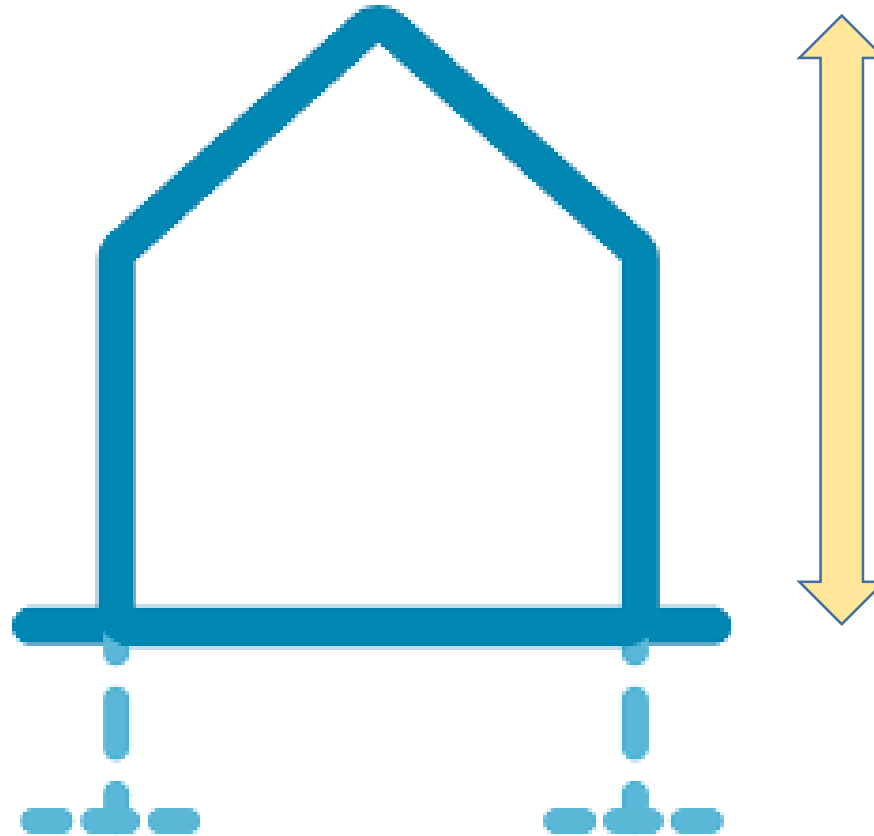
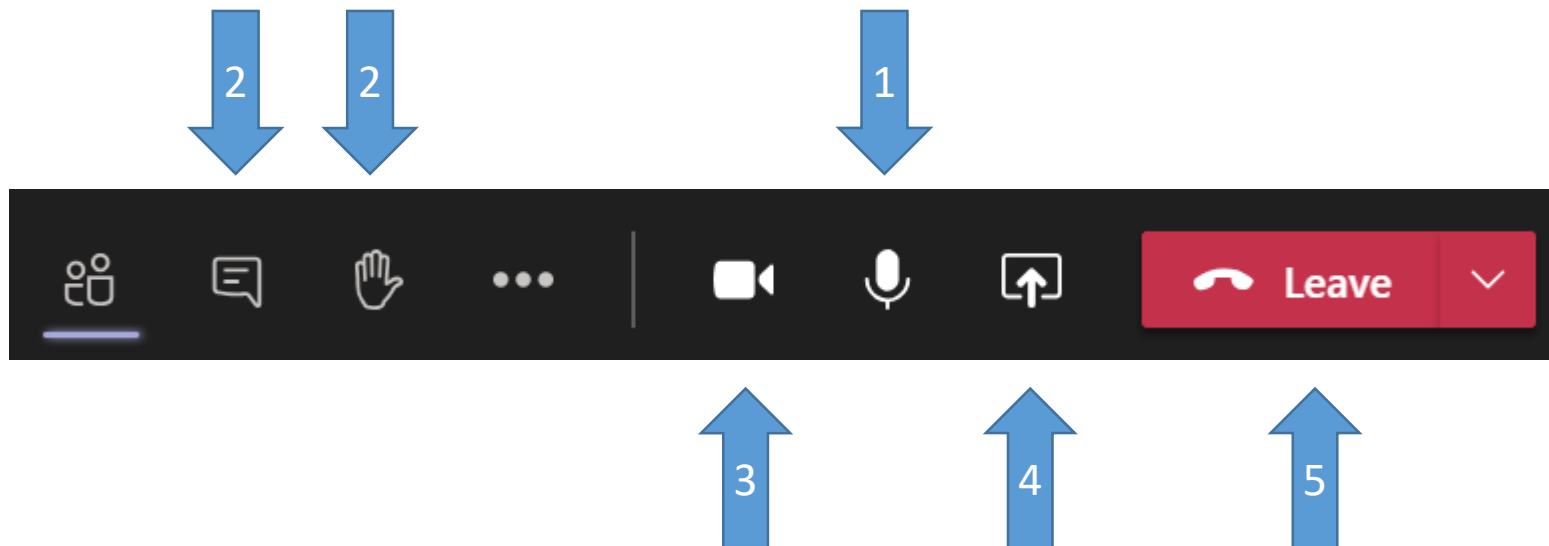


Superstructure 4: Fundamentals of Construction Technology



MS TEAMS HOUSEKEEPING

1. Mute your Microphone
2. Use Chat to Ask Questions or Put your hand Up
3. If you have a poor connection switch off Camera
4. I may ask you to share your screen.
5. When the lecture ends please hang up



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FUNDAMENTALS OF CONSTRUC... ..

General

GROUND WORKS 2

GROUND WORKS 3

Groundworks 1

GROUNDWORKS 5

SUB-STRUCTURE and GROUNDWORK INTROD...

Superstructure wk1

1 hidden channel

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📁	Class Materials		Alan Nantel
📄	ACBA4001 Assignment 1 - brief.docx	October 14	Oliver James Macki...
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📄	Assignment 1.docx		
📄	Borehole Log to print for		
📄	Construction Management		
📄	CPD Presentation.pptx		
📄	EXAMPLE-Site-Investigati		
📄	FOUNDATIONS1.pptx		
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General > Superstructure Lectures

📄	Name	Modified	Modified By
📄	Fundamentals Con Tech Superstructure 1.pdf	November 10	Gavin Traylor
📄	Fundamentals Con Tech Superstructure 2.pdf	6 days ago	Gavin Traylor
📄	Wk 01 Superstructure - Introduction.mp4	6 days ago	Gavin Traylor
📄	Wk 01a Superstructure - Walls.mp4	6 days ago	Gavin Traylor
📄	Wk 02 Superstructure Walls Openings.mp4	6 days ago	Gavin Traylor
📄	Wk 02a Superstructure - Building Regs.mp4	6 days ago	Gavin Traylor

Fundamentals of Construction Technology (ACBA4001)

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ExLibris
Leganto Online Resources List



Fundamentals of Construction Technology (ACBA4001)

PUBLISHED ACBA4001 (2019-20) 14 items in 2 sections

LIST SENT NEW SECTION ADD ITEMS +

Essential reading (4) Material which is an essential part of the course and students are expected to draw on as a core part of their learning. Must be available from the library and should be available online.

	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 : Essential Complete Check holdings	11
	BOOK Construction technology : industrial and commercial building. 2 Riley, Mike., Cotgrave, Alison., 3rd edition., Basingstoke :, Palgrave Macmillan, 2014., Total Pages 427 p. : Essential Complete Check holdings	8
	BOOK Building construction handbook Chudley, R., Greeno, Roger., 8th ed. , Oxford ;, Butterworth-Heinemann, 2010., Total Pages xi, 828 p. : Essential Complete Check holdings	6
	BOOK Architectural technology [electronic resource] Emmitt, Stephen., 2nd ed., Hoboken, N.J. :, Wiley-Blackwell, 2012., Total Pages 1 online resource (265 p.) Essential Complete Check availability >	2

Further reading (10)

ACBA 4001
FUNDAMENTALS OF CONSTRUCTION
TECHNOLOGY: LEVEL 4

Week 4:

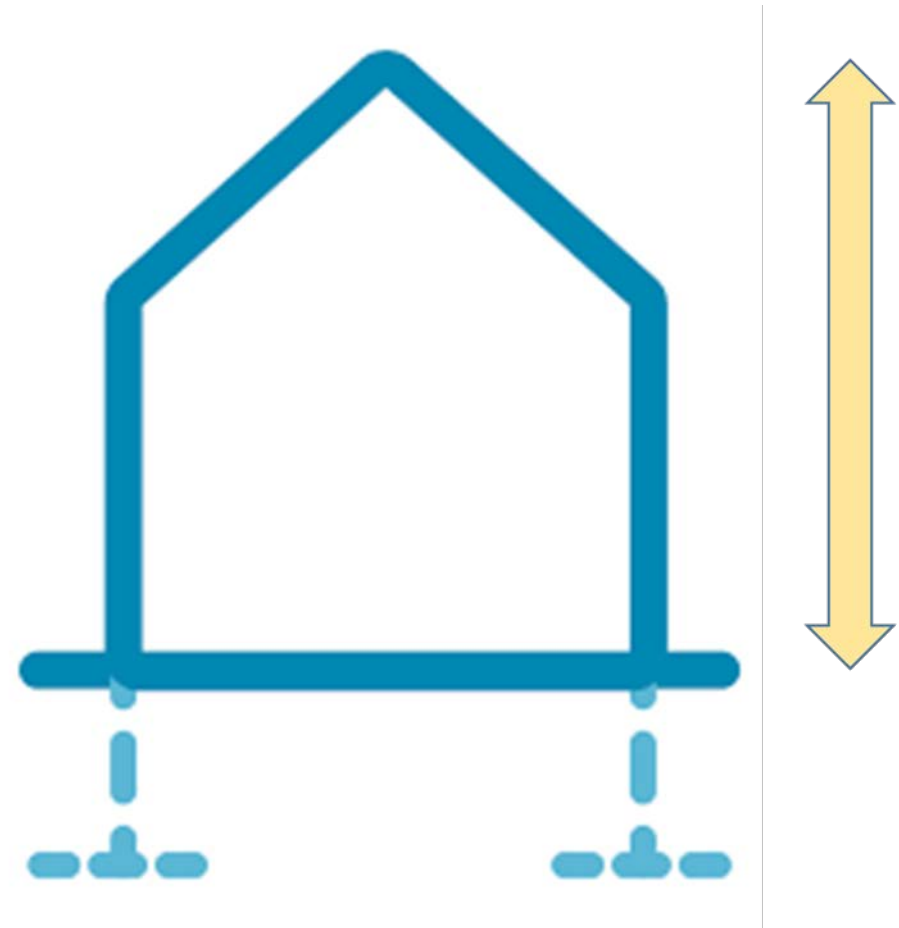
Recap on Assessment 2

Ground Floors

Upper Floors

Roof Construction

Thermal Performance



Assessment 2

Submission
deadline:

22nd January 2021

Module Learning Outcomes (from module syllabus)

- Identify the different types of substructure available for a range of low-rise building systems and techniques used in their production.
- Define and produce annotated sketches that illustrate a broad range of common constructional forms, demonstrating understanding of their potential defect and repair needs.



APPENDIX GA36a

LEVEL 4 ASSESSMENT SPECIFICATION

Student name:		Student ID number:	
Programme:	Construction Portfolio		
Module:	Fundamentals of Construction Technology		
Module code:	ACBA4001	Contribution to Overall Module Assessment (%):	50%
Lecturer:	Gavin Traylor	Internal Verifier:	Allan Nantel
Assignment Title:	New Build Dwelling: Technical report with drawings	Word count (or equivalent):	2,500 words (or equivalent)
Submission deadline:	Friday 22 nd January	Return date of provisional marks & written feedback:	Within 20 working days
Submission method:	All written assessments, where practical and possible, must be submitted via Turnitin unless otherwise instructed by the Lecturer. (Please DO NOT put this assessment specification into Turnitin or it will match many similarities with other students' submissions.) Alternative submission method (if applicable): Late submission of the assessment will result in a late penalty mark. Penalties for late submission: Up to one week late, maximum mark of 40%. Over one week late, 0%. Only the Extenuating Circumstances Panel may approve a change to submission dates.		
Academic honesty / referencing:	Academic honesty is required. In the main body of your submission you must give credit to authors on whose research and ideas your work is based. Append to your submission a reference list that indicates the books, articles, etc. that you have used, cited or quoted in order to complete this assessment.		

Module Learning Outcomes (from module syllabus)

- Identify the different types of substructure available for a range of low-rise building systems and techniques used in their production.
- Define 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:

22nd January 2021

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. [See attached floor plans and elevations].

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 with upper floors to be 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 trussed rafters with a metal profile sheeting finish installed on OSB sheathing boards.

The client has asked you to prepare a technical report that addresses some of the construction details required as they are unfamiliar with timber frame construction. Your technical report should be graphical and contain the tasks highlighted below:

Assessment 2

Submission
deadline:

22nd January 2021

*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 on page 5.*

1. 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**:

The Ground floor Construction, detailing and junctions with external walls. (20%)

The First floor Construction, detailing, junctions with external walls and restraints. (20%)

Eaves detailing and roof covering – indicating appropriate weathering, fixing and laps. (20%)

The main roof **structure**. Construction, detailing and fixing. (20%)

2. Given the specified roof structure and finish describe the advantages and disadvantages of such a method. Give an example of an alternative method of construction and describe what advantages or disadvantages that it may have. (10%)

3. Appropriate ventilation can play an important part of the design of a domestic building and is even more critical when considering a timber framed construction. Clearly describe the causes and sources of condensation, and the detrimental effects of condensation upon building fabric. (5%)

Using neat, annotated, proportional sketches where necessary, describe the appropriate methods of ventilation that will reduce condensation within this proposed building. (5%)

Assessment 2

Guidance specific to this assessment:

Submission
deadline:

22nd January 2021

Engagement with Literature Skills

Where techniques are suggested in the report make reference to the sources such as the Building Regulations and Good Practice. Use sources such as the CIS.

Knowledge and Understanding Skills

Demonstrate your understanding of the methods and techniques. This will be assessed by the depth and awareness of a professional context within this scenario.

Cognitive and Intellectual Skills

Demonstrate your knowledge and skills and present the work in a coherent and professional manner. This will also be assessed by the quality of your evaluation and conclusions.

Practical Skills

This will be assessed via the scenario and how your knowledge has been applied.

Transferable Skills for Life and Professional Practice

The report and drawings should be presented in a professional manner with all work clearly labelled and cross-referenced.

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	Marks available	Marks awarded
1. Engagement with Literature Skills	10	
2. Knowledge and Understanding Skills	25	
3. Cognitive and Intellectual Skills	25	
4. Practical Application Skills	25	
5. Transferable Skills for Life and Professional Practice	15	
Assessment Mark (Assessment marks are subject to ratification at the Exam Board. These comments and marks are to give feedback on module work and are for guidance only until they are confirmed.)	Late Submission Penalties (tick if appropriate) Up to 1 week late (10% loss) Over 1 week late (20% loss)	%

Assessment 2

Submission
deadline:

22nd January 2021



FRONT VIEW

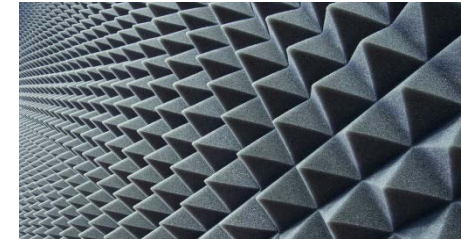
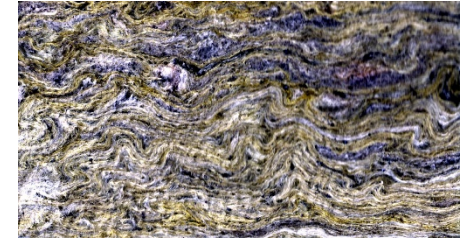


FRONT VIEW

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



GROUND FLOORS

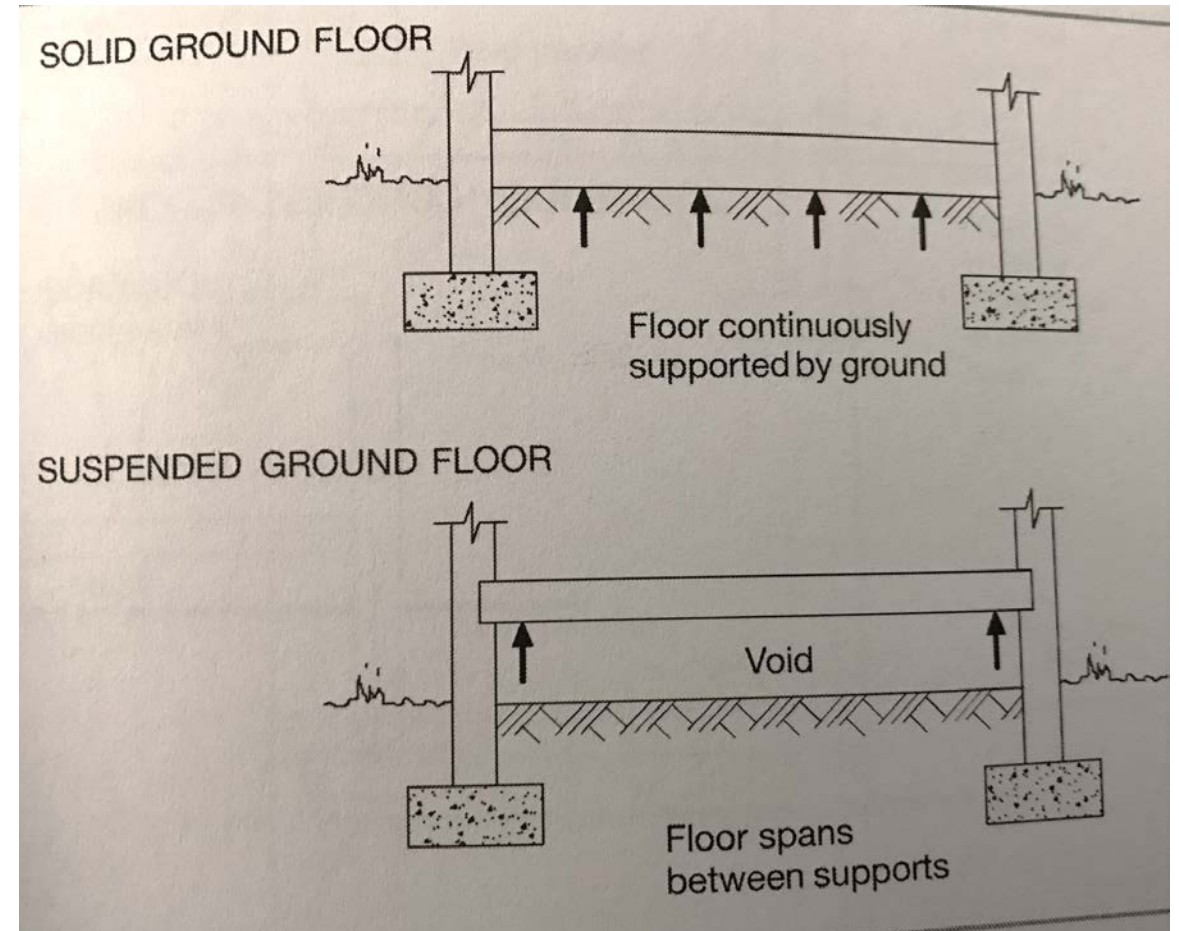
Aims

- **Function of ground floors and selection criteria**
- **Ground-supported floor options**
- **Suspended Floor options**
- **Timber upper floors**

Types of Ground Floor

Solid Floor are formed such that the underside of the floor is in continuous contact with and is supported by the Ground.

Suspended floors are formed such that the structural elements of the floor span between supports, not relying on the ground for support of the floor structures. This may result in the creation of a void beneath the floor and the ground.



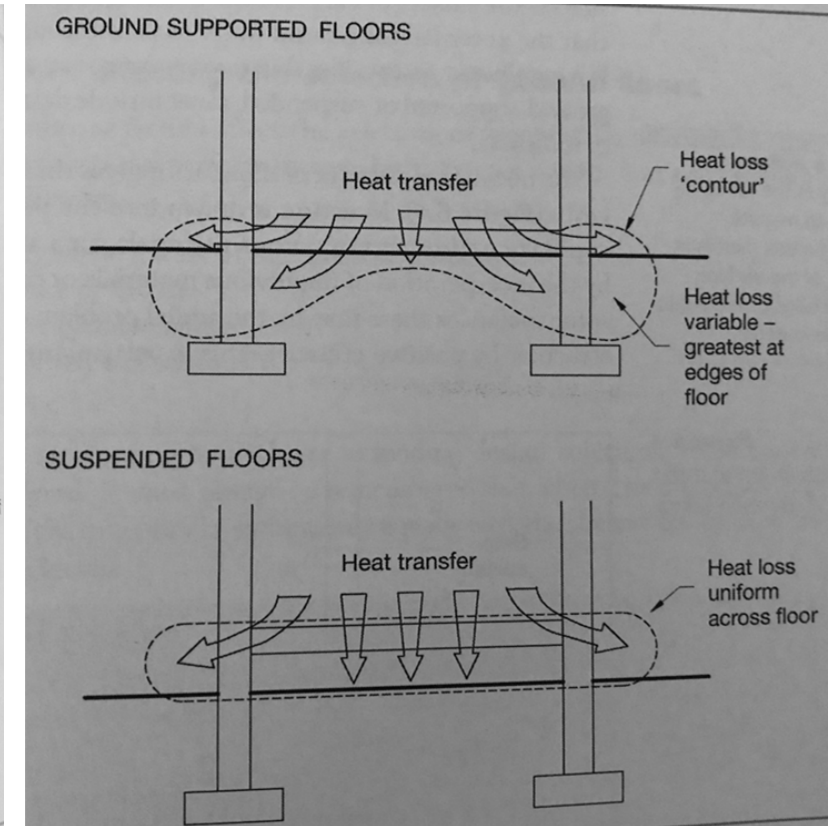
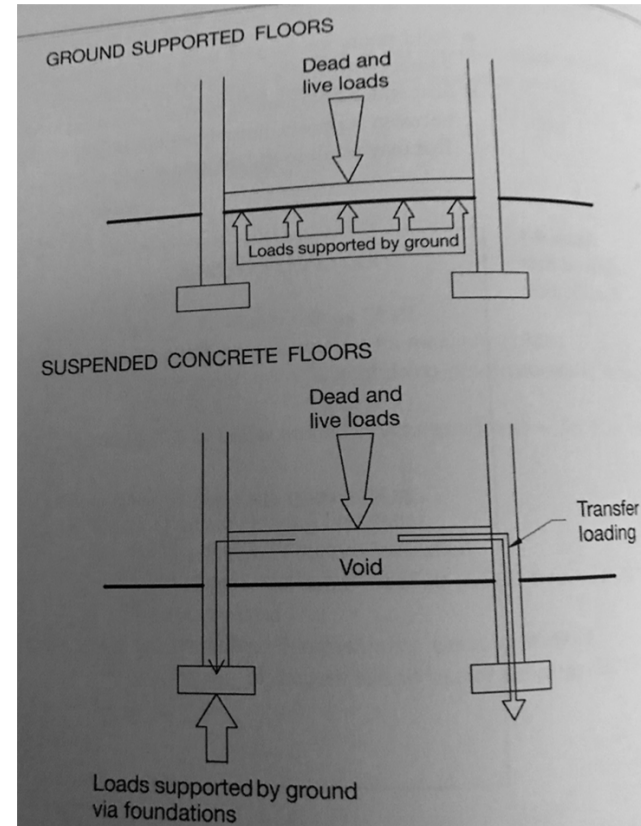
Functional requirements of Ground Floors

Structural Stability

Thermal Insulation

Exclusion of ground water and contaminants

Durability

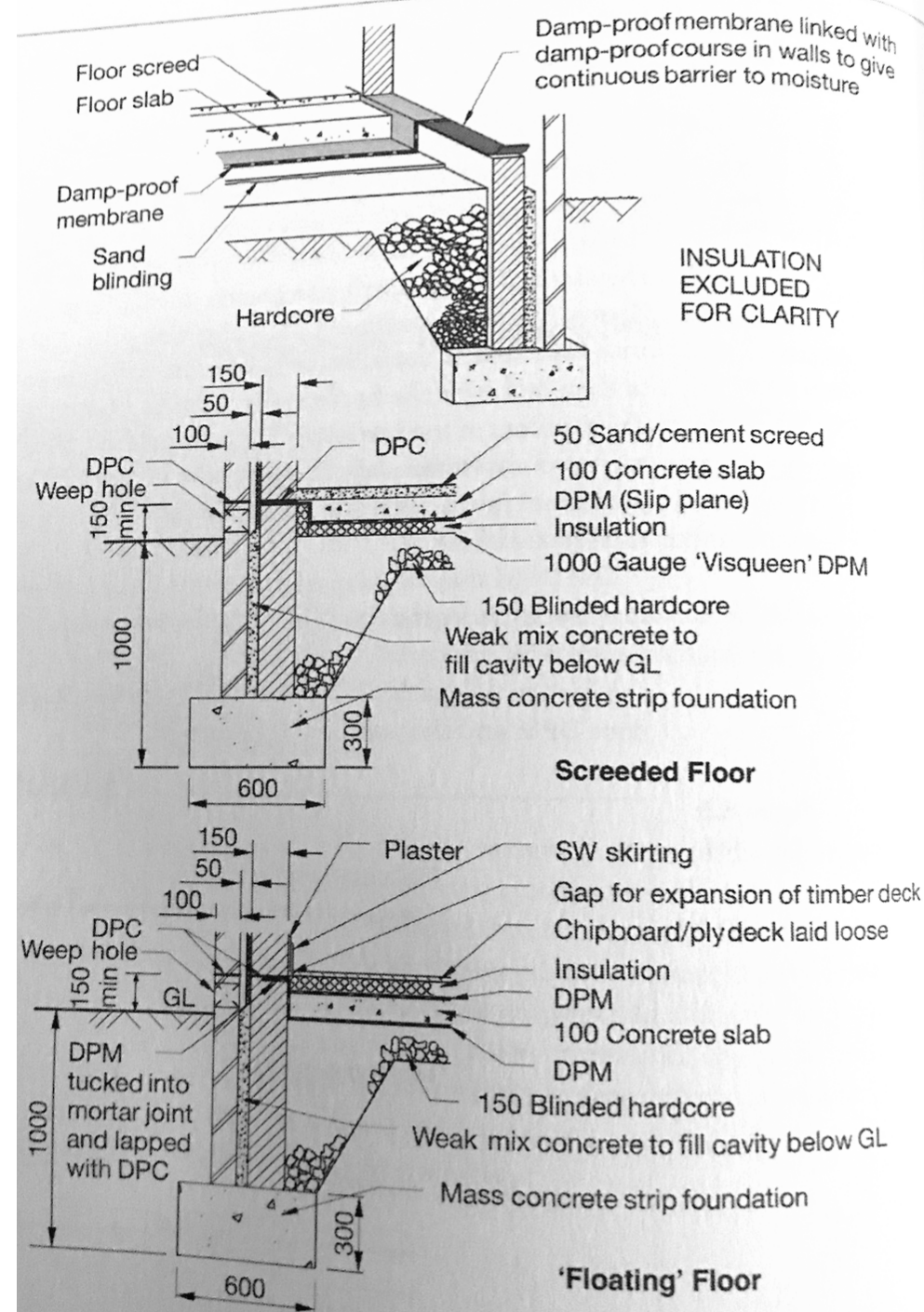


Solid Floor Construction

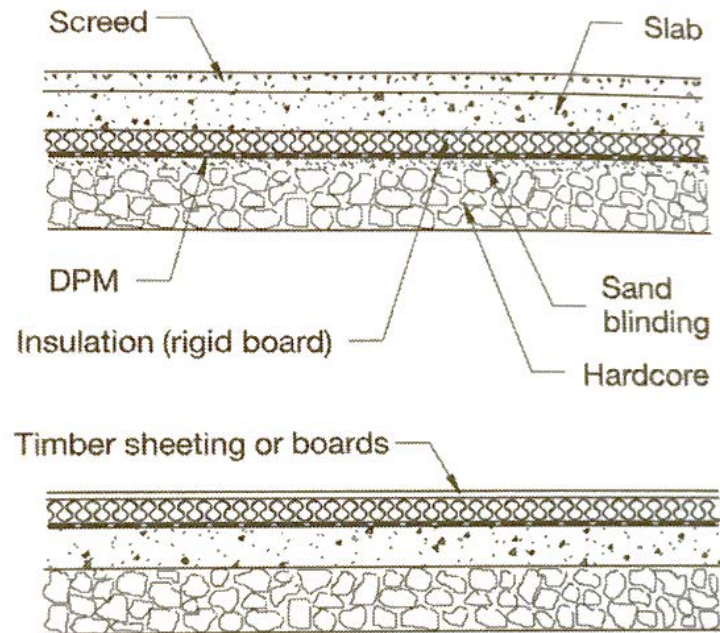
Term used to describe ground supported floors where all design options adopt the same approach to construction of layered elements. The Main Load-supporting element is the floor slab which would normally take the form of a layer of mass concrete cast in-situ to the desired level. Where ground bearing capacity is low, additional reinforcement bars and mesh can be added to the slab to increase the loadbearing capacity of the slab.

