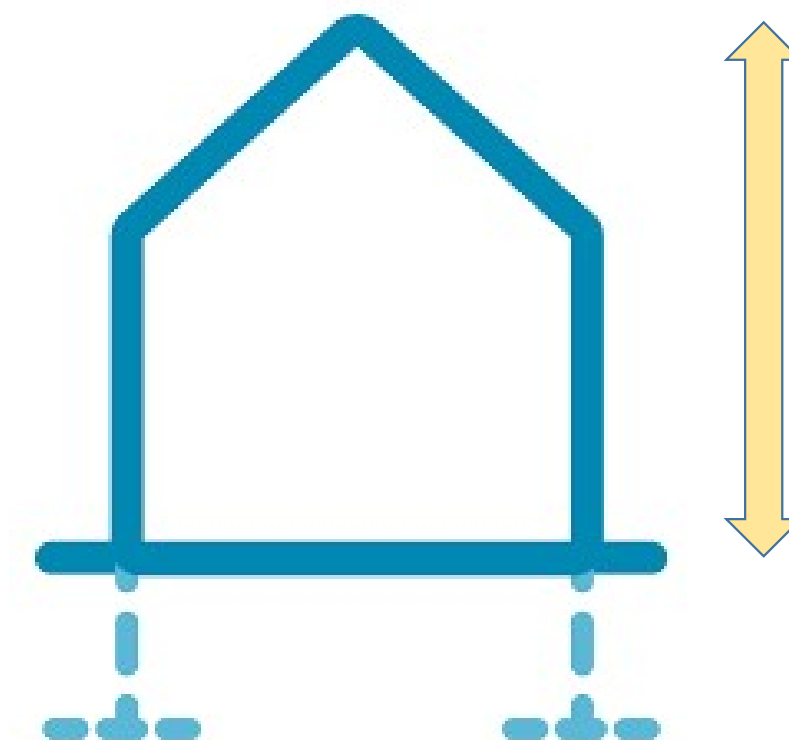
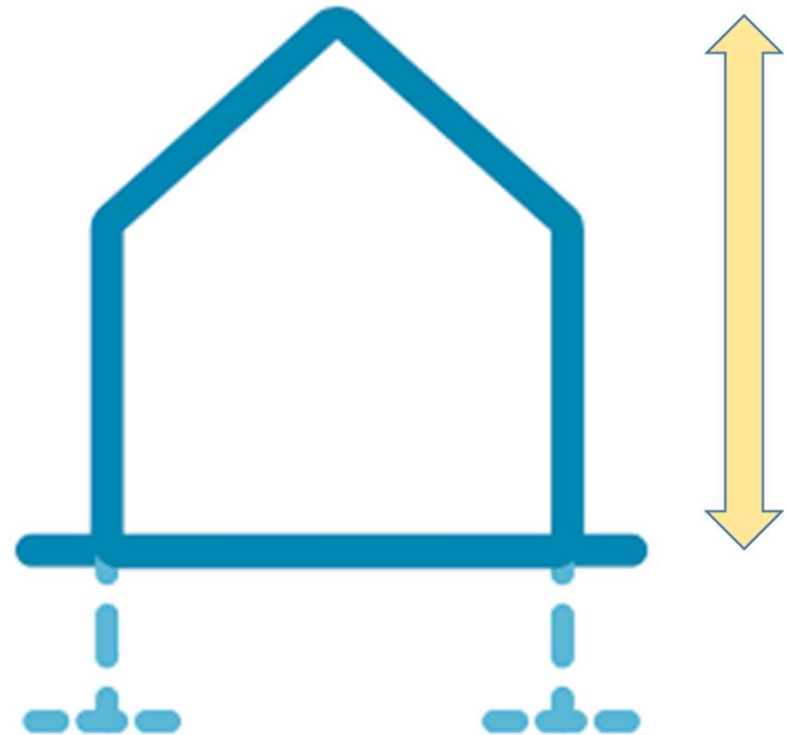


Superstructure : Fundamentals of Construction Technology



Week 3:

Assessment
Roof Construction



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

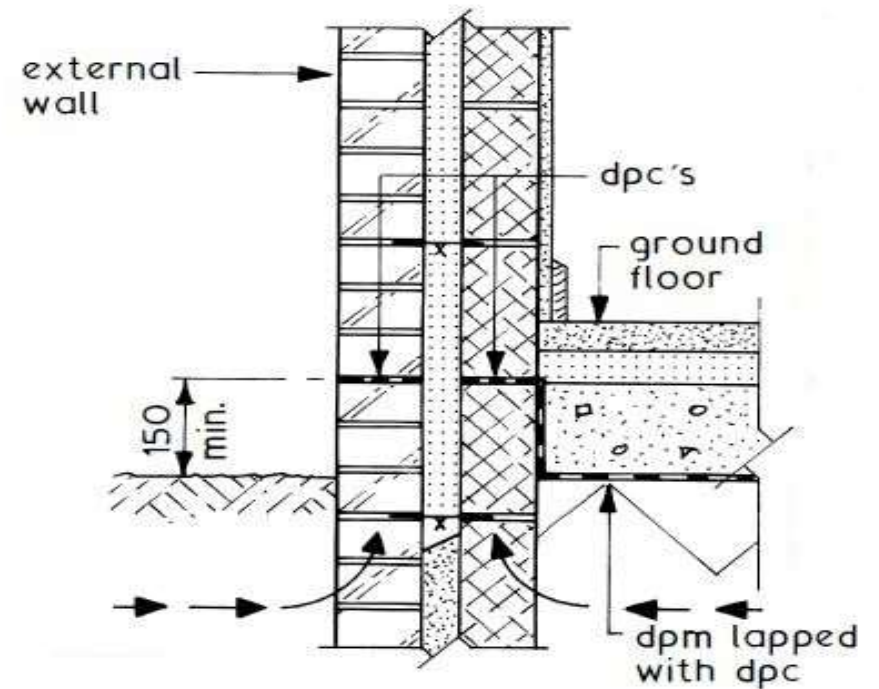
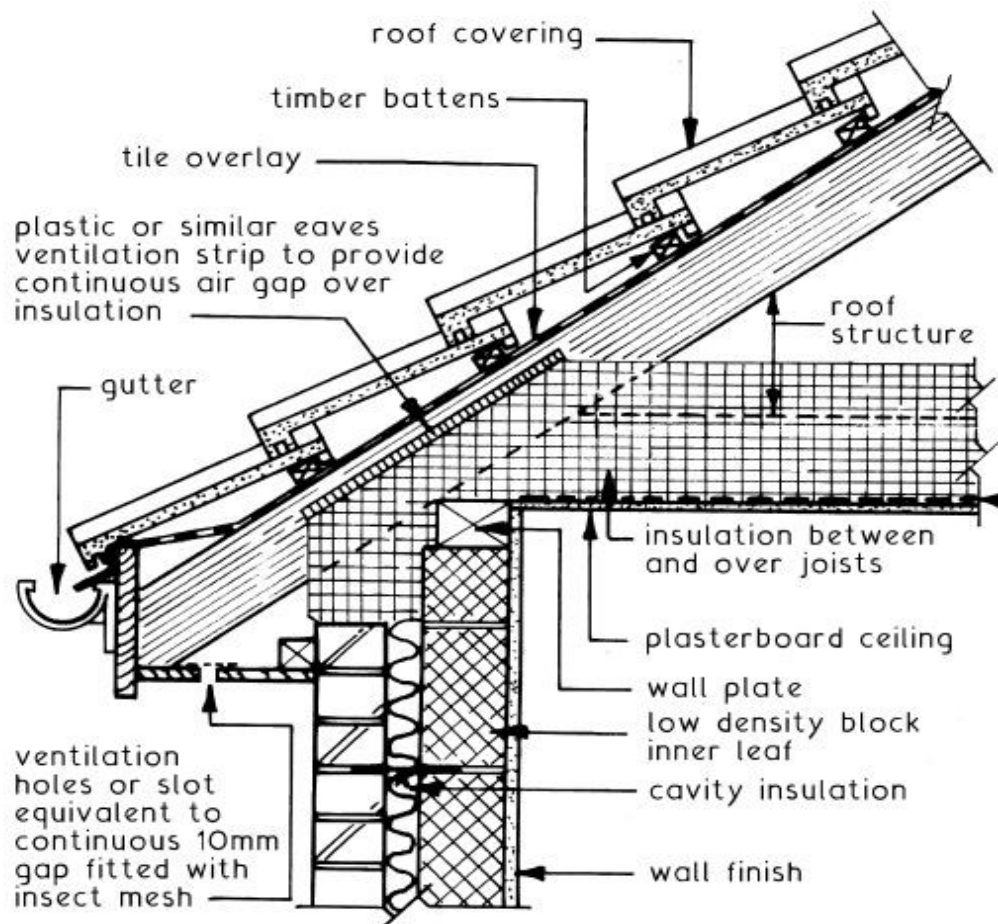
(dedicated lecture on Offsite)

Your sketches not images

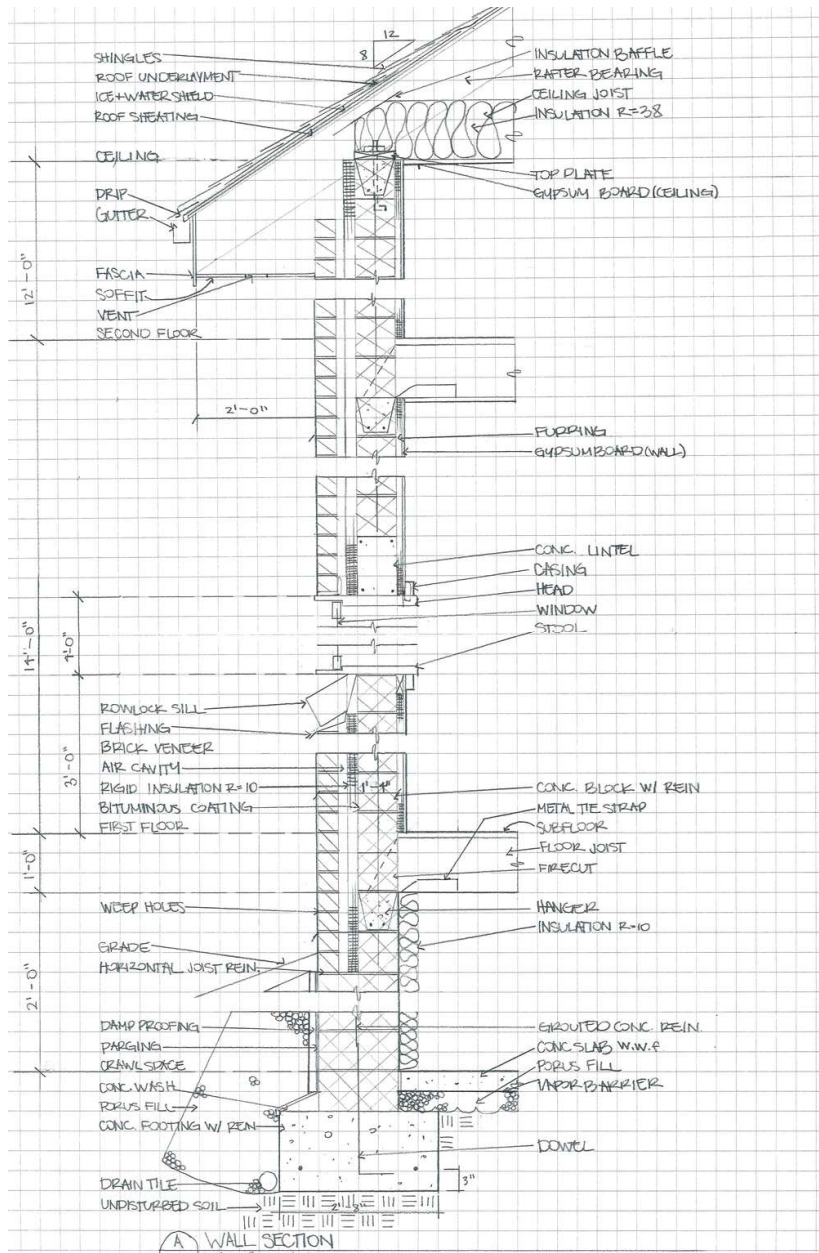
2. Produce neatly drawn, proportionate and suitably annotated sections and sketches that illustrate the materials and methods for the detailing of the following building elements and construction inter-faces. Ensure that detailing shows how the design will meet the current Building Regulations for a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

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Your sketches not images

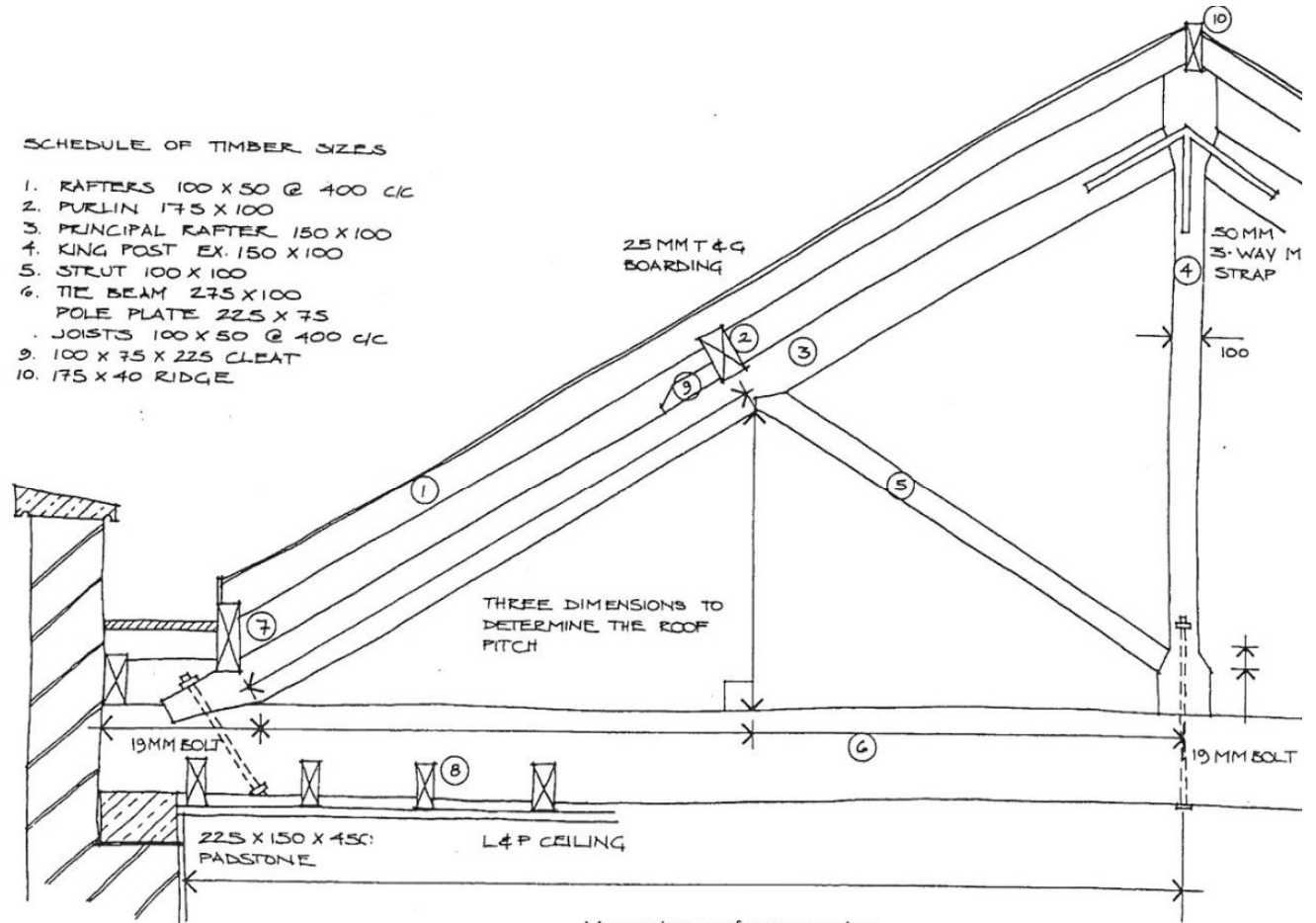


sketches not images



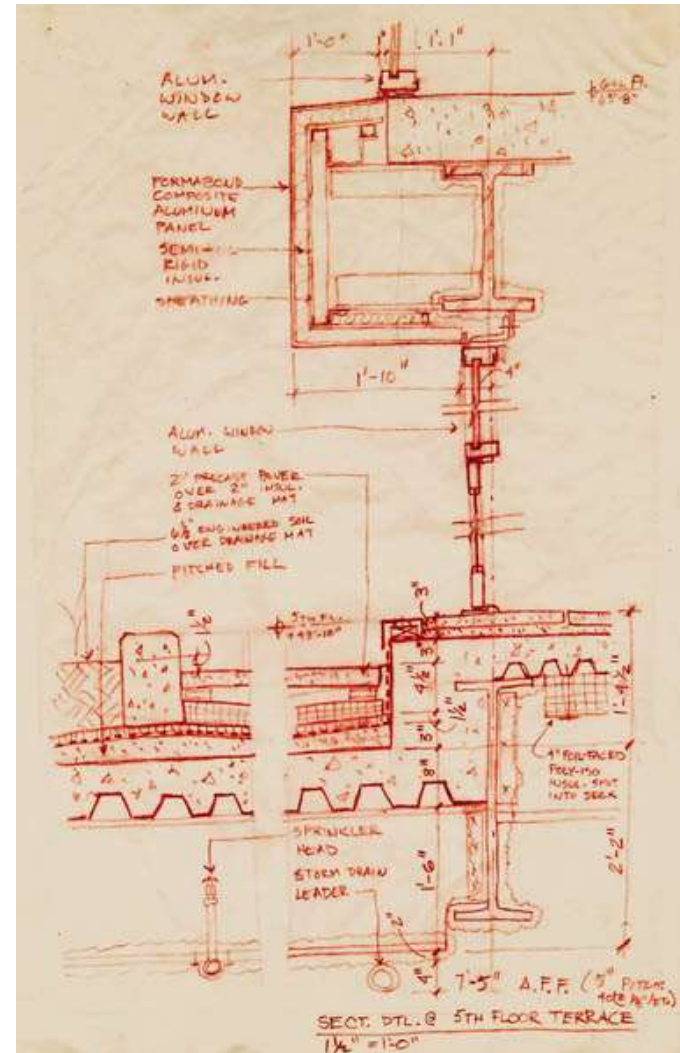
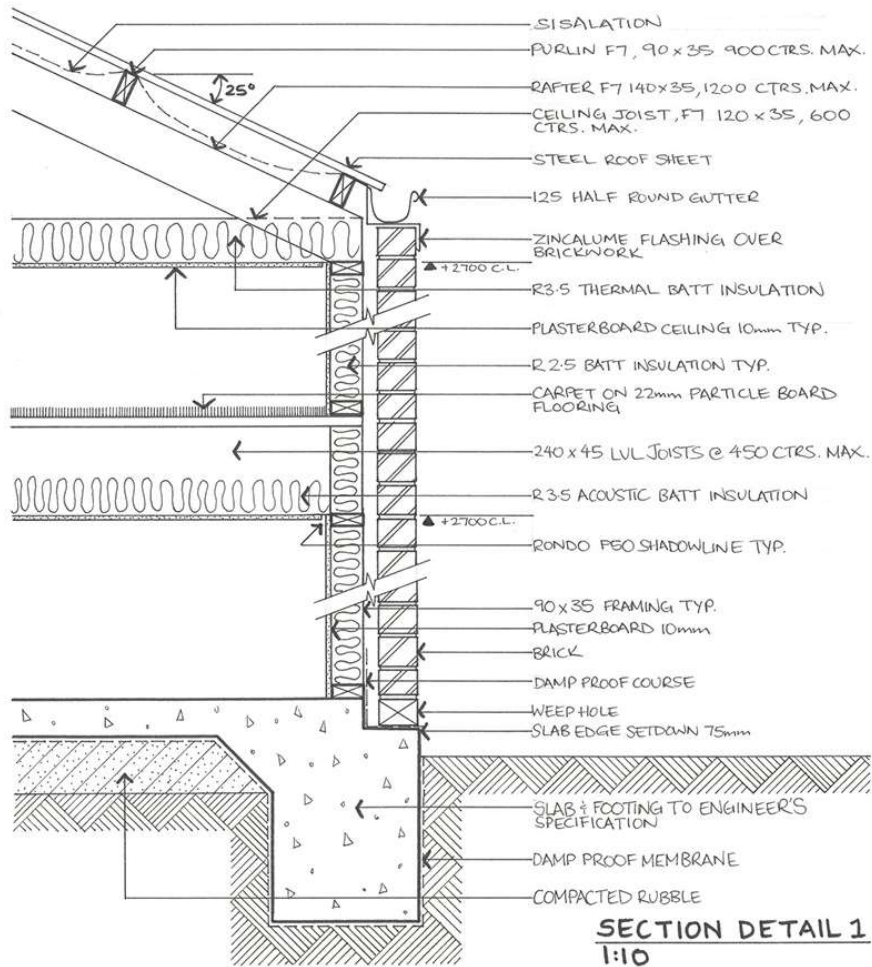
SCHEDULE OF TIMBER SIZES

