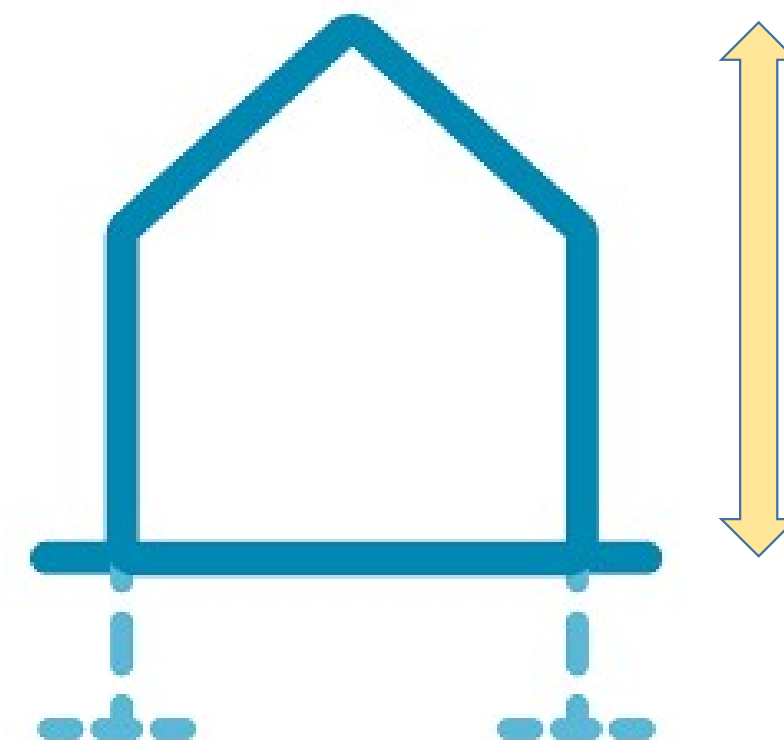


Superstructure : Fundamentals of Construction Technology

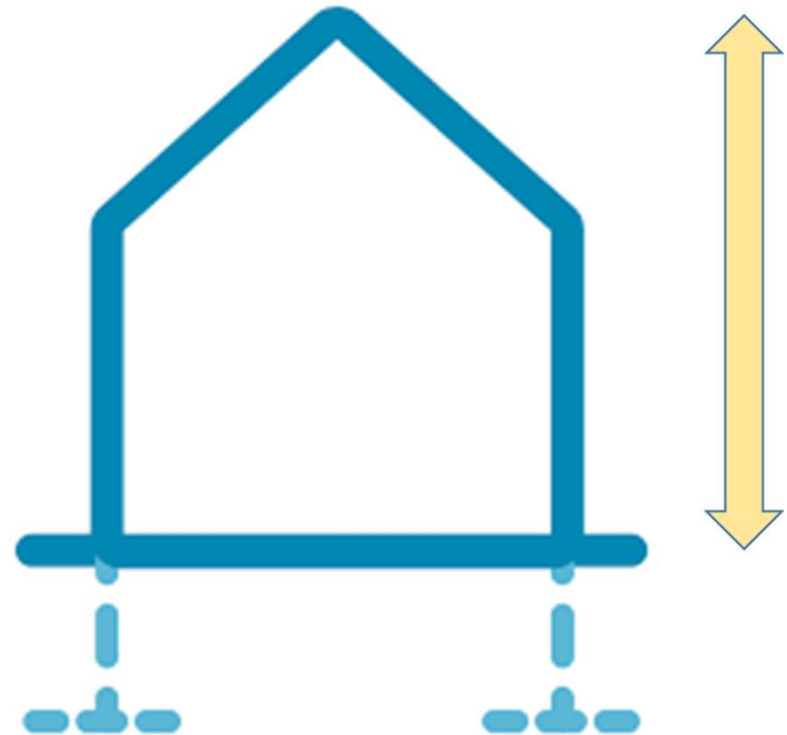


Superstructure:

Queries on the Assessment

Timber Frame Construction Sources

U Values



Assessment 2

Submission
deadline:

1st May 2025

Module Learning Outcomes (from module syllabus)

- interpret and produce annotated sketches that illustrate a broad range of common constructional forms, demonstrating understanding of their potential defect and repair needs.

Assessment 2

Submission
deadline:

1st May 2025

New Build Dwelling: Technical report with drawings (weighting 100%)

Scenario:

You have been approached by Miss A Client who has received planning consent for her single, two storey detached domestic building. It is to be constructed 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 client is considering a number of construction solutions and has asked you to prepare a technical case study that addresses some of the construction details required for each method.

The client is considering three different types of construction: Timber Twin frame, SIPS and Brick and Block and would like you to compare these methods in your submission.

The planning requirements stipulate that the outer skin is to consist of stack bonded facing brick work and blockwork with a smooth render finish.

Other requirements:

Additional insulation board is contained within an internally battened service zone to improve the thermal performance. There shall be an insulated ground floor with underfloor heating in the screed with upper floors of traditional solid timber with tongue and groove softwood flooring.

Windows and external doors are to be powder coated aluminium with triple-glazed units.

Roof structure is to be raised tie trussed rafters with a metal profile sheeting finish installed on OSB sheathing boards.

Assessment 2

Submission
deadline:

1st May 2025

The following tasks are allocated a percentage to emphasise the suggested time you should spend on each individual task. Marks will be allocated against the set Marking Criteria indicated

1. The client has been approached by a company offering offsite solutions on construction projects, but they are confused by the terminology used by the company.

Clearly define the term Offsite Construction giving examples of the four main categories and how these could be incorporated in the house. (5%)

2. Produce neatly drawn, proportionate and suitably annotated sections and sketches that illustrate the materials and methods for the detailing of the following building elements and construction inter-faces. Ensure that detailing shows how the design will meet the current Building Regulations for a domestic new-build giving particular attention to thermal performance of the building fabric.

i) Compare the Ground floor Construction, detailing and junctions with external walls for each method (30%)

ii) Compare a detailed section and plan detail showing a window opening in the external wall for each method (30%)

iii) Compare eaves detailing and roof structure— indicating appropriate weathering, fixing and laps for each method (30%)

iv) Recommend a construction method for the client, explain your reasoning. (5%)

Assessment 2

Guidance specific to this assessment:

Engagement with Literature Skills

You should reference your research on Offsite Construction, clearly using the university approved Harvard method.

Knowledge and Understanding Skills

Demonstrate your understanding of each construction method

Cognitive and Intellectual Skills

Comparison of construction method

Practical Skills

Practical aspects of each construction method

Transferable Skills for Life and Professional Practice

Your recommendations and communicating judgement

Submission
deadline:

1st May 2025

STUDENT FEEDBACK FORM

This section details the extent to which the assessment criteria are demonstrated by you, which in turn determines your mark. The marks available for each category of skill are shown. Lecturers will use the space provided to comment on the achievement of the task(s), including those areas in which you have performed well and areas that would benefit from development/improvement.

Generic Assessment Criteria	Mark & avail able	Mark & awar ded
1. Engagement with Literature Skills		
	5	
2. Knowledge and Understanding Skills		
	30	
3. Cognitive and Intellectual Skills		
	30	
4. Practical Application Skills		
	30	
5. Transferable Skills for Life and Professional Practice		
	5	

Assessment 2



Submission
deadline:

1st May 2025



FRONT VIEW



FRONT VIEW

1. The client has been approached by a company offering offsite solutions on construction projects, but they are confused by the terminology used by the company.

Clearly define the term Offsite Construction giving examples of the four main categories and how these could be incorporated in the house. (5%)

What is Offsite Construction.