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 :

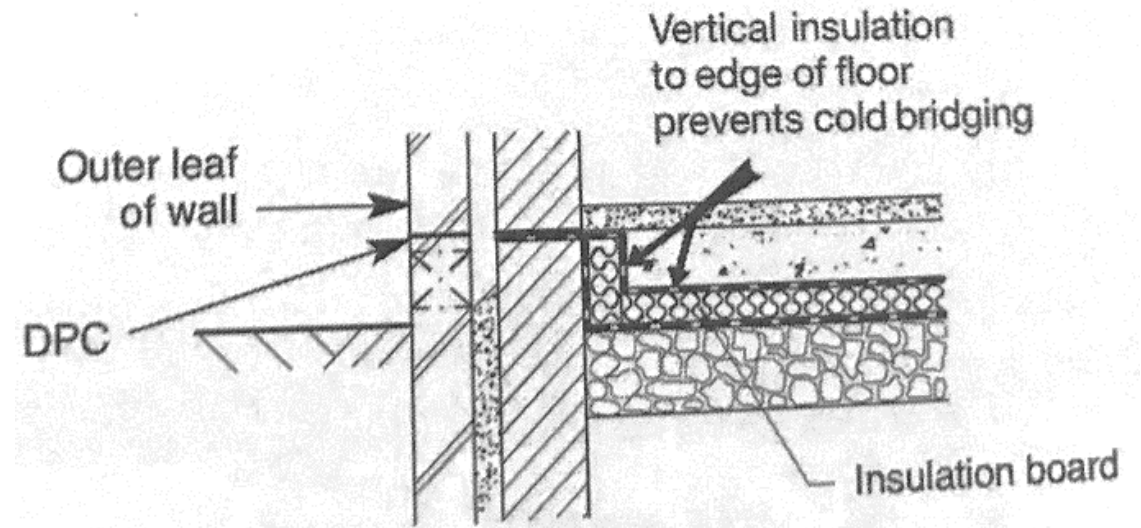


Thermal Insulation



Screeded Floor

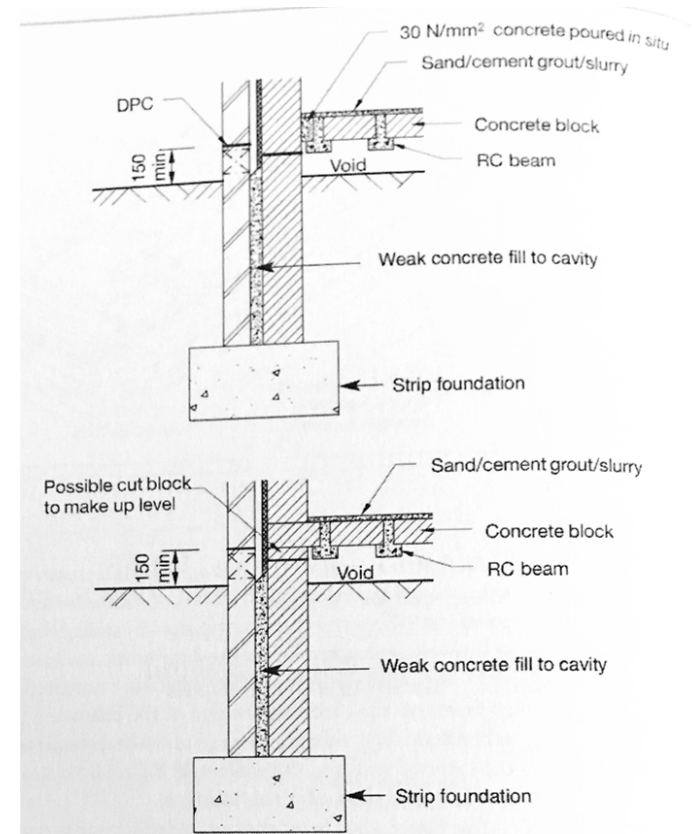
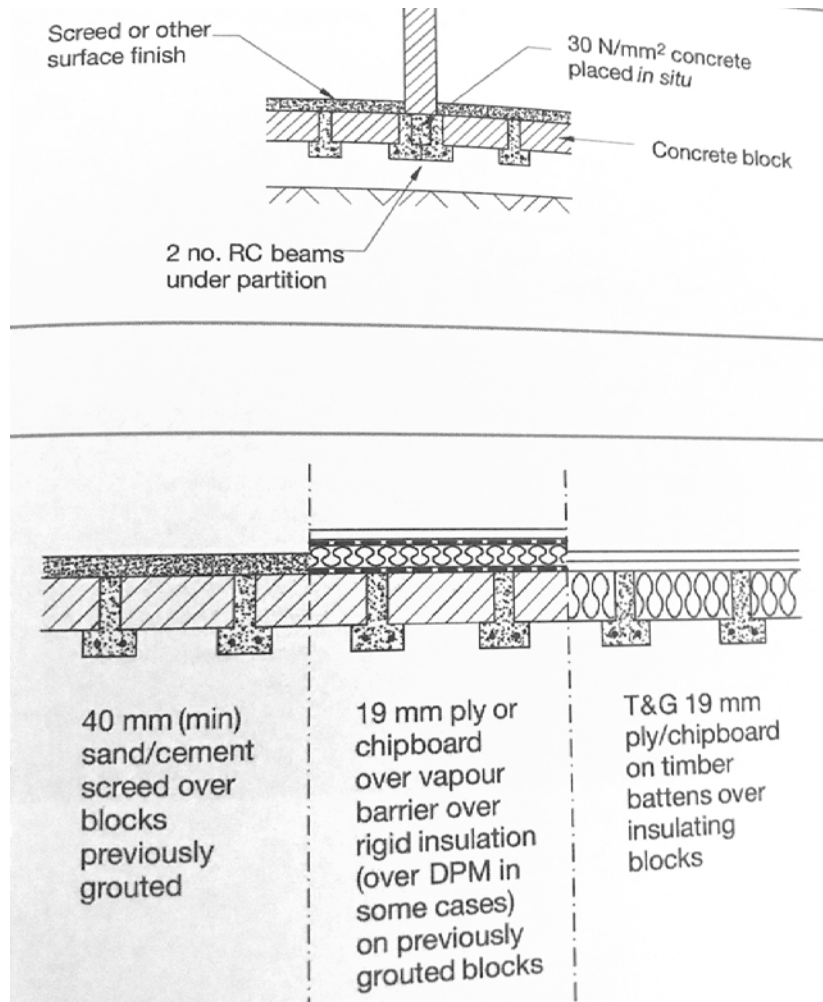
'Floating' Floor



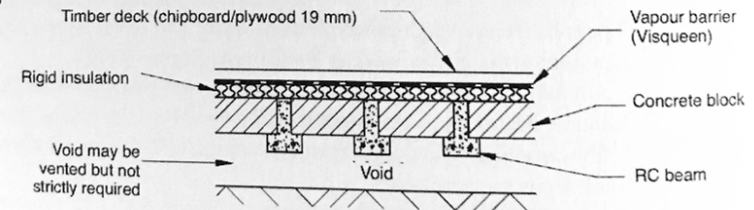
BEAM & BLOCK FLOORS



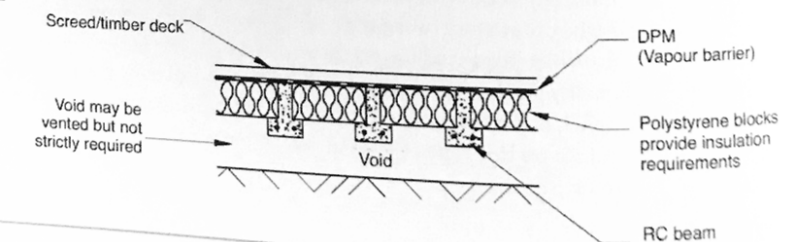
Typical details Beam and Block Suspended Floor



OPTION 1

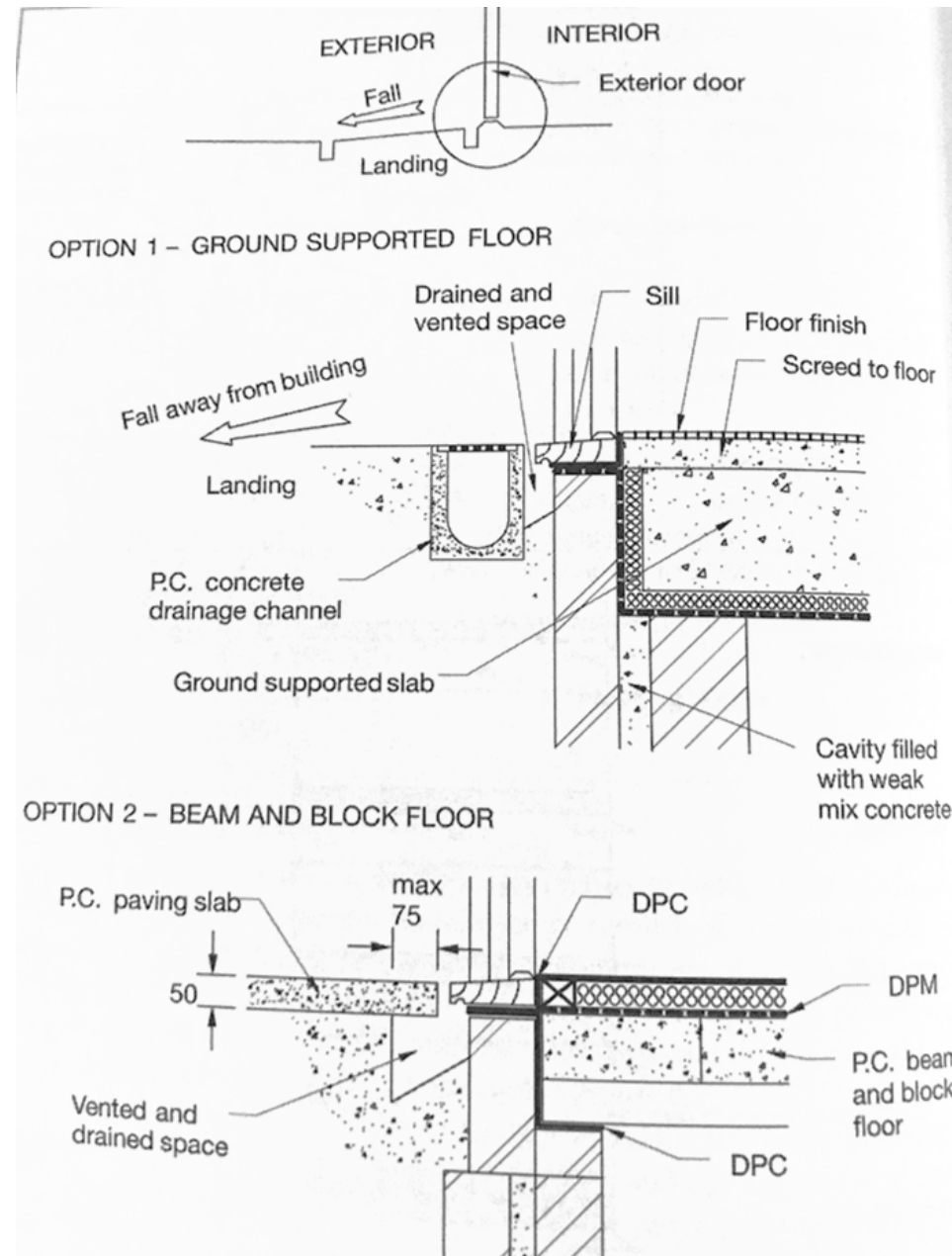


OPTION 2



Options for Level Access Threshold details.

Approved Document Part M



SUSPENDED TIMBER FLOORS



Introduction

Cheap and easy to construct

It can adapt to the site perfectly

Ground preparation is much reduced

It is the solution for level floors, but also can do for ground floors

Legislation applicable:

- Building Regulations, Document A
- Eurocode 5 span tables for solid timber members in floors, ceilings and roofs for dwellings. 4th edition (2014) (Parts 1 to 7)
- BS EN 1995-1-1:2004+A2:2014:2019 UK National Annex to Eurocode 5. Design of Timber Structures
- PD 6693-1:2019 Recommendations for the design of timber structures to Eurocode 5: Design of timber structures. General - common rules and rules for building
- BS 8103-3:2009 Structural design of low-rise buildings. Code of practice for timber floors and roofs for housing

Level floors

Built-in joists

Building in joists is acceptable provided that:

- Not a party wall (would affect acoustic insulation)
- Joists accurately cut to length (supported by the full width of the blockwork)
- Masonry accurately cut to allow an even mortar joint (of between 10mm and 15mm) all the way around the sides and tops of the joist.
- Mortar joint is to be struck or recessed to allow a bead of silicon mastic between the blockwork and the joist
- Blockwork is built level
- Silicon mastic bead installed after both the joists and the masonry are reasonably dry

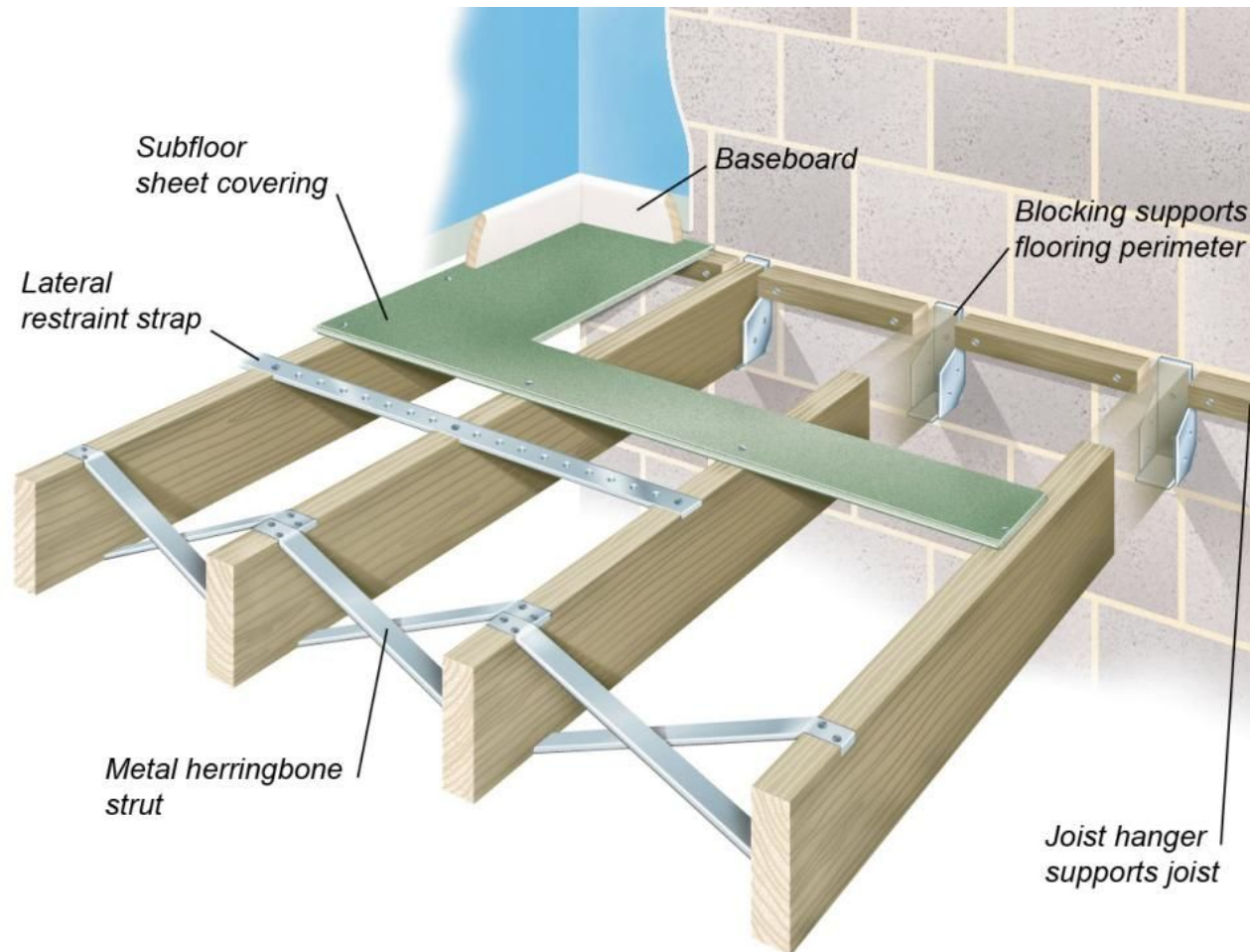
Level floors

Built-in joists



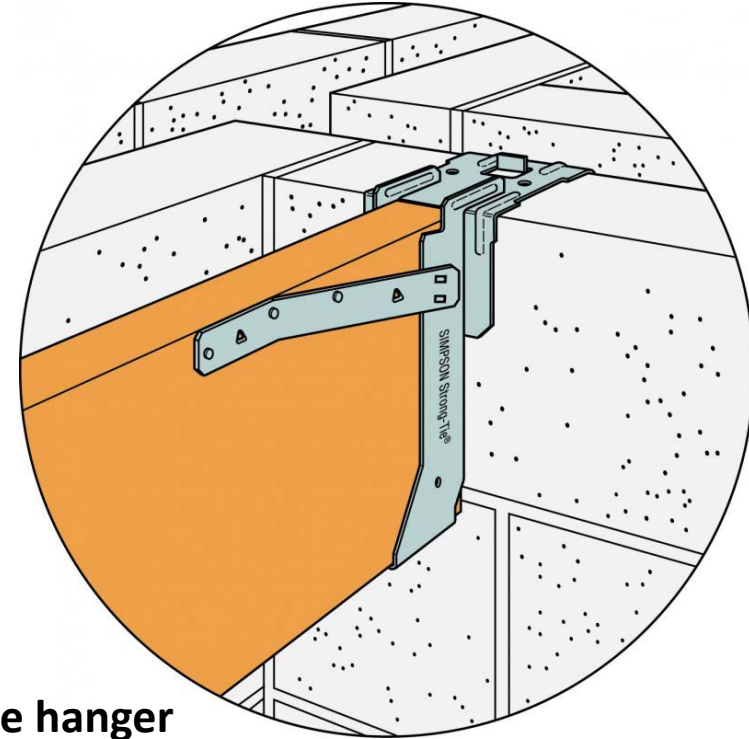
Level floors

With joist hangers



Level floors

With joist hangers



Typical joist hangers

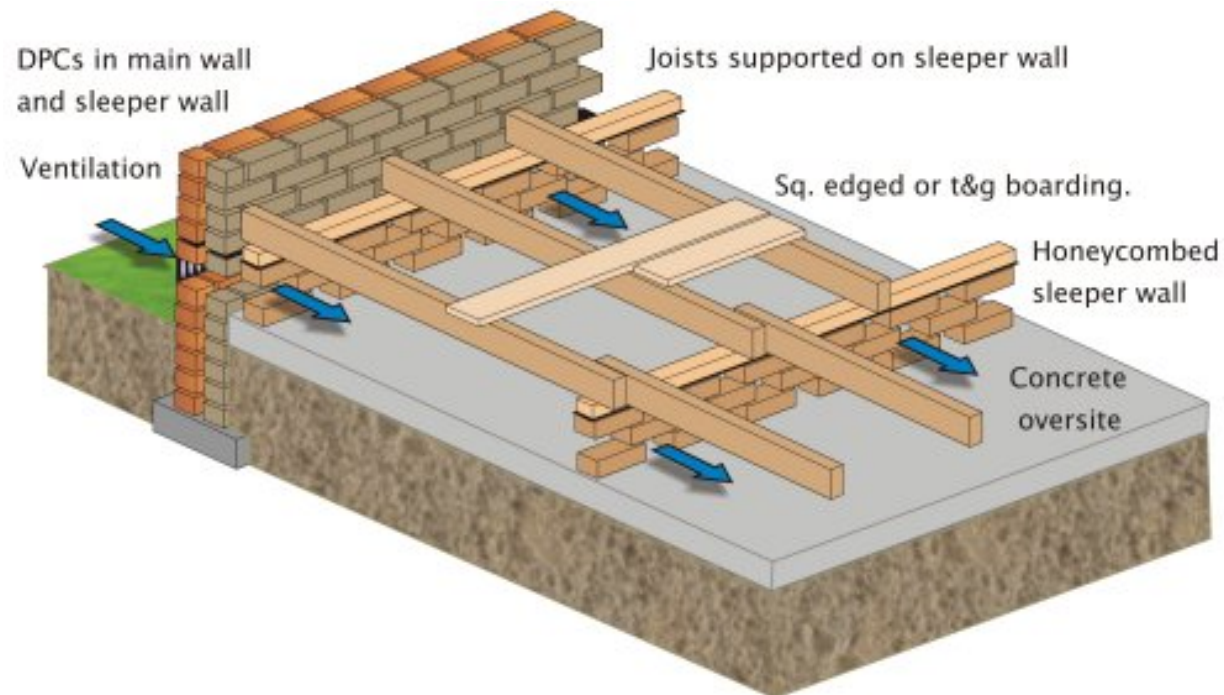


Restraint type hanger

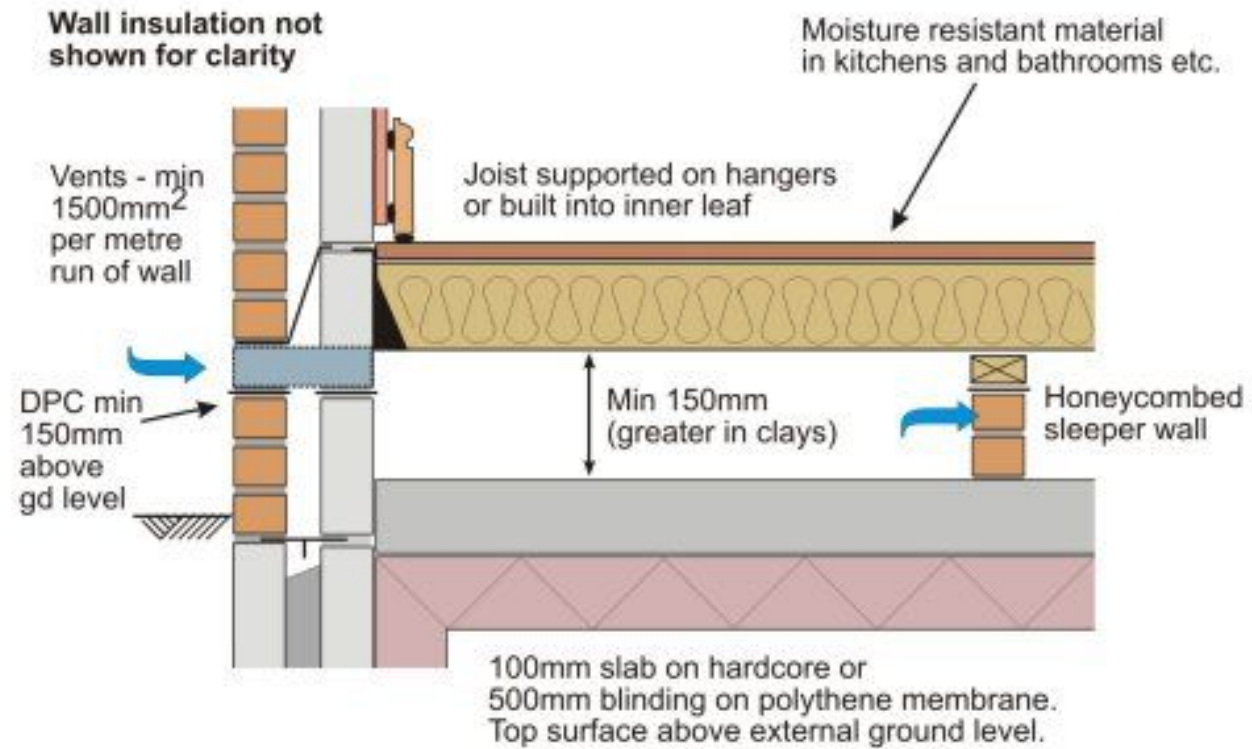


Ground floors

Also known as hollow floors or floating timber floors
It can be uneven ground, little ground preparation needed
Use of sleeper walls over strip foundations or slab.
Need of ventilation



Ground floors

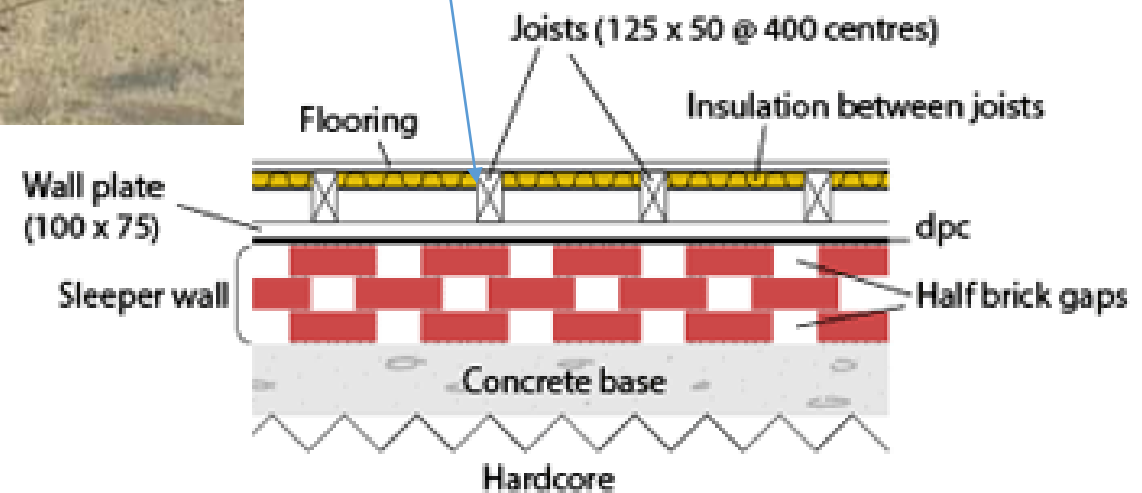


Ground floors

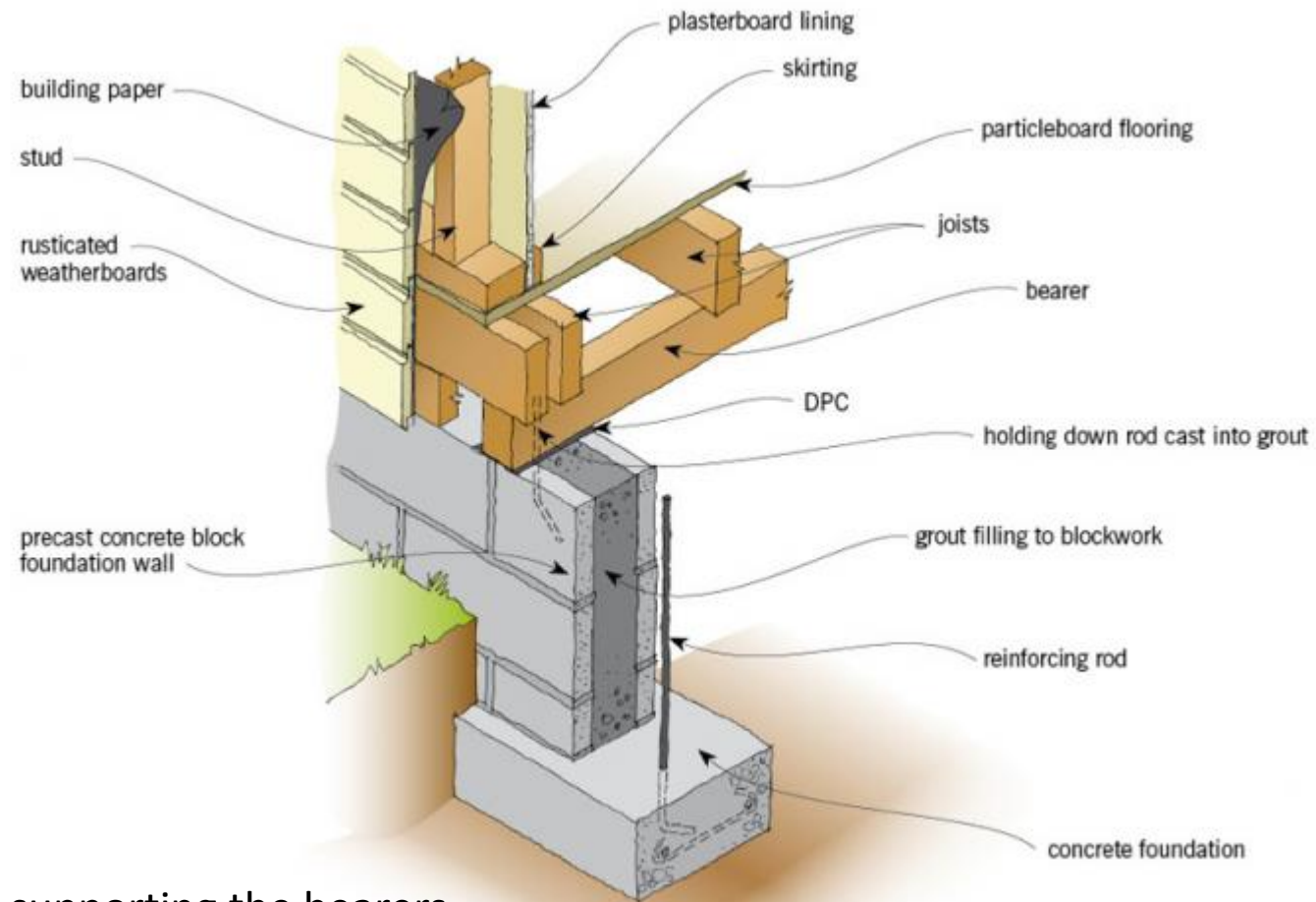


Problem:

Insulation is not continuous.
How can we solve it?

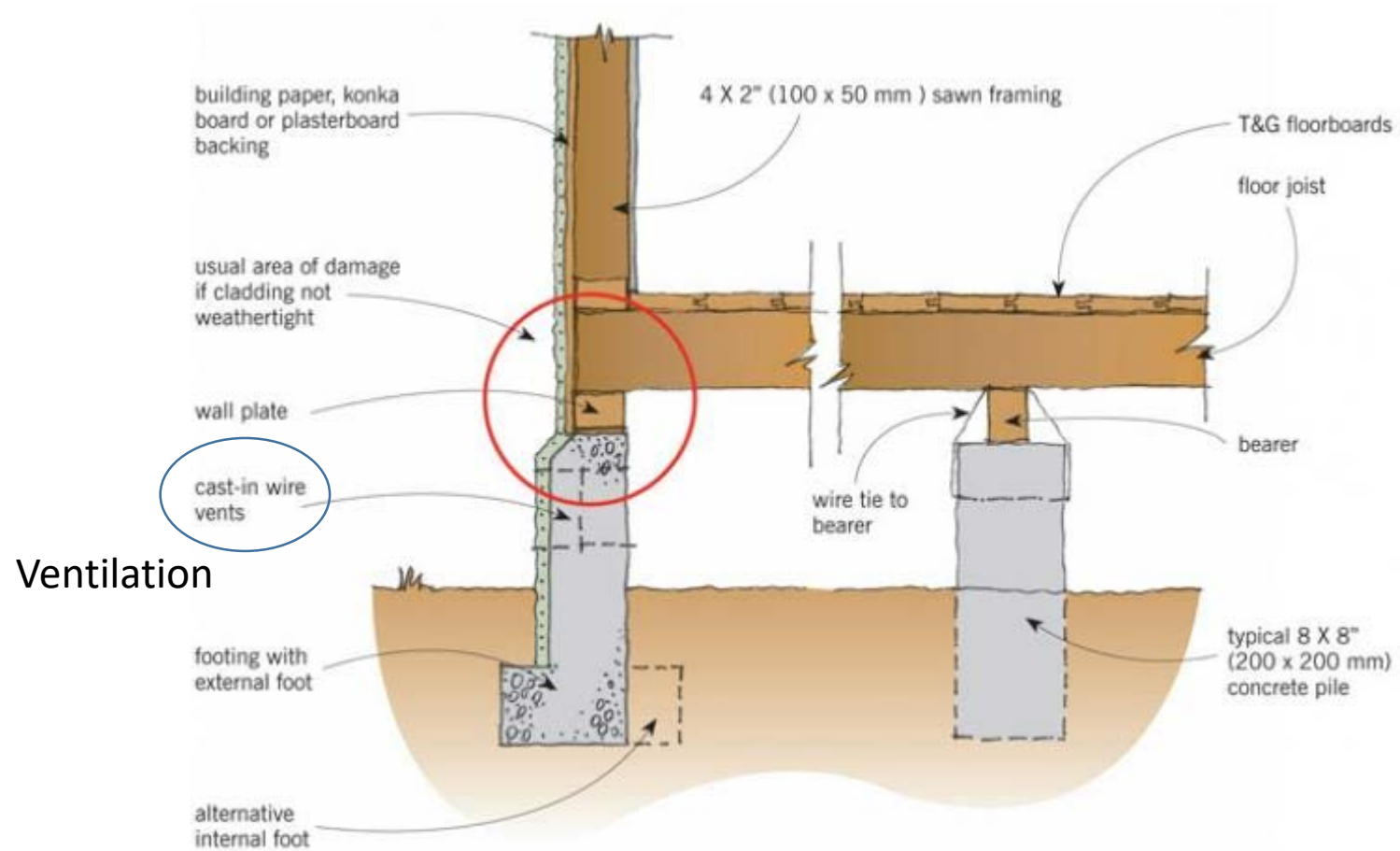


Ground floors. Use of bearers

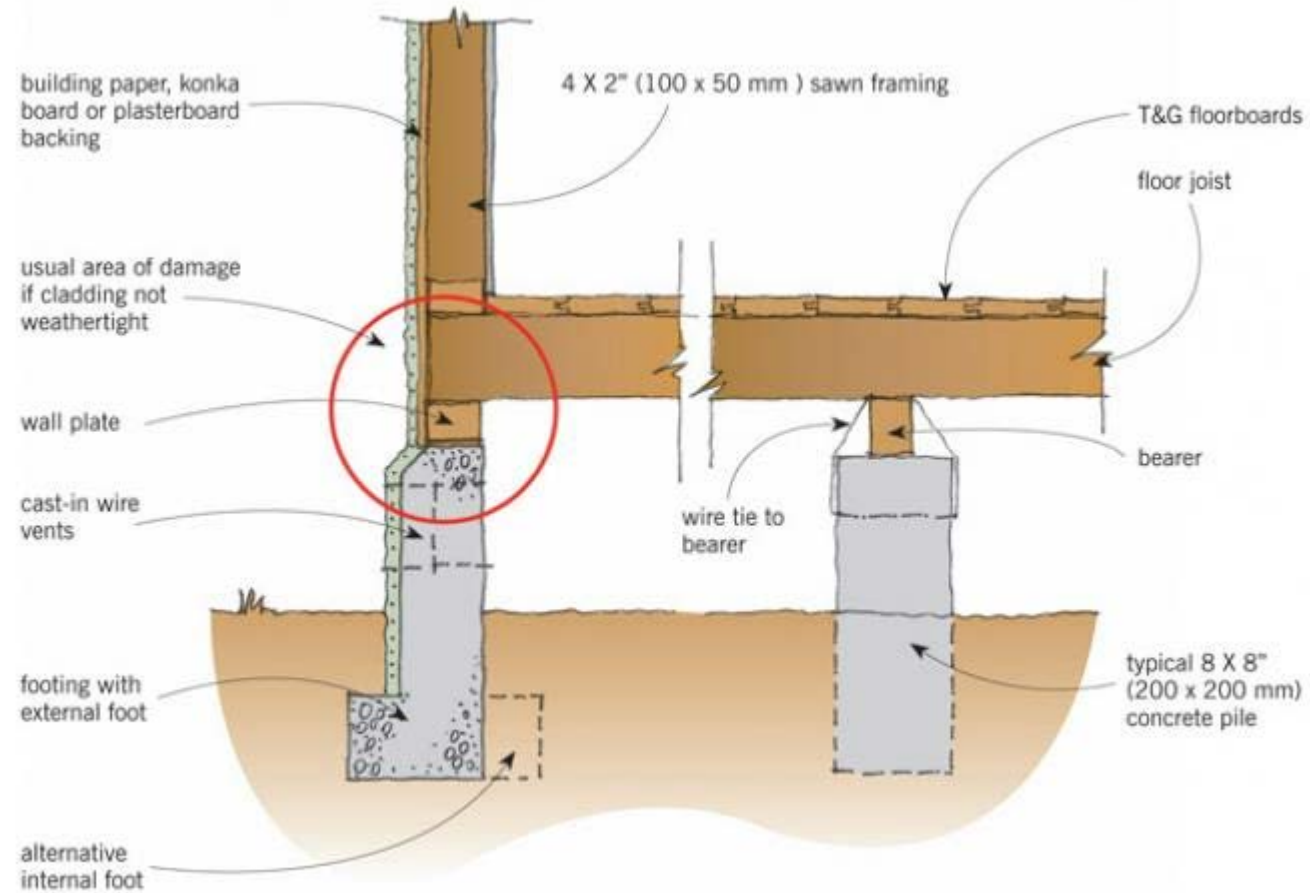


This wall is supporting the bearers
Ventilation is in the other direction

Ground floors. Use of bearers



Ground floors. Use of bearers



Permissible clear spans

BS 8103-3

Timber class C16

No partitions

Table 7 Permissible clear spans of joists supporting floors with no partitions. Timber of strength class C16

C16		No partitions								
Size of joist ^{A)} mm × mm		Dead load kN/m ²								
		Not more than 0.25			More than 0.25 but not more than 0.50			More than 0.50 but not more than 1.25		
		Spacing of joists mm								
		400	450	600	400	450	600	400	450	600
		Maximum clear span of joist m								
BS EN 336 sizes with sawn thickness to tolerance class 1 and processed depth to tolerance class 2	38 × 72	1.130	1.011	0.767	1.061	0.954	0.731	0.920	0.834	0.652
	38 × 97	1.828	1.692	1.303	1.717	1.556	1.214	1.423	1.301	1.037
	38 × 120	2.482	2.385	1.925	2.368	2.215	1.755	1.947	1.791	1.448
	38 × 145	2.983	2.868	2.510	2.853	2.707	2.331	2.453	2.290	1.872
	38 × 170	3.442	3.306	2.873	3.281	3.098	2.690	2.808	2.649	2.267
	38 × 195	3.939	3.752	3.263	3.724	3.518	3.056	3.189	3.010	2.609
	38 × 220	4.434	4.193	3.648	4.161	3.932	3.418	3.567	3.367	2.920
	47 × 72	1.324	1.233	0.942	1.272	1.154	0.891	1.091	0.993	0.783
	47 × 97	2.024	1.914	1.583	1.920	1.818	1.460	1.665	1.527	1.228
	47 × 120	2.663	2.561	2.302	2.548	2.450	2.087	2.255	2.081	1.696
	47 × 145	3.200	3.078	2.786	3.062	2.945	2.609	2.723	2.570	2.174
	47 × 170	3.691	3.551	3.188	3.533	3.398	2.987	3.116	2.942	2.552
	47 × 195	4.221	4.063	3.619	4.042	3.889	3.391	3.538	3.341	2.900
	47 × 220	4.723	4.572	4.044	4.549	4.354	3.791	3.954	3.735	3.244
	63 × 97	2.319	2.197	1.919	2.191	2.079	1.822	1.934	1.839	1.533
	63 × 120	2.931	2.821	2.566	2.807	2.700	2.454	2.527	2.429	2.088
	63 × 145	3.518	3.388	3.084	3.370	3.244	2.950	3.037	2.920	2.577
	63 × 170	4.055	3.905	3.558	3.886	3.741	3.404	3.504	3.370	2.950
	63 × 195	4.633	4.465	4.070	4.442	4.278	3.896	4.009	3.850	3.350
	63 × 220	5.061	4.923	4.580	4.905	4.770	4.365	4.512	4.301	3.745
	75 × 120	3.100	2.985	2.718	2.970	2.859	2.601	2.677	2.575	2.327
	75 × 145	3.719	3.582	3.265	3.564	3.432	3.125	3.216	3.094	2.807
	75 × 170	4.283	4.128	3.765	4.107	3.957	3.605	3.709	3.569	3.212
	75 × 195	4.830	4.700	4.306	4.683	4.523	4.125	4.242	4.084	3.646
	75 × 220	5.268	5.128	4.793	5.109	4.971	4.641	4.740	4.595	4.074
CLS/ALS sizes	38 × 89	1.617	1.463	1.121	1.499	1.356	1.052	1.259	1.149	0.910
	38 × 140	2.843	2.733	2.398	2.719	2.587	2.167	2.330	2.149	1.752
	38 × 184	3.721	3.557	3.092	3.530	3.334	2.895	3.022	2.852	2.471
	38 × 235	4.710	4.460	3.890	4.430	4.180	3.640	3.800	3.590	3.110

Minimum design bearing length

If wane at end-bearing [see Figure 8 b)] is permitted to the strength class limit, i.e. one-third of thickness for strength class C16, the minimum design bearing length is 38 mm.

