Section A *Design Guidance*

A1 Structural form and function

Timber is a versatile building material that has been used for centuries as a structural material. Solid timber is widely used in domestic housing but engineered products are also widely available (used mainly for engineering solutions in many buildings). Products include laminated veneer lumber (LVL), parallel strand lumber, glulam, I beams, box beams, steel web beams and numerous board materials such as plywood, chip board, fibre board and orientated strand board (OSB).

The many products available give the engineer the versatility to design unique timber structures capable of meeting the client's requirements (e.g. safety, cost, functionality, fire performance, durability and aesthetic appeal). Structural forms and concepts are dictated by end use, space requirements and cost. At the preliminary design stage there are many criteria to be considered.

For example:

Building Usage
- Function
- Size
- Space division
- In-plan organisation

Special Considerations
- Fire protection
- Acoustics
- Surrounding properties
- Environment

Site
- Ground conditions
- Access
- Topography

Service Installations
- Ventilation
- Heating
- Acoustics/Lighting
- Water supply
- Waste removal

Loading
- Dead load
- Live load
- Snow/wind
- Impact

The building shape is influenced by many factors including how it fits into its surroundings, the creativity of the designer, its functionality, the economics of construction and its capability to meet the structural requirements.

Timber used structurally must be strength graded by qualified personnel under the supervision of an accredited certification body such as the National Standards Authority of Ireland (NSAI) or the Timber Research and Development Association (TRADA). Timber must be strength graded in the dry state with a moisture content of approximately 20% but its moisture content, treatment (perhaps with preservative or flame retardant) and finish (planed or sawn) can be further specified by the designer. Timber can be an efficient structural material as well as durable, fire resistant, environmentally friendly and aesthetically pleasing.

Solid timber is widely used in domestic housing mainly for roof rafters, trussed rafters, ceiling joists, purlins and floor joists. Timber frame construction has become increasingly popular in Ireland due to its thermal efficiency, rapid construction times, cost and its environmental image. Traditional timber frame construction is almost identical in appearance to masonry construction, essentially the only difference being the inner leaf of the external wall being constructed mainly of timber. The thermal insulation is contained within the external wall inner leaf and is protected and sheltered and therefore performs extremely well. Timber frame is a system that can be designed to easily give increased performance in sound, fire and thermal parameters.

Engineered wood products, the most common ones probably being glulam, LVL, parallel strand lumber and I-beams are used in a wide range of building types; apartments, offices, factories, shopping centres, sports halls as well as housing. The engineering of the timber enhances the performance of the timber and maximises its use. Glulam can be made in almost any size and is capable of carrying heavy loads and spanning large distances. LVL and parallel strand lumber tend to go into products such as I-beams or to be used as part of an I-beam floor system. I-beams and similar engineered systems are increasingly being used especially in timber frame buildings in apartments and housing. Refer to building regulations for thermal performance.

Developing the building
- Will connections be exposed and used aesthetically
- Joints can affect the structure, e.g. with bolted trusses the number of timber members is usually increased to accommodate the number of bolts
- Will loads, spans and performance dictate the material used, e.g. solid timber, I-joists, glulam, steel
- Will other material be used and how will these interact with the timber
- The size of components, this can affect appearance and can raise difficulties in transport and erection
- Manufacturing of components on site is usually to be avoided but on occasions there may be no alternative

Structural considerations
- Stability
- Strength
- Deflection
- Cost effectiveness
- Buildable
- Durability
- Fire resistance
- Layout of structural members
- Connections
- Materials

Architectural considerations
- Use of structure as a visual medium
- Geometry and shape
- Use of colour and texture
- Selection of timber species
- Layout of structural elements

A2 Strength

Factors influencing properties of timber:

General:
- Species
- Source (geographical)

Natural characteristics:
- Density – this can affect the joint design
- Knots – some species are naturally knotty
- Slope of grain - knots can affect the grain and some species are more prone to spiral grain
- Ring width – these are usually wider in the heartwood (the inner portion of the tree)
- Anisotropy – the properties are different in different directions
- Distortion – timber can distort if drying is not controlled, spring, bow and twist can affect timber grading
- Moisture content – in its natural state timber can have a moisture content in excess of 100%. The fibre saturation point is usually around 28%.

Service conditions
- External use will result in high moisture contents and dictate the timber species
- Internal use may result in low moisture contents and may dictate the use of controlled drying
- Treatments might affect metal components

Grading

Visual strength grading
- IS 127 or BS 4978 (softwoods)
- BS 5756 (hardwoods)

Machine strength grading
- EN 14081-4 Machine grading-grading machine settings for machine control systems.

Timber properties
- Timber exhibits different mechanical properties in different growth directions. Generally the strength properties of timber are highest parallel to the grain or the longitudinal axis.
- The mechanical properties of timber change with changes in moisture content and timber should generally be installed at a moisture content close to the equilibrium moisture content likely to be achieved in service.
- Timber generally has a high strength to weight ratio compared to other materials

Design parameters
- Strength class/grade & species
- Moisture content
- Movement
- Joints
- Lateral restraints
- Stability
- Durability
- Fire resistance
- Supports
- Loading

Wood is an anisotropic material with different strength properties in different directions. Its strength is directly dependent on the grain direction; axial, radial or tangential. Its properties also change with environmental conditions. The properties not only vary from species to species but even within the same species. To be able to design timber structures successfully, the practising engineer needs to be aware of the particular properties of the timber being specified.

To assist the designer, species with similar strength properties are grouped together in the same strength class and are thus inter-changeable in the design process. This simplifies the selection process and extends the range of materials available to the designer/specifier.

Timber grading

All structural timber must be strength graded and this process should be carried out by trained graders in a quality control scheme overseen by a suitable third party. In Ireland the NSAI is the main timber certification body while in the UK TRADA, BRE, BSI and others operate timber certification schemes some of which are available in Ireland.

There are two methods of grading timber; visually or by machine, both require trained personnel.

The main standard covering strength grading is EN 14081 which has 4 separate parts. Part 1 covers timber marking (for both visual and machine graded timber) and requirements for visual strength grading standards while parts 2, 3 and 4 cover machine grading. Part 4 gives machine settings for a range of different machines, timber species and timber sources; the settings are dependent on the timber size and the strength class combination that the grader requires. There are a number of different machines on the market using different principles and providing the machines (along with their settings) are referred to in EN 14081 then these machines should be satisfactory for use. Strength grading machines are capable of directly grading timber into a strength class (a grouping of timber with similar strength properties).

EN 14081-1 gives some requirements for visual strength grading but is not actually a strength grading standard; it really gives general requirements that a visually strength grading standard should contain e.g. a standard should have some method of assessing the area of knots in a timber section.

The main visual strength grading standard in Ireland is I.S. 127 while in the UK it is BS 4978; however, these standards are almost identical. There are two main visual grades in these standards GS (General Structural) and SS (Special Structural); the grading rules for these 2 grades are the same in both standards and these grades (and standards) are referred to in EN 1912.

In terms of visual strength grading, EN 1912 is an important standard, as it allocates a strength class to a particular timber grade based on the timber species and source (where it was grown). It references the strength grading standard used for the grades i.e. in Ireland I.S. 127, in the UK BS 4978).

Once the graded timber has been allocated a strength class from EN 1912 then the characteristic strength properties can be obtained from EN 338. Eurocode 5 (the main part for general design is EN 1995-1-1) uses characteristic stress values in design rather than the permissible stress values used in BS 5268. If the timber grade, species and source are not referenced in EN 1912 then it is very doubtful if it can be used for designs to Eurocode 5.

Timber marking

All timber must be strength graded but it must also be properly marked. EN 14081-1 specifies two marking criteria; one where the timber is not CE marked and one for CE marking (which also has specific requirements for factory production control). At the time of writing, Ireland and the UK do not have a requirement that timber must bear a CE mark but some other countries require a CE mark. The Construction Products Requirements will require all construction products to bear a CE mark by July 2013.

The marking requirements set out in EN 14081-1 are summarised below:

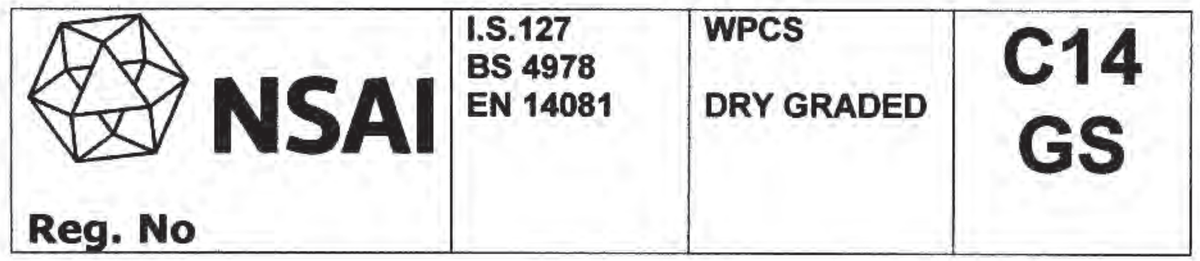
a) Producer's identification mark
b) If visually graded, the strength class as assigned in EN 1912 or the strength grade and grading standard if not included in EN 1912
c) The words 'Dry Graded' if appropriate
d) If machine graded the letter 'M'
e) The following information or reference to a document that contains it:

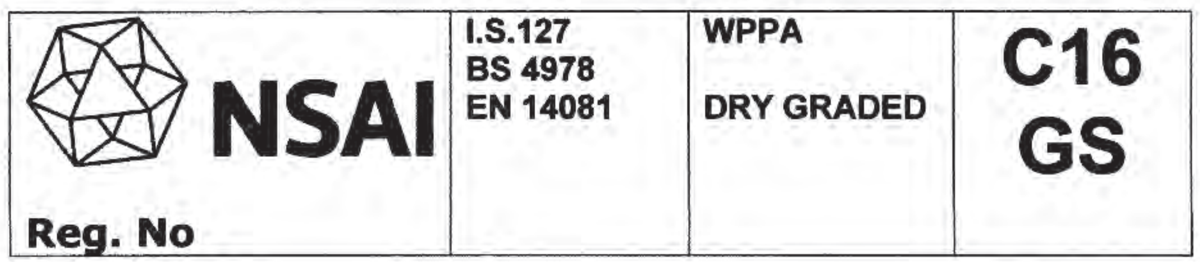
 1) If a single species, the species code in accordance with EN 13556
 2) If a combined species, the species code from Table 4 EN 14081-1
 3) If machine graded, the code identifying the country or region of origin in accordance with EN ISO 3166-1
 4) If visually graded and marked with a strength class, the grade and grading standard.

Information can be omitted for aesthetic reasons and the above information can be placed on accompanying documentation. The standard (EN 14081-1) also refers to timber that has been treated with a preservative being marked according to prEN 15228 but any marking related to this standard is unlikely to be placed by the timber grader. There are also additional marking requirements visually strength graded timber set out in I.S. 127 and BS 4978.

EN 14081-1 allows visually graded timber to be package marked, that is the individual timber pieces do not necessarily have to be stamped and that accompanying documentation may contain the required information on the timber. The standard allows national grading standards to make a national choice on timber marking and both Ireland and the UK require individual pieces of timber to be marked. However, it appears that timber graded in a member state that permits package marking may have to be accepted in Ireland and the UK.

A few examples of timber marks which comply with EN 14081-1 are given below.





The "Reg. No" is the company registration number allocated by the certification body, in this example NSAI. In some cases there may be a second number giving the registration number of the strength grade.

CE marking

To CE mark timber, there must be a factory production control system in place which is monitored by a notified body. The marking requirements in Annexe ZA (annexes dealing with CE marking all have the designation ZA) call for a level of attestation of 2+ which requires a notified body to oversee the strength grading operation.

Additional marking requirements for CE marking (in addition to those above) include the identification number of the notified body and the year when the mark was affixed.

STRENGTH CLASSES

European Standard EN 338 Structural Timber Strength Classes outlines the characteristic strength and stiffness properties for softwoods and hardwoods. The strength classes for softwoods range from C14 to C40 and for hardwoods they range from D30 to D70. The timber visual strength grades and strength classes for some commonly used softwood species are shown below. The most commonly available strength class for general carcassing work is C16.

Table A 2.1.1 *Softwood grades and strength classes.*

Origin	**Timber species**	**Strength grade IS 127/ BS 4978**	**Strength class (EN 1912)**	
			IS 127+	**BS 4978**
Ireland	Sitka spruce and	GS	C14	
	Norway spruce	SS	C18	
				C14
UK	Douglas fir	GS		C18
		SS		
				C16
	Larch	GS		C24
		SS		
				C14
	British pine[1]	GS		C22
		SS		
				C14
	British Spruce[2]	GS		C18
		SS		
				C16
Europe	Whitewood/	GS		C24
(CNE)	Redwood	SS		
				C16
Canada/USA	Douglas fir/Larch	GS		C24
	Hemlock/Fir	SS		
	Spruce-Pine-Fir			

+Generally Irish and British grown timber have the same properties and therefore can be considered as synonymous. While EN 1912 does not contain a reference for Ireland for many of the Irish/UK grown timber species and readily available imported timbers, a submission is being made to CEN to correct this.

[1] This includes species Corsican pine and Scots pine
[2] This includes Sitka and Norway spruce; it is recognised that there is no difference between these species grown in Ireland and the UK.

The grading rules for GS and SS in IS 127 are identical to those in BS 4978 and therefore the standards can be considered to be interchangeable for these grades. The above timbers are some of the more common ones used in Ireland and the UK. EN 1912 contains a greater number of timbers and grading standards than those referred to above.

Europe refers to CNE; that is Central, Northern or Eastern Europe.
For designs to BS 5268 Part 2; timber grades can be allocated to a strength class using that standard.

Timber can be machine graded directly into a strength class.

Table A 2.1.2 *Some hardwood grades and strength classes*

Origin	Timber Species	Strength Grade BS 5756	Strength Class EN 1912
Ireland/U.K.	Oak	TH 1	D 30
	Oak	TH 2	Not Listed
	Oak	TH A	D 40
	Oak	TH B	D 30
USA	Am. White oak	TH 1	D 50
	Am. Red oak	TH 1	D 40
	Am. White ash	TH 1	D 35
	Am. Tulipwood.	TH 1	(D 40)*
Tropical	Balau	HS	D 70
	Greenheart	HS	D 70
	Ekki	HS	D 60
	Keruing	HS	D 50
	Iroko	HS	D 40

Notes.
1. *Strength Class allocation for Irish/UK oak from values given in Table 7 of BS 5268 Pt2 for designs to that standard.*
2. *Strength Class allocation for USA species from tests carried out at BRE in accordance with EN 408 & EN 384. * Tulipwood meets the requirements for strength & stiffness of D 40 but not for density.*

Published in “*Structural Design in American Hardwoods*”.

Strength classification
The classification of timber into a particular strength class is undertaken on the basis of:
- a combination of the species and visual strength grade as shown in table A 2.1.1 or A2.1.2
- directly by use of a machine.

Characteristic stresses
For designs to Eurocode 5, characteristic stresses and moduli of elasticity values for the appropriate strength classes (softwoods and hard woods) are given in EN 338 Structural timber – strength classes; some of the characteristic values for the common strength classes are given in Table A2.2.1

Table A 2.2.1 *Characteristic values for designs to Eurocode 5 – Softwoods.*

		Softwood species						
		C14	C16	C18	C20	C22	C24	C27
Strength properties (in N/mm^2)								
Bending	$f_{m,k}$	14	16	18	20	22	24	27
Tension parallel	$f_{t,0,k}$	8	10	11	12	13	14	16
Tension perpendicular	$f_{t,90,k}$	0,4	0,4	0,4	0,4	0,4	0,4	0,4
Compression parallel	$f_{c,0,k}$	16	17	18	19	20	21	22
Compression perpendicular	$f_{c,90,k}$	2,0	2,2	2,2	2,3	2,4	2,5	2,6
Shear	$f_{v,k}$	3,0	3,2	3,4	3,6	3,8	4,0	4,0
Stiffness properties (in N/mm^2)								
Mean modulus of elasticity parallel	$E_{0,mean}$	7	8	9	9,5	10	11	11,5
5% modulus of elasticity parallel	$E_{0,05}$	4,7	5,4	6,0	6,4	6,7	7,4	7,7
Mean modulus of elasticity perpendicular	$E_{90,mean}$	0,23	0,27	0,30	0,32	0,33	0,37	0,38
Mean shear modulus	G_{mean}	0,44	0,5	0,56	0,59	0,63	0,69	0,72
Density (in kg/m^3)								
Density	ρ_k	290	310	320	330	340	350	370
Mean density	ρ_{mean}	350	370	380	390	410	420	450

Notes:

Values are often given in terms of MPa= 1 N/mm^2.
Strength classes C 20 and C22 are not common in Ireland.
The values are taken from EN 338 and that standard should always be consulted in case of updates.

TR26 while referenced in EN 14081-1 has not yet been included in EN 338; however that standard gives a method of determining characteristic values from test. Characteristic values for TR26 should be available from BRE or TRADA.
For permissible stress designs to BS 5268, the design values for different strength classes should be taken from that standard.

Table A 2.2.2 *Characteristic values for designs to Eurocode 5 – Hardwoods.*

	Hardwood species							
	D18	D24	D30	D35	D40	D50	D60	D70
Strength properties (in N/mm^2)								
Bending	18	24	30	35	40	50	60	70
Tension parallel	11	14	18	21	24	30	36	42
Tension perpendicular	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6
Compression parallel	18	21	23	25	26	29	32	34
Compression perpendicular	7,5	7,8	8,0	8,1	8,3	9,3	10,5	13,5
Shear	3,4	4,0	4,0	4,0	4,0	4,0	4,5	5,0
Stiffness properties (in N/mm^2)								
Mean modulus of elasticity parallel	9,5	10	11	12	13	14	17	20
5% modulus of elasticity parallel	8	8,5	9,2	10,1	10,9	11,8	14,3	16,8
Mean modulus of elasticity perpendicular	0,63	0,67	0,73	0,80	0,86	0,93	1,13	1,33
Mean shear modulus	0,59	0,62	0,69	0,75	0,81	0,88	1,06	1,25
Density (in kg/m^3)								
Density	475	485	530	540	550	620	700	900
Mean density	570	580	640	650	660	750	840	1080

Target size

The target size is really the only relevant term that should be used for specifying timber; terms like planed or regularised can be used but they apply to a process rather than size. Target size is defined in EN 336 and is where the applied tolerances on the dimensions would ideally be zero at the reference moisture content of 20%; where the timber moisture content is different to 20% a formula is given in EN 336 to relate the timber size to 20%. The target size can therefore be thought of as a minium average size while the relevant tolerances given in EN 336 represent the limits on the measurements taken to determine the average size.

Tolerance class

Timber should be specified by tolerance class in accordance with EN 336. There are two tolerance classes TC1 and TC2; TC2 has tighter tolerances and usually applies to factory produced timber components such as timber frame and roof trusses. TC1 with its higher tolerances usually applies to sawn timber products.

Different tolerances could be specified in a specification but this would be unusual for structural timbers. However, CLS sizes used in timber frame construction are usually the actual finished sizes with effectively zero tolerance on the dimensions.

Tolerances to EN 336

Tolerance class	<=100mm	>100mm	Typical uses
TC1	-1/+3	-2/+4	Floors, cut roofs
TC2	-1/+1	-1.5/+15	Timber frame, roof trusses

Load span tables

Swift 6 is a Non-Contradictory Complimentary Information (NCCI) and gives load span tables for designs based on Eurocode 5 and the Irish National Annex. Swift 6 should be consulted for the precise design criteria as the load span tables in *Woodspec* are for information only.

The use of Swift 6 is voluntary and although it is not a standard, in the future it may become one. Swift 6 is expected to be pu blished in 2012. The tables in Swift 6 include floor joists, ceiling joists, roof rafters and purlins for a number of different loadings as well as a method of selecting the design wind loads for a building in Ireland. For buildings where Swift 6 may not be applicable then the design should be undertaken by an experienced structural engineer.

In the UK for designs based on BS 5268-2, load span tables are given in BS 8103-3 and BS 5268-7, TRADA did produce tables which may be concurrent. If designs are to be based on BS 5268-2 then it should be ensured that the document giving the load span tables complies with current practice and regulations as some standards may have been superseded by newer editions or may have been withdrawn (such documents may be satisfactory for design but a check should be carried out to ensure that this is the case).

For designs to Eurocode 5 in the UK TRADA have produced load span tables but these should be checked to ensure that the design criteria meet the requirements of the building and the specification.

A NCCI (PD 6693) is being produced in the UK which will give additional information for designs to Eurocode 5 but it will not include load span tables. It is likely that load span tables will be produced in the UK than also comply with PD 6693 but this is by no means sure.

As Ireland and the UK have different design requirements in their National Annexes (not just for Eurocode 5 and EN 1990 but also for the loading standards and other supporting standards) any load span tables produced by the two countries should not be considered interchangeable.

Floor joist load span tables

The load span tables below are taken from Swift 6 and are based on the Irish National Annexes to Eurocode 5, EN 1990 and EN 1991-1-1 as well as criteria specified in Swift 6.

The spans in Swift 6 are less than those in I.S. 444 especially where a full vibration check is undertaken. I.S. 444 was based on permissible stress design as outlined in BS 5286-2 and there are considerable differences between the design loads and the deflection criterion between the BS 5268-2 and Eurocode 5.

Swift 6 allows a limited check for vibration to be taken for floors in housing while for other purpose groups a full vibration check should be undertaken. Table A 2.2.3 shows allowable spans for housing while Table A 2.2.4 shows allowable spans for floors with the same design load but would be appropriate to apartments.

Table A 2.2.3 *Domestic housing – Floor joists to Eurocode 5; Part vibration check*
(Dead 0,30kN/m^2 Imposed 1.50kN/m^2 Point load 2.00kN).

TARGET SIZE mm		C14			C16			C18			C24			C27		
b	**h**	**300**	**350**	**400**	**300**	**350**	**400**	**300**	**350**	**400**	**300**	**350**	**400**	**300**	**350**	**400**
38	100	1,56	1,55	1,54	1,73	1,71	1,70	1,84	1,82	1,80	2,03	2,00	1,98	2,07	2,05	2,02
38	115	1,98	1,96	1,94	2,12	2,09	2,07	2,24	2,21	2,19	2,47	2,44	2,41	2,52	2,49	2,45
38	125	2,23	2,20	2,18	2,38	2,35	2,32	2,52	2,49	2,46	2,77	2,73	2,68	2,82	2,78	2,72
38	150	2,88	2,84	2,76	3,06	3,02	2,89	3,23	3,14	3,01	3,54	3,36	3,22	3,59	3,41	3,26
38	175	3,54	3,36	3,22	3,70	3,52	3,37	3,85	3,67	3,51	4,04	3,90	3,75	4,08	3,94	3,81
38	200	3,99	3,84	3,68	4,12	3,98	3,85	4,24	4,10	3,98	4,45	4,30	4,17	4,49	4,34	4,21
38	225	4,35	4,20	4,08	4,49	4,34	4,21	4,63	4,47	4,33	4,85	4,69	4,55	4,89	4,73	4,59
44	100	1,74	1,72	1,71	1,86	1,84	1,82	1,97	1,95	1,93	2,17	2,15	2,12	2,22	2,19	2,17
44	115	2,13	2,10	2,08	2,27	2,24	2,22	2,40	2,37	2,34	2,64	2,60	2,57	2,69	2,66	2,62
44	125	2,39	2,36	2,33	2,55	2,52	2,48	2,70	2,66	2,63	2,96	2,92	2,81	3,01	2,97	2,85
44	150	3,07	3,03	2,90	3,27	3,17	3,03	3,45	3,30	3,16	3,71	3,53	3,38	3,76	3,58	3,43
44	175	3,71	3,53	3,38	3,86	3,69	3,54	3,98	3,84	3,68	4,17	4,03	3,91	4,21	4,07	3,95
44	200	4,13	3,99	3,86	4,26	4,12	3,99	4,39	4,24	4,11	4,60	4,45	4,31	4,64	4,49	4,35
44	225	4,50	4,34	4,22	4,64	4,49	4,35	4,78	4,62	4,48	5,01	4,84	4,70	5,05	4,88	4,74
47	100	1,80	1,78	1,76	1,92	1,90	1,88	2,04	2,01	1,99	2,24	2,21	2,19	2,29	2,26	2,23
47	115	2,20	2,17	2,14	2,34	2,31	2,28	2,48	2,45	2,42	2,72	2,68	2,65	2,77	2,74	2,68
47	150	3,17	3,09	2,96	3,36	3,24	3,10	3,54	3,37	3,23	3,79	3,60	3,45	3,82	3,65	3,50
47	175	3,79	3,61	3,45	3,92	3,77	3,61	4,04	3,90	3,76	4,24	4,09	3,97	4,27	4,13	4,01
47	200	4,19	4,05	3,92	4,32	4,18	4,05	4,45	4,30	4,17	4,66	4,51	4,38	4,70	4,55	4,42
47	225	4,56	4,41	4,28	4,71	4,55	4,42	4,84	4,68	4,55	5,08	4,91	4,77	5,12	4,95	4,81
75	175	4,21	4,07	3,95	4,34	4,20	4,08	4,47	4,32	4,20	4,68	4,53	4,40	4,71	4,57	4,44
75	200	4,63	4,48	4,35	4,77	4,62	4,49	4,91	4,76	4,63	5,14	4,98	4,85	5,18	5,02	4,89
75	225	5,03	4,87	4,74	5,19	5,03	4,89	5,34	5,17	5,03	5,58	5,41	5,27	5,62	5,46	5,31

Table A 2.2.4 *Domestic housing – Floor joists to Eurocode 5; Full vibration check*
(Dead 0,30kN/m^2 Imposed 1.50kN/m^2 Point load 2.00kN).

TARGET SIZE mm		C14			C16			C18			C24			C27		
b	**h**	**300**	**350**	**400**	**300**	**350**	**400**	**300**	**350**	**400**	**300**	**350**	**400**	**300**	**350**	**400**
38	100	1,56	1,55	1,54	1,73	1,71	1,68	1,84	1,82	1,75	2,03	1,95	1,87	2,07	1,98	1,90
38	115	1,98	1,93	1,85	2,12	2,02	1,94	2,21	2,10	2,02	2,36	2,25	2,16	2,40	2,28	2,20
38	125	2,21	2,10	2,02	2,31	2,20	2,11	2,40	2,29	2,20	2,57	2,45	2,36	2,61	2,48	2,39
38	150	2,66	2,53	2,43	2,78	2,64	2,55	2,89	2,75	2,65	3,10	2,95	2,84	3,15	2,99	2,88
38	175	3,11	2,96	2,85	3,25	3,09	2,98	3,38	3,22	3,10	3,62	3,45	3,32	3,68	3,50	3,37
38	200	3,56	3,39	3,26	3,72	3,54	3,41	3,88	3,69	3,55	4,09	3,95	3,80	4,14	3,99	3,86
38	225	4,00	3,82	3,67	4,13	3,98	3,84	4,25	4,10	3,99	4,47	4,31	4,19	4,52	4,35	4,24
44	100	1,74	1,72	1,69	1,86	1,84	1,77	1,97	1,91	1,84	2,15	2,05	1,97	2,19	2,08	2,00
44	115	2,13	2,03	1,95	2,23	2,12	2,04	2,32	2,21	2,12	2,48	2,36	2,27	2,52	2,40	2,31
44	125	2,32	2,21	2,12	2,43	2,31	2,22	2,53	2,40	2,31	2,70	2,57	2,48	2,75	2,61	2,51
44	150	2,79	2,66	2,56	2,92	2,78	2,68	3,04	2,89	2,79	3,26	3,10	2,98	3,31	3,14	3,03
44	175	3,27	3,11	2,99	3,42	3,25	3,13	3,56	3,38	3,26	3,81	3,62	3,49	3,86	3,68	3,54
44	200	3,74	3,56	3,43	3,91	3,72	3,58	4,04	3,87	3,73	4,24	4,09	3,98	4,29	4,14	4,02
44	225	4,14	3,99	3,86	4,28	4,13	4,02	4,41	4,25	4,13	4,63	4,47	4,34	4,68	4,51	4,39
47	100	1,80	1,78	1,73	1,92	1,88	1,81	2,04	1,96	1,88	2,20	2,09	2,02	2,24	2,13	2,05
47	115	2,18	2,07	1,99	2,28	2,17	2,09	2,37	2,26	2,17	2,54	2,42	2,33	2,58	2,45	2,36
47	150	2,86	2,72	2,62	2,99	2,84	2,74	3,11	2,96	2,85	3,33	3,17	3,05	3,38	3,22	3,10
47	175	3,34	3,18	3,06	3,50	3,32	3,20	3,64	3,46	3,33	3,89	3,70	3,57	3,95	3,76	3,62
47	200	3,83	3,64	3,50	3,99	3,81	3,67	4,10	3,96	3,81	4,31	4,16	4,05	4,36	4,21	4,09
47	225	4,21	4,06	3,95	4,35	4,20	4,08	4,48	4,32	4,20	4,71	4,54	4,41	4,76	4,59	4,46
75	175	3,91	3,72	3,58	4,05	3,89	3,75	4,17	4,02	3,90	4,39	4,23	4,11	4,43	4,28	4,16
75	200	4,33	4,18	4,06	4,48	4,32	4,20	4,61	4,44	4,32	4,84	4,67	4,54	4,89	4,72	4,59
75	225	4,72	4,56	4,43	4,88	4,71	4,58	5,03	4,85	4,71	5,28	5,09	4,95	5,34	5,15	5,01

Bridging and Strutting

Bridging between joists is used to stiffen the whole floor and is inserted at intervals according to the joist depth to breadth ratio and depending on the span, either one, two or multiple rows of bridging may be required. For joists with spans over 2.7m intermediate bridging shall be provided at 1.35m spacing. Bridging may be achieved by using:

(a) solid timber, or
(b) timber herringbone strutting.

It is important to note that, at the end of the lines of bridging adjacent to a wall, solid packing pieces will be required between the last joist and the wall.

The use of strutting and bridging can be influenced by design; however in the past much of their requirements were based on empirical experience. Herringbone strutting works well when floor joists are placed in position with slightly higher moisture contents and then as they dry out, shrinkage tightens up the herringbone and the floor joists so that the whole floor acts together.

Bridging should be a minimum of 0.75 times the joist depth.

Bridging should be placed so as to restrain the ends of the floor joists at points of support and can also give support to plasterboard edges. Where joists are built into masonry walls, restraint bridging is normally not necessary but the plasterboard edges will still need to be supported.

Where spans exceed 2.7m, Swift 6 recommends for joists spans over 2.7m that bridging should be at centres not exceeding 1.35m.

Bridging can be used to pick up plasterboard edges (typically at 1.2m centres). However these values do not preclude a designer specifying different requirements.

It is important to note that at the end of the lines of bridging adjacent to a wall, solid packing pieces will be required between the last joist and the wall.

Notching of joists

In normal situations, services in floors will either run parallel to joist spans or, when this is not possible, through the joists themselves. Obviously the reduced depth due to notching or by the provision of holes must be taken into account. Joists may be notched or drilled as shown below; joists must be designed where notching or drilling is outside the limits shown.

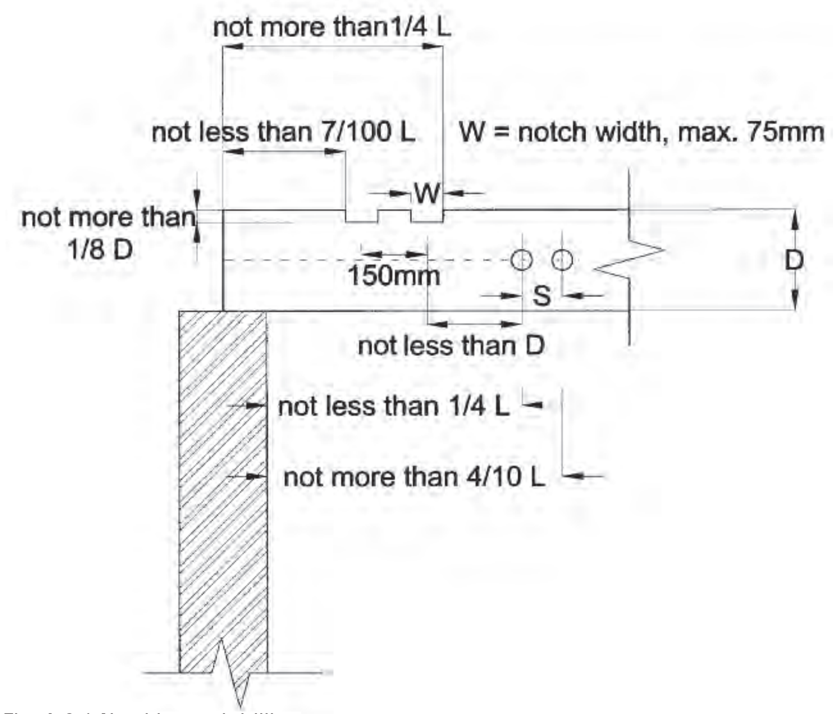


Fig. A 2.1 Notching and drilling

Note: Drilling or notching outside these limits should be designed by an engineer.

A3 Overall stability

Stability is referred to in EN 1990 (Basis of design) as equilibrium and the relevant factors of safety (through the use of partial safety factors applied to the relevant loads) are set out in that standard.

These partial safety factors can be modified by individual member states in their National Annex or possibly in a NCCI (Non Contradictory Complementary Information): currently Ireland has adopted the recommended values in Table A1.2(A) in EN 1990.

For timber construction the most obvious and common application of stability lies in roof uplift.

I.S. 444 only covered heavy concrete tiled roofs and therefore gave little consideration to roof uplift, and did not specify a factor of safety for roof uplift. However, Technical Guidance Document A (Structure) gave information on masonry walls to timber roof and floor connections using metal straps which effectively covered stability for housing using masonry construction under the rules laid out in the TGD.

Swift 6 only gives information on rafter spans for a range of wind loads and does not consider uplift.

For masonry construction it is likely that the wall designer will also have to take account of uplift forces, some of which might be localised.

In the UK BS 5268-3 specified a factor of safety of 1.4 for roof uplift on rafter trussed roofs but this was not taken over into any other standard and was therefore not applied to cut roofs.

Stability was essentially overlooked as timber roofs were considered traditional construction and like Ireland strapping arrangements were given in the Approved Document A (Structure).

The factor of safety of 1.4 is less than that required by EN 1990 and this will result in greater holding down requirements for trussed roofs where designed to Eurocode 5.

Timber frame construction when designed to Eurocode 5 will have to conform to EN 1990 and this too will result in greater holding down requirements. Ireland did use BS 5268-6 (covering timber frame wall design) and this standard was referred to in I.S. 440 (Timber Frame) but I.S. 440 is being revised to conform to Eurocode 5 and therefore design references to BS 5268-6 will be removed.

The factor of safety of a racking wall against overturning is defined as the overturning resistance divided by the overturning moment.

For BS 5268-6 each backing wall under its apportioned wind load should have a factor of safety against overturning of 1.2. In addition the factor of safety of the total racking wall resistance, under the total wind load, should be not less than 1.4.

The resisting moment is provided by permanent or dead loads and any fixings such as anchor straps.

The factor of safety required by EN 1990 typically requires the imposed wind load to be factored by 1.5 and the permanent or dead load to be factored by 0.9 – this essentially results in an overall factor of safety of almost 1.7, ignoring any contribution from fixings and arrangements such as anchor straps.