4 Categories and Examples

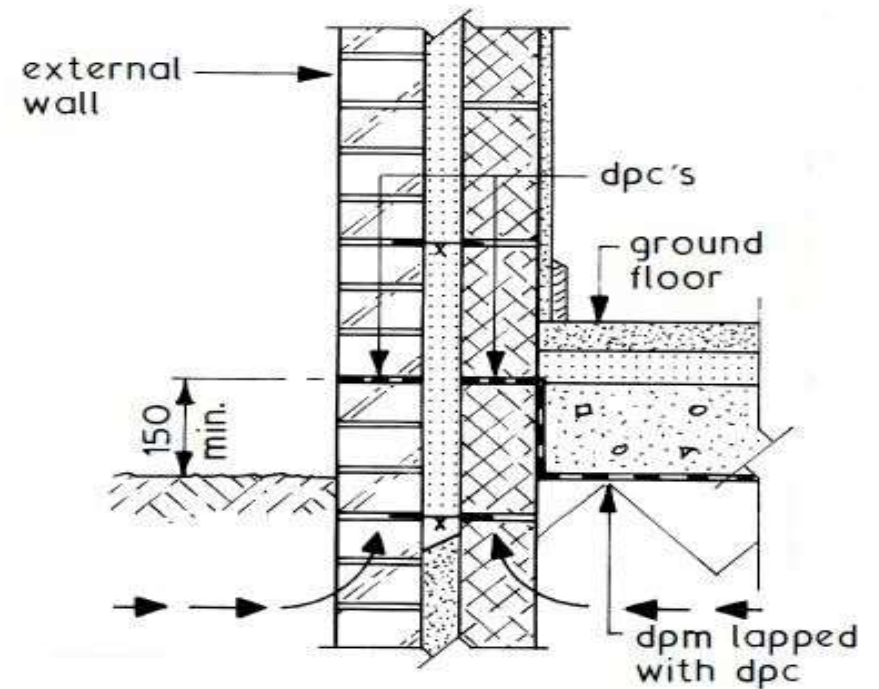
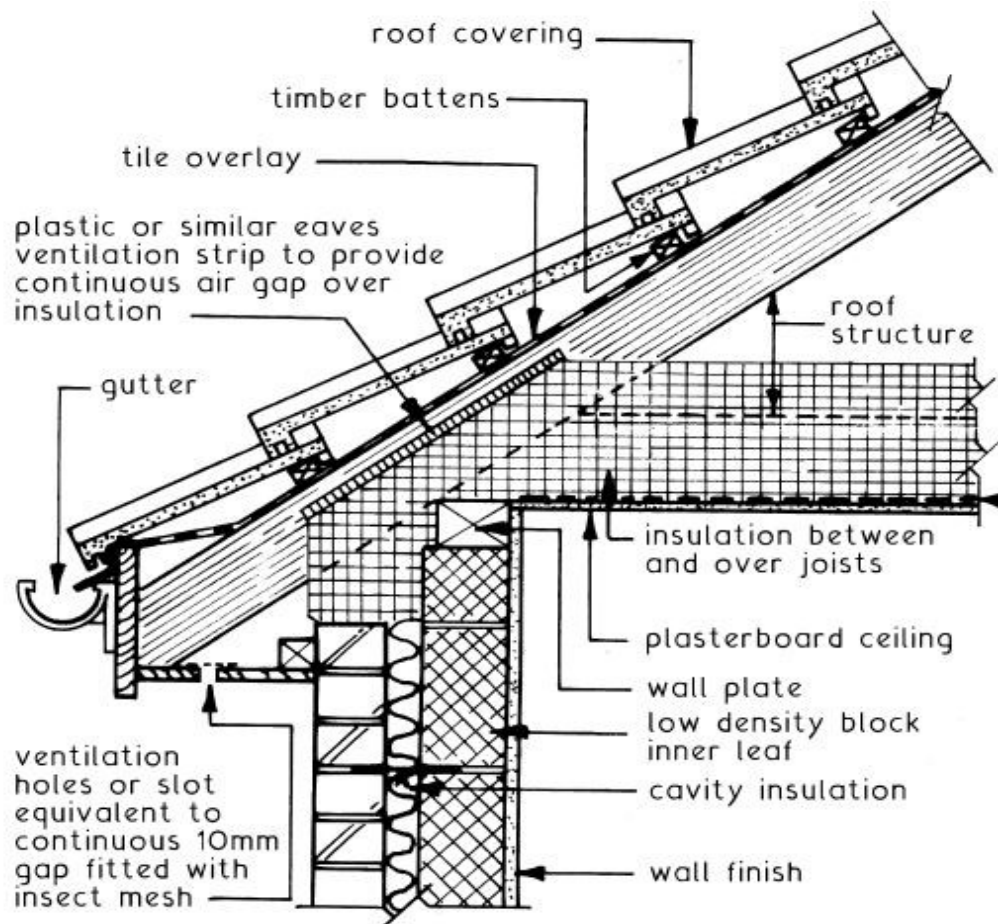
(dedicated lecture on Offsite)

Your sketches not images

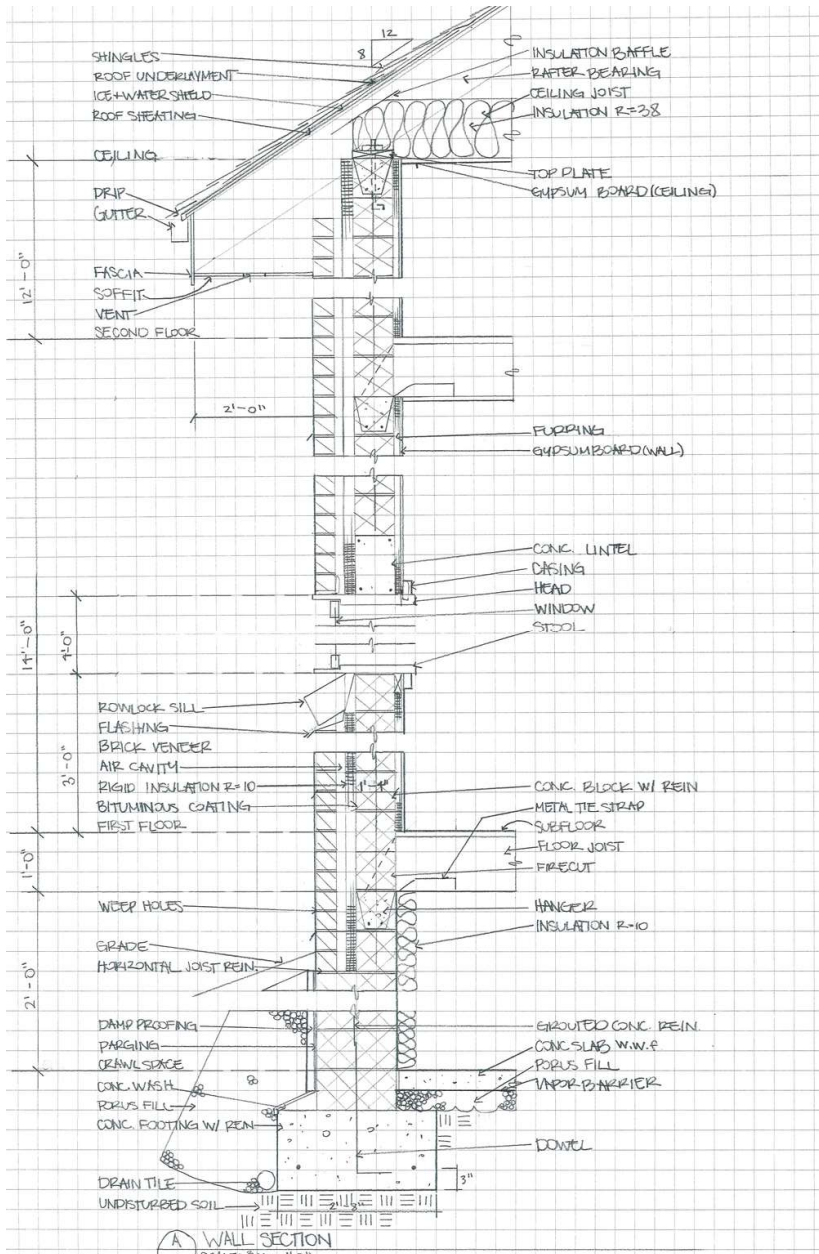
2. Produce neatly drawn, proportionate and suitably annotated sections and sketches that illustrate the materials and methods for the detailing of the following building elements and construction inter-faces. Ensure that detailing shows how the design will meet the current Building Regulations for a domestic new-build giving particular attention to thermal performance of the building fabric.

- i) Compare the Ground floor Construction, detailing and junctions with external walls for each method (30%)
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- iii) Compare eaves detailing and roof structure— indicating appropriate weathering, fixing and laps for each method (30%)
- iv) Recommend a construction method for the client, explain your reasoning. (5%)

