventilation.	When air enters and passes through a building from one side of the enclosure, as a result of the effect of air pressure or wind on the building. The chance of condensation is reduced, and air circulation is achieved.
Vent Tiles.	To facilitate the escape of moisture-laden air.
Positive Pressure Systems.	Subject the house interior to applied air pressure through the installation of a fan forcing air into it. Through whichever route is available, air will be assisted to escape outside if a positive pressure result.
Dehumidifiers.	The development of condensation is assisted by the creation of water vapour by some activities in the home. Although Dehumidifiers are frequently in use nowadays to collect air moisture.
Internal Temperature is maintained.	Condensation will not occur if the external shell of the building is maintained above the dew point temperature, by ensuring the rooms of the building are sufficiently heated.

5. Conclusion

It is apparent that the new build has been built in the correct form in line with the Welsh Government Building Regulations in order to have the best performance. By following the instructions and adhering to the discussions above, the house will be durable, strong, weather resistant and have good insulation performance. Timber-frame construction allows the dwelling to be aesthetically pleasing. Ventilation and the provision of light are critical to the performance of the building. Utilising these allows the house to be more sustainable which improves the overall efficiency of the building and complies with the Building Regulations of Wales.

6. References

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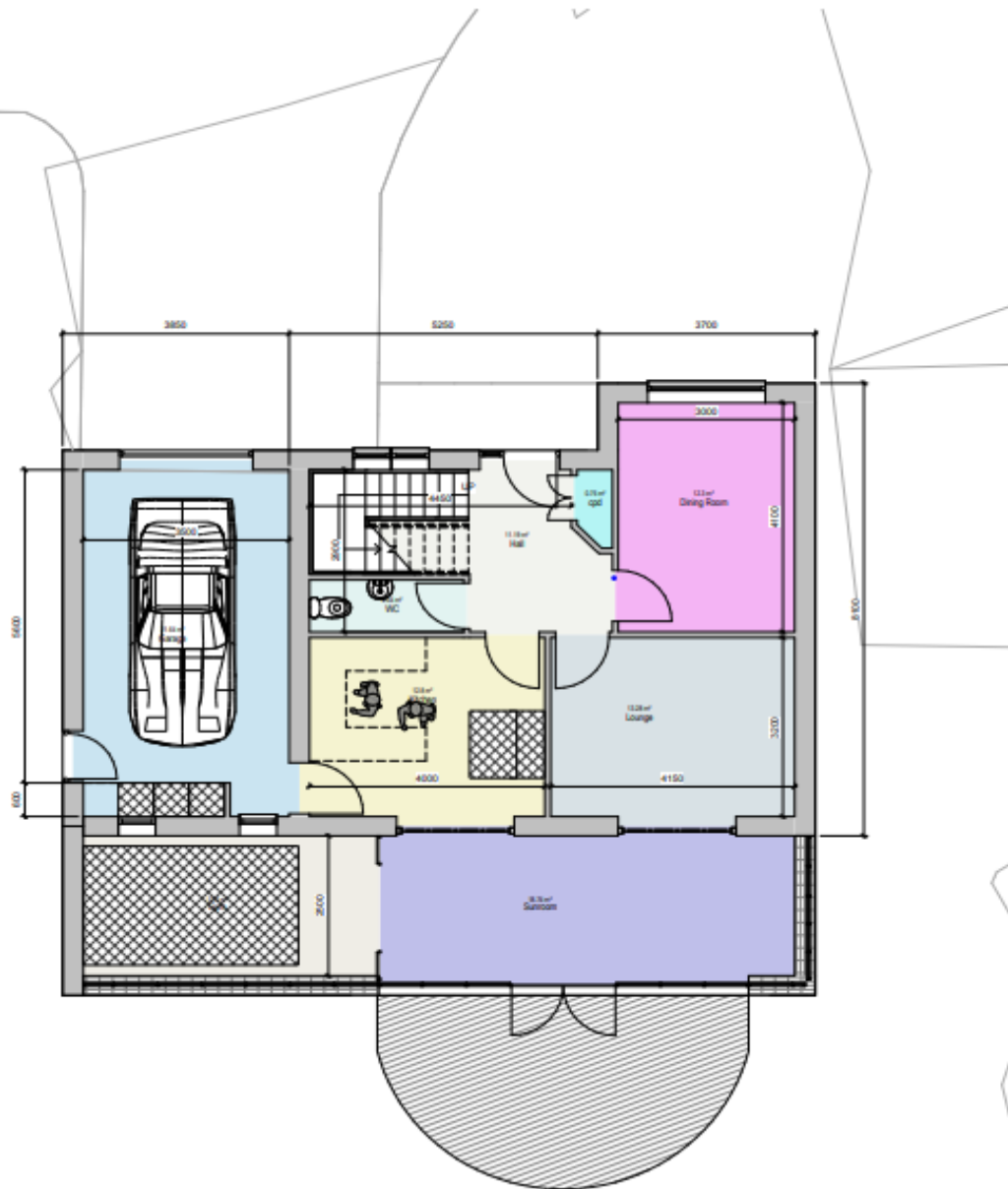
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7. Appendix