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
- JOISTS 100 X 50 @ 400 C/C
9. 100 X 75 X 225 CLEAT
10. 175 X 40 RIDGE

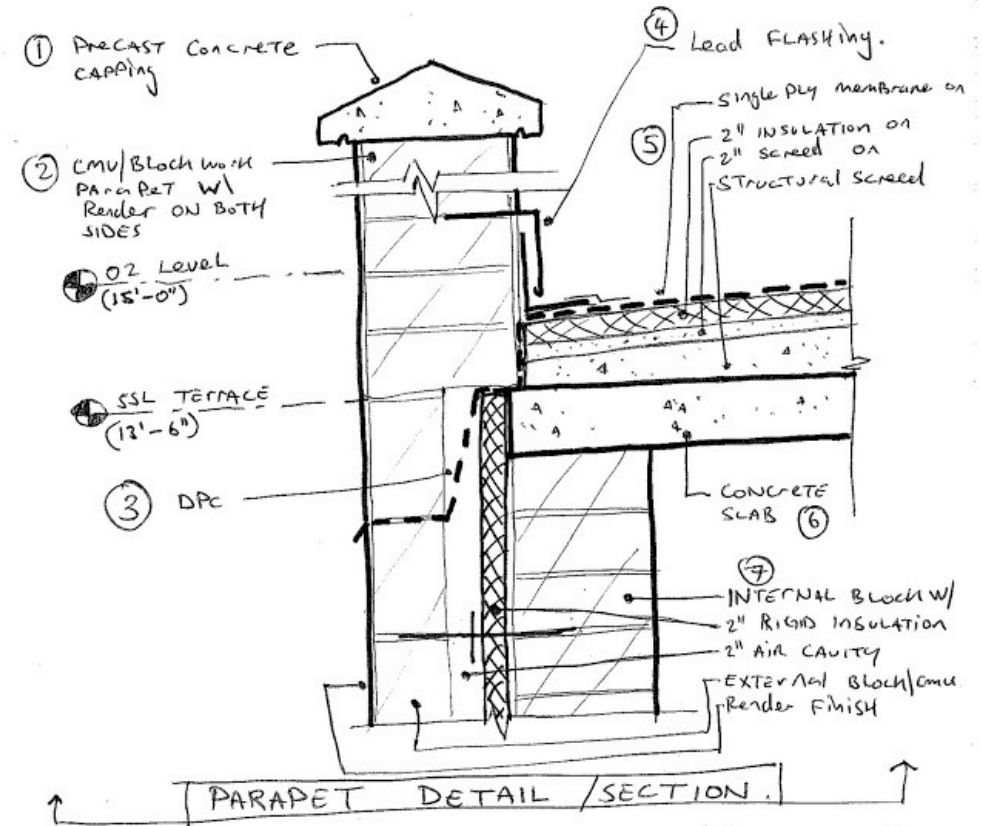
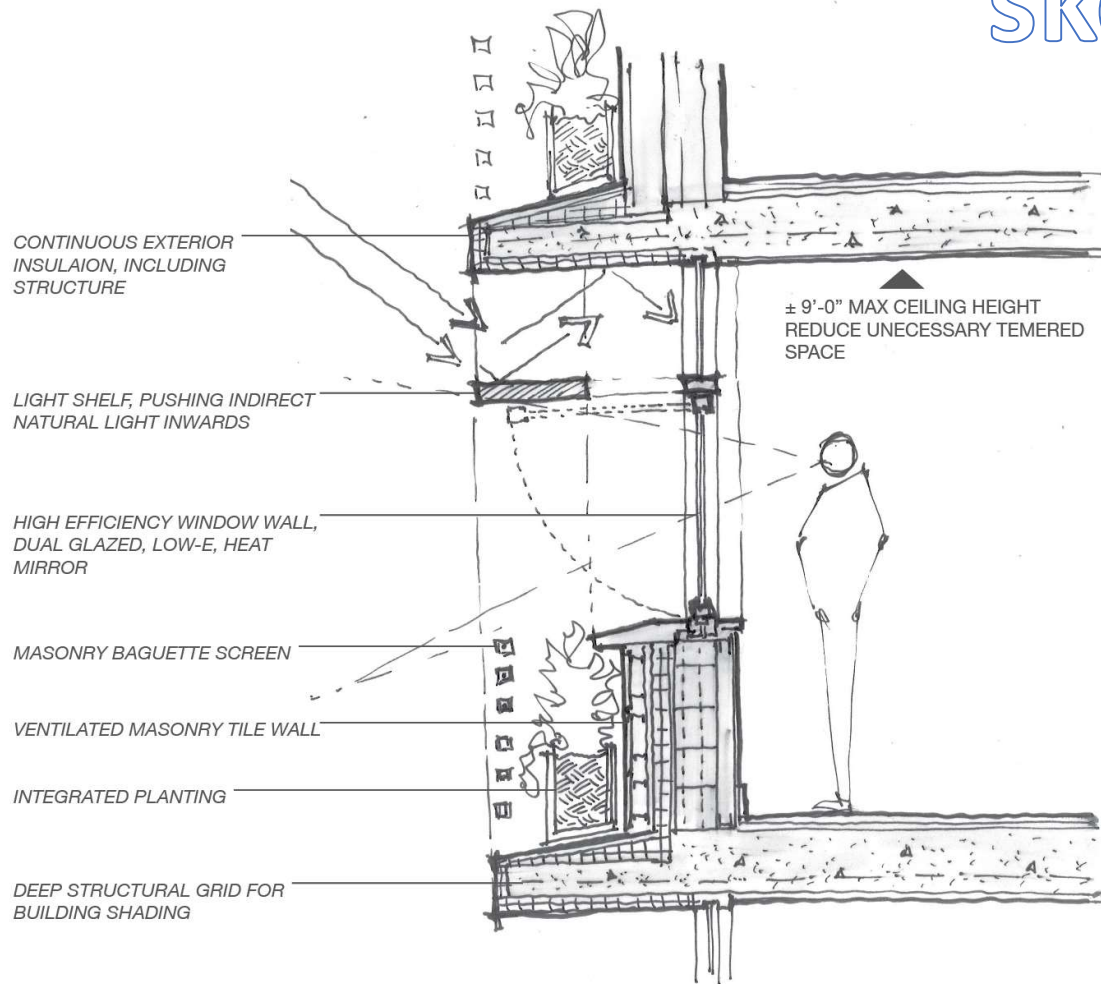


Measuring roof construction.

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:

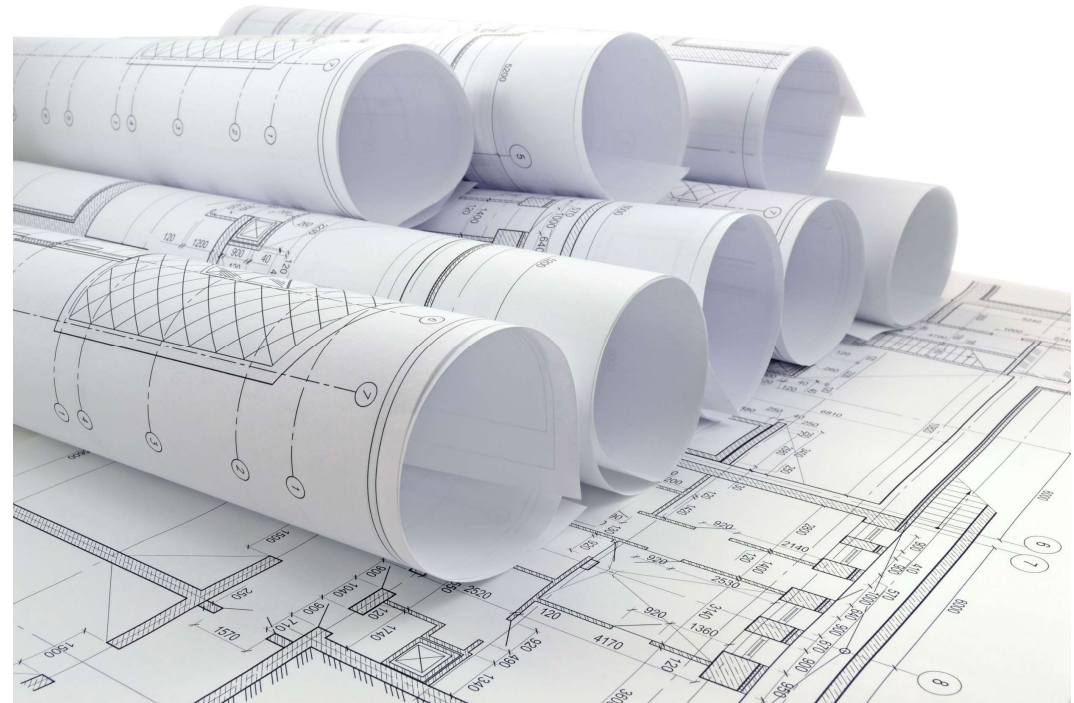
- Thermal Insulation and temperature control
- Acoustic insulation
- Provision of Light (natural and artificial)
- Controls for humidity and ventilation
- Exclusion of contaminants.



Performance Requirements of the Building Fabric

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

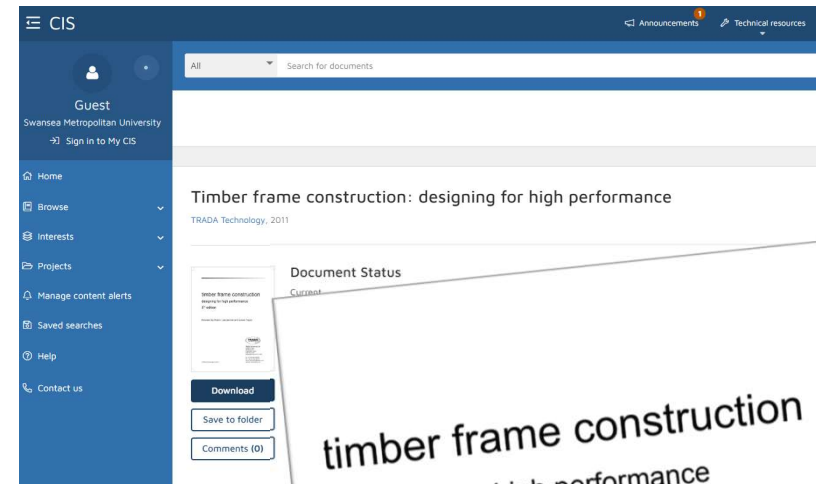
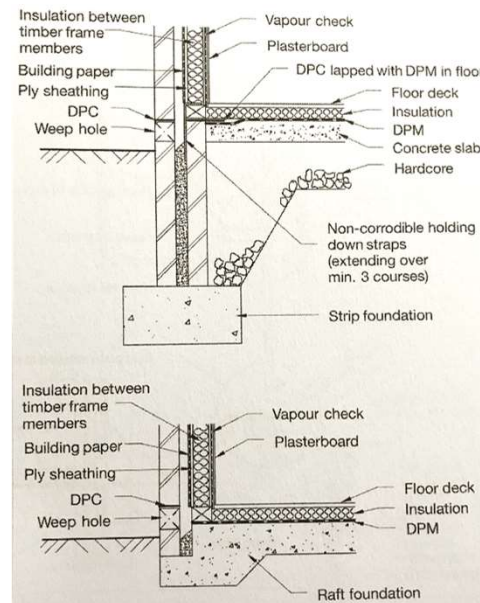
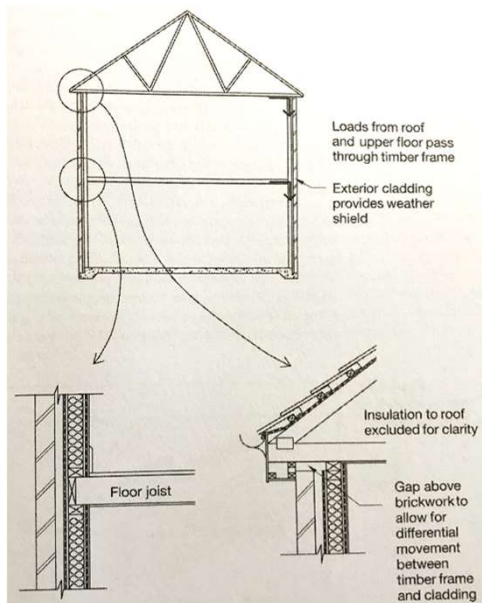
- Structurally Stable
- Durability
- Thermal insulation
- Protection from weather and exclusion of moisture
- Acoustic performance
- Flexibility to change to changing needs
- Aesthetics
- Buildability
- Sustainability



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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website: www.trada.co.uk

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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 :

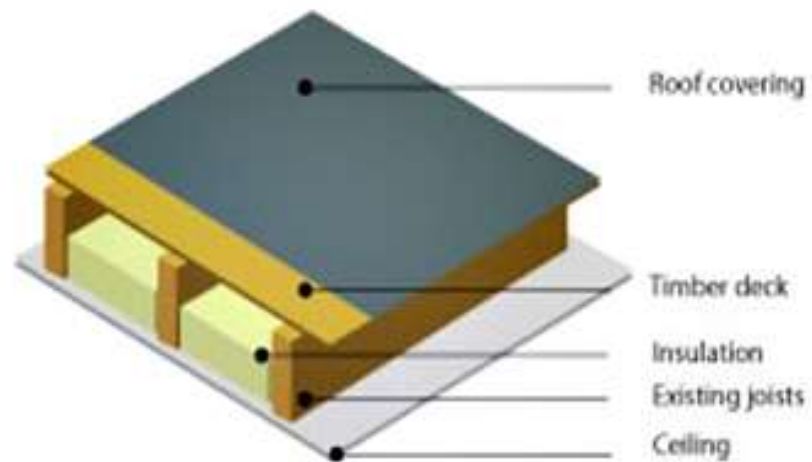
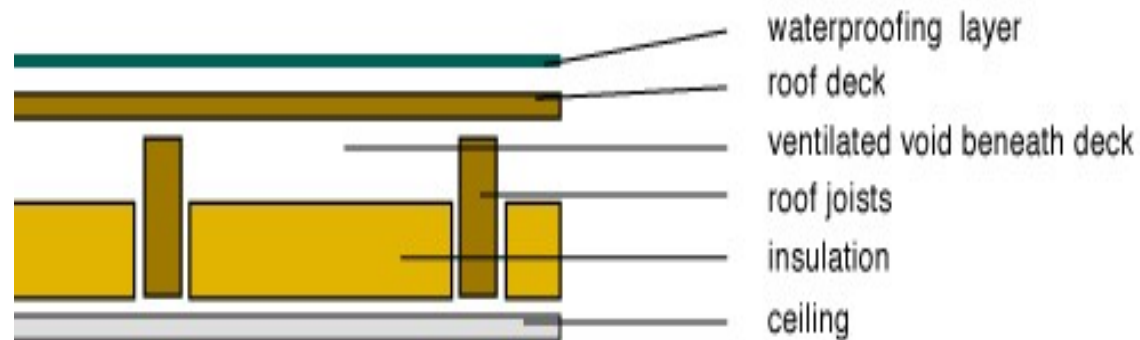
FLAT ROOFS

A photograph of a flat roof, likely on a residential building. The roof is covered in a dark, possibly black, waterproofing material. A metal railing runs along the edge of the roof. On the left side, there is a red gas cylinder and a white gas cylinder. The text "FLAT ROOFS" is overlaid in large, orange, bold letters in the center of the image.