Your sketches not images

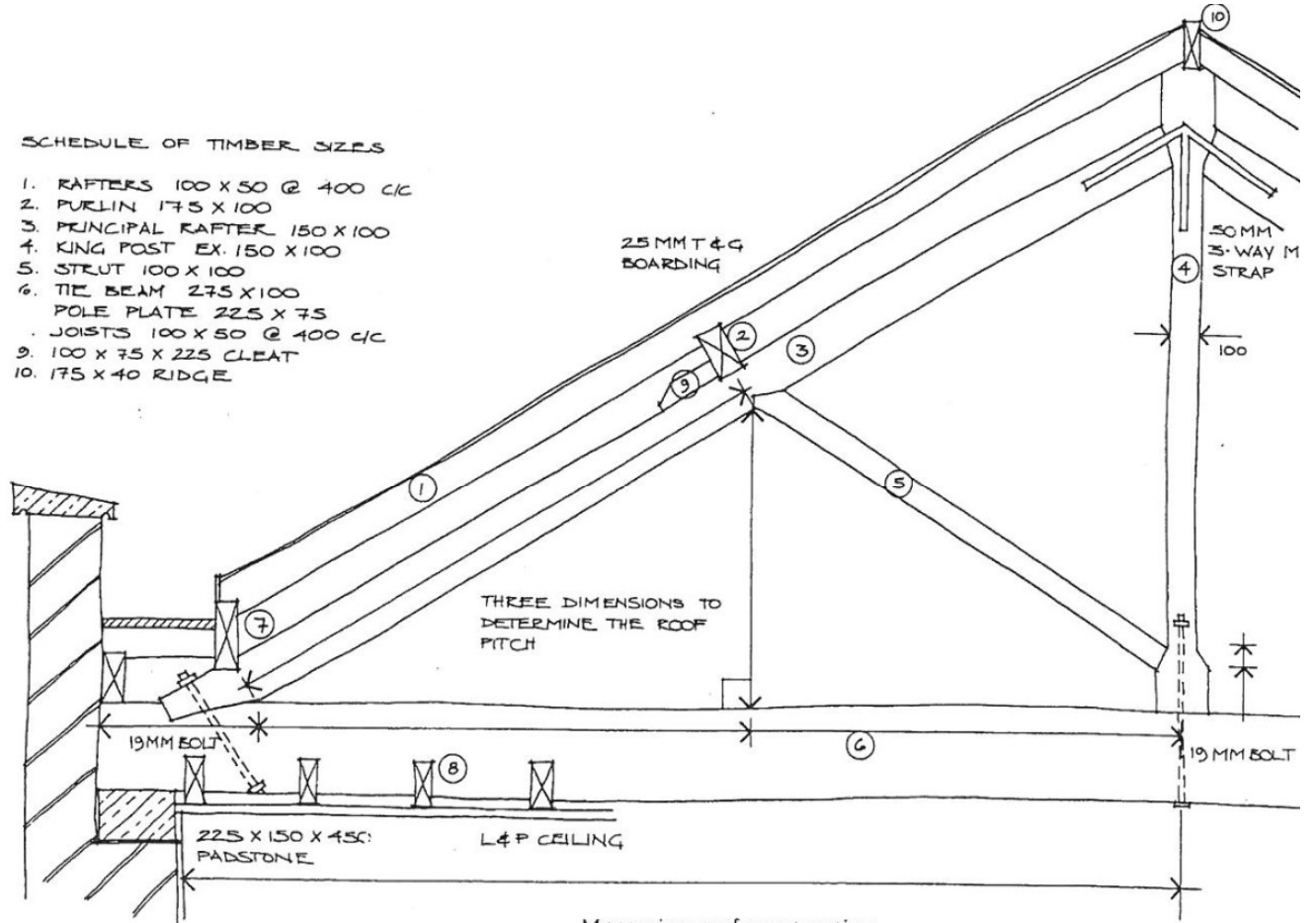


sketches not images



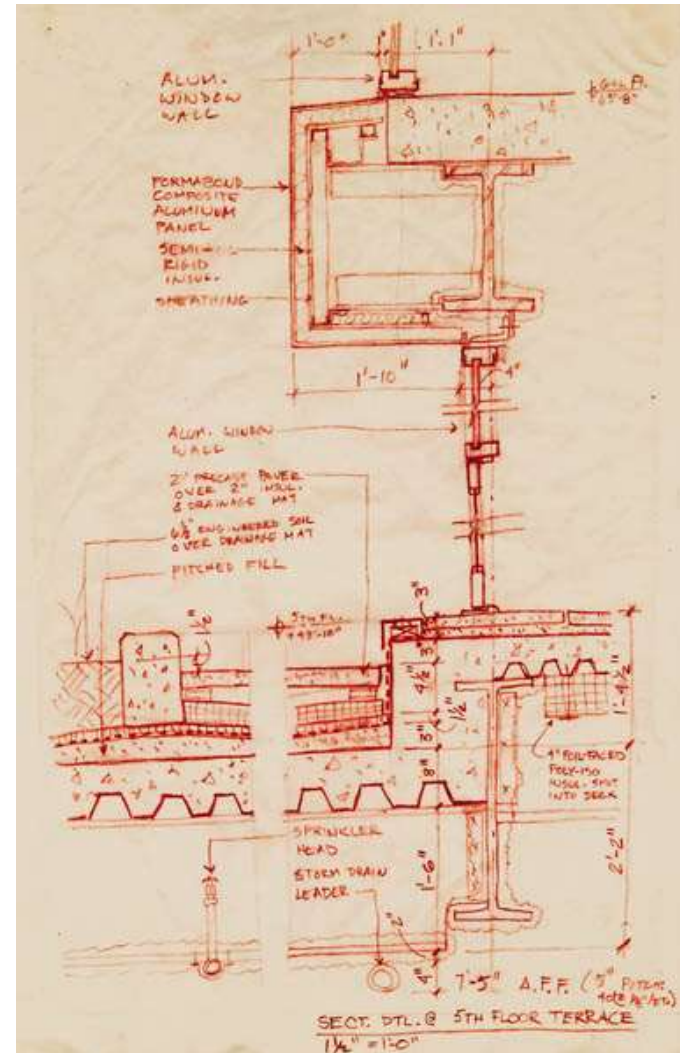
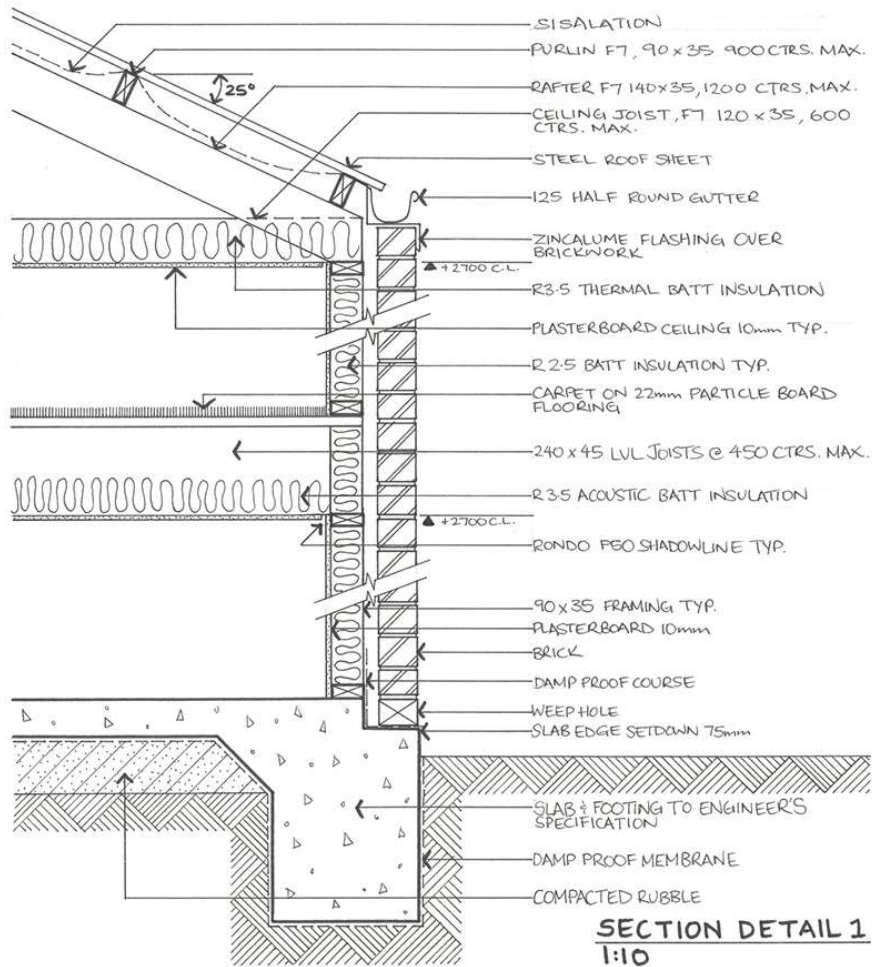
SCHEDULE OF TIMBER SIZES

1. RAFTERS 100 X 50 @ 400 C/C
2. PURLIN 175 X 100
3. PRINCIPAL RAFTER 150 X 100
4. KING POST EX. 150 X 100
5. STRUT 100 X 100
6. TIE BEAM 275 X 100
- POLE PLATE 225 X 75
7. JOISTS 100 X 50 @ 400 C/C
8. 100 X 75 X 225 CLEAT
10. 175 X 40 RIDGE

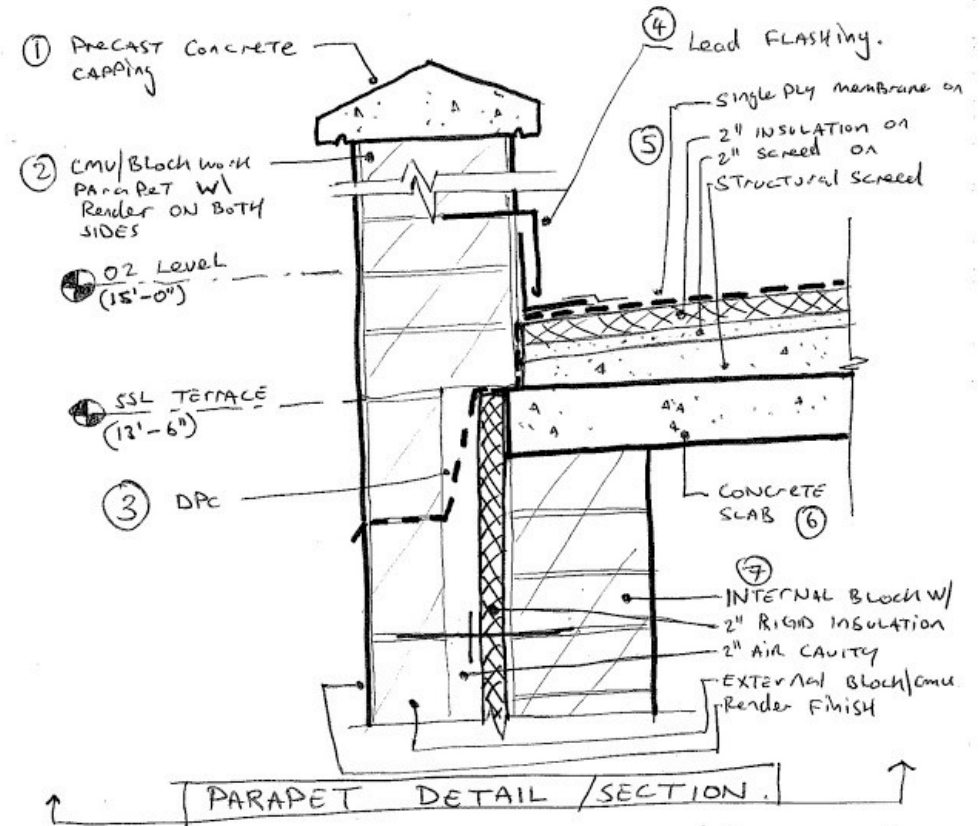
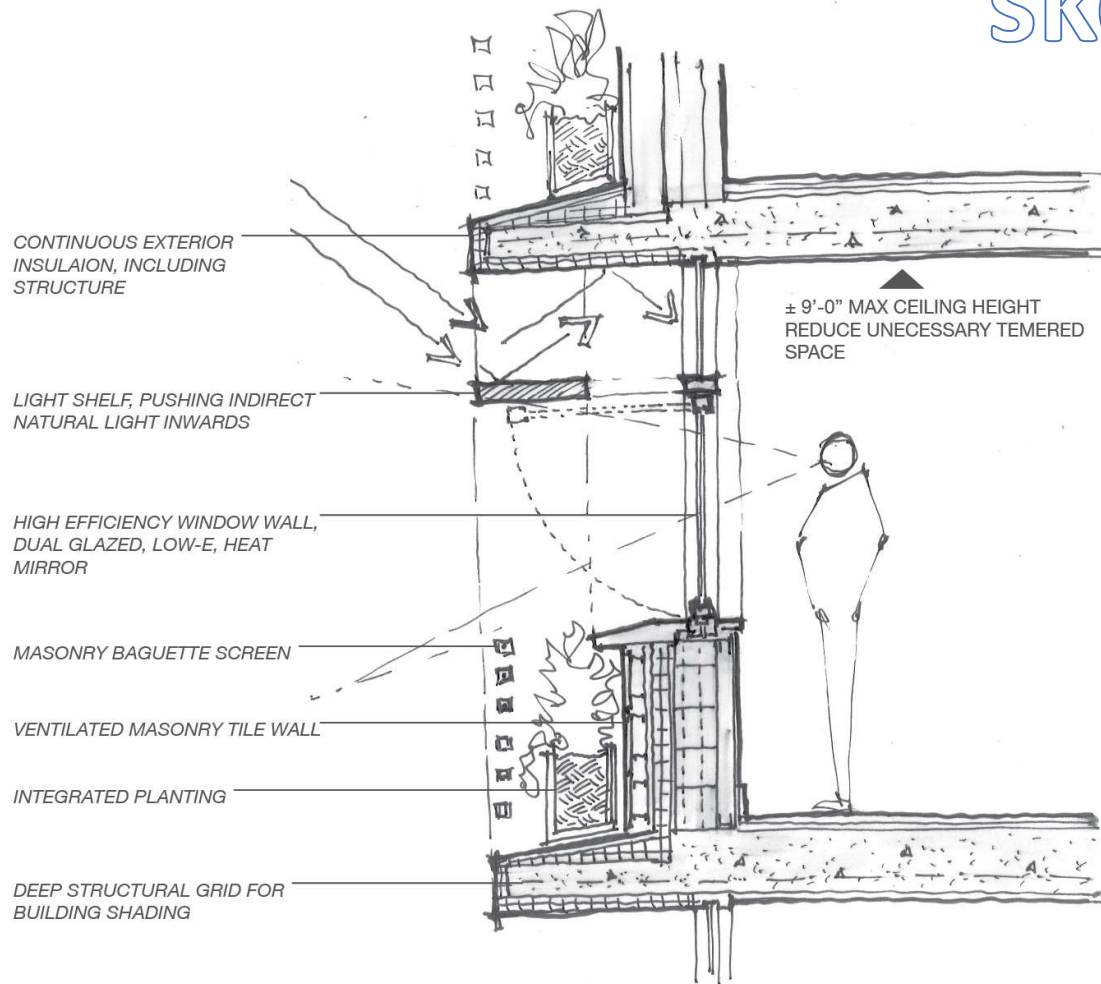