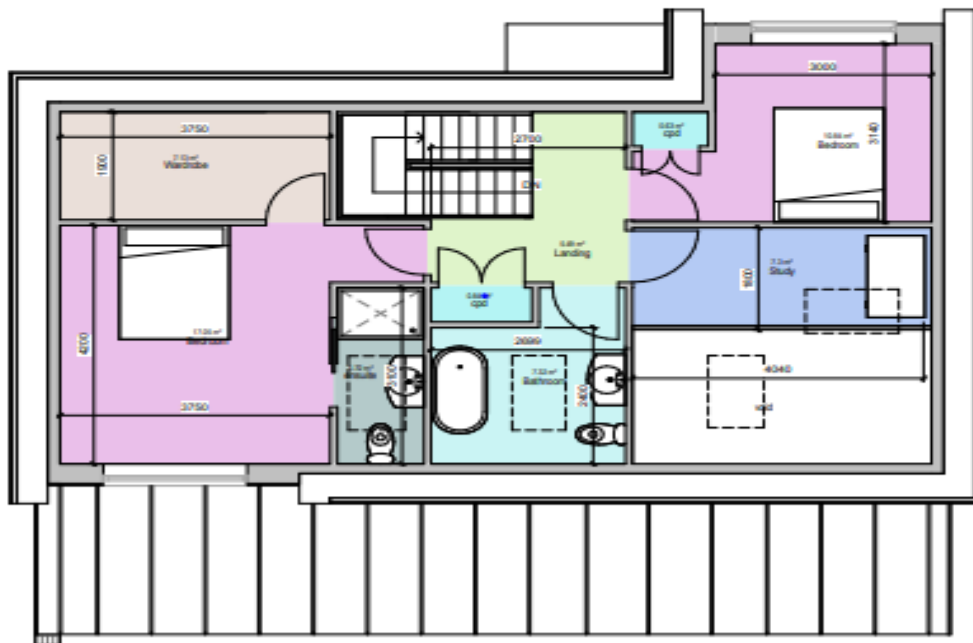
7.1 New Dwelling details

It is to be built on a level but reclaimed site, which prior to advanced ground works had been used as agricultural land. There is a retaining wall structure to the south of the site and the Ground Investigation report suggests a suitable raft foundation be constructed for the property. The building is a timber framed construction where the inner skin of the 'cavity wall' is 140mm thick insulated C16 timber frame. The outer skin consists of stack bonded facing brick work and blockwork with a smooth render finish. Additional PIR insulation is contained within the cavity to improve the thermal performance. There is to be an insulated ground floor with underfloor heating in the screed and the upper floors are to be traditional solid timber with tongue and groove softwood flooring. Windows and external doors are to be powder coated aluminium; windows are triple-glazed units. Roof structure is to be trussed rafters with a metal profile sheeting finish installed over OSB sheathing boards.

