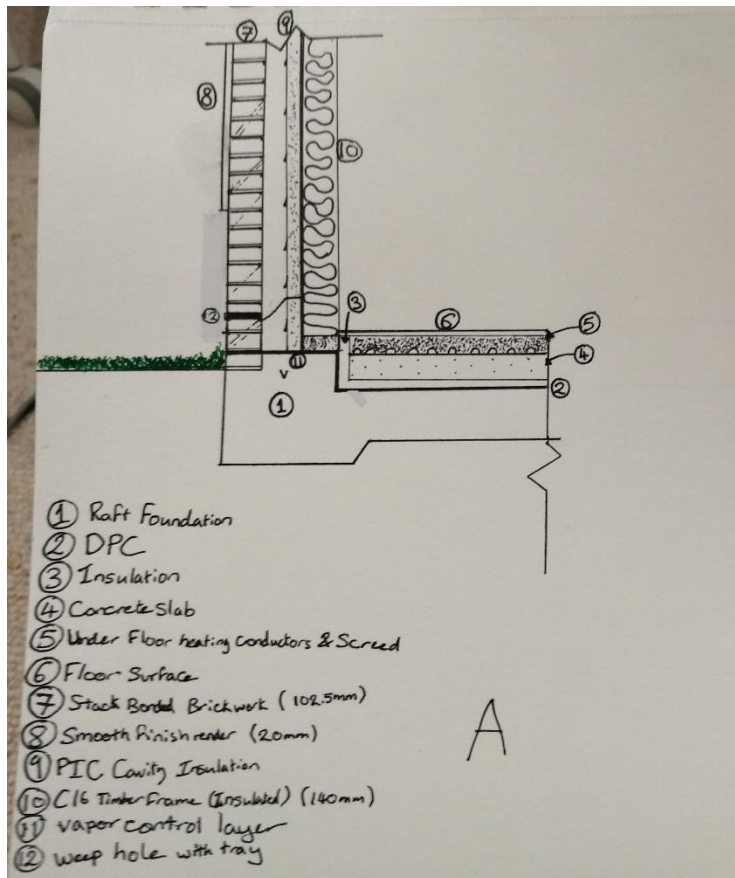


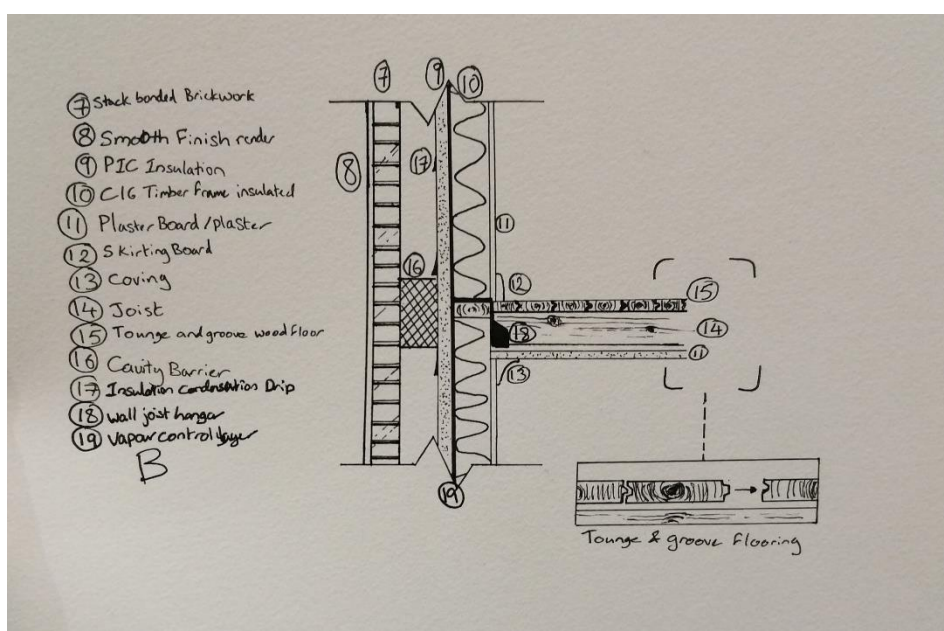
Technical Report for Proposed Dwelling

The Ground Floor Construction:

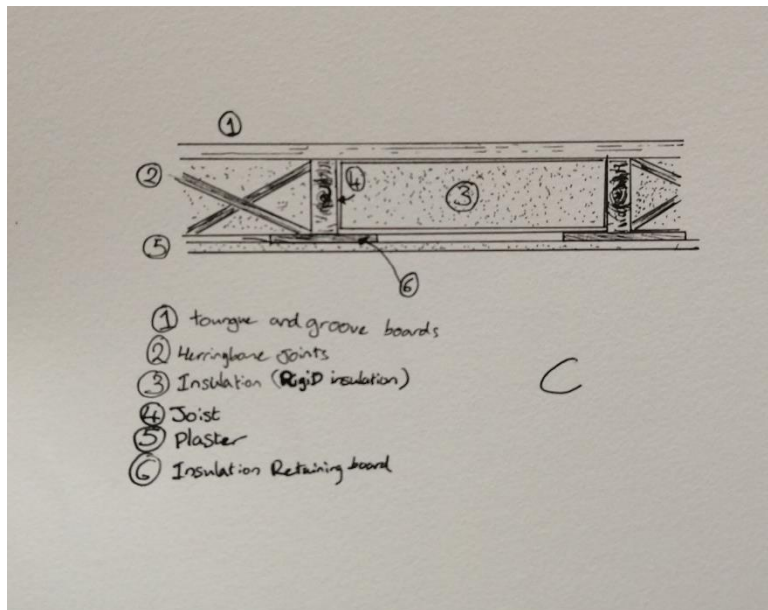


Sketch A: Shows the raft foundation, underfloor heating and wall section.

The First Floor Construction:

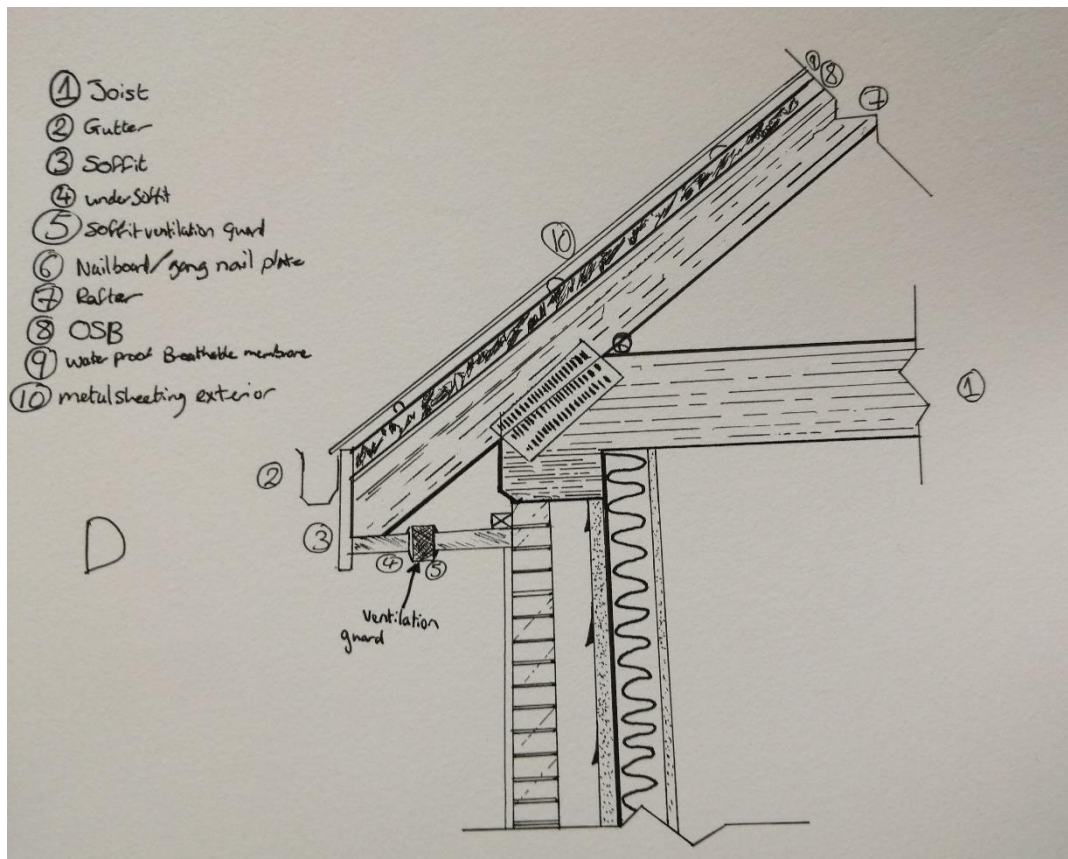


Sketch B: Shows first floor wall and floor section.



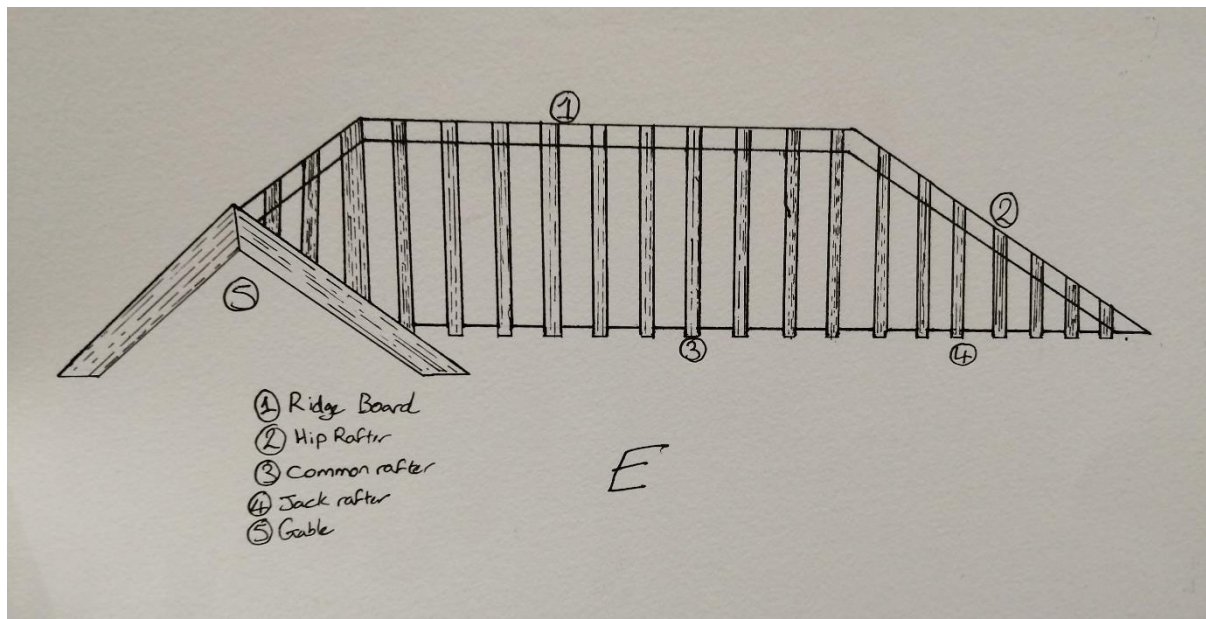
Sketch C: Shows the first floor section from a different angle.