If wane is not permitted, the minimum design bearing length is 20 mm.

See also 6.5.2.

^{A)} Check the availability of section sizes.

Permissible
clear spans

BS 8103-3

Timber class
C24

No partitions

Table 8 Permissible clear spans of joists supporting floors with no partitions. Timber of strength class C24

C24		No partitions								
Size of joist ^{A)} mm × mm		Dead load kN/m ²								
		Not more than 0.25			More than 0.25 but not more than 0.50			More than 0.50 but not more than 1.25		
		Spacing of joists mm								
		400	450	600	400	450	600	400	450	600
		Maximum clear span of joist m								
BS EN 336 sizes with sawn thickness to tolerance class 1 and processed depth to tolerance class 2	38 × 72	1.262	1.189	1.023	1.215	1.146	0.989	1.108	1.048	0.874
	38 × 97	1.936	1.829	1.586	1.838	1.739	1.514	1.635	1.551	1.358
	38 × 120	2.582	2.482	2.200	2.469	2.369	2.076	2.180	2.073	1.826
	38 × 145	3.103	2.984	2.709	2.969	2.854	2.588	2.667	2.561	2.305
	38 × 170	3.580	3.444	3.128	3.426	3.294	2.989	3.079	2.958	2.678
	38 × 195	4.096	3.941	3.581	3.921	3.771	3.423	3.526	3.388	3.068
	38 × 220	4.609	4.436	4.034	4.413	4.246	3.856	3.971	3.816	3.458
	47 × 72	1.404	1.324	1.144	1.347	1.273	1.103	1.223	1.159	1.010
	47 × 97	2.141	2.025	1.763	2.026	1.920	1.678	1.795	1.705	1.499
	47 × 120	2.770	2.664	2.421	2.651	2.549	2.290	2.382	2.268	2.006
	47 × 145	3.327	3.201	2.910	3.185	3.064	2.783	2.865	2.754	2.496
	47 × 170	3.836	3.693	3.359	3.674	3.535	3.212	3.307	3.179	2.883
	47 × 195	4.387	4.224	3.845	4.202	4.045	3.678	3.786	3.640	3.302
	47 × 220	4.860	4.725	4.328	4.707	4.552	4.141	4.262	4.099	3.720
	63 × 97	2.432	2.321	2.030	2.308	2.192	1.925	2.032	1.934	1.709
	63 × 120	3.046	2.933	2.669	2.918	2.808	2.553	2.628	2.527	2.273
	63 × 145	3.665	3.521	3.207	3.503	3.372	3.069	3.158	3.038	2.759
	63 × 170	4.211	4.058	3.699	4.037	3.888	3.541	3.643	3.505	3.185
	63 × 195	4.770	4.637	4.231	4.614	4.445	4.052	4.168	4.011	3.646
	63 × 220	5.204	5.064	4.731	5.046	4.908	4.560	4.678	4.514	4.106
CLS/ALS sizes	75 × 120	3.220	3.102	2.827	3.086	2.972	2.705	2.784	2.678	2.678
	75 × 145	3.862	3.721	3.394	3.703	3.567	3.250	3.344	3.218	3.218
	75 × 170	4.446	4.286	3.913	4.265	4.110	3.748	3.855	3.711	3.711
	75 × 195	4.966	4.833	4.474	4.816	4.686	4.287	4.408	4.245	4.245
	75 × 220	5.415	5.272	4.932	5.253	5.113	4.778	4.878	4.743	4.743
	38 × 89	1.713	1.617	1.399	1.633	1.544	1.341	1.464	1.388	1.201
	38 × 140	2.957	2.844	2.581	2.829	2.719	2.466	2.541	2.440	2.170
	38 × 184	3.869	3.723	3.382	3.703	3.561	3.232	3.329	3.199	2.897
38 × 235	4.850	4.710	4.310	4.700	4.540	4.120	4.240	4.080	3.700	

Minimum design bearing length

If wane at end-bearing [see Figure 8 b)] is permitted to the strength class limit, i.e. one-third of thickness for strength class C24, the minimum design bearing length is 45 mm.

If wane is not permitted, the minimum design bearing length is 24 mm.

See also 6.5.2.

^{A)} Check the availability of section sizes.

Permissible clear spans

BS 8103-3

Timber class C16

Lightweight Partitions

Table 9 Permissible clear spans of joists for floors supporting non load-bearing lightweight partitions^{A)}.
Timber of strength class C16

C16		Lightweight partitions								
Size of joist ^{B)} mm × mm		Dead load kN/m ²								
		Not more than 0.25			More than 0.25 but not more than 0.50			More than 0.50 but not more than 1.25		
		Spacing of joists mm								
		400	450	600	400	450	600	400	450	600
		Maximum clear span of joist m								
BS EN 336 sizes with sawn thickness to tolerance class 1 and processed depth to tolerance class 2	38 × 72	1.017	0.910	0.690	0.955	0.859	0.658	0.828	0.751	0.586
	38 × 97	1.646	1.523	1.173	1.545	1.401	1.093	1.281	1.171	0.933
	38 × 120	2.234	2.147	1.732	2.131	1.993	1.579	1.753	1.612	1.303
	38 × 145	2.685	2.581	2.259	2.568	2.437	2.098	2.207	2.061	1.684
	38 × 170	3.098	2.976	2.586	2.953	2.788	2.421	2.527	2.384	2.040
	38 × 195	3.545	3.377	2.937	3.352	3.166	2.750	2.871	2.709	2.348
	38 × 220	3.990	3.773	3.284	3.745	3.539	3.076	3.210	3.030	2.628
	47 × 72	1.191	1.110	0.848	1.145	1.038	0.802	0.982	0.894	0.705
	47 × 97	1.822	1.723	1.424	1.728	1.636	1.314	1.498	1.375	1.105
	47 × 120	2.397	2.305	2.071	2.293	2.205	1.878	2.030	1.872	1.526
	47 × 145	2.880	2.770	2.507	2.756	2.650	2.348	2.451	2.313	1.957
	47 × 170	3.322	3.196	2.869	3.180	3.059	2.688	2.805	2.648	2.297
	47 × 195	3.799	3.657	3.257	3.638	3.500	3.052	3.184	3.007	2.610
	47 × 220	4.250	4.115	3.640	4.094	3.918	3.412	3.559	3.362	2.920
	63 × 97	2.087	1.978	1.727	1.972	1.871	1.640	1.740	1.655	1.380
	63 × 120	2.638	2.539	2.309	2.526	2.430	2.209	2.274	2.186	1.879
	63 × 145	3.166	3.049	2.775	3.033	2.919	2.655	2.733	2.628	2.319
	63 × 170	3.649	3.515	3.202	3.497	3.367	3.064	3.153	3.033	2.655
	63 × 195	4.170	4.018	3.663	3.998	3.850	3.506	3.608	3.465	3.015
	63 × 220	4.555	4.431	4.122	4.415	4.293	3.928	4.061	3.871	3.370
	75 × 120	2.790	2.687	2.446	2.673	2.573	2.341	2.409	2.317	2.094
	75 × 145	3.347	3.224	2.939	3.208	3.089	2.813	2.894	2.785	2.526
	75 × 170	3.855	3.715	3.389	3.697	3.561	3.245	3.338	3.212	2.891
	75 × 195	4.347	4.230	3.875	4.214	4.070	3.712	3.818	3.675	3.281
	75 × 220	4.741	4.615	4.314	4.598	4.474	4.177	4.266	4.136	3.667
CLS/ALS sizes	38 × 89	1.455	1.317	1.009	1.349	1.220	0.947	1.133	1.034	0.819
	38 × 140	2.559	2.460	2.158	2.447	2.329	1.951	2.097	1.934	1.577
	38 × 184	3.349	3.201	2.783	3.177	3.000	2.606	2.720	2.567	2.224
	38 × 235	4.236	4.009	3.490	3.979	3.760	3.270	3.412	3.221	2.794

Minimum design bearing length

If wane at end-bearing [see Figure 8 b)] is permitted to the strength class limit, i.e. one-third of thickness for strength class C16, the minimum design bearing length is 34 mm.

If wane is not permitted, the minimum design bearing length is 18 mm.

See also 6.5.2.

^{A)} See 6.5.1 when a partition is parallel to the joists.

^{B)} Check the availability of section sizes.

Permissible
clear spans

BS 8103-3

Timber class
C24

Lightweight
partitions

Table 10 Permissible clear spans of joists for floors supporting non load-bearing lightweight partitions^{A)}.
Timber of strength class C24

C24		Lightweight partitions								
Size of joist ^{B)} mm x mm		Dead load kN/m ²								
		Not more than 0.25			More than 0.25 but not more than 0.50			More than 0.50 but not more than 1.25		
		Spacing of joists mm								
		400	450	600	400	450	600	400	450	600
		Maximum clear span of joist m								
BS EN 336 sizes with sawn thickness to tolerance class 1 and processed depth to tolerance class 2	38 x 72	1.136	1.070	0.921	1.093	1.031	0.890	0.997	0.943	0.786
	38 x 97	1.742	1.646	1.427	1.654	1.565	1.362	1.472	1.396	1.222
	38 x 120	2.324	2.234	1.980	2.222	2.132	1.868	1.962	1.865	1.644
	38 x 145	2.793	2.686	2.438	2.672	2.568	2.330	2.400	2.305	2.074
	38 x 170	3.222	3.099	2.815	3.083	2.965	2.690	2.771	2.662	2.410
	38 x 195	3.686	3.547	3.223	3.529	3.394	3.081	3.173	3.049	2.761
	38 x 220	4.148	3.993	3.630	3.972	3.821	3.471	3.574	3.435	3.112
	47 x 72	1.263	1.191	1.029	1.213	1.145	0.993	1.101	1.043	0.909
	47 x 97	1.926	1.823	1.587	1.824	1.728	1.510	1.615	1.535	1.349
	47 x 120	2.493	2.398	2.179	2.386	2.294	2.061	2.144	2.042	1.806
	47 x 145	2.994	2.881	2.619	2.866	2.757	2.504	2.579	2.478	2.246
	47 x 170	3.453	3.323	3.023	3.306	3.181	2.891	2.977	2.861	2.594
	47 x 195	3.948	3.801	3.460	3.782	3.640	3.310	3.407	3.276	2.972
	47 x 220	4.374	4.253	3.895	4.237	4.097	3.727	3.836	3.689	3.348
	63 x 97	2.189	2.089	1.827	2.077	1.972	1.732	1.829	1.741	1.538
	63 x 120	2.742	2.639	2.402	2.626	2.527	2.298	2.366	2.275	2.046
	63 x 145	3.290	3.168	2.886	3.152	3.035	2.762	2.842	2.734	2.483
	63 x 170	3.790	3.652	3.329	3.634	3.499	3.187	3.279	3.155	2.866
	63 x 195	4.293	4.174	3.808	4.153	4.001	3.646	3.751	3.610	3.282
	63 x 220	4.684	4.558	4.258	4.541	4.417	4.104	4.211	4.063	3.696
	75 x 120	2.898	2.792	2.544	2.778	2.675	2.435	2.505	2.410	2.190
	75 x 145	3.475	3.349	3.055	3.333	3.210	2.925	3.009	2.896	2.633
	75 x 170	4.001	3.858	3.522	3.839	3.699	3.374	3.470	3.340	3.039
	75 x 195	4.469	4.350	4.027	4.334	4.217	3.858	3.968	3.820	3.478
	75 x 220	4.874	4.745	4.438	4.728	4.601	4.300	4.390	4.268	3.915
CLS/ALS sizes	38 x 89	1.542	1.456	1.259	1.470	1.390	1.207	1.318	1.249	1.081
	38 x 140	2.662	2.560	2.323	2.546	2.448	2.220	2.287	2.196	1.953
	38 x 184	3.482	3.350	3.044	3.333	3.205	2.909	2.996	2.879	2.607
	38 x 235	4.361	4.238	3.874	4.222	4.077	3.704	3.814	3.666	3.322

Minimum design bearing length

If wane at end-bearing [see Figure 8 b)] is permitted to the strength class limit, i.e. one-third of thickness for strength class C24, the minimum design bearing length is 41 mm.

If wane is not permitted, the minimum design bearing length is 21 mm.

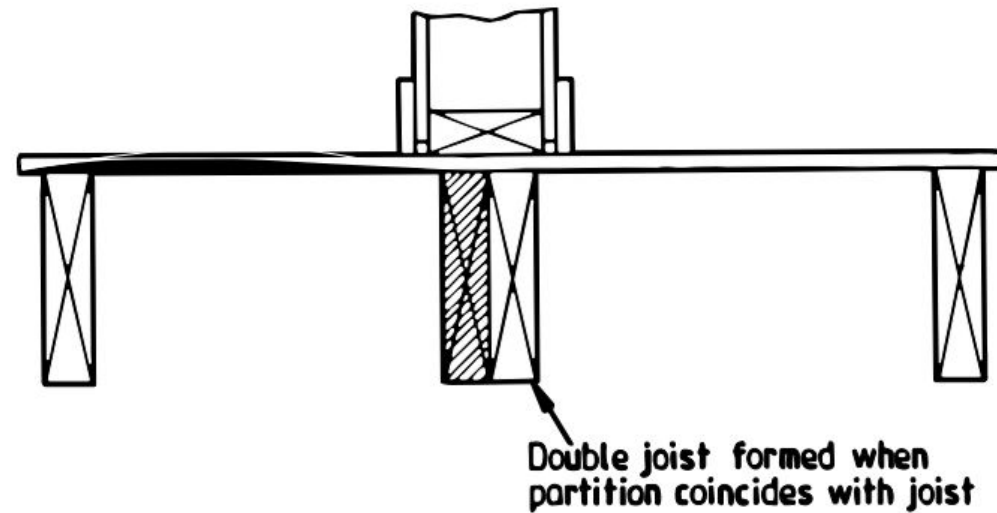
See 6.5.2.

^{A)} See 6.5.1 when a partition is parallel to the joists.

^{B)} Check the availability of section sizes.

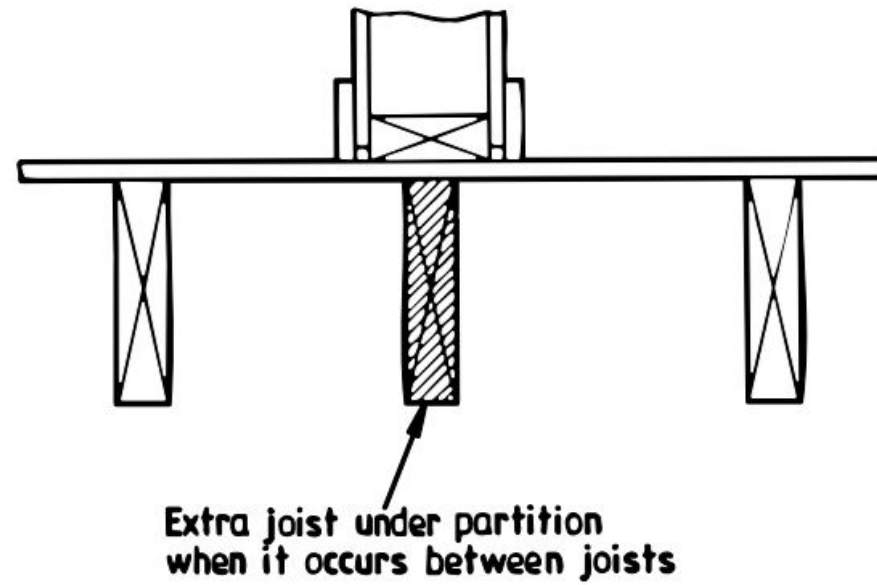
Partitions

When a non-bearing partition is parallel to the joist span, there are different solutions:



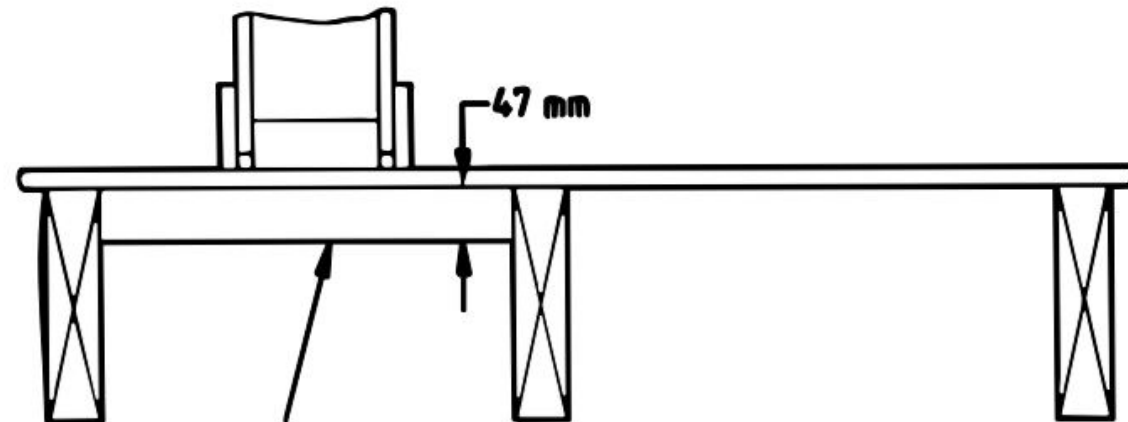
Partitions

When a non-bearing partition is parallel to the joist span, there are different solutions:



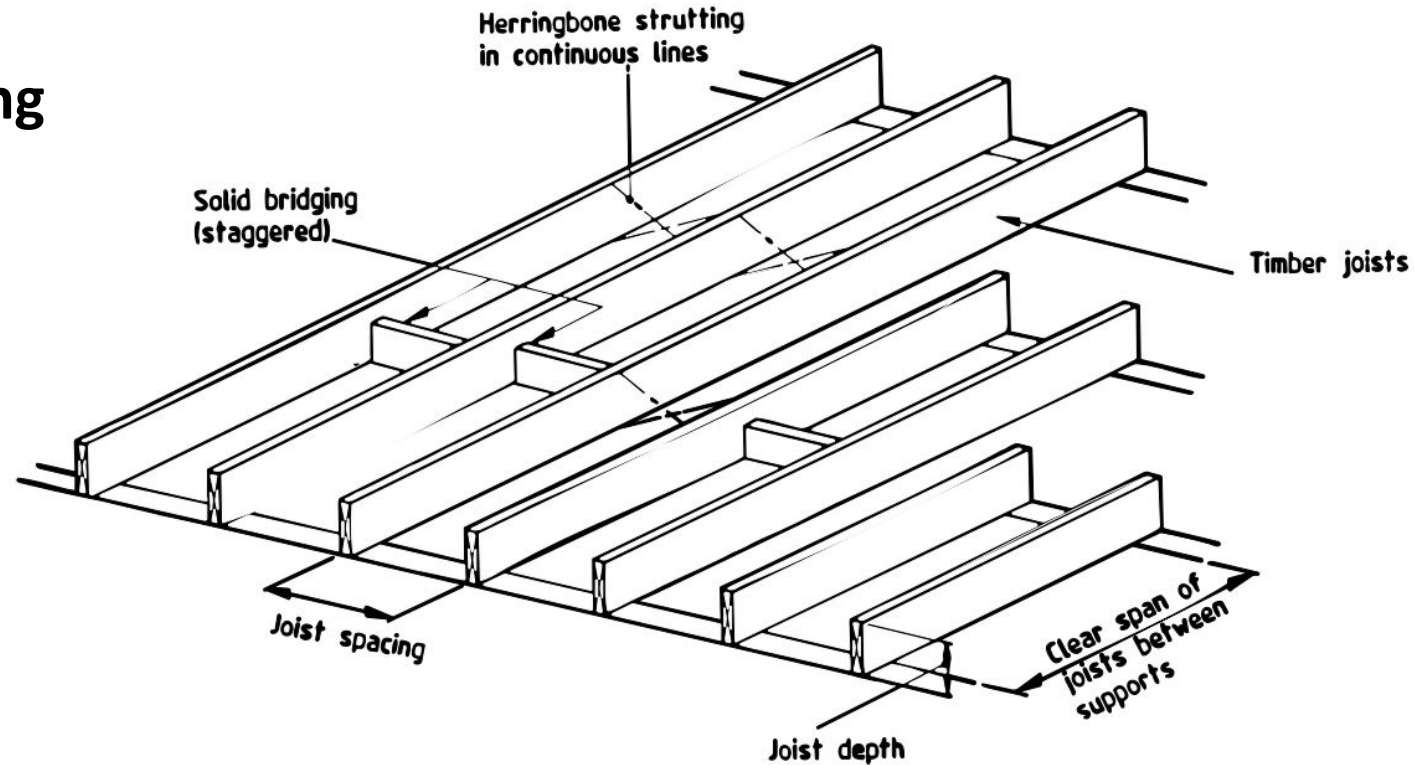
Partitions

When a non-bearing partition is parallel to the joist span, there are different solutions:



**Noggings supporting partitions
should be at least a basic size
of 38 mm x 47 mm at centres not
exceeding 600 mm unless justified
by specialist calculation**

Strutting



Solid bridging

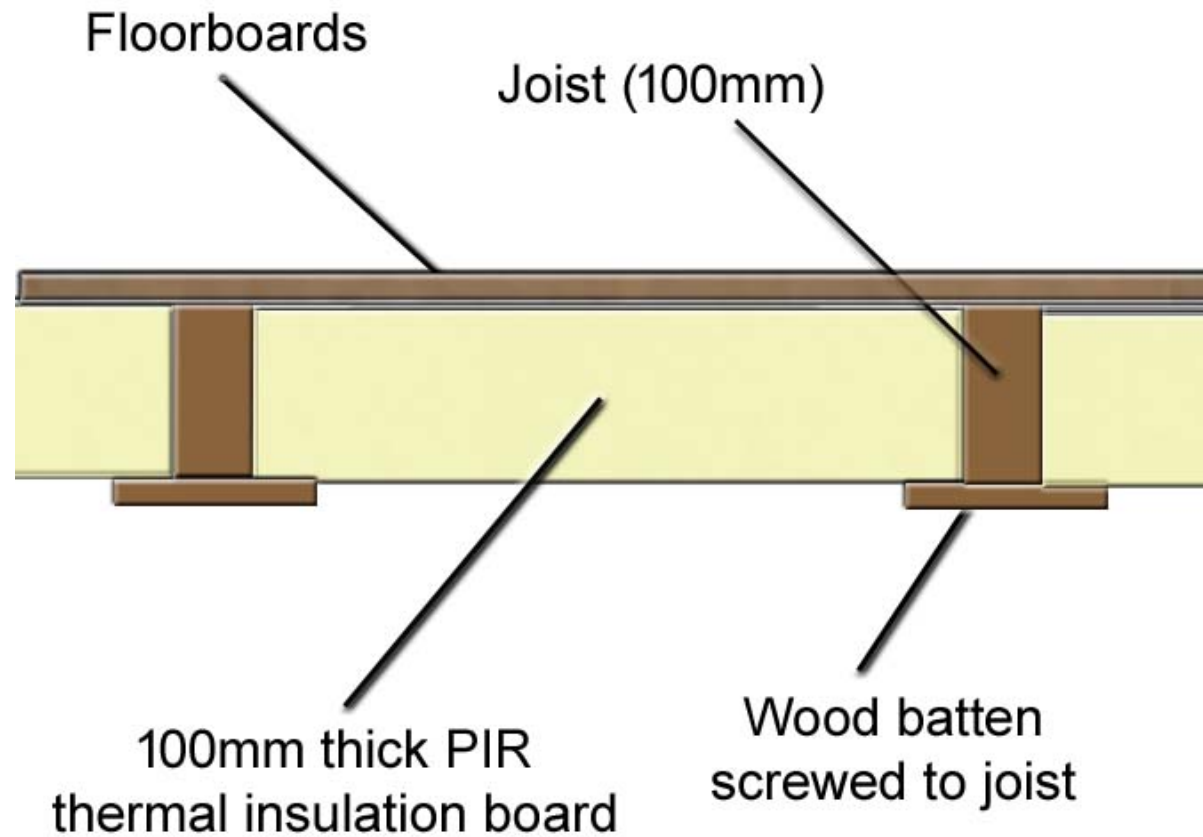
Solid timber with a basic thickness of 38 mm min.

Herringbone strutting

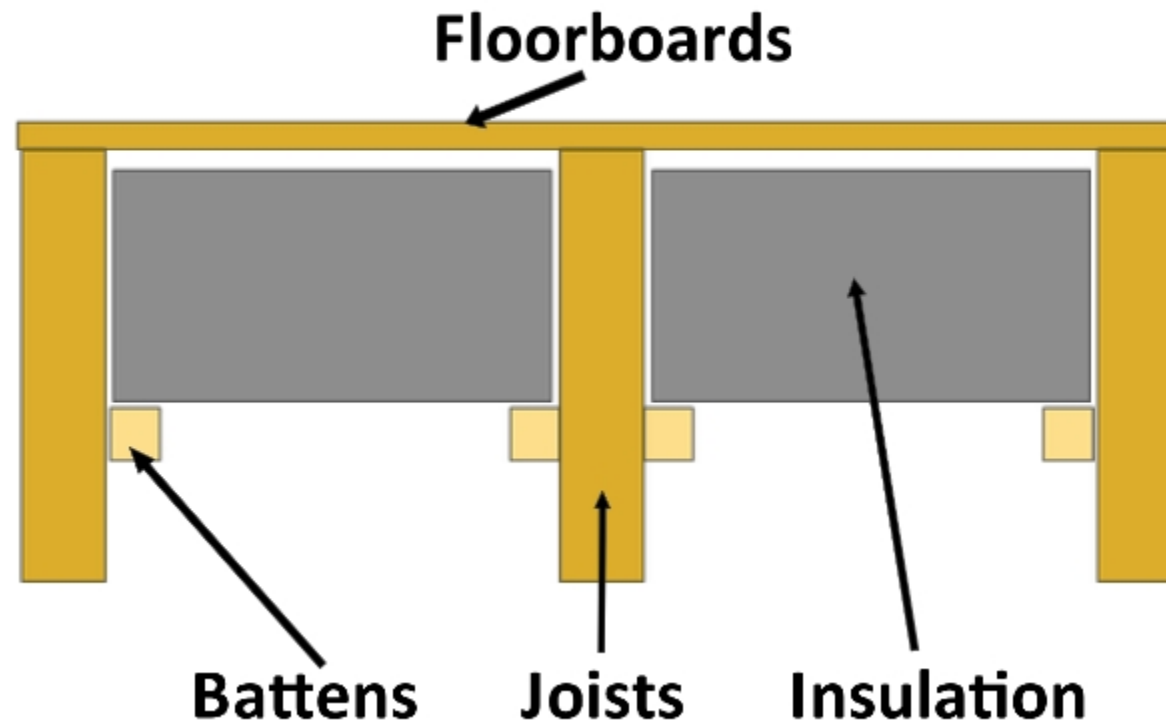
Formed from solid timber sections

Joist clear span m	Number of rows of bridging/strutting required	Position of bridging/strutting
Up to 2.5	None	–
Over 2.5 and up to 4.5	One	At joist mid-span
Over 4.5	Two	At joist one-third span positions

Insulation support



Insulation support



Timber flooring

Subfloor should always be dry, flat and level

Leave expansion gap in all perimeter (at least 15mm)

Advisable to fit a DPM over cementitious sub-floors

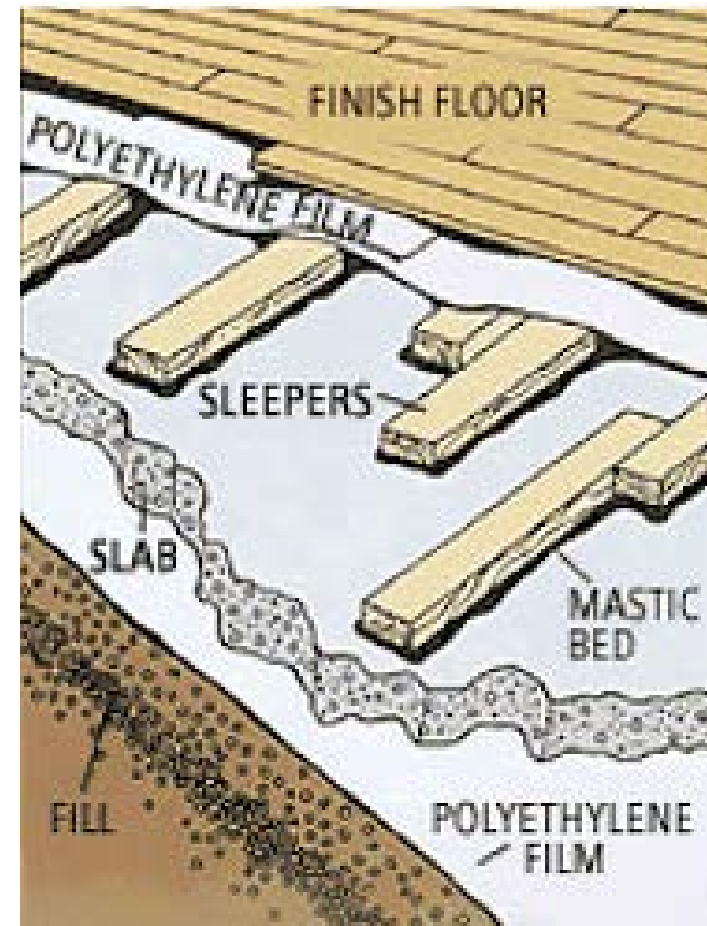
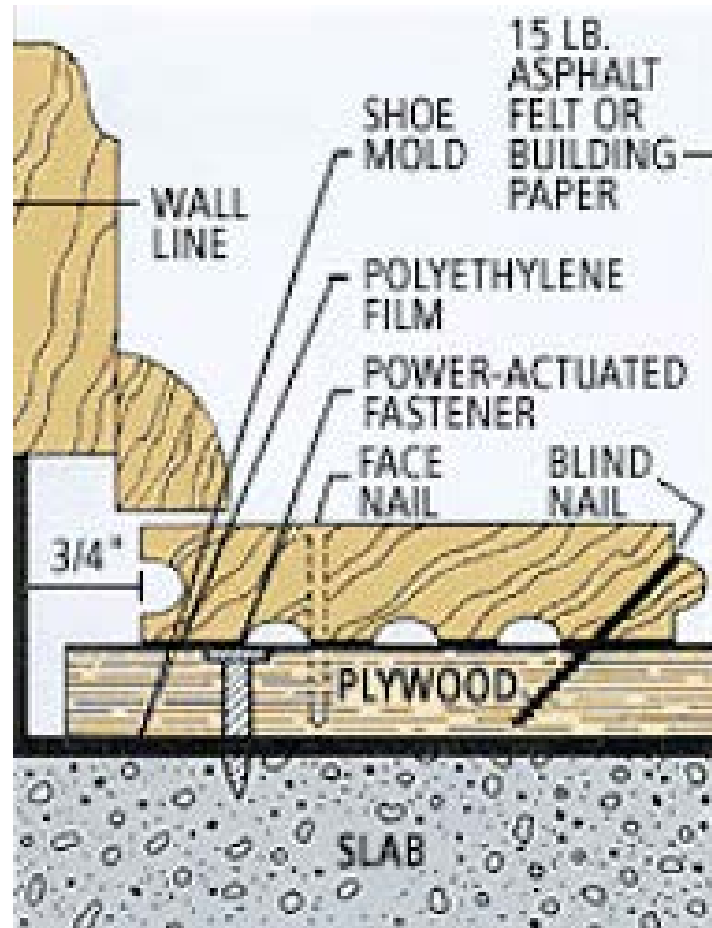
Use of foam underlay (without DPM) on top of wooden sub-floors

Fitting can be gluing or secret nailing

- Gluing
 - Solid subfloor (concrete or timber board)
 - Use of flexible flooring adhesive
 - Spread adhesive with a notched trowel (around 1m²) and put, place the flooring planks and push them together
- Secret nailing
 - Ideal with wooden subfloor
 - Flooring planks should be perpendicular to the subfloor
 - Place a nail gun over the edge of the plank where the tongue is found and push the nail at a 45 degree angle

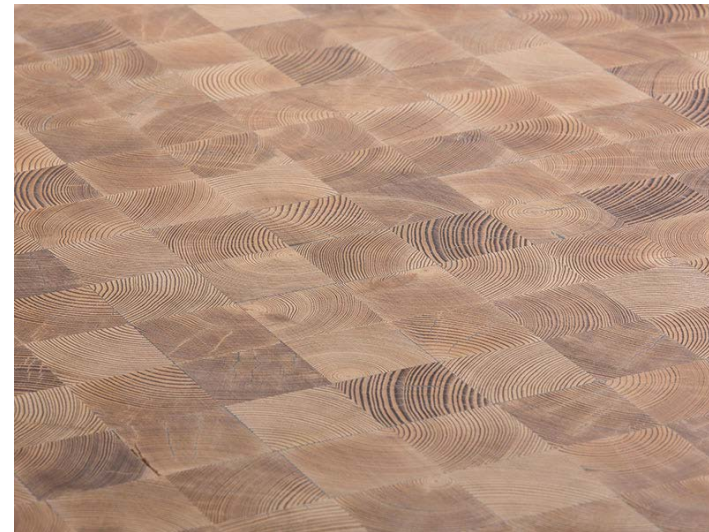


Timber flooring



Timber flooring

Solid blocks



Timber flooring

Tongue and groove



Fitting very similar to a jigsaw puzzle

Planks can installed glued down or floating

For a more secure fitting, they can be either:

- glued together
- held together with nails or screws

Easy solution to install

Repair can be difficult when glued or nailed

Timber flooring

Click



The protruding piece 'clicks' and locks into place

Easier to install

Eliminates nails and glue

Easy to replace

Requires a solid subfloor underneath as it can only be fitted as floating

Comparative Study: Ground Floors

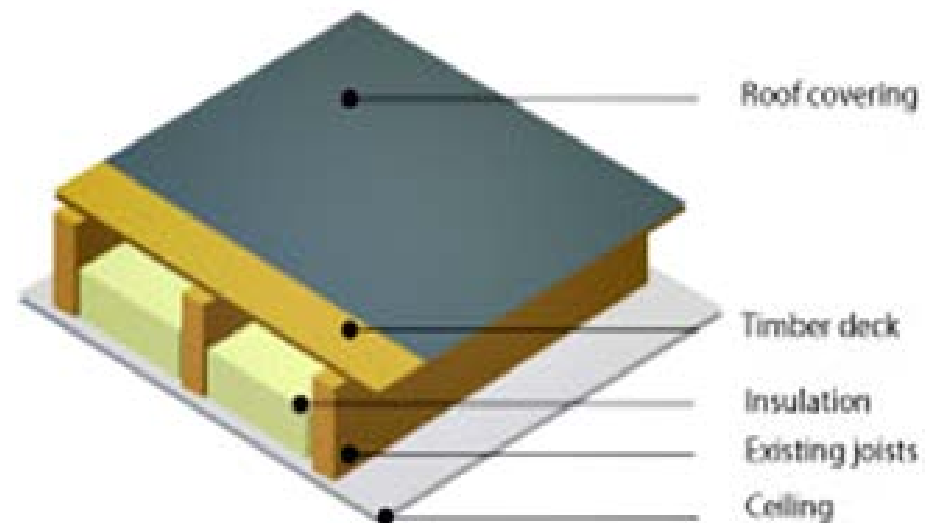
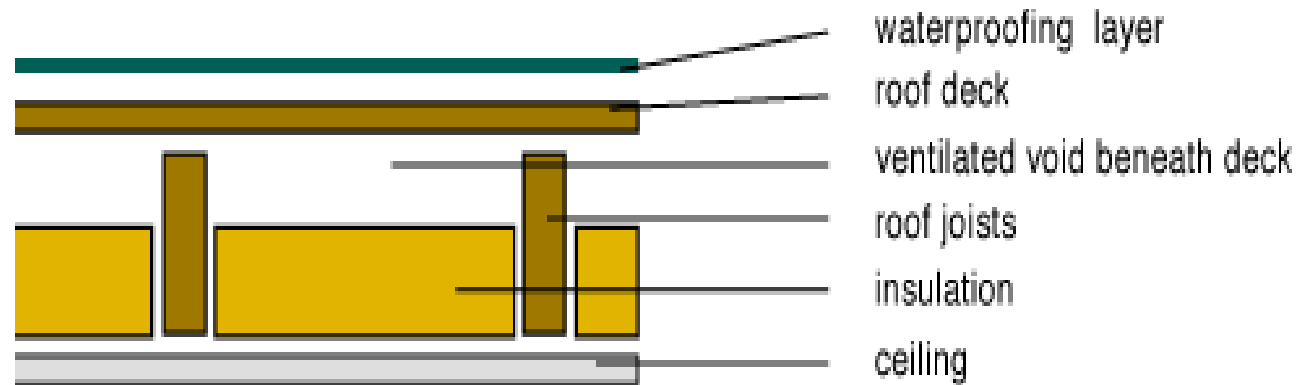
Option	Advantages	Disadvantages	When to use
Solid Concrete	• Cheap • Familiar Technology • Easy detailing to insulate and resist moisture • Good loadbearing performance	• Wet operation slows construction • Several operations involved • Expensive when dealing with deep voids	• Most common form of ground floor • Used on relatively level sites with traditional foundation design
Suspended Timber	• Resilient floor form • Can cope with sloping sites and deep floor voids	• Potential problems of decay if subject to moisture • Expensive • Limited loadbearing capacity	• Rarely used in modern house building • Sometimes adopted for high-quality projects
Beam and Block	• Cheap • Fast • Good loadbearing capacity • Copes with sloping sites and deep voids	• More expensive than solid floor construction on level sites with small voids	• Becoming very common in house building • Particularly appropriate for sloping sites with poor ground conditions and sites involving deep sub-floor voids

FLAT ROOFS

CHARACTERISTICS

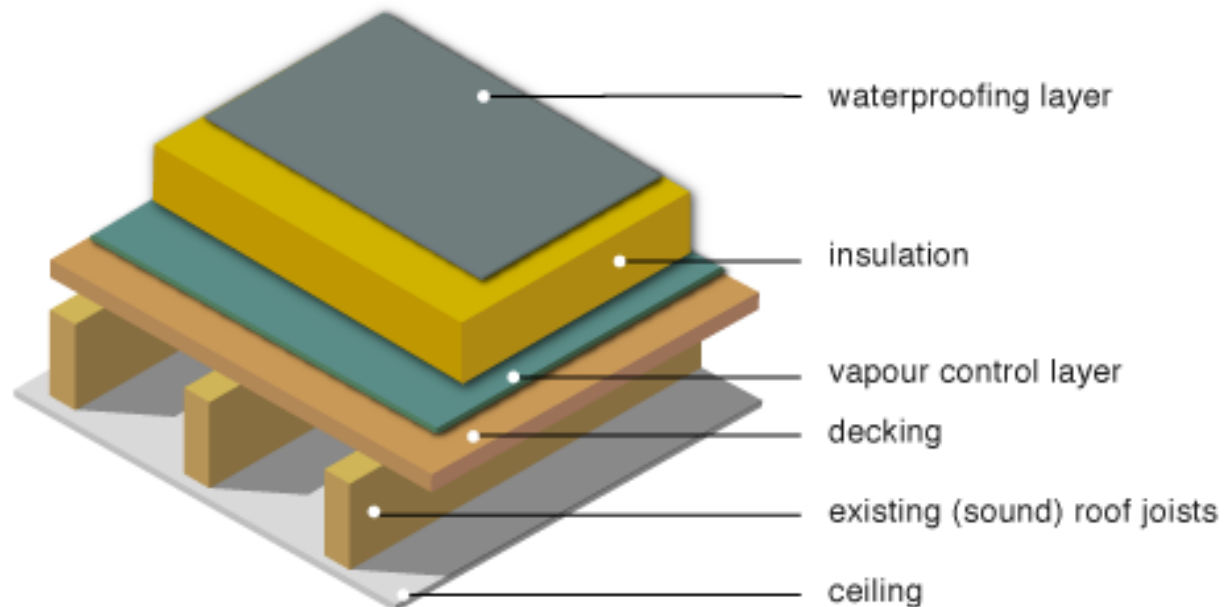
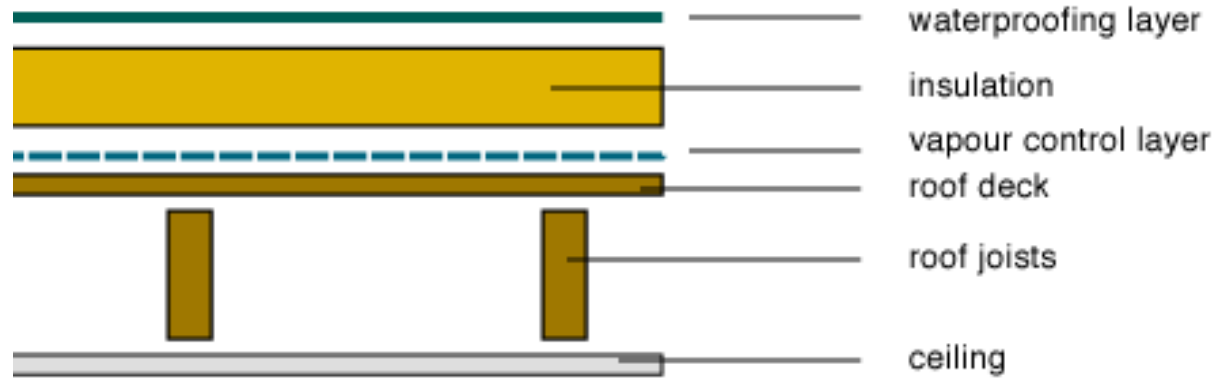
- Having a pitch below 10°
- Continuous covering
- Asphalt, fibre glass = 1:80 12mm/m
- Built up 3-layer felt, ruberoid felt = 1:60 17mm/m
- Minimum falls – if more than one fall (creating a valley) then the fall should be doubled
-

Cold Deck roof

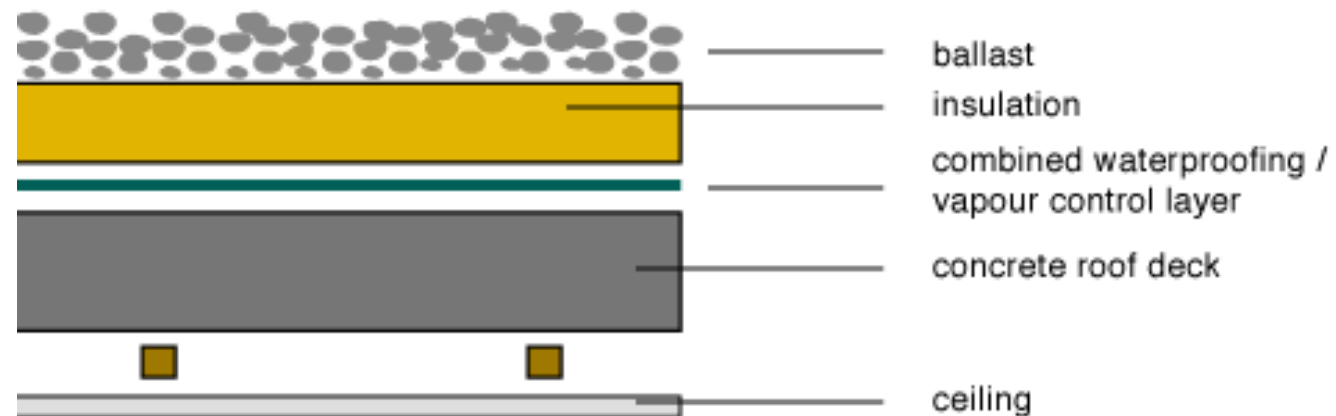
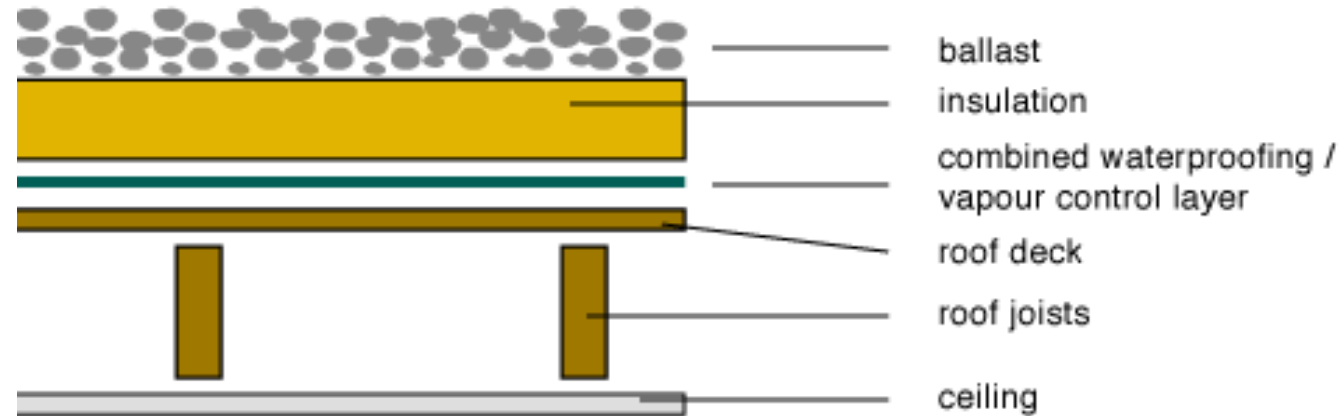


Structural elements are
not protected
Ventilation is required
above the insulation
Not recommended today
Banned in Scotland

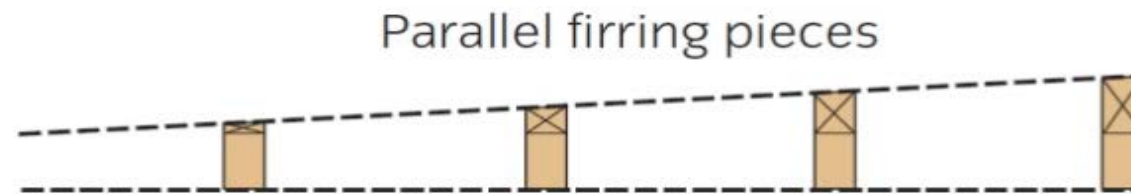
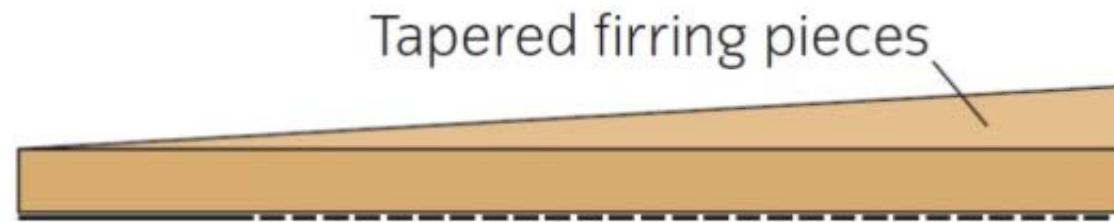
Warm Deck roof



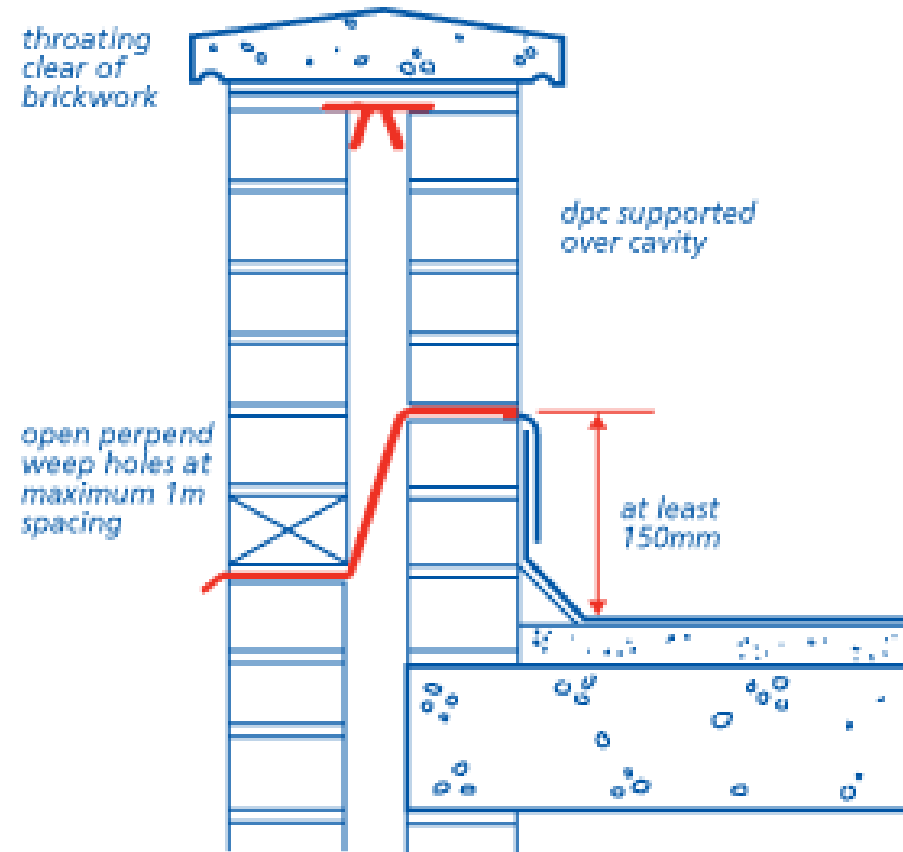
Inverted (upside down) roof



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

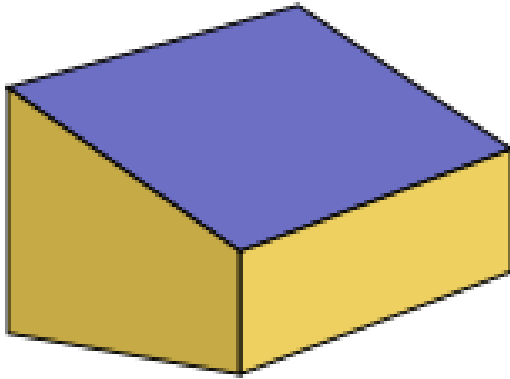


PITCHED ROOFS

Considerations:

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

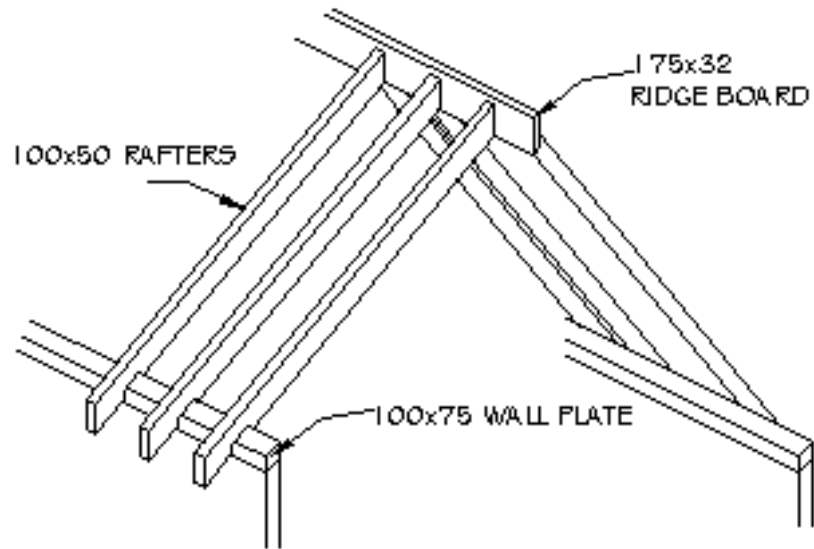
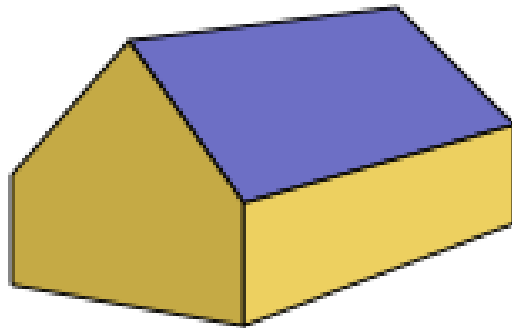
PITCHED ROOFS



Monopitch

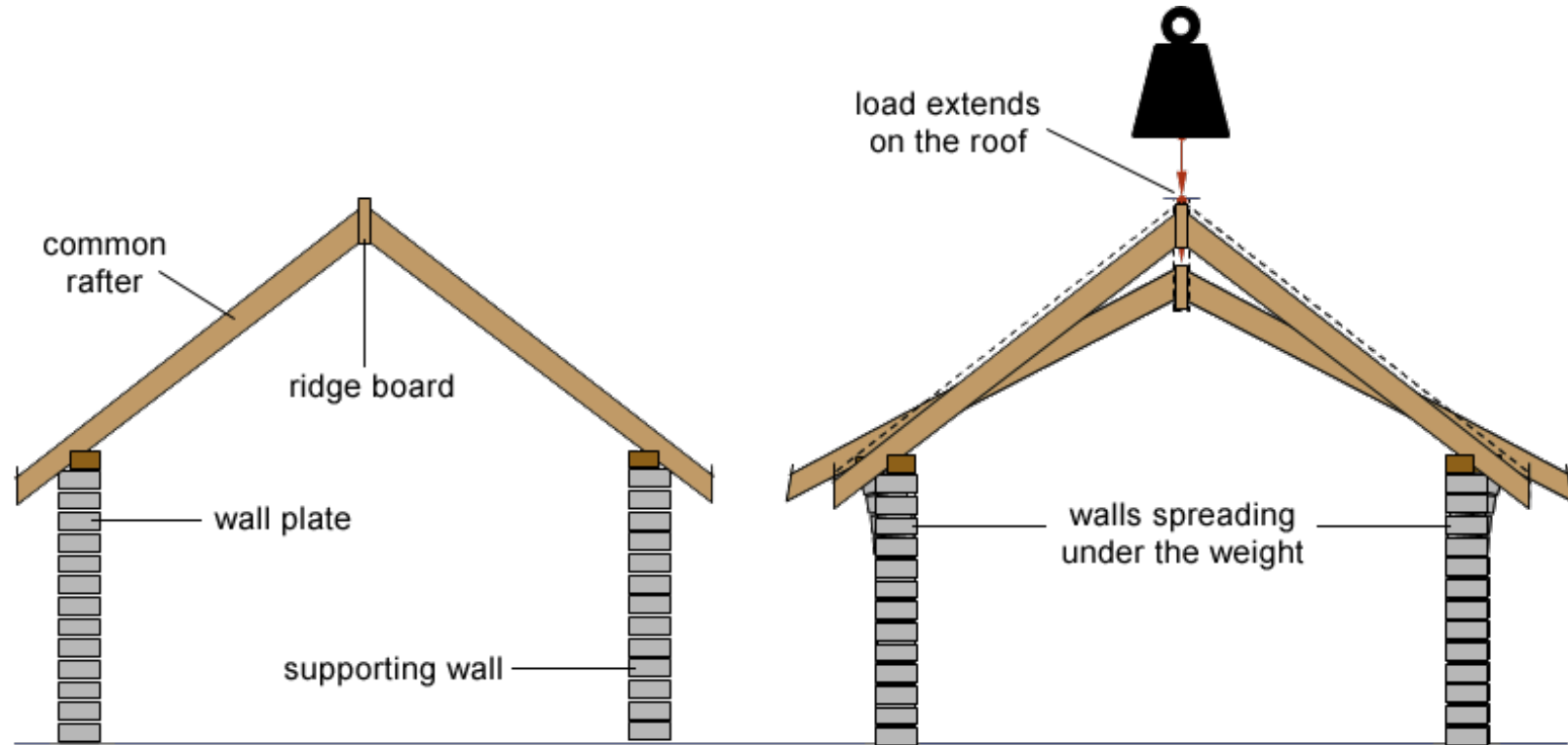


PITCHED ROOFS



Duopitch = couple roof

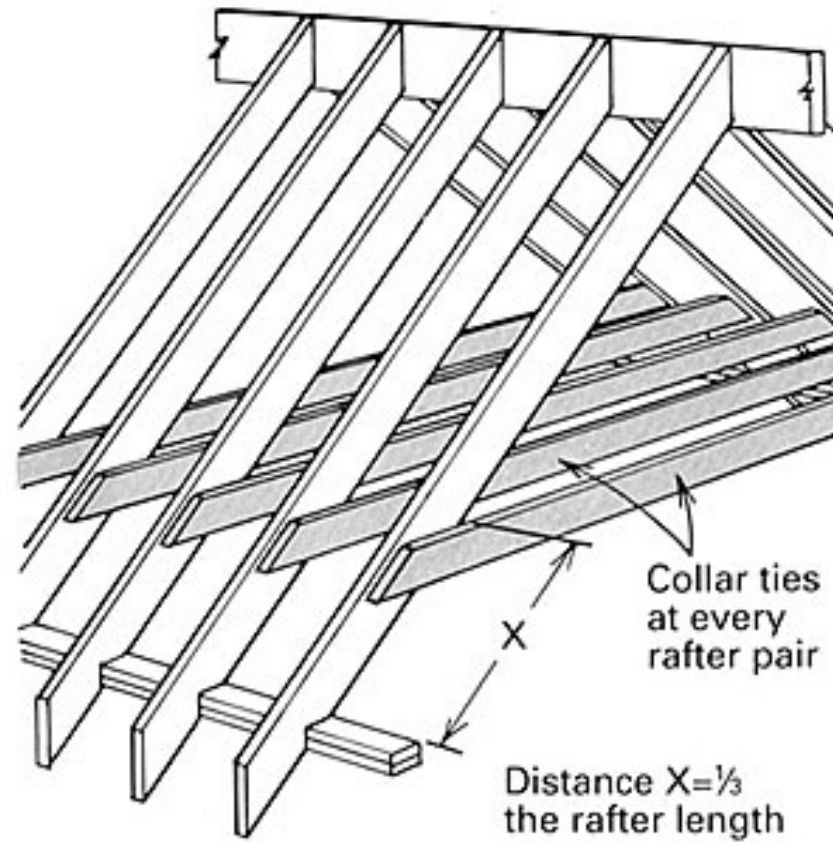
PITCHED ROOFS



Couple roof – maximum span 3.5m

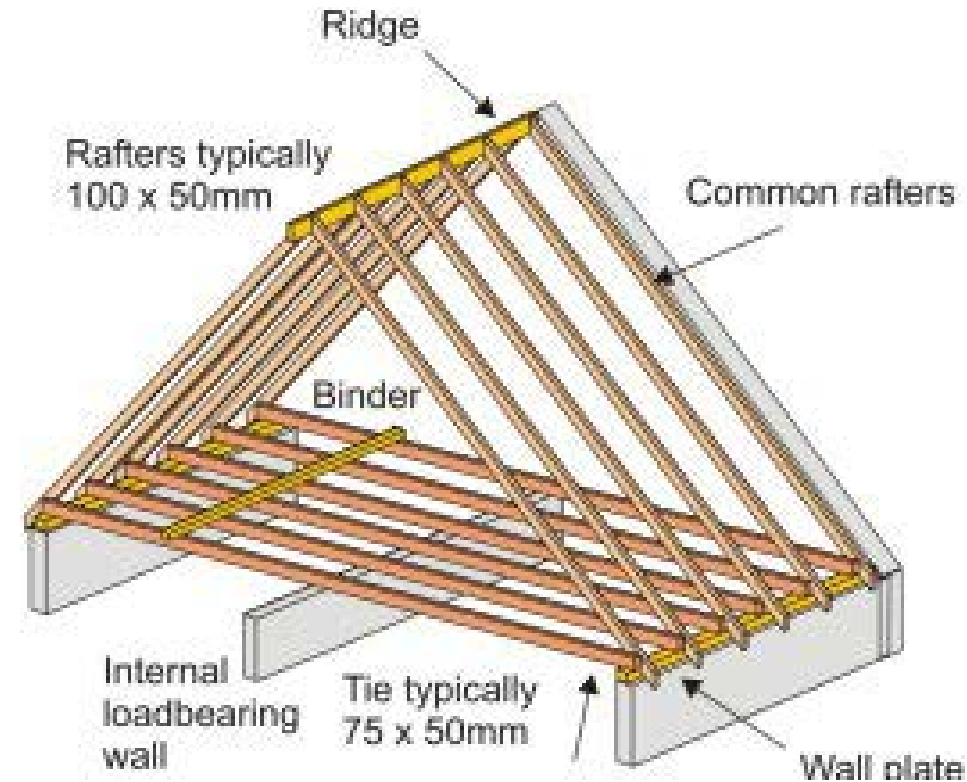
PITCHED ROOFS

Collar roofs –
Maximum
Spans up to
4.5m



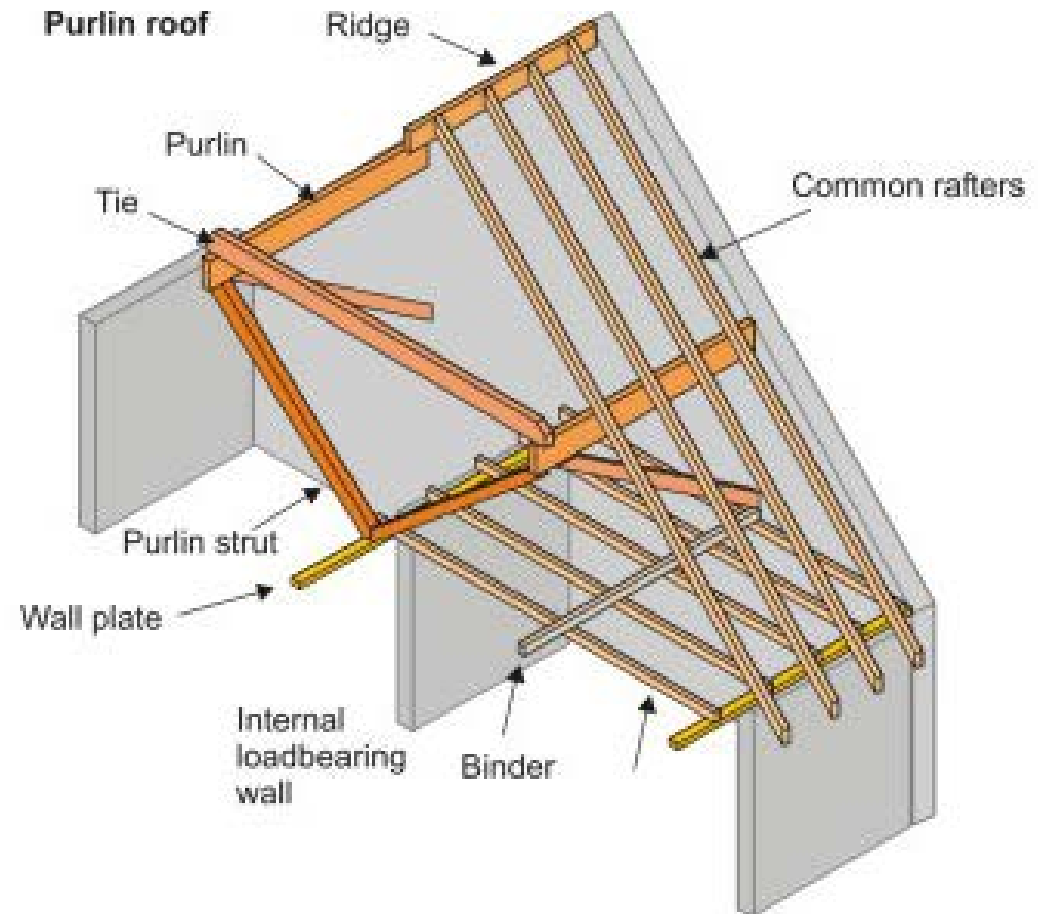
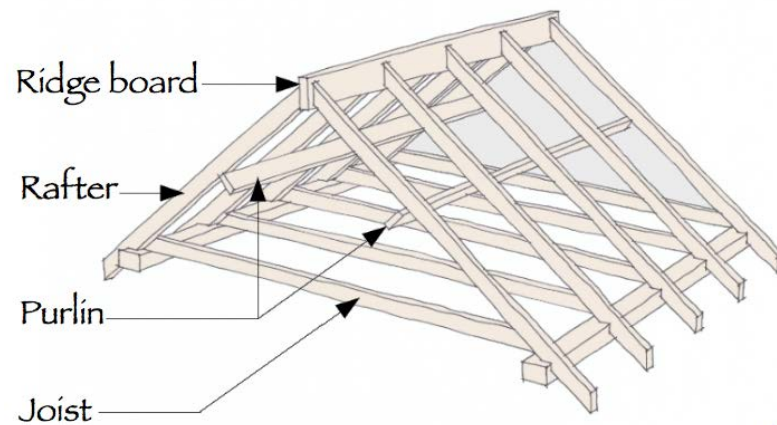
PITCHED ROOFS