Typical Restraint Arrangements (Taken from TGD 'A')

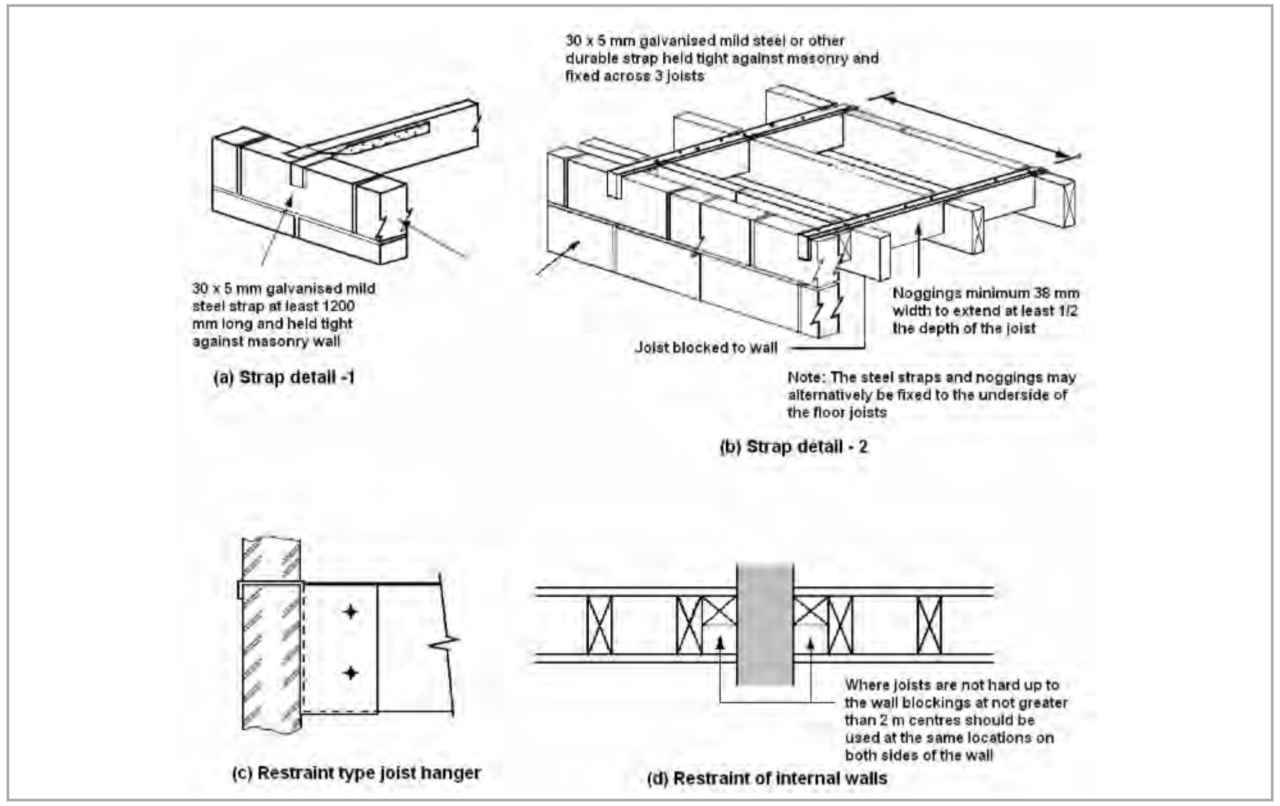


Fig. A 3.1 Lateral support by floors

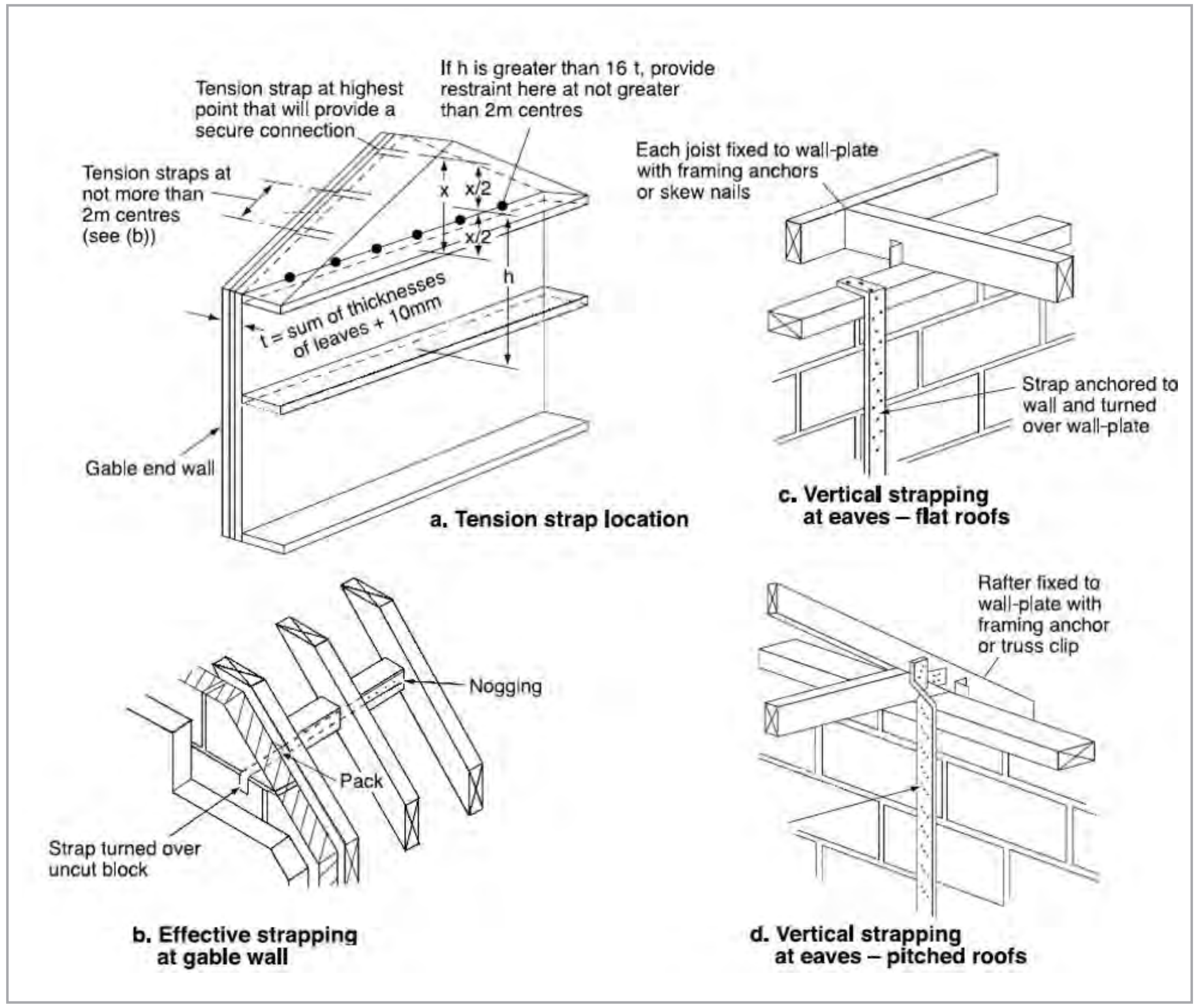


Fig. A 3.2 Lateral support at roof level

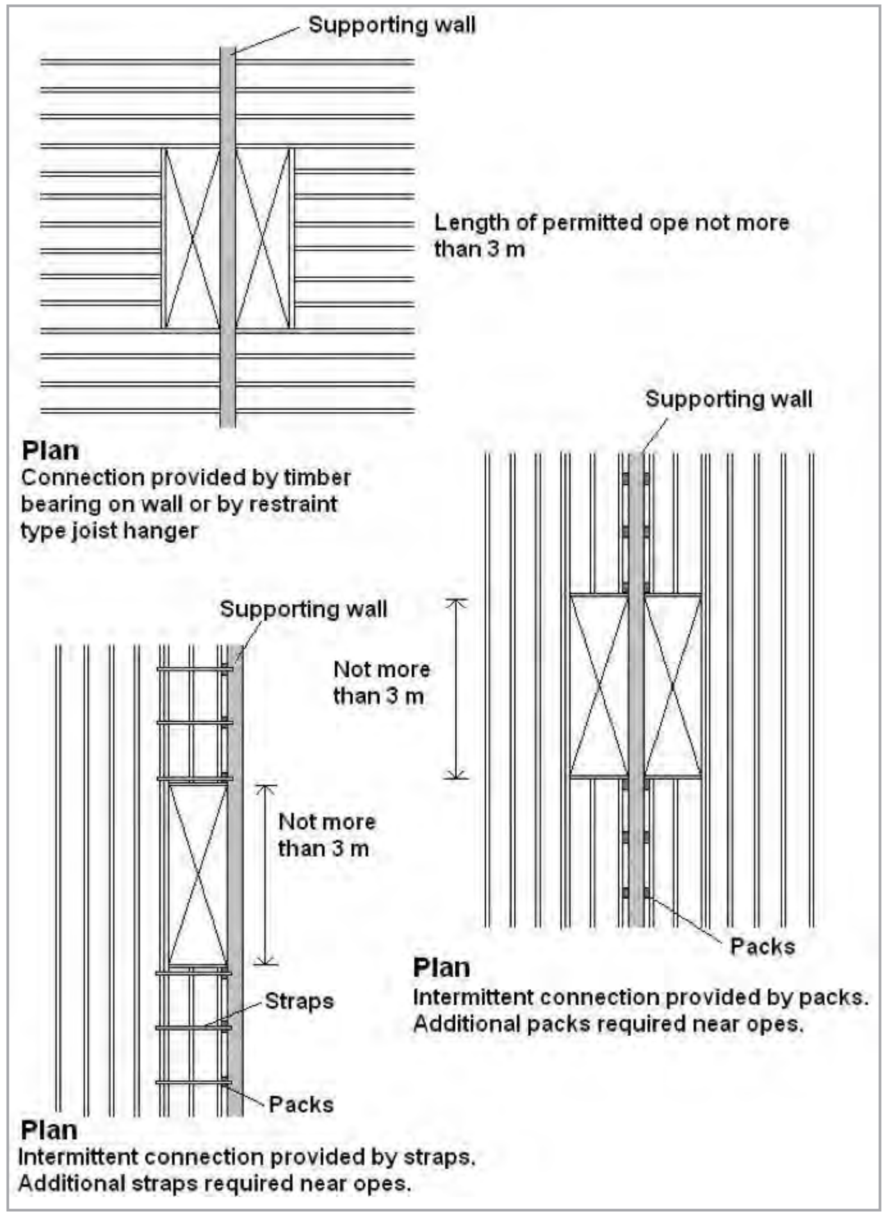


Fig. A 3.3 Interruption of lateral support

Vertical load

In cross wall construction, the floor and roof elements of the structure are supported by the load bearing walls which usually run perpendicular to the front/rear walls, (Fig. 3.4 A). Alternatively, the horizontal elements may span from front to rear with internal load bearing walls also supporting the load (Fig.3.4 B).

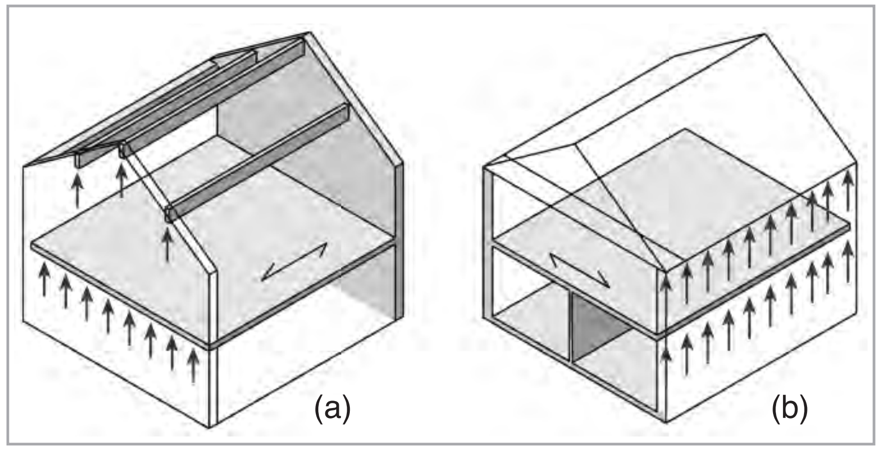


Fig. A 3.4 Vertical Load

Horizontal load

In addition to carrying vertical loads, wall panels may be required to withstand wind forces resulting in shear or racking forces.

Walls subject to horizontal shear or racking forces may need to be restrained from sliding and held down (see fig. A 3.4).

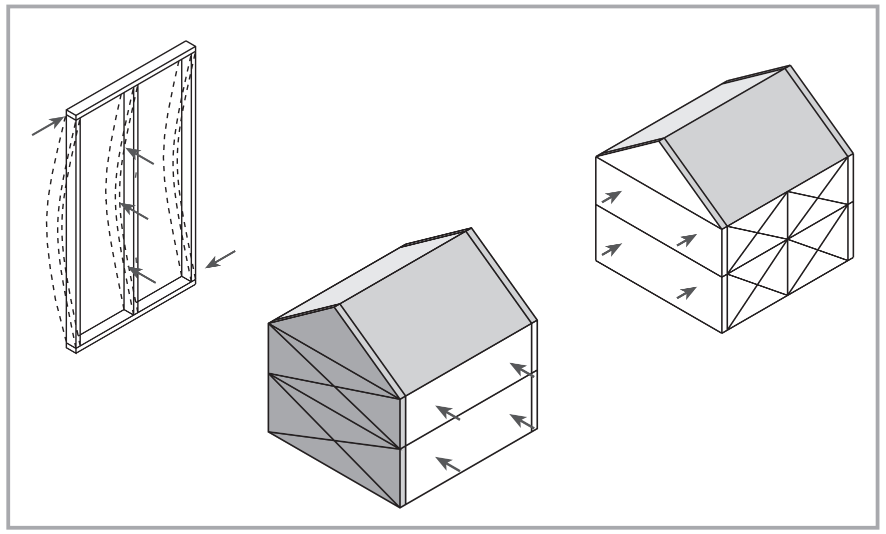


Fig. A 3.4 Horizontal loads

Horizontal diaphragms

Floor, roof and ceiling systems may act as horizontal diaphragms to take loads in their own plane and transfer loads into shear walls.

Figure A 3.5 illustrates such horizontal diaphragms resisting wind loads on a gable wall.

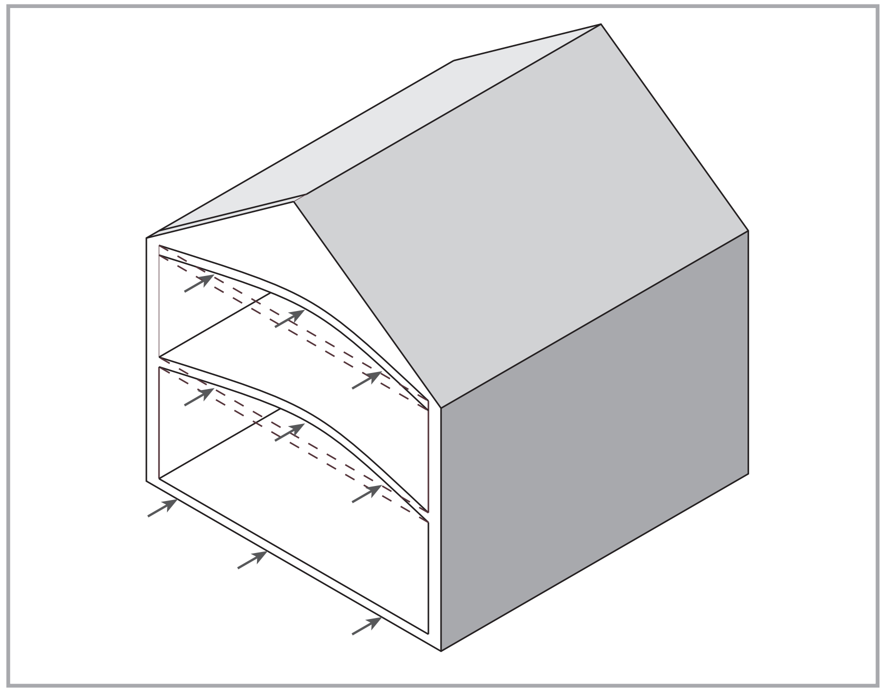


Fig. A 3.5 Horizontal diaphragms

A4 Durability and preservation

Durability relates to the resistance of wood to organisms that cause decay and may be expressed as the time during which wood preserves its usefulness without special protection, such as preservative treatment. The natural durability of a species is greater for the heartwood than for the sapwood; sapwood is rated as perishable or non-durable in both hardwood and softwood species.

In service, fungi and insect attack are the main sources of biological degradation. However, the onset of decay and the rate of decay can be controlled by the correct design and use of wood.

Table A 4.1 *Fungal durability and treatability.ratings*

Species	Durability* (heartwood only)	Treatability (heartwood)	Treatability (sapwood)
Douglas fir (Imported)	3	4	2-3
Douglas fir (Irish)	3-4	4	2
Larch	3-4	4	2
Pitch pine	3	4	1
Redwood (Red deal)	3-4	3-4	1
Norway spruce (Irish)	4	3-4	2
Sitka spruce	4	3-4	2
Western red cedar	2	3-4	3
Whitewood (White deal)	4	3-4	3
Greenheart	1	4	3
Iroko	1-2	4	1
European oak	2	2-3	1
American white oak	2-3	4	1
American red oak	4	2-3	1

The durability and treatability ratings are generally as given in EN 350-2 Part 2. – '*Durability of wood and wood-based products – Natural durability of solid wood.*'
Many other species are also included in this standard. Durability classes (fungi) are rated from 1 (very durable) to 5 (not durable).

Note: this unpreserved durability rating is mainly based on tests for a 50 x 50mm timber section in ground contact. Timber treated in accordance with BS 8417 can achieve a service life of 15-30 years in ground contact - dependent on species and treatment specification. Ground contact should be avoided to further enhance the lifespan of all timbers.

Designing for durability

The main design considerations are to minimise the absorption of water by the wood and to avoid service conditions likely to encourage biological attack. Put simply, wood below a moisture content of 20-22% is immune from decay and is less likely to be attacked by insects.

The end grain of timber absorbs water more readily than side grain. Therefore, the ends of timber should be kept out of situations where water can rise by capillary action. Alternatively, timber should be treated and sealed to reduce moisture uptake. In general, timber should be installed close to the estimated in-service moisture content of the building or structure. Design solutions include:
• Designing to avoid high moisture conditions.
• Selecting timbers that are naturally durable.
• Preservative treating the timber
• Use of metal fixings in accordance with manufacturer's instructions

Why is preservation important?

Except for the heartwood of durable species, wood is not very resistant to attack by fungi or insects; the sapwood of all species is non-durable. Most of the world's old-grown forests have been logged over, and the younger forests or plantations replacing them are being harvested at an early age, resulting in smaller log sizes.

Degradation factors include:
- Plant (bacteria, fungi)
- Animal (insects, marine organisms)
- Climatic
- Mechanical
- Chemical
- Thermal

Degradation can affect wood characteristics such as:
- Appearance
- Strength
- Structure
- Chemical composition

Two types of biological attack:
- Fungal attack which can occur when timber is exposed to high moisture content.
- Insect attack which can occur to a limited extent in fresh timber or to dry timber (mainly sapwood) in service.

Natural durability rating (unpreserved - *applies to heartwood)*

Grade of Durability	Life in Ground Contact (years)
Very durable (1)	>25
Durable (2)	15 - 25
Moderately durable (3)	10 - 15
Slightly durable (4)	5 - 10
Not durable (5)	<5

Design considerations
- End grain shall be typically bevelled and sealed.
- Control condensation by the correct use of insulation and a vapour check.
- Ensure adequate ventilation to avoid the build up of warm damp air.
- Sills, for example, should be adequately bevelled and throated.
- Direct ground contact should be avoided.
- Provide suitable access points for periodic maintenance.
- Where appropriate, utilise corrosion resistant bolts, dowels or steel plate.
- Store all timbers in a manner that avoids prolonged exposure to moisture.
- Avoid water lodgement.
- Take special care at exposed timber joints; design to shed water.

Treatability of wood

Treatability class	Description
1	Easy to treat
2	Moderately easy to treat
3	Difficult to treat
4	Extremely difficult to treat

To maximise the yield from these logs means that it is now an unaffordable luxury to remove all the sapwood, except for a few large-diameter hardwood timbers. Therefore, there is every likelihood that at least some if not all of any parcel of timber will be non-durable or perishable.

Where there is absolutely no risk of fungal decay, i.e. no chance of the timber getting wet and remaining so for some time, then protection from fungal decay is not necessary. Interior timbers, where there is free ventilation and which can be inspected, may be safe, but exposed timbers and interior timbers which are hidden and where ventilation may be limited, or lacking, are not. Woodworm, *Anobium punctatum*, the most common insect species attacking wood in service, will attack dry timber of non-durable species but is more common at higher moisture contents. Modern board materials bound with resin adhesives are generally not attacked. Pretreatment of non-durable species is advised.

How wood preservatives work

For decay and wood-boring insects to thrive requires the basics of food, air, moisture, and warmth. Whereas in normally dry conditions decay fungi cannot survive, woodworm and powder post beetles can. Treating the wood with fungicide, insecticide or a combination of both will render the food source unavailable to these organisms and prevent its deterioration. Application of preservative ranges from brush coating to pressure impregnation. The more comprehensive the treatment the longer and more effective will be the preservative action.

Table A 4.2 *Types of preservatives*

PRESERVATIVE TYPE	DESCRIPTION	PROPERTIES	LIMITATIONS
Tar oil preser vative	Consist predominantly of distillates of coal tar, which are commonly known as creosotes.	They are largely water insoluble, are resistant to leaching and are particularly suitable for exterior work. They are not corrosive to metals and can have a protective action on iron or steel. Commonly used for poles and piles.	Has a characteristic odour, which can affect foodstuffs and other materials in their vicinity. Should not be used indoors. May pose a health hazard due to carcinogenic nature of some constituents.
Waterborne preservatives copper-based	These new generation preservatives are copper-based with secondary biocides eg Tanalith E, Copper triazole, ACQ and Celcure AC 500	They are resistant to leaching and therefore the treated wood is suitable for external as well as internal use. After re-drying, treated wood is odourless, clean (albeit coloured grey/green). It can be painted and glued satisfactorily.	Application of waterborne preservatives involves re-wetting the wood being treated, which may cause raising of the grain together with the possibility of distortion, treated timber should be allowed to dry to in service moisture content.
Boron-based preservatives	They are based on water soluble boron compounds such as boric acid, disodium tetraborate (borax), or disodium octaborate, applied by diffusion to green timber.	After application as a simple aqueous solution borate treated wood is clean, non-coloured, non-corrosive and can be stained or glued.	Borates are not fixed in the wood and can become mobile under wet conditions. Not suitable for use in unprotected external or ground contact situations.
Organic solvent preservatives commonly known as light organic solvent preservative (LOSP), and micro-emulsions (water based)	Consist of one or more fungicides or insecticides in an appropriate carrier, i.e. solvent or water-based. May have a dye added for proof of treatment.	Resistant to leaching and usually suitable for both interior or exterior use when coated. When the carrier has evaporated, can usually be painted and glued satisfactorily. LOSP does not cause rising of the grain and can be used without causing movement or distortion.	Not for use in wood in ground contact or below DPC level. Timber intended for external use should receive a surface coating. These solvent based preservatives are only recommended for external joinery protected by a finish. Water based are recommended for internal structural timbers. Allow to dry before painting.

Types of preservatives and their characteristics

Table A4.2 lists preservatives available in Ireland which are grouped into the following categories:

- Waterborne preservatives (EN 599) e.g. Copper triazole or ACQ.
- Organic Preservatives (BS 5707/EN 599), e.g. Prevac, Vac-Vac
- Micro-Emulsion Type Preservatives (EN 599), eg. Prevac, Vac-Vac

The two most widely used methods of preservation are high pressure or low pressure with organic solvent or micro-emulsion preservatives.

High pressure treatment with waterborne preservatives such as Copper triazole and ACQ is required for timbers in ground contact or hazardous locations. In above ground situations pressure treated timber should be allowed to dry to its inservice moisture content. Metal fittings should not be attached to treated timber until the moisture content has fallen to 20% or less.

Organic solvent-based preservation does not affect timber moisture content (no redrying). It does not cause dimensional change to timber sections and has little effect on timber colour. It should be specified for close fitting joinery such as doors and windows. A dye is often added to indicate that treatment has been carried out.

Preparation of timber for preservative treatment

Timber must be sufficiently dry before treatment unless the method is specifically designed to treat freshly felled, green timbers (such methods are the oscillating pressure method and diffusion treatment).

The maximum permissible moisture content for satisfactory preservative treatment has to be below the wood fibre saturation point, generally regarded as 28%. At this point the wood contains the maximum amount of water capable of being held by the wood cell walls without occupying the void spaces which would make it difficult to force preservative fluid into the wood.

For most end uses it is preferable to dry the timber before treatment to the minimum moisture content likely to be achieved in service; this applies especially to such items as exterior joinery where component dimensions and the integrity of the joints can be critical.

Drying the timber is an essential part of the treatment process and checking the moisture content of the timber should always be carried out before impregnation with preservative begins.

The timber must be clean and free of both inner and outer bark, paint and any other surface finish because they are all impermeable to preservation solutions. All cutting, shaping and drilling of timber should, as far as possible, be complete prior to preservative treatment as subsequent working will remove the treated exterior face of timber and may expose untreated timber.

Cut faces should be re-treated. Specifiers should consider timber preservation in a similar light to the protective galvanising of steelwork. No specifier would allow the galvanising to be removed during factory or site work because of the detrimental effect it would have on the steelwork.

The same thought and vigilance should be given to preserved timber. Attempts to rectify this after treatment, for example by brush application, will not necessarily attain the level of treatment originally achieved by the treatment process. This is less important where complete penetration has been achieved, as in the diffusion process.

Sawn timbers, which are thicker than 75mm and resistant to impregnation, will often benefit from an incising pre-treatment if intended for pressure treatment.

Conditioning after treatment

Timber treated with LOSP, or micro-emulsion type preservatives or creosote should be open stacked, preferably under cover in a well-ventilated area to allow the solvent/water to evaporate. The drying process takes 2-7 days or more depending on drying conditions. The EPA requires that low pressure treated timber is held for 24 hours before dispatch. The moisture content should be below 20% before surface coatings are applied.

Timber treated with copper based preservatives require a period of storage before use to ensure fixation of the preservative within the wood (i.e. conversion to water insoluble forms). To allow for this, treated timber should be held under cover at the treatment plant for at least 48 hours to comply with EPA requirements. Pressure treated timber should be allowed to dry to its in-service moisture content before installation.

Table A 4.3 *Treatment processes & effectiveness*

METHODS & PRESERVATIVES	TREATMENT PROCESS	HAZARD CLASS* 1	2	3	4	5	REMARKS
High pressure/vacuum process creosote, copper triazole, copper ammoniacal quaternary ACQ. Also with brown dye. Creosote only in Class 5, or for transmission poles and stud fencing.	The timber is placed in a closed cylinder and immersed in a preservative fluid. A relatively high pressure is applied, usually 10-14 bars for 1-6 hours, which forces the fluid into the wood. This is followed by a vacuum to withdraw excess preservative.	✔	✔	✔	✔	✔	Good penetration of most sapwood but variable penetration of heartwood depending on species. Recommended for use for timbers in ground or water contact especially, and may be used for cladding provided it is redried after treatment. The water base of the preservative can cause raising of the wood grain and possibly some distortion After re-drying the treated wood is odourless but has grey/green colour. It can be painted or stained. Do not fix fittings to the timber until 14 days after treatment — MC is below 20%. If treated timber is liable to become wet and a long service life is required, stainless steel or silicon bronze fastners should be used. For occasionally damp conditions Galvanised or plated fasteners can be used.
Low pressure/double vacuum process LOSP Micro-emulsions	The timber is placed in a treating cylinder and a partial vacuum created and held for several minutes before the cylinder is filled with preservative. The vacuum is released and the timber allowed to remain in the preservative for up to an hour, either under atmospheric pressure or an applied pressure of up to two bar. After the pressure is released and the cylinder drained, a second vacuum is created to recover a proportion of the preservative from the wood and provide a dry surface.	✔	✔	✔ 3A only with a surface coating			Good penetration of most heartwoods. LOSP is suitable for most out of ground locations above DPC level and recommended for fine tolerance joinery. Does not require redrying after treatment or cause raising of woodgrain. It has an odour until solvent evaporates and can be painted or stained. It is colourless. It is critical that all low pressure treated timber receives a surface coating when used in hazard class 3. As with all waterborne preservatives micro-emulsions can raise the grain and cause some distortion so it is recommended to provide for extra drying here with small section sizes.
Diffusion process boron	Applied to 'green' timber which should be well above fibre saturation point. Timber is immersed in concentrated solution of boron compound; then close stacked under cover for several weeks to allow inward diffusion; the timber is then dried.	✔	✔	✔ 3A only with a surface coating			Can be used on 'green' timber above fibre saturation point but requires several weeks to achieve penetration. A disadvantage is that the preservative remains water soluble after drying and where subjected to a regular wetting leaching of preservative will occur. After treatment and drying the wood is non-coloured, non-corrosive and can be painted or stained. Not readily available in Ireland.

*See Table A 4.4

Note: Hazard Classes may also be referred to as Use Classes

European standards for timber preservation

European Standards, covering the production of preservative treated timber have been and are being introduced. They replace the previous process type specification with one based on performance results.

Timber must be fit for the intended purpose. There is a Hazard (Use) Class system which categorises the risk of deterioration to which the timber may be exposed; graded from 1 (insect risk only) to 5 (maximum risk as experienced in a salt water environment).

Table A 4.4 describes these hazard classes and the preservative treatment offered must ensure a good service life when the timber is exposed to the hazard into which it is categorised. Specifiers should check with timber treatment plants and the relevant preservative company's technical departments whether the methods of treatment comply with Irish, British or European standards. Both systems depend on preservative penetration and retention in order to be effective. With either the BS or EN system the specifier must decide:

- the desired durability required;
- the relevant code of practice;
- compatibility with other products.
- the type and method of preservative application.

Table A 4.4 *Hazard (Use) Class and typical service situations*

HAZARD /USE CLASS	HAZARD/USE	PRINCIPAL BIOLOGICAL AGENCY	TYPICAL SERVICE SITUATION	EXAMPLES
1	Above ground, covered Permanently dry. Permanently <18% MC	Insects	Internal, with no risk of wetting	All timbers in normal pitched roofs except tiling battens and valley gutter members. Floor boards; architraves; internal joinery; skirtings. All timbers in upper floors not built into solid external walls.
2	Above ground, covered Occasional risk of wetting Occasionally >20% MC	Fungi/Insects	Internal, with risk of wetting	Tiling battens; *frame timbers in timber frame houses; timber in pitched roofs with high condensation risk; timbers in flat roofs;*ground floor joists; sole plates (above DPC); timber joists in upper floors built into external walls*.
3	Above ground, not covered Exposed to frequent wetting Often >20% MC	Fungi	A- External, above damp proof course (DPC) - coated	External joinery including roof soffits and fascias; bargeboards, etc.; cladding; *valley gutter timbers
			B - External, above damp proof course (DPC) - uncoated	Fence rails; gates; fence boards; agricultural timbers not in soil/manure contact.
4	In contact with ground or fresh water. Permanently exposed to wetting Permanently >20% MC	Fungi	A- Soil contact. Timbers in permanent contact with the ground or below DPC	Fence posts; gravel boards; agricultural timbers in soil/manure contact; poles; sleepers; playground equipment; motorway and highway fencing; sole plates below DPC.
			B - Fresh water contact. Timbers in permanent contact with fresh water.	Lock gates; revetments.
			C - Cooling tower packing Timbers exposed to the particularly hazardous environment of cooling towers.	Cooling tower packing (fresh water).
5	Permanently exposed to wetting by salt water. Permanently >20% MC	Fungi, Marine borers	All components in permanent contact with sea water.	Marine piling; piers and jetties; dock gates; sea defences; ships hulls; cooling tower packing(sea water)

MC = % moisture content of the timber

* These timbers are assigned to a "higher" hazard class than suggested by their location, owing to the potential consequences of failure.

Guide to specification

The amount of preservative solution absorbed by timber during treatment can vary greatly. Appropriate selection of the preservative formulation and the application process is important for the most effective use of preservative treatment. This in turn depends on the end-use and required performance of the treated component in service (i.e. the appropriate Hazard Class it is subjected to).

European Standards have introduced a system where a defined combination of penetration and retention of preservative must be achieved in the treated wood. The application process is not defined and any process may be used which achieves the desired penetration and retention combination.

The timber species and the environmental service conditions should be assessed with respect to the hazard posed. The classification of service conditions and hazard risk are listed in EN 335, and are shown in table A 4.4. When specifying treatment, identify the hazard class and state that it should comply with it.

A durability flow chart is shown in fig. A 4.1 to assist the designer in the decision making process.

Quality control

The traditional approach to specifying preservative treatment was underpinned by the evidence by the treater (usually in the form of a treatment certificate) that the required treatment schedule has been completed. This will continue to be the case where timber is treated to current standards (at least for the next few years). However, the new European approach will require a demonstration that the treatment used has produced the specified results and this demand can only be achieved through reference to chemical analytical methods.

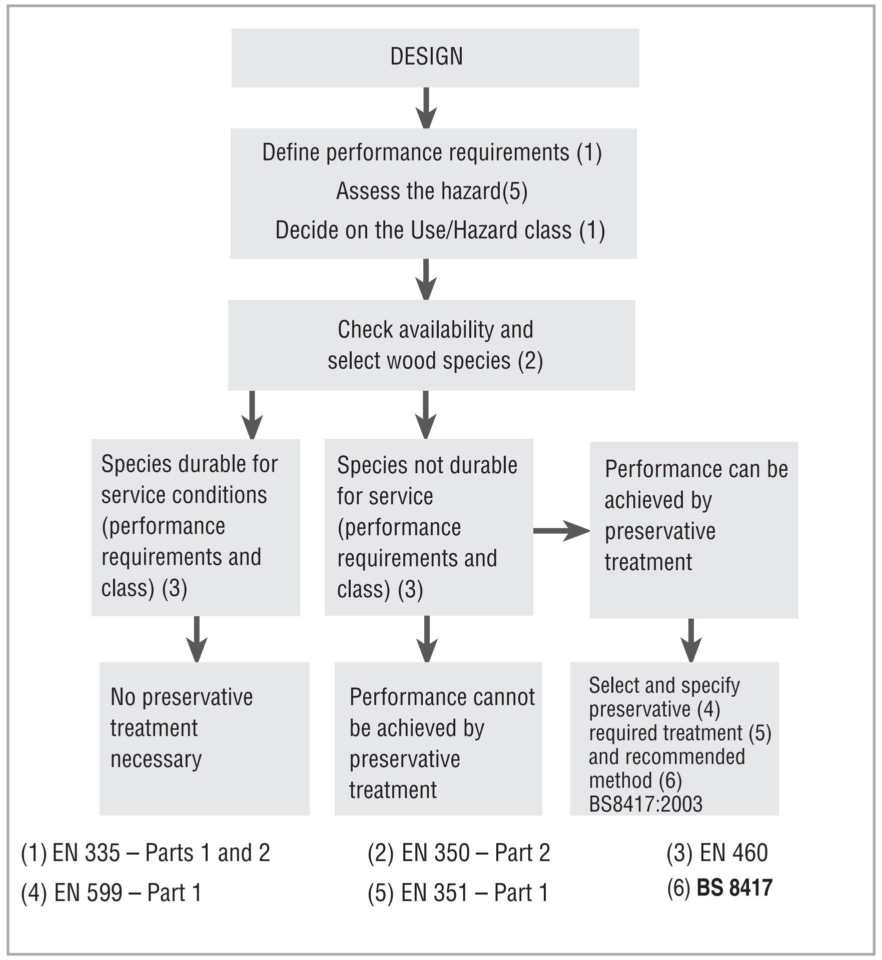


Fig. A 4.1 indicates durability classes and treatability for various timber species.

Specification

Specify durability required.

Specify the current Code of Practice.

Specify the type of preservative, and the following:

- Composition of treatment solution
- Condition of timber prior to treatment
- Method of application
- Treatment cycle
- Uptake of preservative

Hazard classes

EN 335:

- Defines five hazard classes with respect to biological attack

Class 1:

- Timber or wood-based product under cover and fully protected from weather and not exposed to wetting

Class 2:

- Timber or wood-based product under cover and fully protected from the weather
- High environmental humidity can lead to some but not persistent wetting

Class 3:

- Not covered
- Not in contact with ground
- Exposed to weather

Class 4:

- In contact with ground or fresh water
- Permanently exposed to wetting

Class 5:

- Permanently exposed to salt water

Penetration Class (mm)	
P1	None
P2	3mm lateral, 40mm axial
P3	4mm lateral
P4	6mm lateral
P5	6mm lateral, 50mm axial
P6	12mm lateral
P7	20mm lateral
P8	Full sapwood penetration
P9	Full sapwood, 6mm heartwood

A5 Fire performance

Timber and its performance in fire can be an emotive issue. In terms of 'spread of flame' and 'heat release' tests, timber performs poorly unless it is treated with flame retardants. However, in one important aspect of performance, namely the maintenance of strength with increasing temperature over time, wood performs well. This is due to the fact that timber chars at a constant rate throughout a fire; the formation of this char protects the un-burnt timber underneath. EN 1995-1-2 (the second part of Eurocode 5) gives charring rates for softwoods and hardwoods (see table A 5.1) and a method of calculating the fire resistance of timber components that is not too dissimilar to that in BS 5268-4. For permissible stress design in the UK BS 5268 Part 4 gives charring rates for softwoods and hardwoods (see table A 5.2) and a method of calculating the fire resistance of timber components that is not too dissimilar to that in BS 5268-4. However the two methods should not be mixed.