Eaves Detailing and Roof Covering:

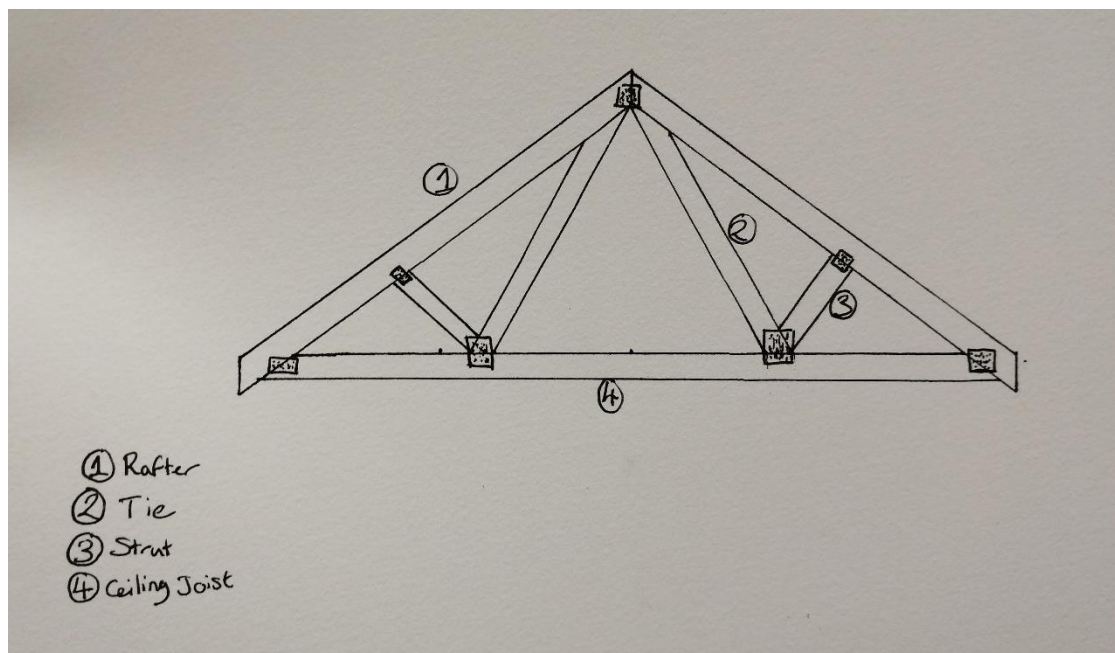


Sketch D: Shows the Eaves section.

The Main Roof Structure:



Sketch E: Shows the roof structure.



Sketch F: Shows an example of a Trussed rafter.

Building Regulations in Timber Frame Construction:

Timber frame construction must be conducted in specified ways, as detailed by the sketches shown above, in order to meet building regulations set by the Welsh Government (Welsh Government, 2020). The sketches above illustrate how some of these regulations are met, the relevant regulations are discussed in further detail below.

First is approved document A, which establishes guidelines for stability of the building against loads and ground movement. Significant ground movement such as land-slips or subsidence are unlikely at this site due to the extensive ground works conducted since its use as agricultural land. The building will also be stable against dead, imposed and wind loads and meet the safety standards to ensure this. Joist hangers provide lateral support for the First floor (*sketch B*) and gang nail plates will be used to secure the roof (*sketch D*). Walls will meet the minimum thickness required for their height and length, which is 190mm. Wooden cladding will be firmly attached with screws to ensure it is able to withstand the loads of the building.

Approved document B establishes the fire safety requirements of the building, as a two-storey dwelling it is a group 1(b) building. The building plans show good access to fire escape routes from all rooms. Following construction, smoke and heat alarms should be fitted to ensure fire safety of the property at all times. Structural elements of the building will meet the minimum fire resistance requirements – external walls are required to have fire-resistant insulation (PIR insulation shown in sketches A, B and D) to limit the spread of fire, heat or smoke across the property boundaries to neighbouring buildings. The structural brick wall in the centre of the property will maintain the property's structure during a fire and prevent early collapse. Cavity barriers will be installed (*sketch B*) to prevent the spread of fire or smoke through the cavities.

Approved document C contains guidelines for preventing contamination and moisture within a build. Similarly, approved document F contains regulations on ventilation within a property. Condensation and ventilation are discussed in more detail in a later section of this document.

Approved document D sets the guidelines for cavity insulation. It states that the use of urea formaldehyde foam is discouraged due to its potential to release toxic fumes. This is not an issue with PIR insulation used in this property (*sketches A, B and D*).