Measuring roof construction.

sketches not images



sketches not images





Ensure that detailing shows how the design will meet the current Building Regulations for a domestic new-build:

- i) Compare the Ground floor Construction, detailing and junctions with external walls for each method (30%)
- ii) Compare a detailed section and plan detail showing a window opening in the external wall for each method (30%)
- iii) Compare eaves detailing and roof structure– indicating appropriate weathering, fixing and laps for each method (30%)
- iv) Recommend a construction method for the client, explain your reasoning. (5%)

Compare and contrast

Text and Drawings

The use of buildings to house people, equipment and processes have resulted in the development of buildings that can control these internal environments with greater accuracy.

As well as protection and **enclosure** we can now consider:

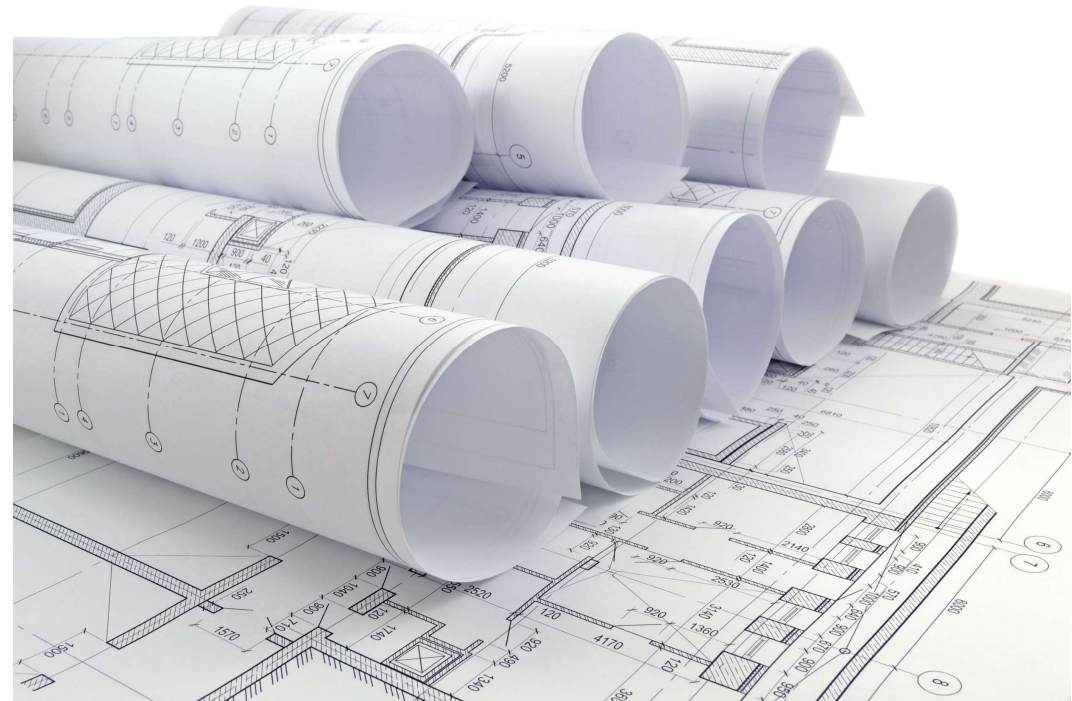
- Thermal Insulation and temperature control
- Acoustic insulation
- Provision of Light (natural and artificial)
- Controls for humidity and ventilation
- Exclusion of contaminants.



Performance Requirements of the Building Fabric

What are the key drivers in providing a building that is suitable for the need?

- Structurally Stable
- Durability
- Thermal insulation
- Protection from weather and exclusion of moisture
- Acoustic performance
- Flexibility to change to changing needs
- Aesthetics
- Buildability
- Sustainability

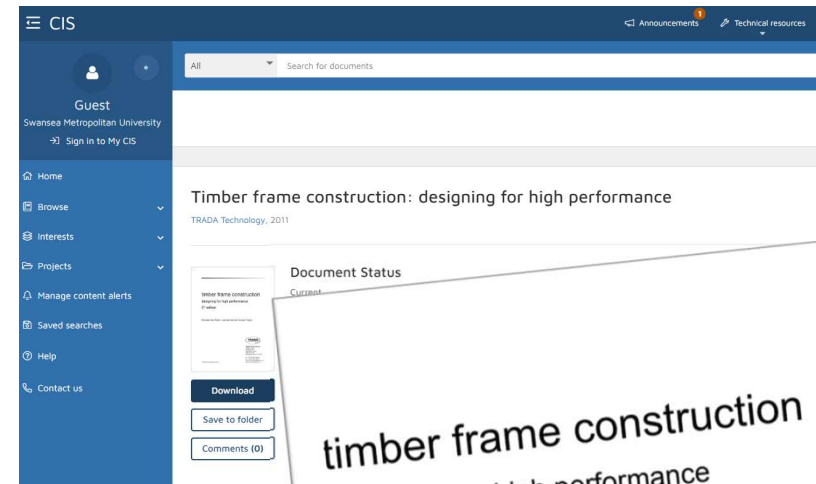
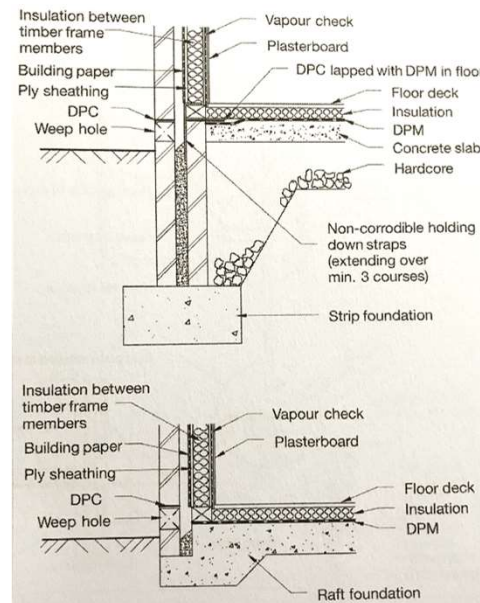
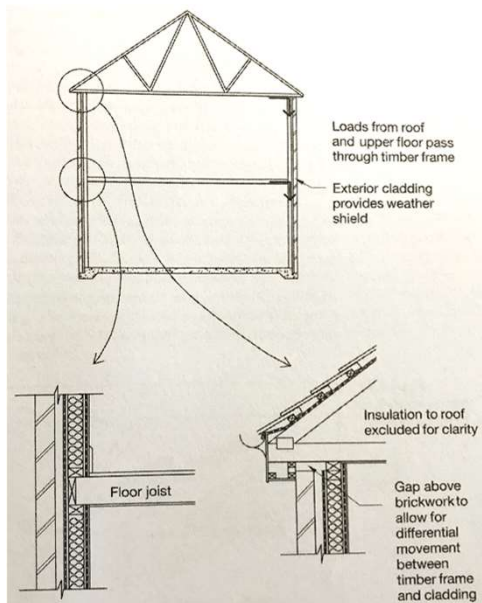


Class Exercise:
Construction Information
Service

Timber Frame Construction

Sources for Timber construction

<https://www.macmillanihe.com/companion/Riley-Construction-Technology-1/resources-zone/Chapter-07-Case-Study-2/>



timber frame construction
designing for high performance
5th edition

Revised by Robin Lancashire and Lewis Taylor



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book Construction technology. 1, House construction