The main fire performance requirements affecting materials and building elements are Fire Resistance and 'reaction to fire'; similar to the surface spread of flame classification referred to in Technical Guidance Document B (Fire Safety). Technical Document B also refers to limited combustibility and non-combustible materials which are also defined according to fire tests or by reference in the document. It should be noted that the Irish TGD on fire safety is similar to the equivalent UK Approved Documents especially in relation ot fire performance tests but differences do exist but generally the comments here would apply to many buildings in the UK.

Reaction to fire

Technical Guidance Documents B to the Building Regulations classifies buildings according to their purpose group or type of occupancy/usage, for example most domestic dwellings fall into Purpose Group 1a, while apartments fall into Purpose Group 1c. Many of the purpose groups require wall and ceiling surfaces to have a particular performance in relation to reaction to fire (or surface spread of flame classification where BS 476 is referenced) for different locations within buildings. Untreated timber, plywood, particleboard and hardboard usually fall into European Class D-s3,d2 (or approximately surface spread of flame Class 3). However, many timbers can be upgraded by pressure impregnation to meet higher performances but the treatment is expensive and impregnation treatments (as distinct from brush on treatments) are usually only available in the U.K. and on the continent. There are treatments and proprietary boards available from specialist suppliers that meet higher classifications such as European Class B-s3,d2 and Class C-s3,d2 (essentially Class 0 and Class 1). The European Class system is classified using I.S. EN ISO 13501-1 according to test results from I.S. EN ISO 1182 (non-combustibility), I.S. EN ISO 1716 (determination of the gross calorific value) and I.S. EN 11925 (Ignitability when subject to direct impingement of flame). Class 0 is the highest classification and is defined in Technical Guidance Document B (Fire Safety) while Classes 1 to 4 are defined by Fire Test to BS 476 Part 7.

While the two systems are similar they use different test standards. If Technical Guidance Document B is revised and the National System (to BS 476 i.e. Classes 0, 1 and 3) are removed then it probably should not be assumed that a material that was designated under the National System Class 4 automatically meets the European Class.

Fire resistance

Fire resistance relates to three terms, Load-bearing capacity, Integrity and Insulation and in the European standards these three properties are designated by the letters REI. In relation to the specified period of time, load-bearing capacity refers to the ability to carry load, integrity refers to the passage of flame, heat and smoke and insulation refers to the temperature rise on the unexposed face of a wall or floor.

A column would usually only be required to have a fire resistance related to its load-bearing capacity (R) and if necessary the column could be sized to take account of timber lost during fire.

How can timber be designed for fire conditions?

Timber is difficult to ignite and once ignited it tends to burn slowly producing a layer of char on the surface. This layer acts as a protective coating for the remainder of the timber, which remains relatively unharmed by the fire. The size and strength of this remaining core can be determined and the section can be designed to carry the load safely for a predetermined period of time.

Charring rates are related to :

- Density
- Species
- Moisture content
- Shape/Section

For floors and walls the fire resistance is calculated for the element of construction taking into account the whole construction. Thus plasterboard would protect the timber from fire for a period of time and contribute to all three fire resistance properties (REI); flooring would not contribute to load bearing but (subject to joints being protected) would contribute to integrity and insulation (EI) while the timber member would only contribute to load-bearing (R).

Fire resistance can be determined by testing or by calculation or by assessment if the performance of different materials is known. In most buildings using timber, plasterboard makes an important contribution to fire resistance and not only is the thickness and type of plasterboard important so is its' fixing and it is important that the fixings are properly specified (length and spacing) and checked on site.

Theory of fire

There are two main distinct phases to a fire, the developing phase and the fully developed phase. A material's performance has to be categorised in respect of these two conditions.

The developing phase incorporates a number of separate phenomena, the combustibility of the material, the ease of ignition, the speed of the spread of fire/flame across its surface and the rate at which heat is released.

The ability to resist the fully developed fire is known as fire resistance, in general terms fire resistance relates to an element of construction rather than the material.

The behaviour of solid timber and wood-based materials when subjected to fire is such that it burns, and as such it is termed combustible. This combustible nature of wood and wood-based products can be modified by the use of intumescent coatings. or impregnation with flame/fire retardant salts. While these treatments will not make timber non-combustible, whey will raise the energy level required to cause it to burn.

Ignition of Wood

In general, the higher the density of the wood, the longer it will take the wood to ignite.

Cellulose is one of the main constituents of wood. As the temperature of wood is increased the cellulose begins to decompose, i.e. it is pyrolysed. The first gas produced will be water vapour and as the heating process continues above 100°C, volatile gases are emitted. At 250°C and in the presence of a pilot flame, wood will ignite. However, at a thickness greater than 12mm (approximately) wood cannot support self maintained combustion.

Softwoods contain large quantities of resins and when exposed to heat these resins vapourise rapidly. Softwoods have a more open cellular structure and lower density than most hardwoods, and the combustible vapours are distilled from softwoods at lower temperatures than from hardwoods. This is one of the factors which account for the difference in the ignition temperatures of various woods.

The onset of pyrolysis in timber is marked by a darkening of the timber and the commencement of emission of volatile gases, the reaction becomes exothermic and the timber reverts to a carbonised char popularly known as charcoal (fig. A 5.1).

The volatiles, in moving to the surface, cool and char and are subsequently ejected into the boundary layer where they block the incoming convective heat. This most important phenomenon is known as 'transpirational cooling'. High surface temperatures are reached and some heat is ejected by thermal radiation. The surface layers crack badly both along and across the grain and surface material is continually being lost. A steady state is reached where a balance exists between the rate of loss of surface and the rate of recession of the undamaged wood. Refer to tables A5.1 and A5.2 for common charring rate.

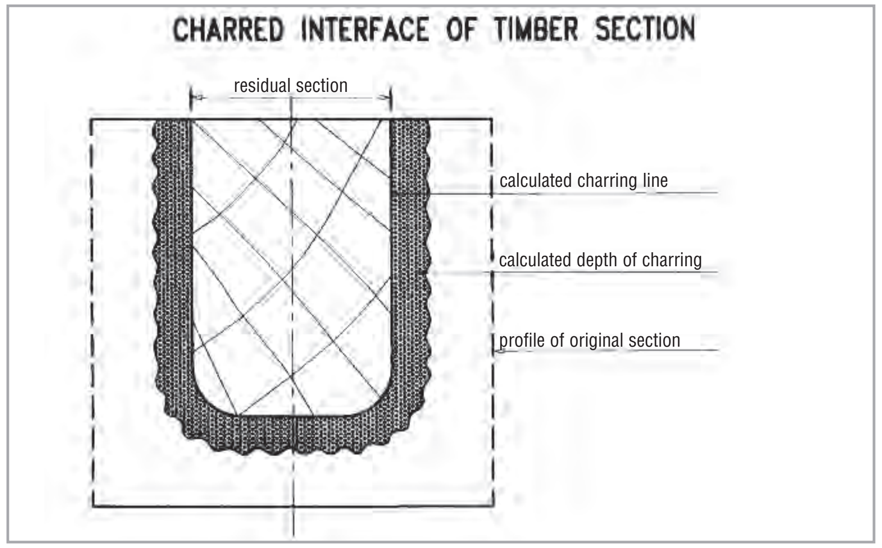


Fig. A 5.1 Charred interface of timber section.

The formation of char:

The formation of char protects the unburnt timber which may be only a few millimetres from the surface. Failure of a beam or strut will occur when the cross-section area of the unburnt core becomes too small to support the load. By increasing the dimensions of timber, it is possible to guarantee structural integrity in a fire for a given period of time. This is sometimes called the 'sacrificial timber' method. The performance of timber in fire is predictable and generally stable compared with for example steel, where sudden buckling failure can occur due to the expansion and softening of steel members in a fire.

Design

The charring rates in tables A5.1 and A5.2 are taken from EN 1995-1-2 and BS 5268-4 and can be used in conjunction with those standards for a relatively simple fire design. A constant charring rate is assumed for calculation of the fire resistance of the section.

It is wise to bear in mind that fire resistance is defined as the ability of an element to carry on performing a building function in spite of being exposed to a fully developed fire. It is thus a property of the elements of building construction, not materials. Different timbers char at varying rates, largely as a function of their density, with the higher density timbers charring more slowly.

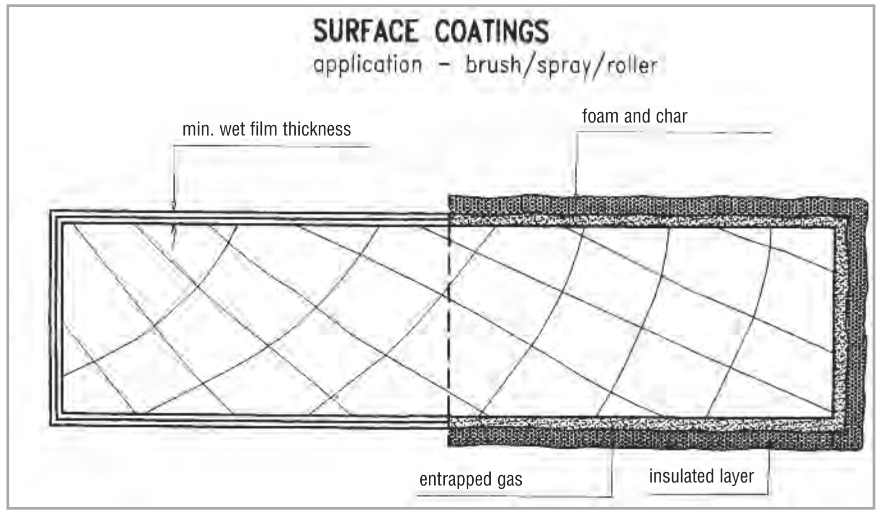


Fig. A 5.2 Effect of fire on treated wood

Flame-retardant treatment
Flame-retardant treatments are utilised to reduce the surface spread of flame which enables timber and wood-based panels to be used for many applications for which they would otherwise not be used in the untreated state.

There are two types of treatment:

(a) impregnation with inorganic salts or leach-resistant chemicals;
(b) surface coating.

Table A 5.1 *Design charring rates β_0 (to be used with EC5 only)*

MATERIAL		β_0 in mm/min
Solid softwood	with $\rho k \geq 290$ kg/m^3 and min $a_o \geq 35$mm	0,8
Glued laminated softwood	with $\rho k \geq 290$ kg/m^3	0,7
Wood panels	with $\rho k \geq 450$ kg/m^3 and $t_p = 20$mm	0,9
Solid hardwood	with $\rho k \geq 450$ kg/m^3	0,5
Glued laminated hardwood	with $\rho k \geq 450$ kg/m^3	0,5
Oak		0,5
Solid hardwood	with $\rho k = 290$ kg/m^3	0,7
Glued laminated hardwood	with $\rho k = 290$ kg/m^3	0,7
Plywood	with $\rho k = 450$ kg/m^3 and $t_p = 20$mm	1,0
Wood-based panels	with $\rho k = 450$ kg/m^3 and $t_p = 20$mm	0,9
Where ρk = characteristic density of the material; a_o = width/depth of cross section; t_p = thickness		

Table A 5.2 *Notional rate of charring for the calculation of residual section, (from BS 5268:Part 4).*

Species	Charring. in 30 min. mm	Charring in 60 min. mm	Charring rates mm/min.
(a) Structural timbers listed in BS 5628 Pt 2 other than (b) and (c)	20	40	0.67
(b) Western red cedar	25	50	0.83
(c) Oak, utile, keruing, teak, greenheart, jarrah	15	30	0.50

Specifications for fire-treated timber
A specification for treatment of wood or a timber product should include references at least to the following data:
1. The species of wood or type of timber product;
2. The name of the treatment to be applied;
3. The nature of the treatment – and in the case of a paint – its colour and, where known, the loading and dry film thickness;
4. The method of application of the treatment;
5. The test or regulation to which the treated product must comply.

Fire door sets
Designs for timber fire doors sets are available for periods of 20, 30 and 60 minutes. When specifying a fire door it is essential to check with the manufacturer that the doors comply with EN 1634 Parts 1 to 3 as necessary (for designs to BS 5268 the relevant standard is BS 476 Part 22) for the specified minimum fire resistance. Fire doors are likely to need an intumescent strip to be positioned in the door or door frame (or door lining) to achieve the specified performance.

Any reference to a fire door set is intended to mean a complete door assembly which includes the door leaf, door frame, ironmongery and any seals.

The performance of a fire door critically depends on the correct installation of the complete door assembly, strictly in accordance with the terms of the relevant test certification supplied by the door manufacturer.

All fire doors should be classified in accordance with BS EN 13501-2: 2003, Fire classification of construction products and building elements, Part 2 - Classification using data from fire resistance tests (excluding products for use in ventilation systems). They are tested to the relevant European method from the following:

I.S. EN 1634-1: Fire resistance tests for door and shutter assemblies, Part 1 - Fire doors and shutters;

I.S. EN 1634-2: Fire resistance tests for door and shutter assemblies, Part 2 - Fire door hardware;

I.S. EN 1634-3: Fire resistance tests for door and shutter assemblies, Part 3 - Smoke control doors and shutters;

An additional classification of Sa is used for all doors where restricted smoke leakage at ambient temperatures is needed for tests to BS 476: Part 22.

The method of test exposure in either case is from each side of the door separately, except in the case of lift doors which are tested from the landing side only.

An example of a European specified fire door for 30 minutes is E30, or E30 Sa where resricted smoke is required (E stands for integrity). An example of a similar BS 476 specified fire door is FD 30 and FD 30S.

Manufacturers' product data sheets often provide a suggested wording for a treatment specification relevant to their product.

Note:
It is important to consider the fire resistance of the element as a whole as well as the fire resistance of the materials used to make up the element.

Fire stops
Every joint, imperfection of fit or opening should be fire stopped where required.

Technical Guidance Document B
- B1 Aims to ensure that a satisfactory means of escape is provided for persons in the event of fire in a building;
- B2 Aims to ensure that fire spread over the internal linings of buildings is restricted;
- B3 Aims to limit internal fire spread, that there is a sufficient degree of fire separation within buildings and between adjoining buildings, and to inhibit the unseen spread of fire and smoke in concealed spaces in buildings;
- B4 Aimsto ensure that external walls and roofs have adequate resistance to the spread of fire over their external surfaces, and that spread of fire from one building to another is restricted; and
- B5 Aims to ensure that satisfactory access is provided for fire appliances to buildings and facilities in buildings to assist fire fighters in the protection of life and property.

Building regulations

The Irish Building Regulations, Part B sets out the requirements in respect of fire safety in all buildings. Technical Guidance Document B provides general guidance on how these requirement can be complied with (the UK has a similar structure in terms of Building Regulations and Approved Documents). It is divided into five main parts:

- B 1 Means of escape in case of fire;
- B 2 Internal fire spread (linings);
- B 3 Internal fire spread (structure);
- B 4 External fire spread;
- B 5 Access and facilities for the fire service.

Although timber members can be designed for full exposure in a fire situation, it is more common for the timber to be concealed by other building materials (e.g. plasterboard). Where these materials have fire resistance themselves they may be taken into account in determining the fire resistance of the element as a whole.

A fire stop is a seal provided to close an imperfection of fit or design tolerance between elements or components, to restrict or prevent the passage of fire or smoke. Rock fibre as distinct from glass fibre is frequently used as a fire stop. Smoke seals can be provided as required around doors.

Fire safety certificate

In Ireland, the Building Control Act 1990 and the Regulations made subsequently require that the designer shall obtain a Fire Safety Certificate from the Local Authority if the proposed works include the following.

(a) the erection of a building, except a dwelling house (other than a flat);
(b) the material alteration or extension of a building;
(c) a material change of use of a building.

It is a requirement to submit to local Building Control Authority, if requested, calculations, specifications and drawings showing that the buildings or works would comply with the requirements of Part B of the First Schedule to the Building Regulations.

Usually an experienced architect, engineer or fire consultant with specialist knowledge is required to make the application. It is advisable to discuss any proposed upgrading of timber (for both flame retardant and fire resistance) with the Fire Officer when applying for the Fire Safety Certificate and to make sure that the product has been tested to the European Standards if they are the referenced standards.

A6 Architectural criteria

Structural timber (softwoods and hardwoods) can be used to enhance the overall design. Features of timber such as knots, grain, colour and texture can be expressed visually as an integral part of the design.

Specification

Visually expressed timber will require special considerations in the following areas:

- Large solid timber sections will have defects such as knots, splits, checks, and shakes. Limits on their sizes may need to be specified.
- Laminated sections for exterior use generally utilise phenol resorcinol formaldehyde adhesive, which tends to leave a thin black line along the lamination. Clear glues are also available.
- Location of finger joints, scarf joints or butt joints may need to be restricted.
- Concealed joints are typically specified e.g. to hide steel plates in glulam members.
- Recessed connections are commonly plugged with machined timber dowels on the exposed face.

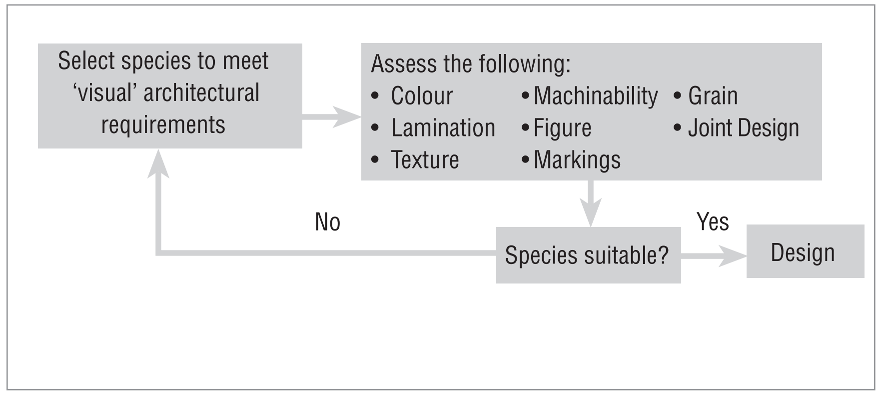


Fig A6.1 Architect's flowchart

Species selection

Certain timbers are noted for specific properties - balsa for lightness, teak for stability, greenheart for resistance to marine borers - but, in terms of suitability for the use identified, it is prudent to ensure that all the relevant criteria are met by the properties of the timber. In identifying these criteria there may be one overriding factor which determines which timber to select, but more often there are a number of criteria which need to be considered.

Table A 6.1 *End-use criteria*

END USE	CRITERIA
Structural timbers	Strength, good strength to weight ratio, toughness, workability, appearance, nail holding properties
Joinery	Workability, good machining properties, stability, good finishing properties, durability, treatability and appearance.
Furniture	Appearance, workability, good machining properties, good finishing properties, good strength to weight ratio.
Flooring	Wear resistance, appearance, good machining properties, stability.
Fencing	Durability or treatability, good nailing properties, strength and appearance stability.
Cladding	Machinability, good finishing properties, durability, treatability, appearance and stability.

Visual Characteristics

Colour
Wood comes in a variety of natural colours and colour differences exist even between individual boards. Wood exposed to the atmosphere frequently darkens. Long exposure of light coloured woods to sun or rain may cause distinct colour changes.

Grain
This generally refers to the direction of the fibres in the wood.

Texture
This is defined as the relative size and amount of variation in size of the cells. It is defined typically as coarse, medium or fine.

Figure
This is used to describe the natural pattern on the wood surface. While the figure of normal wood may be pleasing, more attractive figure may, in some cases, be produced by natural abnormalities, however for structural reasons these are generally not allowed.

Processing Defects
These arise from machining, finishing and handling.

Markings

Where end use requires markings to be omitted for aesthetic reasons each parcel of timber of a single grade should be despatched under the cover of a compliance certificate stating the following minimum information:

- Serial No. and date of certificate
- Both the grading company's and customer's name and address
- The purchase order number
- Timber dimensions and quantities
- Date of grading
- Signature of grader, countersigned by the supervisor
- The standard, strength class and species

- BS 4978, EN 14081-1, and I.S. 127 give specific requirements relating to marked and un-marked timber

Decorative timbers

- Quartered oak
- Flat sawn ash
- Walnut
- Fiddle back sycamore
- Bird's eye maple
- Yew
- Western Red Cedar

Timber ranges from bland to highly figured, from blonde to black. Even timbers of a fairly uniform colour can show attractive figure due to the presence of growth rings. How the wood is presented can affect how its decorative features are displayed. Oak is generally a uniform pale brown but it has very prominent rays so that if quarter sawn or sliced the rays show up as contrasting wavy bars across the vertical stripes of the growth rings and pores.

Decorative timbers can be used in plank or veneer form. Veneers, bonded to a backing panel, are normally used for decorative panels. Furniture and joinery can also incorporate veneered panels. Use of contrasting woods, as laminates or inlay, can enhance items of furniture.

An important aspect of the use of veneers is that when a veneer is bonded to the face of a panel there must be a balancing veneer bonded to the back, otherwise distortion of the panel is likely to take place.

Aspects of the structure of timber which contribute greatly to its decorative value are distortion of grain (walnut forks), waviness of grain (wavy grain, fiddle back), and dimpling of grain (bird's eye).Variation in colour may be caused by soil conditions or even bacterial or fungal infection of the wood (e.g. spalted beech, brown oak) and with some species there can be a plain strong colour, or it may be striped through with a lighter shade (e.g. ebony).

Table A 6.2 *Sample species selection*

Species	Density kg/M^3	Texture	Moisture movement	Working qualities	Durability *	Colour	Common Uses
Ash	670-710	Medium/Coarse	Medium	Good	5	White-Brown	Interior joinery
Alder	500	Fine	Medium	Good	5	Pale Red-Brown	Interior joinery
Balau, yellow	980	Medium	Medium	Medium	1-2	Yellow-Brown	Marine decking
Beech	720	Fine	Large	Good	5	White-Brown	Furniture
Birch	600	Fine	Medium	Good	5	White-Brown	Furniture
Cherry	580-630	Fine	Medium	Good	3 - 4	Red-Brown	Interior joinery
Douglas fir	530	Medium	Small	Good	3 - 4	Pink-Brown	Exterior joinery
Ekki	1070	Coarse	Large	Difficult	1	Dark-Brown	Marine works
Iroko	660	Medium	Small	Medium	1 - 2	Yellow-Brown	Exterior joinery
Keruing	740	Medium	Large	Difficult	3	Dark-Brown	Vehicle flooring & decking
Larch	560-590	Fine	Small	Medium	3 - 4	Red-Brown	Boats, poles
Sapele	560-650	Medium	Medium	Medium	3	Dark red-brown	Interior & exterior joinery
Maple, hard	740	Fine	Medium	Medium	5	Creamy-White	Flooring, furniture
Maple, soft	650	Fine	Medium	Medium	5	Creamy-White	Furniture
Oak, red	740	Medium/Coarse	Medium	Medium	4	Yellow-Red	Interior joinery, flooring
Oak, white	670-770	Medium/Coarse	Medium	Medium	2 - 3	Yellow-Brown	Exterior and interior joinery
Pine, pitch	670	Medium	Medium	Medium	3	Yellow-Red	Exterior and interior joinery
Pine, Scots	510	Medium	Medium	Good	3 - 4	Yellow-Brown	Joinery
Pine, yellow	420-560	Medium	Medium	Medium	4	Yellow-Brown	Interior joinery
Southern yellow pine**	550	Medium	Medium	Medium	4	Yellow	Joinery
Spruce, Sitka	410	Coarse	Small	Medium	4	Pink-Brown	Studding, pallets
Spruce, Norway	400-500	Medium	Small	Good	4	White-Brown	Interior joinery
Teak	660	Medium	Medium	Medium	1	Gold-Brown	Exterior and interior joinery
Walnut	560-660	Coarse/Medium	Small	Good	3	Dark-Brown	Furniture
Western Red Cedar	390	Coarse/Medium	Small	Good	2	Red-Brown	Exterior cladding
Tulipwood	450	Fine	Medium	Good	5	Yellow-Brown	Furniture and mouldings
Utile	650-690	Medium	Medium	Good	2 - 3	Red-Brown	Joinery
	Note: Oak and western red cedar are acidic timbers and will corrode metals in damp conditions. Use only stainless steel or silicon bronze fitttings externally.						

*** Durability is the resistance of the heartwood to fungal attack as listed in EN 350-2. Durability classes (fungi) are rated from 1 (very durable) to 5 (not durable).**

**** Southern yellow pine is derived from the same species as pitch pine, but is fast grown and contains a high proportion of sapwood. Preservative treatment is needed for exterior applications.**

A7 Building systems

7.1 TIMBER FRAME

Timber-frame construction is a prefabricated factory manufactured building system, which can be transported to site in a flat pack or volumetric units and assembled on site. The NSAI operate the Timber Frame Manufacturers' Approval Scheme and maintain a National Register of approved timber frame manufacturers.

The Irish Agrément Board (IAB) have certified a number of building systems and products that may be suitable for timber frame construction. Similar approval and certification procedures exist in the U.K. through for example TRADA, the British Board of Agrément and BRE. The approval of manufacturers, products and building systems does not necessarily extend to buildings and their design, installation, use and construction as these are often site and workmanship related. The certification of buildings is usually undertaken by project architects and engineers.

Typically a system can be one of four methods;
(a) platform frame
(b) balloon frame
(c) volumetric or
(d) post and beam

The most common method used in Ireland and the UK is the platform method.

Stick building (the cutting of timber and the manufacture of panels on site) is not recommended due to the extended period of exposure to the weather and the difficulty of obtaining the necessary tolerances and workmanship and perhaps more importantly the difficulty of certifying the building.

A system will typically consist of the following structural elements:

Roof: Can be either prefabricated timber trussed rafters or roof panels
Walls: Timber framing. External walls incorporate a breather membrane, sheathing timber studs, insulation, a vapour check and an internal lining such as plasterboard.
Floors: Ground floors can be either concrete or suspended timber floor panels. Prefabricated timber floor panels are usually used for subsequent floors.

In Ireland I.S. 440 (Timber Frame Dwellings) was published in 2009 and covers the main requirements of timber frame construction:

- Responsibilities
- Materials
- Design
- Manufacture
- Construction details
- Site work
- Services

While the standard is applicable to dwellings including apartments much of the standard can be applied to other buildings. Revision on the standard commenced in 2010, mainly to comply with Eurocode 5 but it is proposed to include other building uses in its title and content.

Structural design

Timber frame structural elements should be designed in accordance with IS 440 which refers to Eurocode 5 and BS 5268; however, following its revision it is anticipated that only Eurocode 5 will be referred to. Roof trusses should be designed to Eurocode 5 and when published, Swift 5 will give some further guidance on roof trusses. Swift 6 (due to be published In 2012) contains load span tables to Eurocode 5 and the Irish National Annex for floors, ceiling ties, rafters and purlins amongst other elements.

In the UK, at least for the present, it is likely that designs will continue to be carried out to BS 5268 (Parts 2, 4 and 6) and BS 5268: Part 3 (for trussed rafters). However, designs can be carried out to Eurocode 5 with the UK National Annex and PS 6693 gives some additional guidance on designs to Eurocode 5.

Timber wall panels should be designed for vertical loads (due to roof and floor elements) and for horizontal loads (from wind). The main design criteria are racking resistance, sliding and the overall stability of the walls (overturning). Wind loads are transferred through floors and roofs acting as horizontal diaphragms connected to shear (or racking) walls and on into the substructure. The overall design must be undertaken by a qualified engineer and most timber frame manufacturers usually employ an external consulting structural engineer. The overall design package supplied by the timber frame manufacturer will typically include design calculations, structural drawings, assembly and site details (such as a Site Fixing Schedule) and if required most manufacturers would offer site supervision and certification.

Durability

For designs based on Eurocode 5 reference should be made to I.S. EN 335 (Parts 1, 2 and 3), I.S. EN 350-2, I.S. EN 351-1 and I.S. EN 460, to determine the requirement for preservation treatment.

I.S. 440 requires that timber softwood components in external wall panels (excluding sheathing) should be treated with a suitable timber preservative. These components include:

- timber framing including studs, I-studs, top rails and bottom rails;
- head plates;
- sole plates;
- timber cavity barriers; and
- cladding battens.

Other timber components e.g. header joists may require preservative treatment if so specified.

Where timber treated with preservative is cut on-site, all cut ends shall be liberally brush treated with a suitable preservative.

For designs based on BS 5268-6 reference should be made to BS 8417 for information on the preservation of timber. BS 8417 also gives good advice in relation to timber treatment and durability requirements for designs to Eurocode 5.

The preservative manufacturer's technical recommendations should always be complied with.

Where non-durable timbers are exposed to the weather (e.g. soffit and barge boards) they should be treated with an appropriate wood preservative. External timber cladding has specific requirements and traditionally has been made from durable timbers such as cedar.

The sapwood of all timber species is non-durable.

Some preservative treatments may leach out unless the timber is sealed.

Notes:

Softwood timber should usually be considered as perishable due to the presence of sapwood.

In Ireland and the U.K. softwood timbers in the external wall panels and timber cavity barriers have traditionally been pressure treated with a preservative.

Fire performance

Most building elements (walls, beams, floors etc.) are required to attain a level of fire resistance. Fire resistance is generally achieved by a combination of internal lining materials, the timber structure and in some cases insulation.

In addition it is necessary to provide cavity barriers around openings in the external wall, at the top of external walls, at the ends of party walls and depending on

the purpose group, to limit the cavity distances. In addition continuous vertical fire stops should be placed at the ends of party and compartment walls and horizontal fire stops at floor level within the cavity of any party or compartment wall. For precise requirements for cavity barriers and fire stops refer to I.S. 440 and Technical Guidance Document B (Fire Safety) and for the U.K. the equivalent U.K. Approved Document.

Gaps in a fire resisting component will require fire stopping and suitable materials (preferably ones that have been fire tested) must be used.

It is also necessary to control the spread of flame across surfaces of walls and ceilings and these requirements are set out in TGD B and the equivalent U.K. Approved Document.

Note:

Designs to Eurocode 5 must refer to EN fire test standards; designs to BS 5268 should refer to fire test standards such as the appropriate part of BS 476. The EN fire tests are generally considered to be slightly more severe than the equivalent BS 476 part.

In Ireland compartment floors are required to have a service cavity under the main fire and acoustic linings. A similar requirement exists for party and compartment walls where services are on those walls. It is recommended that a service cavity should be placed on a wall where future services might be installed on that wall.

Quality of materials

Materials sourced by the timber frame manufacturer must be subject to the company's quality control procedures. Timber should be visually strength graded in accordance with IS 127 (or in the U.K. BS 4768) or machine graded to EN 14081-4. Marking should comply with IS 127 and/or EN 14081-1.

OSB and plywood are the most commonly used sheathing materials used in timber frame; OSB 3 should be used and should comply with EN 300 while plywood should comply with EN 636 (type 2 or 3). Other materials can be used for sheathing providing they are suitable; see I.S. 440 and for the U.K. BS 5268 parts 2 and 6. In I.S. 440 attention is drawn to the need to check that the satisfactory performance of wall ties, cavity barriers and fire stops where other sheathing materials to OSB or plywood) are used. Care should be taken about the source of sheathing and that it is properly certified.

Fixings should be corrosion resistant and comply with Eurocode 5 or BS 5268 for designs to that standard.

The breather membrane should have a vapour resistance not greater than 0.6 MNs/g and be suitably durable. Breather membranes should have appropriate certification; membranes conforming to type 1 or type 3 of BS 4016 are considered suitable.

Wall ties, anchor straps and similar products should conform to EN 845-1 (largely in relation to references to testing and the appropriate standards). In terms of durability, these products (and their fixings) should be made from austenitic stainless steel or a material with a similar durability. The products should be marked identifying the manufacturer and the wall tie or strap type. For wall ties the manufacturer should provide information on the wall tie spacing and wind forces which should be related to cavity widths.

Proprietary cavity barriers should have been fire tested (to EN 1364 or BS 476-22 for designs to BS 5268. They should be marked with the manufacturers' name and the range of cavity widths for which they are suitable and be protected by a suitable material from moisture and site damage. More information is contained in I.S. 440. Timber cavity barriers should be treated with a suitable preservative, have a minimum thickness of 38mm and fill the wall cavity (for masonry mortar or another suitable material may need to be used to fill any gaps. Timber cavity barriers will need a DPC between the barrier and the masonry; polythene (made from un-recycled plastic) with a minimum thickness of 0.24mm (1000 gauge) is considered suitable.

The vapour control check (VCL) should have been tested to EN 1931 and EN ISO 12572 and should not be made from recycled materials; where the vapour resistance is less than 250 MNs/g a condensation risk analysis should be carried out to EN ISO 13788. Un-recycled polythene with a thickness of 0.12mm (500 gauge) is considered suitable for use as a VCL.

Generally proprietary materials should be fixed in accordance with the manufacturers' instructions unless specified otherwise (e.g. by the project architect or design engineer).

I.S. 440, Eurocode 5 and BS 5268 give further information on materials,

Thermal insulation

U-values are a measure of the thermal performance of a building element (essentially the building envelope - wall, floor, roof, window or door) and Technical Guidance Document L (TGD L) gives advice on the U-values levels as well as general energy conservation. There are two documents; one dealing with dwellings and one dealing with other building types.

Guidance is given on CO^2 emissions, energy consumption, air tightness (including the air permeability of the building envelop), mechanical ventilation, the use of renewables (e.g. solar power), cold bridging, fabric insulation (i.e. U-values) as well as requirements on the efficiency of gas and oil boilers (a minimum of 86% efficiency). Limits are placed on U-values (for various elements) which are weighted (designated Um); some relaxation is allowed on the weighted values and these values are also given.

Timber frame can provide very high level of thermal insulation by the placement of insulation between the timber framing and the plasterboard lining and the timber sheathing. Typically timber frame manufacturers use a 140mm stud fully filled with glass fibre insulation to achieve the required U value. However, walls can easily be insulated to higher levels by using deeper studs or better performing insulations (such as the polyurethane foams). In addition, as the insulation in timber frame construction is fully covered and is shielded from air movement in the wall cavity, the performance of the insulation tends to be superior to those building methods that place insulation directly in the wall cavity.

Standard timber frame construction usually performs well in relation to air tightness and building fabric air permeability. However, attention is drawn to the need to check that the bottom of walls (especially where they sit on masonry walls) are sealed and that there are no gaps around windows and doors or at upper floor levels between the wall panels and floor panels.

Platform method

The platform method is the most commonly used method for domestic timber frame construction. Each storey is erected as a separate operation with the floor deck of one floor becoming the erection platform of the next. Wall, floor and roof panels are of a size that can be manhandled into position, often with the help of a crane.

The construction details of Section B concentrate only on the platform method. Panels may be continuous, full wall length or shorter separate panels nailed together and tied together with head binders. External walls are usually sheathed with plywood or OSB fixed to the external face of the wall panel frame. The outer face of the sheathing is covered with a breather membrane properly lapped over fixed with austenitic stainless steel staples to the sheathing. This helps to protect the building during erection and later against any wind-driven rain or moisture that might penetrate the external cladding. Glass fibre thermal insulation is usually placed between the timber frame studs and is secured in place in order to avoid sagging. To prevent interstitial condensation a vapour check membrane (also referred to as a vapour control layer) is fixed on the warm side of the insulation behind the internal wall lining; five-hundred gauge un-recycled polyethylene sheeting is normally used for this purpose. The external weather screen can include timber, brick, block, hanging tiles or other suitable materials, details for some of which are shown in Section B. The structural timber framing of external wall panels together with sole plates, timber cavity barriers, cladding battens, counter battens and external timber cladding should all receive appropriate pressure preservative treatment.

Balloon frame

This is similar to the platform method except studs are 2 storeys high.