Approved document E sets the sound-proofing requirements for construction projects. For a two-storey dwelling walls and floors should provide insulation against airborne sounds of 45 dB and floors must provide insulation against impact sounds of 62 dB. The timber-framed cavity construction, including cavity barriers (*sketch B*), will facilitate this level of sound-proofing. There are no additional requirements on external walls as this is a detached property.

Approved document L1A covers the requirements for fuel and power conservation in new dwellings. The PIR insulation (*sketches A, B and D*) will prevent heat gains and losses through the external walls. The insulation of the roof (*sketch D*) will prevent heat gains and losses through the roof. This property must meet standards for the Target CO₂ Emission Rate (TER) and the Target Fabric Energy Efficiency (TFEE) rate, calculated based on the square-meters of floor space, in order to pass the regulations established in document L1A. Construction as detailed by the sketches provided should pass these tests.

Finally, there are also regulations for workmanship and materials, which requires the use of suitable construction materials used by adequately trained construction workers. This is met by the construction plan as long-lived materials are used in all structural and non-accessible elements such as: trusses in the roof; timber framing and brickwork in the walls; concrete rafts to form the foundations; PIR insulation. These materials are detailed in all sketches provided.

Roof Structure:

The roof structure detailed for this property is timber trussed rafters, which uses a combination of rafters and ceiling joints (*Sketch F*) and allows roof elements to be pre-manufactured by off-site

specialists to be delivered to site when needed. The main advantage of this construction method is vastly improved construction time compared to more traditional methods, as the rafter structure does not need to be put together on-site (Riley & Cotgrave, 2018). The pre-fabrication of the rafters also makes them relatively easy to manufacture, meaning that custom sections can be produced, allowing more complicated roofs to be constructed easily (Mindham, 2006). The pre-manufacture of the structure also improves space on-site, improving access for contractors.

Another major advantage of this construction method is the use of wood as the main construction material, although steel trussed rafters can be used for commercial buildings. Wood, especially when responsibly sourced, is the most environmentally conservative choice for housing construction compared to its steel counterpart (Svaklenka & Kozlovskaya, 2020). Wood is also more light-weight than steel, making the construction lighter and limiting the need for deeper foundations and/or thicker walls (Svaklenka & Kozlovskaya, 2020). The use of wood is also highly cost-effective, adding to the relatively cheap nature of trussed rafters, as it is cheaper to manufacture than other materials such as steel (Riley & Cotgrave, 2018).

The main disadvantage of the trussed rafter method is the tendency of wood to rot, particularly in the presence of condensation (Mindham, 2006). This is a major concern as rot will eventually weaken the structure and may cause the roof to become unstable. This can be combated by implementing proper ventilation of the wooden structure, as demonstrated in the sketches shown in the next section of this report. There must also be a waterproof, but permeable, membrane between the rafters and the roof to prevent weathering (Mindham, 2006). Another disadvantage of using wood is that it is relatively weak compared to steel, this means that wooden rafters cannot withstand a heavy roof or extreme weather conditions. The climate of the local area and the load required by the rafters are therefore important considerations in wooden rafter construction.

Another disadvantage is the inability to use the roof space as a habitable room (Mindham, 2006). Although buildings with trussed rafter roofs can still contain loft storage space, the wooden frame will occupy a lot of the available space and, due to transport difficulties, trussed rafter structures are often set to a relatively low pitch (Riley & Cotgrave, 2018). Therefore, the room would not usually be suitable for loft conversion to expand living space of the home (Mindham, 2006).

Another popular roof structure construction method is rafter and purlin roofs, which are similar to trussed rafter roofs in appearance but involve no pre-fabrication of the structure. These roofs do not have the diagonally placed timber used in trussed rafter roofs, instead consisting of a triangular rafter structure supported by horizontal purlins, which connect to the ceiling joist below via vertical timber hangers. This method is also timber-based so carries the same advantages and disadvantages of using wood in construction as described above. A major advantage of this method is the ability to use the roof space for storage or even for accommodation with use of suitable joiners, usually incorporating a dormer to increase space (text-book). Rafter and purlin roofs are often constructed with a higher pitch, of around 35 to 45 degrees, than trussed rafter roofs; therefore, rafter and purlin roofs have a greater availability of space within the roof structure (Riley & Cotgrave, 2018). This allows for much simpler loft conversion than in properties that were constructed using a trussed rafter structure (Mindham, 2006).