Closed couple roof



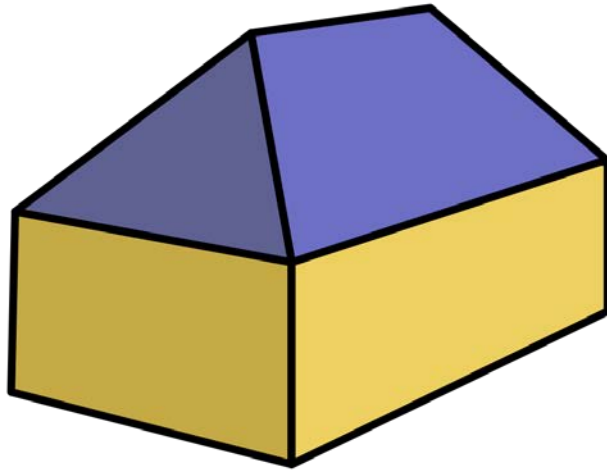
Close Couple roof – maximum span 5.5m

PITCHED ROOFS

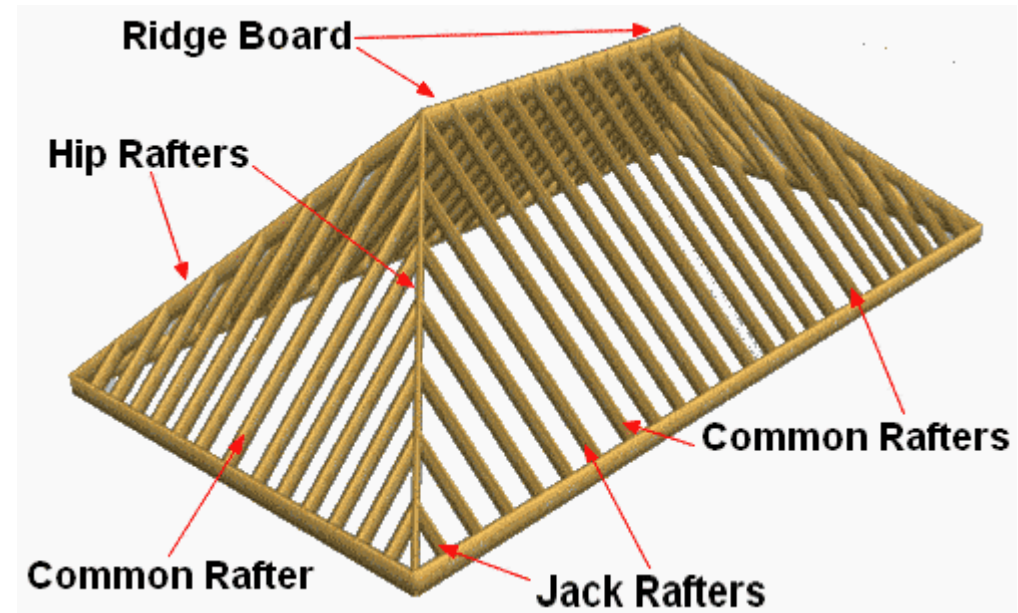


Purlin roof – Spans up to 8m

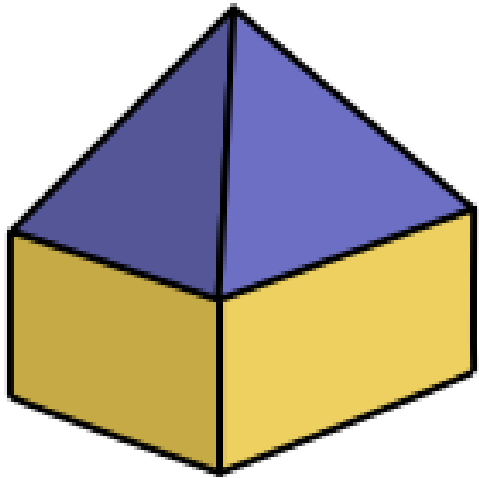
PITCHED ROOFS



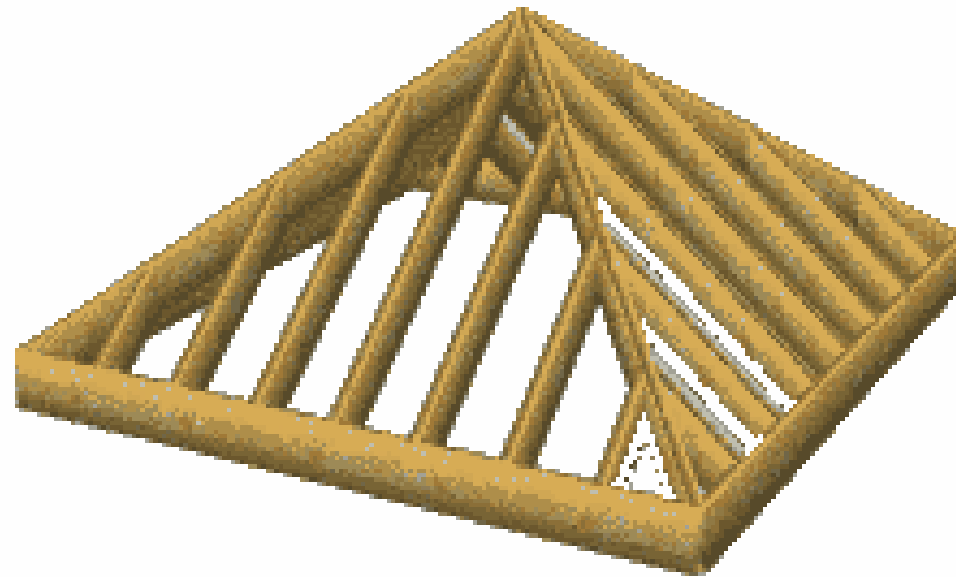
Hipped roof



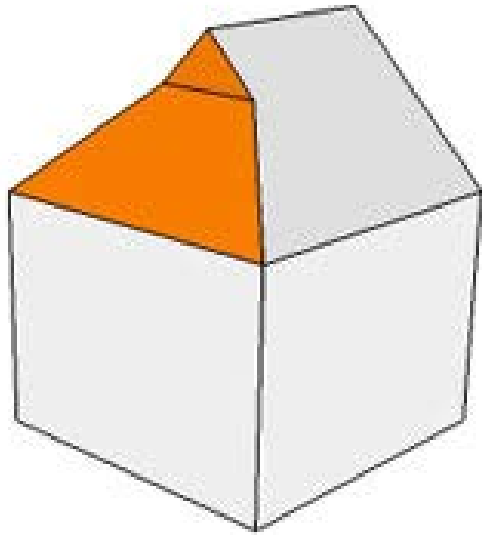
PITCHED ROOFS



Pyramid roof



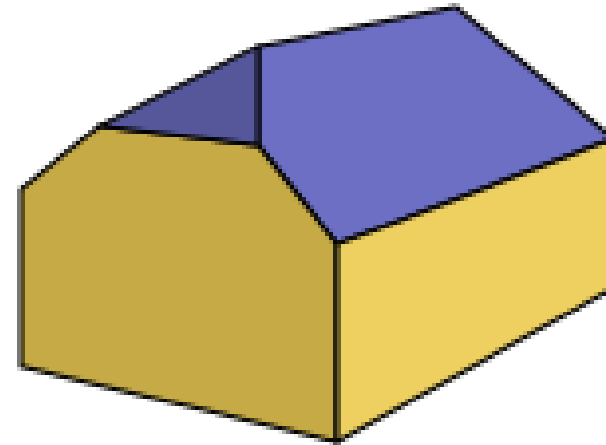
PITCHED ROOFS



Gabled roof



PITCHED ROOFS

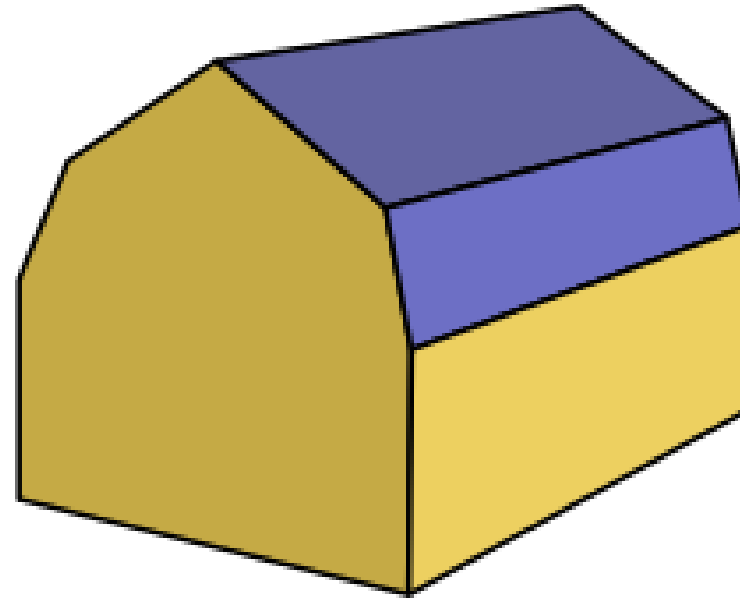


Half hip roof

PITCHED ROOFS



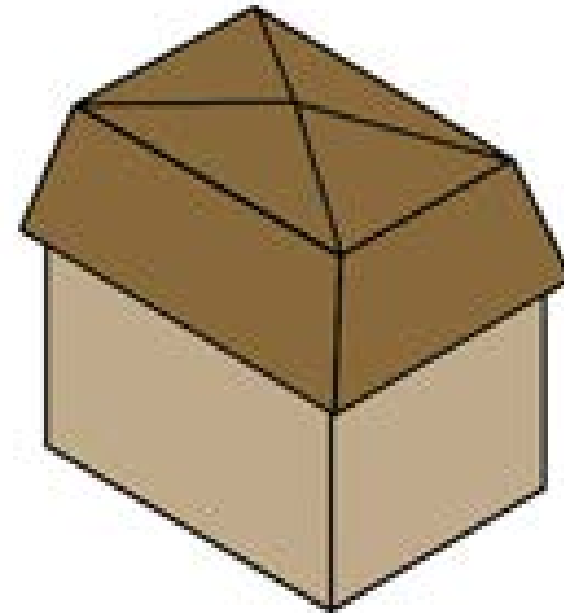
Gambrel roof



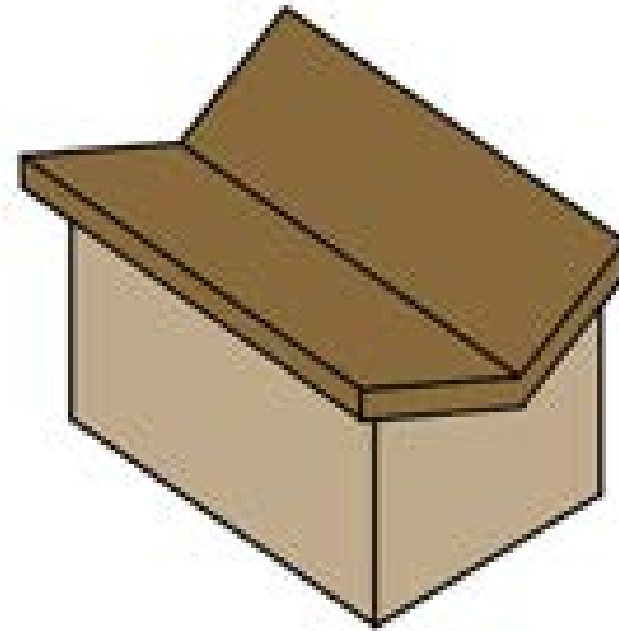
PITCHED ROOFS



Mansard roof



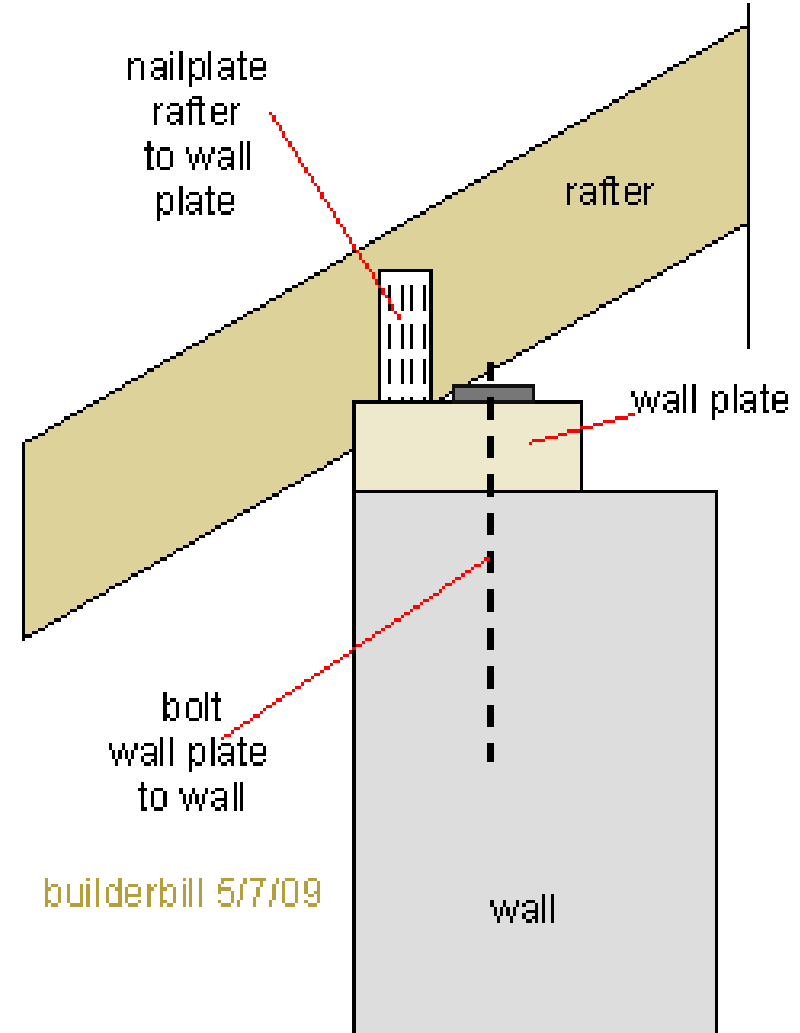
PITCHED ROOFS



Butterfly roof

WALL PLATES

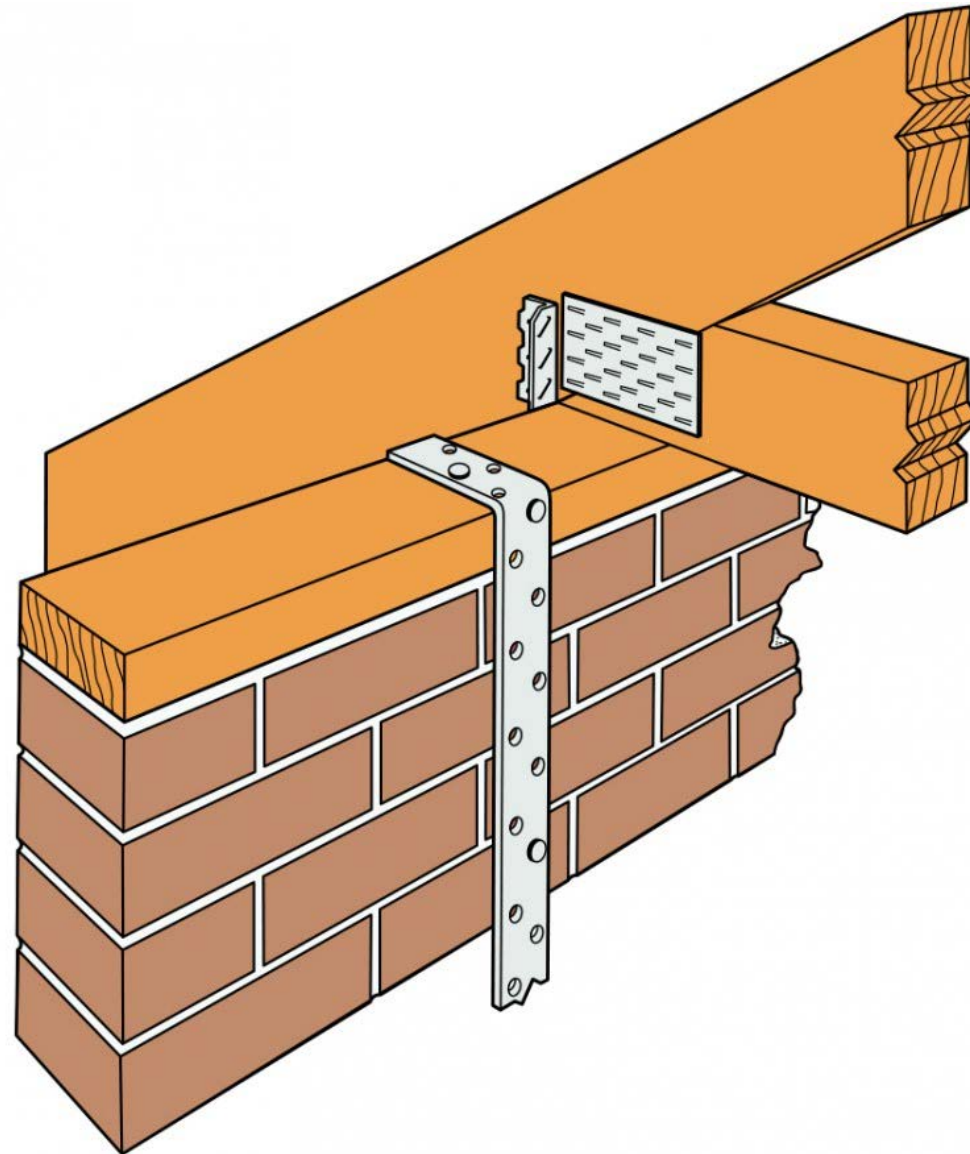
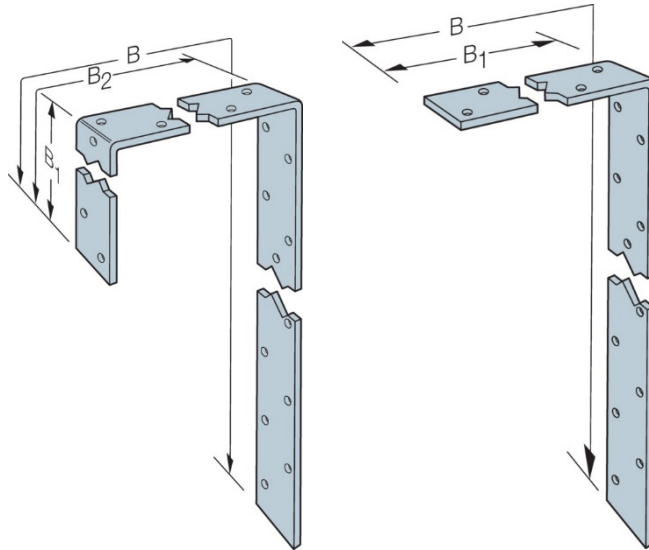
- Provide the bearing and fixing medium for various roof members
- Distribution of loads evenly over the wall
- Bedded in cement mortar on top of load-bearing walls



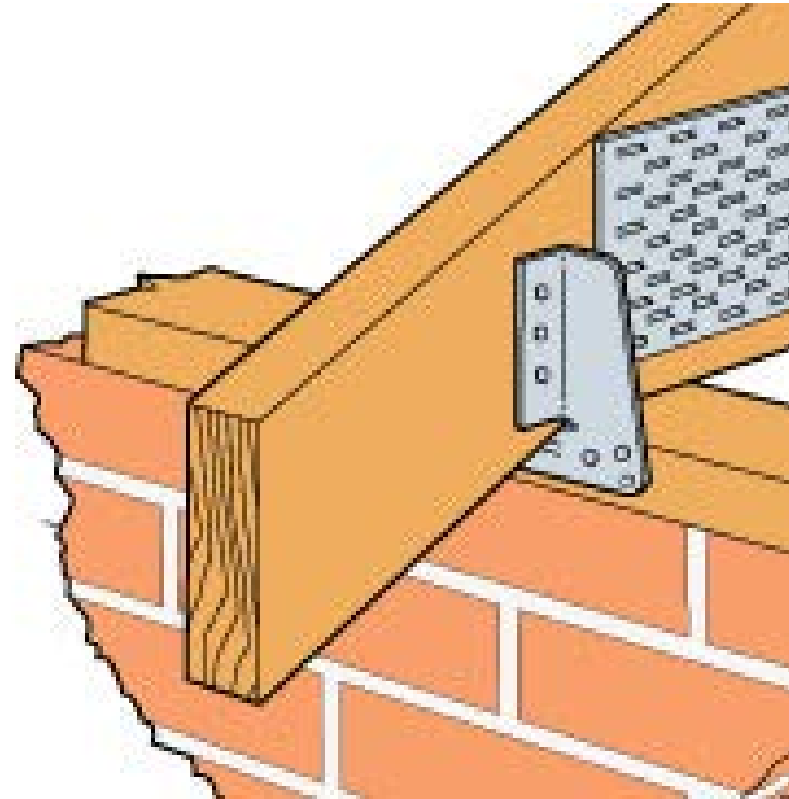
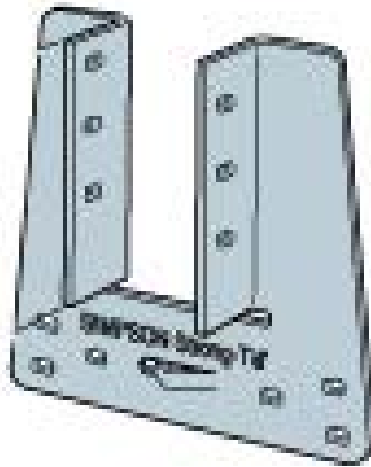
WALL PLATES

Heavy/light restrain straps

- Heavy for lateral restrain
- Light for vertical loads



WALL PLATES



Simpson clip

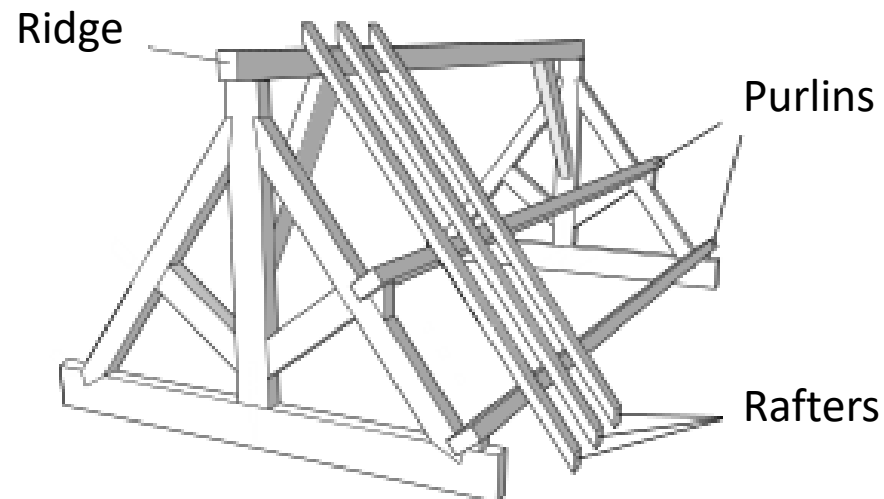
TRUSSES

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

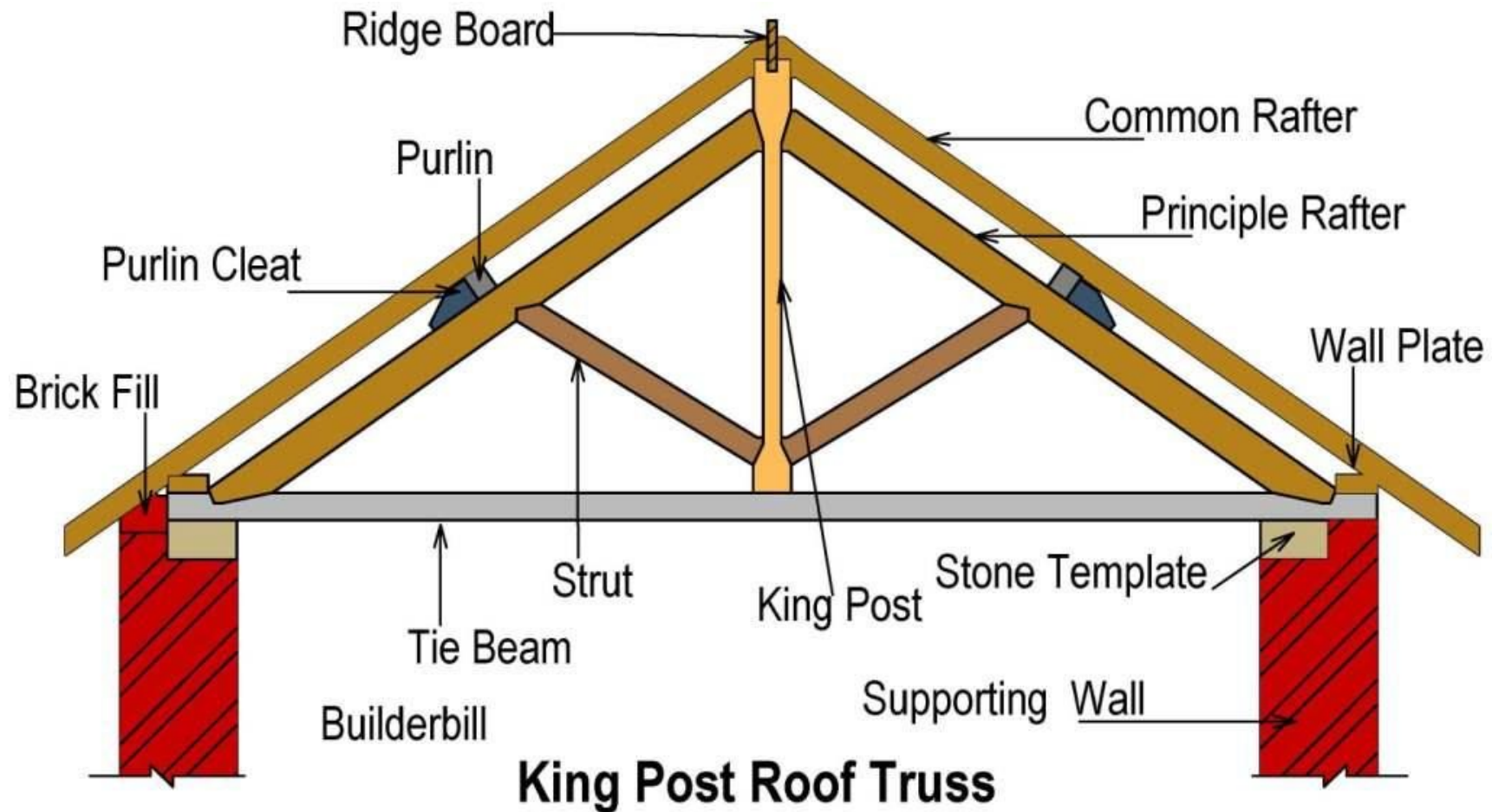
- Large spans
- Less need for intermediate load-bearing internal walls
- Faster construction
- Constructed in factory conditions – quality control
- Economic use of material – minimal waste
- Reduced skills required

TRUSSES

Disadvantages

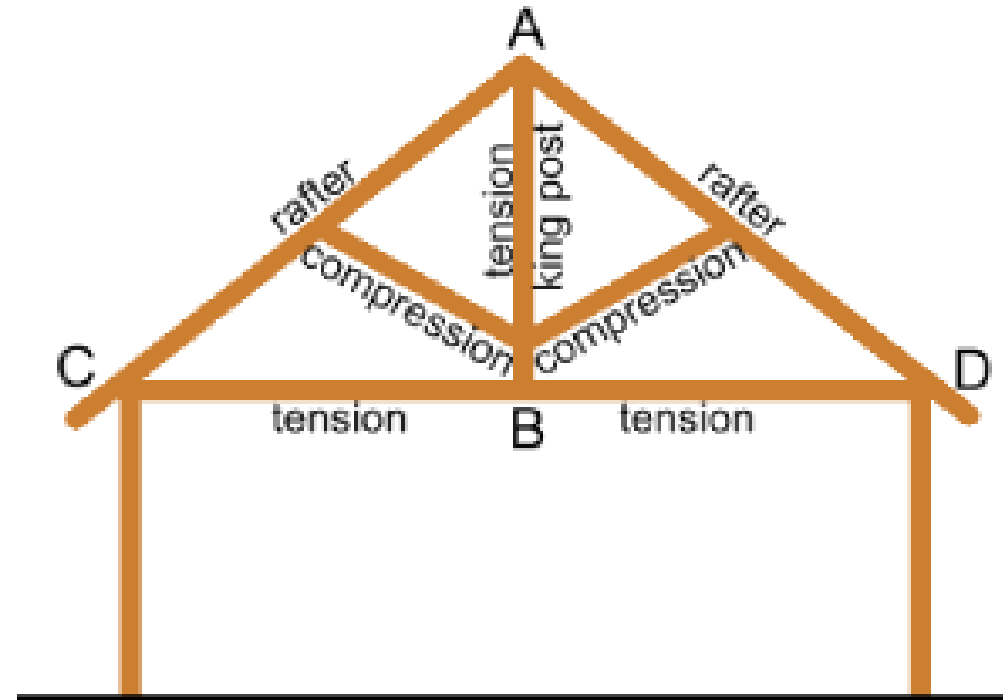
- Design based upon span, loading of covering, wind loading and snow/rain loads – cannot be adapted if changes are made to any of the above
- Little or no loft storage space
- Internal partitions cannot be built until the roof has been loaded by the covering
- Trusses must be plumb and spaced evenly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

TRUSSES



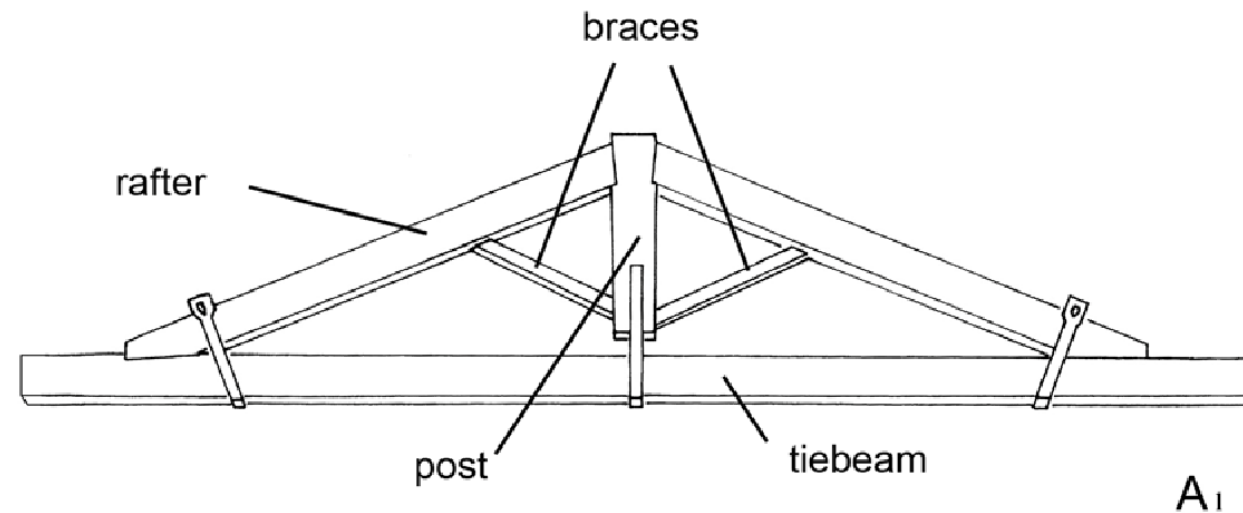
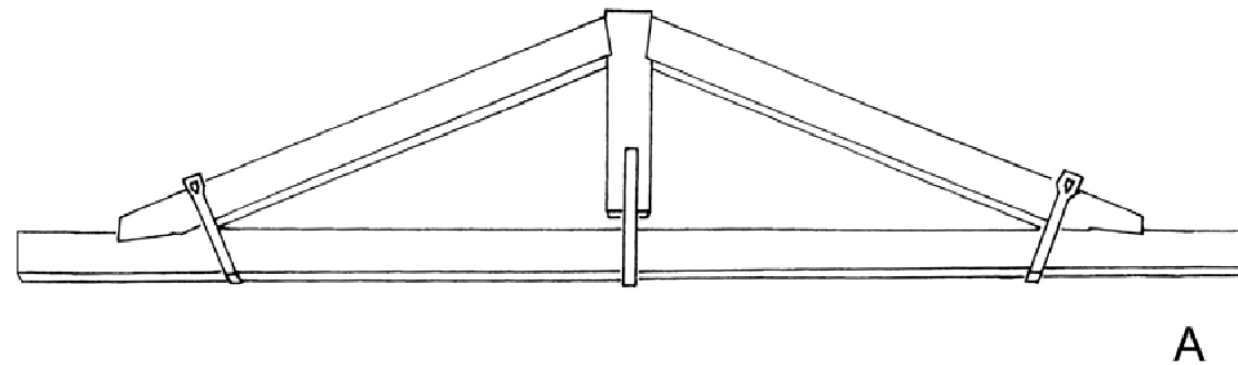
TRUSSES

How does a king post truss work?



TRUSSES

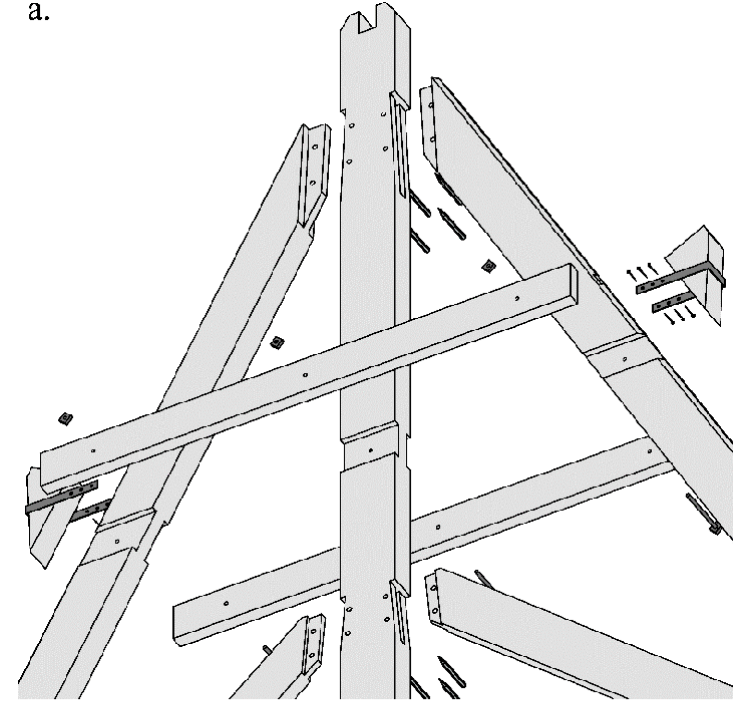
How does a king post truss work?



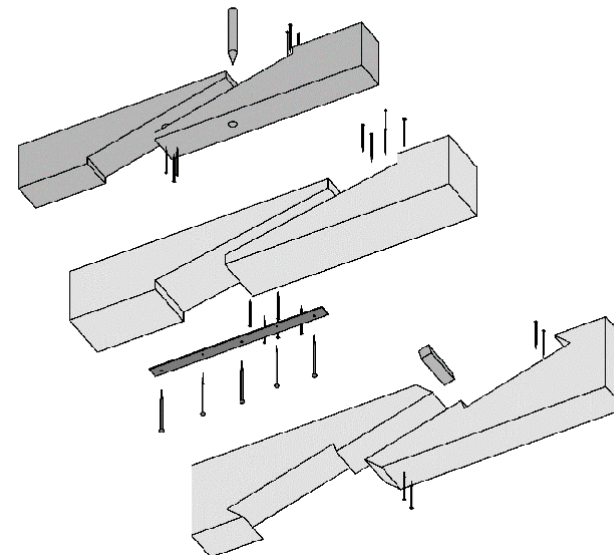
TRUSSES



a.