CHARACTERISTICS

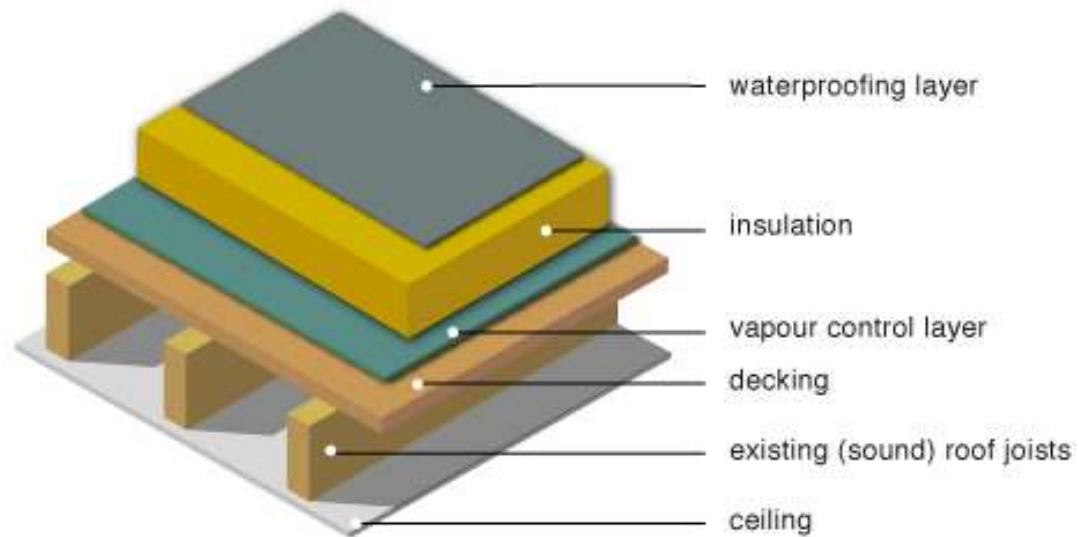
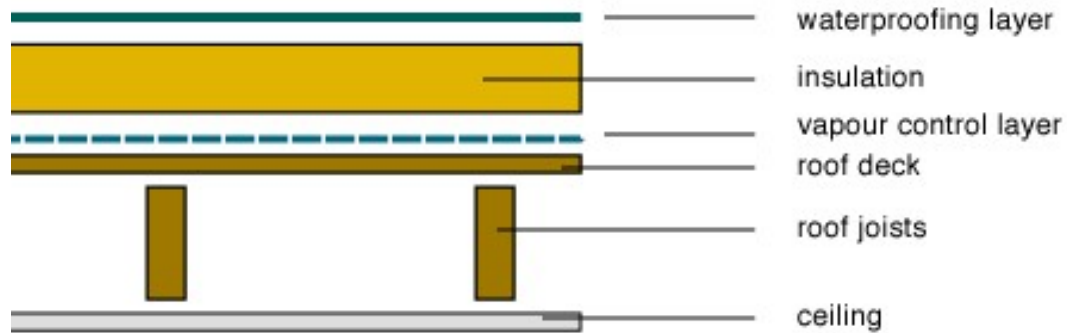
- Having a pitch below 10^0
- Continuous covering
- Asphalt, fibre glass = 1:80 12mm/m
- Built up 3-layer felt, ruberoid felt = 1:60 17mm/m
- Minimum falls – if more than one fall (creating a valley) then the fall should be doubled

Cold Deck roof

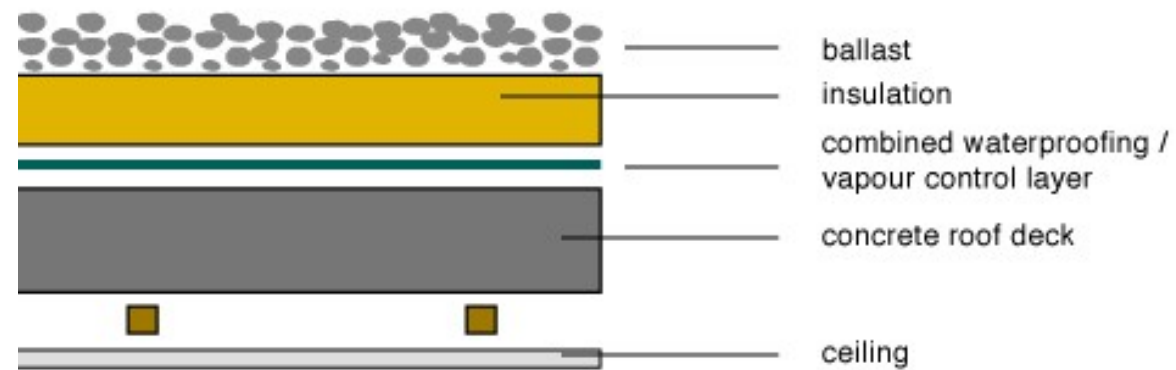
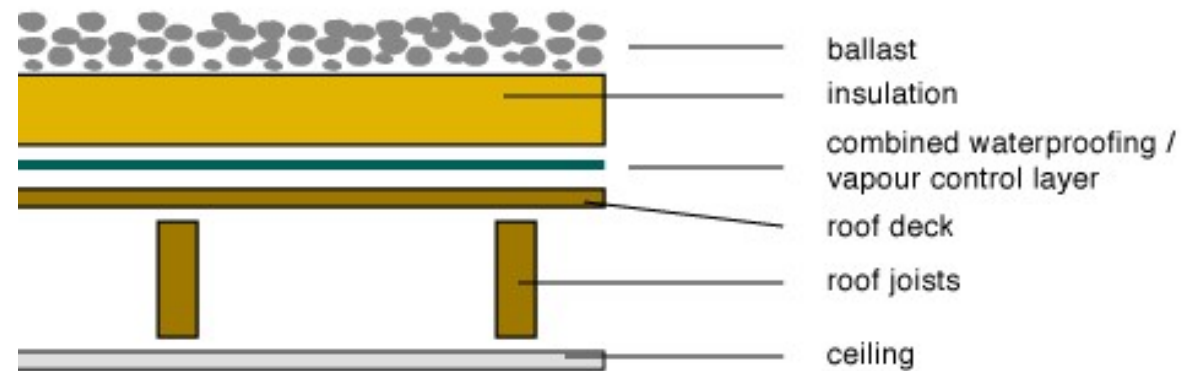


Structural elements are
not protected
Ventilation is required
above the insulation
Not recommended today
Banned in Scotland

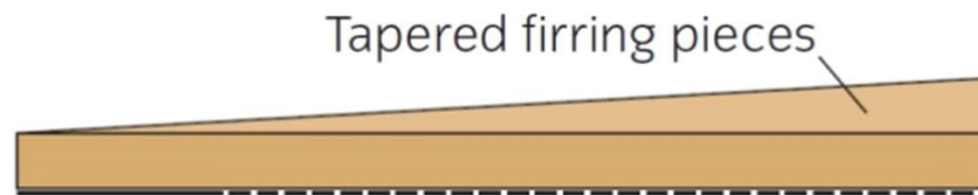
Warm Deck roof



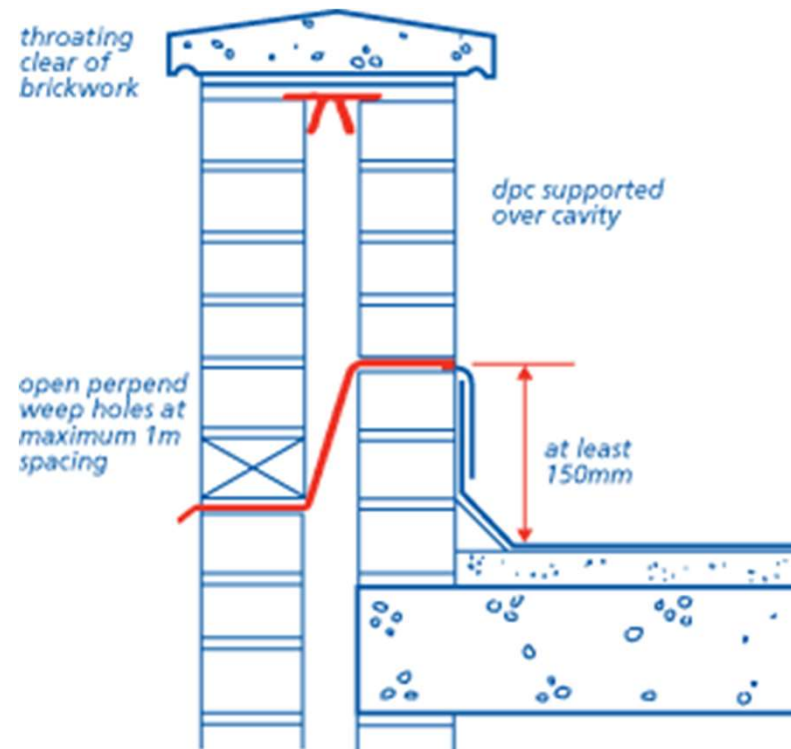
Inverted (upside down) roof



Creating the slope on a timber flat roof



- Abutment details:
- Twice weathered Concrete Coping
- DPC below coping
- Cavity tray
- Weep holes @ 1m c-c
- 50mm angle fillet
- Code 3 lead flashing built into mortar joint
- Lead upstand flashing
- 3-layer felt dressed up masonry
- Screed to concrete roof @ 1:60 minimum fall



Building Regulations. Part H

- Water should drain to one or two edges
- There must be a slope of 1:80
- Waterproofing should extend up the adjacent walls at least 150mm from the roof surface
- Cold roofs must have ventilation
- Warm roofs must have a vapour control layer bonded to the deck
- Roofs must be wind resistant and strong enough to walk on

PITCHED ROOFS

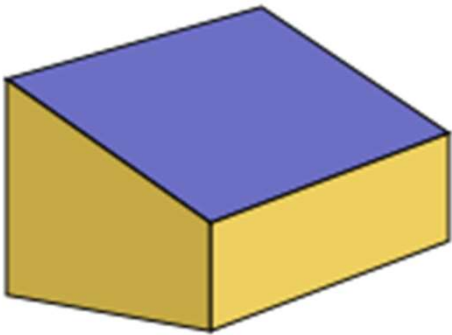


PITCHED ROOFS

Considerations:

- Span
- Materials
- Strength
- Durability
- Moisture resistance
- Fire resistance
- Stability
- Insulation

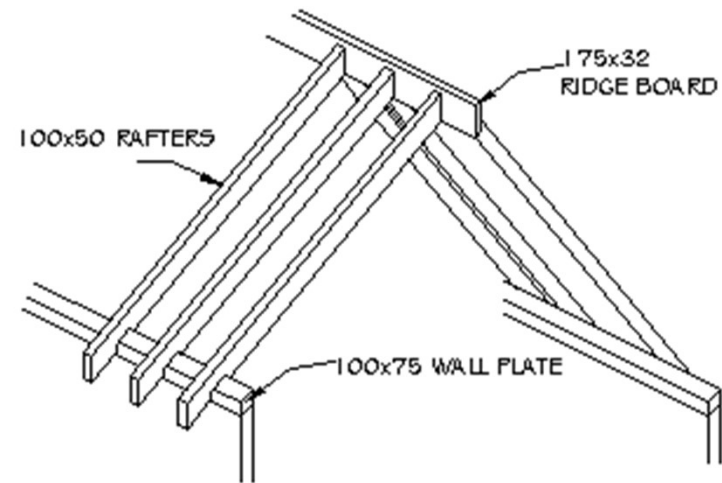
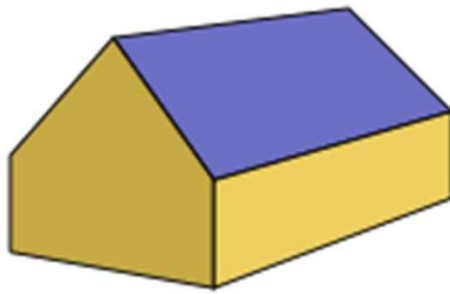
PITCHED ROOFS



Monopitch

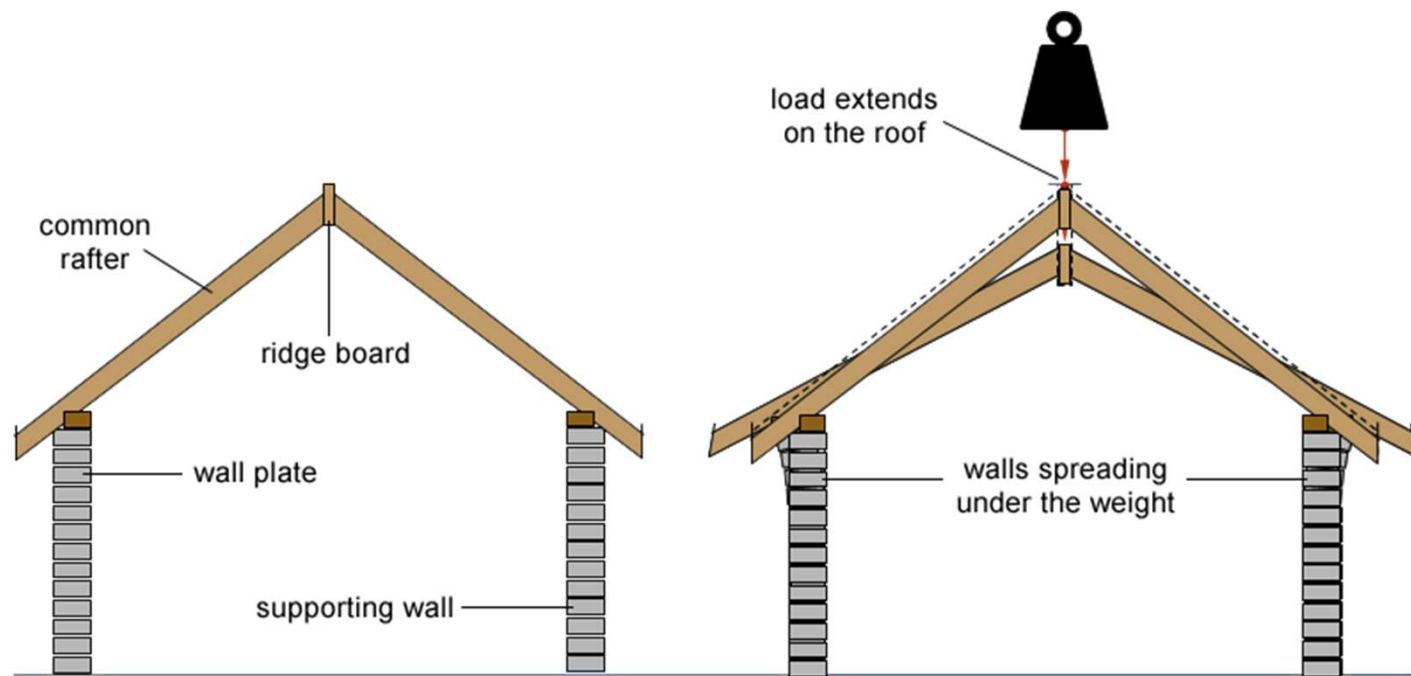


PITCHED ROOFS



Duopitch = couple roof

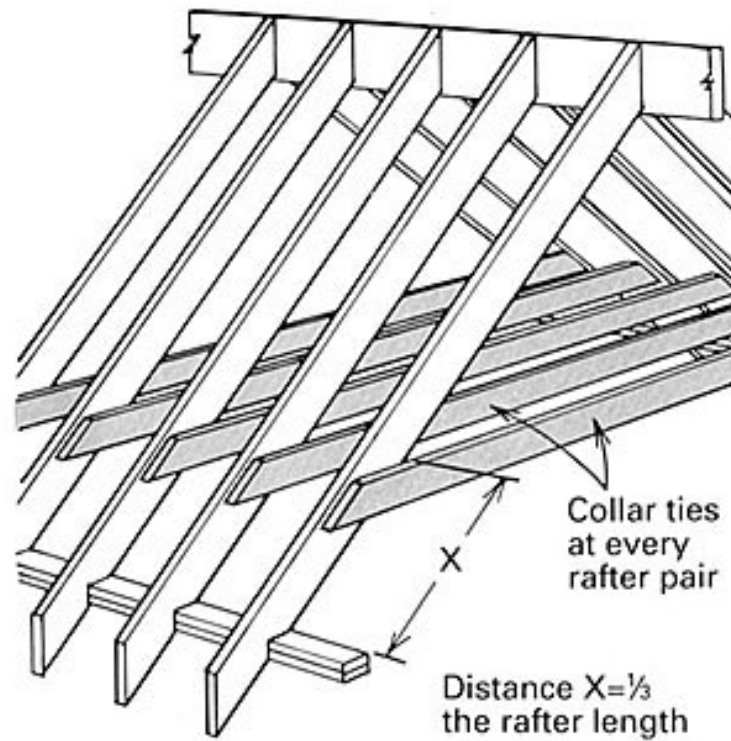
PITCHED ROOFS



Couple roof – maximum span 3.5m

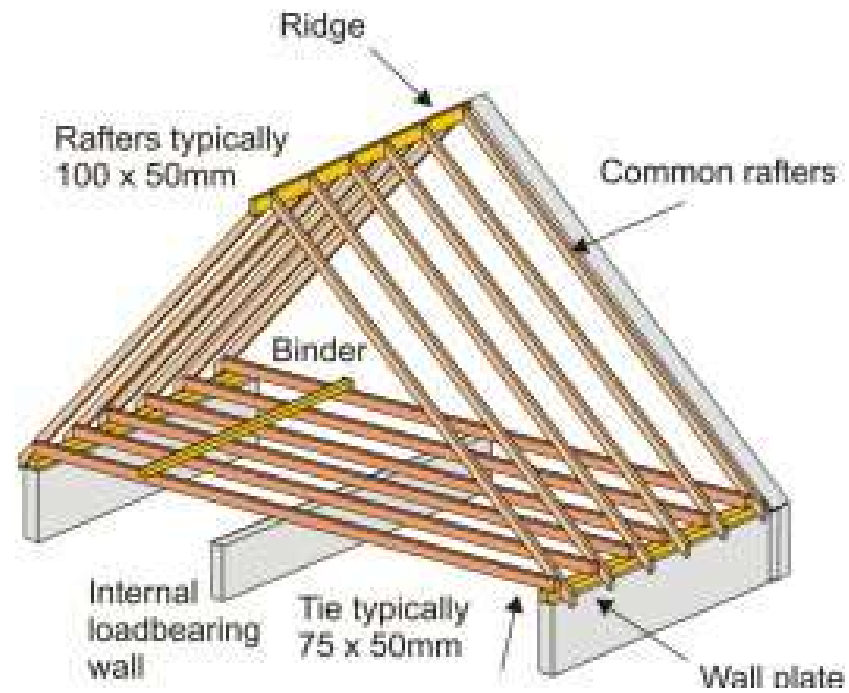
PITCHED ROOFS

Collar roofs –
Maximum
Spans up to
4.5m



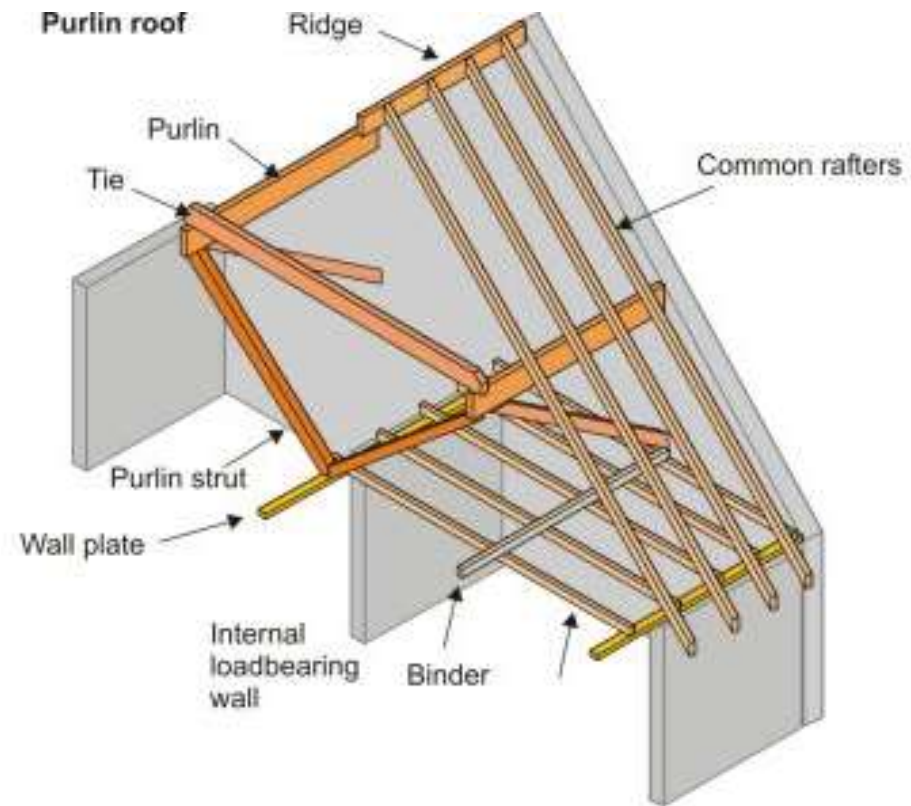
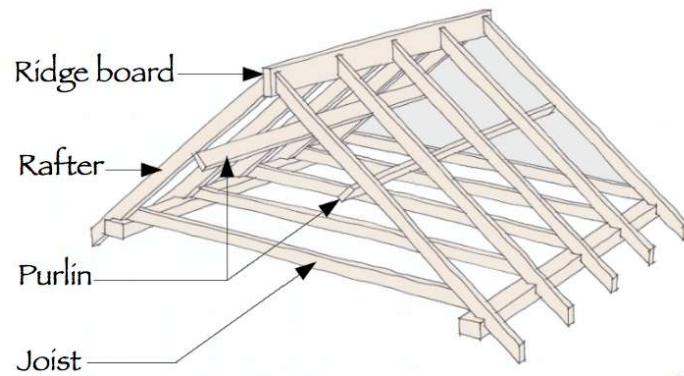
PITCHED ROOFS