Riley, Mike., Cotgrave, Alison., Third edition., Basingstoke, Hampshire : Palgrave Macmillan, 2013., Total Pages vii, 382 pages, 8 pages of unnumbered plates :



timber frame construction

designing for high performance

5th edition

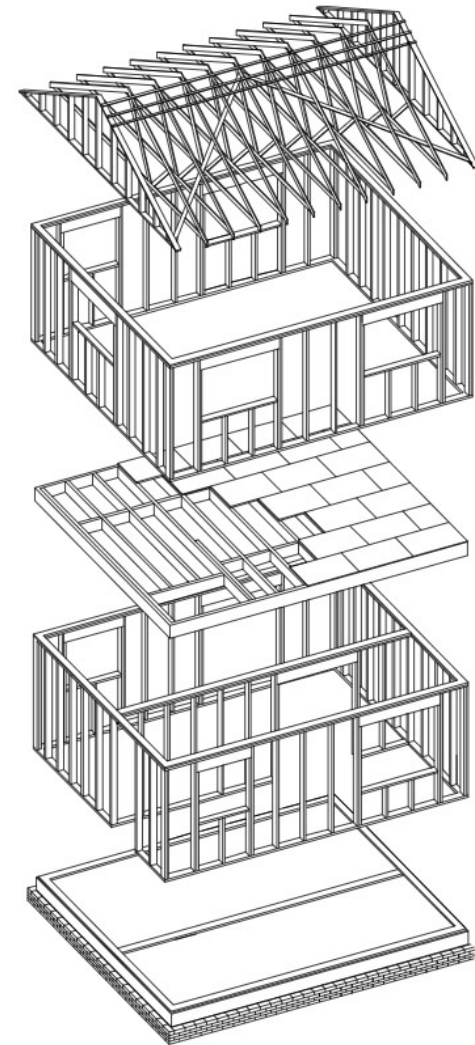
Revised by Robin Lancashire and Lewis Taylor



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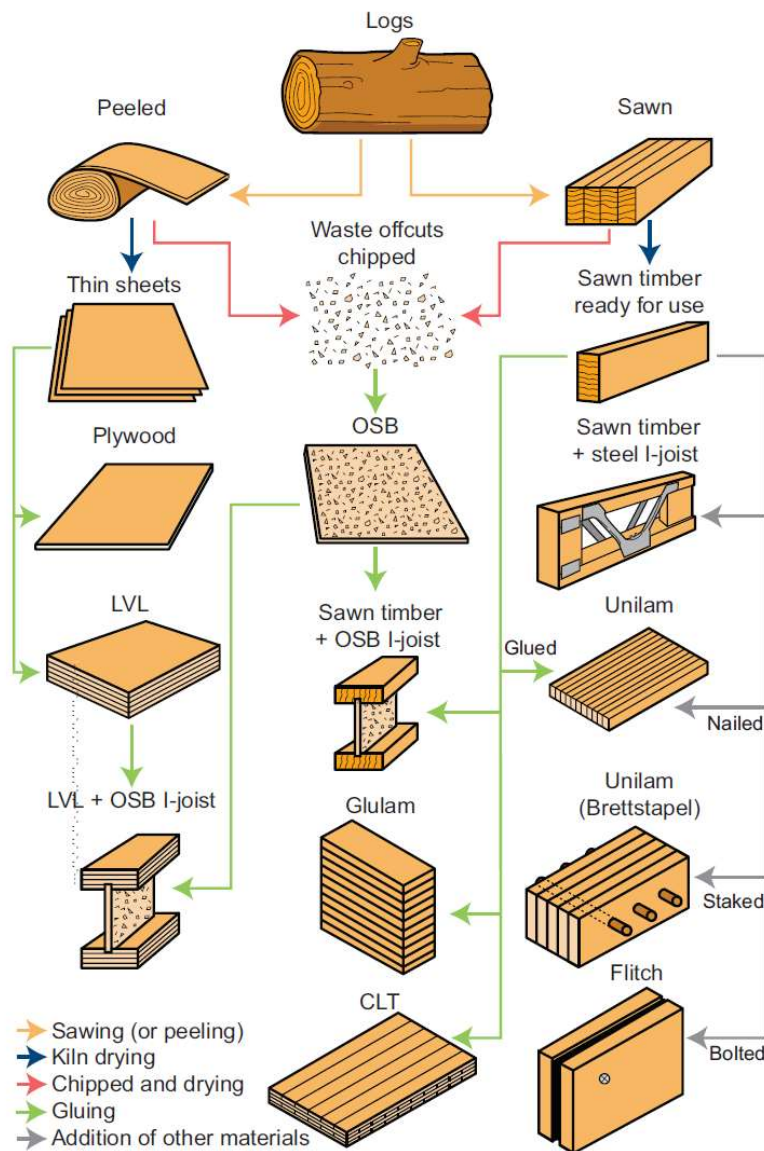


Figure 4.1: Processing from logs to products

4.3 Floor options

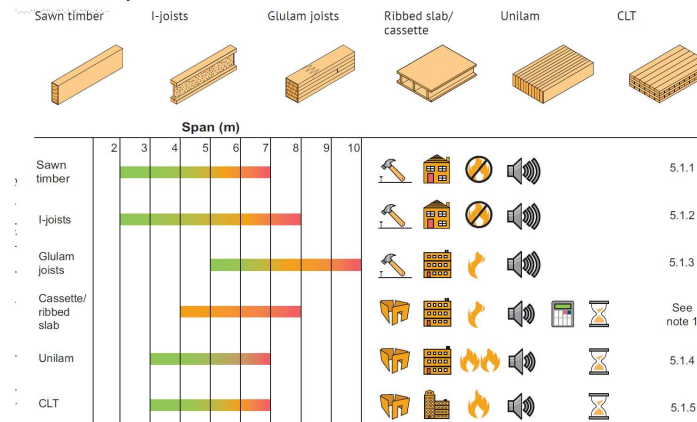


Figure 4.2: Floor options (see notes below)

4.4 Roof options

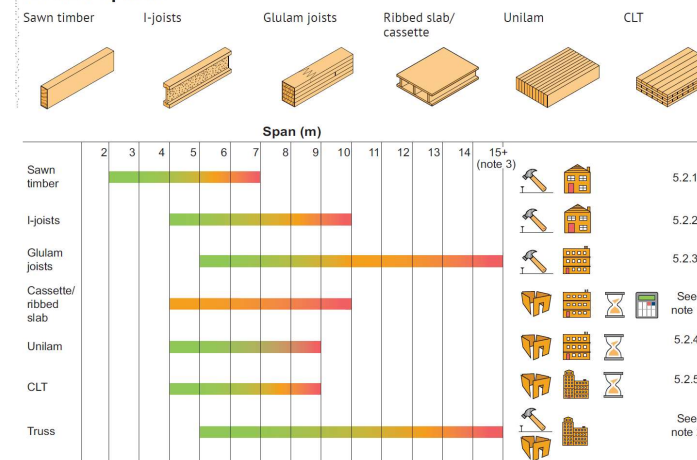
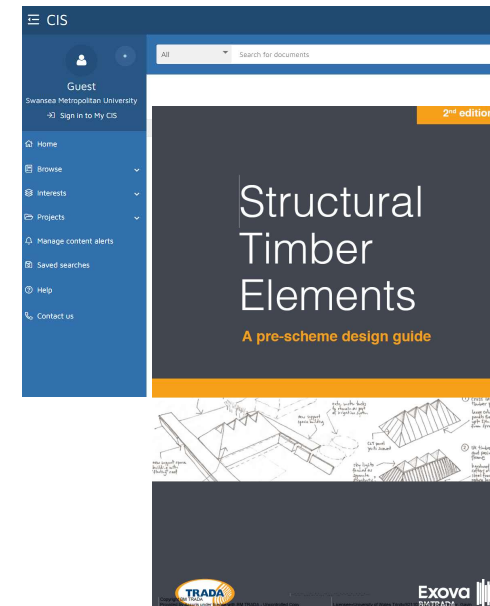


Figure 4.3: Roof options (see notes below)



Available from the library services via 'CIS' database



Ensure that detailing shows how the design will meet the current Building Regulations for a domestic new-build:



Thermal Insulation & U-Values

Introduction

Insulation products have developed significantly with technological advances.

Legislation has acted as the catalyst for development, from the basic requirements under the Building Regulations Part L, to compliance with government carbon reduction targets, driven through advanced programmes such as the Code for Sustainable Homes and BREEAM.

Specification of insulation products is often based upon the minimum requirement of the Building Regulations AD (Approved Document) Part L and their relationship with manufacturers performance data, and it has been suggested that legislation is driving the production of a range of products that 'just work', presenting little apparent difference between them.

BREEAM®



Wall U-value

Roof U-value

Floor U-value

Window/door U-value

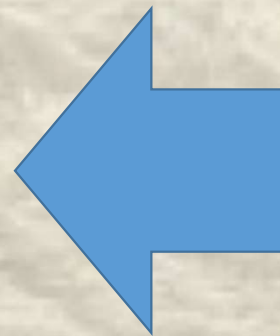
Thermal bridging value

Design air permeability

In order to specify insulation correctly however, the specifier needs to understand the reasons why it works, and apply the correct technology to any given construction detail.

In understanding more fully the processes that make insulation work, and indeed the factors that stop it from working, specifiers will be in a far stronger position to specify the correct material for the correct application.

The installed performance of an insulation product is reliant upon not only performance characteristics and the adherence of contractors to manufacturers and general best practice workmanship requirements, but also the suitability of the insulant specified to its installed location.



WHY?

November 2022 saw the latest release of Part L.

The new release saw the consolidation of Part L1A & L1B and Parts L2A & L2B into the new Volumes 1 (Dwellings) & Volume 2 (Buildings other than Dwellings)



Heat Transfer

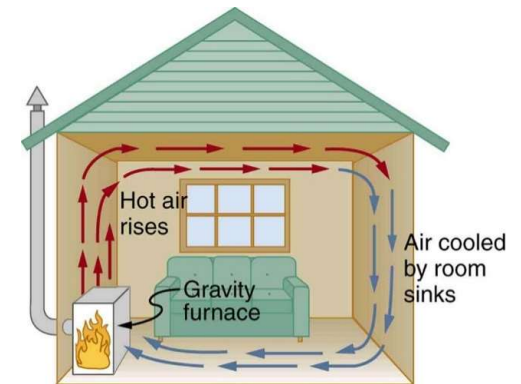
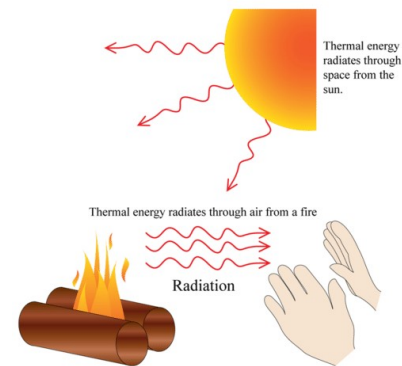


Heat Transfer

- **How insulation works**
- Insulation products are designed to frustrate the transfer of heat across the material itself. There are three methods of heat transfer: radiation, conduction and convection.