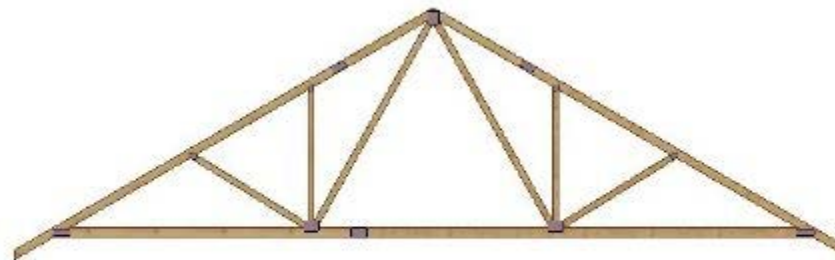
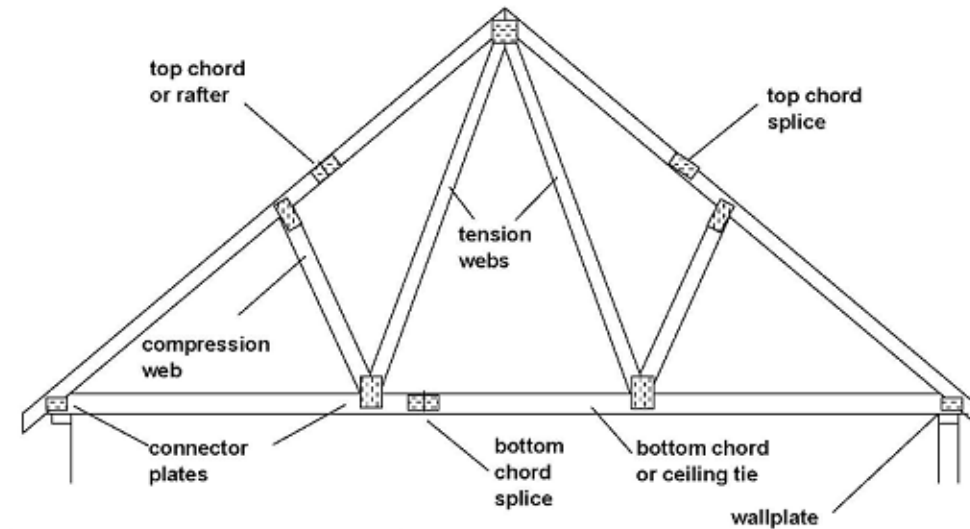
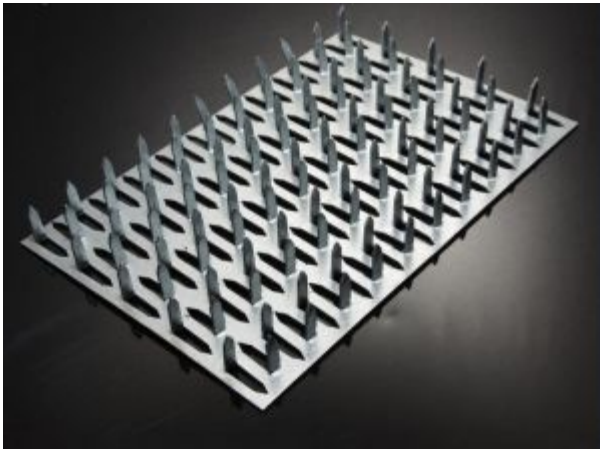


b.



TRUSSES

Factory
assembled
Gang-nail plates



TRUSSES



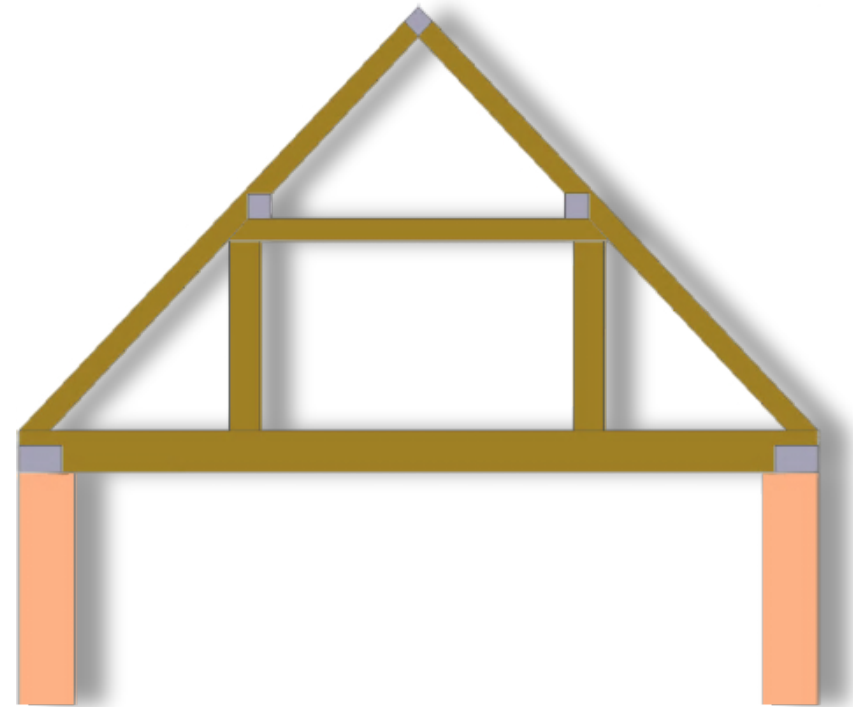
King Post Truss

Bolted steel plates rather than traditional timber-frame joints

TRUSSES



Queen Post Truss



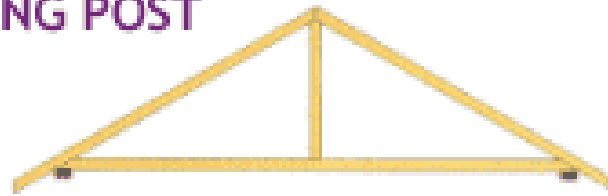
TRUSSES



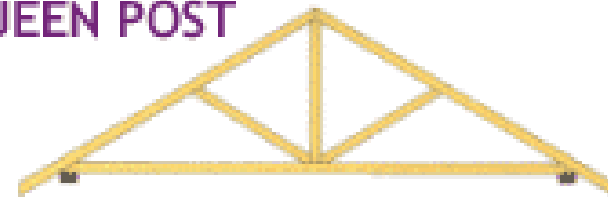
Crown Post Truss

TRUSSES

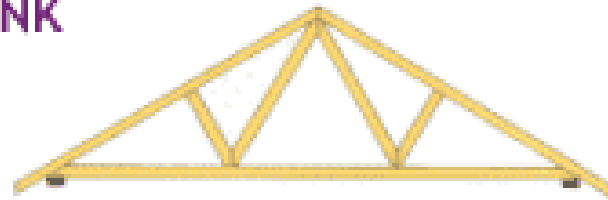
KING POST



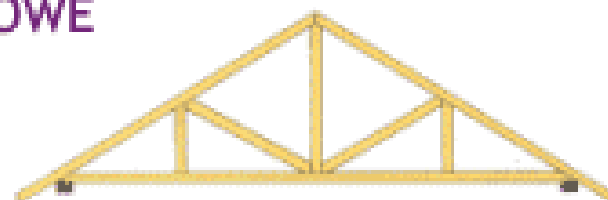
QUEEN POST



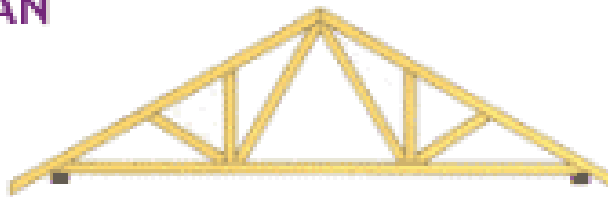
FINK



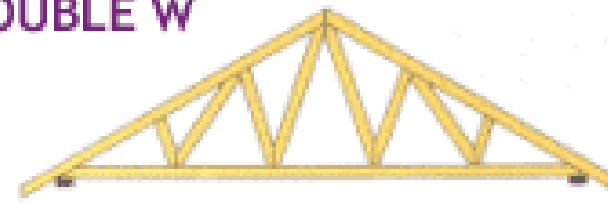
HOWE



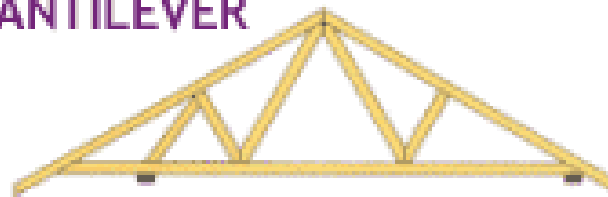
FAN



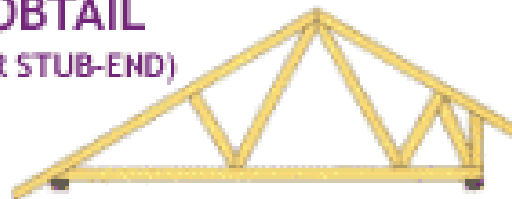
DOUBLE W



CANTILEVER

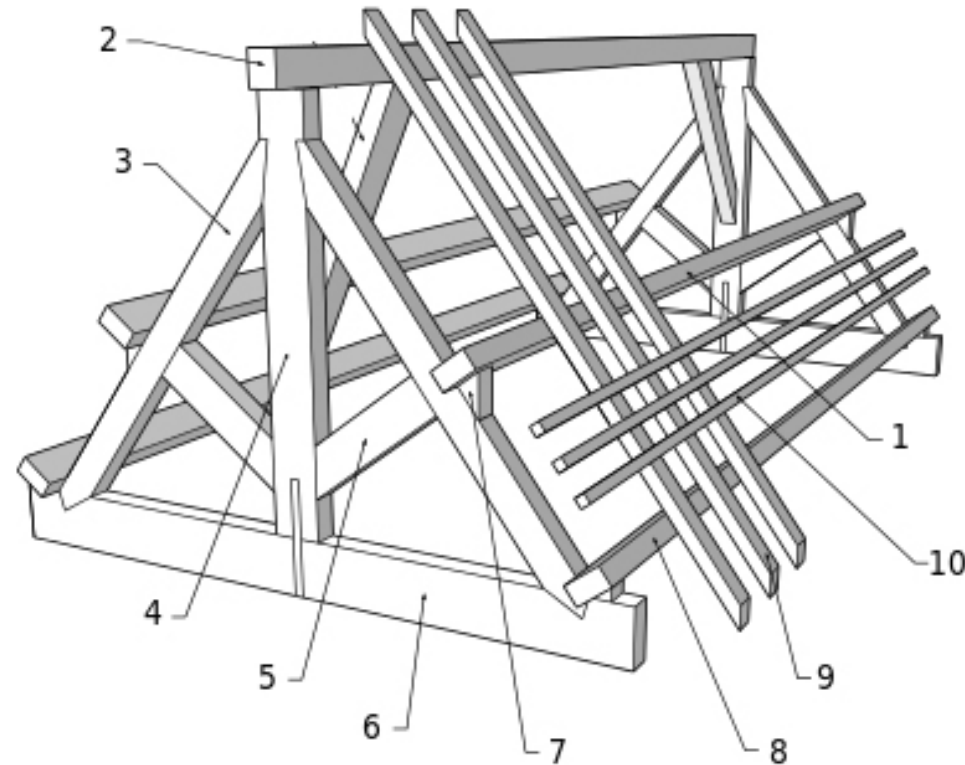


BOBTAIL
(OR STUB-END)



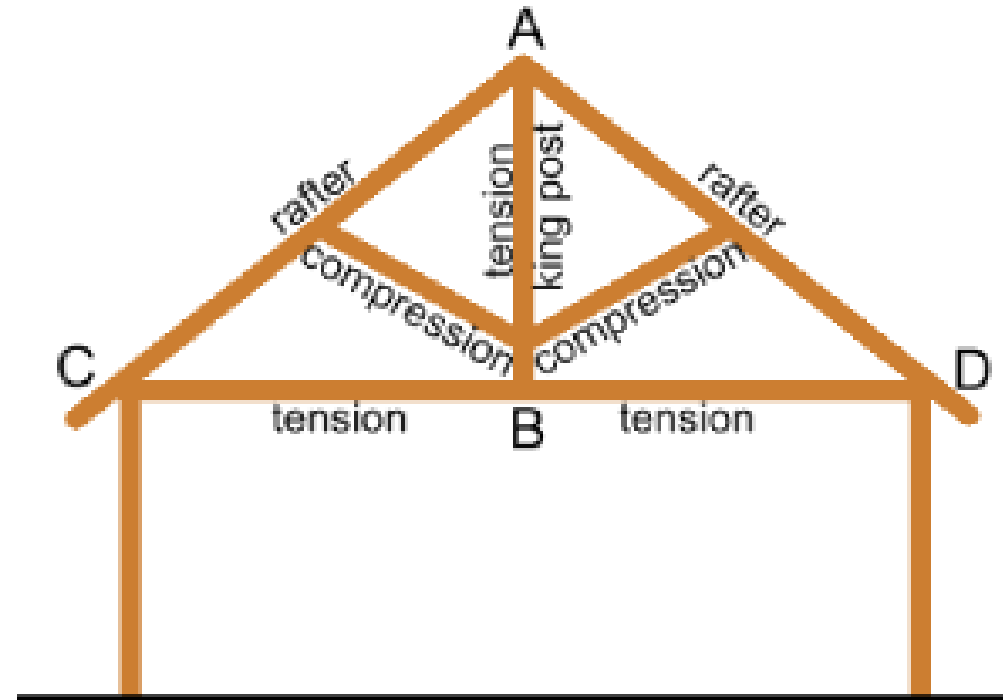
EXERCISE

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



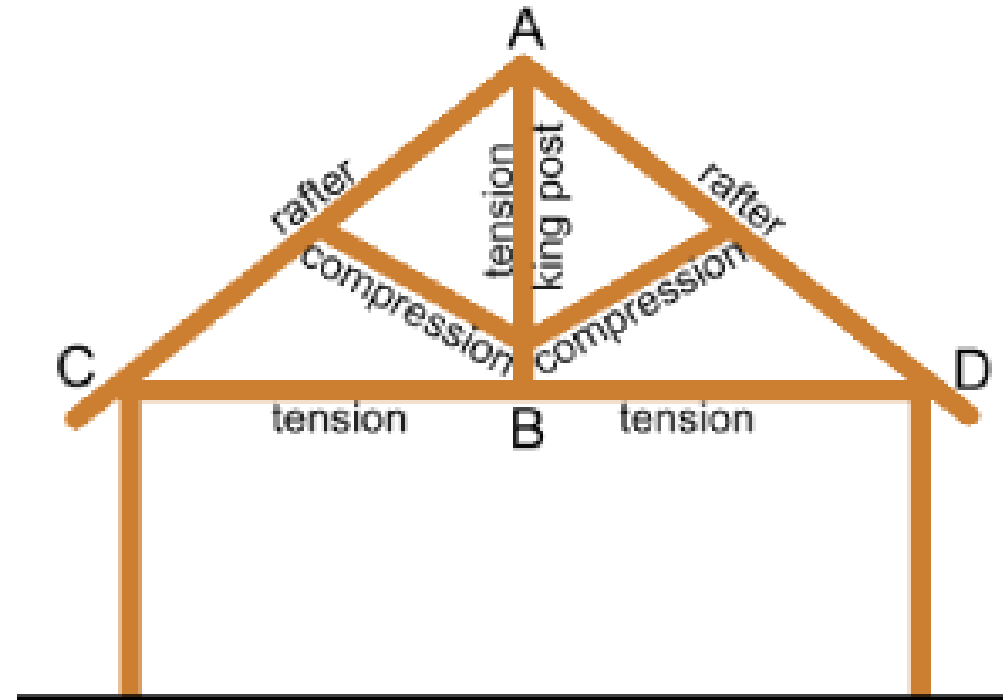
EXERCISE

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

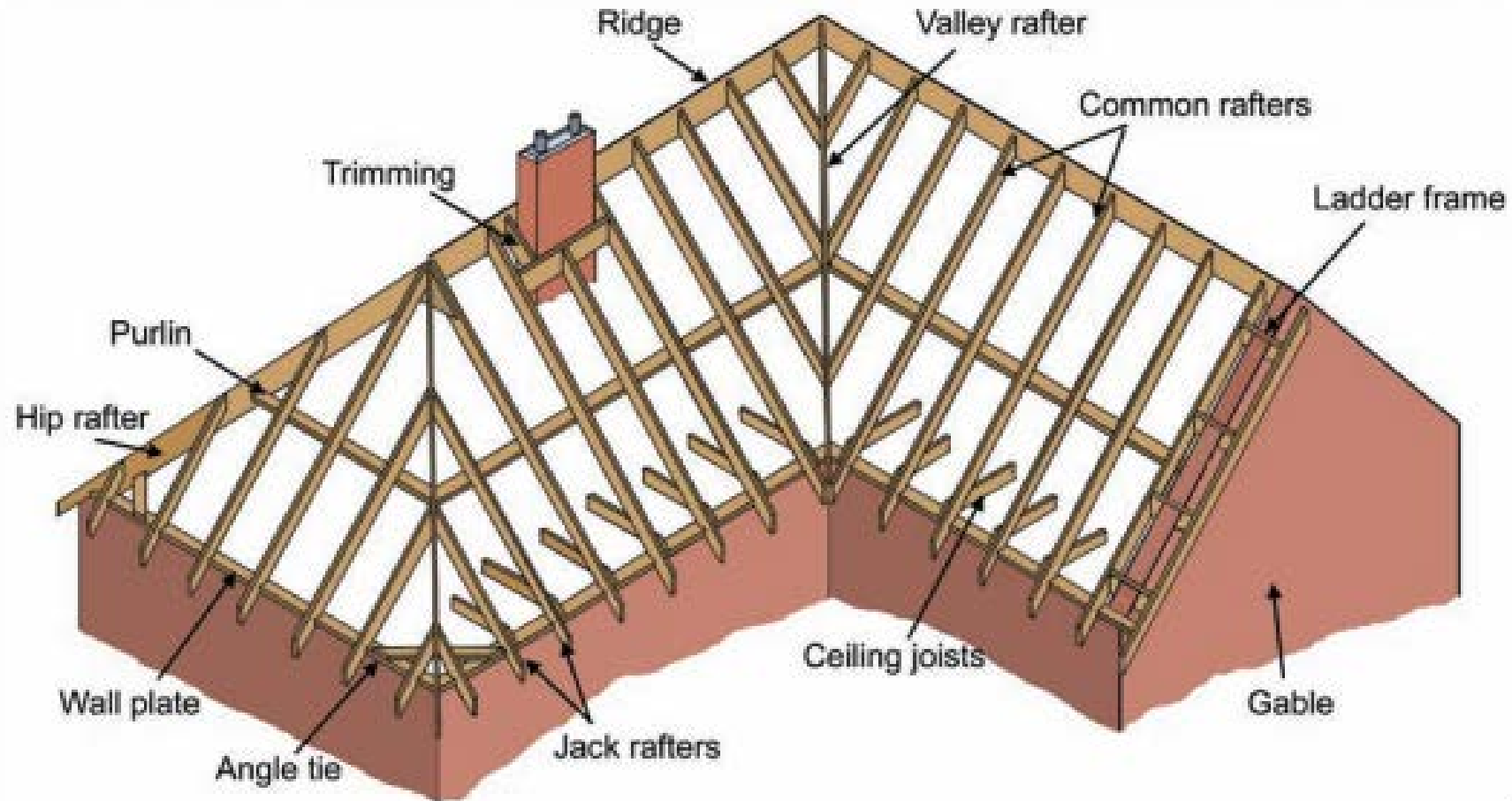


EXERCISE

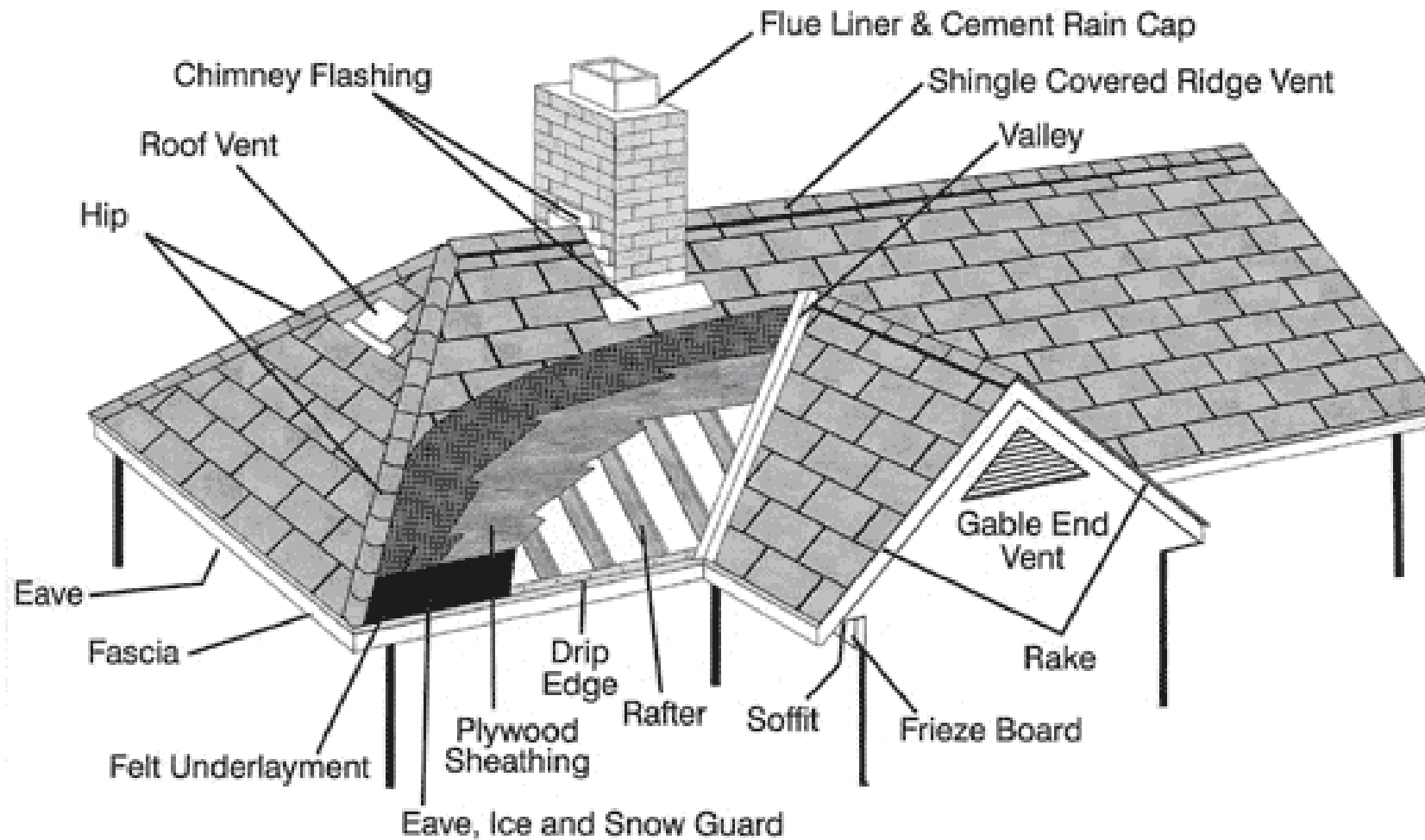
Design two different solutions for the joints A, B and C, one traditional and one with plates.