Volumetric method

Volumetric method involves the factory fabrication of box units which require crane erection. The most common use of volumetric construction is the use of bathroom pods in hotels and apartments. These pods often consist of fully finished bathrooms and include special plumbing and electric fittings that only require to be connected to the main services on site. With domestic buildings a fully assembled house can arrive on site on the back of 1 or 2 trailers. This method or construction is not widespread and due to transport requirements difficulties can arise in transporting the building to site and in accessing the site itself.

Reverse wall construction

This form of timber frame construction is similar to standard timber frame construction. Typically the external structural sheathing (typically OSB or plywood) on the external side of the timber framing is replaced by a wood fibre board with low vapour resistance characteristics which is used mainly for insulation purposes and for support to the breather membrane (although there are some boards that can be used structurally providing they have appropriate certification).

The structural sheathing is usually placed on the inside face of the framing although this can result in difficulties in fixing the wall panels to the sub-structure or soleplate. Often the sheathing stops 300mm or so from the bottom rail to allow fixing into the sub-structure and the final strip of board is site fixed afterwards. Where this is done then there should be bridging pieces between the studs to pick up the edges of the sheathing.

The advantage of placing the relatively high vapour resistant structural board on the inside is that the board contributes to the protection against interstitial condensation provided by the vapour control layer. If the external boards are low density then they might affect the effectiveness of wall ties, holding down straps, cavity barriers and fire stops.

To ensure air tightness it is recommended that the breather membrane always be supported and backed by a board rather than just the thermal insulation.

Breathing walls

Breathing walls rely on a balance of materials with different vapour resistance characteristics with the higher vapour resistance materials being placed on the inside face of the timber frame. The construction usually has no vapour control layer (at least one that has a high vapour resistance) and relies on the construction allowing the water vapour to pass through the structure. There is a rule of thumb often quoted which refers to the internal materials having 5 times the vapour resistance of the layers on the external face of the timber frame. However, it is always advisable to have a robust vapour condensation risk analysis carried out where there is no VCL with a high vapour resistance being used.

This form of construction is not widely used and there is a debate about its suitability and therefore it should be used with care.

The performance of these walls is probably helped if mechanical extraction systems are used.

Single skin systems

Following the widespread failures of single skin systems in Canada and New Zealand there were a number of reports on their use. These systems are not considered suitable for timber frame in Ireland and the UK.

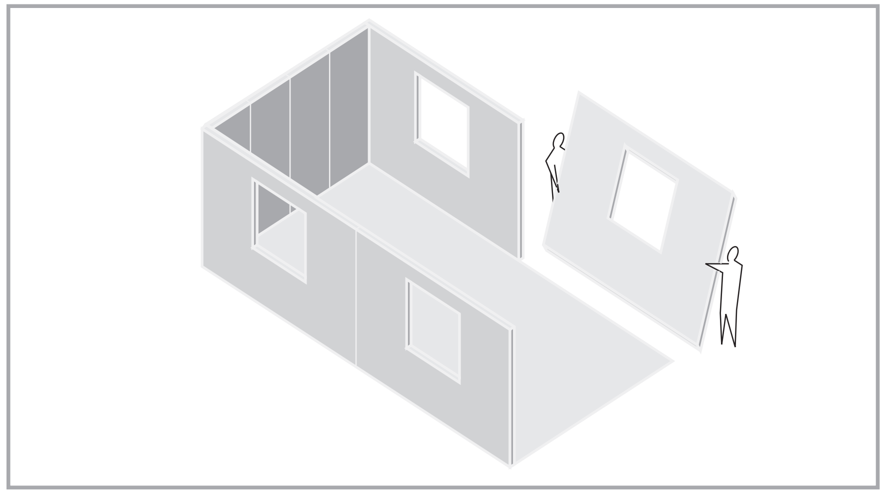


Fig. A 7.1.1 Platform method of construction

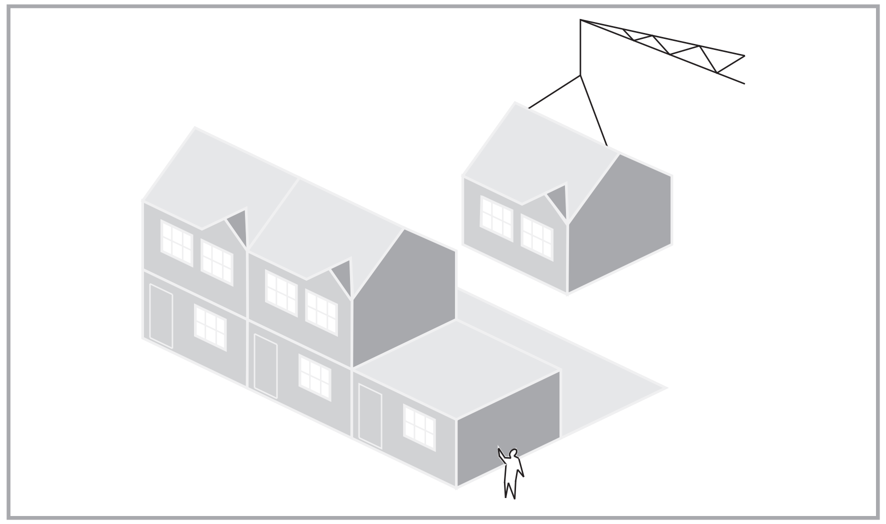


Fig. A 7.1.2 Volumetric method of construction

7.2 POST AND BEAM CONSTRUCTION

The post and beam system consists of a modular framework of heavy section beams and posts which provide the main structure. The system is a three-dimensional load-bearing construction where the floor and roof decks transfer the loads to the beams which in turn transfer them to posts and on to the foundation. There is a clear division between the load-carrying elements and the facade elements. Post and beam elements are larger and spaced farther apart than the studs, joists and rafters of conventional timber frame. Design is governed by many factors including architectural form, layout, wind loads, fire requirements and connections.

Some of the following connections may be suitable to connect the main beam to the column:

- Dowels or bolts
- Toothed plate connections
- Ring and shear plate connections
- Steel brackets
- Joist hangers
- Proprietary fasteners

The selection of the appropriate connection depends on structural considerations.

Foundations

- Pier or continuous
- Connections between foundation and super structure should be designed to remain dry
- End grain of posts should be treated with preservative

Timber Sizes

Some factors influencing material sizes include:

- Span, spacing and loading
- bracing requirements
- connection details

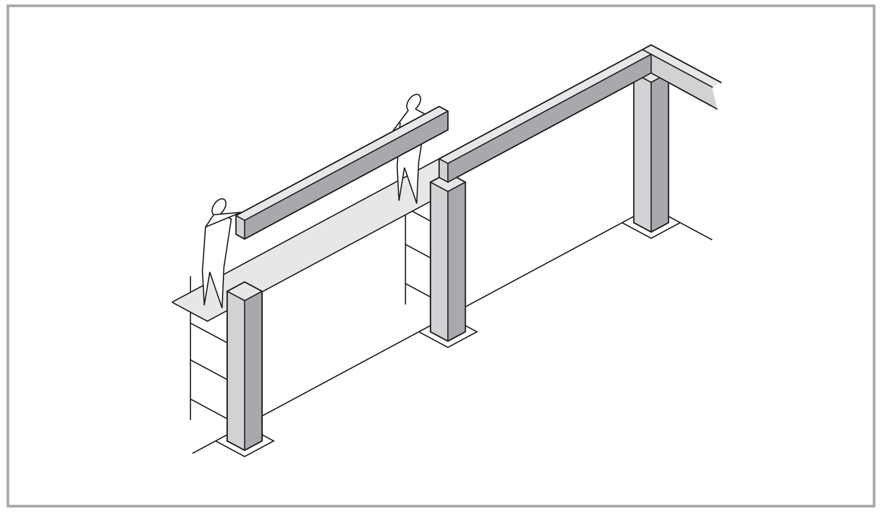


Fig. A 7.2.1 Post and beam

Post and beam can impose restrictions on the location of services which may necessitate advance planning

Decking and roofing

- Exposed planking or standard joist construction
- The finished deck should distribute loads laterally between adjacent planks
- Various proprietary plank and laminated decking systems are available
- Wood-based panels are also used

Partitions

- generally non load-bearing

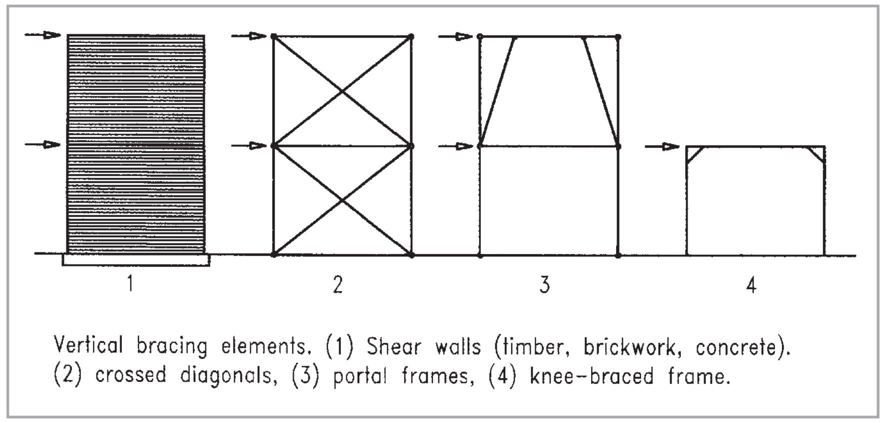


Fig. A 7.2.2 Portal frames – these usually have straight vertical and horizontal members.

7.3 STRESSED SKIN PANELS

General

Stressed skin panels consist of solid timber webs (longitudinal framing members) covered on one or both sides typically with plywood or OSB sheets. The plywood/OSB sheets are glued and nailed to the timber webs so that the assembly acts as a single structural unit. Web spacing and the thickness of the sheathing are dependent on the span and loading and spans typically range from 2.4 to 9.6m. In effect, the panels act like a series of I-joists with the sheathing taking most of the bending stresses.

Panels are generally fabricated in multiples 1200mm wide corresponding to the width of commercially available panel products. However, narrower panels are used when required to make up the difference between the panel width module and the overall length of the building. It is advisable to consider the width of the panels at design stage.

Economic solutions are possible provided the following are taken into account:

- Panel width conforms to commercially available widths (1200 or 1220mm).
- Rectangular plans are generally the most economical for stressed skin panel roofs.
- Stressed skin panels are factory fabricated and delivered as components to site.

Aspects of design, execution and handling not to be ignored are:

- Face grain of plywood/OSB should run parallel to longitudinal web members
- Plywood to web member joints are designed to transmit horizontal shear
- Web members run the full length of the panel, the use of finger joints where permitted should be kept to a minimum.
- Panels over 6m in length may require crane handling

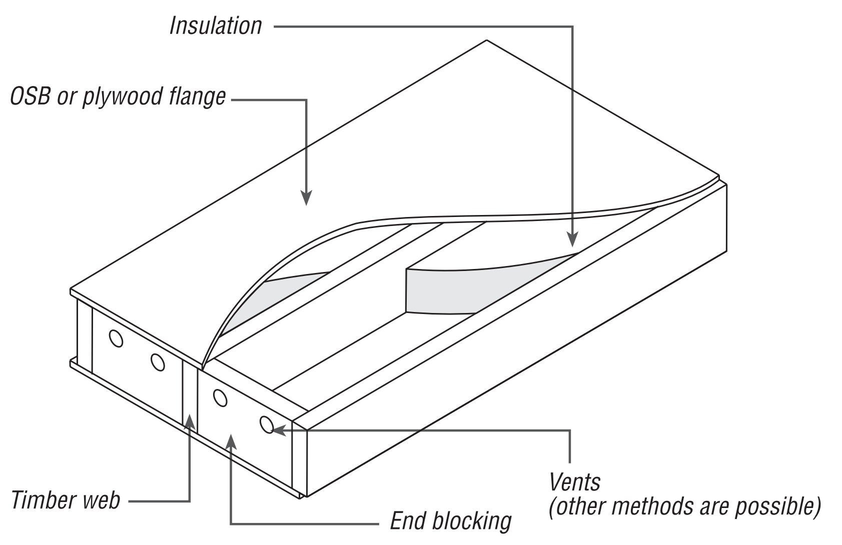


Fig. A 7.3 Typical stressed skin panel

Keywords

Blocking: short lengths of timber placed between web members for alignment and stiffness

Flange: Plywood sheets ranging from 9.5 to 18.5mm thick.

Web: longitudinal solid timber members.

Applications

- Floor panels
- Flat roof panels
- Pitched roof panels
- Wall panels

Typical Dimensions

Panels are normally 1220mm or 1200mm wide with 3 or 4 intermediate web members.

Spans range from 2.4 to 9.6m. For longer spans the plywood flanges are scarf jointed or spliced, while the web members may be extended by use of punched metal plates.

Advantages

- Prefabricated units enable speedy construction.
- Long spans are possible.
- Pitched roof panels can enable a clear roof space with no internal members required.
- Reduced labour costs on site.

Construction

- Webs are typically kiln dried softwood, strength class C16 of Irish origin or imported.
- Flanges are typically plywood or OSB

Where panels are utilised for pitched roof construction a steep roof pitch enables the roof to be erected free from internal members and this allows the occupants to utilise the roof space to their advantage. Intermediate timber blocking stiffeners can be incorporated in the panel during fabrication. Often the horizontal thrust from the panels is transferred into floor panels by specially designed hardwood bearers and fixings.

Where thermal performance is a design criterion, insulation can be incorporated between the timber web members. When used as roofing, it is normal to incorporate a ventilation space above the insulation layer and to incorporate a vapour check to avoid the possibility of interstitial condensation occurring; the ventilation space should be at least 50mm.

Where the roof is a cold deck roof; care should be taken with the overall construction (e.g. BS 5250 recommends that cold deck roofs should be avoided where possible). There is a increased risk of interstitial condensation (which tends to take place under the decking or the weathering membrane) and good through ventilation between the decking and insulation needed is needed as well as a good vapour control layer, properly sealed. Mechanical ventilation can also remove a lot of moisture from the building thereby reducing condensation risk; it is recommended that a condensation risk analysis be carried out for cold roofs.

Roof panel construction

- Dual pitch roof structures - span panels from eaves to ridge and the floor construction restrains the outward thrust at the eaves.
- Floor joists should span in the same direction as the roof panels.
- Monopitch roof structures - provision must be made to restrain the horizontal thrust at bearing points.
- Usable attic space can be provided with spans greater than 5m and pitch angles of 35 to 50 degrees.
- Roof panels can be used with both timber frame and masonry type construction.
- Sometimes used to incorporate a balcony feature into the gable wall.
- Design considerations include structural stability, fire resistance, thermal performance, ventilation and protection against condensation.
- Roof windows or dormer windows can be fitted within the panels to suit design requirements.
- The structural design of roof panels generally does not make allowances for supporting water tanks and these should be supported independently.
- Hips and valleys can be designed where required.
- All blocking should be vented and be the same size as the web members.

Floor panel construction

- For panels with tension flanges, intermittent blocking can be installed at the discretion of the specifier.
- The installation of end blocking between web members is generally recommended.

Load/span tables

Manufacturers produce load span tables to aid the designer in the selection of the most suitable panel. Tables give the allowable load carrying capacity for various panel configurations and common arrangements are outlined in the manufacturer's documentation.

7.4 TRUSSED RAFTERS

Most truss fabricators use punched metal plates, engineering software and design backup provided by a System Owner; the principal System Owners in Ireland are Alpine, Gangnail, Mitek, and Wolf.

Trussed rafters should be manufactured to EN 14250 under a recognised third party scheme. (In Ireland) NSAI operate a scheme to this standard and have a National Register of Approved Roof Truss Manufacturers.

Roof trusses should be designed to Eurocode 5 (and any requirements in the National Annex) while additional advice is given in Swift 5 (to be published). In the U.K. designs can be undertaken to BS 5268 Part 3 (for permissible stress design) or Eurocode 5 taking into account the U.K. National Annex and additional advice is given in PD 6693. Most truss fabricators have engineering software and backup from System Owners and the design can be carried out to Eurocode 5 (for Ireland and Britain) using Non-Contradictory Complimentary Information (NCCI i.e. Swift 5 or PD 6693).

Three dimensional roof stability

To convert a two dimensional trussed rafter design into a three dimensional frame requires a secondary structural system such as a diaphragm or diagonal bracing to transfer and resist horizontal forces.

Truss fabricators usually design the trusses and specify the bracing required by the truss design and any minimum bracing required by the design standards or NCCI (Swift 5 and in the U.K. PD 6693). Most truss fabricators will offer a roof design service (i.e. the overall roof design) while the building designer would be responsible for any bracing needed to stabilise walls.

Rafter stability

There are four common approaches to transmitting the rafter lateral restraint forces to the supporting walls.

- Diaphragm action by timber boarding or sheet material (sarking) to the top plane of the rafters.
- Specific diagonal bracing as designated by the designer and/or in Swift 5. In the UK as per BS 5268 Part 3 and/or as designated by the designer, PD 6693 should be consulted for designs to Eurocode 5.
- The use of timber tiling battens as bracing
- The use of hipped roofs

Attic trusses

Attic roof trusses will have fire resistance requirements and therefore the thickness of the timber should be considered in relation to the fixing of internal fire linings, Designs to Eurocode 5 require a minimum timber thickness of 35mm but this is generally considered inadequate for the fixing of plasterboard; therefore the advice of the truss fabricator (or the System Owner) should be sought as should the advice of the lining manufacturer.

The junction of the ceiling and wall lining should be sealed for air-tightness. The junction of the wall lining and the floor should be sealed for air-tightness; it is recommended that timber noggings be placed between trusses to give support to the bottom of the wall lining at floor level.

Where roofs are designed for future access, the trusses and roof should be designed and framed out for the future conversion so that cutting of trusses is at a minimum and will not compromise the structure.

Gable wall stability

Masonry walls and timber frame walls are required to be adequately restrained in the plane of the rafters and at floor level.

Lateral support to perimeter walls

The ceiling diaphragm provides essential lateral support to perimeter walls. In most domestic scale construction, the plasterboard ceiling provides adequate and proven restraint. In non-domestic applications, an appropriate diaphragm may have to be designed and incorporated into the structure. Where there is a suspended ceiling, diagonal bracing or in-plane boarding or sheeting is required to transfer roof forces back to the shear wall (party wall or wall at right angles to external wall), together with a specific wind girder designed to ensure stability to the perimeter supporting walls.

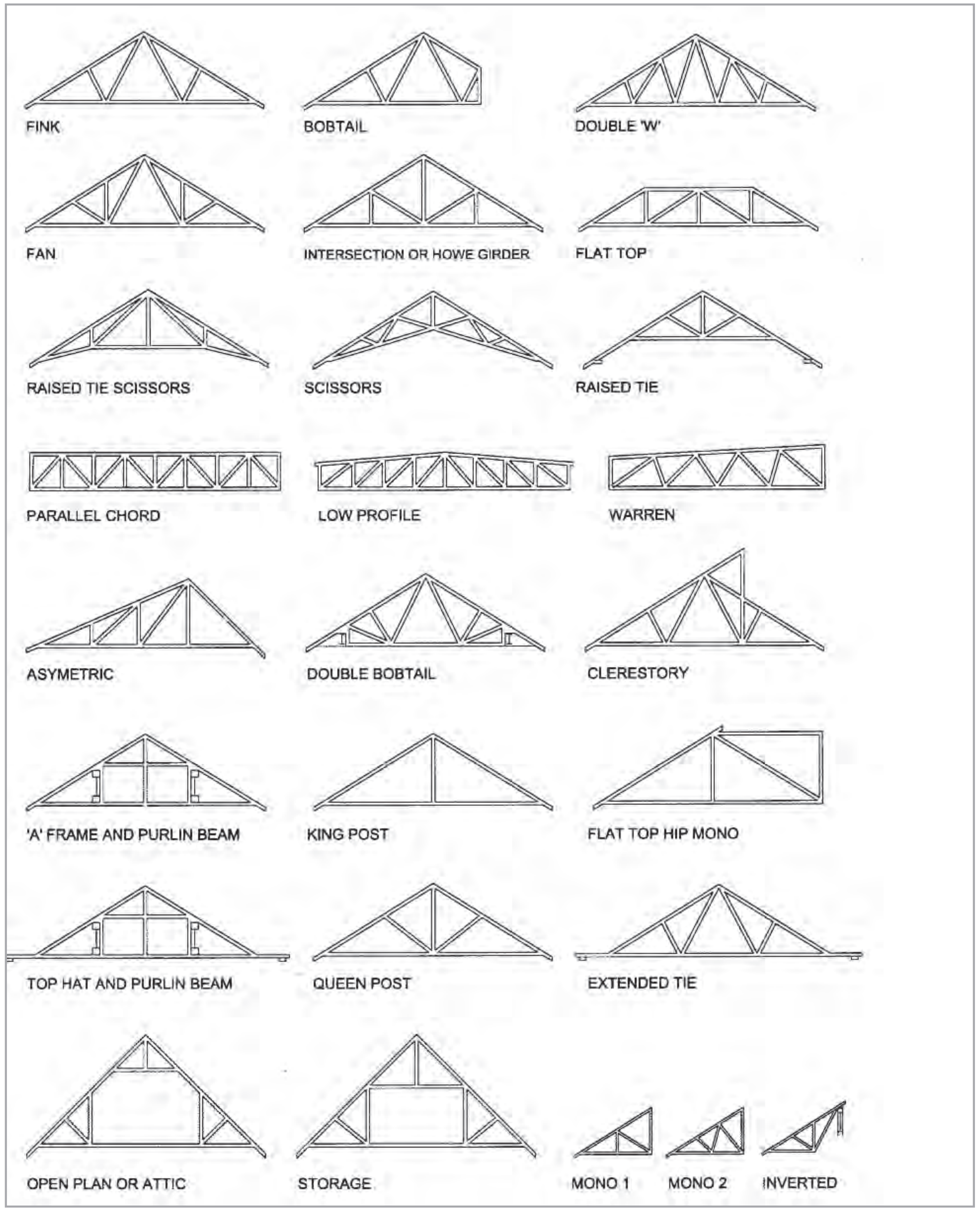


Fig. A 7.4.1 Selection of trussed rafter configurations

A8 Engineered wood products (EWPs)

EWPs can be categorised as:
- Composite (reconstituted fibres, flakes, components using a combination of materials, etc.);
- Laminate (strength graded timber or veneers glued together);
- Panel product* (board materials composed of fibres, chips, veneers or flakes);
- Components or systems (combinations of above)

**Note: Panel products are generally not considered EWPs themselves but are used as components in the production of some EWP systems such as I-joists*

8.1 GENERAL

• EWPs are generally produced from a combination of wood in its various forms, with adhesive (or other type of connection);

• They are typically used for structural applications;

• They are generally stronger, stiffer and more dimensionally stable (uniform MC) than solid timber;

• They are available in a wide variety of lengths and cross sections;

• It is important to check the availability of any EWP and to check the product has been approved for use by an appropriate body such as the Agrément Board

• Can now be manufactured out of American temperate hardwoods – white oak, red oak, ash and tulipwood.

Table A 8.1 outlines the various applications of EWP's:

Table A 8.1 *Summary of engineered wood products.*

Product	Category	Applications
LVL	Laminate	- Beams, columns, vehicle decking, door & window frames, flanges of I-joists. - Industrial, commercial, recreational & institutional.
Parallel strand board (eg Parallam)	Composite	- Beams, columns, truss members, window & door headers, portal frames, post & beam systems. - Industrial, commercial, recreational, institutional & residential.
Glulam	Laminate	- Beams, columns, trusses, bridges, portal frames, post & beam systems, extensions, conservatories. - Industrial, commercial, recreational, institutional & residential.
I-Joists	System	- Floor & roof joists, formwork, ceiling ties, load- bearing stud wall units, available as complete systems.
Box Beams	System	- Residential & commercial. - Beams (one offs) - Residential & industrial buildings.

8.2 GLULAM

Glulam typically consists of a minimum of four timber laminates bonded together. Glulam with no theoretical limits on section size, length or shape is ideally suited for use in structural systems, especially medium to large span roof structures. It is commonly used as roof beams, portal frames, arches, floor beams, shell structures and domes.

Structural use and function

Simple continuous span beams, curved beams, hinged portals and arches are glulam systems which are very applicable to buildings such as churches, schools, hotels, conference halls and leisure complexes. Simple continuous beams can be obtained off the shelf and can span up to 20m depending on their size.

Materials

Glulam laminated timber components are fabricated from carefully selected softwoods of a strength class (or species and grade) specified by the Design Engineer. The timber specified must be in accordance with Eurocode 5 (or where appropriate BS 5268: Part 2) and visually strength graded in accordance with IS127 (or for the U.K. BS 4978) or machine graded to EN 14081-4. Hardwoods may be considered for special strength or appearance requirements and should be strength graded in accordance with BS 5756 and assigned a strength class from EN 1912.

Adhesives

The adhesive used in the manufacture must be fully weatherproof for example phenol resorcinol formaldehyde in accordance with EN 301 Type 1. The adhesive is required to have strength sufficient to provide a joint at least as strong as the timber and be creep free. Where temperatures can exceed 37°C e.g. in insulated roof conditions, urea formaldehyde is not suitable.

Durability - preservative treatments

In external locations where the moisture content exceeds 20%, the timber must be either resistant to decay or preservative treatment is required. As most glulam members are made from softwood timbers with a low durability, consideration should be given to the need for treatment with a suitable timber preservative. For designs based on Eurocode 5 reference should be made to I.S. EN 335 (Parts 1, 2 and 3), I.S. EN 350-2, I.S. EN 351-1 and I.S. EN 460, to determine the requirement for preservation treatment. For designs to BS 5268 reference should be made to BS 8417 which provides good advice on timber preservation some of which would be applicable to designs to Eurocode 5.

If copper based preservative is used, corrosion of metals may be accelerated; therefore the correct choice of metal is imperative. Failure of certain types of stainless steel in the environment of swimming pools under such circumstances has been experienced and due caution is advised.
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8.3 I-JOISTS

General

I-joists consist of flanges made from solid wood, parallel strand lumber or LVL and a web made from OSB, plywood or hardboard. The flanges and web are bonded together to form an ' I ' cross-section shape. I-joists are economical, strong, light and versatile building elements. The geometry makes efficient use of the wood being used by concentrating the timber in the outermost portion of the cross-section where the bending stresses are at their highest. The flanges essentially resist the applied bending moments and the webs the applied shear forces.

I-joists are available as proprietary systems and manufacturers produce supporting literature covering design and their use. This includes information such as load span tables, permitted web hole requirements, hanger details, stiffener requirements, site advice, fixings etc. The manufacturers' literature should be consulted.

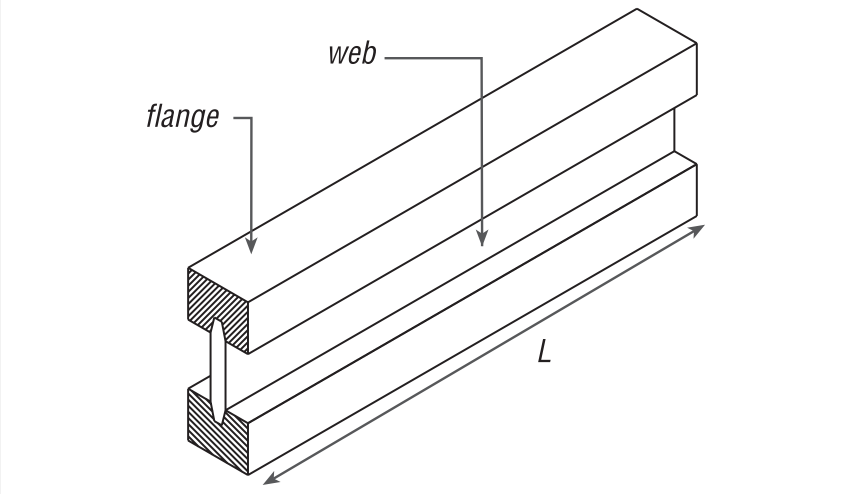


Fig. A 8.3.1 Typical I-joist

Applications
- Floor & roof joists
- Available as complete systems
- Rafter & ceiling ties
- Formwork beams
- Load-bearing stud wall units

Applications
I-joists can be used as structural framing in floors and roofs (flat and pitched). They can also be utilised in wall construction in place of solid timber studding.

Storage
Joists should be stored clear of the ground and stacked vertically (in the plane of the web). Joists should not be stored flat and must be protected from adverse weather. The stiffness of joists about their minor axis is significantly less than that about the major axis and care must be taken to ensure that joists are not damaged during handling and erection.

Installation and fixing
The manufacturer's installation guides should be consulted for specific details. Some general notes are included here:
- I-joists are lightweight and can easily be handled.
- Flanges should not be cut, notched or drilled. Refer to manufacturer's literature for specific requirements.
- Joists are unstable until braced laterally during construction. The structural performance of the joist relies on adequate lateral restraint. To achieve this, restraints should be provided at specified centres depending on joist size and the load being carried. Restraints can be in the form of solid timber blocking, I-joist off cuts or strutting.
- All sheathing must be fully nailed as specified to each joist before any additional loads can be placed on the system
- Reinforcement may be required in cantilever situations. See the manufacturer's details.
- Nailing and other fixings can cause splitting and damage and care should be taken in their use.

Design Tips
- Span joists in one direction
- Run joists over the shorter span
- Maintain a constant depth and centres
- Select deeper joists for longer spans
- Cantilver joists at stair locations to minimise framing

Deflection
Designers should always include shear deflection calculations. This is always included in manufacturers' load span tables and software but it may not be included in third party software.

Note that deflection requirements differ considerably for Eurocode 5 and BS 5268.

Web holes
In standard timber I-joists, openings can be cut in the webs for the passage of utilities such as electrical wiring, SVPs, heating ducts and plumbing and these are often perforated and ready to be knocked out. Manufacturers usually provide clear definite guidelines for the shape, size and position of these holes; they are generally located in areas where shear loads are low

Web Stiffeners
- Glued or nailed to the web.
- Used to increase the bearing capacity and also to reinforce the web against buckling.

Web stiffeners
Stiffeners are generally required at the bearing support. At this location shear forces are high and usually much higher than the flange to web joint shear capacity alone. Stiffeners are usually wood blocks positioned vertically on both sides of the web. If stiffeners are cut too long and are forced to fit, the prying action could damage the flange to web bond; therefore stiffeners should be cut accurately. Stiffeners are usually connected to the web with nails but for some higher capacity I-joists gluing may also be required. Stiffeners also reinforce the joist against buckling and are usually required along the span on deeper joists. At concentrated load points stiffeners also may be required. The manufacturers' documentation should be consulted for further information.

Joist hangers
Many hangers developed for sawn solid timber sections are not suitable for I-joists and proprietary hangers should be used. Generally they use larger nails spaced in a pattern that would split the flanges and web stiffeners. The manufacturers' literature should be consulted for nailing recommendations. Usually hangers provide lateral restraint to the compression flange of the joist and help to resist torsion at the joist ends.

Timber frame walls

I.S. 440 places limits on the use of I-joists as header joists within external, party and compartment walls; refer to that standard for more information. In addition most I-joist manufacturers provide special components (e.g. header joists and LVL beams) to match in with their I-joists

8.4 BOX BEAMS

General
Box beams typically consist of solid timber, parallel stand lumber or LVL flanges with plywood or OSB webs. The webs are glued to the flanges on each side to form a box shape and are very similar to the I joists discussed above. Machine driven nails can be used to aid fabrication but should generally not be used on their own. All joints should be glued over the full contact area.

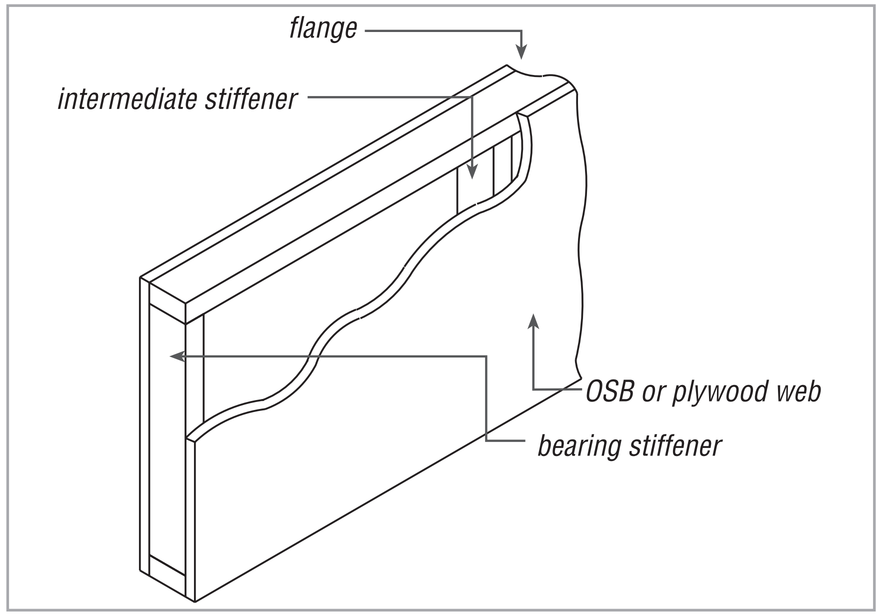


Fig. A 8.4.1 Typical Box Beam

Applications
- Beams
- Portal frame construction
- Rafters & columns
- Load bearing stud walls
- Formwork supports

Application
Box beams are manufactured in depths up to 1.2m although the most popular depths are in the order of 600-800mm. Web stiffeners can help control shear buckling of the web and provide convenient locations for web butt joints. Additionally, it is good practice to have stiffeners located at positions of point loads to counter localised web buckling. In box beams, the web joint locations are best alternated from side to side and away from the areas of highest shear.

The selection of flange material is governed by price, maximum lengths and size availability; parallel stand lumber or LVL flanges can be used to provide longer lengths than solid sawn timber. Finger-joints should be located away from points of high tension and shear.

Typical Dimensions
- Can be fabricated upto 1.2m in depth but 600-800mm are the most common section depths.
- Spans of 30-40m are possible with portal frame construction.

Webs
Structural plywood and OSB are the most common panel products used. Plywood has a high shear resistance which makes it suitable for large spans and high load carrying capacity box beams. The most common size is 2400 x 1200 mm (although the old imperial sizes of 2240 x 1220mm may still be available) with the face grain running in the longer direction (i.e. parallel to the beam span).

Flange to web joints
Webs are usually glued to the flange using phenol resorcinol formaldehyde (PRF) which is the most common glue for structural use of timber. Machine driven nails can aid construction but should not generally be used on their own. All joints should be glued over their full contact area. Stiffeners should be spaced at centres as shown in the design and always at supports and concentrated load points.

Design considerations

Box beams are generally not mass-produced and are designed for one-off situations. Design properties are determined by the material properties of the flange and web materials.

Generally the three most important criteria in size selection are the flange stresses, material costs and the calculated deflection. A summary of the main design considerations are shown below.

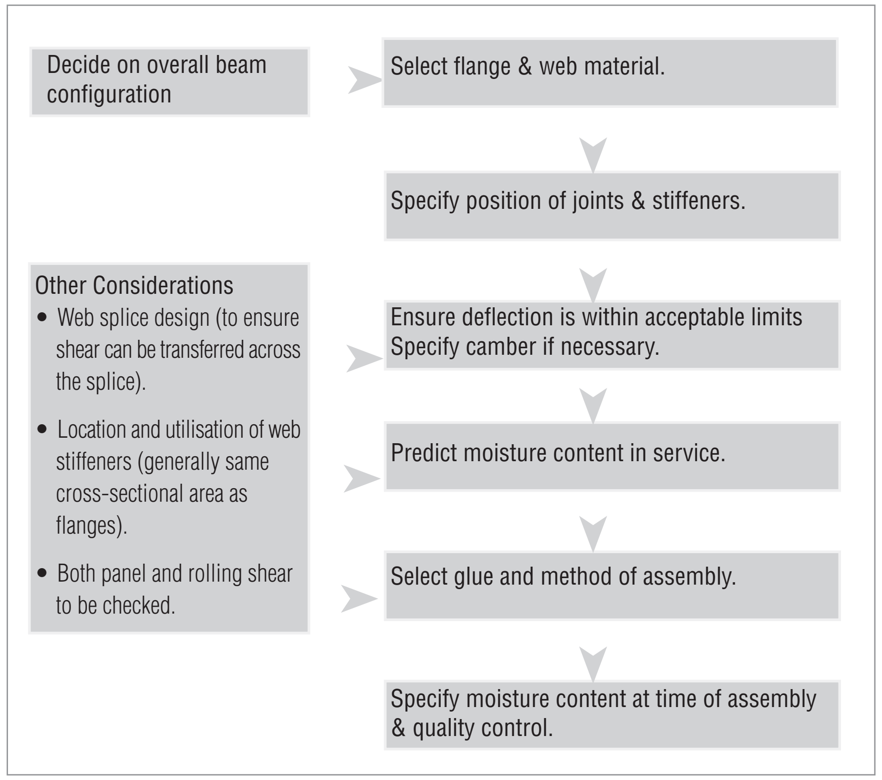


Fig. A 8.4.2 Design considerations

8.5 LAMINATED VENEER LUMBER (LVL)

General

Dried veneers (typically 3mm thick) are laminated together to form panel boards from which structural sections of the desired dimensions are cut. The density of LVL is typically 10% higher than the density of the timber species used in its manufacture. For example, the density of Douglas fir LVL is in the region of 610kg/m^3 as against 530kg/m^3 for solid timber. Various properties for structural design, i.e. design bending stresses, compression stresses, modulus of elasticity, etc. are supplied by the LVL manufacturer.