Heat transfer mechanisms include:

- Radiation.
- Convection.
- Conduction.



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Radiation

Any object whose temperature is higher than the surfaces that surround it will lose energy as a net radiant exchange.

Radiant heat can only travel in straight lines. Introduce a solid object between points A and B, and they will no longer directly exchange radiant heat.

Radiation is the only heat transfer mechanism that crosses vacuums.

Conduction

Conduction is reliant upon physical contact.

If there is no contact, conduction cannot take place.

Contact between two substances of different temperature results in a heat exchange from the higher temperature to the lower temperature substance.

The greater the temperature differential, the faster the heat exchange.

CONDUCTION

Heat energy is transferred through direct physical contact

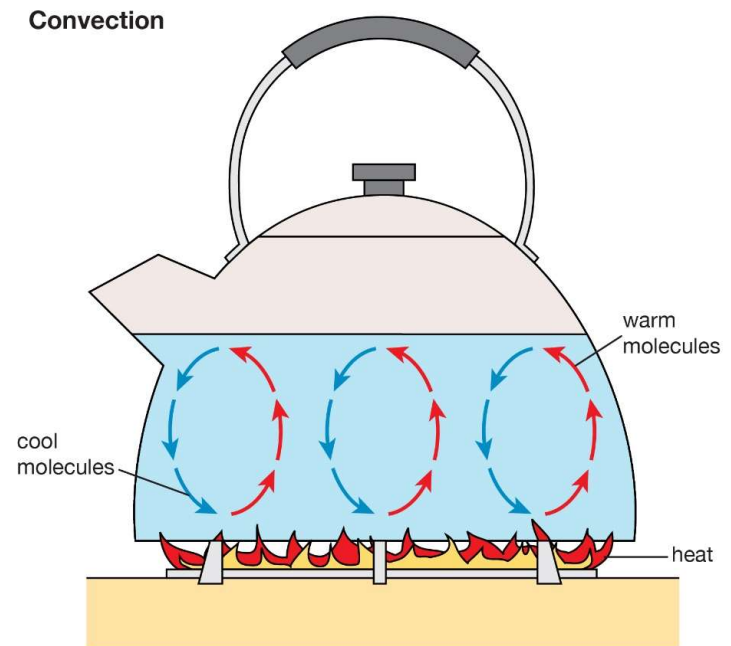


Convection

Convection is the transfer of energy via fluids (gases and liquids).

It is this method that plays the greatest role in the liberation and transfer of heat in buildings.

The most common propagation of this effect is from solid to gas, i.e. object to air, and then back again, typically as the air meets with the external building fabric.



**How does a
conventional Radiator
work?**



Performance

Insulation materials limit the flow of energy (heat) between two bodies that are not at the same temperature.

Greater insulation performance is directly attributable to the thermal conductivity of the insulant. That is, the rate at which a fixed amount of energy transfers across a known thickness of the material.

The direct inverse (reciprocal) of this measure is the material's thermal resistance, which measures the material's ability to resist the transfer of heat.



Thermal conductivity

Thermal conductivity, often referred to as the 'K' or ' λ ' (lambda) value, is a constant for any given material, and is measured in W/mK (watts per kelvin meter).

The higher the λ value, the better the thermal conductivity.

Good insulators will have as low a value as possible.

Steel and concrete have very high thermal conductivity and therefore very low thermal resistance. This makes them poor insulators.

Thermal resistance

Thermal resistance, referred to as the 'R' value of a material, is a product of thermal conductivity and thickness.

The R-value is calculated from the thickness of the material divided by its thermal conductivity and expressed in the units $\text{m}^2\text{K/W}$ (square metre kelvins per watt).

The greater the material thickness, the greater the thermal resistance.

U-value

In construction terms, while a U-value may be calculated and attributed to a single thickness of any material, it is more usual to calculate it as a product resulting from the assembly of different materials in any given form of construction.

It is a measure of the transmission of heat through a pre-determined area of the building fabric — this being 1 sq. m.

The unit measurements are therefore $\text{W/m}^2\text{K}$ (watts per square metre kelvin) and describe the heat transfer, in watts, through a square metre of a building element (such as a wall, floor or roof). This is used to calculate the heat transfer, or loss, through the building fabric.

For example, if a wall had a U-value of $1 \text{ W/m}^2\text{K}$ — with a temperature differential of 10° , there would be a heat loss of 10 watts for every square metre of wall area.

Typical values

U-values are measured in watts per square metre per degree Kelvin ($\text{W/m}^2\text{K}$).

For example, a double glazed window with a U-value of 2.8, for every degree difference in temperature between the inside and outside of the window, 2.8 watts will be transmitted every square metre.

A range of U-values are indicated below for the purposes of comparison only:

Solid brick wall: $2 \text{ W/m}^2\text{K}$.

Cavity wall with no insulation: $1.5 \text{ W/m}^2\text{K}$.

Insulated wall: $0.18 \text{ W/m}^2\text{K}$.

Single glazing: 4.8 to $5.8 \text{ W/m}^2\text{K}$.

Double glazing: 1.2 to $3.7 \text{ W/m}^2\text{K}$ depending on type.

Triple glazing below: $1 \text{ W/m}^2\text{K}$.

Solid timber door: $3 \text{ W/m}^2\text{K}$.

Common available insulation materials



INSULATION MATERIAL		THERMAL CONDUCTIVITY W/MK - LESS INDICATES BETTER PERFORMANCE	THERMAL RESISTANCE M2K/W - MORE INDICATE BETTER PERFORMANCE	U - VALUE W/M2K
Mineral Wool				
	Glass fibre	0.032 - 0.044	3.10 - 2.25	0.32 - 0.44
	Rock fibre	0.035 - 0.044	2.85 - 2.25	0.35 - 0.44
Sheep's wool		0.042	2.38	0.42
Expanded polystyrene (EPS)		0.036	2.77	0.36
Multi-foils		0.040	The nature of this insulant does not lend itself directly to direct comparison on thermal resistance or stand alone U-value	
Hemp		0.039	2.56	0.39
Extruded polystyrene (XPS)		0.029 - 0.036	3.44 - 2.77	0.29 - 0.36
Polyurethane foam board (PUR)		0.022 - 0.029	0.45 - 3.44	2.22 - 0.29
Polyisocyanurate foam board (PIR)		0.021 - 0.022	4.76 - 4.54	0.21 - 0.22
Phenolic foam board		0.021	4.76	0.21
Evacuated panels - 20mm thk		0.004	5.00	0.20
Aerogel board - 10mm thk		0.013	0.77	1.29

Thermal resistance figures are based 100mm thickness of insulation material

Thermal conductivity figures are typical for each material and may vary slightly between manufacturers

U - values shown indicate heat loss in watts / sq.m degree for insulation product alone

Part L of the Building Regulations (Conservation of fuel and power) now prevents certain forms of construction by setting limiting standards (i.e. maximum U-values) for building elements.

It should be noted however that these are maximum permitted values, the specification for the notional domestic building referred to in Part L1A has considerably lower values, for example:

External wall: $0.18 \text{ W/m}^2\text{K}$.

Floor: $0.13 \text{ W/m}^2\text{K}$.

Roofs: $0.13 \text{ W/m}^2\text{K}$.

Windows, roof windows, glazed rooflights and glazed doors: $1.4 \text{ W/m}^2\text{K}$.

In November 2022 the latest edition of Part L was revised to allow more flexibility in design for new and existing dwellings. The whole house approach is preferred over the elemental calculations as above.



New dwellings – Target fabric performance values

4.6 For a new dwelling, it must be demonstrated that the target fabric performance values have been met. The calculated fabric performance values for the new dwelling must be entered into the [Standard Assessment Procedure](#). For new dwellings, in order to demonstrate compliance with regulation 26B, the [fabric performance values](#) must be as good as or better than the worst acceptable values set out in Table 4.1.

Existing dwellings

4.7 New fabric elements in existing dwellings (such as those constructed as part of an extension) should meet the limiting standards in Table 4.1.

4.8 The U-value of a replacement fabric element in an existing dwelling should both:
a. be no worse than that of the element being replaced
b. meet the limiting standards in Table 4.1.

4.9 Further guidance for existing dwellings in relation to renovated and retained thermal elements, extensions and [consequential improvements](#) is given in [Sections 10, 11 and 12](#).

Table 4.1 Worst acceptable fabric performance values

Element type	Maximum U-value W/(m ² .K) ¹	
	In new dwellings	In existing dwellings
Roofs ²	0.13	0.13 ¹³
Wall – Dwelling Houses	0.18	0.18
Wall – Flats	0.21	0.21
Floor	0.15	0.15 ^{10,14}
Party wall	0.20	0.20
Swimming pool basin ³	0.25	0.25
Window or roof window ^{4,5}	1.4	1.4 ¹¹ or minimum WER ⁸ Band B
Roof-light ^{6,7}	2.2	2.2

Doors: >60% internal face glazed All other doors	1.4	1.4 ¹² or minimum DER ⁸ Band B
	1.4	1.4 ^{12,12} or minimum DER ⁸ Band C
Air Permeability	8.0 m ³ / (h.m ²)@50Pa OR 1.57m ³ /(h.m ²)@4Pa	N/A

Notes:

- Area-weighted average values (except for windows, doors, roof windows and rooflights).
- For dormer windows, 'roof' includes the roof parts of the windows, and 'wall' includes the wall parts (cheeks).
- The U-value of a swimming pool basin (walls and floor) calculated according to **BS EN ISO 13370**.
- If other performance needs (e.g. wind load, safety, security or acoustic attenuation require thicker glass to be used, an equivalent window unit with standard thickness (6mm) glazing should be shown to meet the required standard.
- Including roof windows and curtain walling
- U-values for rooflights or rooflight-and-kerb assemblies should be based on the developed surface area for the rooflight (U_d-values), which is often greater than the area of the roof opening. Further guidance on U_d-values is given in the Building Research Establishment's BR 443 and the National Association of Rooflight Manufacturers' Technical Document NTD02.
- The limiting value for rooflights also applies to kerbs that are supplied as part of a single rooflight-and-kerb assembly sourced from the same supplier and for which the supplier can provide a combined U_d-value for the assembly. An upstand built on site should exceed a U-value of 0.35W/(m².K).
- The methods for calculating Window Energy Rating and Doorset Energy Rating are set out in the Glass and Glazing Federation's Glazing Manual Data Sheet 2.3, Guide to the Calculation of Energy Ratings for Windows, Roof Windows and Doors.
- For external fire doorsets, as defined in Appendix A of Approved Document B, Volume 1, a maximum U-value of 1.8W/(m².K) is permissible.
- The U-value of the floor of an extension can be calculated using the exposed perimeter and floor area of the whole enlarged dwelling.
- For timber windows, a maximum U-value of 1.6 W/(m².K) or Window Energy Rating Band C is permissible where a building notice or an initial notice has been given to, or full plans have been deposited with, a local authority, in respect of that building, before 23 November 2023, to allow manufacturers additional time to transition to the full standard of 1.4 W/(m².K) or Window Energy Rating Band B.
- For timber doors, a maximum U-value of 1.8 W/(m².K) or Doorset Energy Rating Band E is permissible where a building notice or an initial notice has been given to, or full plans have been deposited with, a local authority, in respect of that building, before 23 November 2023, to allow manufacturers time to transition to the full standard of 1.4 W/(m².K).
- If there are problems with the load-bearing capacity of the frame or height of the upstand, for a flat roof or roof with integral insulation, a lesser standard may be appropriate.
- If meeting such a standard would create significant problems in relation to adjoining floor levels, a lesser standard may be appropriate.

Calculation

The U value of an **element** (in W/m²K) can be calculated from sum of the thermal resistances (R-values in m²K/W) of the layers that make up the element plus its inside and outside surface thermal resistances (R_i and R_o).

$$U\text{-value} = 1 / (\Sigma R + R_i + R_o)$$

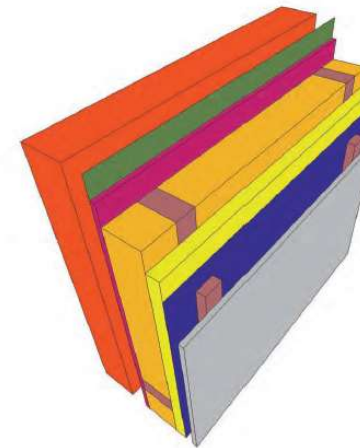
Where the thermal resistance of the layers of the element $R = \text{the thickness of each layer} / \text{the thermal conductivity of that layer (its k-value or lambda value } (\lambda) \text{ in W/mK)}$.

Note: Direction of heat flow must be considered (upwards / horizontal / downwards)

U-VALUE CONVENTIONS IN PRACTICE

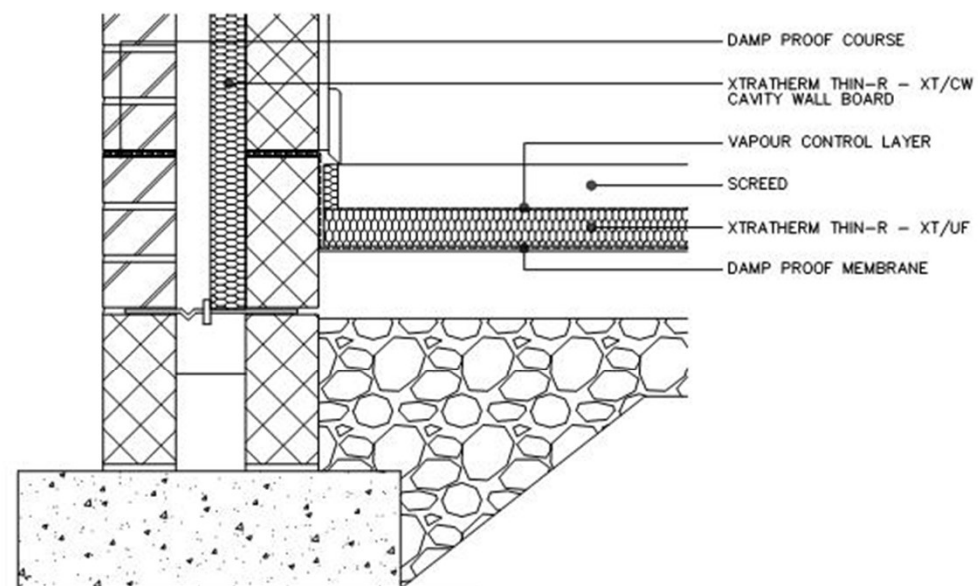
Worked examples using BR 443

Sean Doran



brepress

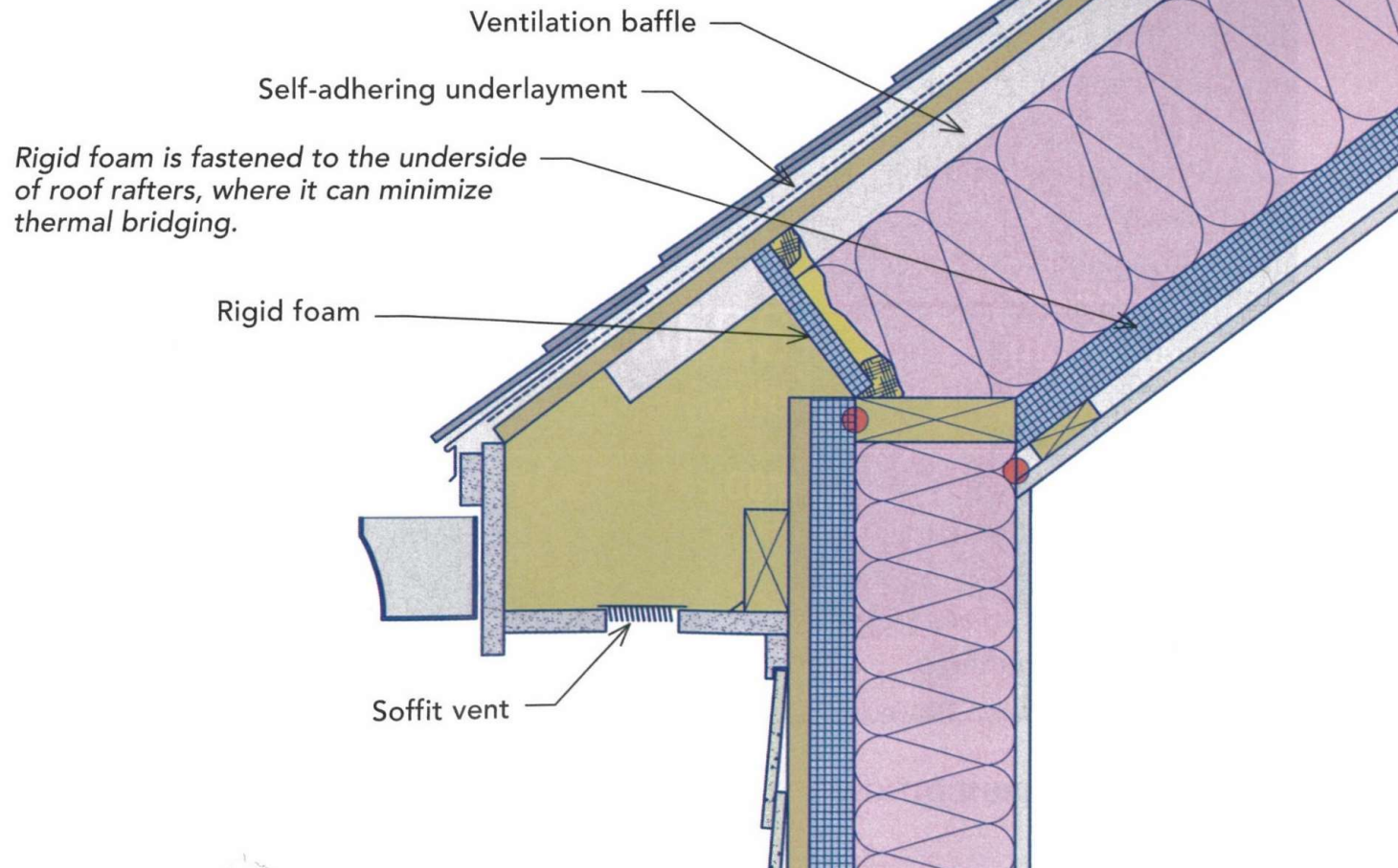
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XTRATHERM
WALL/FLOOR INTERSECTION DETAIL
XTCWFJSC