7.2 Ground floor plan



7.3 First Floor plan



7.4 Elevations



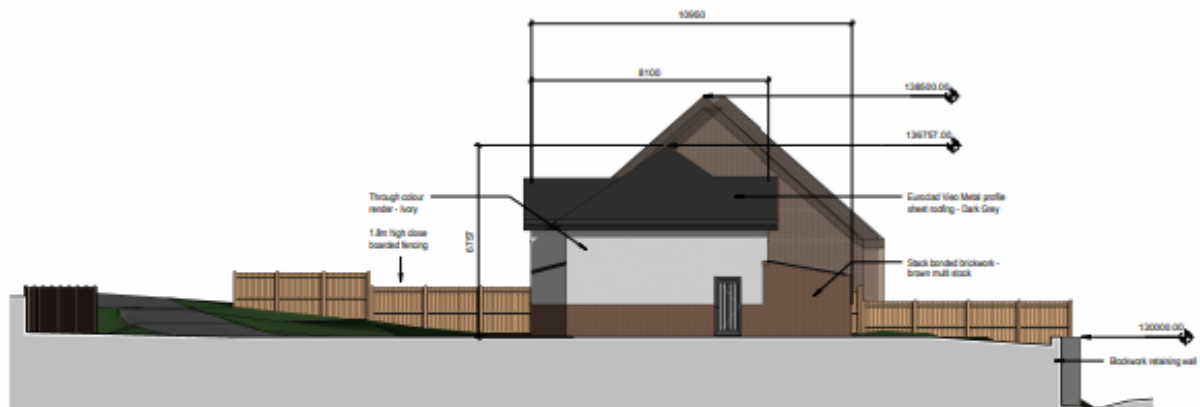
North East Facing Elevation

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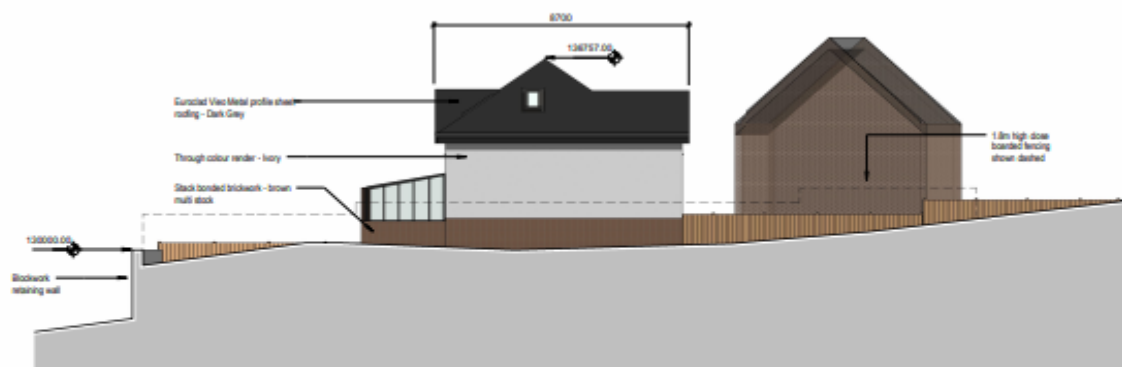
South West Facing Elevation

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North West Facing Elevation

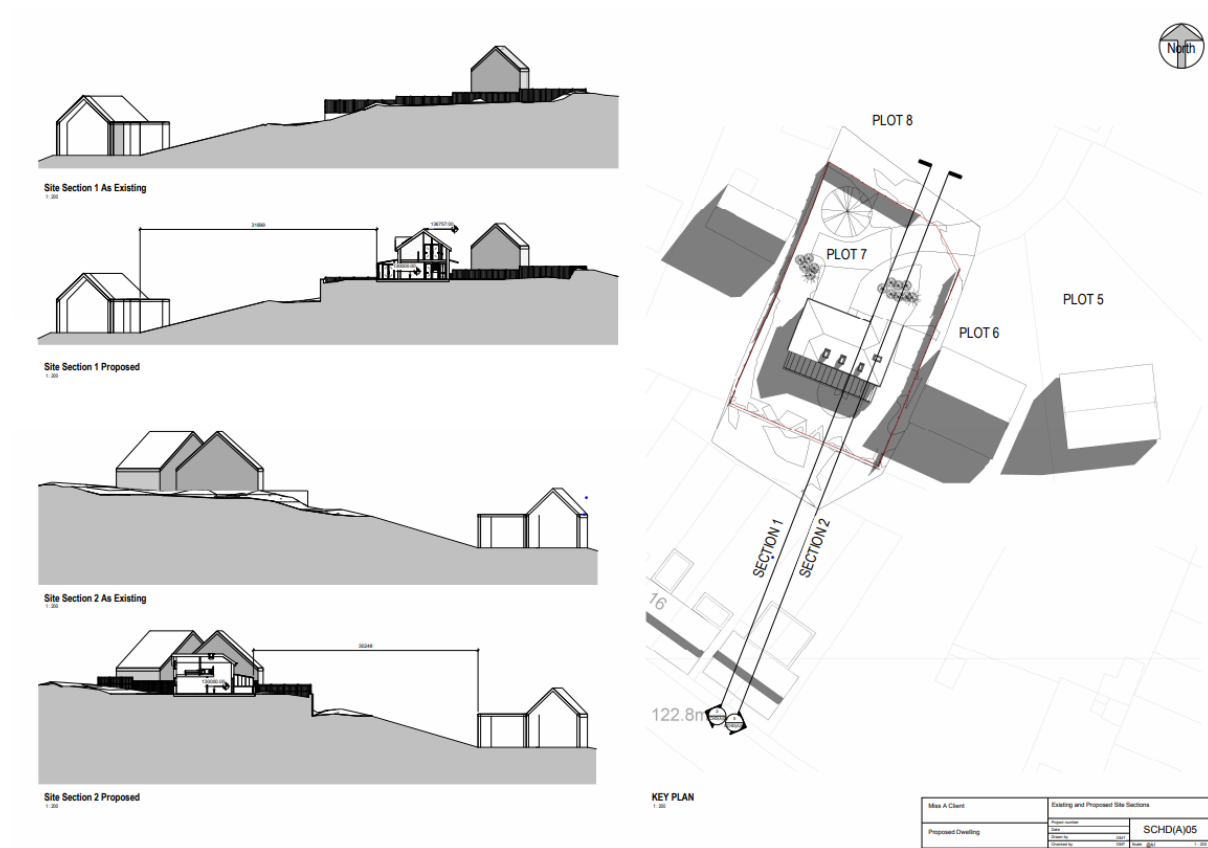
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South East Facing Elevation

1:100

7.5 Proposals



7.6 House view



FRONT VIEW



FRONT VIEW



REAR VIEW



REAR VIEW



REAR VIEW (AERIAL)

Site & Client	Proposed Visuals	
Proposed Dwelling	Site & Client	SCHD(A)06
	Proposed Visuals	