TERMINOLOGY

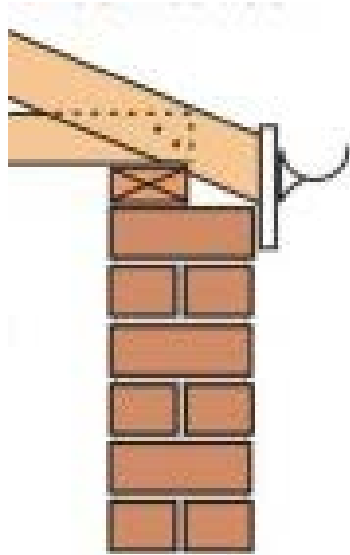


TERMINOLOGY



PITCHED ROOF EAVES

CLOSED EAVES

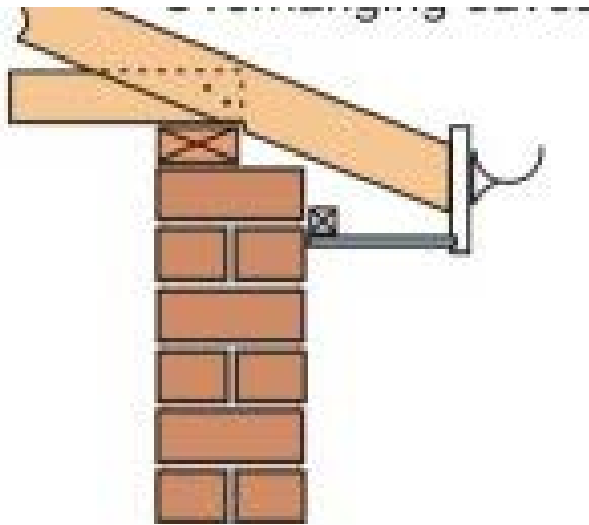


Flush eaves

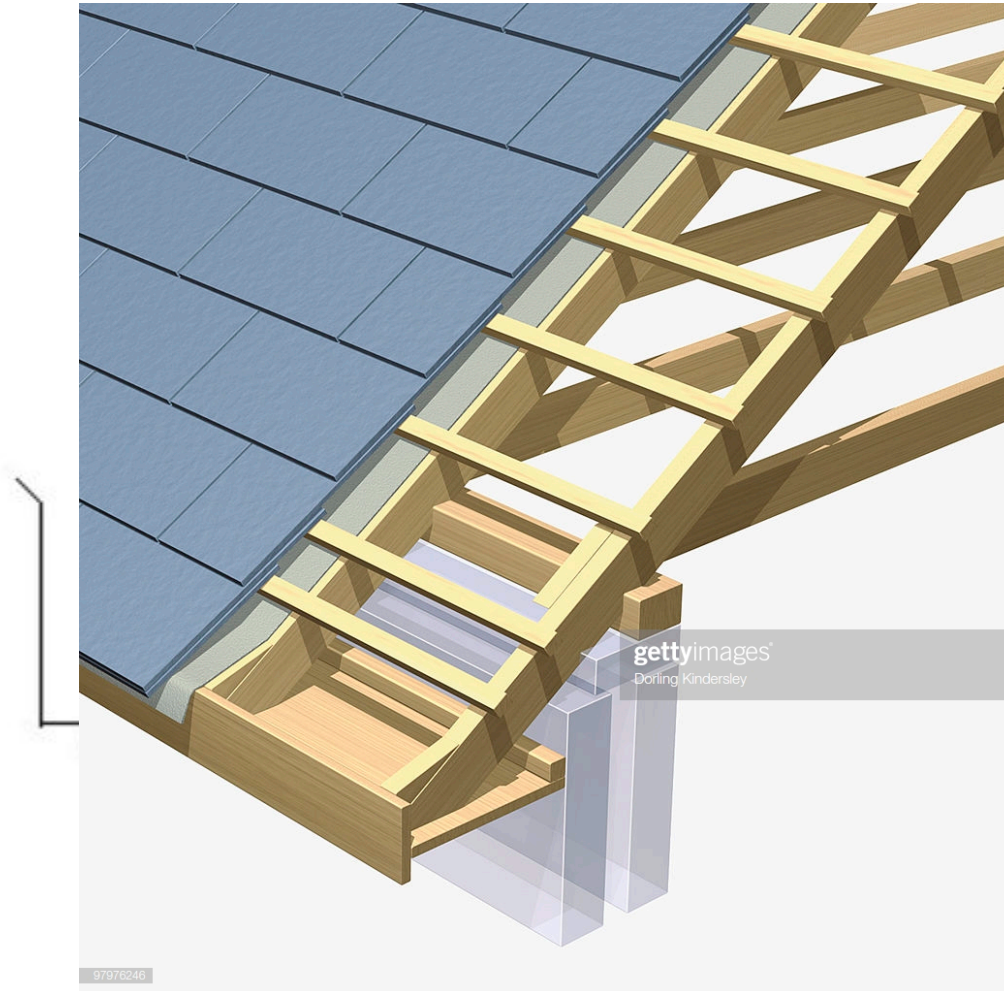


PITCHED ROOF EAVES

CLOSED EAVES

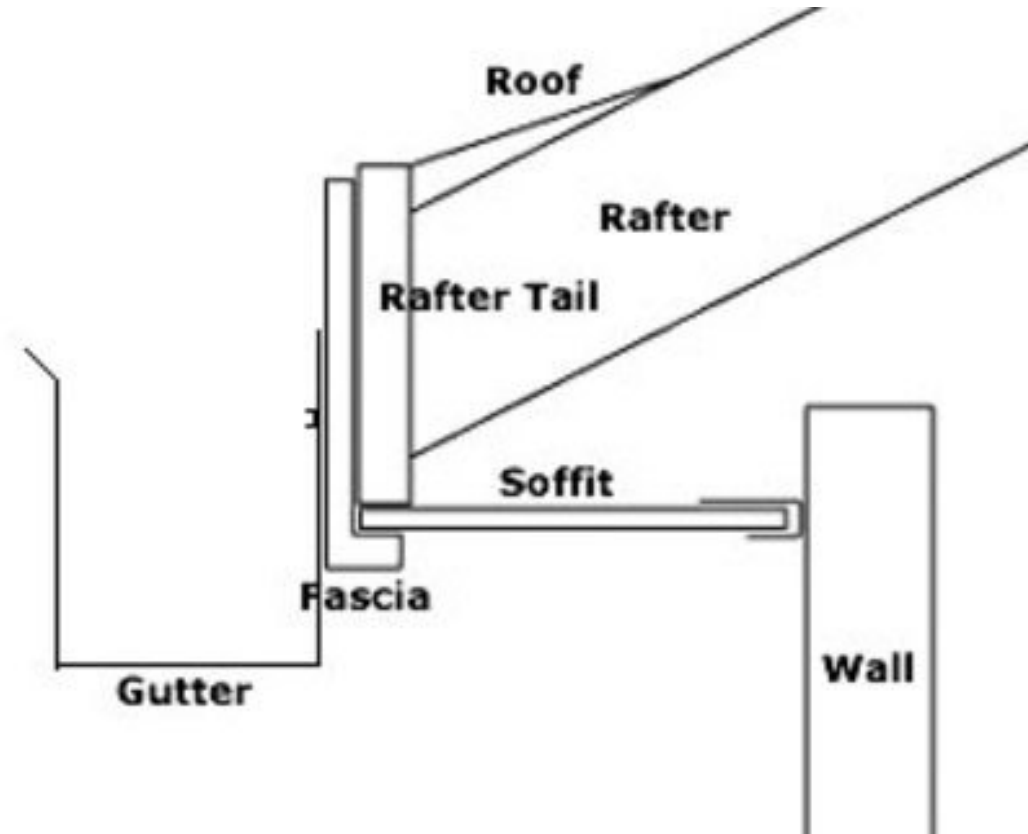


Soffit eaves



PITCHED ROOF EAVES

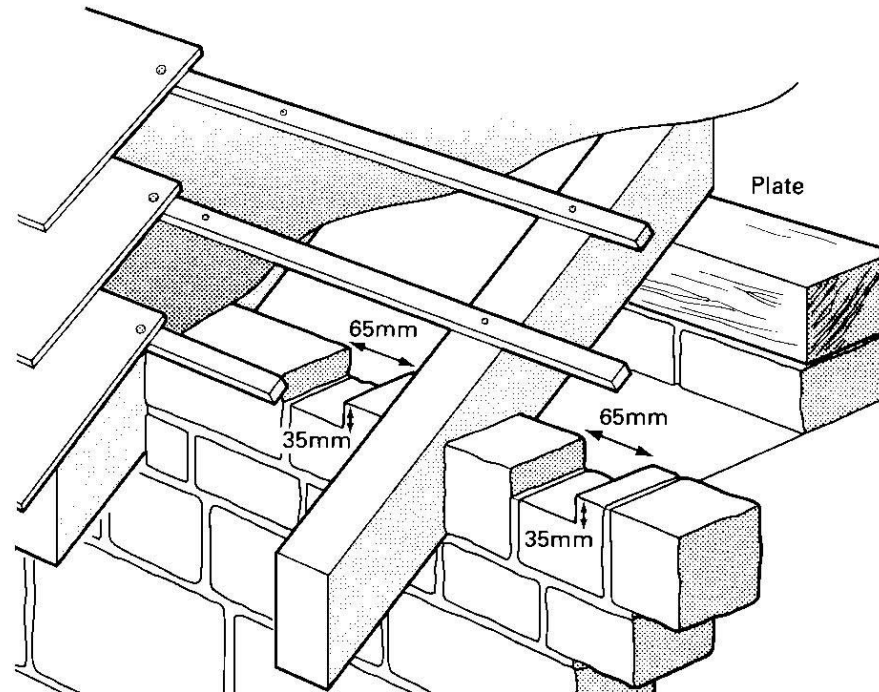
CLOSED EAVES



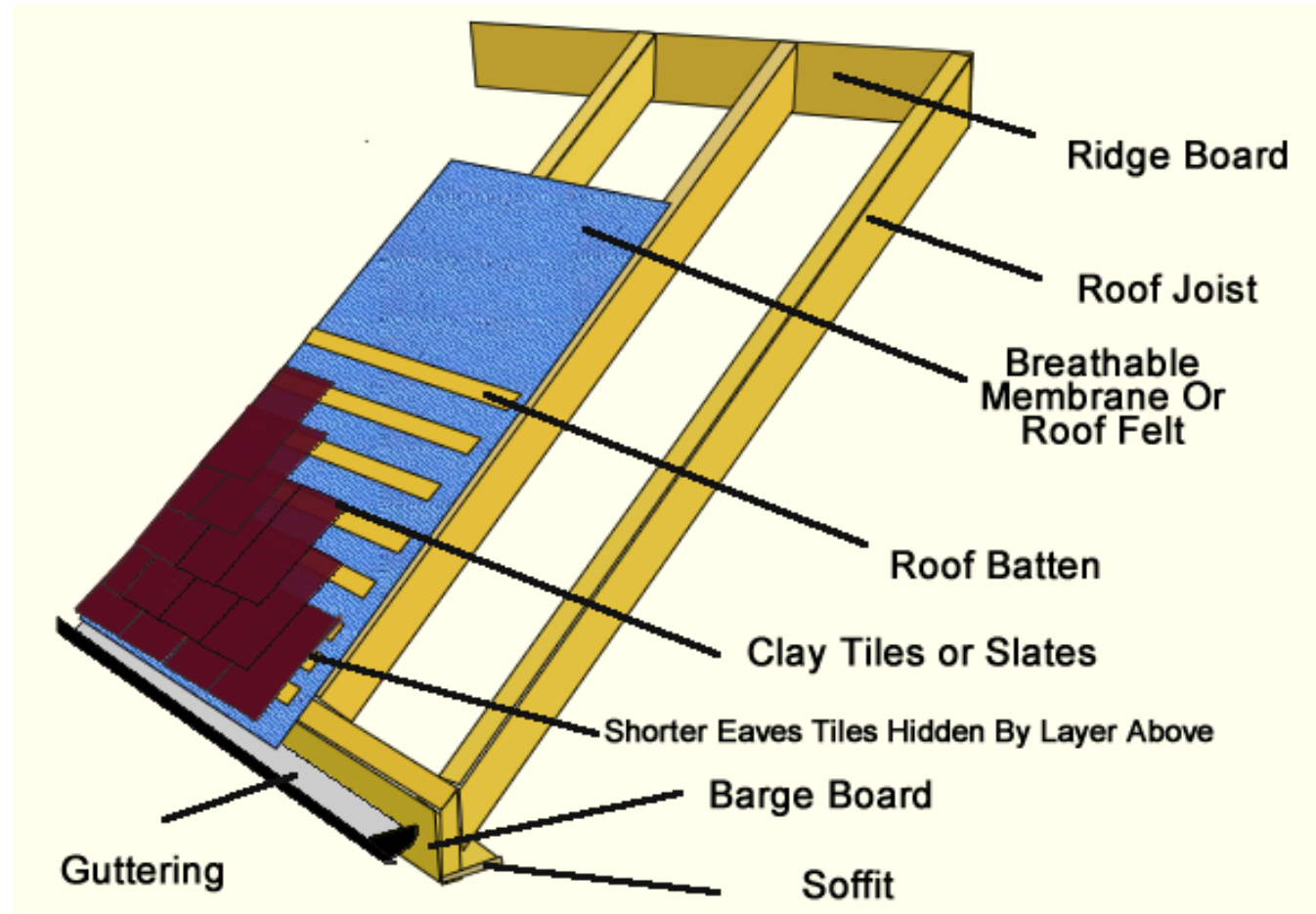
Soffit eaves

PITCHED ROOF EAVES

OPEN EAVES

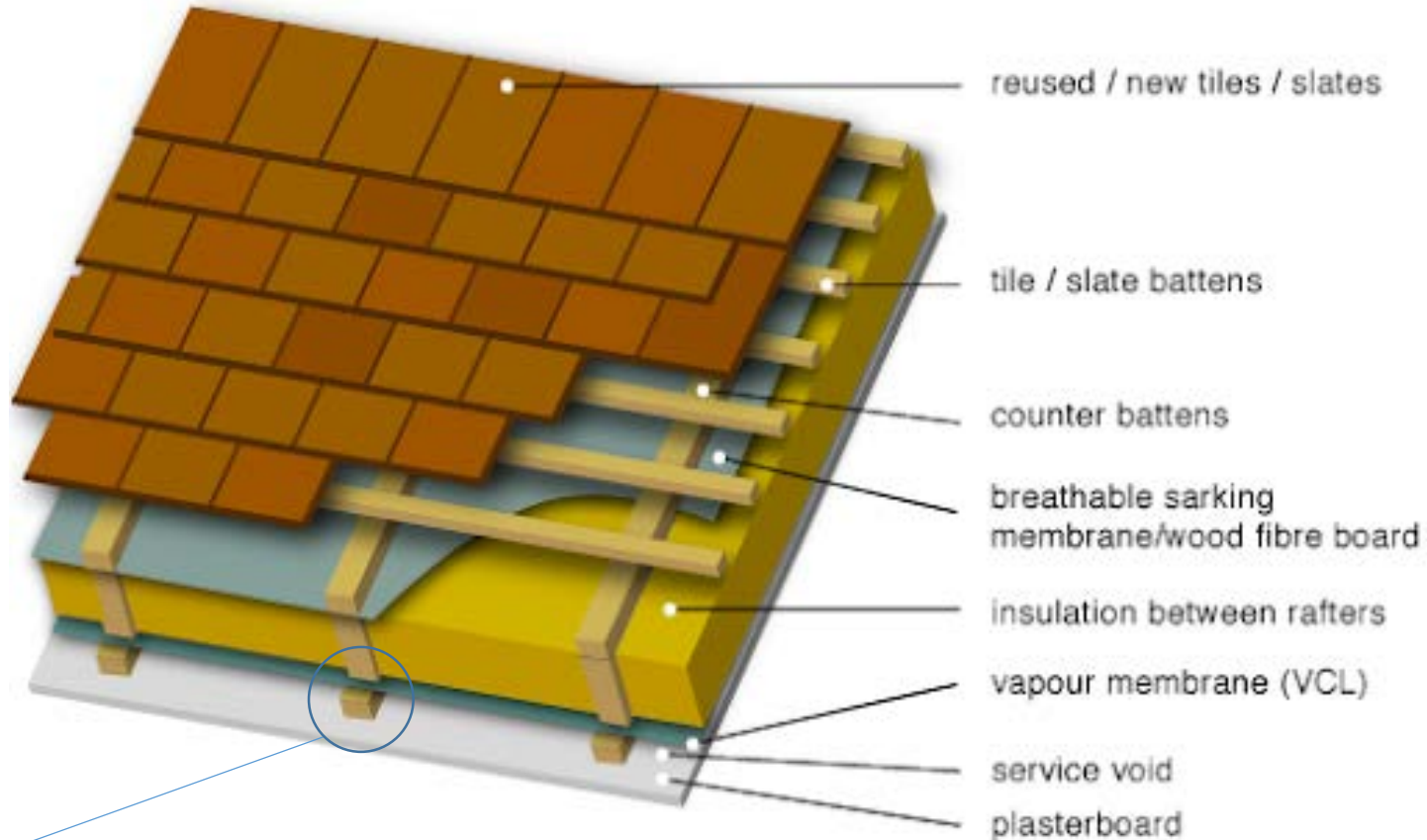


ROOF COVER



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

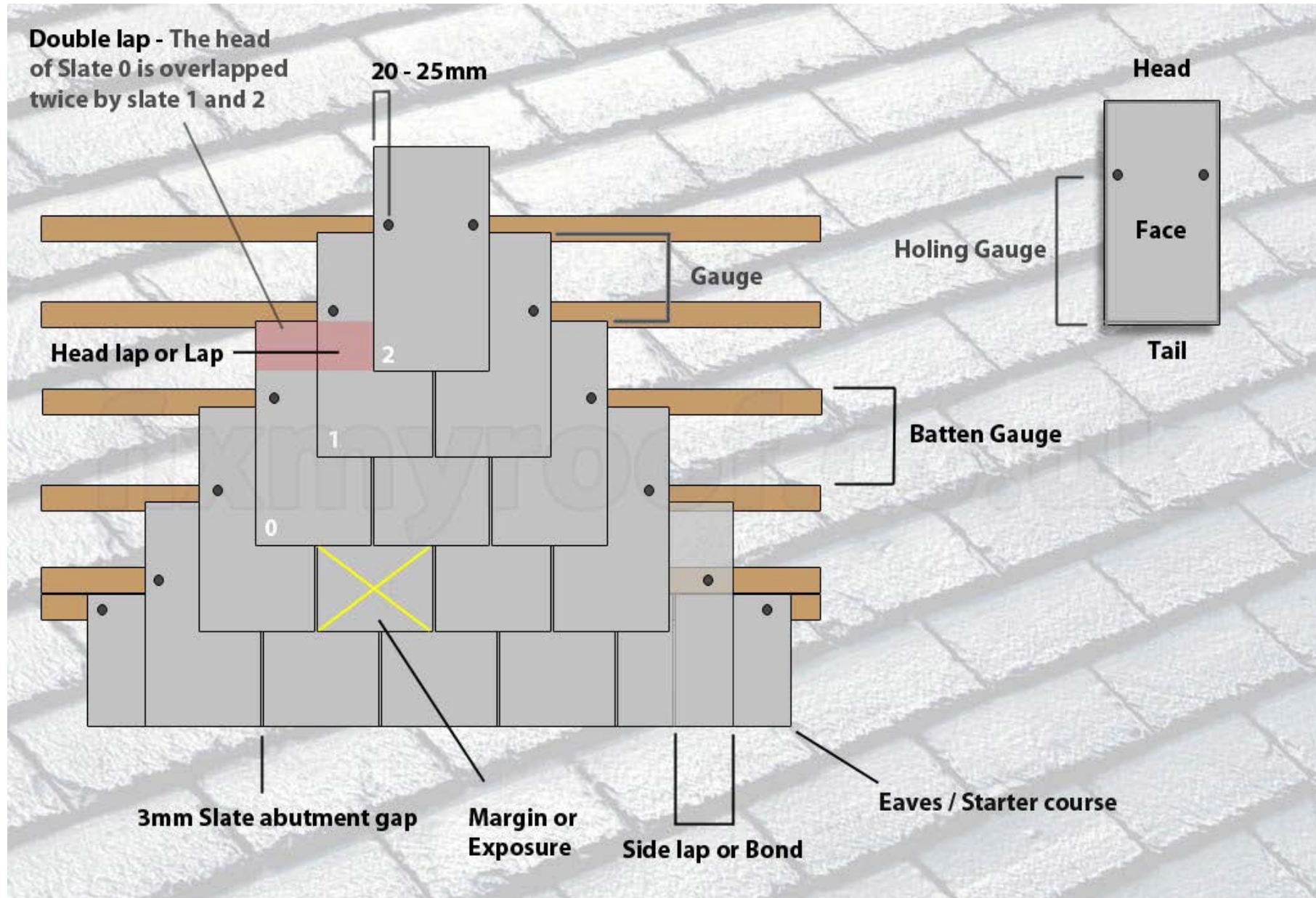
Slate shingles

- 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

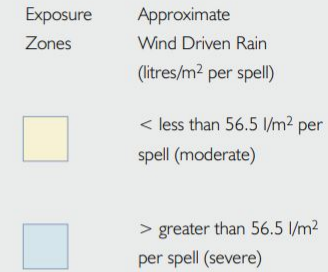
Natural slate shingles:

- 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)





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

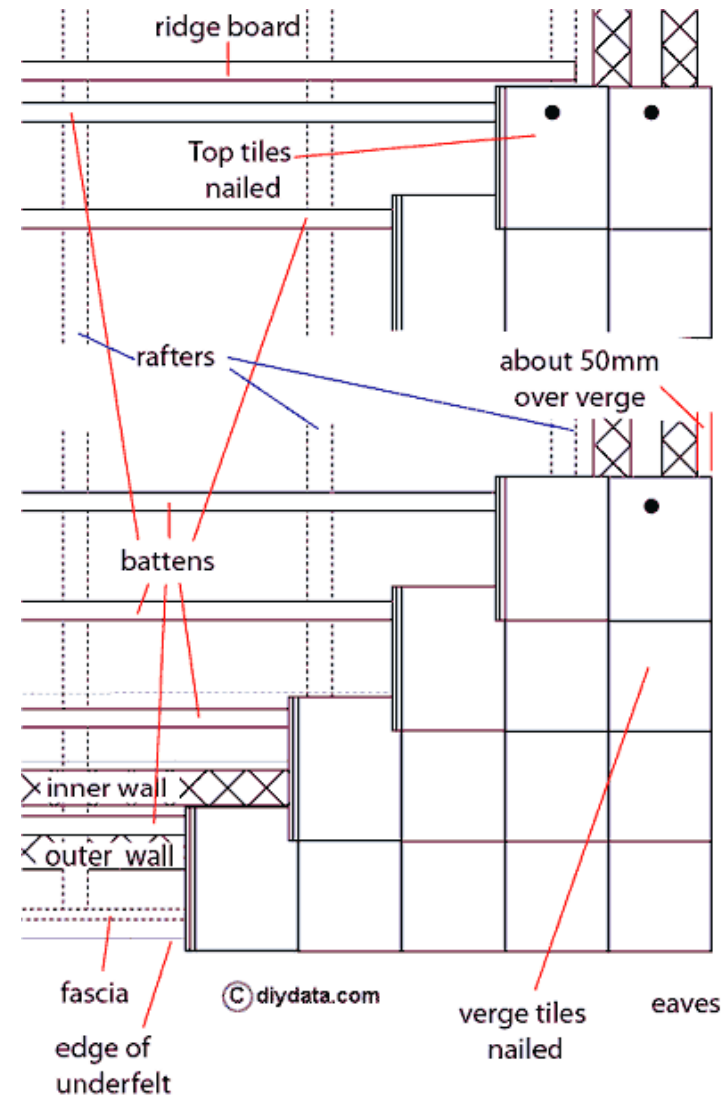
Concrete

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

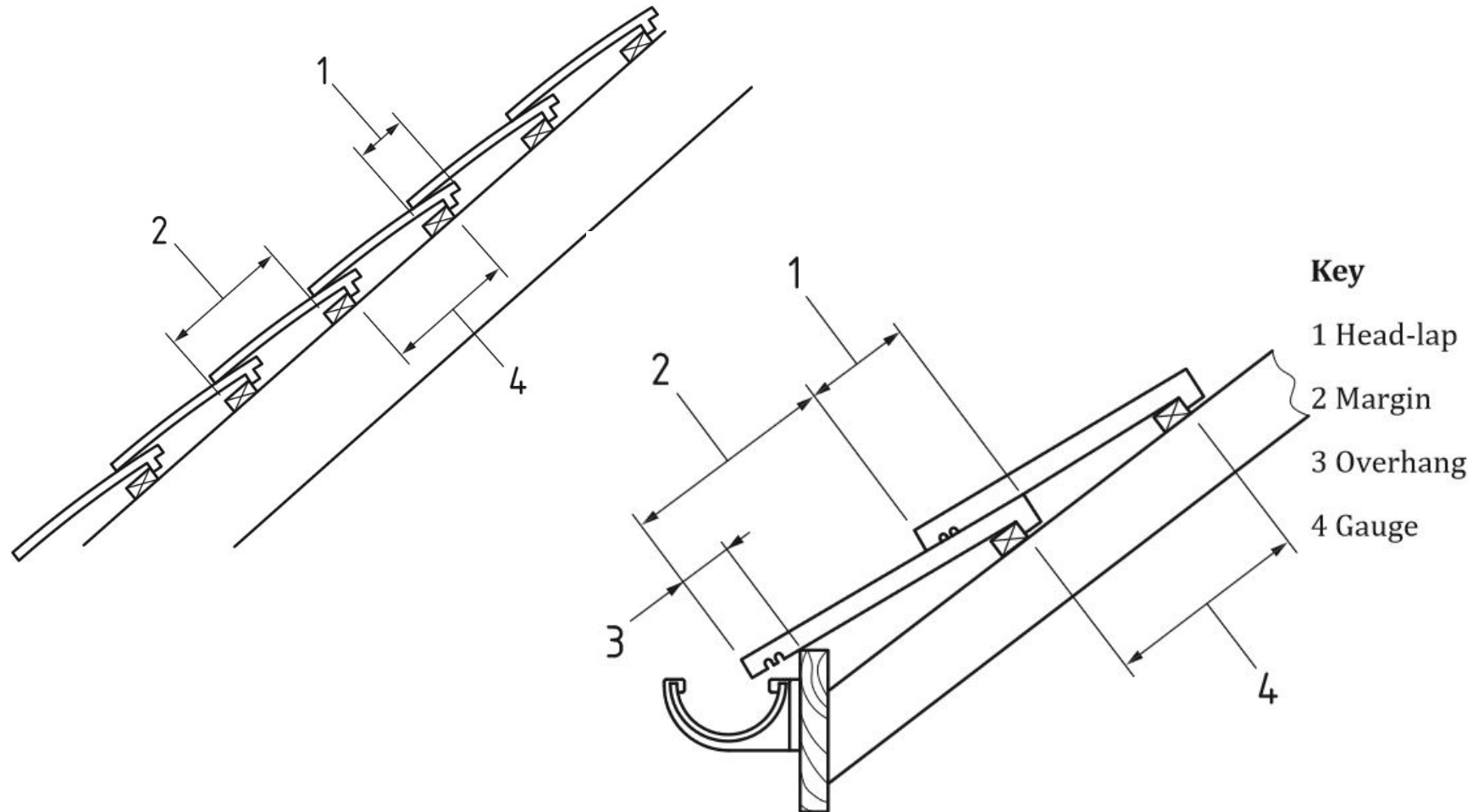
ROOF COVER



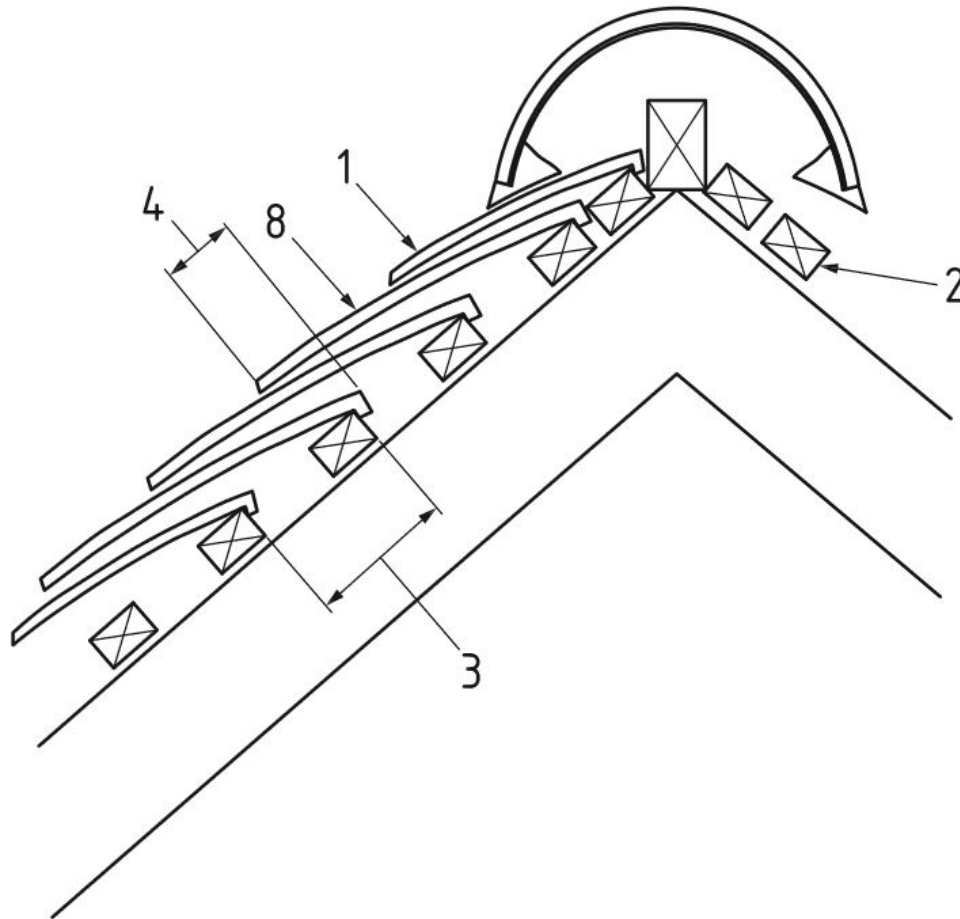
Just interlocking concrete tiles
At pitches lower than 12.5°
With a bigger angle, concrete tiles
hooked over battens
Nailed every 4th row
Straight joints or staggered



Single lap, flat tiles



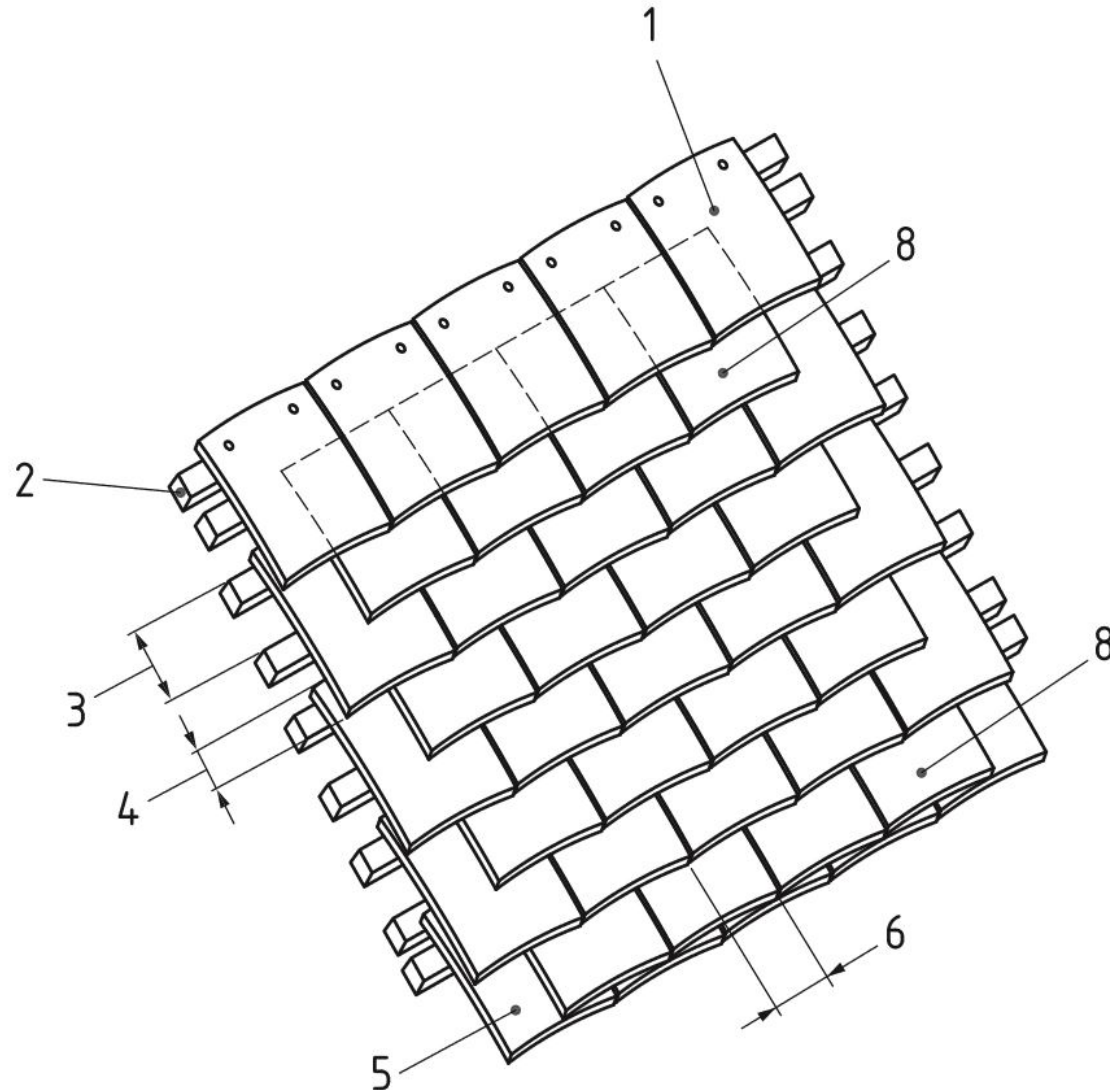
Double lap, flat tiles



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 |

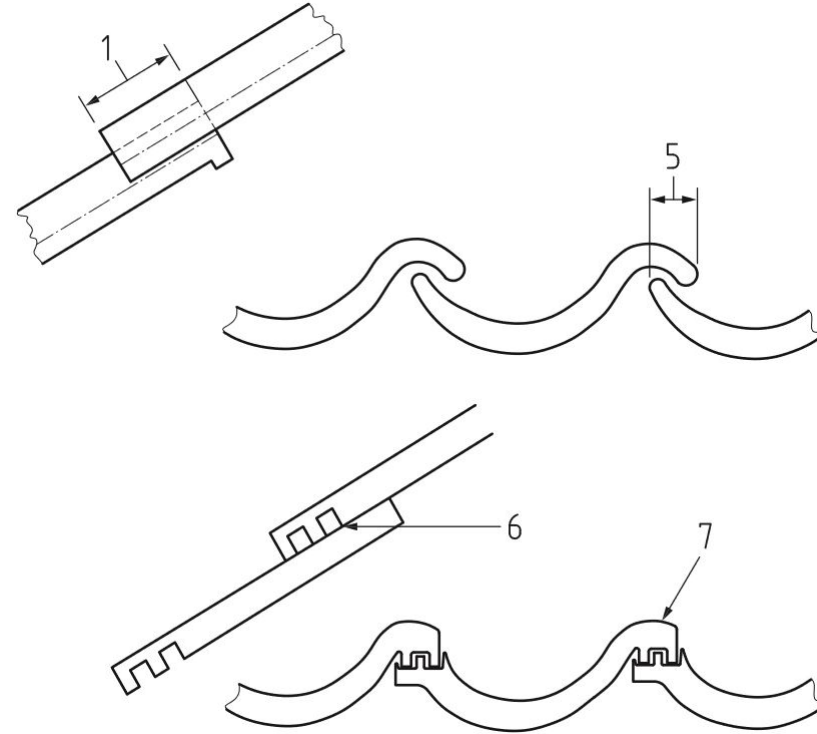
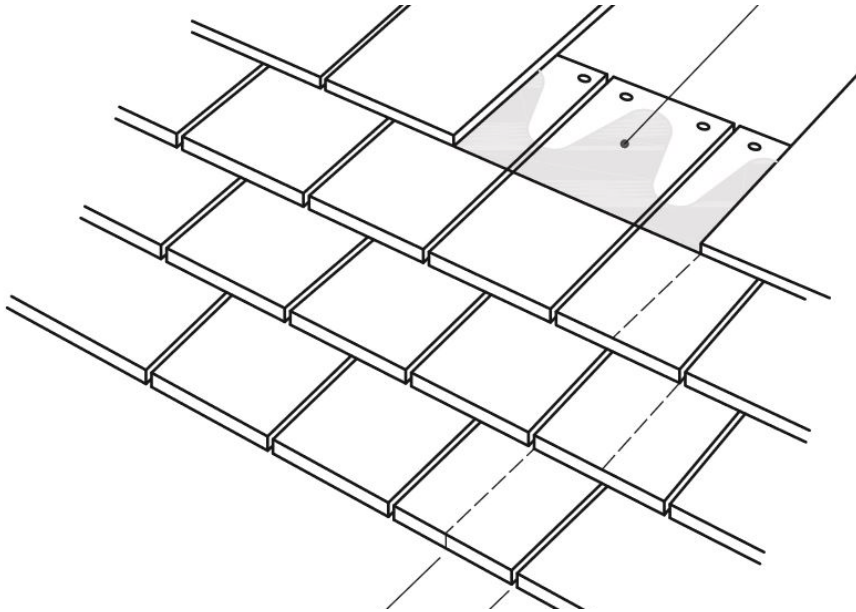
Double lap, flat tiles



Key

- | | |
|---|-------------------------|
| 1 | Top course tiles |
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| 5 | Eaves course tiles |
| 6 | Side-lap |
| 7 | Area of spread of water |
| 8 | Standard tiles |

Side laps



5 Overlapping side-lap

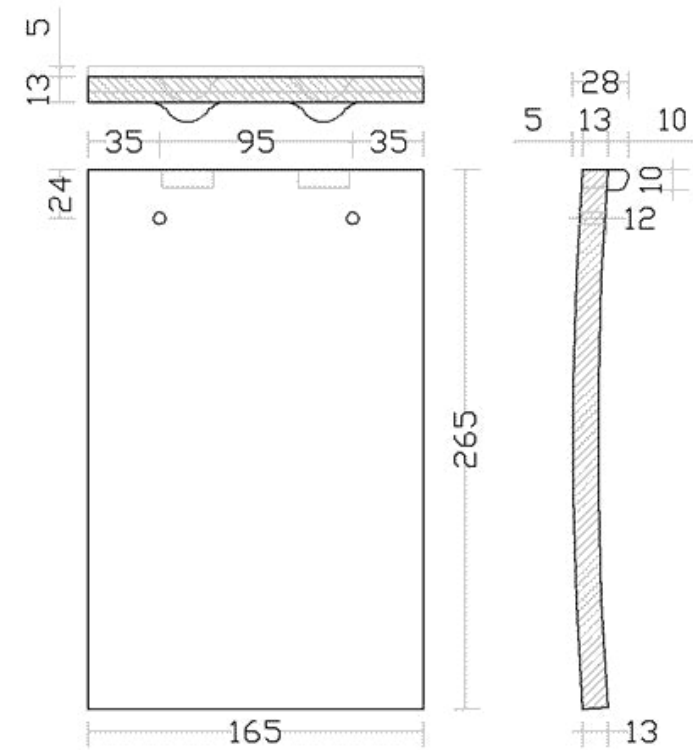
6 Anti-capillary bars

7 Side interlock

TRADITIONAL SLATES

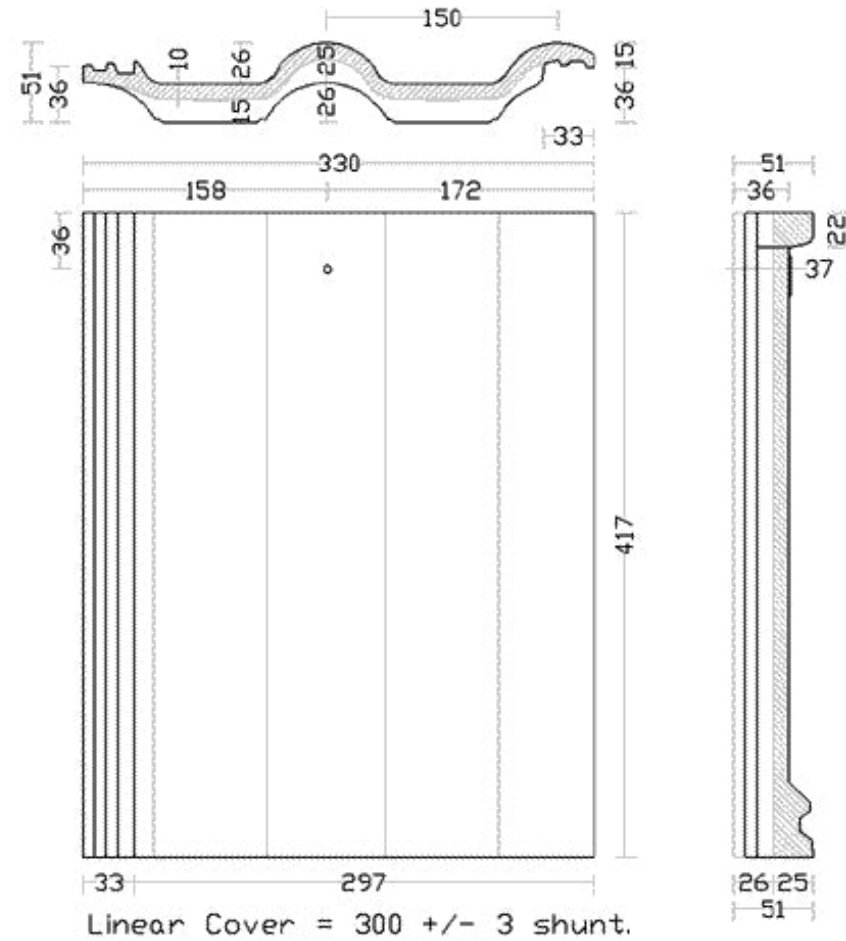
SIZE IN INCHES - LENGTH x WIDTH

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

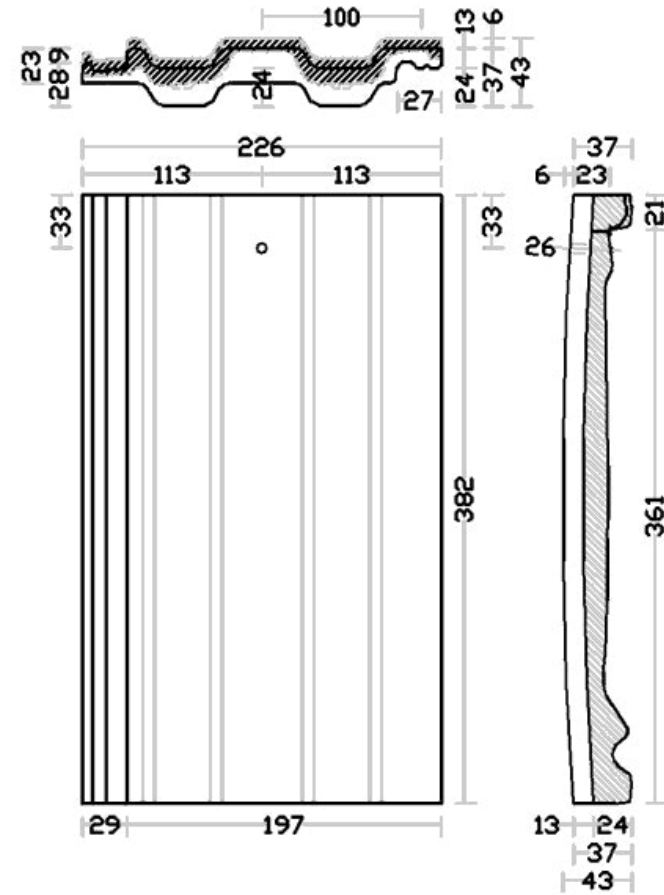


Linear Cover = 166.5 +/- 1.5 shunt.