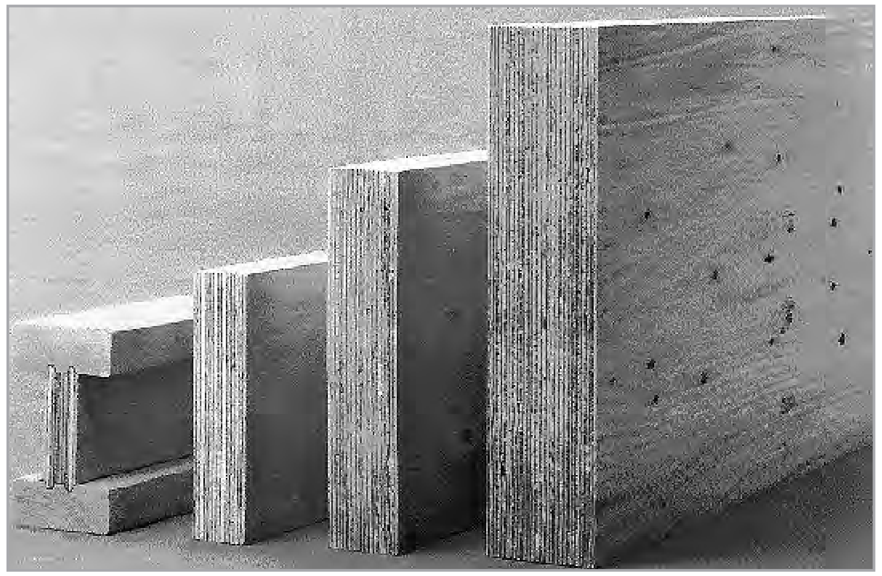


Fig. A 8.5.1 LVL products

Applications
1. Beams & columns
2. Flanges of I-joists
3. Scaffold boards
4. Vehicle decking
5. Door & window frames

Common Species
- Norway spruce
- Radiata pine
- Douglas fir
- Yellow poplar
- Lodgepole pine
- Southern yellow pine

Common Sizes

Overall panel size produced:
24m long by 1.2 -1.8m deep and from 19 - 89mm thick. (Panel is then cut to the required product size).

Stock dimensions range from:
38 - 900mm deep by 19 - 89mm thick (lengths over 12m to order). Consult the manufacturer for more details

For beam applications, common sizes are as follows:
44mm thick by 140, 184, 241, 302, 356, 406 and 476mm deep.

Moisture content and storage

LVL is manufactured at a moisture content of approximately 8% and consequently warping or splitting are less likely to occur. Cupping can occur on wide thin sections of LVL when one face gets wet and the other remains dry. LVL will generally take up moisture from the atmosphere at a slower rate than sawn timber.

Installation and fixing

LVL is easily cut and fixed using conventional woodworking tools. Normal joints made with nails, screws, bolts or timber connectors should be structurally designed, the manufacturers' literature should be consulted for details of timber connectors.

An ETA should be checked that it is applicable to the end use. There should be accompanying information showing compliance with the Irish or UK Building Regulations.

Adhesives

Phenolic resins classified in accordance with EN 301 should be used in the manufacture of LVL. In general scarf joints are used on all veneers except for core veneers where butt joints are allowed.

Mechanical Properties
Refer to the manufacturer's Agrément certificate or similar documentation.

Code approval and design

LVL can be used for construction provided the manufacturer has appropriate third party certification. In Ireland manufacturers must have an approved accreditation in accordance with Technical Guidance Document D to the Irish Building Regulations (or the equivalent document in the U.K.). Reference should be made to the manufacturer's technical literature for specific design guidelines and values.

All LVL should comply with EN 14279:2004+A1:2009 'Laminated veneer lumber (LVL). Definitions, classification and specifications'

Note that British Board Agrément certificates are often accepted for use in Ireland (unless an Irish Agrément Board is available), but a European Technical Approval (ETA) would also be acceptable but would need additional documentation to show compliance with the Irish Building Regulations (in the UK this documentation would be to the UK Building Regulations).

Durability and treatment
LVL is satisfactory for use in conditions where moisture content does not exceed 16% for any significant period or 20% at any time. The use of LVL is generally restricted to areas where preservative treatment is not required. Consult the manufacturer's literature if in doubt. Treatments are available that can improve resistance to insect and fungal attack.

Behaviour in fire
LVL behaves similarly to solid wood with charring rates related to the density of timber used in its manufacture. LVL has a Class 3 surface spread of flame classification. Treatments are available that can improve the surface spread of flame to Class 1 or Class 0.

Connections
Dowel type fasteners are commonly used with LVL. Bolt and nail performance is similar to that of sawn timber. It is advisable to seek manufacturers' advice with respect to approved connector types and performance.

8.6 PARALLEL STRAND LUMBER

Applications
1. Beams & columns
2. Truss members
3. Window & door headers
4. Portal frames
5. Post & beam systems

Common species
- Douglas fir
- Southern yellow pine
- Western hemlock

Common sizes
Lengths up to 20m ±3mm
Depths 200 to 406mm ±1mm
Thicknesses 45 to 178mm ±1mm
Columns available:
89 x 89, 89 x 133, 89 x 178, 133 x 133, 133x 178 and 178 x 178mm.
(to the required product size)
Consult the supplier for more details.

General
Parallel Strand Lumber (e.g. Parallam) is an engineered wood composite product consisting of long thin strands of veneer laminated together to form a structural member. The density of Parallel Strand Lumber is typically 15% higher than the timber species from which it is made. Various properties for structural design are supplied by the manufacturer.

Moisture content and storage
Parallel Strand Lumber is manufactured at approximately 10% moisture content and is a very stable product. Parallel Strand Lumber will take up moisture at a slower rate than solid sawn timber but still must be protected from the weather.
Parallel Strand Lumber can be expected to swell approximately 12% perpendicular to the face of the strands and 5% parallel to the strands after prolonged exposure.

Parallel Strand Lumber should be stored above ground on level bearings and should be protected from the weather. Other construction materials should not be stacked on PSL beams or columns.

Installation and fixing
Connections designed for specific applications vary based on design loads and local building codes. Typical connections used in the US are joist hangers, framing anchors, column caps, dowels and tie straps. Manufacturers' literature should be consulted for standard connection details. The same fasteners and strength capacities that are commonly used for solid sawn are used for this material.

Weathering
Discolouration may occur due to long exposure to sunlight or repeated wetting and drying. Parallel Strand Lumber should not delaminate but prolonged exposure to weather must be avoided. Such exposure will cause roughening of the surface.

Adhesives
The adhesive used in the manufacture of Parallel Strand Lumber is usually phenol formaldehyde mixed with wax, which enhances the stability of the finished product. The formaldehyde is almost all consumed chemically in the curing process and emissions are generally not a problem.

Code approval and design
LVL can be used for construction provided the manufacturer has appropriate third party certification. In Ireland manufacturers must have an approved accreditation in accordance with Technical Guidance Document D to the Irish Building Regulations (or the equivalent document in the U.K.). Reference should be made to the manufacturer's technical literature for specific design guidelines and values.

Note that British Board Agrément certificates are often accepted for use in Ireland (unless an Irish Agrément Board is available), but a European Technical Approval (ETA) would also be acceptable with appropriate accompanying information.

Durability and treatment
Untreated Parallel Strand Lumber is satisfactory for use in conditions where moisture content does not exceed 16% for any significant period nor 20% at any time. The use of Parallel Strand Lumber is generally restricted to areas where preservative treatment is not required. Consult the manufacturers' literature if in doubt. Treatments are available that can improve resistance to insect and fungal attack.

Behaviour in fire
Parallel Strand Lumber is a combustible material rated as Class 3 surface spread of flame. It can be upgraded to Class 1 or 0 by specialist treatment.

An ETA should be checked that it is applicable to the end use. There should be accompanying information showing compliance with the Irish or UK Building Regulations.

A9 Wood-based panel products

The following is a range of wood-based products readily available in Ireland and the UK:

- Chipboard
- Hardboard including doorskins
- Laminboard and blockboard
- Medium density fibreboard (MDF)
- Oriented strand board (OSB)
- Plywood
- Softboard

The above list falls into three main groups, namely laminated boards, particle boards and fibreboards. Laminated boards include plywood, blockboard and laminboards. Blockboard although a light-weight material is now rarely used for furniture applications due to show-through of the core blocks on the surface when there are changes of moisture content.

Plywood comes in various types such as interior plywood, exterior grade plywood, and marine plywood. Plywood is made from veneers cut from a wide range of timbers. Veneer thickness and orientation can be varied to achieve particular strength and appearance characteristics. It is important for specifiers to be aware that there are significant quality control variations in plywood manufacture depending on its place of origin. Plywood is the strongest wood-based board available at present.

Particle boards such as chipboard and OSB have many uses. Chipboard of various types is available for veneered furniture. Oriented strand board is a three or five layer wafer board. Rectangular wood flakes in the two surface layers are aligned parallel to the long axis of the board while the core layer flakes are aligned across the board. The result is high bending strength and stiffness in the longitudinal direction. OSB can do many of the tasks required of plywood, such as sheathing for timber-frame buildings.

Low value wood chips and sawdust are processed to manufacture a range of panel board products such as MDF, OSB and chip board. MDF for example is reprocessed to manufacture flooring, skirting boards, furniture, shop fronts and panelling such as the reception area of the European Bank for Restoration and Development

Hardboard, softboard and MDF are fibreboards with a homogeneous construction of wood fibres. Hardboard and softboard do not use additional binders but derive their strength from the “felting” together of the wood fibres allied to the adhesive action of the natural lignin in the wood due to heat and pressure in the manufacturing process. MDF achieves its additional strength through the use of a synthetic resin binder applied to the wood fibres. MDF has mechanical and physical characteristics approaching the levels associated with solid wood. Its density, low moisture content and smooth surface finish make it an ideal base material for various surface finishes including quality veneers. In addition, the range of possible end uses of MDF has been extended through the development of flame retardant grades suitable for use in public buildings with onerous Fire Certificate requirements.

EN 13986 Wood based panels for use in construction – Characteristics, evaluation of conformity and marking.

This standard defines wood-based panels for construction and specifies their relevant characteristics and test methods. A particular board may be intended for a specific use and not all the properties and tests may be appropriate and the manufacturer may therefore only need to state a limited number of performance characteristics. There are 5 general sub-divisions of application in the standard:

- Structural
- Non-structural
- Structural floor decking
- Structural roof decking
- Structural wall sheathing

These are further divided into 3 categories depending in the conditions of use:

- Internal
- Humid
- External

Internal conditions refer to dry conditions typically inside a building such as floor joists (this equates to Eurocode 5 and BS 5268-2 Service Class 1 although floor joists are usually designed for Service Class 2). Humid conditions approximate to Service Class 2 and include members such as roof rafters and members of external timber frame walls. Internal and Humid both describe boards for internal use. External conditions approximate to Service Class 3 and relate to timber used externally and exposed to the weather.

The standard includes 6 main divisions of wood based panels solid wood, plywood (including LVL), OSB, particleboards (chipboards), resin or cement bonded boards and fibreboards (wet and dry process). The main board properties to be determined are listed by application (structural, non-structural etc.) and by conditions of use (Internal, Humid and External).

While the main board properties to be determined are obvious (e.g. bending strength, stiffness and bond quality) there are also some newer properties or probably truer to say properties that have new categories. The most important of these is reaction to fire and involves linings being assigned a Euroclass as defined in EN 13501-1. Boards can be tested to determine their classification or their classification can be taken from Table 8 of EN 13986 provided the boards conform to the requirements of that table.

The requirement for surfaces or linings are given in Technical Guidance Document B (Fire Safety) and in the equivalent UK Approved Document, the old classification system (referred to as National Classes) related to tests to BS 476 Parts 6 and 7. There were 5 classes, 0, 1, 2, 3 and 4 with 0 being the highest classification and was defined in the TGD B/Approved Document, the others being defined in BS 476-7. Timber generally was considered to be Class 3 but could be treated with a flame retardant up to Class 0. The Euroclass system will replace the National Class system and should be used for designs to Eurocode 5.

The Euroclass system has 7 classifications for linings; A1, A2, B, C, D, E and F with A1 being the highest. The additional sub-texts refer to the production of smoke (s1, s2 or s3) and to flaming droplets or particles (d0, d1 or d2). However in relation to specifying the performance of surfaces and linings TGD B/Approved Document refers only to 3 classifications:

Class D-s3,d2 taken as equivalent to National Class 3
Class C-s3,d2 taken as equivalent to National Class 1
Class B-s3,d2 taken as equivalent to National Class 0

The requirement s3 and d2 mean that there is no requirement regarding the production of smoke or flaming droplets and particles.

EN 13986 also gives technical classes for different wood-based panels. For example for plywood the technical classes refer to EN 636 and are EN 636-1 for dry use, EN 636-2 for humid use and EN 636-3 for exterior use. For OSB they are OSB/1, OSB/2, OSB/3 and OSB/4 and the standard referred to is EN 300. For construction EN 636-2 and OSB/3 are the most common references for plywood and OSB.

EN 13986 deals with evaluation of conformity and marking, but there are additional requirements if panels are to be CE marked. Marking refers to the product information (as set out in EN 13986) rather than actual marks on the panels. Additional marking requirements are given in the individual product standards e.g. EN 636 etc. Accompanying documents could contain information not marked on the boards, including performance and strength properties.

9.1 PARTICLEBOARD

General

Chipboard or particleboard is normally formed as a flat panel comprised of wood particles which are dried, coated with resin and bonded together under heat and pressure. Extruded boards, often of flax shives, are widely used for the cores of flush doors.

Particleboard Standards
EN 312
Particleboard Specifications.
EN 633
Cement-bonded Particleboards.
EN 14755
Extruded particleboards. Specifications.

Applications

Chipboard is used in a wide range of interior applications for flooring, interior fittings, furniture and packaging. It is readily available overlaid with natural wood veneer, melamine or foil finishes in a wide range of colours and with a low formaldehyde 'E1' rating.

Sheet sizes

Chipboard is typically available in 2440x1220mm sheets, with other sizes to special order. For flooring, it is available with tongue and groove edges.

Storage

Boards should be stacked flat, off the ground, and on a level surface in a dry storage with all edges flush. Special care should be taken with tongued and grooved and overlaid boards to protect the surface and edges. A sacrificial top board should be used to prevent warping of the upper boards.

Machining

Boards can be cut with normal woodworking saws but tungsten carbide (TCT) blades are recommended.

9.2 HARDBOARD

Hardboard is a fibreboard which is produced by a 'Wet' process whereby wood fibres in a slurry of water are laid down on a wire mesh which allows the water to drain away and the fibres to felt together. The boards are then bound under heat and pressure using the natural lignin in the wood. This produces the characteristic mesh imprint on one side, the top side being smooth. Hardboard is typically produced in thicknesses of 2.5-4mm and in a sheet size of 2440x1220mm. 'Oil-tempered' board with improved moisture resistance is available. Standard hardboard should meet the requirements of Type HB of EN 622 and oil tempered Type HB HLA. Hardboard has no added formaldehyde.

As manufactured hardboard can have a low moisture content and like all wood based sheet materials is hygroscopic. In its use as panelling or for overlaying flooring it should be conditioned before use. This is typically done by laying the boards flat and scrubbing water into the mesh side until it is visibly wetted (the boards have degree of water repellence and mere wetting by spray is insufficient). The boards are then stacked back to back for at least 24 hours before fixing. This procedure ensures that the boards will subsequently shrink and remain flat in service.

Hardwood door skins are made by a slightly different process in moulded patterns to simulate panelling and are supplied pre-primed to specialist door manufacturers.

9.3 PLYWOOD

Plywood composition
It is a characteristic of plywood that successive veneer layers are at right angles to one another. For most plywood panels, the number of plywood layers is odd (3, 5 etc). For decorative plywood, face veneers tend to be of a higher quality and value than internal veneers. Decorative veneers tend to be cut from hardwoods (oak, birch, beech etc). Utility plywood tends to be made from softwoods (southern yellow pine, Douglas fir, spruce etc)

General

Plywood is a flat panel made up of veneer sheets, bonded under pressure by a bonding agent. In traditional plywood manufacture the veneers are clipped into standard sizes, dried, graded and stacked. Strips of veneer may be jointed into full size sheets by edge gluing, stitching or scarfing. Glue is applied and veneers are laid up at 90° to each other. Veneers are hot pressed, cured, trimmed and sanded. Plywood veneers like other wood-based materials, are hygroscopic, and therefore the moisture content of plywood depends on the climatic conditions of the surrounding air.

Plywood standards
EN 636 Plywood. Specifications.

Three grades listed:
Type 1 Interior
Type 2 Moisture resistant
Type 3 Exterior

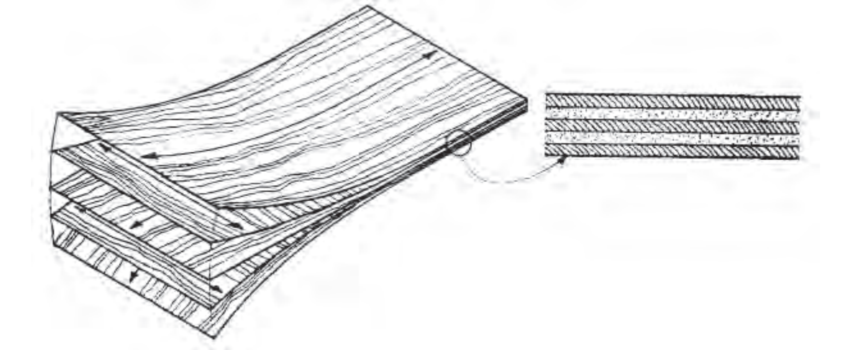


Fig. A 9.1 Plywood is made by bonding veneers together usually with the grain at right angles to each other and symmetrical about the centre ply.

Table A 9.3.1 *Approximate equilibrium moisture contents*

Surrounding air with temperature at 20°C & RH of:	30%	65%	85%
Equilibrium MC of plywood	5%	10%	15%
Equilibrium MC of softwood	6%	12%	17%

Moisture content (MC)
The influence of MC changes is greater in plywood made from denser woods. In general, the movement of plywood depends on the number and thickness of layers, species of wood or woods and MC. Irregular shrinkage or swelling may cause plywood to warp.

Applications

Plywood is utilised in similar applications to OSB. It can be used as the web material for structural I-joists or in stressed skin wall and roof panels as the structural sheathing material. Plywood is also suitable for diaphragms or as gussets in spaced columns and trusses. The advantages of plywood are excellent strength properties, a wide range of available grades, wide acceptance and an attractive grain.

Structural plywood should comply with EN 13986 and EN 636, characteristic design values should be taken from EN 12369-2 or from an ETA, Agrément Board Certificate or similar. For designs to Eurocode 5, EN 12368-2 gives characteristic values based on a F and E classification system, the F referring to the characteristic bending strength and E the mean bending modulus; the F and E values (e.g. F40/E50) should be declared by the manufacturer. EN 636 has characteristic values for the F/E strength class system, these are to enable a plywood to be assigned to a F/E class based on test results; the values in EN 636 must not be used for structural design.

Structural plywood (BS 5268 Part 2) should be subject to the quality control procedures of one of the following:
• American Plywood Association (APA)
• British Standards Institution (BSI)
• Council of Forest Industries (COFI)
• Technical Research Centre of Finland (VTT)
• The National Swedish Testing Institute (Statens Provningsanstalt)
• Timberco Inc. (TECO)
• Or have appropriate certification

Technical data

Recommendations
BS 5268 Part 2 gives recommendations for the use of sanded and unsanded plywood manufactured in accordance with specified standards.

Sheet sizes
Typically available in 2440x1220mm and 2400x1200mm sheets and in standard or tongued and grooved format. Special sizes are available for the timber-frame industry.

Thicknesses range from 3 to 31.5mm in sanded or unsanded finish.

Strength properties
Grade stresses and moduli for structural plywoods are outlined in BS 5268 Part 2. These apply to long-term loading in service class 1 and 2. For other durations of load and/or service class 3 conditions the stresses should be multiplied by the appropriate modification factors outlined in the Standard.

Plywood thickness
Plywood is available from 3-30mm thick. Standard thicknesses are 6, 9, 12, 15, 18mm.

The bending stresses and moduli given in BS 5268 Part 2 apply to the appropriate (transverse or longitudinal) axis of the plane of the board.

Typical sheet sizes: 2440x1220mm
2400x1220mm
2440x590mm
2400x590mm

Durability
Durability of plywood is affected by:
• species used for the veneers
• individual ply thickness
• the adhesive used

Plywood used for permanent structures in damp or wet conditions, unless made from inherently durable species, should be adequately treated against decay with a preservative treatment. If plywood is pretreated with water based products then the plywood glueline should be suitable for humid/wet use as defined in EN 636.

Specifying plywood
When specifying for plywood for structural use, reference should be made to the:
1. Type
2. Grade
3. Nominal thickness
4. Number of plies
5. Finish (sanded/unsanded)

Plywood exposed to the weather and having long term service life expectations should have no open defects (e.g. knots, holes, splits) on the exposed face(s).

The risks of biological attack of plywood given in EN 335-3 is in relation to hazard classes 1, 2 and 3. The use of plywood in hazard class 4 (in contact with ground or fresh water) and in contact with sea water is noted as being appropriate only if the inherent and/or conferred properties of the boards are adequate.

Table A 9.3.2 *Formaldehyde release classes for plywood*

CLASS	CONTENT	RELEASE
E1	≤ 8MG/100g O.D. board	≤ 3.5mg/m^2/h
E2	> 8 to 30mg/100mg O.D board	>3.5 to ≤ 8mg.m^2/h

Classification
EN 313 Plywood - Classification and terminology Part 1: Classification

Health and safety

Formaldehyde Release refers to the perforator value in EN120 or the Steady state emission value in ENV 717-1. Two formaldehyde release classes are defined, E1& E2, E1 having the lower emission.

Classification

Plywoods can be grouped by:
• general appearance
• construction i.e. veneer plywood and wood core boards – blockboards and laminboards
• their form and shape - flat or moulded
• their principal characteristics
• their durability - for use in exterior, humid or dry conditions
• mechanical properties
• surface appearance
• surface condition - unsanded, sanded, prefinished or overlaid
• user requirements

Surface appearence
EN 635-1 (General rules) divides plywood into 5 classes, based on appearance. EN635-2 Hardwood and EN 635-3 Softwood define the allowable characteristics for any one grade.

Surface appearance
Classification by surface appearance is covered in the four parts of the EN 635 series, Plywood - Classification by surface appearance. These surface appearance classes are not intended to be used for strength classification.

Conditions of use
The conditions are defined according to the parameters laid down for hazard classes in EN 335-1 *Classification of hazard classes:*

Dry conditions: for interior applications with no risk of wetting, defined in Hazard Class 1,with a moisture content corresponding to environmental conditions of 20°C and 65% relative humidity.

Humid conditions: for use in protected exterior applications as defined in Hazard Class 2, with a moisture content corresponding to environmental conditions of 20°C and 85% relative humidity.

Exterior conditions: for use in unprotected external applications, as defined in hazard class 3, where the moisture content will frequently be above 20%.

Structural bending properties
EN 1072: *Plywood - Description of bending properties for structural plywood* defines the bending properties needed for structural plywood.
• characteristic bending moment per unit width
• characteristic bending strength
• characteristic bending stiffness per unit width
• characteristic bending modulus of elasticity

Characteristic values are required for structural design of plywood using the limit state method.

These properties are derived from tests on medium sized pieces tested in accordance with EN 789: Timber structures - Test methods. Determination of mechanical properties of wood-based panels and EN 1058: Wood-based panels - Determination of characteristic values of mechanical properties and density.

Marking
Boards should be marked with the :
• name, logo or code of the manufacturer
• standard number
• type of panel (Trademark)
• nominal thickness
• formaldehyde release class
• quality label and the certification body, if any.

9.4 ORIENTED STRAND BOARD (OSB)

General
OSB to EN 300 is an engineered wood based panel product composed of wood strands (flakes) arranged in layers at right angles to one another and bonded together with a waterproof adhesive. OSB exhibits strength and dimensional properties similar to many plywoods.

OSB like other wood based panels is hygroscopic and its dimensions change in response to changes in humidity. Boards as manufactured (OSB 2) have a low moisture content and may need to be conditioned prior to installation. This enables the moisture content of the board to be brought into equilibrium with its environment. The time required to achieve equilibrium will vary depending on the temperature and relative humidity in the building. OSB 3 grade is a pre-conditioned panel with a moisture content closer to the in-service equilibrium moisture content.

Applications
OSB is used for applications such as wall sheathing, structural flooring, heavy-duty industrial flooring, roof sarking and roof decking when supported at centres of not more than 600mm. Other applications include furniture, packaging, hoarding, signboards, pallet tops, shop fitting and displays. The range typically includes 6mm board for floor wearing surface, 9mm for wall sheathing, 18mm for floor and roof decking and 25mm for industrial applications.

For designs to Eurocode 5, characteristic design values for OSB should be taken from EN 12369-1 (for service class 1) or from the manufacturers published data. Where the manufacturer's published data is less than the value in EN 12369-1 then the lower values should be used in design. Where the board is used for permissible stress design then the design should comply with BS 5268-2. Designs generally should also comply with the recommendations in the manufacturer's Agrément Certificate, European Technical Assessment (ETA) or similar certification.

Classification of Boards
EN 300 classifies boards by their properties, which relate to intended use. Boards are classified into four board types:
OSB/1 General purpose boards, and boards for interior fitments (including furniture) for use in dry conditions.
OSB/2 Load-bearing boards for use in dry conditions.
OSB/3 Load-bearing boards for use in humid conditions.
OSB/4 Heavy duty load-bearing boards for use in humid conditions.

The following table assists the specifier with the selection of the correct type of OSB for typical end uses:

Table A 9.4.1 *Selecting OSB panels*

APPLICATION	CONDITION	OSB TYPE
Pitched roofs		
Sarking		OSB 3
Flat roof decking		
Uninsulated, unheated buildings	Variable humidity	OSB 3
Insulated, heated buildings	Warm deck, low humidity	OSB 3
	Warm deck, high humidity (intermittent)	OSB 3[1]
	Cold deck (ventilated), low humidity	OSB 3
Cladding		OSB 2[1], OSB 3[1]
Soffits		OSB 3[1]
Sheathing	Dry use	OSB 3
	Risk of wetting	OSB 3[1]
Flooring		
Domestic flooring		
OSB3 only should be used for underlayment with hardwood flooring products	Dry use	OSB 2, OSB 3
	Risk of wetting	OSB 3
Non domestic flooring		
Floating	Dry use	OSB 2, OSB 3
	Risk of wetting	OSB 3
Raised	Dry use	OSB 3
	Risk of wetting	OSB 3
Light duty suspended	Dry use	OSB 3
	Risk of wetting	OSB 3
Formwork	One-off usage here	OSB 3 (sanded panels may be needed for above ground formwork)

[1] Implies no protection against decay; if such protection is required, preservation may be necessary.

For formwork, boards are often given a film face to ease release

Conditioning
Wood-based panel products expand on taking up moisture from the air and shrink on losing moisture. It is important that panels are installed at a moisture content close to that which they will attain in service. The likely moisture contents of OSB in various conditions are as follows:

Building with continuous heating 5-7%
Building with intermittent heating 8-10%
Unheated building up to 16%

These values are lower than for solid timber under the same conditions.

Installation and fixing

Floors and roof decking
Boards must be laid with the major axis crossing the joists. The T&G or square edged boards must be fixed to all supports using ring shank nails or screws (minimum penetration to the support of 50mm at maximum 150mm centres on all joists). The cross-joints on the boards must be staggered and the joints between the boards must be glued. Bridging and nogging supports should be used where required. A minimum 10mm expansion gap should be provided around the floor perimeter, larger floors may need a wider gap and intermediate gaps of 2mm per metre to allow for expansion.

Wall sheathing
Where OSB is used in cold frame construction, the vapour check is located on the cold side of the internal leaf of the cavity wall. 0SB 3 boards should be treated as conventional plywood boards with regard to detailing at eaves and soleplate. A 3mm gap between boards is recommended to allow for expansion.

Technical data

Sheet sizes
Smartply manufactures boards in 'laid measure' sizes of 2440x1220mm, 2400x1200mm, 2440x590mm or 2400x590mm. Other cut sizes are available on request. Panels are manufactured in thicknesses of 6, 8, 9, 11, 15, 18 and 25mm. Panels 15mm and 18mm are manufactured either square-edged or tongued and grooved. All T&G panels are fully sanded.

Strength properties
The design properties for Smartply OSB2 and 3 are outlined in the tables below. (Note: these values are for use in limit state design only). It is the responsibility of the specifier to consult the manufacturer's literature to check the design values are still current. Other manufacturers also produce their own tables.

Table A 9.4.2 *Characteristic bending, tension and compression values*

Grade	Thickness	Bending		Tension and Compression			
	t mm	$f_{m,0}$ N/mm²	$f_{m,90}$ N/mm²	$f_{t,90}$ N/mm²	$f_{c,90}$ N/mm²	$f_{t,90}$ N/mm²	$f_{c,90}$ N/mm²
OSB/2 OSB/3	6 - 10	17.5	13	8	7	10	9
OSB/2 OSB/3	10 < t < 18	18.5	13	10	9	12	11
OSB/2 OSB/3	18 - 25	20	14	10	9	12	10

Table A 9.4.3 *Characteristic modulus of elasticity mean values*

Grade	Thickness	Bending		Tension and Compression	
	t	$E_{m,0}$	$E_{m,90}$	$E_{t,0}$ AND $E_{c,0}$	$E_{t,90}$ AND $E_{c,90}$
	mm	N/mm²	N/mm²	N/mm²	N/mm²
OSB/2 OSB/3	6 - 10	6000	3000	5000	3500
OSB/2 OSB/3	10 < t < 18	6000	3000	5000	3500
OSB/2 OSB/3	18 - 25	6000	3000	5000	3500

Table A 9.4.4 *Characteristic values of density and mean values of modulus of elasticity*

Grade	Thickness	Density	Panel Shear		Planar Shear	
	t	p	Strength	Modulus	Strength	Modulus
	mm	kg/m²	$E_{m,90}$ N/mm²	G_v N/mm²	f_p N/mm²	G_p N/mm²
OSB/2 and 3	9 - 22	550	7.9	1400	1.3	75

Note: Characteristic values of Modulus of Elasticity are found by multiplication of the mean values of Modulus of Elasticity by a factor of 0.80.

Flooring
Suitable for domestic use as defined in BS 6399 Part 1 *Design loadings for buildings* - which is the Code of Practice for dead and imposed loads for designed joist spacings not exceeding 600mm centres provided the fixings are in accordance with the manufacturer's instructions.

Consult the manufacturer for specific requirements for use as ground floors.

Wall sheathing
The board may be considered as a Category 1 material in accordance with Table 2 of BS 5268 Part 6, Section 6.1. The basic racking resistance for 9mm board when used with the datum conditions for fasteners of Category 1 sheathing is 1.68kN/m and can be used with the modification factors in BS 5268 Part 6, Section 6.1.

Modified half hour fire resistance flooring
T&G Louisiana-Pacific Class 3 OSB panels laid together on min 44mm timber joists and incorporating a 12.5mm plasterboard ceiling fixed with 40mm galvanised nails at 150mm centres with the joints taped and filled and backed by timber.

Roof decking
Suitable for use with an appropriate waterproofing specification, as a roof deck having a minimum finished fall in excess of 1:80 and where access to the roof is restricted for cleaning only.

Roof sarking
A suitable waterproof run-off membrane and batten system should be incorporated.

Behaviour in relation to moisture
The product is unsuitable for use in permanent wet or damp conditions. The product is suitable for installation in buildings where the moisture content does not exceed 16% for any length of time and does not exceed 20% at any time.

Thermal conductivity
The thermal conductivity of OSB is in the region of 0.13 W/(mK).

Edge stacking is not recommended.

Boards are manufactured to dimensional tolerances to allow close fits to be achieved on jointing. Conditioning allows boards to gradually attain the moisture content dictated by the atmosphere within the building.

Durability
When used in the conditions set out in the manufacturer's literature, the product will have adequate resistance to bacterial and fungal attack and physical degradation due to moisture. Under prolonged wet conditions, OSB may be prone to attack by fungi (e.g. wet rot). OSB can be preservative treated to increase resistance to attack by fungi.

Behaviour in relation to fire
In general boards have a European Class D – s3,d2 for their reaction to fire and a Class 3 surface spread of flame in accordance with BS 476: Part 7. It is possible to treat the boards to improve their performance and classification.

Storage
Panels should be stored on level bearers on a flat surface above the ground in a dry stable environment. Where external storage cannot be avoided, panels should be covered with polythene or tarpaulin, and the period of storage should be kept to a minimum.

Edges shall be protected from lashings or other bandings and all boards should be stored to avoid distortion. Details of board type and quantity should accompany each delivery.

A sacrificial protective board should be used as the top board on all stacks to prevent warping of the main top board. Intermediate bearers are recommended every 10 to 15 boards with the bearers placed directly below those above. Bands should be cut as soon as practicable after delivery.

Only when the boards are required for conditioning should any protective wrapping be removed. Boards should be conditioned to the equilibrium moisture content likely to be attained in service prior to fixing. Conditioning in air in an enclosed dry building is suitable for most board types.

Finishing
High quality finishes are achieved when boards are primed and coated with a spirit based coating. Care should be taken when using water based products as they may cause swelling. Varnishes and gloss paints can be used. Certain overlays can be applied to the surfaces of the boards to achieve special finishes.

Reference EN 120 and BS 5669 Part 1
The 'Extraction Method' is used to determine the amount of formaldehyde emission from a board and the results are expressed in mg/100g.

Health and safety
OSB can be machined using normal woodworking machinery but care should be taken to avoid inhalation of the dust particles. The formaldehyde content of the board is controlled by the manufacturer and should be below 8mg/100g (E1 grade).

Marking
All load-bearing board types shall be clearly marked by the manufacturer by indelible direct printing and typically include the following information:
• Manufacturer's name, trade mark or identification mark
• European Norm (e.g. EN)
• Type/grade of board
• Nominal thickness
• Major axis (if not the length of the panel)
• Formaldehyde class
• Batch number or production week and year

9.5 MEDIUM DENSITY FIBREBOARD (MDF)

General
Medium Density Fibreboard (MDF) is an engineered wood based panel product manufactured from wood fibres bonded together with a synthetic resin adhesive. It is usually smooth on both sides, pale sand in colour and with a density in the range 450 - 960 kg/m³. It has excellent machining characteristics and takes a variety of finishes readily due to its homogenous nature. MDF is produced in a range of thicknesses, from 3mm to 60mm. EN 622-5 applies.

Originally only one type of board was produced - standard MDF - there are now several different board types available, to meet varying needs.

Applications
MDF is classified as a dry process board having a density of more than 450 kg/m³ and is further sub-divided into various board types based on the purpose of the board and the environment in which it will be used.

The product range produced is extensive, and includes:*

Medite Ultralite: (Density 500 kg/m³). A low-density board produced for applications where weight is critical.

Standard MDF accepts a wide variety of finishes

Medite Plus: (Density 750 kg/m³). A specially engineered panel with an extra-smooth finish intended for fine machining and further finishing.

Flame retardant boards accept a wide range of flame retardant paint and coating systems, veneers, laminates and overlays.