Closed couple roof



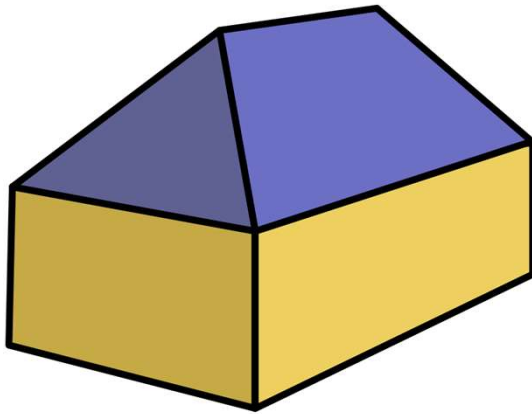
Close Couple roof – maximum span 5.5m

PITCHED ROOFS

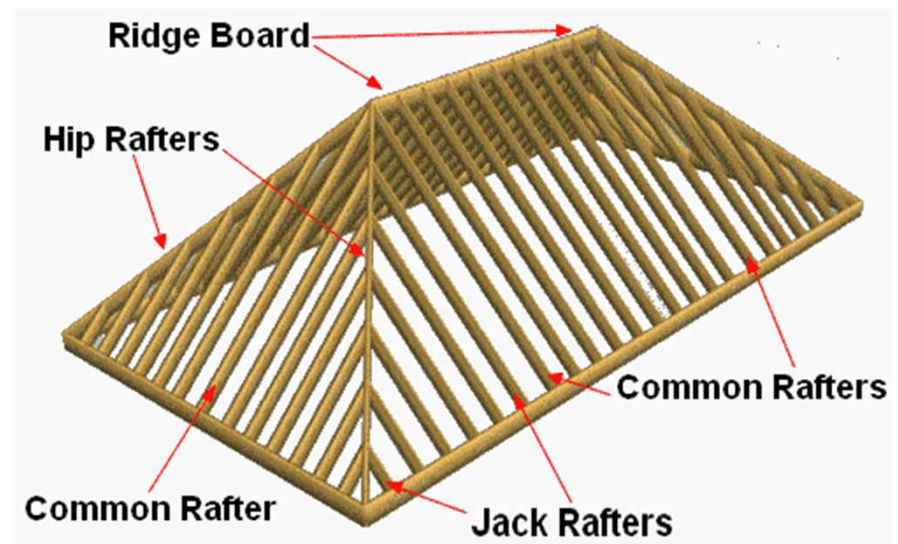


Purlin roof – Spans up to 8m

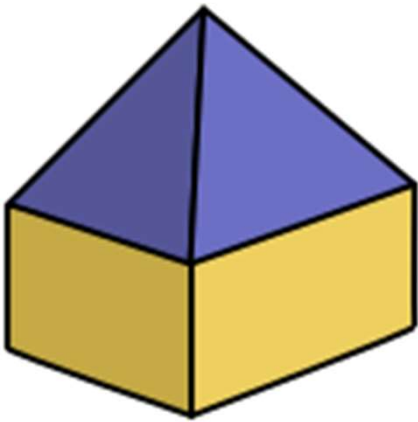
PITCHED ROOFS



Hipped roof



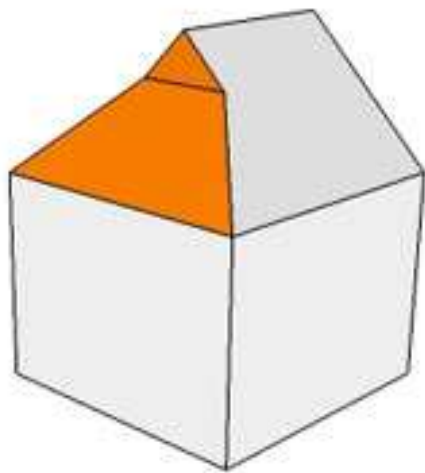
PITCHED ROOFS



Pyramid roof



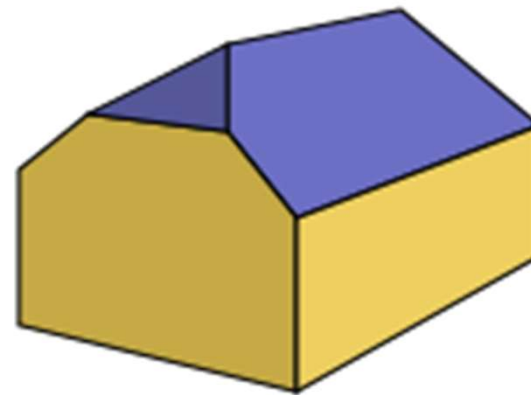
PITCHED ROOFS



Gable roof



PITCHED ROOFS

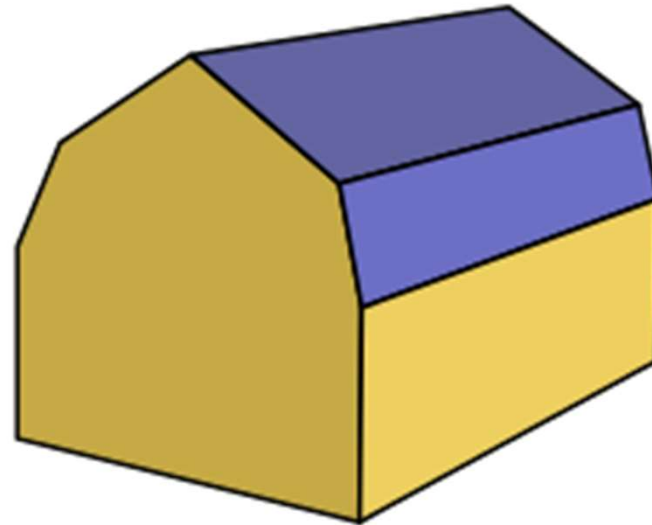


Half hip roof

PITCHED ROOFS



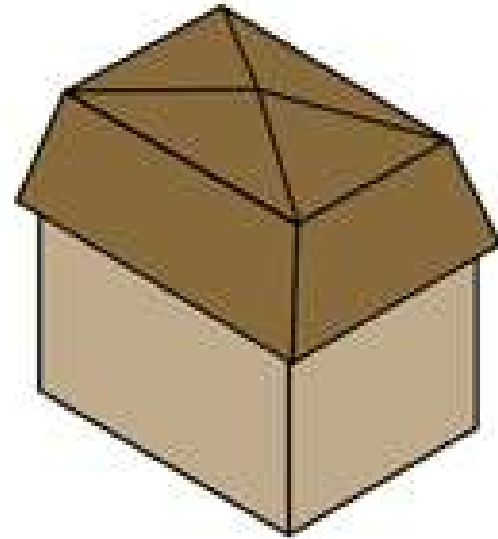
Gambrel roof



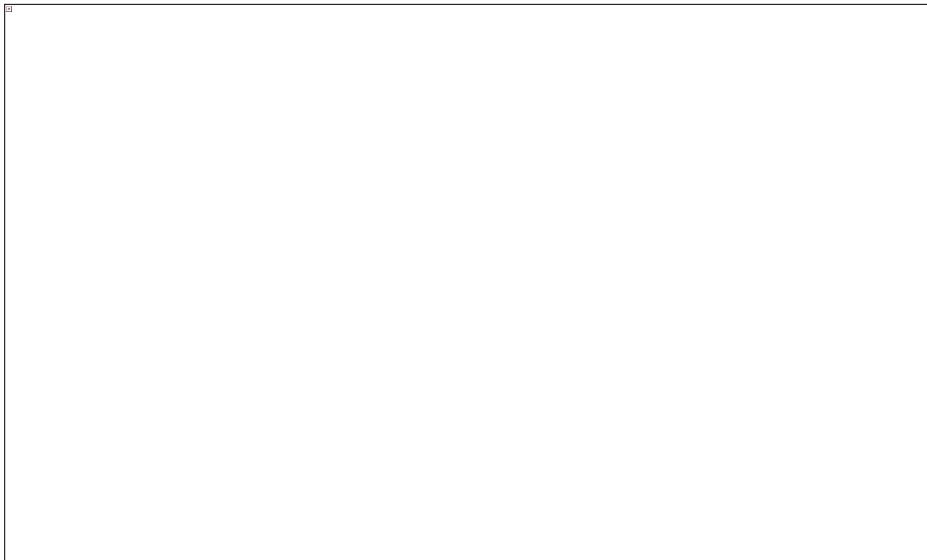
PITCHED ROOFS



Mansard roof



PITCHED ROOFS

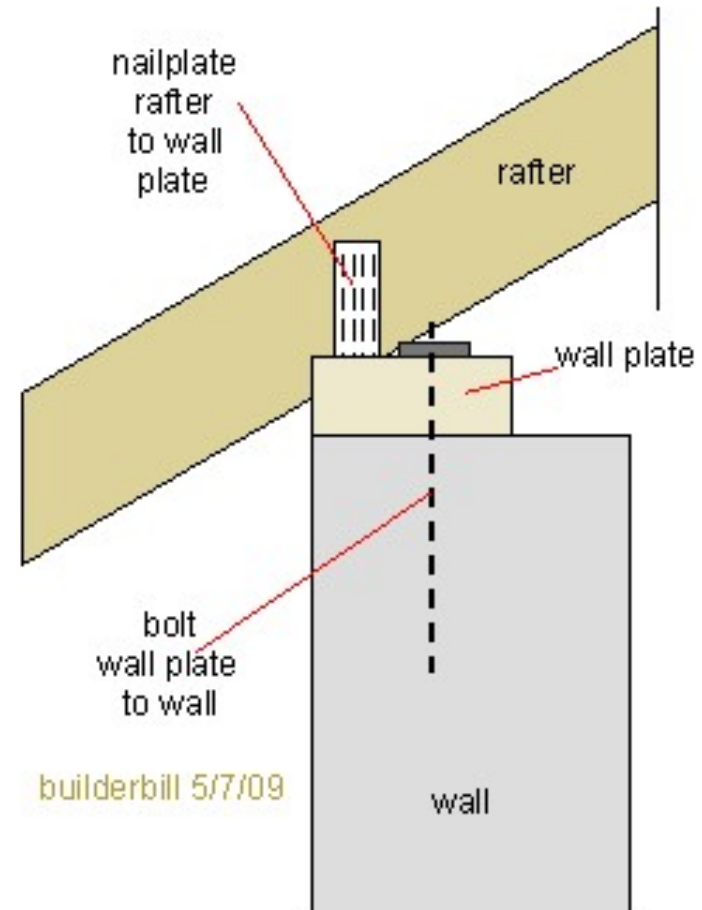


Butterfly roof



WALL PLATES

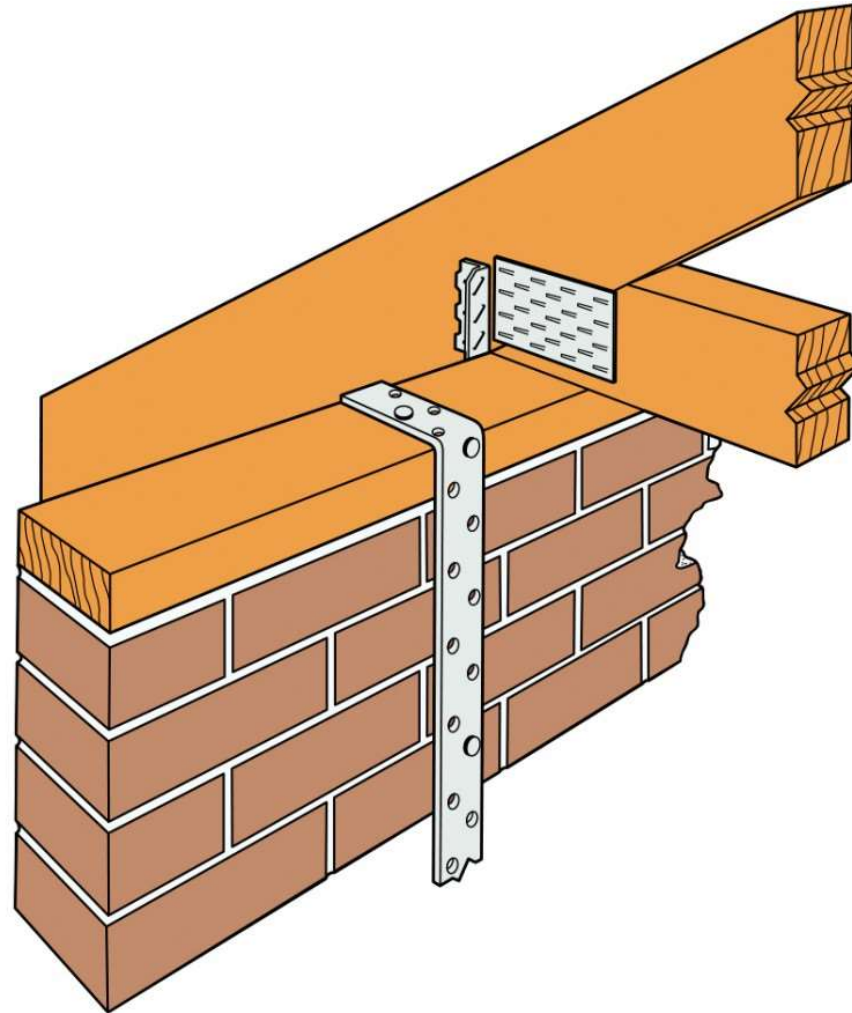
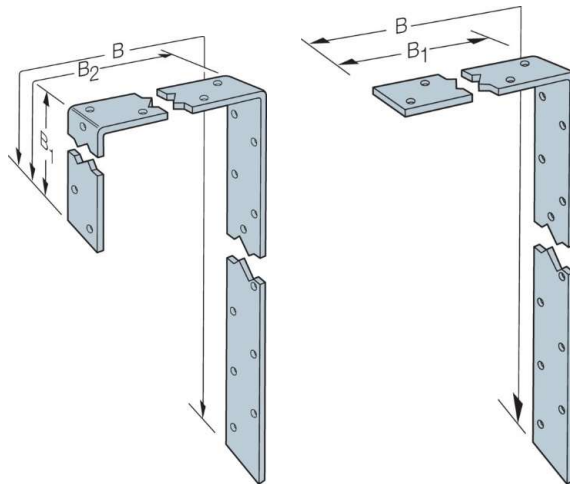
- Provide the bearing and fixing medium for various roof members
- Distribution of loads evenly over the wall
- Bedded in cement mortar on top of load-bearing walls



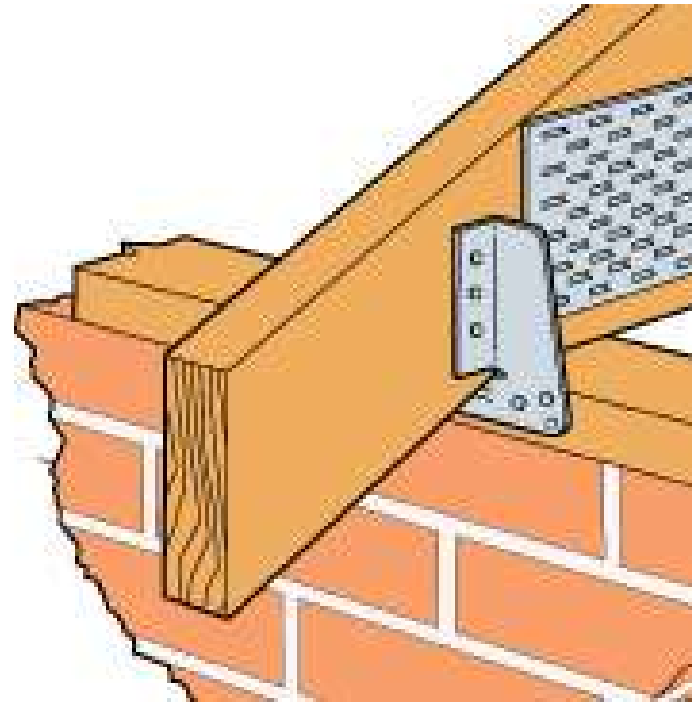
WALL PLATES

Heavy/light restrain straps

- Heavy for lateral restrain
- Light for vertical loads



WALL PLATES



Simpson clip

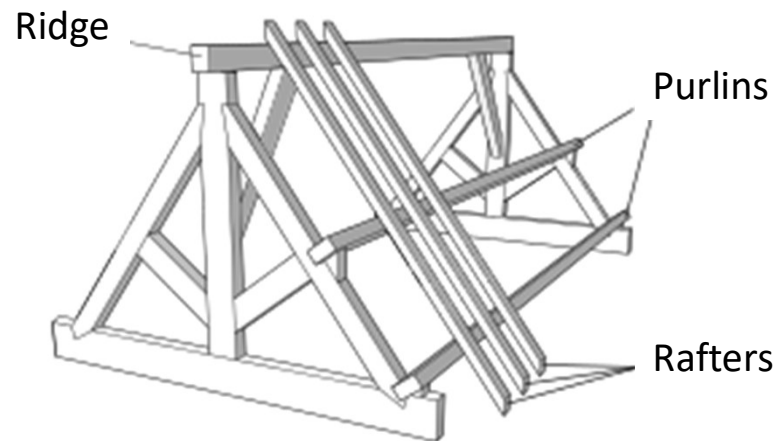
TRUSSES

Heavy timber roof trusses

Can cover 10-15m span

Support between 1 and 3 purlins (depending on the rafter length) and a ridge beam.