Rosemary Clay Classic Smooth

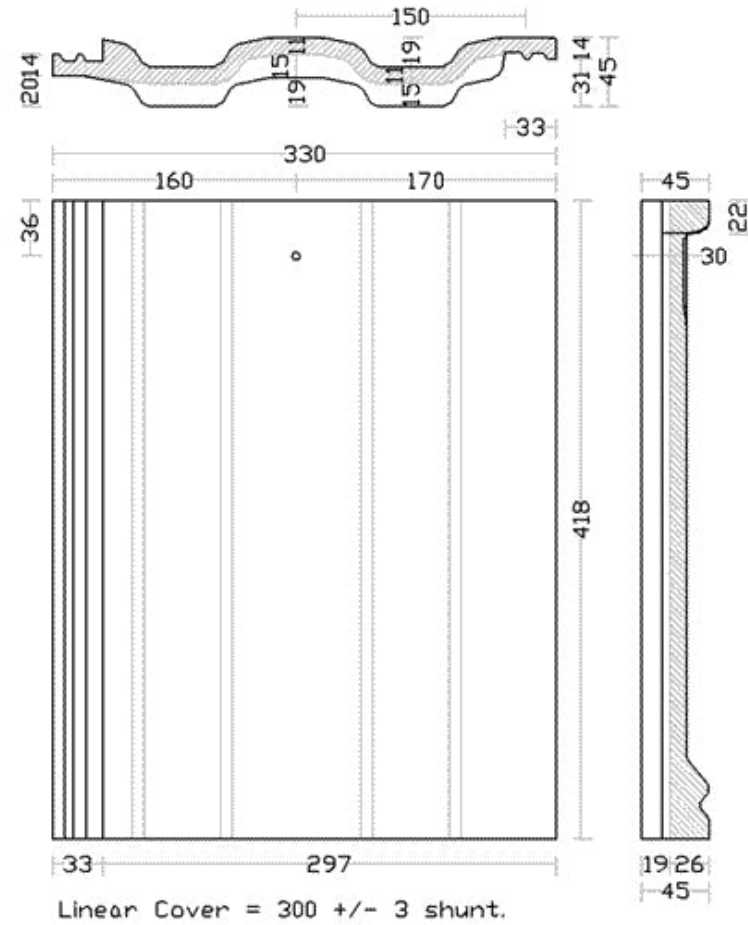


Double Roman Concrete Interlocking



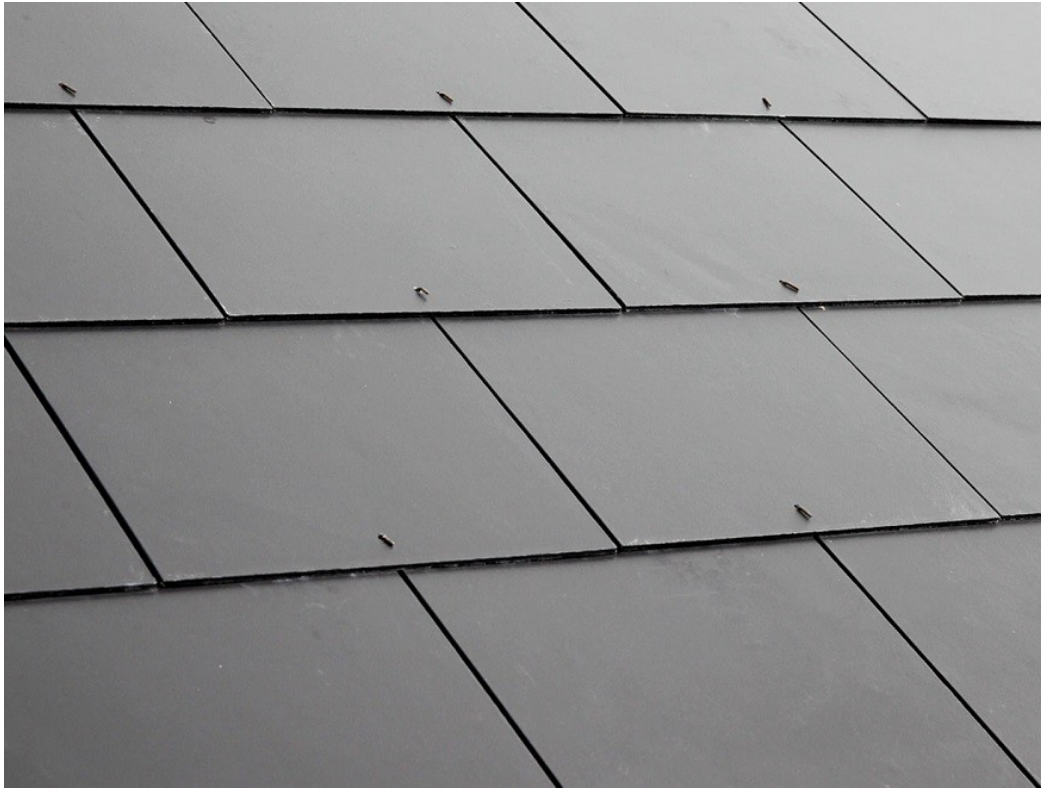
Linear Cover = 200 (±3 Shunt)

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)

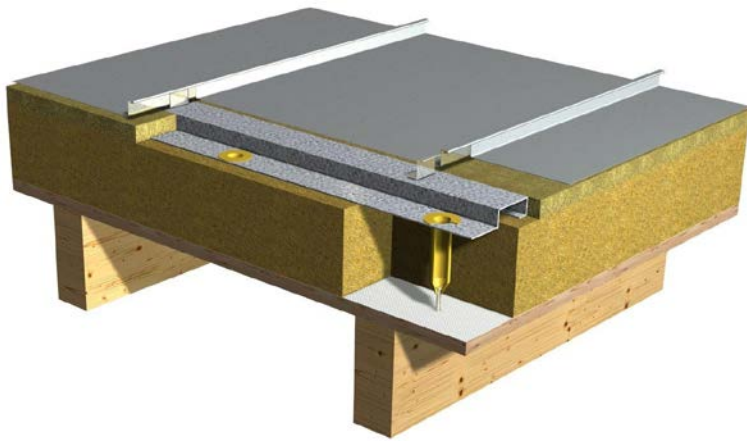


Profile sheets

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

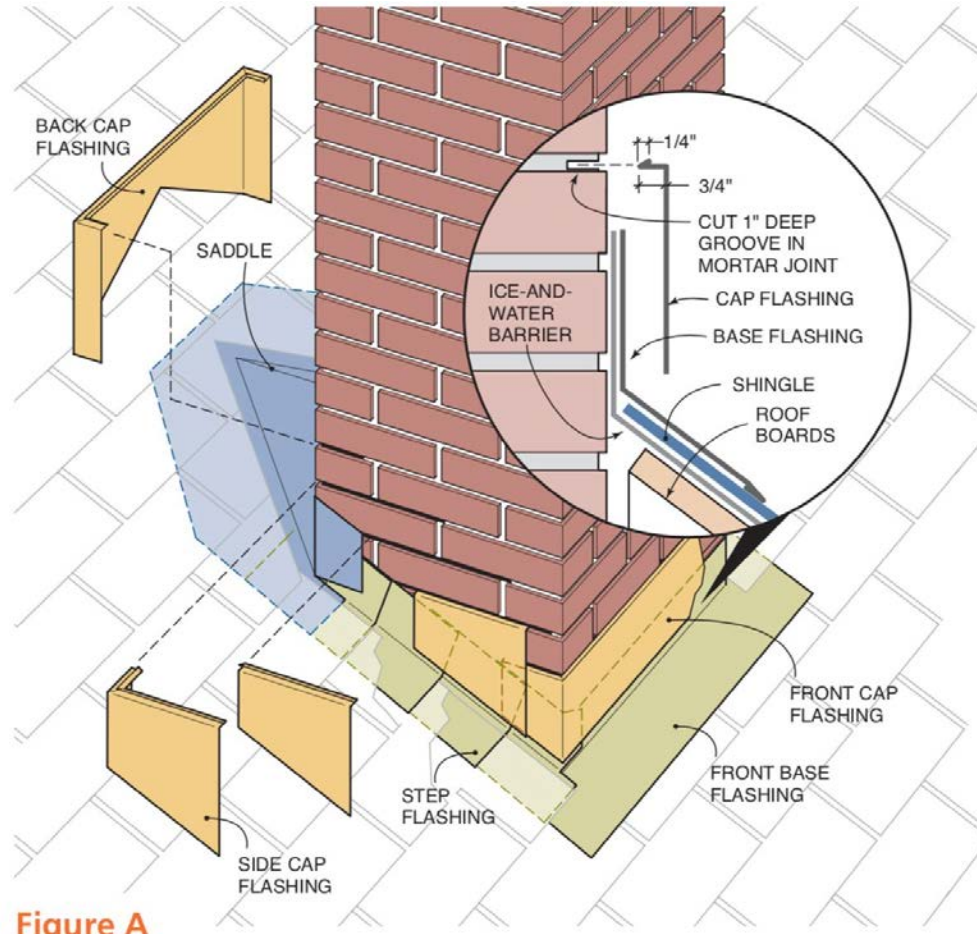
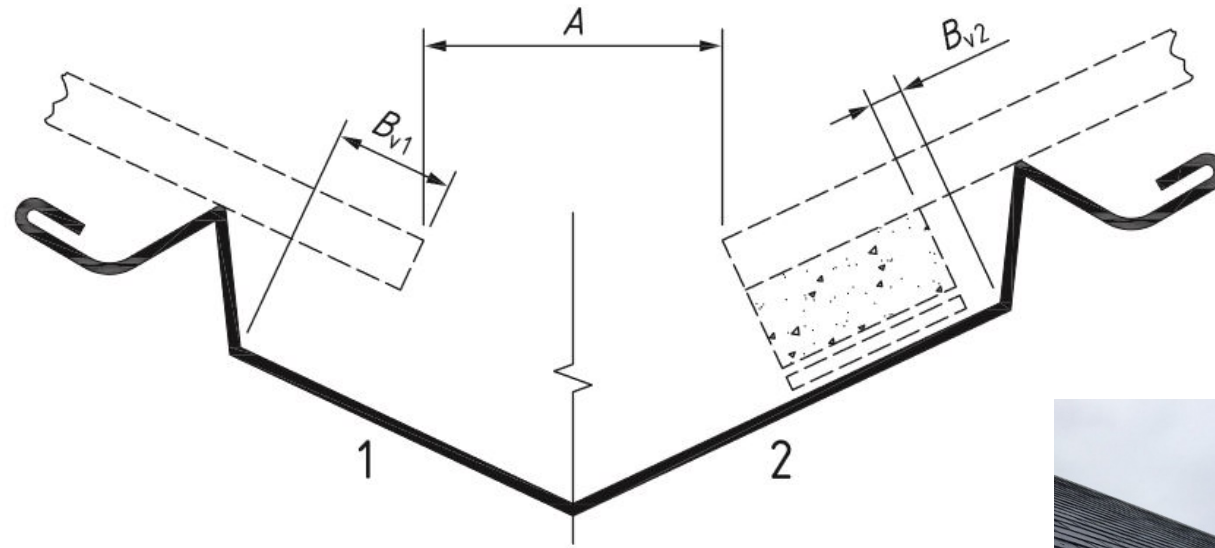


Figure A
Chimney flashing details





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)}	$X_d > 25 \text{ m}^2$, $\leq 100 \text{ m}^2$ on plan ^{C)}	$X_d \leq 25 \text{ m}^2$ on plan ^{B)}	$X_d > 25 \text{ m}^2$, $\leq 100 \text{ m}^2$ on plan ^{C)}	$X_d \leq 25 \text{ m}^2$ on plan ^{B)}	$X_d > 25 \text{ m}^2$, $\leq 100 \text{ m}^2$ on plan ^{C)}
degrees (°)	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).

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.

The Building Regulations

Conservation of fuel and power

L1A

APPROVED DOCUMENT

**L1A Conservation of fuel and power
in new dwellings**

**Latest Edition
with up-to-date
amendments**



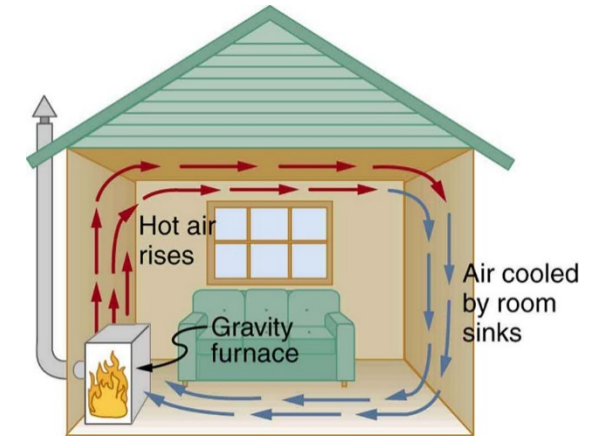
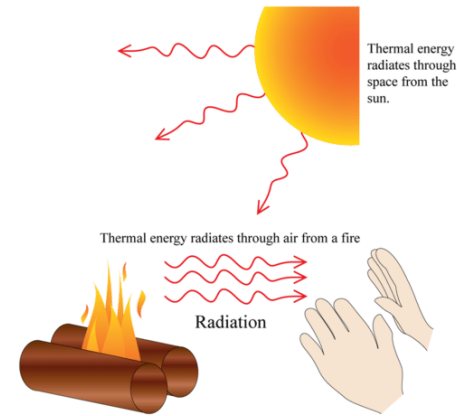
In order to specify insulation correctly however, the specifier needs to understand the reasons why it works, and apply the correct technology to any given construction detail.

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.

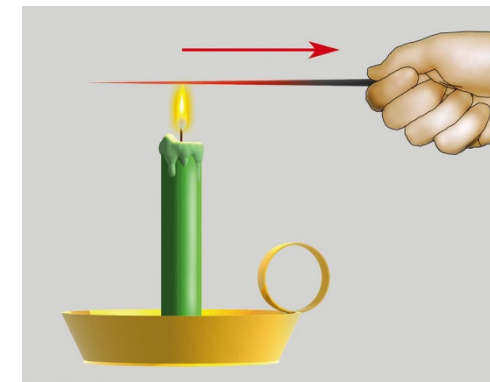
Heat Transfer

- **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.





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

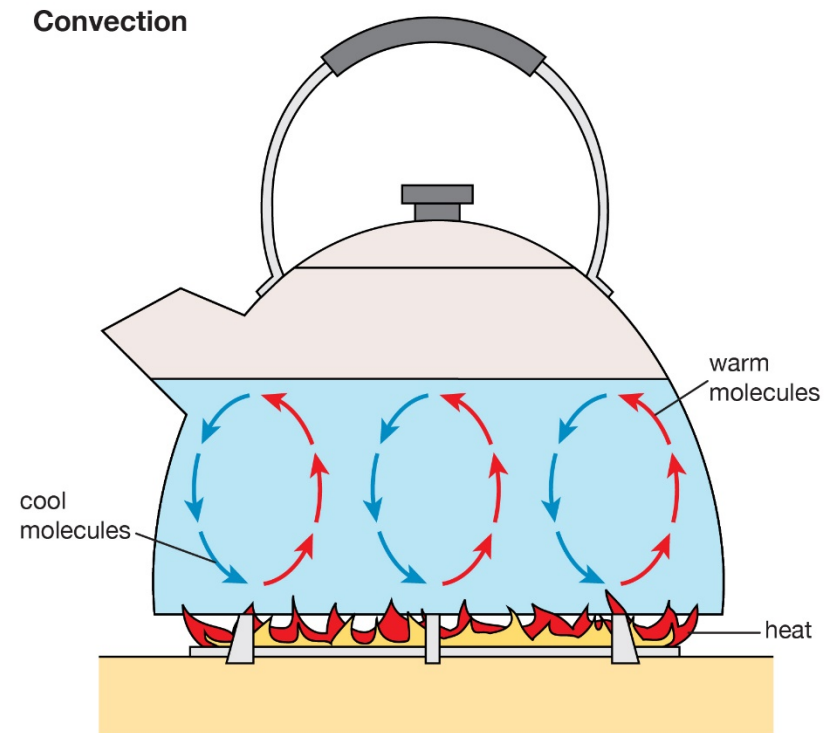


Convection

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.

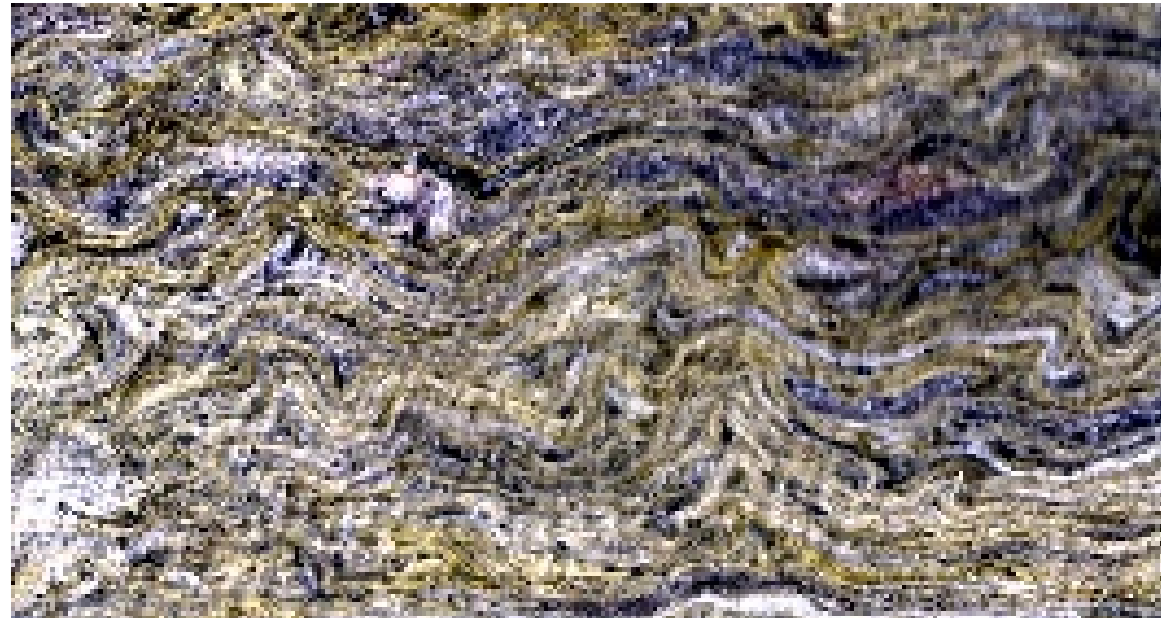


Performance

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)	0.22 - 0.29	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: $0.13 \text{ W/m}^2\text{K}$.

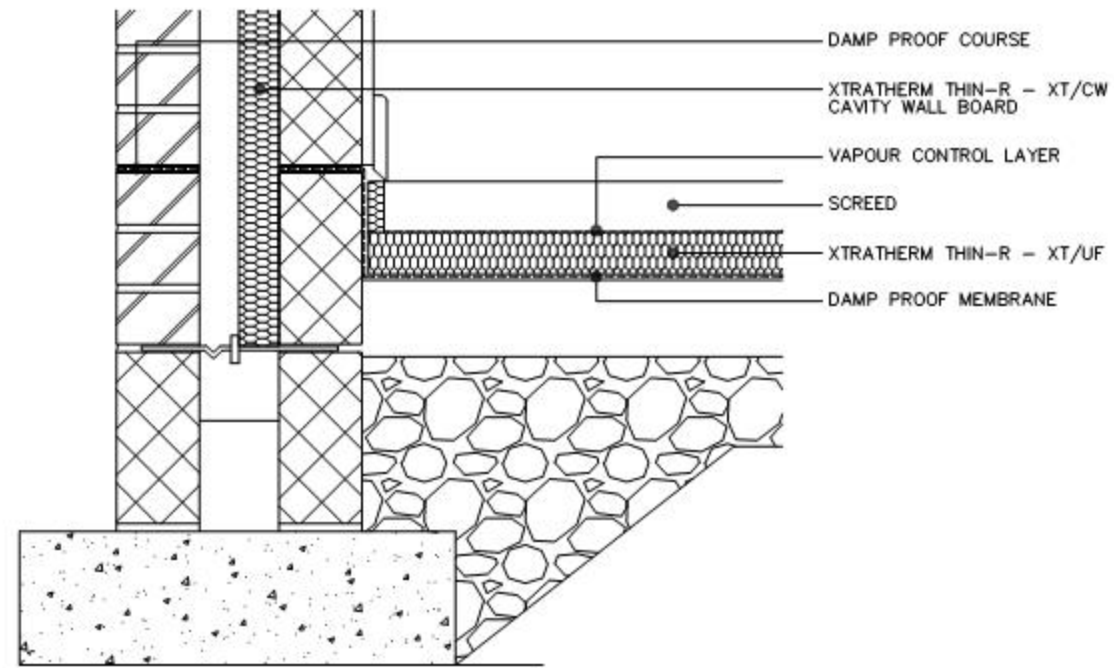
Windows, roof windows, glazed rooflights and glazed doors: $1.4 \text{ W/m}^2\text{K}$.

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).

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

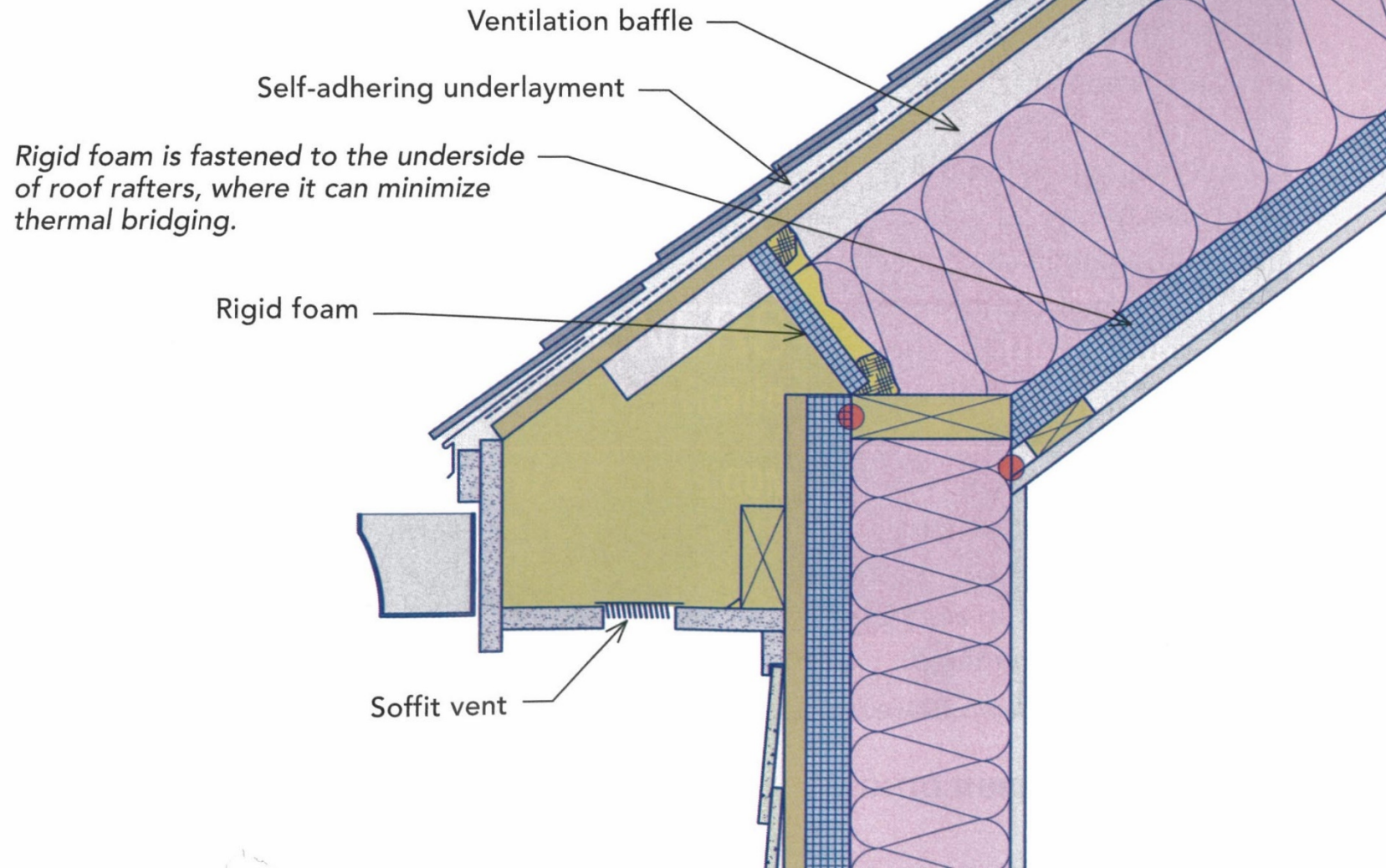
Where the thermal resistance of the layers of the element $R = \text{the thickness of each layer} / \text{the thermal conductivity of that layer (its k-value or lambda value } (\lambda) \text{ in W/mK)}$.



XTRATHERM
WALL/FLOOR INTERSECTION DETAIL
XTCWFJSC

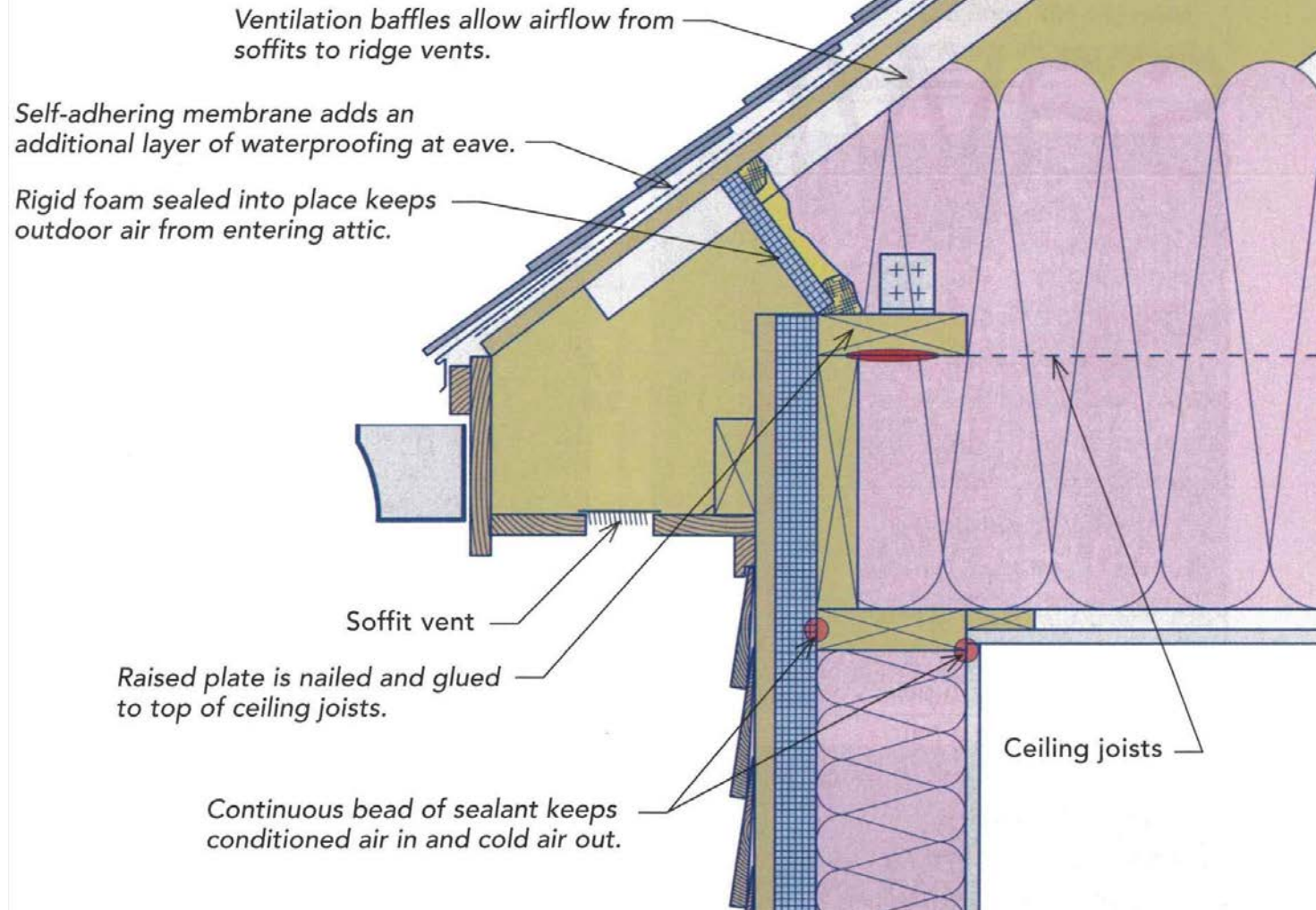
Rigid foam makes cathedral ceilings possible

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.





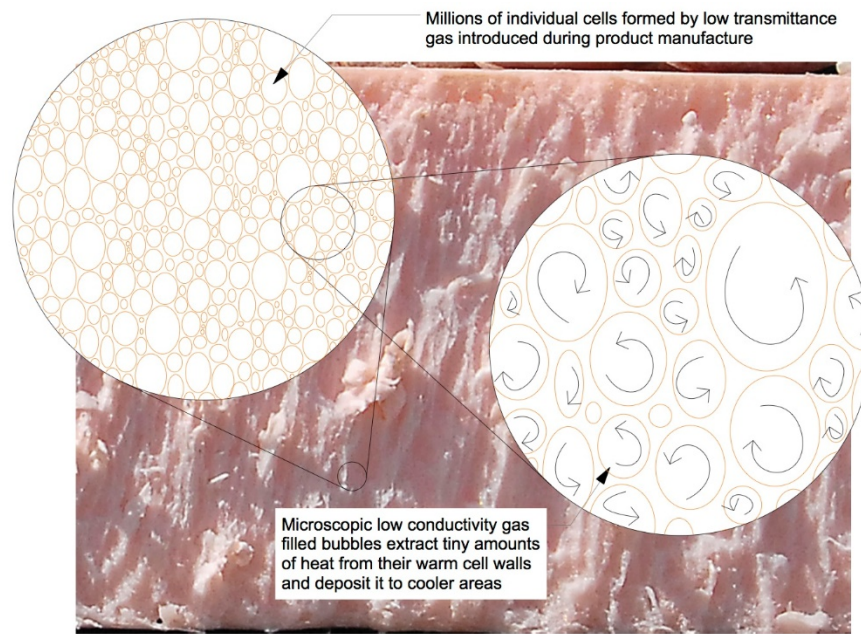


Types of Insulation

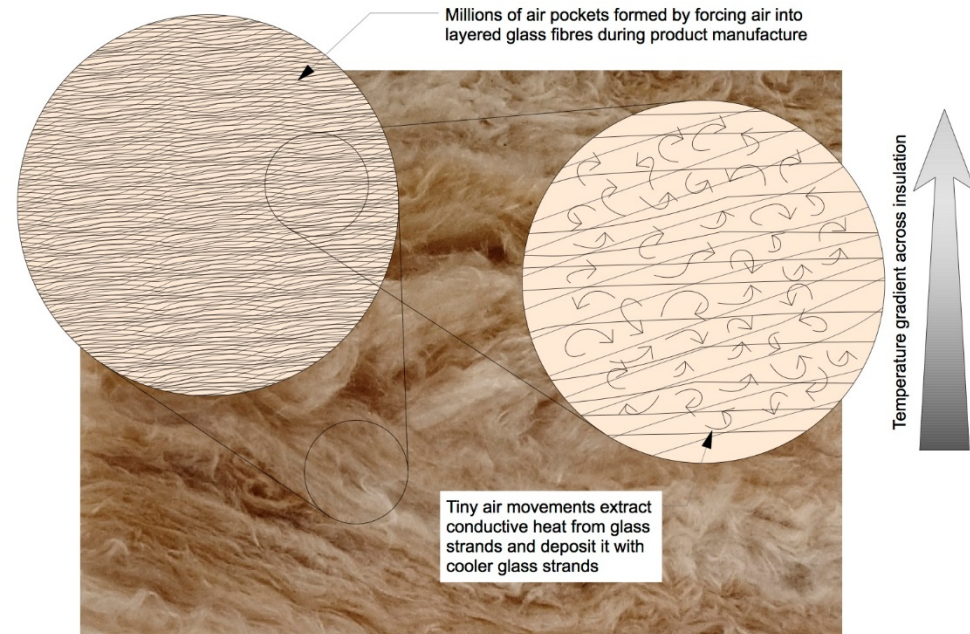
Thermal insulation materials have a low thermal conductivity which serves to limit the flow of heat energy between one side of the insulation and the other.

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



Open cell insulation - glass wool

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.

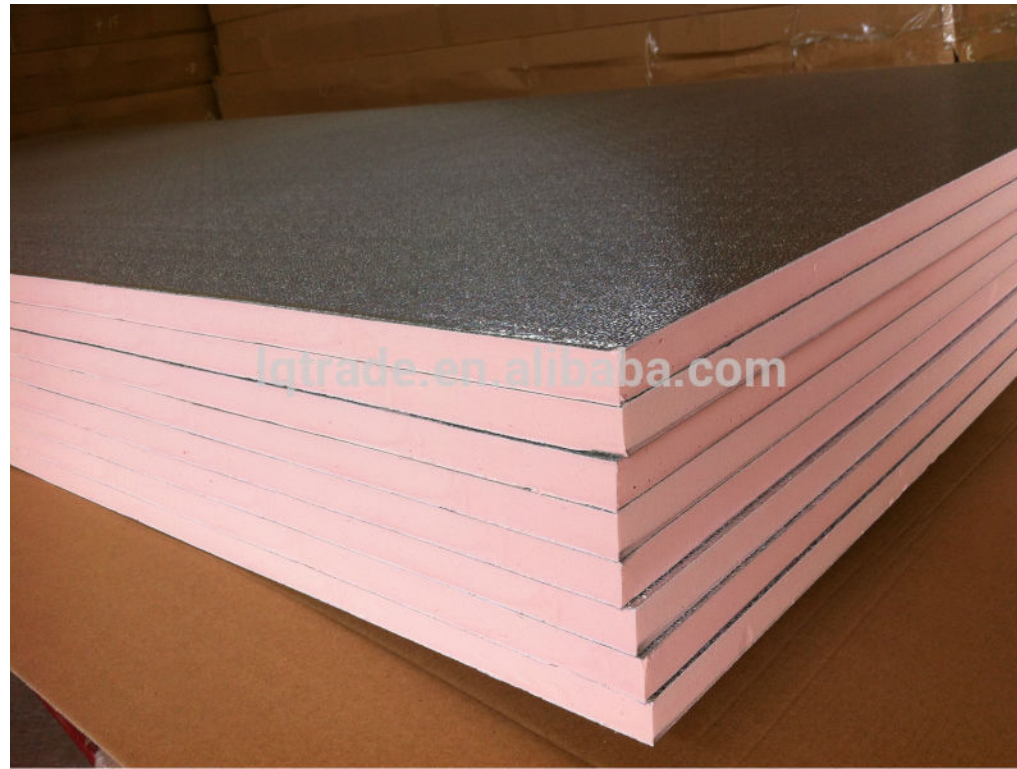


Foam boards

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.

Summary Week 4:

Assessment 2

Ground Floors

Upper Floors

Roof Construction

Thermal Performance