Standard MDF (Medite Premier): (Density 620 kg/m³). Suitable for interior joinery including doors and staircases, cabinetry, built-in fitments, furniture, toy-making. Can be machined and profiled.

High density MDF is suitable for processes that require more exacting machining characteristics.

Flame-Retardant Board (Medite FR): (Density 720-750 kg/m³). Flame retardant MDF is available to Class 0 and Class 1 surface spread of flame rating. It is suitable for shop fittings and walls, partitions and ceilings in public buildings to comply with the Building Regulations. Consult the manufacturer for more detail and range of thicknesses available.

Provide expansion gaps (5mm per 2440mm) and seal all surfaces and exposed edges with an exterior grade coating system.

Exterior MDF (Medite Exterior): (Density 720-750 kg/m³). An exterior quality board is produced. Care in its external use should be exercised. These boards should be painted and special care taken to achieve the optimum result.

Moisture resistant boards are not suitable for external use.

Moisture Resistant MDF (Medite MR): (Density 720-750 kg/m³). For use in internal joinery applications and in high humidity environments such as bathrooms and kitchens in accordance with MDF.H as defined in EN 622 Part 5.

Flooring quality MDF is suitable as a substrate for a wide variety of overlay materials such as wood veneers, high pressure laminates and melamine impregnated paper overlays.

Flooring Grade MDF (Medite FQ): (Density 850 kg/m³). A substrate produced specifically for laminated flooring applications in domestic and commercial applications.

Zero formaldehyde MDF is now a requirement for many applications.

Zero Formaldehyde MDF (Medite Ecologique): (Density 740 kg/m³). Conventional resin systems, which are formaldehyde based, are not used in production and, as a result, no formaldehyde is added. It is particularly suitable for use in environmentally sensitive areas such as hospitals, laboratories, nurseries and museums.

With the development of continuous pressing technology MDF with thicknesses as low as 3.0mm are now produced.

Technical data

Density
Typically, standard MDF has an average density within the range of 600-800kg/m³. High Density Fibreboard (HDF) weighs up to 960kg/m³. Light MDF has a density of < 600kg/m³ and ultra light MDF has a density of < 550kg/m³. The weight of MDF is not constantly proportional to the thickness due to variation between brands.

Sheet sizes
Available sizes are commonly 1220, 1525 or 1830mm wide by lengths up to 3660mm. Thicknesses are available up to 60mm, although thicknesses between 3.0mm and 30mm are more common.

MDF is available cut to size from any of the four full mat sizes of 1220/1525mmX4880/5490mm. It can be supplied in narrow strips for the door and moulding industries as well as component panels for furniture manufacturers.

**Produced by Coillte MDF*

Table A 9.5.1 *Table of characteristic values for MDF*.*

PRODUCT	Thickness (mm) ±0.15mm	Density (kg/m³) ±4%	MC (%)	Internal bond (N/mm²) (Min.)	Bending strength (N/mm²) (Min.)	MOE (N/mm²) (Min.)	Screw (face) (N) (Min.)	Thickness Swelling (%) (Max.)
Standard MDF	15.0	750	5 - 9	0.70	32.0	3200	1000	10.0
Flame retardant	15.0	750	5 - 9	0.65	30.0	2700	900	10.0
High density	15.8	960	5 - 9	1.50	70.0	5000	1700	5.5
Exterior grade	15.0	740	5 - 9	1.20	37.0	3000	1000	7.0
Flooring grade	8.0	850	5 - 9	1.50	50.0	4500	–	10.0
Moisture resistant	15.0	750	5 - 9	0.90	40.0	3500	1000	6.0
Zero formaldehyde	15.0	740	5 - 9	0.90	35.0	3000	1000	8.0

**Check individual manufacturers*

Movement
MDF is hygroscopic and its dimensions will change in response to change in humidity. Typically, a 1% change in moisture content will increase the length and width by 0.4mm per metre. A 600mm wide door panel made from 15mm thickness MDF will swell by about 1.5mm in width and 0.3mm in thickness in moving from 35 to 85% relative humidity (equivalent to about 5% increase in moisture content). Conditioning before use is recommended. Complete immersion in water must be avoided.

Decay and insect damage resistance
MDF will not normally be attacked by wood-boring insects found in Ireland. It is susceptible to fungal attack if exposed to prolonged wet conditions.

Water vapour resistivity
The vapour resistivity is between 100 and 280MNs/gm when tested in accordance with BS 7374.

Thermal conductivity
The thermal conductivity of MDF is approximately 0.12 W/mK.

Fire properties
Factors such as thickness and method of fixing affect the fire resistance of the board. Seek manufacturer's advice.

Fire properties
Standard grades achieve a Class 3 surface spread of flame rating. There are integrally treated boards on the market which achieve Class 1 or Class 0 rating.

Formaldehyde
MDF that complies with low formaldehyde emission rate Class E1 for total extractable formaldehyde using EN 120 test methods is available.

Cutting and machining
MDF is machine workable using ordinary joinery tools, and may be routed carved, bored and worked in the same way as solid timber. Carbide tipped tools are recommended. Saw blades used for particle-board are normally satisfactory.
Compared to saw blades for solid wood all types of MDF saw blades require higher clearance and increased tooth angles. Having clean edge and face machining characteristics, contour designs are almost unlimited. However, care must be taken in the selection of profiles, as the presence of sharp corners or narrow sections will alter the uniformity of paint coverage and reduce the resistance of profiles to impact damage. A large hook angle is required to ensure clean cutting, with a large clearance angle to prevent the back of the cutter from rubbing against machined edges. Mitre joints are not recommended, especially in external situations.

Installation and fixing
Most adhesives used in the woodworking industry can be used for jointing MDF. The selection of an individual adhesive will depend on the surface characteristics of the material to be bonded, the jointing technique, the strength required, and service conditions.

In general, parallel threaded screws are recommended in pre-drilled pilot holes not less than 25mm (face) or 70mm (edge) from the corners of the board. They should be spaced at 150mm apart to avoid splitting. Nails should only be used if no other jointing technique is applicable. The diameter of dowel holes should be a minimum of 0.2mm greater than the dowel itself to prevent cracking if swelling of the board occurs.

Installation and fixing
Consult manufacturer's literature for specific details. Suitable jointing techniques include:
- Adhesives
- Staples (to fix glue joints)
- Nails
- Dowels
- Screws
- Pins

Finishing
The choice of finish depends on the specific application and the appearance and durability requirements. In general MDF is suitable for painting. Sanding, sealing and priming the surface may be required and it is advisable to follow the manufacturer's advice to ensure satisfactory performance.

Finishing
- Suitable finishes include:
- Nitrocellulose systems
- Water based paint systems
- Acid-catalysed systems
- Polyester systems
- Isocyanate bonds

Health and safety
The dust generated by machining operations carried out on MDF (sawing, moulding, routing, sanding etc.) can be quite fine. Precautions must be taken when working with MDF, as with any wood product, to prevent inhalation of fine dust particles.

MDF Type	Use Classification*
MDF	General purpose - dry
MDF.H	General purpose - humid
MDF.LA	Load bearing - dry
MDF.HLS	Load bearing - humid

**Defined in EN 622: Part 5*

Specification
MDF should be specified in accordance with European standards. The specifications classify boards according to their intended end use.

Specification
The relevant standards include:
EN 622 Fibreboards Specifications: Part 1: General requirements
EN 622 Fibreboards Specifications: Part 5:Requirements for dry process boards

General purpose boards are classified as being suitable for use as furniture. Loadbearing boards are suitable for use where the panels contribute to provide mechanical resistance and stability to a structure.

Fibreboards in the European Standards are separated on the basis of their performance in differing environmental situations. Three environmental situations are defined; these relate to the three Service Class conditions defined in BS 5268 *Structural use of timber Part 2: Permissible stress design, materials and workmanship* and in Eurocode 5: Design of timber structures: common rules and rules for building.

DRY - Boards of this type are only suitable for use in Hazard Class 1 of EN 335-3
HUMID - Boards of this type are suitable for use in Hazard Classes 1 and 2 of EN 335-3 provided an appropriate coating system is used.
EXTERIOR - Boards of this type are suitable for use in Hazard Classes 1, 2 and 3 of EN 335-3 provided an appropriate coating system is used.

Dry: moisture content in the material corresponding to a temperature of 20°C and relative humidity of surrounding air only exceeding 65% for a few weeks each year. (Service Class 1).

Humid: moisture content in the material corresponding to a temperature of 20°C and a relative humidity of surrounding air exceeding 85% for only a few weeks each year. (Service Class 2).

Exterior: moisture content in the material higher than those in humid conditions. This implies exposure to weathering conditions or to water or water vapour in a damp but ventilated location. (Service Class 3).

The general requirements for fibreboards are given in EN 622-1 *Fibreboards - Specifications Part 1 General requirements.*

Marking
Product packs and panels (where possible) should be marked with indelible ink printing or adhesive labelling with the following information:

- manufacturer's name, trade mark or identification mark
- number of the relevant standard and symbol of the board type
- nominal thickness
- batch number or production week and year
- dimensional tolerance
- length
- width and thickness
- squareness
- edge straightness
- moisture content
- mean density within a panel
- formaldehyde class

A 10 Cladding

TImber as a cladding material
Timber is a very attractive and ecological building element as an architectural treatment to the exterior of a building. It has been used for thousands of years and is the most common external finish to Scandinavian, Canadian and American homes. With modern preservative treatment methods and improved detailing, timber cladding is experiencing increasing popularity in Ireland.

The primary function of any external cladding system is the protection of the building structure and fabric from weather, dampness and ultra-violet degradation.

Fire restrictions
The Technical Guidance Documents to the Building Regulations do not permit timber cladding when the wall is less than one metre from the relevant boundary and limits are placed on it depending on its height above ground level. When the boundary distance exceeds one metre, the cladding may be of wood, if it is at least 9mm thick and complies with the 'unprotected area' rule (Technical Guidance Document B to the Building Regulations, Part B4). However, good practice requires a minimum thickness of 18mm (depending on the timber species) for external cladding board for long life durability.

Moisture content
Due to environmental fluctuations, adequate accommodation for moisture movement must be provided to avoid stresses and eventual cracking. Cladding boards should be free to move independently of each other and where overlapping occurs, care should be taken to avoid nailing through underboards. End grain of cladding boards should be sealed to avoid end splitting and ingress of moisture. Specified moisture content should be 18% ± 2%.

Ventilation
All cladding systems should be fixed on battens which allow a continuous vertical cavity. This vertical cavity provides a route for the drainage of any superfluous moisture. It also provides ventilation to the back-face of the cladding, this allows effective and quick drying of both surfaces of timber cladding after heavy rain conditions. Where vertical cladding is used, counter battens will be required unless the profile of the cladding board and staggered horizontal battens are used to allow ventilation and the escape of any penetrating rain water. A breather membrane should always be provided behind the battens.

Ecological considerations
Timber is the classic ecologically friendly material. It is a renewable resource, is very low in embodied energy and it can be recycled.

Most timber today contains both heartwood and sapwood in its sawn state. Preservation is advisable especially for the moderately durable woods, and those of lesser durability (Class 3-5). Preservative treatment is essential if sapwood is present.

Fixings
Both oak and western red cedars are acidic and react with most metals, causing corrosion and dark staining in damp conditions. Austenitic stainless steel or silicon bronze ringshank nails should be used for all external cladding, although the latter are now difficult to obtain. Galvanised or aluminium nails are not suitable as they will stain cladding within a very short time.

Finishes
All wood species will weather naturally to a silvery-grey colour when exposed externally. The rate of weathering will depend on the level of exposure, and areas under overhangs will retain their original colour longer. In urban areas or locations close to traffic discolouration can occur and a surface finish is advisable. Pigmented microporous finishes have been found to perform well in the Irish climate and, if correctly applied, give a long service life. Oils or varnishes when used externally perform poorly and should be avoided.

Key Considerations
- Performance
- Function
- Fire restrictions
- Moisture content
- Detailing

Timber Cladding Systems
- Vertical "Board on Board"
- Horizontal "Shiplap"
- Vertical Tongued, Grooved & V-jointed
- Shingles/Shakes
- Log Effect

Design considerations
- Specific climatic conditions
- Exposure
- Orientation
- Species
- Preservative Treatments
- Finishes
- Jointing
- Maintenance
- Surface spread of flame

Pitfalls
- Moisture entrapment
- Surface cracking
- Peeling of coatings
- Staining
- Discolouring
- Decay
- Movement & Distortion

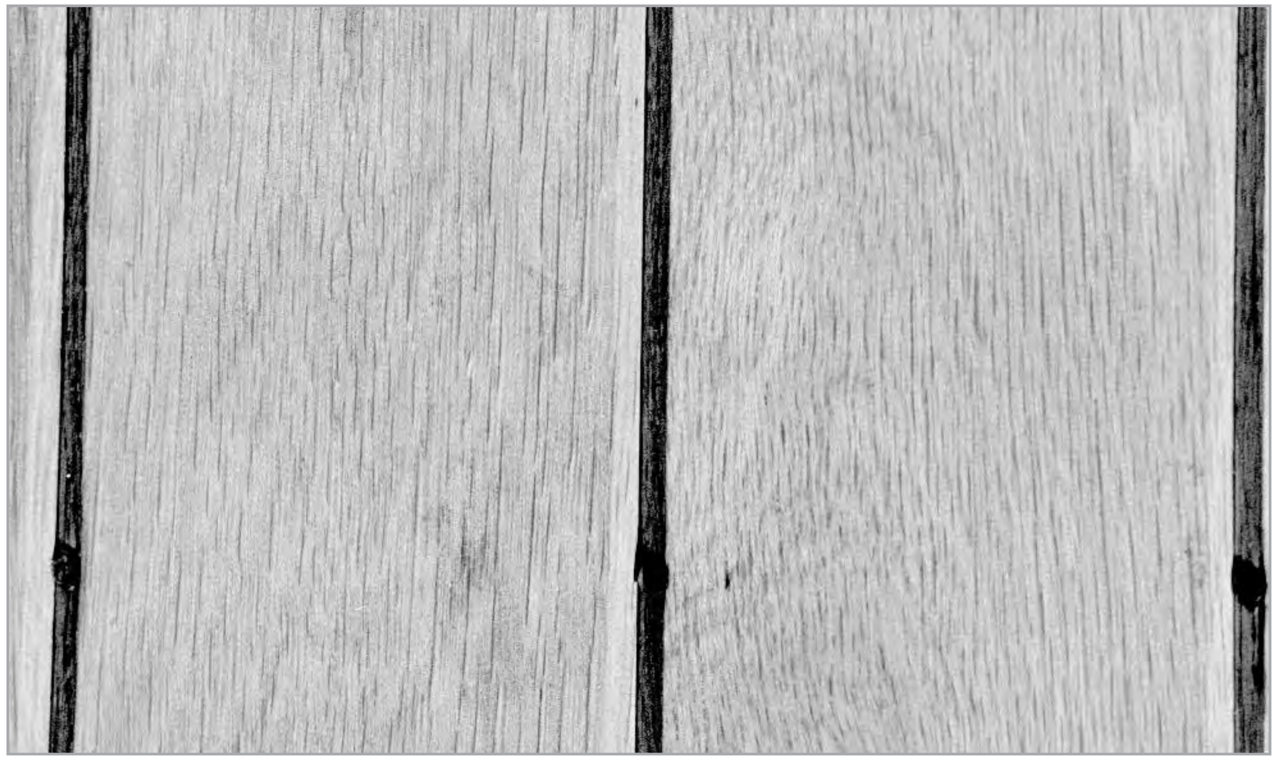
Reference
EN 942

Table A 10.1 *Suitable species for cladding*

Species	Natural Durability (heartwood)	Durability if preserved	Ease of preservation	Remarks
Douglas fir	3	4/5	3	Small movement, prominent grain, red-brown
Iroko	5	5	1	Small movement, no distinct grain, yellow dark-brown
Larch	3	4/5	3	Small movement, no distinct grain, pale dark-brown
European or American White oak	4/5	5	1	Medium movement, distinct grain, pale yellow yellow-mid brown
Pine, pitch	2/3	4/5	3	Medium movement, distinct grain, yellow-red brown
Pine, Scots	2	4/5	4/5	Medium movement, moderate grain, pale yellow-red brown
Spruce, Norway	2	4	3/4	Small movement, moderate grain, pale-pink brown
Teak	5	5	1	Small movement, no distinct grain, golden dark-brown
Western red cedar	4	5	2/3	Small movement, fine grain, red-brown

1	2	3	4	5
Poor . . . . Average . . . . Good				

Note: The preserved durability of all the timbers listed above can be well in excess of 50 years depending on location, detailing and the treatment schedule chosen.



Close up of cladding - note stainless steel ring-shank nail fixing in v-joint; one fixing per board per batten.

White oak cladding and joinery.

Types of timber flooring
- Softwood flooring
- Hardwood flooring (solids and composites)
  - Strip and plank flooring
  - Wood block
  - Parquet
- Wood based panel flooring and structural horizontal diaphragms
  - OSB
  - Chipboard
  - Plywood

Design Considerations
- Aesthetics
- Resistance to wear (impact, abrasion, indenting)
- Resistance to dimensional change (movement/moisture content)
- Slip resistance
- Sound insulation
- Thermal insulation
- Fire resistance
- Resistance to colour change
- Sub floor conditions

Maintenance
- Protecting
- Cleaning
- Re-sanding, finishing, staining and polishing
- Repairs to damage

Pitfalls
- Slippy conditions
- Shrinkage
- Gaps, creaking
- Grooves cut in joists to accomodate services should be avoided
- Inadequate subfloor ventilation
- Poor workmanship

References
- BS 8201
- BS 1187
- BS 4050
- BS 5268
- BS 1297
- BS 7916

A11 Flooring

Introduction
Timber can provide beautiful and hardwearing floors in narrow or wide boards, wood block, mosaic, parquet and in wood-based products. Hardwoods such as ash, hard maple and white oak will give a long service life if detailed and installed correctly. Special effects can be obtained through the use of borders, medallion inserts, and the use of herringbone patterns.

Types of flooring products
Utility softwood flooring is supplied as tongued and grooved boards. BS 1297 –Tongued and grooved softwood flooring – covers the use of such products. Other timber flooring and its installation is covered by BS 8201 – Code of practice for flooring of timber, timber products, and wood-based panel products. Specific types are covered by a series of European standards.

Decorative flooring is available as:-
1. Solid tongued and grooved strips and parquet boards, either pre-finished or unfinished. Strips are often supplied in random lengths. Widths range from 62 –200mm, but it should be noted that the narrow boards are generally more stable.
2. "Engineered" or "Semi-solid" boards. These are of cross-bonded or plywood construction with a top wear layer, usually 4mm thick, of the chosen species. Movement in the width of these boards is considerably less than with solid boards. The top layer is of sufficient thickness to allow them to be sanded several times. Top wear layers of 6-8 mm thick are available for a longer floor life.
3. Board or panel products, typically with veneer or laminate finishes.

Methods of laying
Traditionally, strip flooring was secret nailed to battens, while block parquet was laid in hot bitumen. Nowadays a number of other methods are more widely used.

1. Secret nailing
Boards are nailed through the tongue on to battens or boards fixed to the sub-floor, usually by machine, and this is the usual method for large areas. Sports floors can incorporate resilient pads and proprietary systems which meet the particular requirements of either BS 7044 or DIN 18032 for such floors are available to achieve the required resillience and rebound for specific sports.

2. Gluing
Boards can be bonded to solid sub-floors with mastic-type adhesives using a toothed trowel. A primer or liquid D.P.M. may be necessary.

3. Clips
Some proprietary systems use metal clips inserted into grooves on the underside of the boards. These clips are sized for various service conditions and the supplier should be consulted for detailed information.

4. Floating
Boards are glued along the tongue and groove joints and laid over a resilient layer, usually plastic foam. This method should only be used when the joints are specifically designed for gluing. As all movement has to take place at the perimeter of the floor it is confined to domestic scale applications. (Less than 4 m wide) and is mainly used for engineered or laminate boards.

As mentioned above, some movement will occur in service due to changes in the humidity of the atmosphere. Allowance for this is made by leaving a gap at the perimeter of areas, and in larger areas by providing intermediate or "washer" gaps (nailed or glued) floors. Perimeter gaps are usually covered by skirting boards. Cover strips, in matching wood, metals or plastic, are widely available to cover expansion gaps at doorways, where timber flooring butts on to tiling, or at radiator pipes. Compressible materials such as cork strip can also be used.

Fig. A 11.1 Wide board solid oak floor laid with a quick clip system.

Finishes
Most flooring is now supplied pre-finished with factory applied lacquer in gloss, semi-gloss or matt. Unfinished boards are sanded and sealed in-situ, usually with two-pack products. Oiled and waxed finishes are popular in Europe but are little used here. Regular light maintenance is required for these latter finishes.

Little maintenance is required for the lacquered products. The need for maintenance and periodic re-finishing is minimised by the provision of mat wells at entrances to trap grit from shoes – the greatest cause of wear. Felt pads should be fitted to the legs of furniture. Floors should be re-finished once wear is apparent and before dirt is ground into the wood so as to minimise re-sanding.

Moisture content and movement
To minimise "movement" or shrinkage and swelling in service, it is essential that timber flooring is laid at the correct moisture content for the service conditions (See table A11.1) and/or provision is made to allow such movement, for example by the provision of expansion gaps at the perimeter of floors. Failure to make such allowance can lead to distortion or the appearance of excessive gaps. For large areas such as sports floors, or where floors are laid with timber at low moisture contents as is the case with some imported products, it is normal practice to provide additional intermediate expansion gaps. When properly calculated for the anticipated service conditions these will close up after laying. Where large changes in moisture content in service are anticipated species with high movement, such as beech, should be avoided.

It is also essential that buildings are adequately dry before laying and that heating/air conditioning systems have been commissioned and are in operation. Concrete sub-floors are the most common cause of problems. The usual rule of thumb is to allow 1 day per millimetre of thickness (1 inch/month) for drying but if slab thicknesses exceed 100mm, or are power floated, this period can be extended considerably. The moisture content of such slabs should always be checked before laying. Particular care must be taken in measuring the moisture content of screeds incorporating under-floor heating over concrete slabs as the screed may be dried by the heating coils while residual moisture remains in the underlying slab. The hygrometer method given in BS 8201 is recommended in these cases.

Moisture movement, classified as % in width for a change from 60-90% RH (approx. 12-20% MC). In-service movement will normally be much less than this.

Large	Medium	Small
Beech	Ash	Teak
Birch	Cherry	Iroko
	Maple	Spruces
	Oak	
	Pines	
	Walnut	

Table A 11.1 *Average moisture content of floor boarding in service (BS 8201)*

Unheated building	15% to 19%
Intermittent heating with a substantial drop in temperature between periods of heating	10% to 14%
Continuous heating with the temperature maintained day and night throughout the year at a reasonably constant level	9% to 11%
Underfloor heating	6% to 8%

Species selection

There is a wide variety of timber species to select for various end uses. Softwoods are generally used in conjunction with a floor covering while hardwoods are used where a more hardwearing or decorative exposed surface is required. Table A11.2 lists the most widely available species, but many other species are available from specialist suppliers. It should be noted that the terms "hardwood" and "softwood" do not refer to the actual hardness of a given species and some hardwood species used for flooring, for example alder and cherry, are softer than pitch pine, a softwood.

Within a given species a wide range of effects can be obtained, with grades ranging from clear, straight-grained sapwood free boards of uniform colour (often referred to as Prime or 1st. grade) to Rustic grades incorporating knots, sapwood and distorted grain. It is best to view a sample of at least a square metre to assess the appearance when laid.

Table A 11.2 *Species selection*

	Species	Hardness & Wearability	Moisture Movement	Texture	Remarks
Softwoods	Douglas fir	3	Small	Medium	Reddish-brown with flame-like growth figure, when flat-sawn.
	Larch	3/4	Small	Fine	Pale to dark brown with distinct grain.
	Pine, pitch	4	Medium	Medium	Yellow to red-brown with noticeable grain.
	Pine, Scots	3	Medium	Fine	Pale yellow to red-brown with moderate grain.
	Spruce, Sitka	2	Small	Fine	Pale to pink-brown. Indents easily.
	Spruce, Norway	2/3	Small	Fine	Pale to yellowish. Indents easily.
Hardwoods	Ash, American/European	4	Medium	Coarse	White to light brown with noticeable grain.
	Beech, American/European	4	Large	Fine	White to pale brown. European more consistent in colour.
	Birch, American/European	4	Large	Fine	White to brown with moderate grain.
	*Cherry, American/European	3	Medium	Fine	Red to reddish brown, darkening on exposure to light.
	Iroko	5	Small	Medium	Yellow to dark brown with no distinct grain.
	Maple, hard	5	Medium	Fine	Cream to light red-brown with generally straight grain.
	Maple, soft	3	Medium	Fine	Grey-white to red-brown. Not as hardwearing as hard maple.
	Oak, red	4	Medium	Medium	Yellow to red-brown, not as hardwearing as white oak.
	Oak, white	4	Medium	Medium	Pale yellow to mid-brown. More figure than red oak.
	Sycamore	3	Medium	Fine	White to yellow-white often with interlocking grain.
	Teak	5	Small	Medium	Golden to dark brown with no distinct grain.
	Walnut, American/European	3	Medium	Coarse	Light to dark chocolate brown. Generally straight grained.

1	2	3	4	5
Poor		Average		Good

Note: Hard maple has excellent abrasion qualities. Great care should be taken with beech with under-floor heating or south facing rooms with large glazed areas as it may move too much. A proprietary system on the market claims to overcome this problem.

** Cherry commonly incorporates some pale sapwood, giving a distinct colour contrast*

A 12 Joinery

Suitable species

Table A 12.1 has been scored on the basis of natural durability, timber density, moisture movement and end use suitability. Most timbers will score in the region of 4 to 5 for exterior use if they are given the recommended preservative treatment in accordance with their likely exposure or hazard class, for example, Hazard/Use Class 3A for external joinery and cladding. Some species such as iroko, mahogany, white oak and teak are extremely resistant to preservative impregnation treatment but their natural durability more than compensates.

Western red cedar would be as naturally durable as white oak but its low density and softness make it unsuitable for areas where strength or abrasion resistance is required, such as glazed doors, opening windows or thresholds. Non-durable species listed at "1" in the table below – Ash; beech; maple and sycamore are unsuitable for exterior use.

Both oak and western red cedar are acidic and will corrode most metals and cause rust staining in damp conditions. Choose stainless steel fixings in these conditions. Silicon bronze or stainless steel ringshank nails should be used for all external cladding. Galvanised or aluminium nails will stain cladding within a short time. Stainless steel pins are best for joinery. Aspects such as colour and texture have not been included in the table and samples should be sought prior to final specification.

Note
Hazard and Use class are synonomous with Hazard class gradually replacing Use class

Moisture movement, classified as % in width for a change from 60-90% RH (approx. 12-20% MC). In-service movement will normally be much less than this.

Large	Medium	Small
Beech Birch	Ash Cherry Maple Oak Pines Walnut	Teak Iroko Spruces

Table A 12.1 *Joinery species suitability*

SPECIES	INTERIOR			EXTERIOR			REMARKS/USES
	Furniture	Doors	Stairs	Windows	Doors	Steps	
Ash+	4	4	4	1	1	1	Medium movement; panelling & flooring
Alder+	4	4	2	1	1	1	Medium movement; kitchen cabinets, mouldings
American soft maple+	4	4	3	1	1	1	Medium movement; kitchen cabinets, joinery
American tulipwood	4	3	2	1	1	1	Medium movement; kitchen cabinets, mouldings
Beech+	4	4	4	1	1	1	Large movement; furniture & flooring
Cherry	4	4	4	2	2	2	Medium movement; furniture & cabinetry
Douglas fir*	3	4	3	4	4	4	Small movement; external joinery & cladding
Iroko	5	5	5	5	5	5	Small movement; external joinery & cladding
Larch*	4	4	4	4	4	4	Small movement; external joinery & flooring
Mahogany	5	5	5	4	4	4	Small movement; joinery & furniture
Maple, hard or rock+	5	5	5	1	1	1	Medium movement; furniture & flooring
Oak, red	4	4	2	2	2	2	Medium movement; furniture & flooring
Oak, white	5	5	5	4	4	4	Medium movement; furniture & flooring
Pine, lodgepole*	4	4	3	3	3	2	Small movement; panelling & furniture
Pine, pitch*	4	4	4	4	4	3	Medium movement; joinery & flooring
Pine, Scots*	4	4	3	3	3	3	Medium movement; construction & joinery
Pine, southern yellow*	4	4	3	3	3	3	Medium movement; construction & interior use
Spruce, Sitka*	3	3	2	2	2	2	Small movement; construction
Spruce, Norway*	3	3	3	3	3	2	Small movement; construction & joinery
Sycamore+	4	4	3	1	1	1	Medium movement; panelling & furniture
Teak	5	5	5	5	5	5	Small movement; joinery & furniture
Western red cedar	2	3	1	2/3	3	2	Small movement; cladding & greenhouses
Walnut	5	5	4	2	2	2	Small/medium movement; panelling, furniture, joinery

1	2	3	4	5
Poor		Average		Good

* Softwoods. These species require preservative treatment for exterior use.

\+ Non durable hardwoods not suitable for exterior use

Fig. A 13.1 Multi-veneered door inspired by Mondrian, Botanic Gardens Centre.

A 13 Veneers

The art of veneering is nearly four thousand years old and was practiced in Egypt under the Pharaohs. The price of veneers can vary greatly. Inexpensive veneers include gaboon, koto and sapele. Moderately costed veneers include ash, aspen, beech (steamed and unsteamed), cherry, Douglas fir, elm, maple, oak, pine, sycamore, teak, American black walnut, wenge and zebrano.

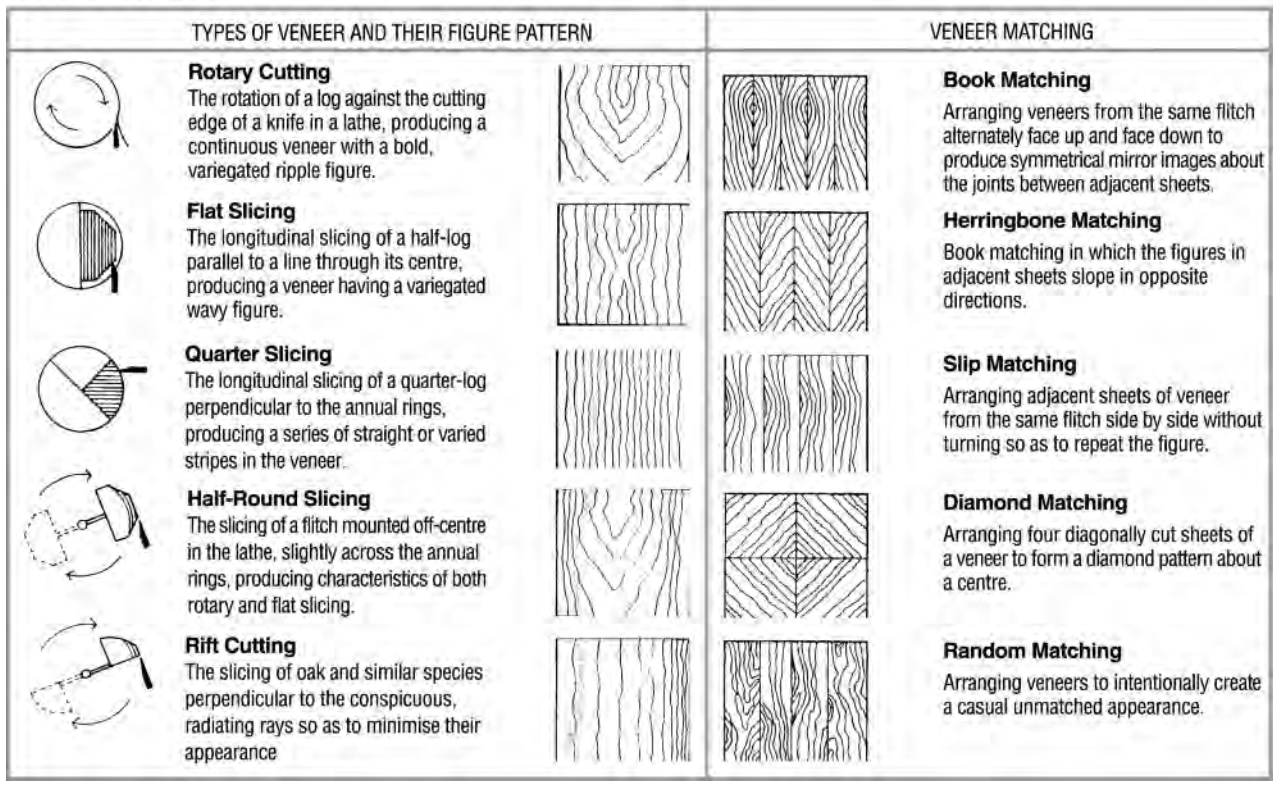
Expensive veneers include white fiddle back anegré, bird's eye maple, pear, rose-wood, thuya burr, American/European burr walnut and yew. Representative samples of veneers should be sought before making the selection.

The specifier should be informed when the *whole* of the stock is available for inspection and approval prior to the commencement of the work to ensure uniformity.

Don't just specify 'veneer' as a generic finish. There are five principal veneer cutting methods, each one of which will produce a different visual effect from the same wood species.

- Rotary veneers are exceptionally wide with a multi-patterned grain marking.
- Flat slicing is cut parallel to a line through the centre of the log. As a result it looks similar to a conventionally cut solid board.
- Quarter-sawn veneer produces a series of stripes both straight and varied and highlights the medullary rays of most species.
- Rift-cut veneer gives a comb-like grain effect without any medullary ray.
- Half-round slicing results in a cut slightly across the annual growth rings and usually shows the combined yet modified effects of both rotary and flat sliced veneers.

Fig A 13.1 *Veneers*



A 14 Furniture

Timber is easily shaped and moulded and is ideal for furniture. Most specialist workshops can execute one-off furniture designs. Designers should be aware of the European Regulation on General Product Safety which was implemented into Irish legislation in April 1997 under Statutory Instrument No. 197 of 1997. This legislation requires designers and specifiers to provide safe products which will not injure the end user. Chair design requires special attention in this regard.

Fig. A 14.1 Internal view of dining space. The dining tables were designed by the architects

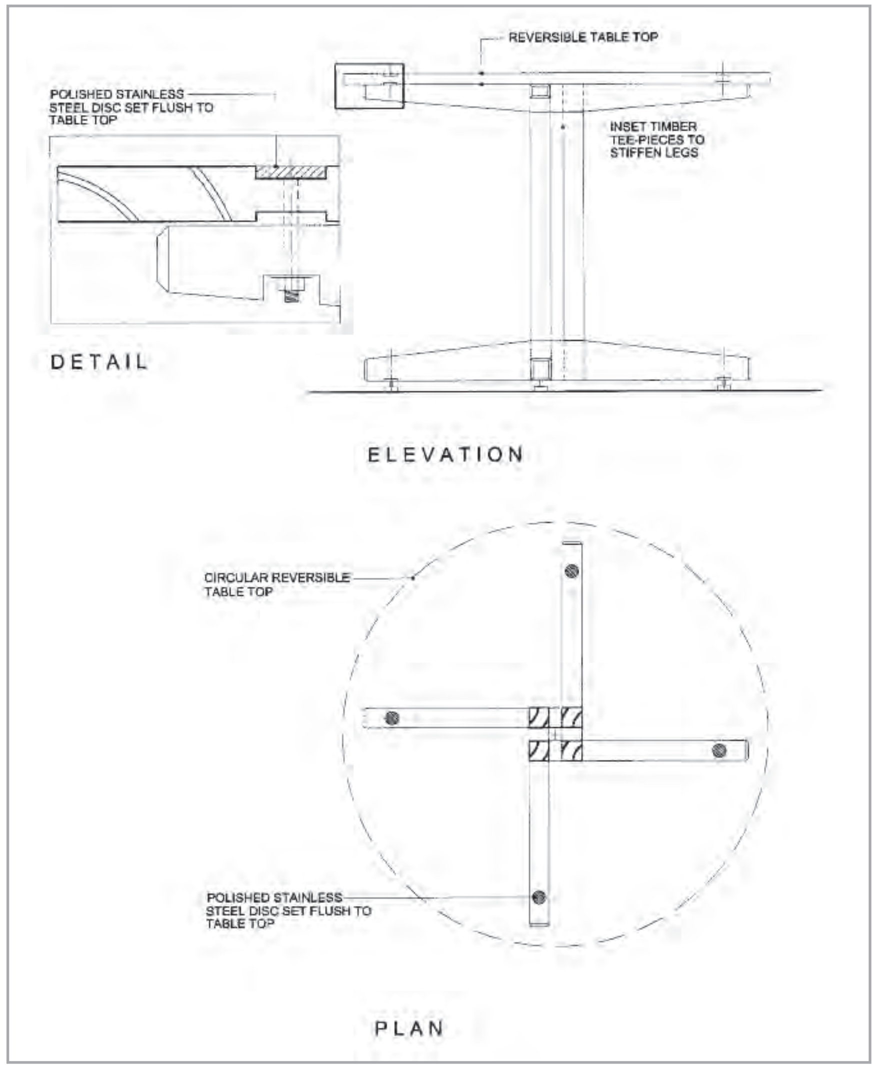


Fig. A 14.2 A detailed drawing of a table.