In turn these support the common rafters



TRUSSES

Advantages

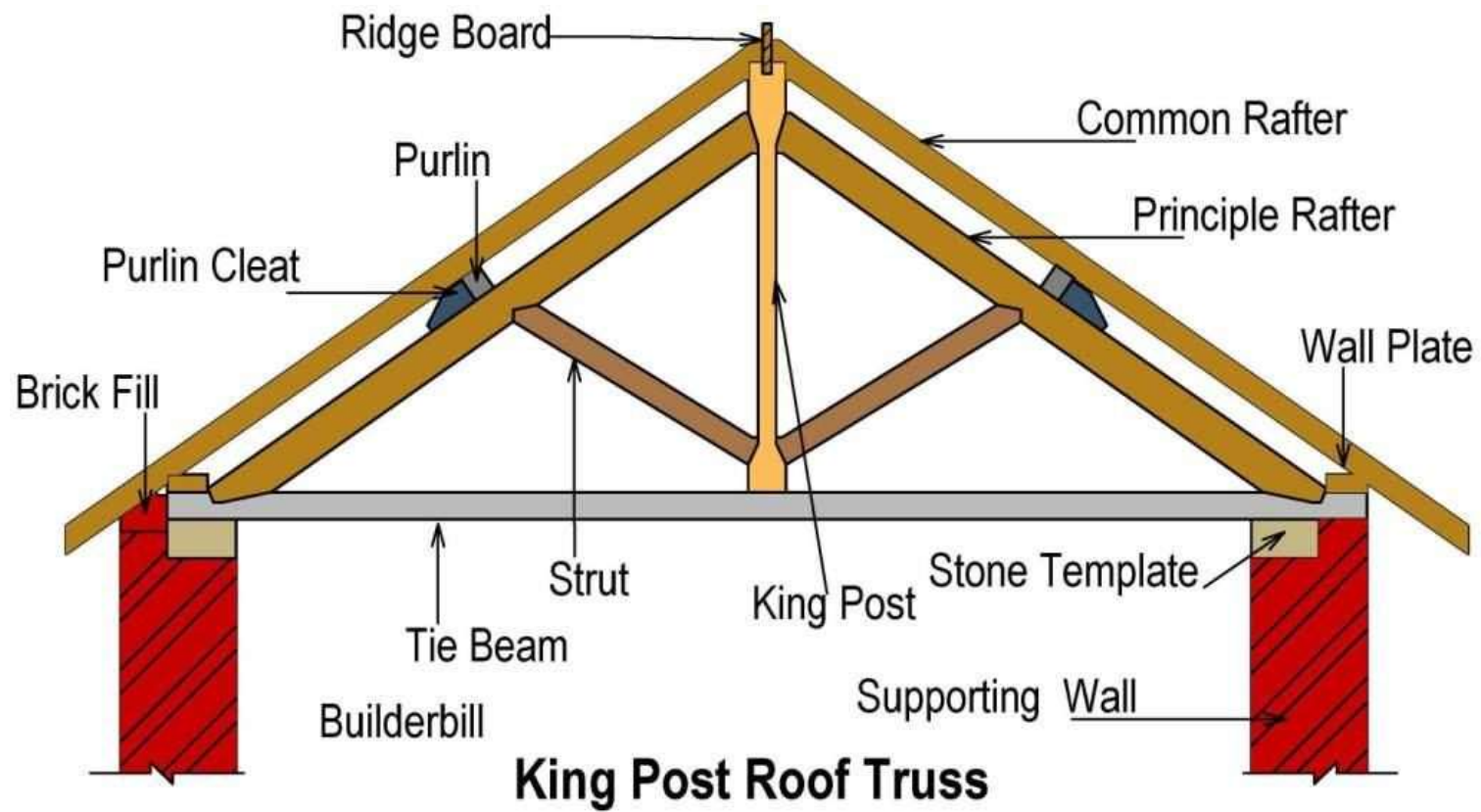
- Large spans
- Less need for intermediate load-bearing internal walls
- Faster construction
- Constructed in factory conditions – quality control
- Economic use of material – minimal waste
- Reduced skills required

TRUSSES

Disadvantages

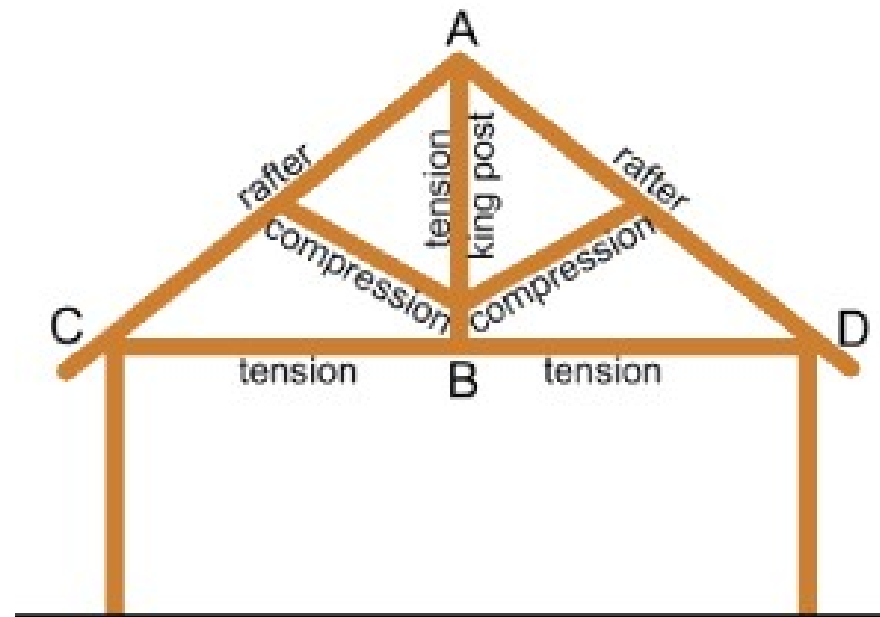
- Design based upon span, loading of covering, wind loading and snow/rain loads – cannot be adapted if changes are made to any of the above
- Little or no loft storage space
- Internal partitions cannot be built until the roof has been loaded by the covering
- Trusses must be plumb and spaced evenly and fixed correctly
- Binders and braces are vital
- Delivery, handling and storage can affect their performance

TRUSSES



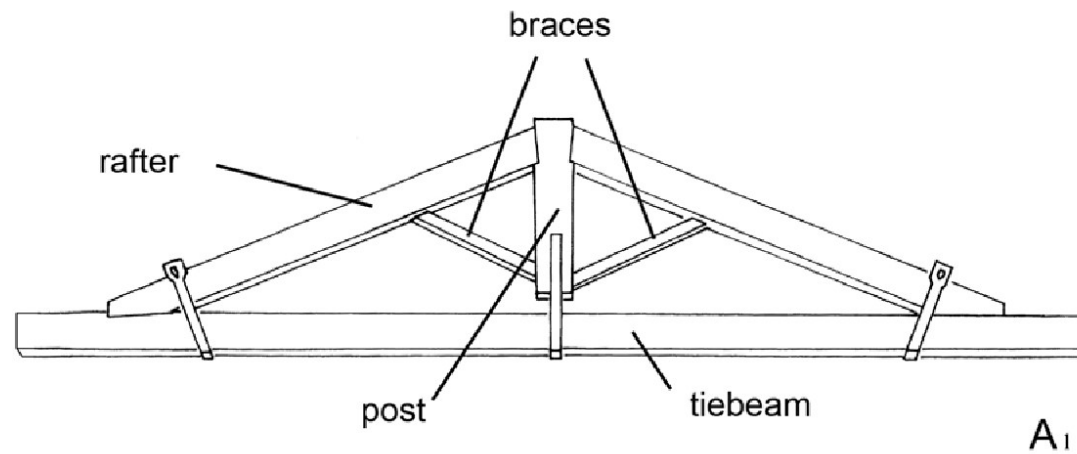
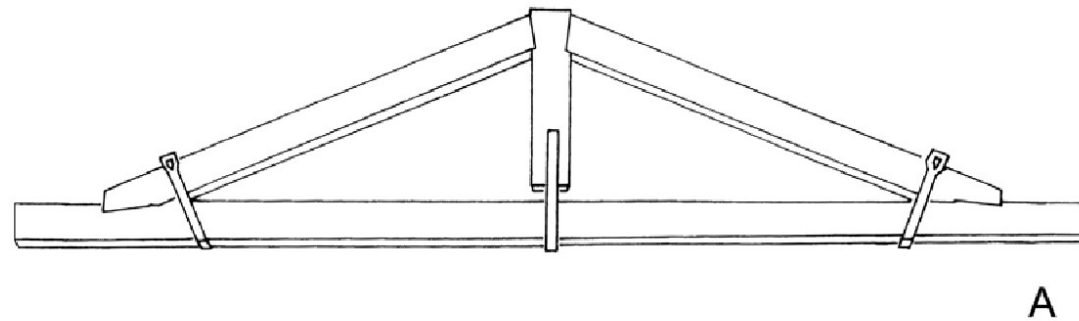
TRUSSES

How does a king post truss work?

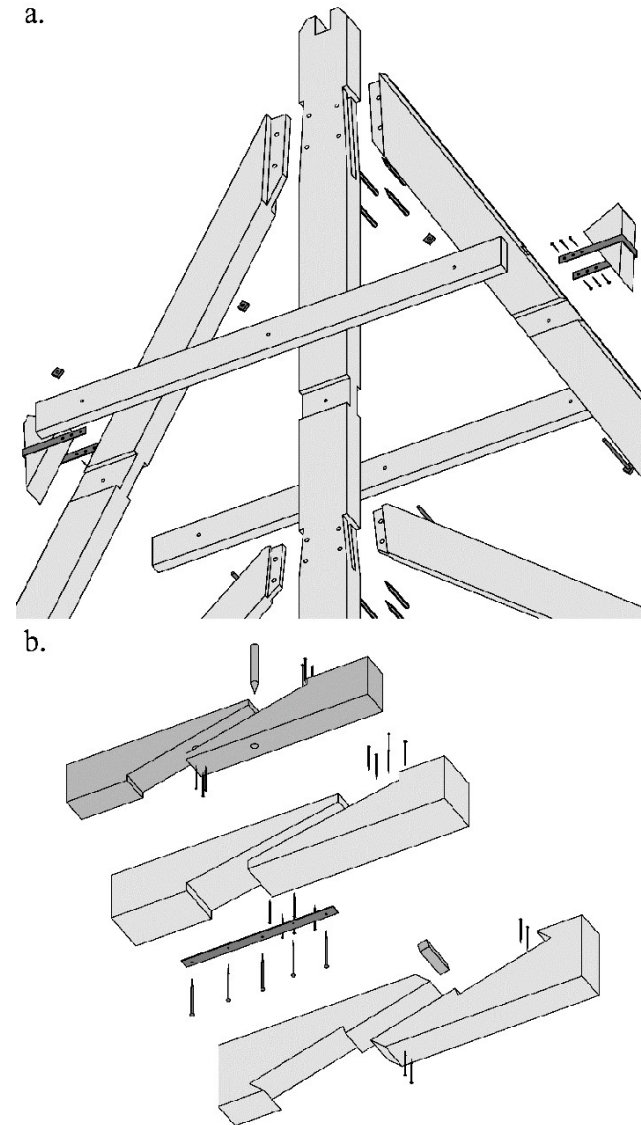


TRUSSES

How does a king post truss work?

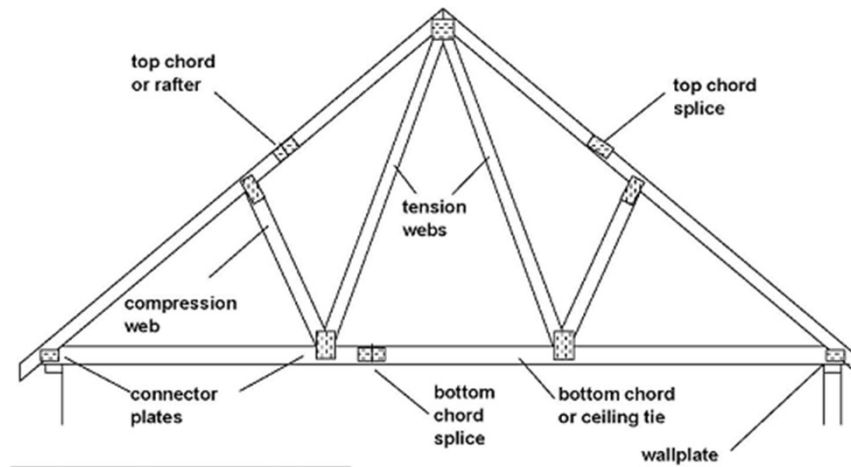
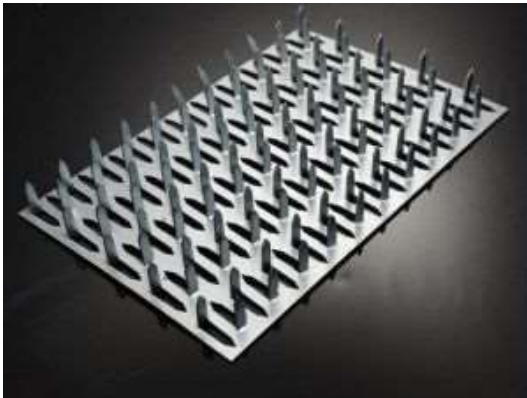


TRUSSES

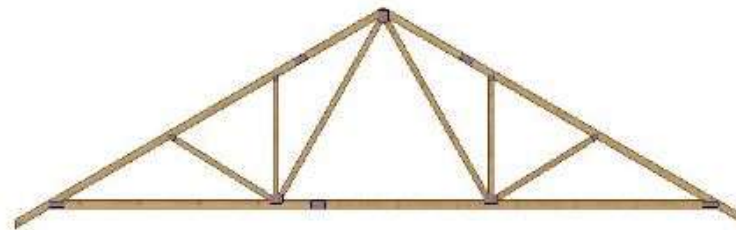


TRUSSES

Factory
assembled
Gang-nail plates



anatomy of a truss - (Fink)



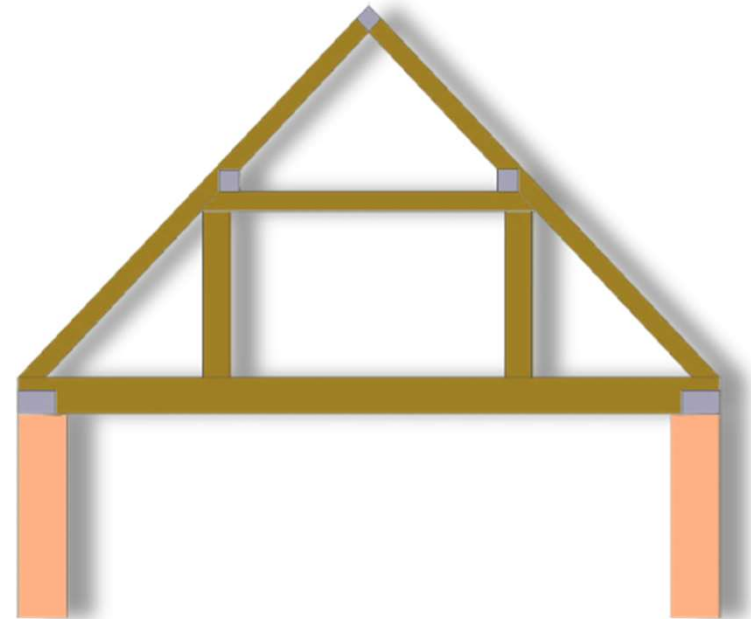
TRUSSES



King Post Truss

Bolted steel plates rather than traditional timber-frame joints

TRUSSES



Queen Post Truss

TRUSSES



Crown Post Truss

TRUSSES

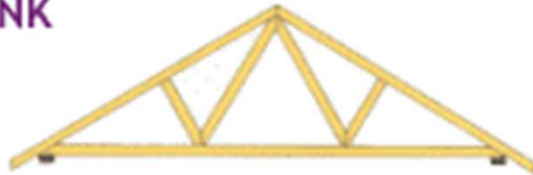
KING POST



QUEEN POST



FINK



HOWE



FAN



DOUBLE W



CANTILEVER

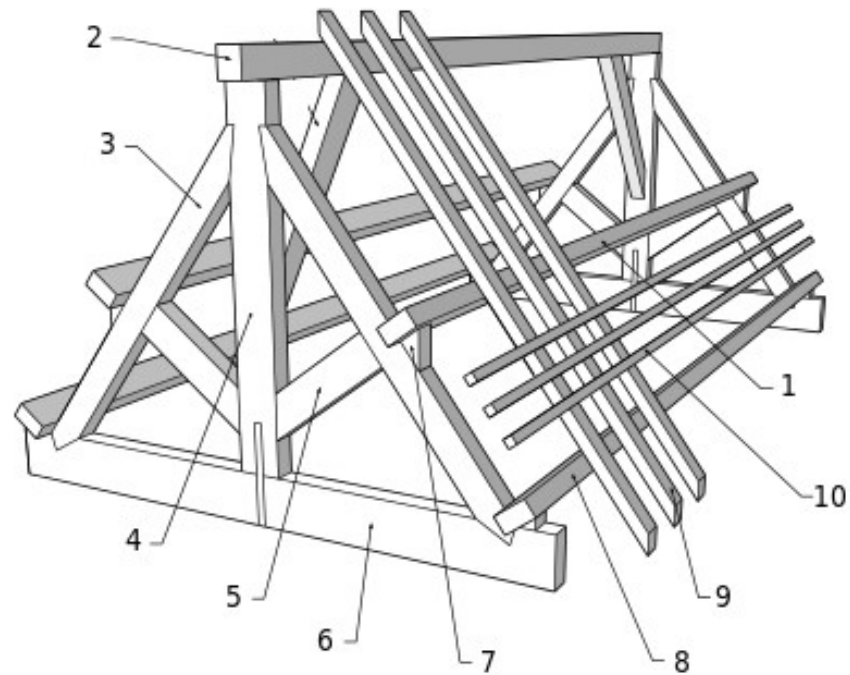


BOBTAIL
(OR STUB-END)



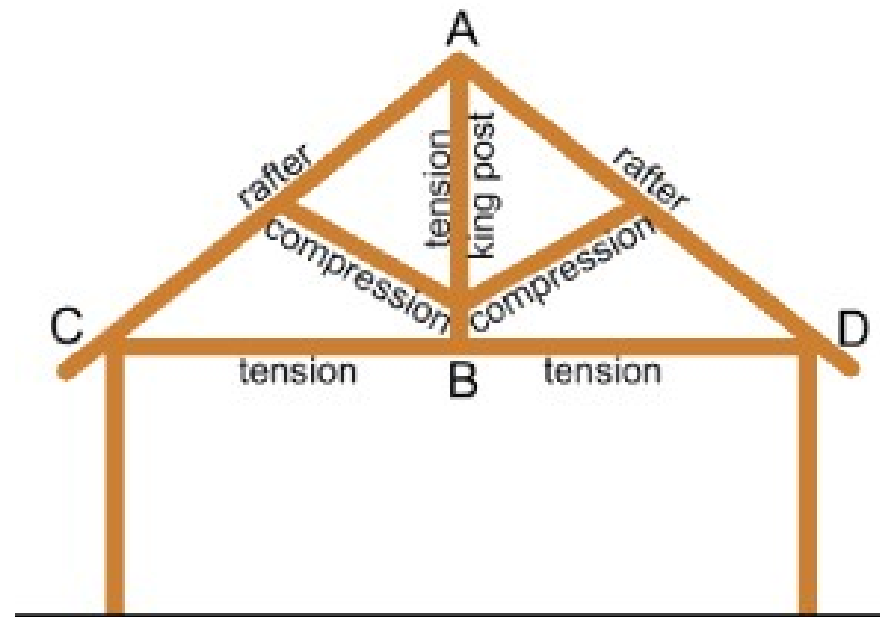
EXERCISE

Consider what type of roof the image shows.
List and name the elements numbered 1 - 10



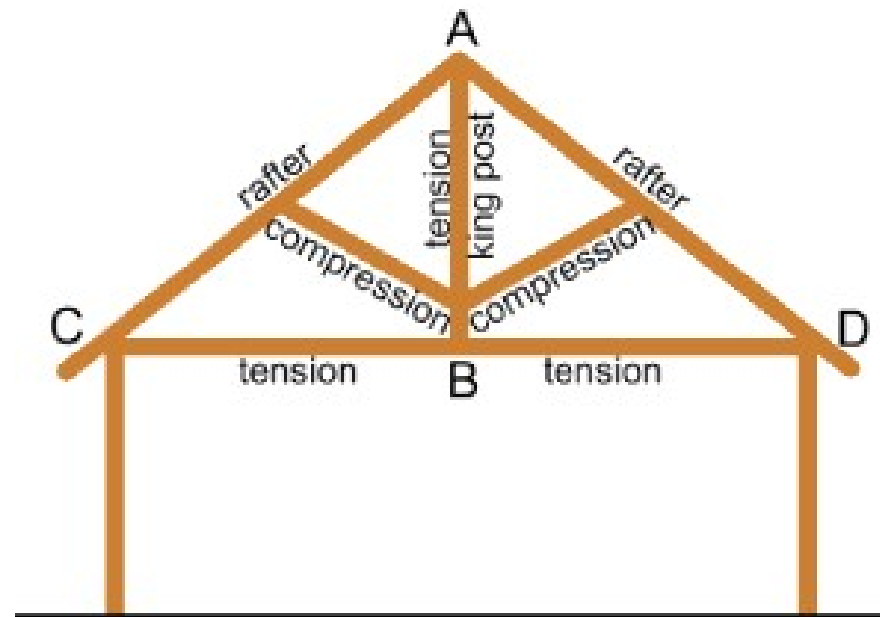
EXERCISE

Considering this picture, design your own truss replacing as many elements as possible by cables.