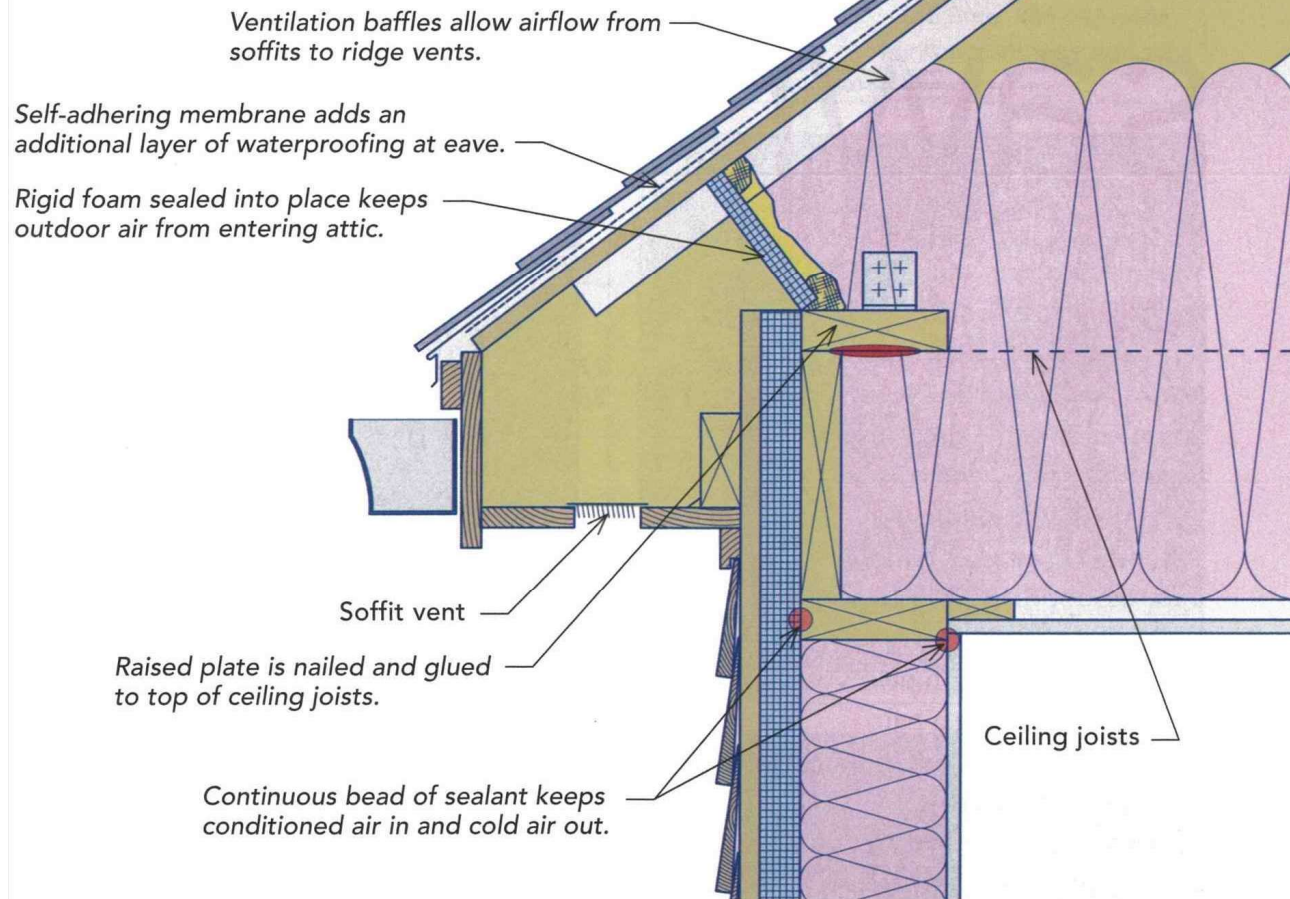
Rigid foam makes cathedral ceilings possible

A vented cathedral ceiling is difficult to insulate well enough for cold climates without rigid foam installed on the underside of roof rafters. Not only does the rigid foam add necessary R-value, but taping the seams also helps to prevent air leakage. As with a flat ceiling, block between the rafters with rigid foam, and make sure the cavity insulation covers the top plate.



Raised plates allow deeper insulation

When rafters bear on the exterior wall's top plate, there is little room for insulation at the eave. A raised plate sits on top of the ceiling joists and allows deeper attic insulation. (Similarly, raised-heel trusses are a good option.) Make sure the insulation covers the plate, and use a piece of rigid foam beneath the ventilation baffle to prevent airflow into the attic.





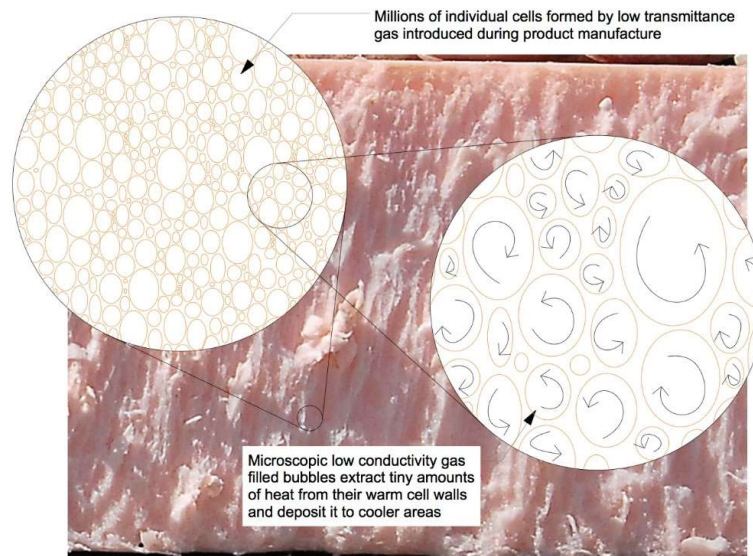


Types of Insulation

Thermal insulation materials have a low thermal conductivity which serves to limit the flow of heat energy between one side of the insulation and the other.

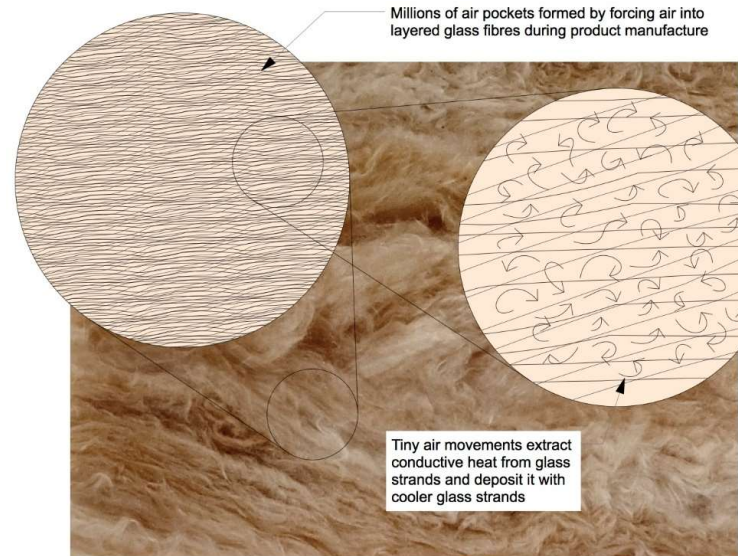
In the build environment, thermal insulation is typically used to reduce the passage of heat between the inside of a building and the outside.

There are many different types of insulation, which vary in terms of colour, surface finish texture, core composition and performance. Very broadly however, they tend to be open cell or closed cell.



Closed cell insulation - extruded polystyrene

Temperature gradient across insulation



Open cell insulation - glass wool

Temperature gradient across insulation



Open cell insulation allows the passage of air through air pockets, but the route is so complex that effectively, no air will pass from one side to the other, and so heat transfer by convection is prevented.

Closed cell insulation is formed by bubbles of gas whose thermal conductivity is very low.

Blanket insulation (also called matting insulation)

This is generally the easiest to install and is commonly used as roof insulation. It typically comes in foil-backed rolls which can be placed between joists or rafters, and may be held in place by timber battens attached to and across the joists or rafters.

It is usually made of mineral or glass wool but can also be made from plastic fibres, and natural fibres such as cotton and sheep's wool. The depth of blanket-style insulation varies depending on the exact composition and the performance required, but it is typically in the range of 100-200 mm.



Mineral wool

Mineral wool generally refers to fibre materials that are formed by spinning or drawing molten minerals. It can be manufactured in various thicknesses and widths and is often supplied in rolls.

Sheep's wool

This type of insulation has the benefit of being 'sustainable', and offers an effective alternative to other synthetic types of insulation. It is increasingly being used between roof beams, under floors and in solid walls. It is often treated to make it more fire and insect resistant.

Glass wool

This type of insulating material consists of glass fibres arranged using a binder into a wool-like texture. Glass wool can be produced in a variety of ways, such as in rolls, slabs, applied in place, or sprayed.



Foam boards

These are rigid panels of insulation which are cut and fitted in place.

Most commonly they are made from polystyrene, polyisocyanurate, and polyurethane, and may be fitted to a depth of around 175 mm. They are used predominantly where there is weight that needs support, i.e. under a floor or in a loft.

The benefits of foam boards are that they are durable and can also provide acoustic insulation.





Radiant barriers

These inhibit heat transfer by thermal radiation. They are capable of being stapled to the underside of rafters.

They are more effective in hot climates, where reduced heat gain may allow for smaller air conditioning systems.

In cool climates, installing more thermal insulation it is usually more cost effective. The thickness of a radiant barrier is usually between 3-5 mm.

Blown-in insulation

This involves mineral fibres being blown into a void in the space that needs insulating. Although requiring specialist equipment, it is quick to install and can be effective for spaces with limited access, such as gaps between roof joists or cavity walls.

The most common materials that are used include cellulose, fibre glass and mineral rock wool.





Spray foam insulation

Typically, spray foam is formed of polyurethane and is sprayed as a liquid which gradually expands to up to 100 times its original volume.

Once set, it creates an effective thermal and noise insulating layer.

Slow-curing foams can be used for cavity walls as they will flow around any obstructions before hardening. As spray foam can produce dangerous fumes and damage the structural integrity of the building if applied incorrectly, professional installation is recommended.

U-Value Calculator Tool – Online Insulation Calculator

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U-Value Calculator

Our U-value calculator is a free, online tool designed to help specifiers, selfbuilders and construction stakeholders to calculate U-values for their individual projects using ROCKWOOL stone wool insulation.

[Access U-Value Calculator](#)

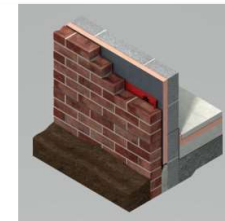
Kingspan Insulation Calculation Service



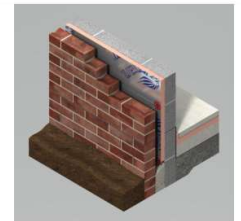
U-value Calculator

Choose a construction below to get started. The U-values in this application are calculated according to BS EN ISO 6946:2017 and BS

Wall



Cavity Wall - Near Full Fill



Cavity Wall - Partial Fill (total cavity greater than 175mm)

Summary:

Queries on the Assessment

Timber Frame Construction Sources

U Values