Disadvantages of rafter and purlin roofs include the same disadvantages of timber construction discussed for trussed rafter roofs. Rafter and purlin roofs are also associated with increased construction time, due to the need to construct the roof on-site with no pre-fabrication (Riley & Cotgrave, 2018). There will also be reduced space on-site while the roof structure is constructed, which may reduce access to the property from contractors involved with the build. Rafter and purlin

roof construction tends to be more expensive than trussed rafter construction, due to the increased labour costs involved (Riley & Cotgrave, 2018). The inability to pre-manufacture the roof structure also limits the overall complexity that can be achieved in the roof structure, as the roof must be constructed by on-site contractors instead of off-site specialists (Mindham, 2006).

Ventilation and Condensation:

Condensation is the formation of water droplets on a surface when the humidity or temperature difference reaches the 'dew point'. Sources of condensation can include: cooking; use of bathrooms; lack of ventilation; indoor exercise; swimming pools; increased temperature change from interior to exterior; and damp rising from the foundations.

Condensation can cause many problems for a building, particularly timber framed buildings. Interstitial condensation promotes mould growth, this damages building materials - particularly timber and plaster (Mindham, 2006). Mould growth promotes rot in timber frames, which may compromise the integrity of the structure. Surface condensation from inside the building is likely to cause damage to plaster and paint and can also promote mould growth.

Temperature changes can be promoted through thermal bridging if a cavity has not been blocked effectively, commonly occurring where metal frames are used around windows or doors. The warm and humid air of the interior condenses on the sill or joist above as the heat is conducted away from the area leaving a cold surface.

In accordance with building regulations, DPC has been laid between the foundation of the structure, The damp proof is laid 150mm above ground level (Welsh Government, 2020). Joints between door frames and the ground are further sealed with a weather seal, reducing the chance of water ingress or drafts (Welsh Government, 2020).

Within the cavity, weep holes are installed to allow trapped water and water vapour to escape, installed with a 150mm tray to collect water droplets from the cavity (Welsh Government, 2020). The cavity also has a water vapour check/control layer and is 50mm wide, only to be bridged by wall ties and cavity barriers. An insulated cavity closer will be installed around the window fittings to reduce any possible opportunity of thermal bridging (Welsh Government, 2020).

The roof sheets are joined and sealed tightly to prevent an ingress of water, the roof and its insulation are to provide a U value no greater than $0.35\text{W/m}^2\text{K}$ at any point (Welsh Government, 2020). Vents will also be installed in the soffits to allow water vapour to escape (Welsh Government, 2020). To combat condensation within the interior, extractor fans will be installed in 'wet rooms', such as the kitchen and bathrooms, to remove excess water vapour (Riley & Cotgrave, 2018). The use of purge ventilation, such as opening the window, is also possible in such areas as the kitchen to remove excess smoke or steam from cooking (Riley & Cotgrave, 2018). The windows will have trickle vents installed to provide background ventilation to reduce the overall humidity levels (Riley & Cotgrave, 2018).

References:

Mindham, CN. (2006) *Roof Construction and Loft Conversion, Fourth Edition*. Oxford: Wiley-Blackwell
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Riley, M., Cotgrave, A. (2018) *Construction Technology 1: House Construction*. Fourth Edition.
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Svajlenka, J., Kozlovska, M. (2020) 'Evaluation of the efficiency and sustainability of timber-based construction.' *Journal of Cleaner Production*. 259. <https://doi.org/10.1016/j.jclepro.2020.120835>

Welsh Government (2020) Building Regulations: approved documents Available at:
<https://gov.wales/building-regulations-approved-documents> (Accessed: 21/01/2021)