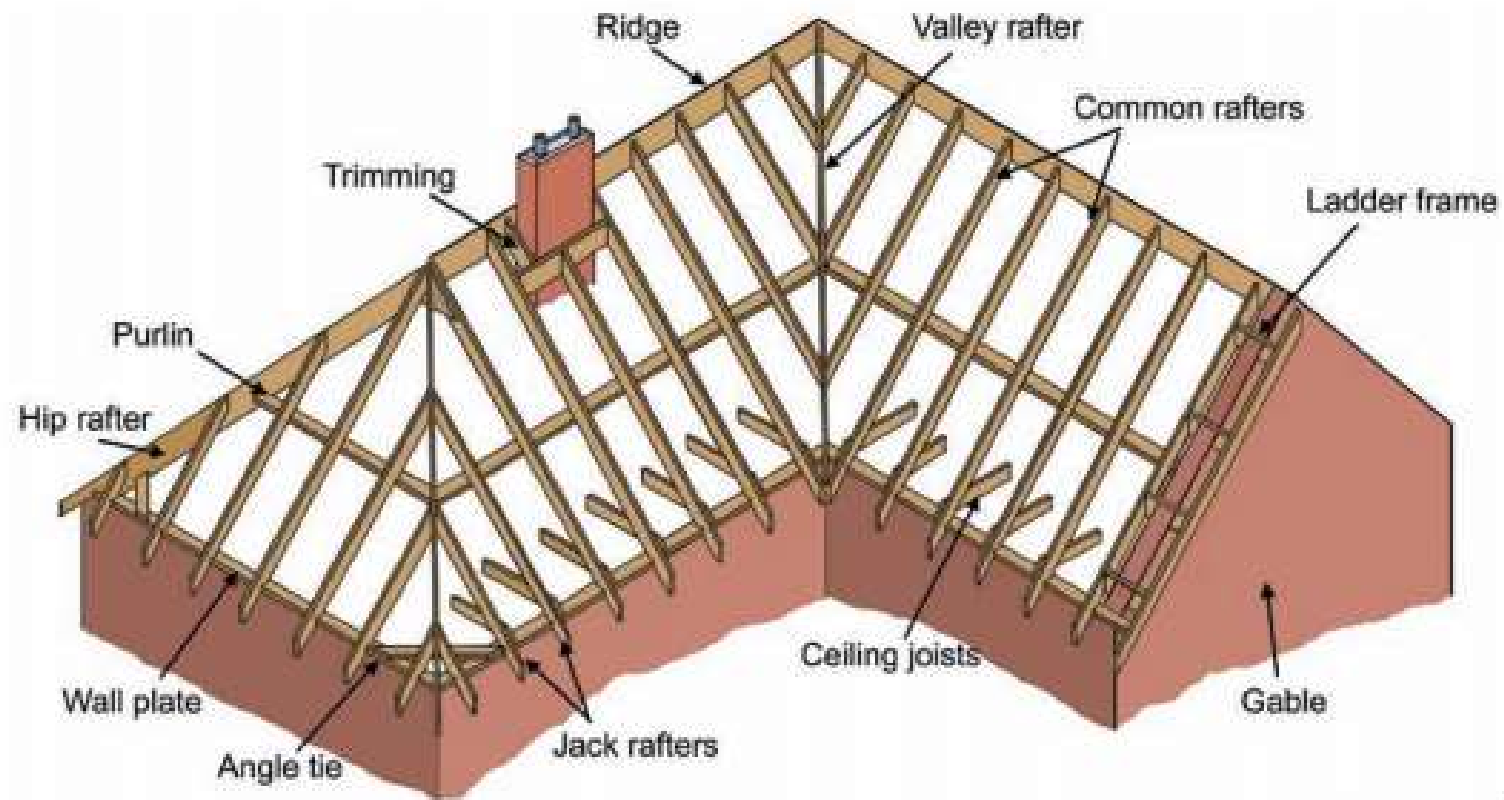


EXERCISE

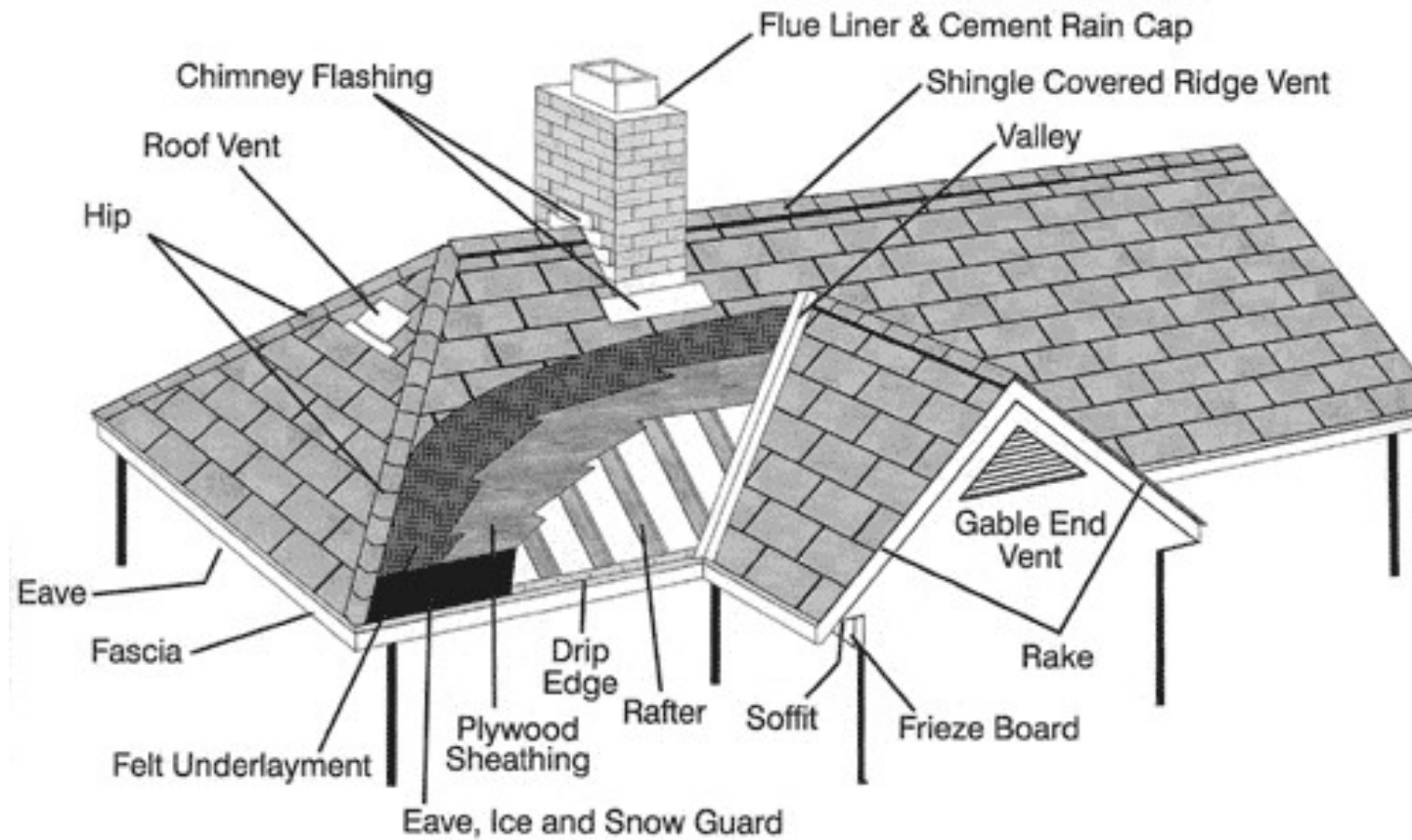
Design two different solutions for the joints A, B and C, one traditional and one with plates.



TERMINOLOGY

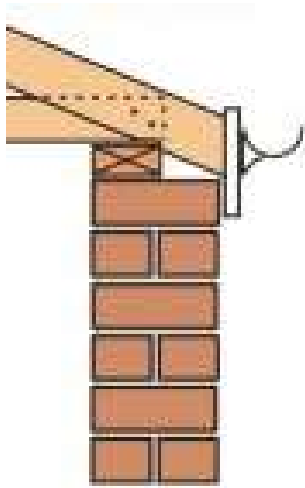


TERMINOLOGY



PITCHED ROOF EAVES

CLOSED EAVES

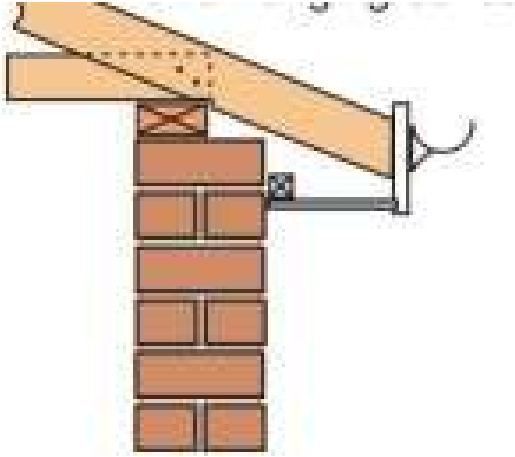


Flush eaves



PITCHED ROOF EAVES

CLOSED EAVES

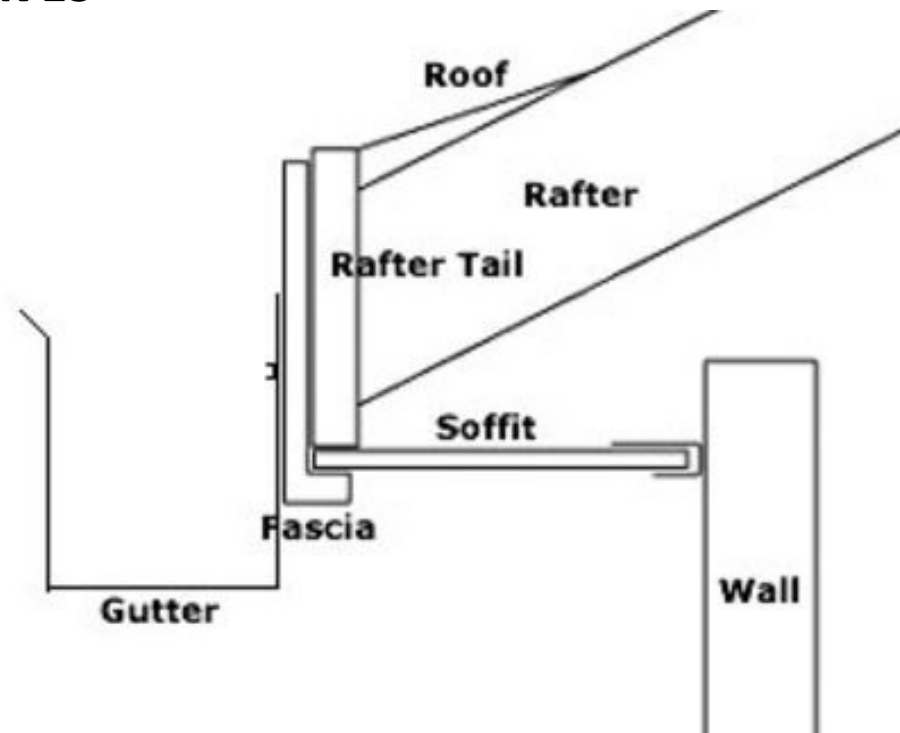


Soffit eaves



PITCHED ROOF EAVES

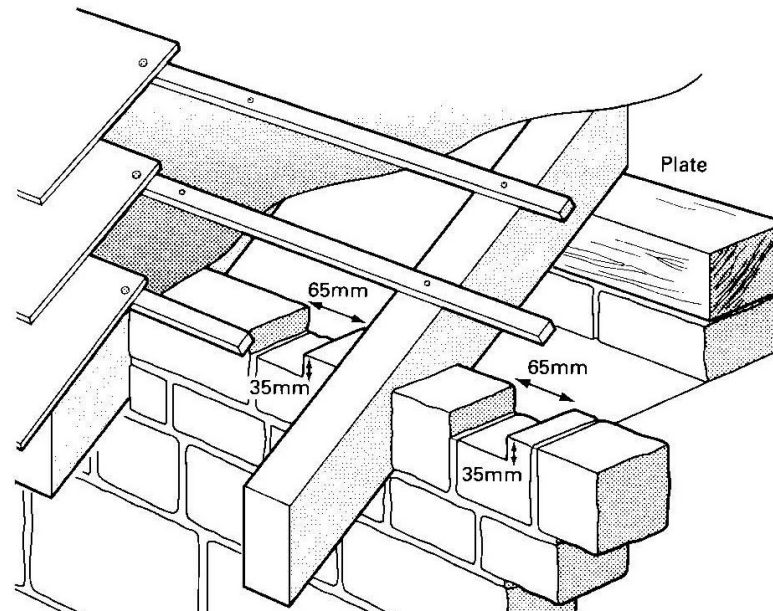
CLOSED EAVES



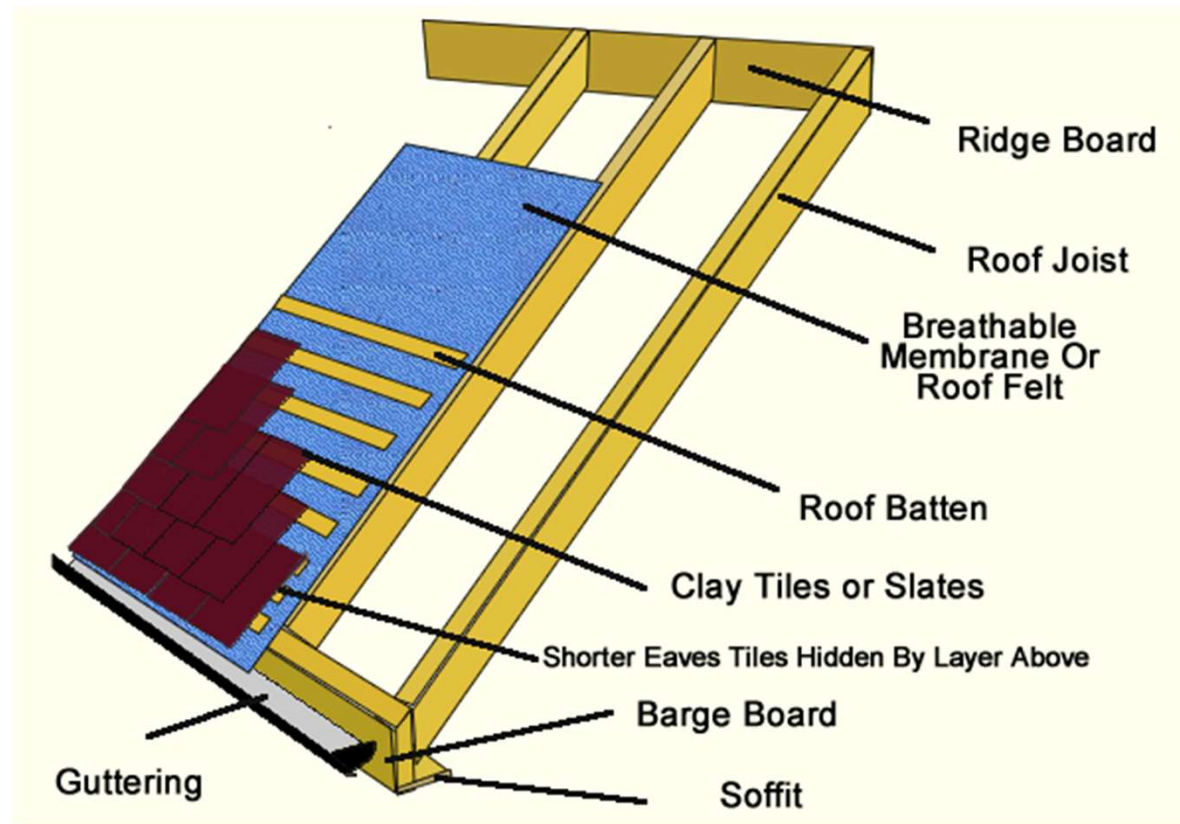
Soffit eaves

PITCHED ROOF EAVES

OPEN EAVES

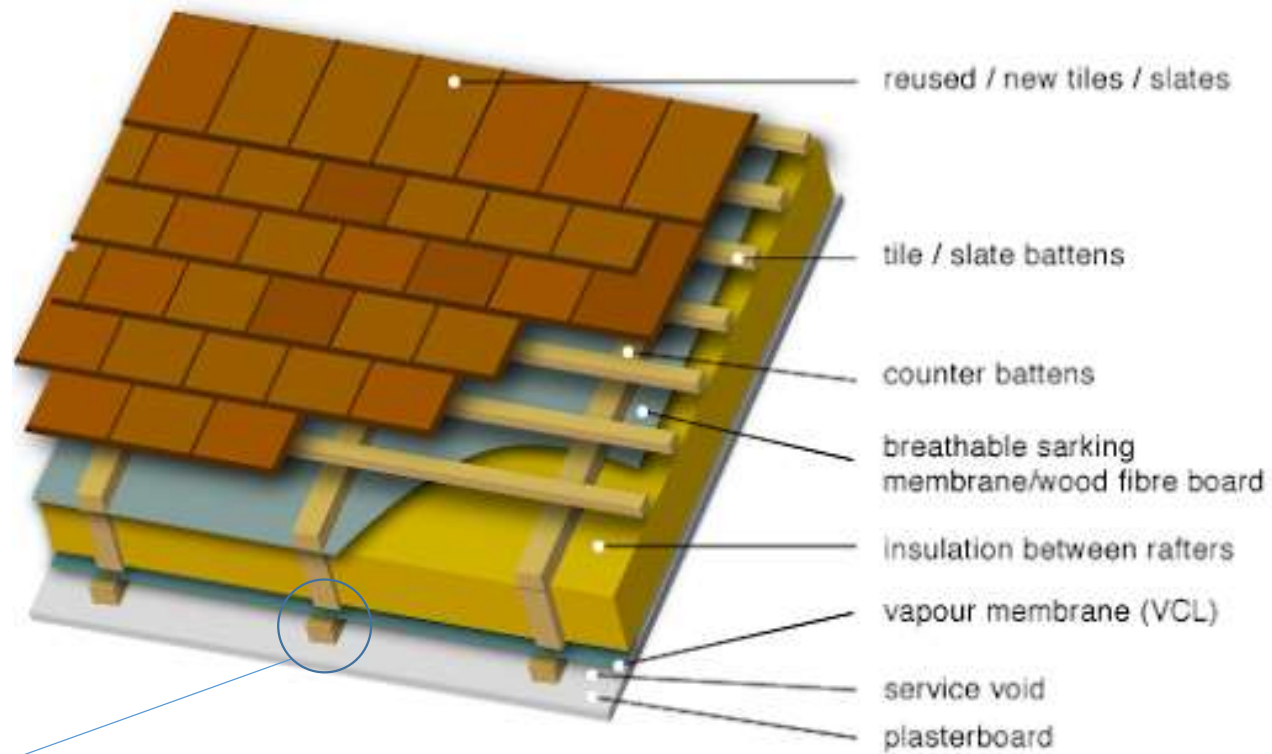


ROOF COVER



Where do we put insulation?

ROOF COVER



Potential thermal bridge
Another insulation layer is required

Timber battens and counterbattens (BS 5534:2014+A2:2018)

should be of the following species:

a) British-grown

- larch
- British pine
- British spruce

b) imported:

- redwood
- whitewood
- spruce-pine-fir (USA, Canada)
- southern pine (USA)

Timber battens and counterbattens

(BS 5534:2014+A2:2018)

Minimum timber batten sizes

Application	Basic minimum size of batten ^{A), B), C)}			
	Up to 450 mm span ^{D)}		451 mm to 600 mm span ^{D)}	
	Width mm	Depth mm	Width mm	Depth mm
Slates (double-lap):				
• natural: sized or random	50	25	50	25
• fibre-cement or concrete	38	25	50	25
Clay and concrete tiles:				
• double-lap	38	25	38	25
• single-lap	38	25	50	25

^{A)} Tolerances on the basic sizes of timber batten should be: width ± 3 mm, depth $\frac{-0}{+3}$ mm, based on measurement at areference moisture content of 20% (see [Annex D](#)).

^{B)} These minimum sizes do not apply to battens used to support ridges, hips and valleys.

^{C)} Batten sizes for other slates, tiles and shingles such as timber shingles and shakes and metal tiles, or other proprietary roofing products, should be in accordance with the manufacturer's recommendations.