Conservation principles

- Research prior to planning work
- Minimum intervention - repair rather than replace
- Maintenance of the visual setting
- Where necessary accurate replacement, not conjecture
- Significant new work to be identifiable and recorded
- New interventions to be reversible as far as possible
- Sustainable conservation through proper maintenance and repair

Conservation procedure

- Research and analyse history of timber element/building from primary sources if possible
- Survey using drawings and photographs to identify original material
- Plan and execute work according to conservation principles
- Use experts/specialists where necessary
- Record work in visual and written form
- Put in place regular maintenance procedures

A15 Restoration and conservation

The restoration of a timber building or element involves returning a heritage object to a known earlier state, without the unnecessary introduction of new materials.

Conservation involves the prevention of decay and the prolonging of the life of the particular timber element. This work should be done without damaging the timber element or the building it is a part of. Historical evidence should not be falsified.

Reconstruction generally involves altering a heritage object by the introduction of new or old materials to produce an end result which respects the original.

Restoration and reconstruction often, by necessity, occur in the conservation of old buildings. Pastiche should be avoided but properly executed replicas, in particular cases, are acceptable.

Where completely new works are required in an otherwise conservation setting, the use of architecturally well designed forms and carefully chosen materials of a contemporary nature is far more appropriate and respectful of an historic setting than bland pastiche.

Fig. A 15.1 An historic illustration of the last recorded urban timber-framed historic building in Ireland. Note the angle posts and jettying of the upper floor, the various expressions of bracing, and decorative quatrefoil panelling on the second and third floors similar to extant buildings in Lancashire, Essex, and Shropshire in Britain. This illustration shows a shop and house built by Nicholas Bathe on the corner of Shop St. and Laurence St. in Drogheda, Co. Louth. It was demolished in 1824.

Structural

Structural elements of older buildings have often suffered damage or have become weakened due to decay, insect attack, or alterations or interventions such as notching for plumbing and wiring. Floors may be subject to deflection due to over-stressing. Structural analysis and strengthening may be necessary to meet modern loading and fire requirements. Susceptible areas include parapet gutters and valleys, bearing ends of joists in external walls, or timber at ground level where damp proof courses may not exist.

An assessment of structural timber in older buildings should include:-
Survey of decay, insect attack and other damage/deterioration
Strength grading of components
Identification of species present, so that stresses can be assigned to the timber and structural calculations performed. Note that age alone has a negligible effect on the strength of timber once it remains dry. There are numerous instances of timber in Irish buildings still perfect after 2-3 centuries.

TIMBER WINDOWS

The most common window up to the early 18th century was the side hung casement. The sliding sash window superseded the casement window and dominated window design for over 200 years. It is important not to confuse Georgian and Victorian sliding sash design.

The typical Georgian timber window was not equally split between top and bottom sash. The convention was to have nine panes of glass over six below, with a matching split pattern for the shutter panels of three over two. The Victorians often replaced the Georgian windows with equally split top and bottom sashes. The Victorians also introduced plate glass in lieu of the original Georgian crown or cylinder sheet glass. In addition, the Victorians 'improved' the sash window construction by the addition of window horns (extensions to the bottom of the top sash).

Much information on specialist craftsmen, restorers, and salvage materials is available on the Irish Georgian Society website, www.igs.ie.

Glazing bars varied in their width and thickness with each architectural period. Early 18th century Georgian window glazing bars were wider and usually heavier than mid to late 18th century glazing bars.

Sashes and window weights

If a new sash is required it should be a faithful historical copy. It is important to match the weight of such replacement windows with the original so that the original window sash cords, pulleys and weights can be reused where possible. The rule of thumb is that the weights for the upper sash are a little heavier than the sash itself so as to maintain it at the top of the frame. The opposite is true of the lower sash where the weights are usually a kilo lighter than the sash so as to ensure that it sits firmly on the sill.

Preventing draughts

A common problem with old sliding sash windows is their rattling under wind pressure and subsequent draughts. Proprietary systems are available to draught strip sliding sashes such that they perform as well as any standard replacement window on the market.

Repairing joints

Wear and tear and the inconsistencies of some old animal based glues can lead to the loosening of timber joints over time. If the timber is sound the joints can be reglued and cramped. Where additional strengthening of the joint is required insert a stainless steel or brass screw from the inside (to avoid external rot problems) through the tenon or dovetail joint, ensuring that the structural integrity is not compromised.

Thermal insulation and avoiding condensation

The use of original shutter panels will give added heat insulation and security to sliding sash windows. All buildings need both heat and ventilation in order to avoid mould growth, decay and condensation. If there are no shutter panels, and after draught stripping it is still necessary to improve the thermal performance of sash windows, then secondary glazing is preferable to altering the glazing bars of the original window design. The divisions of the new internal secondary glazing should be aligned with the meeting rail and/or the glazing bars of the original window. To reduce the effect of a double image reflection, the glazing bar members of the secondary window should be painted a dark colour.

Maintenance

Windows need maintenance inspection and repainting every three to five years. When painting, the elements of the window should be painted in a sequence to avoid the sashes sticking.

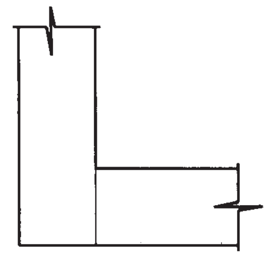
A common problem with old windows is the cracking of the linseed oil putty used to glaze the panes of glass. The result is often water ingress at vulnerable corners. There are a number of modern glazing mastics which can be overpainted to match the original putty look and which out-perform putty in terms of lifecycle and protection of the timber glazing bars. Special mastics (to specialist order) can also be got for larger projects with colours to match traditional paint finishes. While some conservation purist might recoil at such a suggestion it is far more preferable to use such compatible special mastics than allow the proven poor track record of putty to undermine historical windows.

Replacement

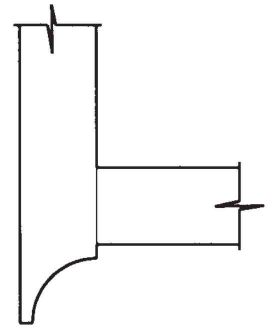
If, as a last resort, the original windows cannot be conserved then historically accurate replacement windows should be made. Sliding sash windows are not any more difficult to make than other common window types. Replacement in PVC or aluminium can in no way accurately replace historical timber ones. PVC windows have a life span of 30 to 40 years with repolishing required after 15 - 20 years.

Typical top window sash detail

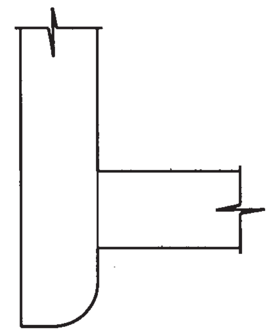
Early Georgian windows did not have horns, or extensions, to the bottom of the sash. Late Georgian windows sometimes had small horns. Scrolled horns belong to the Victorian period.



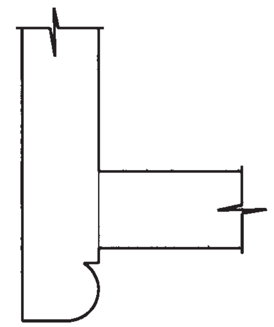
Georgian 18th century, no horn.



Late Georgian, early 19th century, concave horn.



Late Georgian, early 19th century, convex horn.



Victorian scrolled Horn.

Victorian replacement and original Georgian joinery forms part of the history of this 1732 estate house in the National Botanic Gardens.

Wide square edged floorboards with a black painted finish are common in many 18th and 19th century heritage and buildings.

They have thermal expansion and window ironmongery replacement problems. Plastic windows are environmentally unsupportable due to the resources and energy required in their making and their inability to be recycled.

Ireland has many good joinery workshops which can accurately make historically accurate replacement windows under specialist architectural guidance. The choice of correct species and method of preservation would be similar to that of modern windows detailed elsewhere in this specifier's guide.

INTERIOR JOINERY AND FITTINGS

Like timber windows, interior joinery such as staircases, doors, (including ironmongery), architraves, panelling and mouldings are part and parcel of the architectural heritage of an old building. They should not be replaced by either inappropriate modern or pastiche joinery. Where heritage joinery is beyond repair or a significant new addition is required, then a contemporary design of a high standard could be the most appropriate approach. Remember that historical joinery and panelling was always painted except for special feature oak and mahogany handrails, doors and panelling.

STAIRCASES

The medieval spiral stairs developed into more open and feature type staircases in the 18th and 19th century. The urban Georgian houses used the dog leg staircase in a rectangular or elliptical manner with a series of half and quarter landings. Most of these staircases were made of pine and were always painted. In prestige houses the stair handrail would often be made of mahogany or oak and polished in beeswax. Balusters became more slender and refined during the 18th century. Today such balusters are visually elegant but may require careful strengthening in public use buildings to comply with current building regulations. Seek expert advice if such interventions are required.

DOORS AND ARCHITRAVES

The simple ledged door was used in vernacular buildings into the 20th century. The late 17th century saw the widespread introduction of panelled doors in wealthier houses throughout Ireland. Panels were either recessed or raised and fielded with a chamfered edge.

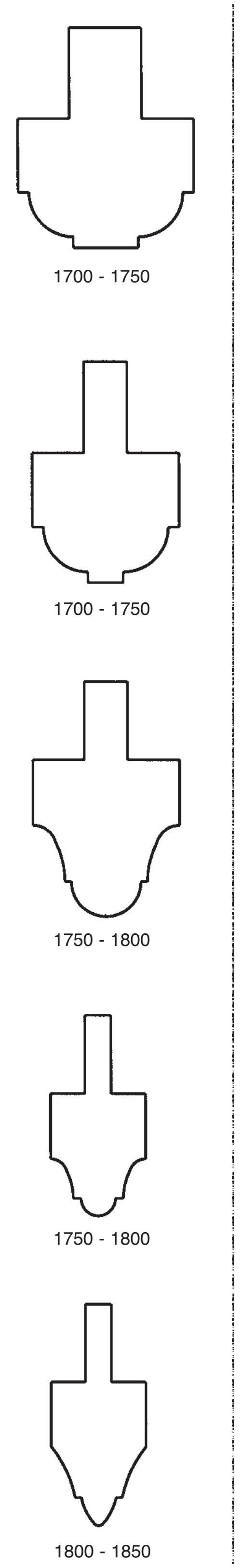
Flat panelling became more common as the 18th century progressed until the application of decorative head moulding became the norm from the middle of the 19th century onwards. Georgian architraves, panelling and mouldings are in general visually lighter than their Victorian counterparts.

Historical ironmongery such as locks, hinges, number plates, door knobs and bell pulls should be preserved. There are a number of specialist brass and metalworkers who can repair and refurbish such ironmongery.

PANELLING

The use of timber wall panelling in public buildings and larger houses became popular at the end of the 17th century. Unlike earlier medieval panelling which was not proportioned in any particular way, 17th century panelling was governed by the rules of classical proportion. The panelling itself was usually of softwood, painted in the popular colours of the time. On occasions oak or mahogany panels finished in beeswax, was used to denote rooms of special importance. On other occasions painted softwood skirtings, panelling and dado rails formed the lower part of the wall with decorative plaster panels above. From 1880 onwards the dado rail became less prominent while the skirting board grew taller and more prominent.

Typical 18th and 19th century glazing bars.
(relative proportions)



TIMBER FITTINGS

Timber mouldings in Georgian and Victorian buildings can be extensive and appear intricate. However, all mouldings are based on two historic and simple forms - the convex quadrant called the ovolo (cavetto when concave), and the right angled, flat faced fillet. Most 18th century mouldings were based on Roman examples while most 19th century mouldings were based on Grecian examples.

Do not use standard hardware shop mouldings in restoration work. Remember that mouldings and panelling were directly proportioned to the proportions of the particular room or space in which they were situated. A good joiner can repair or match damaged mouldings or panels under architectural guidance.

PAINTING

When stripping old timber do not use blowtorches or hot-air guns because of the damage they may cause to the original wood and the risk of fire they pose in historic buildings. The original colour of historical timber work can be determined by chemical and/or spectrometer analysis by a paint specialist. A number of matching historical paints are available from specialist suppliers in Ireland and the U.K.

Note that old paints were lead-based, and the appropriate precautions should be taken.

FLOORS

Most timber floors in heritage buildings would have been made up of square edged floor-boards with a painted finish. Tongue and groove floor-boards are a relatively new floor type. In prestige buildings or particular rooms, oak, mahogany or special inlay floors were laid. Great care is required in repairing an inlay floor. Rare species can be identified by a wood anatomist from a small sample.

TIMBER DECAY

Timber is an organic material. As such it is subject to degrade through wet or dry rot and insect attack unless protected from moisture or preserved by various methods. In historic buildings, the basic building technology used in their construction was not always conducive to the well-being of timber. In particular, bonding timbers were used in masonry wall construction where dampness was present due to the absence of a damp proof course and porous wall construction.

The first priority in any heritage building is to eliminate all sources of water penetration. When the basic fabric of the building is secure from water ingress the conservation work can begin on the other elements of the building including the timber components. Ventilation must be maintained to prevent condensation and build-up of moisture.

WET ROT AND DRY ROT

The fungi that cause Wet and Dry rot are not active below 20% moisture content. If the timber moisture content can be held below 20% there is no need for the saturation use of preservatives particularly in the case of Dry rot. However, if there is a significant damp or insect hazard beyond control then an appropriate Hazard Class treatment should be used as detailed elsewhere in this guide.

Wet rot is a term for decay fungi other than Dry rot. These are usually found where timbers are in ground contact or subject to constant wetting. Affected timbers will need to be removed and the source of damp eliminated.

Dry rot is the most serious of wood rots, but should not be a cause of panic preservative treatment using saturation irrigation systems unless it is very extensive and aggressively active. Dry rot needs moisture to survive. It is still widely believed by many specifiers that Dry rot can obtain moisture from adjacent timber below 20% moisture content and thereby continue to spread throughout a building. This could only occur in unventilated conditions and very rarely happens.

Recent scientific research shows that such a belief is incorrect. Dry rot is normally restricted to areas of timber and masonry which are subject to periodic but severe wetting. However, in areas of restricted ventilation the decay can spread to adjacent areas of drier timber. It is true that dry rot spores can lie dormant for a number of years. However, these spores will only become active above 20% moisture content. If the timber is kept dry the Dry rot will die and spores cannot germinate.

What is most important is the need to discover the location and cause of the dry rot outbreak and its present level of activity. Then eliminate all sources of moisture. Use ventilation or dehumidifiers to reduce the relative humidity and thereby help dry the timber to 16% moisture content or below. Affected timbers should be removed to beyond 300mm past the last signs of decay. Replacement timbers should be pressure preservative treated to the required Hazard Class treatment. Non-decayed timber adjacent to affected wood should have a preservative paste or injected treatment carried out. Similarly, adjacent wall surfaces should be spray treated to kill spores.

For heritage buildings consideration should be given to a remote monitoring system which can detect moisture content levels in hidden areas and thereby indicate if conditions conducive to decay have arisen.

INSECTS

The most common type of wood damaging insect is the furniture beetle or woodworm. It is now less common inside centrally heated houses, preferring wood at a higher moisture content. The young grub (larva) remains in the affected wood for two to five years before it emerges from its flight hole during the period May to August. Severely damaged wood must be replaced with preservative treated timber. The preservative must contain an appropriate insecticide, and not just a fungicide, treated in accordance with its hazard class requirements.Where floor joists or boards are attacked they should be spray treated on all surfaces wherever possible.

Death watch beetle is seldom encountered in Ireland today but it has been found in old oak timber in some heritage buildings. The grub can stay in the wood for up to five years before taking flight in spring time. These insects require the wood to be damp and adequate moisture is necessary for infestation. Attack is frequently initiated in decaying timber, so the drying out of the timber will do much to eradicate death watch beetle attack.

Powderpost beetle is occasionally encountered in the sapwood of recently installed hardwood species with large pores, principally ash and oak. It cannot attack the heartwood of these species, or of softwood species. Attacks normally peter out within a few years even if untreated and any occurrence in older buildings is likely to be extinct.

Ambrosia beetle or “Pinhole borer” attack, characterised by dark-stained holes of varying sizes, occurs only in freshly felled or “green” timber. This attack cannot continue once the timber is dried. It is normally of no structural significance.

FIRE SAFETY REGULATIONS

If the public have access to a heritage property then the owner or ‘person in control’ is responsible for their safety in accordance with Section 18(2) of the Fire Services Acts 1981 and 2003. In addition, the Building Control Regulations may apply and a Fire Safety Certificate be required. There can be a conflict of heritage interests and fire safety requirements. For example, the upgrading of the fire resistance of existing floors could threaten decorative ceilings below the floor. The sub-dividing of halls and staircases to restrict smoke movement can destroy the architectural integrity of these spaces. Similarly, original timber wall panelling or panel doors may not meet surface spread of flame or modern fire rating requirements, respectively. To maintain heritage features and at the same time comply with the Building Regulations fire requirements expert advice is needed. There is an element of flexibility in the Building Regulations’ which allows the Fire Safety Certificate applicant to demonstrate that there are alternative solutions to the standard Regulations. The onus is on the applicant to clearly demonstrate from first principles that any proposed alternative to the Regulations will provide an equivalent level of fire safety.

SAMPLE OF DETERIORATION DUE TO LACK OF MAINTENANCE AND POOR BUILDING PRACTICE

Dry rot damage to roof rafter caused by water and lack of ventilation.

Woodworm infestation of roof rafter at eaves. High moisture content due to restricted ventilation.

A 16 Miscellaneous

16.1 FENCING

General

Timber for post and rail roadside fencing should comply with the requirements of IS 435 Part 1; for farm fencing with IS 436; and for stud fencing IS 437.

At present, NSAI operate a quality control scheme for roadside fencing. It is envisaged that this scheme may be extended to cover farm and stud fencing.

The choice of fence is affected by

- Intended purpose
- Aesthetic considerations
- Maintenance after erection
- Desired service life
- Availability of components

(A) Site Conditions

- Line and length of fence
- Site preparation
- Ground condition
- Location of gates/stiles
- Method of setting posts in ground

(B) Construction

- Species
- Preservative treatment
- Fence height
- Post type/fixing of rail
- Spacing of posts

Typically, the following items will need to be specified:

Selected timbers can be used for the following applications:

1. Roadside (post and rail)
2. Stud (post and rail)
3. Decorative (post and rail)
4. Farm round (post only)

Suitable species

Species suitable for timber post and rail roadside and stud fencing should be chosen from the listed standards. Typical species are outlined in table A 16.1.

Table A 16.1 *Suitable species for roadside and stud fencing**

Common name	*Botanical name*	*Post*	*Rail*
Douglas fir	*Pseudotsuga menziesii*	✓	✓
Larch	*Larix spp.*	✓	✓
Lodgepole pine	*Pinus contorta*	✓	✓
Norway spruce (1)	*Picea abies*	✗	✓
Oak	*Quercus spp.*	✓	✓
Scots pine	*Pinus sylvestris*	✓	✓
Sitka spruce (1)	*Picea sitchensis*	✗	✓

**Reference the NSAI quality scheme document for suitable species for farm posts.*

Work has shown that only home grown spruce will achieve the penetration requirements of IS435. Imported spruce (white deal) is more resistant to treatment.

Limits are generally placed on knots, slope of grain, wane, end splits, fissures, sap stain, decay, insect damage and distortion.

Note

Further information can be obtained from:

1. National Roads Authority Specification for Roadworks: Series 300 Fencing.
2. IS 130 : Chainlink fencing.
3. BS 4102 : Steel wire fences.
4. IS 126 : Galvanised fencing wire.
5. BS 1722 : Fences.
6. IS 435 Timber post and rail roadside fencing:
7. Part 1 Materials;
   Part 2 Erection of fencing by excavation of materials;
   Part 3 Erection of fencing by driving of posts.
8. IS 436 Farm fencing – Timber post and wire.
9. IS 437 Stud fencing: Timber post and rail.
10. BS 144 Wood preservation using coal tar creosotes.
11. BS 5589 Code of practice for preservation of timber.

Advantages

Timber is used extensively for the manufacture of fencing and it is recognised for its:

- aesthetic qualities
- fitness for purpose
- durability
- cost competitiveness
- simple maintainence

Keywords

- Post-Vertical support member set in the ground.
- Rail-Horizontal member joining post to post.
- Chainlink-Wire mesh fixed to field side of rails.
- Pointing-Bottom of posts cut to aid driving.
- Weathering-Angle cut on top of post to allow rainwater run-off.
- Line-Wire running along the bottom of the fence line to hold the chain link in place.

Creosote - health note
Creosote has to be used with great care and is not suitable for use within buildings or where there is a risk of frequent skin contact. Limits are placed on the concentration of certain compounds in creosote. See Clause B.2.2 of IS 435 for full details.

Treatment

After drying and immediately prior to preservative treatment the moisture content of the posts and rails shall not exceed 26% for roadside and stud fencing and shall not exceed 28% for farm posts.

Roadside post and rail fencing - Treatments should comply with the recommendations in BS 8417 Table 9 for Tanalith E/ACQ and BS 8417 Table 5 for creosote. The treatment requirements are detailed in IS 435 for each product.

Farm posts - Treatments allowable are the Copper organic (Copper triazole/ACQ) or Tanalith E/AC500 process and the creosote pressure process. Treatments shall comply with the relevant British Standard.

Unless specified otherwise, all timber shall be cut to final dimensions and all fabrication and machining shall be carried out before treatment. Extended service life is possible through proper maintenance of the fence after erection. Premature failure can be avoided by taking care not to damage the protective treatments during installation. Any cut, drilled or damaged surfaces should be re-treated with an appropriate preservative.

Erection and fixing

Erection and fixing of roadside and stud fencing shall be in accordance with IS 435 and IS 437 respectively.
The posts shall be set in the ground, to the depths shown on the drawings (See fig. A 16.1), in holes of a minimum of 330x300mm on plan or 300mm diameter. All holes shall be 700mm deep. The granular backfill shall be well rammed as the filling proceeds, and finished with topsoil proud of the surrounding ground.

Any proposal to use driven posts must have the approval of the engineer.

Rails shall be fixed to the field side of the posts and shall have their joints staggered so that only alternate joints occur on one post. Rails shall be butt-jointed on the centre line of the posts and each rail shall be fixed to each post with two 100mm long, 4.5mm diameter galvanised round wire nails driven in on the skew.

Chain link and line wire requirements shall be in accordance with IS 435.

To help avoid splitting, the minimum number of nails or staples shall be used. If more than a single line of wire is being erected the staples shall be angled and staggered. Bed-logging shall be used on sharp turns of 90 degrees or less.

Roadside post and rail

Dimensions and tolerances shall be in accordance with the table A 16.2

Table A 16.2 *Dimensions and tolerances for roadside fencing*

Dimension	Post	Rail
Width mm	150 ± 3	100 ± 3
Thickness mm	75 ± 3	44 ± 3
Length mm	2100 ± 3	4200 ± 3

All fence posts shall be cut square at the bottom when placed and backfilled except in the case of driving, when posts shall be pointed. In all cases the top of the posts shall be weathered. Where oak rails are utilised they must be used exclusively. Oak rails, if so specified, may be used untreated but in that event must be free from sapwood.

Stud fencing

Dimensions and tolerances shall be in accordance with the table A 16.3 below.

Table A 16.3 *Dimensions and tolerances for stud fencing*

Dimension	Post	Rail
Width mm	150 ± 3	100 ± 3
Thickness mm	75 ± 3	44 -0,+3 Paddock 38±3
Length mm	1800 ± 3	4800 ± 3

All stud posts shall be four way pointed and shall be driven to a depth of 600mm. Where this depth cannot be achieved the minimum shall be 450mm. Obstructions preventing driving shall be excavated and the hole refilled with soil and rammed before proceeding. Where the post has not been driven to the correct depth the top shall be cut and treated.

Farm timber posts

Timber for farm posts shall comply with the requirements and recommendations of NSAI quality scheme for farm round posts. There are 3 types of farm timber posts:

1. Peeled rough
2. Profiled (round or half round)
3. Square sawn

Farm timber posts may be fabricated from lodgepole pine, Douglas fir and larch.

All bales of posts shall carry an identification number on a durable tag. This number shall also be entered on all production records, treatment charge sheets and delivery dockets.

Ensure the use of the correct hand tools when posts are being driven as ordinary sledge hammers can cause damage. If using a hydraulic post driver a post cap shall be used.

Straining posts shall be a minimum diameter of 150mm and correctly bed-logged or strutted where more than one strand of wire is being erected. Straining posts should be used at ends of fences and at marked changes in direction or gradient.

Cutting and notching of posts shall be avoided if possible. Any cut surfaces should be re-treated. To help avoid splitting, the minimum number of nails or staples shall be used. If more than a single line of wire is being erected the staples shall be angled and staggered to avoid splitting posts.

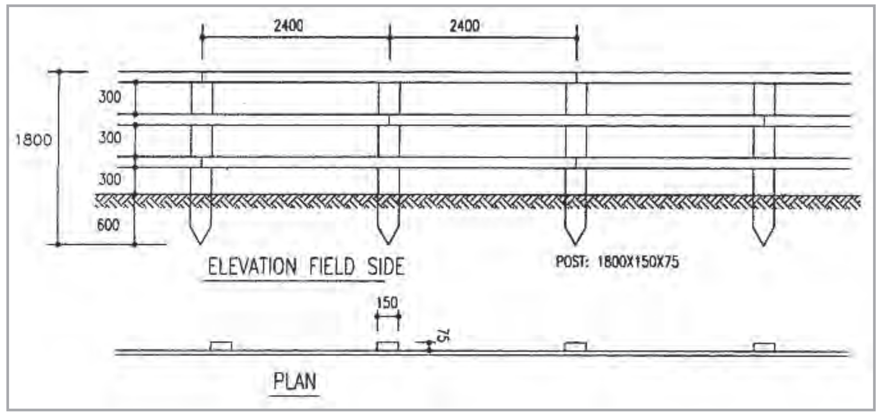


Fig. A 16.1 Post and rail stud fencing (measurements in mm)

Garden fencing

Fencing used in gardens and other areas where people may come into regular contact should follow the basic principles given above, but must be treated with an appropriate preservative such as Tanalith E or ACQ. Creosote is not appropriate and is not permitted in such locations. Horizontal, vertical, and woven patterns are readily available and are often available in modular sections for ease of erection.

16.2 OTHER USES

16.2.1 Temporary works

Raking shores
Optimum angle 60˚ (max. 75˚). A wall piece is fixed to the wall to receive the heads of rakers and spread the load. A timber needle is morticed into the wall piece to resist the thrust of the rakers. The head of the raker should only be placed where there is a floor or a roof at the back of the wall to resist the thrust. The feet of the raker should rest on an inclined sole plate embedded into the ground. Wedging should not be used.

Flying shores
One metre between walls is the maximum allowed for single shores. For spans of 9m-12m a double compound shore should be used with horizontal timber set between walls with the ends resting on the wall pieces, stiffened by inclined struts above and below at each end.

Timber scaffold boards
BS 2482 covers the requirements for timber scaffold boards, both visually and machine graded. Due to safety considerations, it is essential that scaffold boards are properly graded and so marked. Markings are normally placed on the protective end straps. Boards should be carefully handled on site and protected from abuse. Boards in storage should be properly supported and separated by stickers to allow through ventilation. Any boards showing sign of damage or decay should be rejected.

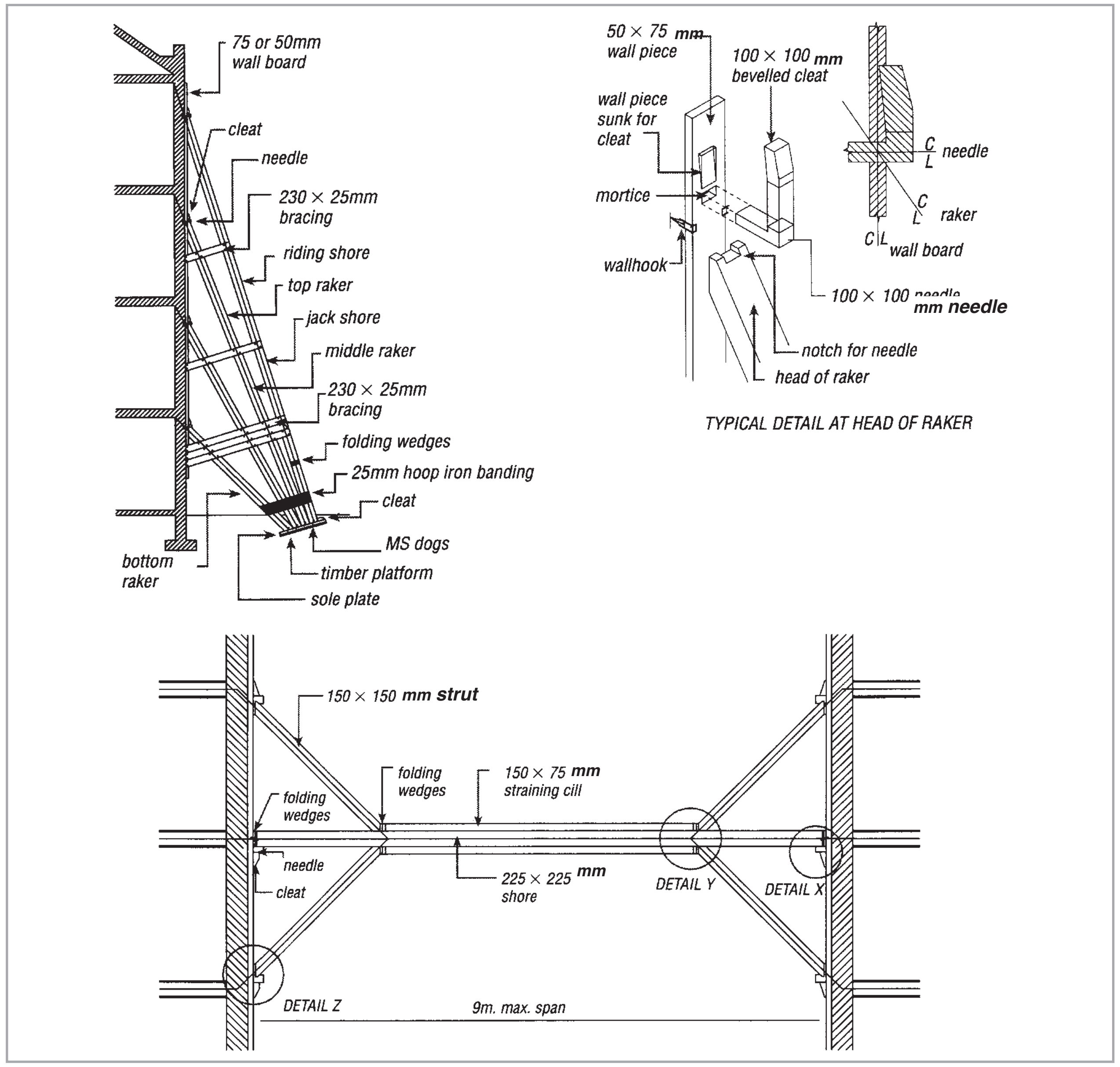


Fig. A 16.2.1 Temporary works - raking and flying shores

16.2.2 Children's play equipment

Children's play equipment has greatly improved in design in play value in the last decade. Gone are the old tarmac and ironmongery playgrounds which have been replaced by more imaginative and timber-based play facilities. A number of specialist suppliers offer an increasing variety of equipment or you can design your own components provided you meet the safety requirements of EN 1176. Timber square or cylindrical posts should be quarter sawn and dressed on all sides, with arrises eased to a diameter of 5mm to avoid cracking and splintering. If possible, steel bases should be specified to keep the timber out of ground contact and allow ease of replacement. All fixings should be concealed for safety reasons. The metal components, such as swing rotation arms, slides and chairs should be sourced from specialist suppliers. All play equipment should be under direct control of the child using it for his/her own safety. If possible give the children under 5 years of age a separate but adjoining space to the older children's play area for reasons of safety and the option of catering for imaginative play and not just diverse physical play. Play equipment needs to be carefully sited, especially swings.

The single most important safety issue is the play area surface. The best surface is a rubber tile laid on a specially prepared space. Other materials such as woodchip pea-gravel or sand require a significant depth of material to meet safety standards and are prone to tracking and animal fouling.

Note: The European Standard allows for heights above ground of 4m which would include any accessible roofs to play structures. However, the British Health and Safety Authority sets an independent height limit of 2.6m. The maximum fall height for the rubber safety tile is presently 3.6m.

Reference: EN 1176
Space for Play ISBN 0 95071130 6

16.2.3 Marine works

Sheet piles, groynes and wave screens
Untreated timber piles require naturally very durable timber such as greenheart or ekki. Other timbers will require inorganic preservative treatment to Hazard Class 5. Specialist design is required.

Fendering
Fendering is used to absorb berthing energy and to protect the berth itself. Influencing issues include the vessel type, variations in the water level and allowable deflection, as well as strength and durability. Similar species and preservation treatment as in piles. Specialist design is required.

Lockgates
Timber lockgates were traditionally made from European oak, with elm boarding but are now generally made of ekki or greenheart because of their superior durability, dry and wet basic stresses, and moduli of elasticity compared to most other tropical hardwoods available from managed resources. Specialist design is required.

Reference: BS6349 and Nederland Standards NEN549 & 6740.