^{D)} Span is defined as the distance between centres of supports, or the clear distance between the faces of supports plus half the bearing length at each end support, whichever is the lesser. The end-bearing length should be not less than 17.5 mm.

Roof materials

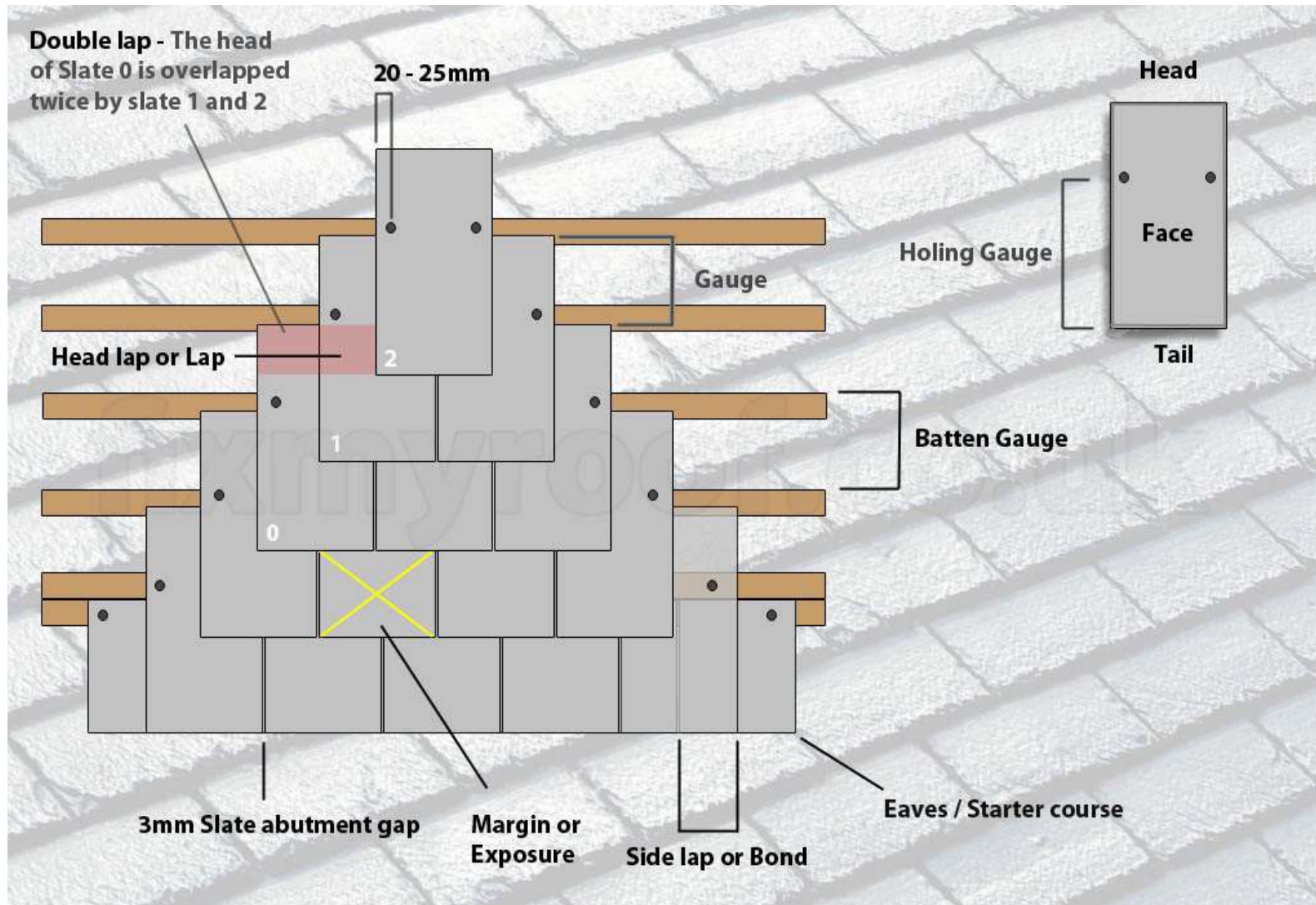
Slate shingles

- Long lasting (up to 150 years)
- Fire resistant
- Low water absorption
- Relatively heavy roof
- Common large size 600x300mm
- Quality determined by thickness
 - Best: 4mm thick
 - Medium strong: 5mm
 - Heavy: 6mm
 - Extra heavy: 9mm

Natural slate shingles:

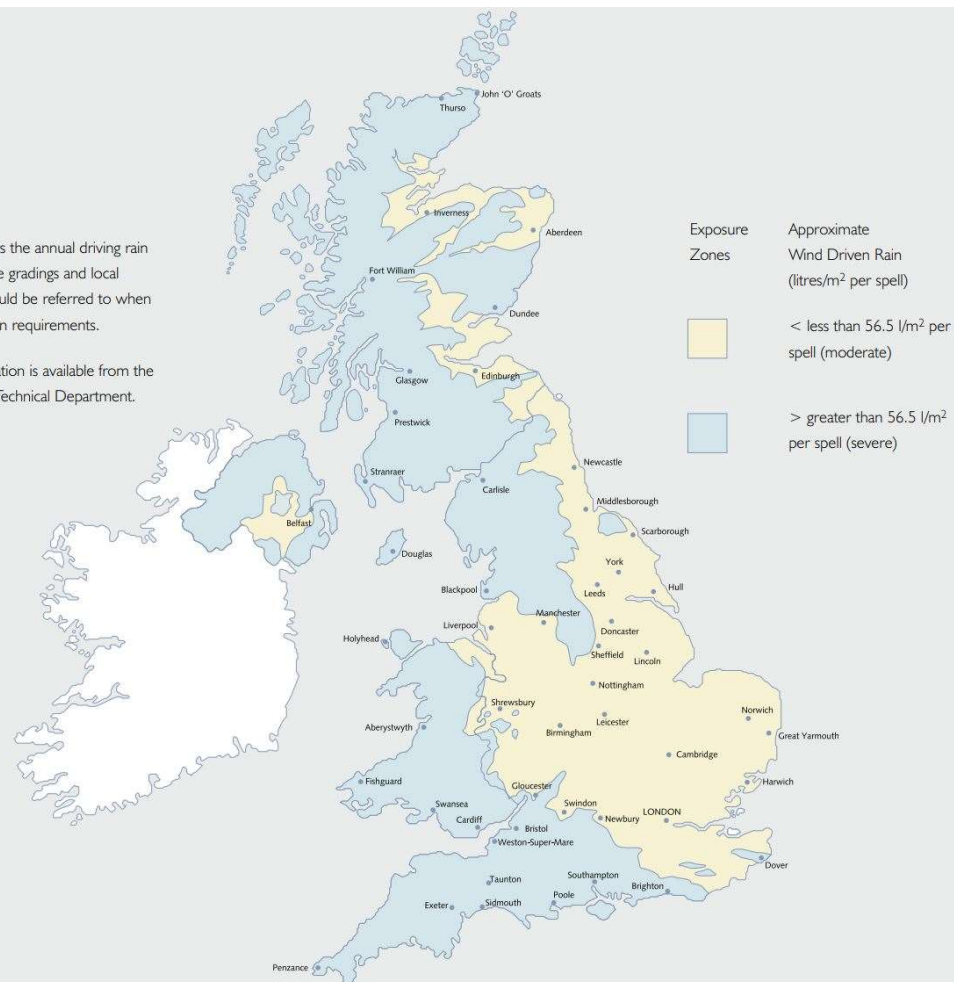
- Pitches from 20° to 45°
- Every slate double nailed (head or centre fixed)
- Staggered joints
- Half slates traditionally at verges
- The larger the slate, the lower the roof and the greater head lap required
- Weather conditions also affects
- (see BS 5534:2014+A2:2018)





This map shows the annual driving rain index. Exposure gradings and local knowledge should be referred to when discussing design requirements.

Further information is available from the Welsh//Slate Technical Department.



Annual driving rain index



MODERATE EXPOSURE less than 56.5 l/m² per spell

Heap lap (mm)

Size (Nominal)	Minimum Rafter Pitch								
mm	20°	22.5°	25°	27.5°	30°	35°	40°	45° to 75°	85°
600 x 350	115	105	95	85	80	70	60	55	-
600 x 300	-	-	95	85	80	70	60	55	-
550 x 300	-	105	95	85	80	70	60	55	-
500 x 300	115	105	95	85	80	70	60	55	-
500 x 250	-	-	95	85	80	70	60	55	50
450 x 300	-	-	-	-	80	70	60	55	50
450 x 250	-	-	-	-	80	70	60	55	50
400 x 300	-	-	-	-	80	70	60	55	50
400 x 250	-	-	-	-	80	70	60	55	50
400 x 200	-	-	-	-	80	70	60	55	50
350 x 300	-	-	-	-	80	70	60	55	50
350 x 250	-	-	-	-	80	70	60	55	50
350 x 200	-	-	-	-	80	70	60	55	50
300 x 200	-	-	-	-	80	70	60	55	50
250 x 150	-	-	-	-	80	70	60	55	50

**SEVERE EXPOSURE** 56.5 l/m² or greater per spell**Heap lap (mm)**

Size (Nominal) mm	Minimum Rafter Pitch								
	20°	22.5°	25°	27.5°	30°	35°	40°	45° to 75°	85°
600 x 350	-	130	120	110	100	90	80	70	-
600 x 300	-	-	-	-	100	90	80	70	-
550 x 300	-	130	120	110	100	90	80	70	-
500 x 300	-	130	120	110	100	90	80	70	-
500 x 250	-	-	-	110	100	90	80	70	65
450 x 300	-	-	-	-	100	90	80	70	65
450 x 250	-	-	-	-	100	90	80	70	65
400 x 300	-	-	-	-	100	90	80	70	65
400 x 250	-	-	-	-	100	90	80	70	65
400 x 200	-	-	-	-	100	90	80	70	65
350 x 300	-	-	-	-	100	90	80	70	65
350 x 250	-	-	-	-	100	90	80	70	65
350 x 200	-	-	-	-	100	90	80	70	65
300 x 200	-	-	-	-	100	90	80	70	65
250 x 150	-	-	-	-	100	90	80	70	65

Roof materials

Clay

- Long lasting (less than slate)
- Fire resistant
- More porous
- Many shapes (flat or curved)



Plain clay tiles
35°- 50° Pitch



Plain clay tiles Hooked
over battens and nailed
every course
Staggered joints



Historic clay
Roman tiles
15⁰- 20⁰ Pitch

Roof tile materials

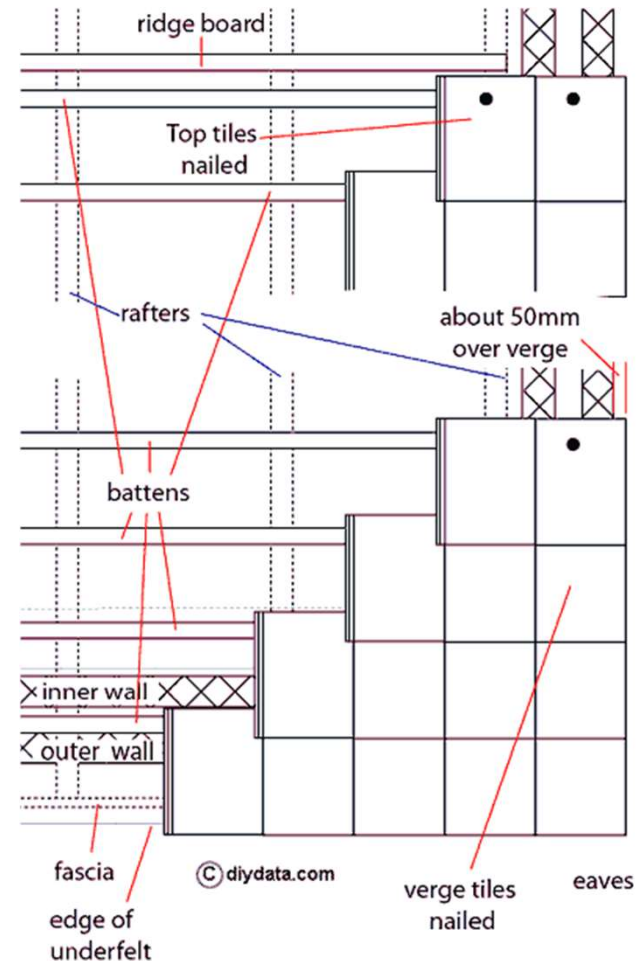
Concrete

- Most common type in the UK
- Much stronger
- Can support weather conditions much better (wind, rain)
- Fire resistance
- Cheaper

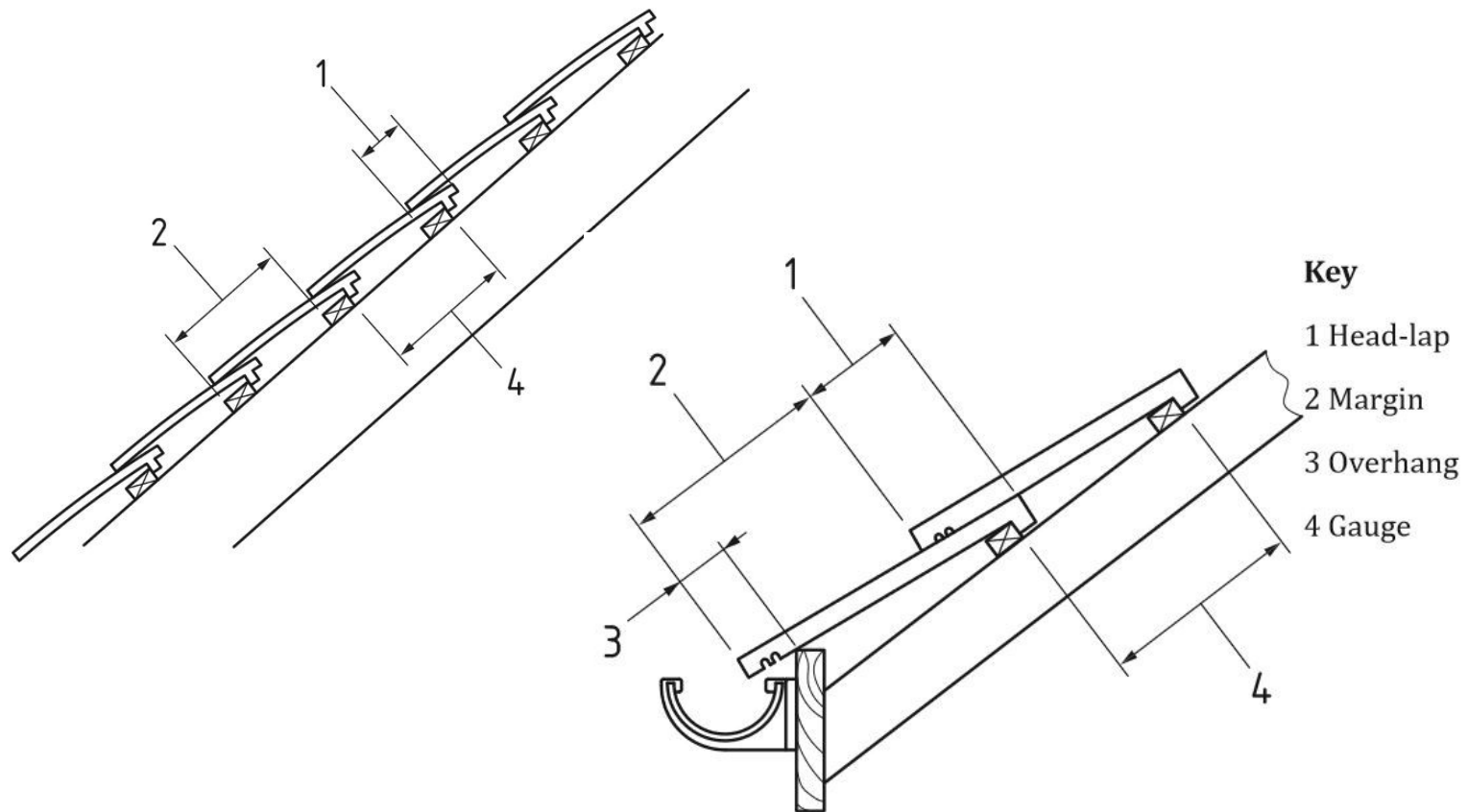
ROOF COVER



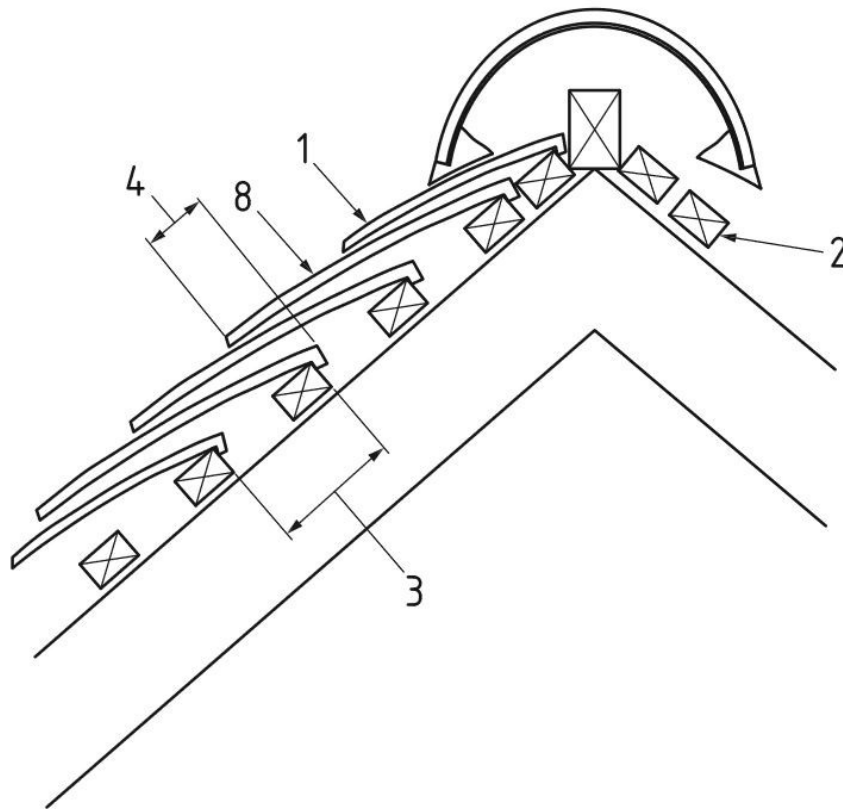
Just interlocking concrete tiles
At pitches lower than 12.5°
With a bigger angle, concrete tiles
hooked over battens
Nailed every 4th row
Straight joints or staggered



Single lap, flat tiles



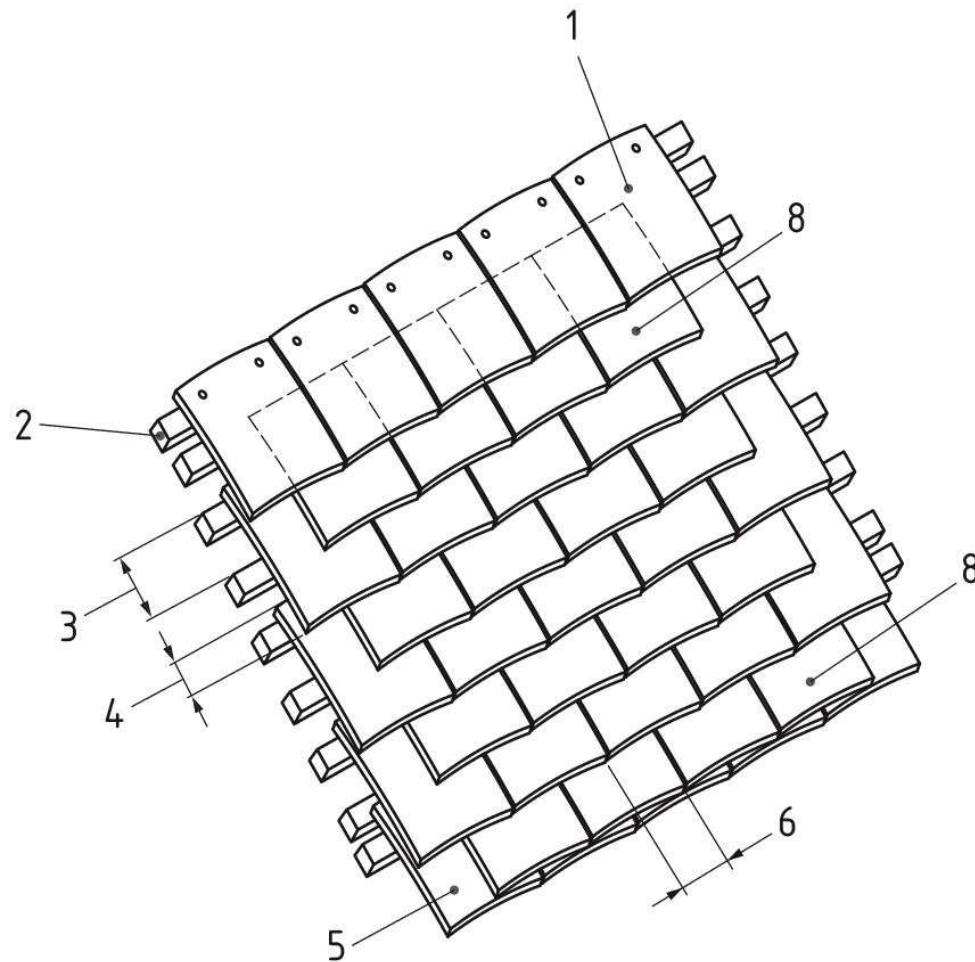
Double lap, flat tiles



Key

- 1 Top course tiles
- 2 Tile battens
- 3 Batten/tile gauge
- 4 Tile head-lap
- 5 Eaves course tiles
- 6 Side-lap
- 7 Area of spread of water
- 8 Standard tiles

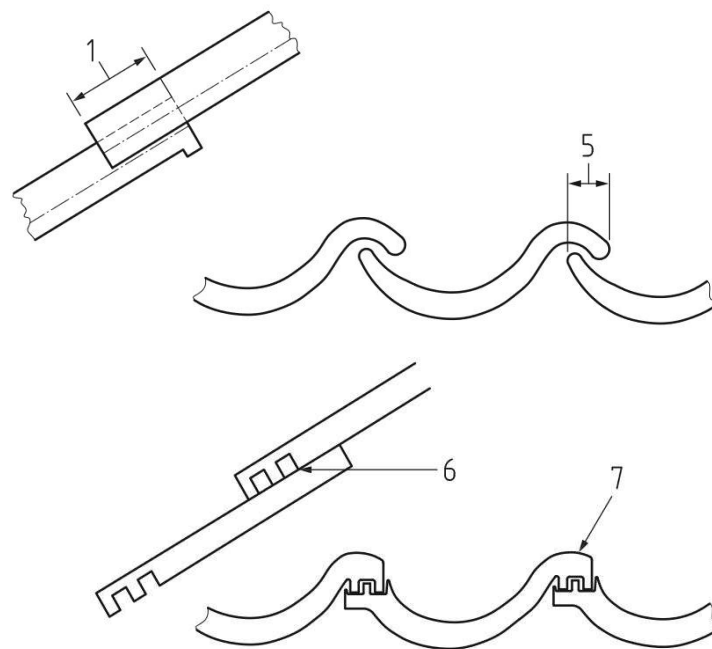
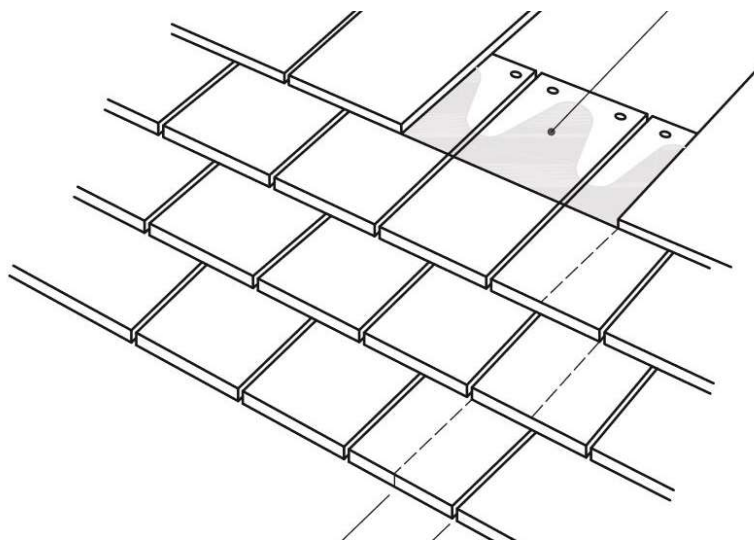
Double lap, flat tiles



Key

- | | |
|---|-------------------------|
| 1 | Top course tiles |
| 2 | Tile battens |
| 3 | Batten/tile gauge |
| 4 | Tile head-lap |
| 5 | Eaves course tiles |
| 6 | Side-lap |
| 7 | Area of spread of water |
| 8 | Standard tiles |

Side laps



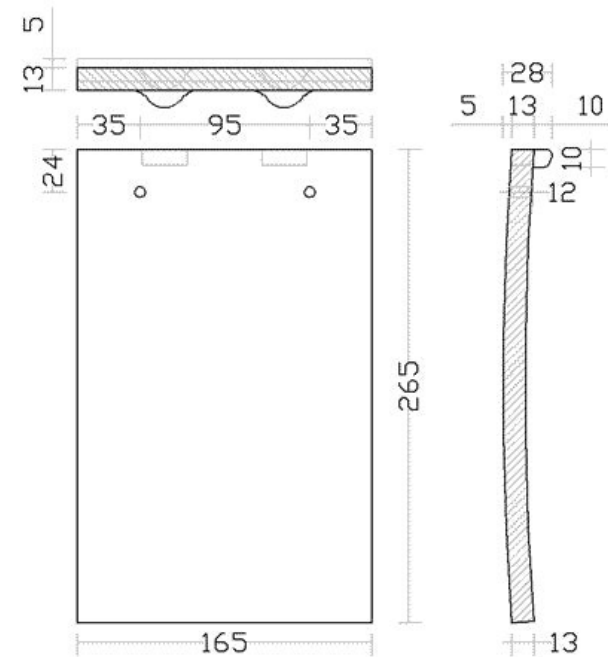
5 Overlapping side-lap

6 Anti-capillary bars

7 Side interlock

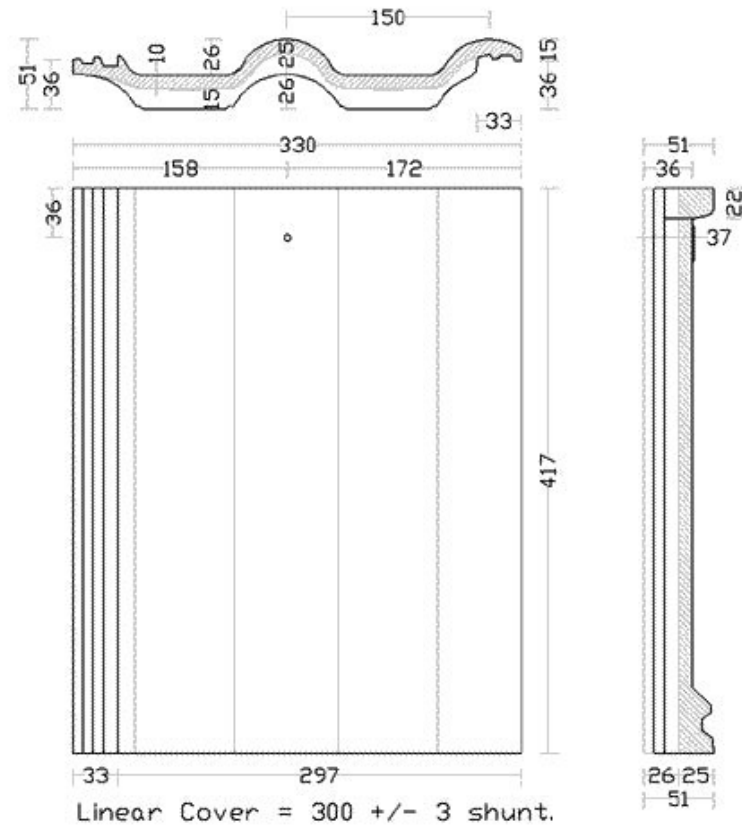
TRADITIONAL SLATES
SIZE IN INCHES - LENGTH x WIDTH

EMPRESS	26 x 16	VISCOUNTESS	18 x 9
PRINCESS	24 x 14	WIDE LADY	16 x 10
DUCHESS	24 x 12	BROAD LADY	16 x 9
SMALL DUCHESS	22 x 12	LADY	16 x 8
MARCHIONESS	22 x 11	WIDE HEADER	14 x 12
BROAD COUNTESS	20 x 12	HEADER	14 x 10
COUNTESS	20 x 10	SMALL LADY	14 x 8
SMALL COUNTESS	18 x 10	NARROW LADY	14 x 7



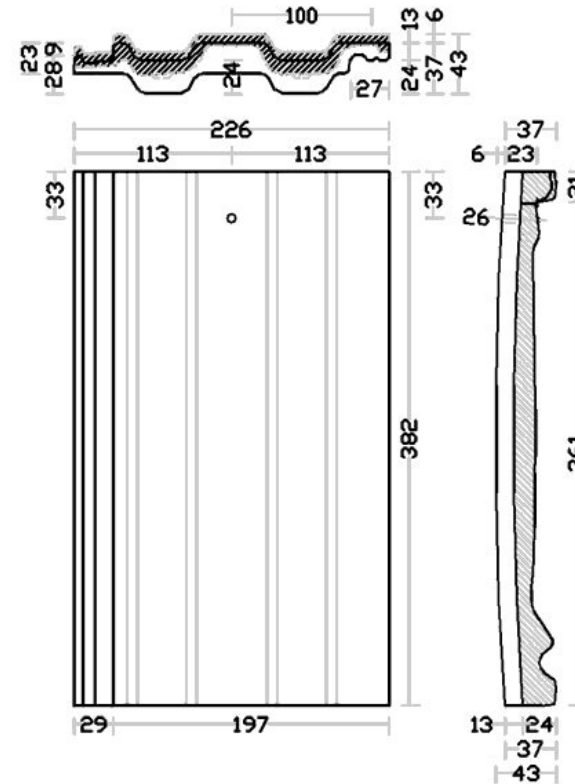
Linear Cover = 166.5 +/- 1.5 shunt.

Rosemary Clay Classic Smooth



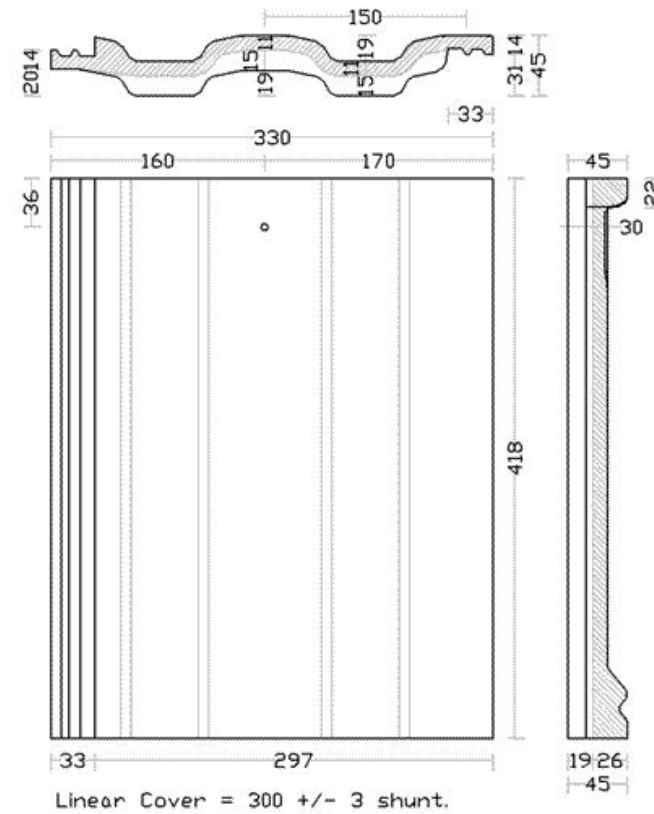
Double Roman Concrete Interlocking


Redland



Linear Cover = 200 (±3 Shunt)

Concrete Profiled



Renown Concrete

Fibre cement slates



Were asbestos!
Nailed as natural slate
but additional copper
disc rivets are
required



Timber shingles

Western Red Cedar or Sweet Chestnut



Stone tiles



Stone tiles with
diminished courses
Traditionally hooked over
battens with dry oak pegs

Detailing and supplementary guidance from manufacturers.



Profile sheets

Corrugated steel (iron)

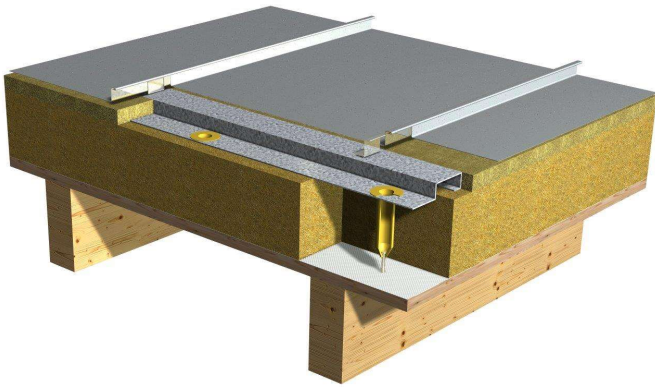


Profile sheets

Box section – plain & Insulated



Profile sheets Standing Seam



<https://www.euroclad.com/roofs/vieo-roof-profile/>

Profile sheets

Plastic, steel or composite replicating tiles or slates



**Thatch - Long straw or reed
depending upon exposure and location
Steeper pitch for reed thatch**



Solar roofing tiles



Exercise

Design the following joints:

- Valley
- Hip
- Encounter with a chimney

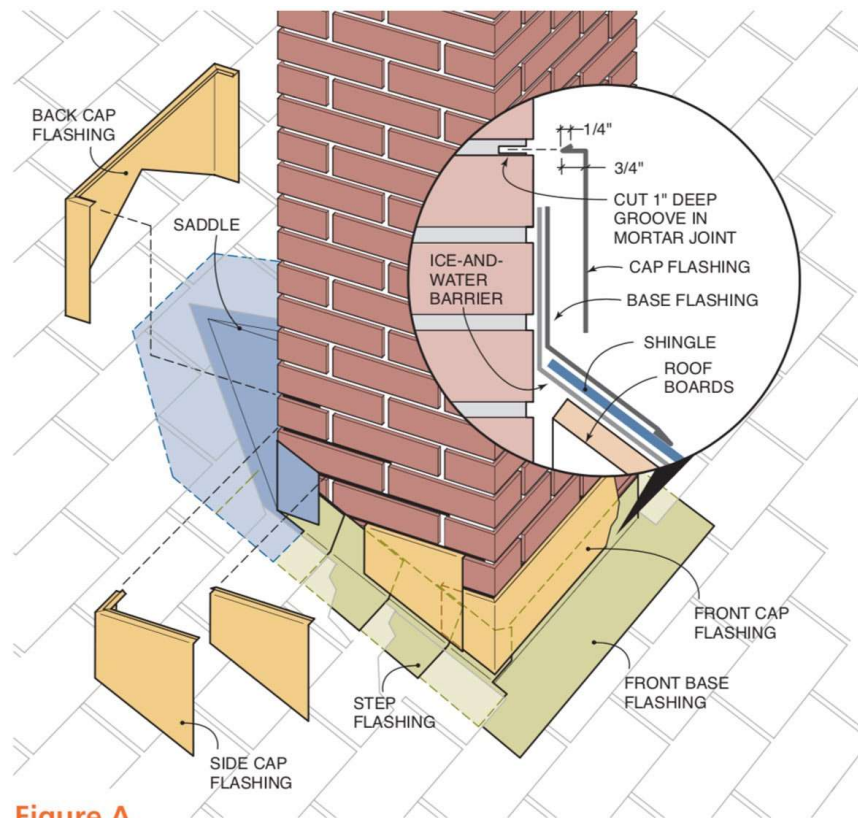
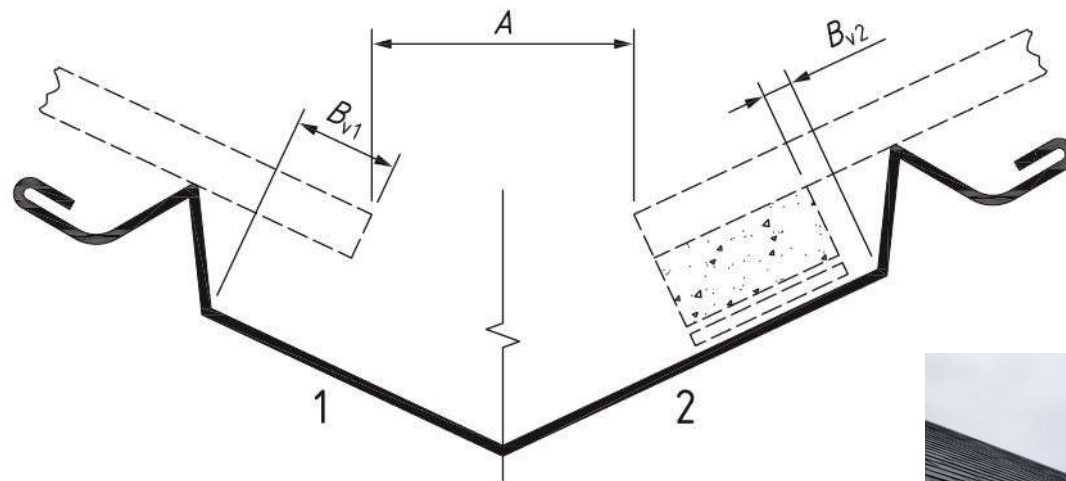


Figure A
Chimney flashing details





Key

A Valley gutter width

B_{v1} Tile/slate overhang to the tilting fillet to be not less than 50 mm

B_{v2} Clear channel between bedding and tilting fillet to be not less than 25 mm



Minimum gutter valley width (BS 5534:2014+A2:2018)

Roof pitch	Valley gutter width (A) ^{A)}					
	Design rainfall rate 225 mm/h		Design rainfall rate 150 mm/h		Design rainfall rate 75 mm/h	
	$X_d \leq 25$ m ² on plan ^{B)}	$X_d > 25$ m ² , ≤ 100 m ² on plan ^{C)}	$X_d \leq 25$ m ² on plan ^{B)}	$X_d > 25$ m ² , ≤ 100 m ² on plan ^{C)}	$X_d \leq 25$ m ² on plan ^{B)}	$X_d > 25$ m ² , ≤ 100 m ² on plan ^{C)}
	mm	mm	mm	mm	mm	mm
12.5 to 17	150	250	125	200	125	150
17.5 to 22	125	200	125	150	100	125
22.5 to 29	100	150	100	125	100	100
30 to 34	100	125	100	100	100	100
≥ 35	100	100	100	100	100	100

NOTE See also NFRC Technical Bulletin 28 [12].

^{A)} Dimension A (see [Figure 7](#)) is measured as a horizontal distance between the tiles or slates in metres.

^{B)} See 6.13.2b).

^{C)} See 6.13.2c).

Summary

Roof Construction