16.2.4 Decking

Decking can be laid on suitably designed joists, beams and column supports, or on a patented support system over a solid structure such as a patio or roof garden. Pre-profiled anti-slip marina decking is available in yellow balau, ekki, and some other hardwoods which are naturally very durable timbers. Other hardwood or softwood decking, for domestic or commercial use, will need to be preservative treated to Hazard Class 4 (ground contact) or 3 (out of ground contact) using a high pressure process with copper based (Tanalith E, ACQ) or copper triazole/ACQ preservative. Ideally all cutting, notching and drilling should be carried out before treatment but if this has to be done afterwards these areas should be liberally treated with an appropriate preservative. For more information please consult the WMF Decking Guide at www.wood.ie

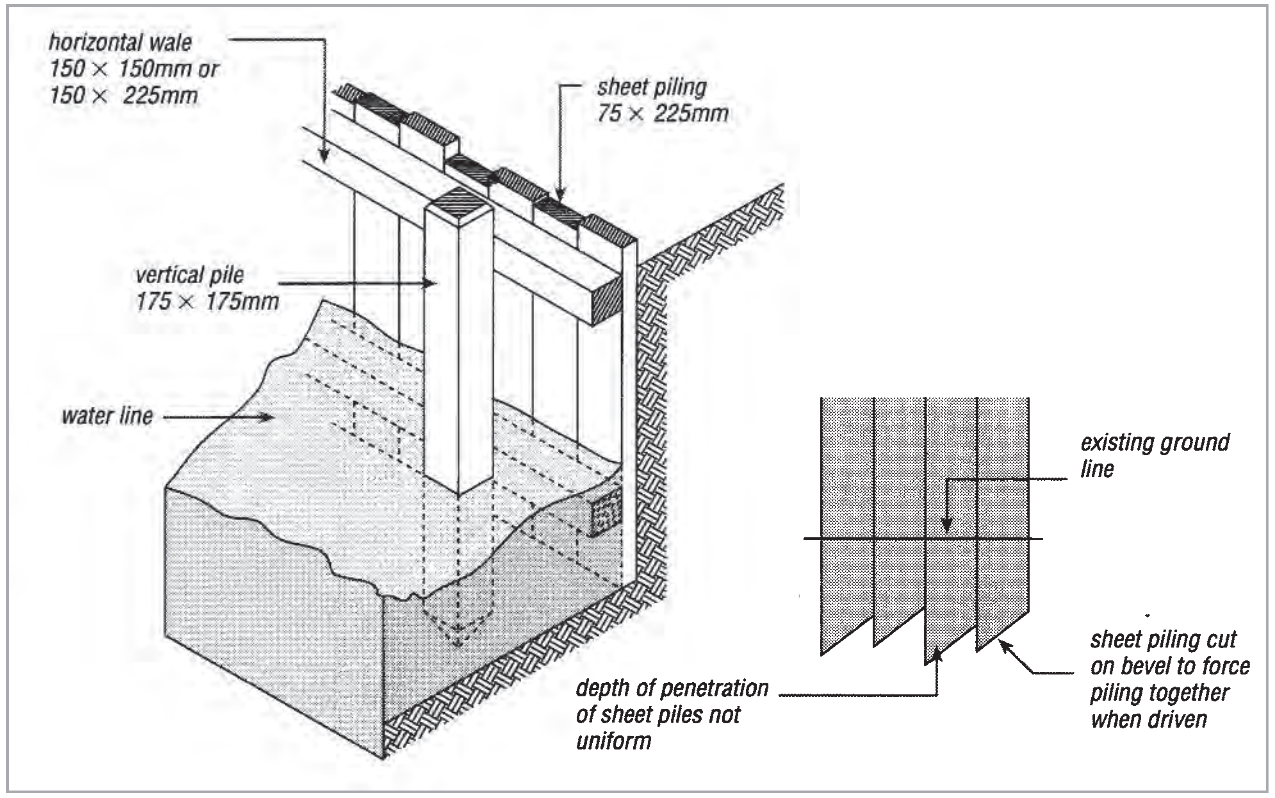


Fig. A 16.2.3 Marine works – sheet piles

Use a minimum gap of 5mm between deck boards. A profiled ribbed surface, laid to a fall to prevent ponding, is the best finish for public areas. To maintain a non-slip surface regularly clean the deck surface with a stiff yard brush and apply a proprietary brand of cleaner a number of times per year to the walking surface. Water repellent or stain finishes can be used to give or maintain a desired colour. Left untreated the wood will weather naturally to a silvery-grey colour.
All fixings should be either stainless steel, hot dip galvanised or coated to the requirements of IS/EN ISO 1461. Ring shank nails, or preferably screws, should be used for fixings to prevent "popping". Deck boards should be pre-bored and countersunk, not closer than 25mm to the edge or end.

Reference: Wood Marketing Federation decking guide. (www.wood.ie)

16.2.5 Timber in the landscape

Crib walls (see Fig. 16.2.5.1)
A number of patent systems are available which are easy to construct and are cost efficient in terms of building a retaining wall. The specially preserved timber, often radiata pine, will last in excess of 50 years in ground contact. A concrete foundation slab is required as is specialist engineering design. Wall infill material should be clean crushed quarried rock or river gravel. Drainage is vital at the rear of the base slab.

Reference: EN 1997-1 Geotechnical design - general rules

Pergola (see Fig. 16.2.5.2)
A pergola can be designed to frame a view, link the landscape to the building or define a space. Columns should be kept out of ground contact using steel bases. Use naturally very durable species or with non-durable species treat in accordance with BS 8417, Similar species options and metal fixings as for external cladding and joinery.

Pavilion (see Fig. 16.2.5.3)
A timber pavilion or shelter set within a parkland can have a mutually enhancing effect on both elements. The versatility of wood allows various expressions from solid structure to tapered dome. Illustrated is an Irish Douglas fir structure and lodgepole pine dome with imported western red cedar shingle roof.

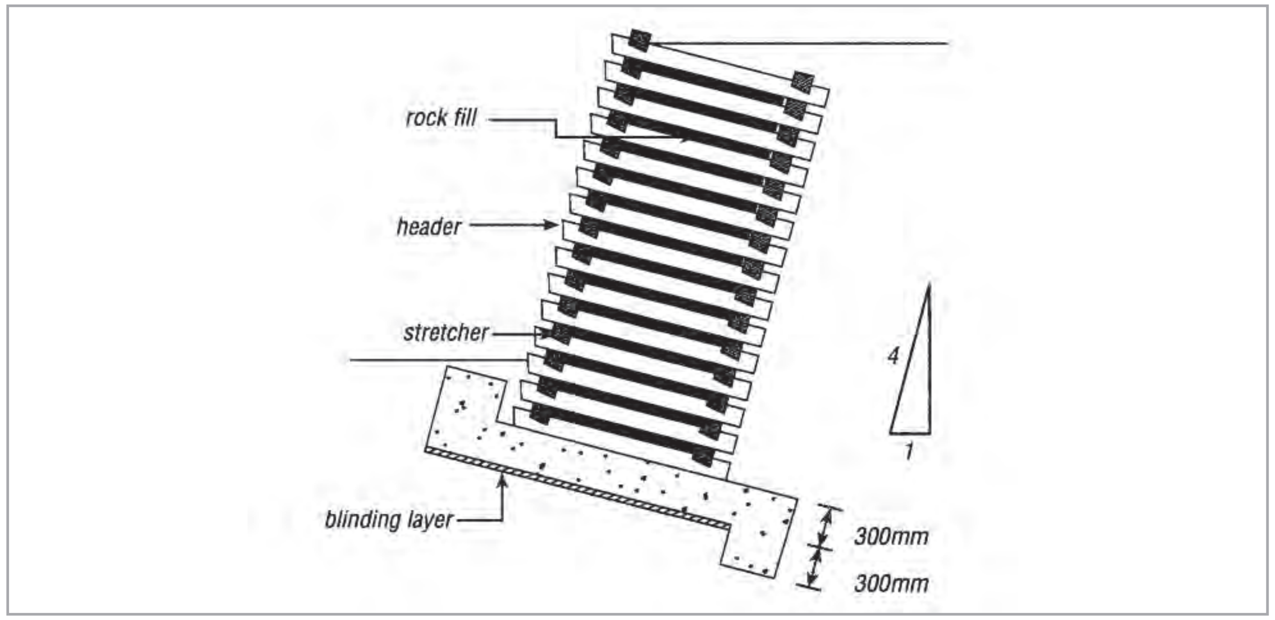


Fig. A 16.2.5.1 Typical crib wall

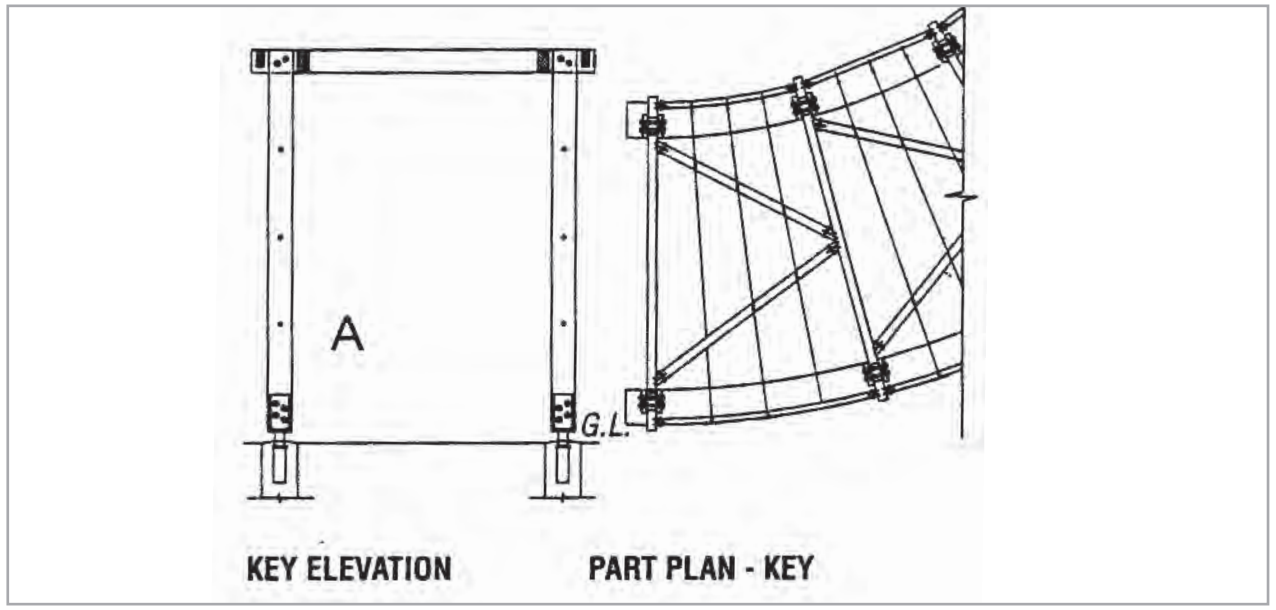


Fig. A 16.2.5.2 Elevation and plan of pergola

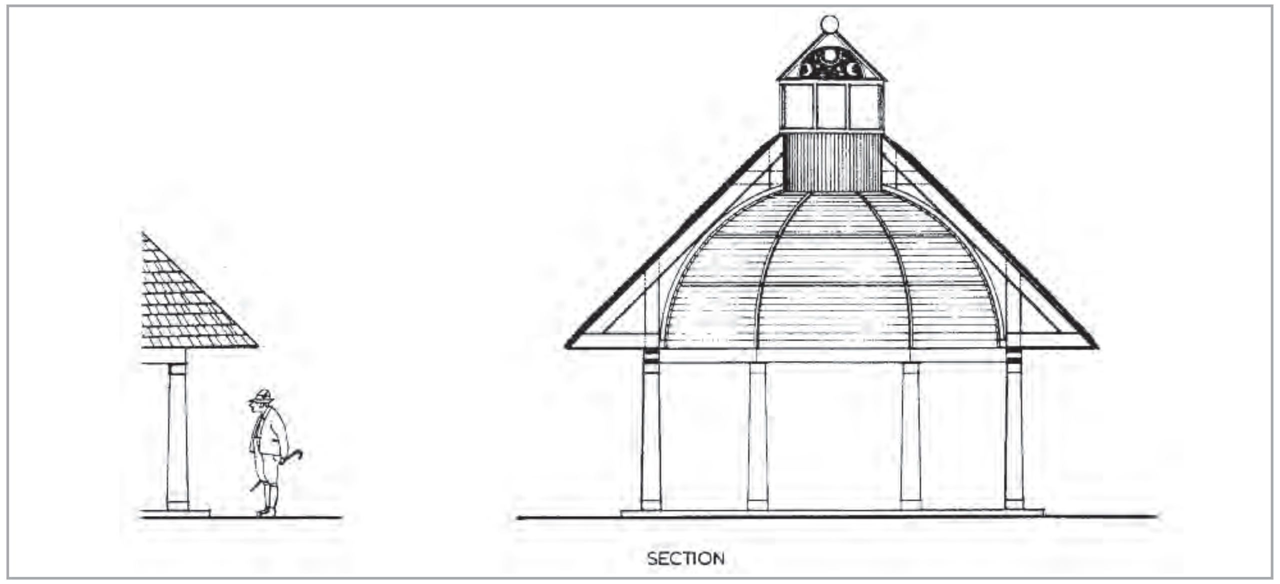


Fig. A 16.2.5.3 Irish timber pavilion in St. Stephens Green, Dublin.

16.2.6. Acoustic barriers

Timber-based barriers have proven to be highly effective at sound reduction, particularly in use on motorways and other roads, as well as at locations such as shopping centres and industrial installations. They are also aesthetically pleasing, and are obtainable in modular units in a range of heights for ease of erection. Preservative treatment, appropriate to the location, should be applied to non-durable species.

Fig. A 16.2.5.4 Oak bridge at Lough Gill, Sligo.

A 17 Modified wood

A wide range of wood-based materials whose properties have been modified by physical or chemical treatment are now available. These include:-

Wood/plastics composites (WPC's)
Wood particles or flour, bound with resin or other plastics, and extruded in various profiles for uses such as cladding, decking and internal trim such as skirting boards. Generally stable in varying humidities and resistant to micro-organisms but less strong and stiff than solid wood or board materials.

Heat-treatment
Wood treated to 160-200˚C in the absence of oxygen, sometimes in hot oil. This reduces the uptake of moisture and renders the wood more stable and resistant to decay. The natural colour of the wood is noticeably darkened. Some reduction in strength properties, particularly shock resistance, occurs.

Chemical modification
Reaction between a chemical and wood can result in modification of wood properties. The most commonly encountered process is acetylation, where the wood is treated with acetic anhydride. Radiata pine so treated is now commercially available under the trade name "Accoya" and supplied for use in joinery and similar applications. The strength, machining and finishing properties of the wood are largely unchanged but durability and stability are considerably enhanced.

Wood can also be impregnated with resin monomers which are then polymerised in-situ by heat or radiation to form a composite product. This process has been widely used for small components such as cutlery handles.

PEG – polyethylene glycol
Wood can be immersed in a solution of polyethylene glycol which diffuses into the wood, taking the place of bound water and thereby minimising shrinkage. This process is widely used for the preservation of even large archaeological remains such as the Swedish warship the "Wasa". It is also widely used in woodturning.

Section B *Detailed Drawings*

B1 Cut roofs

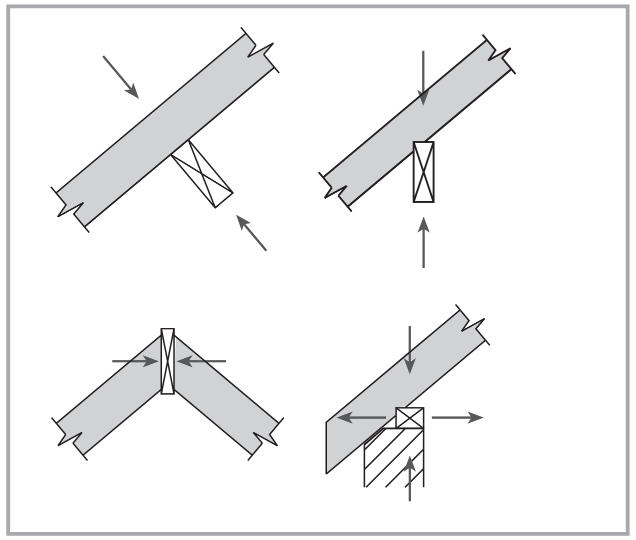
General

Swift 6 provides Non-Contradictory Complimentary Information (NCCI) for designs to Eurocode 5; this information mainly consists of load span tables for specified design criteria. In the U.K. TRADA have produced similar load span tables and it may be that BSI will also produce tables to Eurocode 5 to replace their permissible stress design tables to BS 5268-2 and given in BS 5268-7 and BS 8103-3.

B.1.1 STABILITY AND LOAD TRANSFER

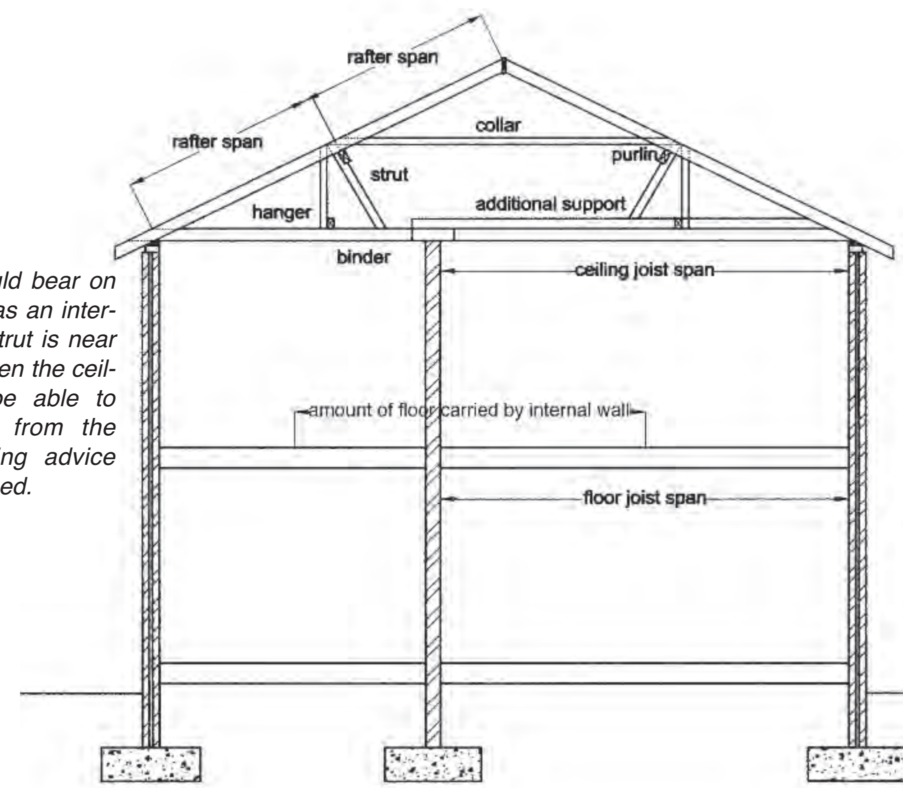
The stability of cut roofs is dependent on the triangulation or tying in of the different elements and in limiting the spans of the rafters, ceiling ties and purlins to the appropriate section size and timber strength class. The location of purlin supports should be carefully considered and identified to ensure loads are transferred to load bearing walls or supporting beams. With hip ends, particular attention must be paid to how purlins are supported as often there may be no load bearing walls to provide support to the purlins under the hip end.

Roof rafters produce a horizontal thrust at eaves level and this thrust is usually taken out by the ceiling ties. In a symmetrical dual pitched roof the horizontal thrusts on each side of the roof are cancelled out. In a roof that is significantly unsymmetrical or mono-pitched, alternative means of catering for the horizontal thrust may have to be found.



Where raised ceiling ties are used in a roof, the roof must be designed by a qualified engineer; generally the length of the raised rafter or position of the raised ceiling tie must be limited to reduce stresses and connection loads

DETAIL B 1.1.1 Transfer of load

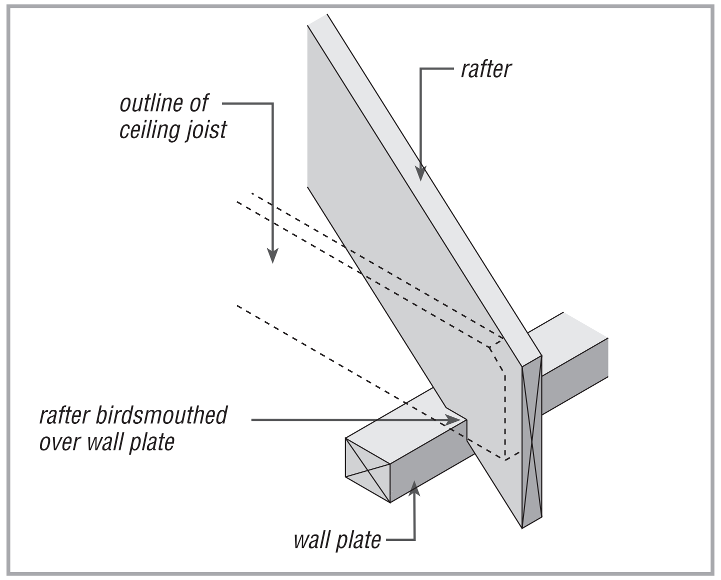


Note: Strut should bear on a support such as an internal wall. If the strut is near to the support then the ceiling tie might be able to carry the load from the strut. Engineering advice should be obtained.

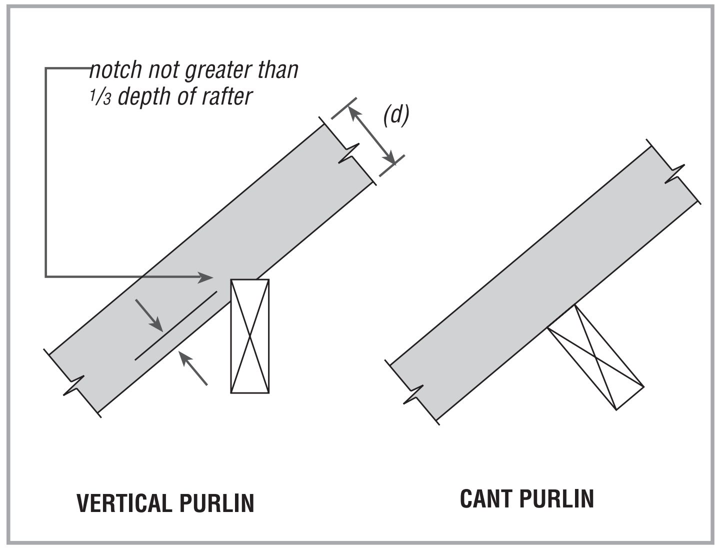
DETAIL B 1.1.2 Spans

Note: In the absence of a purlin the rafter span extends from wall plate to ridge board.

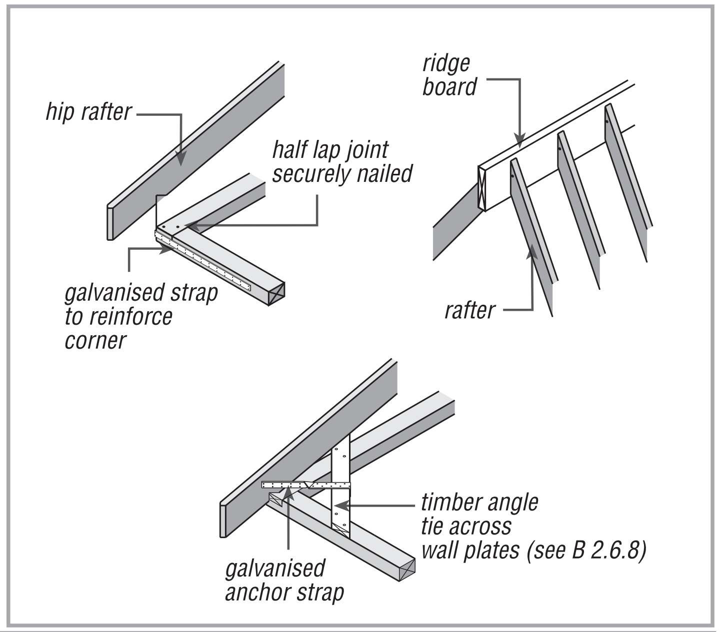
B 1.2 CUT ROOFS - RAFTER DETAILS



DETAIL B 1.2.1 Support at Wall Plates



DETAIL B1.2.2 Support at Purlins



DETAIL B 1.2.3 Support at Ridge and Hipped Ends

Uplift forces

Uplift forces acting on a roof will depend on a number of factors including; the weight of the roof covering, the location of the building, the roof angle and the height of the building. Uplift forces must be catered for and must be designed by a qualified engineer.

Support at wall plates

The rafters are usually birdsmouthed over and skew-nailed to the wall plate although other details are possible. It is recommended that the wall plate and rafter ends as well as any site cut ends be treated with a suitable timber preservative. Rafters should be triangulated with a ceiling tie or walls reinforced with a ring beam to cater for any horizontal loads. Rafters should be fixed down to the supporting structure to cater for any uplift forces and the fixing details should be designed by a suitably qualified engineer.

Support at purlins

The rafter should be fixed to a cant purlin by skew-nailing on each side of the rafter. Where a purlin is installed vertically the rafter should be birdsmouthed over and skew-nailed to the purlin. The depth of the notch should not exceed one third of the depth of the rafter. Where purlins are placed vertically there may be a horizontal thrust which would have to be catered for.

Support of purlins

Purlins must be supported by load bearing walls or by structural beams and any horizontal thrust from the purlin must be catered for. The strut and its associated connections and supports should be of adequate size and strength to resist buckling and to carry the appropriate loading. How the purlin is supported affects the bearing stresses acting on the purlin; Swift 6 recommends the use of 75 x 150 mm struts at each end of a purlin and that purlins use butt joints at their supports. Shear and bearing stresses may limit the purlin span especially for scarf and half joints and these joints are not covered in Swift 6.

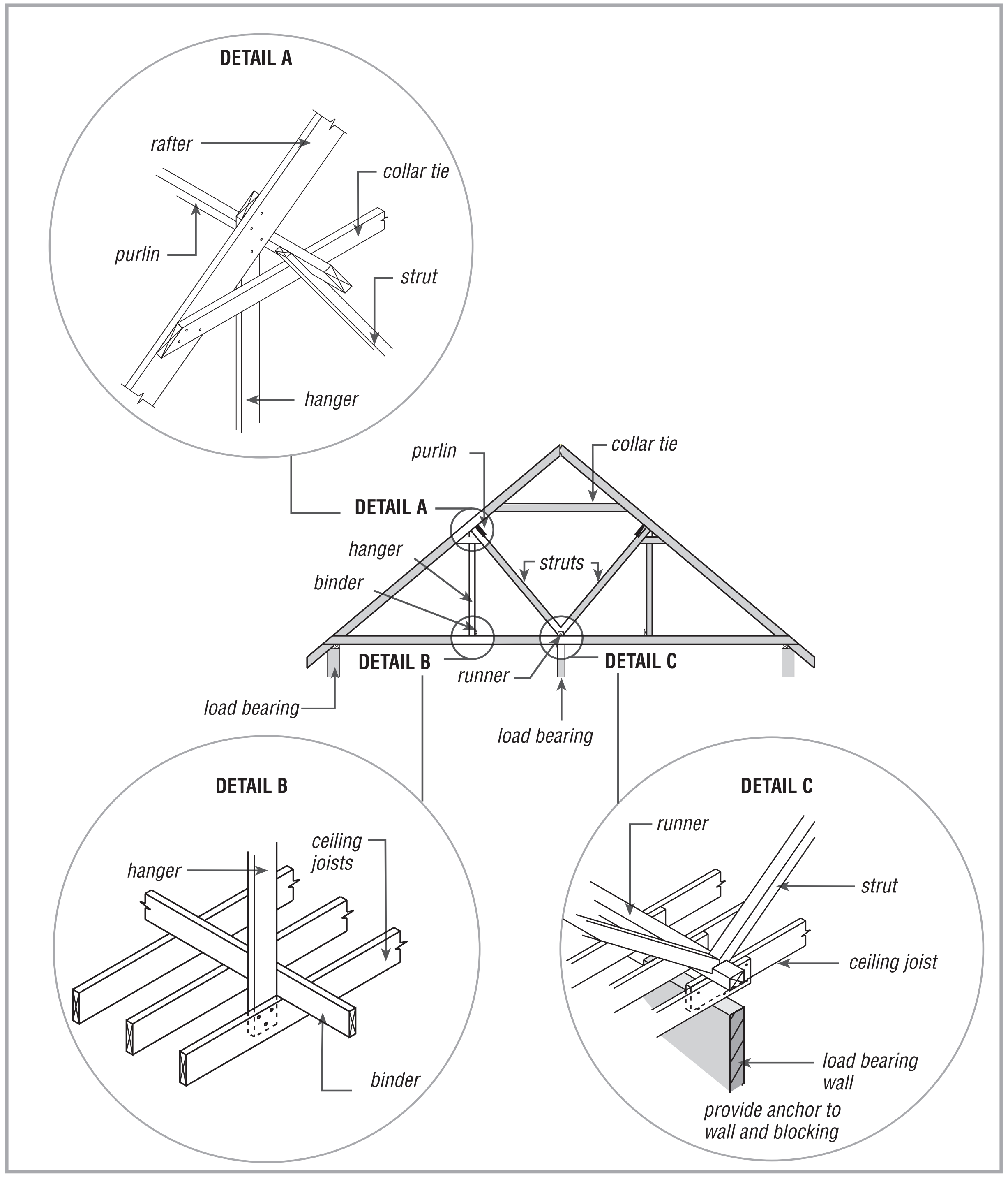
Support at hipped ends, ridge and valleys

In addition to skew-nailing hipped rafters at wall plate level, the wall plates should be reinforced either by using a steel strap tying the wall plates together, or a steel anchor strap may be fixed to a timber angle cut into or fixed to the wall plates (see detail B.1.2.3.). The steel straps should be galvanised steel or austenitic stainless steel and the nails used to fix these straps should be of the same material. There can be significant horizontal forces acting from a valley and these must be catered for; valleys must be designed by a qualified engineer.

Support at ridge level

At ridge level the rafters should be skew-nailed to the ridge board. Care should be taken to ensure that the rafters are opposite each other and that the ridge board is capable of resisting any eccentric horizontal load. Any uplift forces at this level should be catered for as directed by the design engineer.

B 1.3 CUT ROOFS - PURLIN DETAILS



DETAIL B 1.3.1 Typical Purlin Support Arrangement

Purlin support and arrangement

Purlin loads must be transferred to load-bearing walls or properly designed joists or beams.

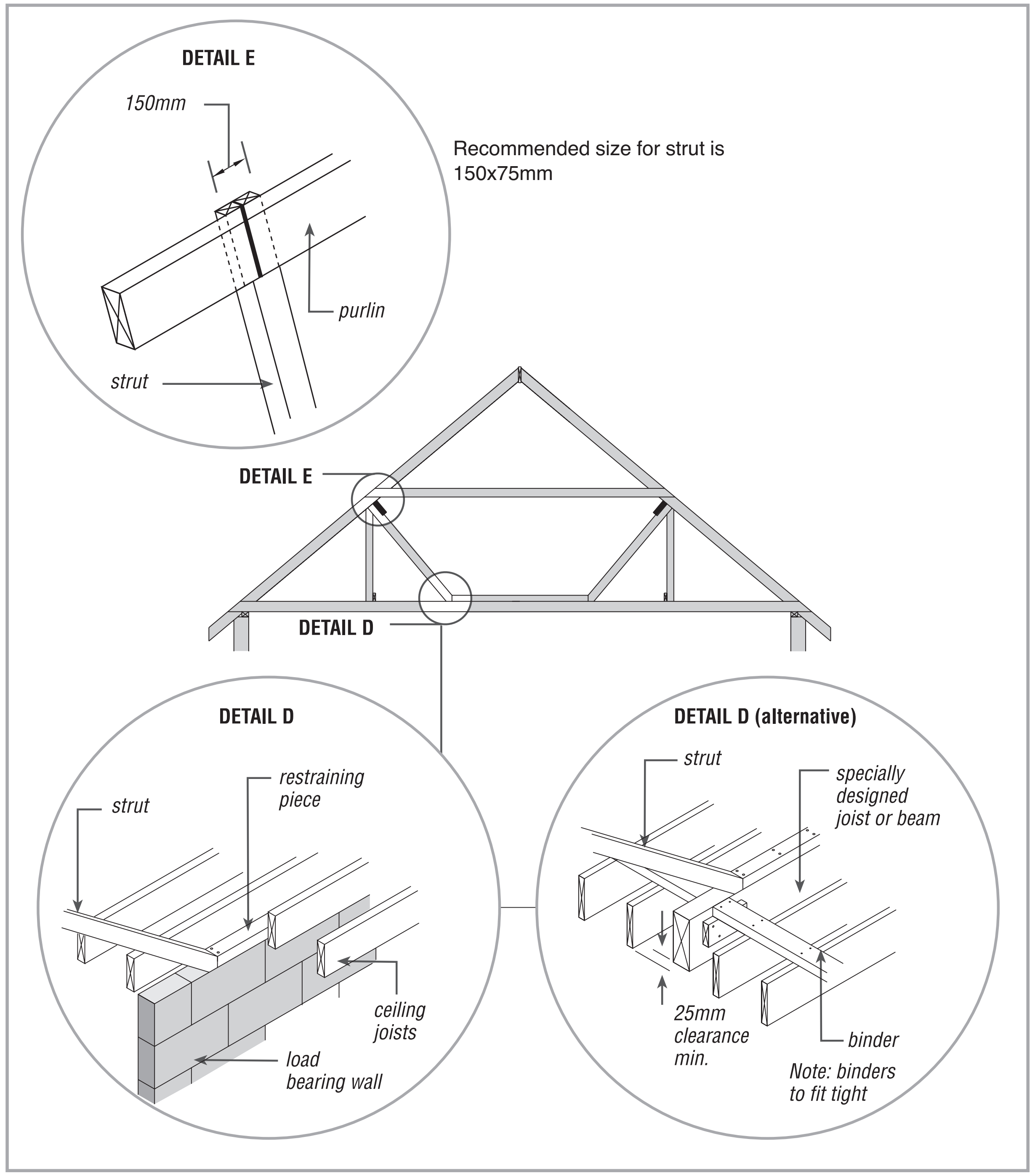
DETAIL A - Typical arrangement at junction of rafter, purlin, hanger and collar tie. Additional collars may be placed between purlin supports.

DETAIL B - Typical arrangement at junction of hanger, binder and ceiling joist. Typical hanger and binder sizes are 100x36 mm but larger sections may be required. The hanger/binder provides support to the ceiling joists (and can limit the deflection of the ceiling tie if the connections and general arrangement are designed for this). The binder should be securely fixed to each ceiling joist and the hangers are usually provided at every third rafter.
The binder should be nailed to the ceiling joists and rafters after the roof is loaded but before plasterboard is fixed to ceiling.

DETAIL C - Typical arrangement of struts at ceiling level where the ceiling joists overlap at a supporting wall. The lap should be a minimum of 300mm and double nailed at either end. The vertical loads from the strut are taken by the wall while the horizontal strut loads cancel each other out if the roof is symmetrical. The connections and general detail here should be provided by the design engineer.

B 1.3 CUT ROOFS - PURLIN DETAILS (CONTINUED)

DETAIL B 1.3.2 Typical purlin support and arrangement



DETAIL D **-** Strutting of purlin on to a load-bearing wall. The restraining piece caters for the horizontal thrust from the strut. Again the details here should be provided by the design engineer.

ALTERNATIVE DETAIL D **-** Where a purlin cannot be propped onto a load-bearing wall it may be propped on a specially designed joist(s) or beam which transfers the load to a load-bearing wall or structural frame.

A minimum of 25mm clearance should be left between the bottom of the beam and the underside of the ceiling joists to accommodate any differential deflection.

Purlin splices

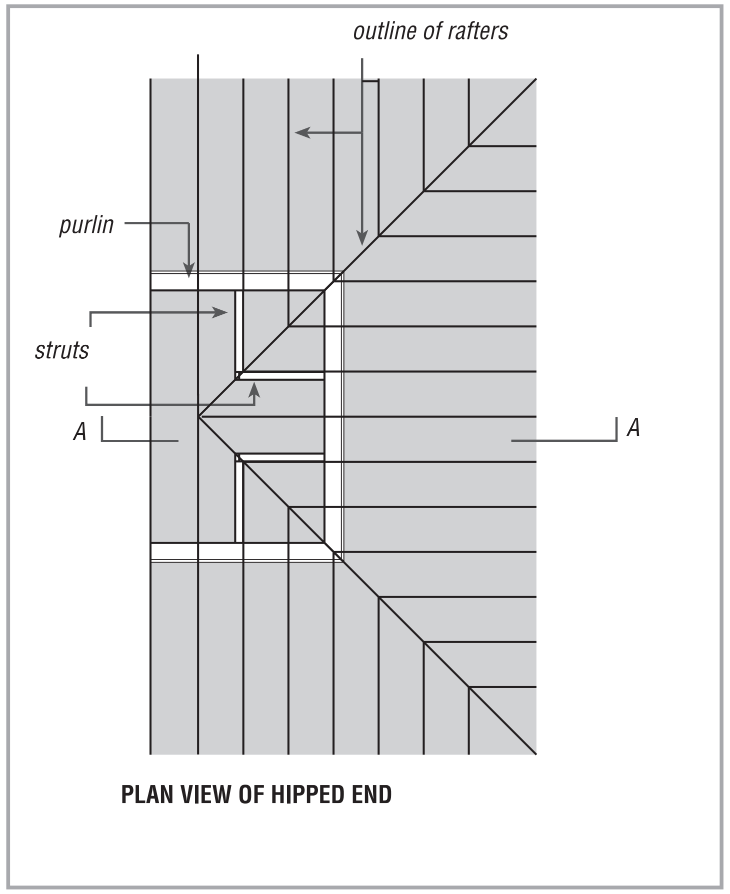
DETAIL E **-** Where purlins are be connected by halving joints, the joints should be a minimum of 150mm long and support must be provided directly below the joint. The use of this joint is not recommended as the joint is often poorly cut on site and shear requirements result in short purlin spans. Swift 6 caters only for butt joints; purlins with half or splice joints require a special design; bearing and shear stresses must be checked and these depend on how the purlin is supported.

B 1.3 CUT ROOFS - PURLIN DETAILS (CONTINUED)

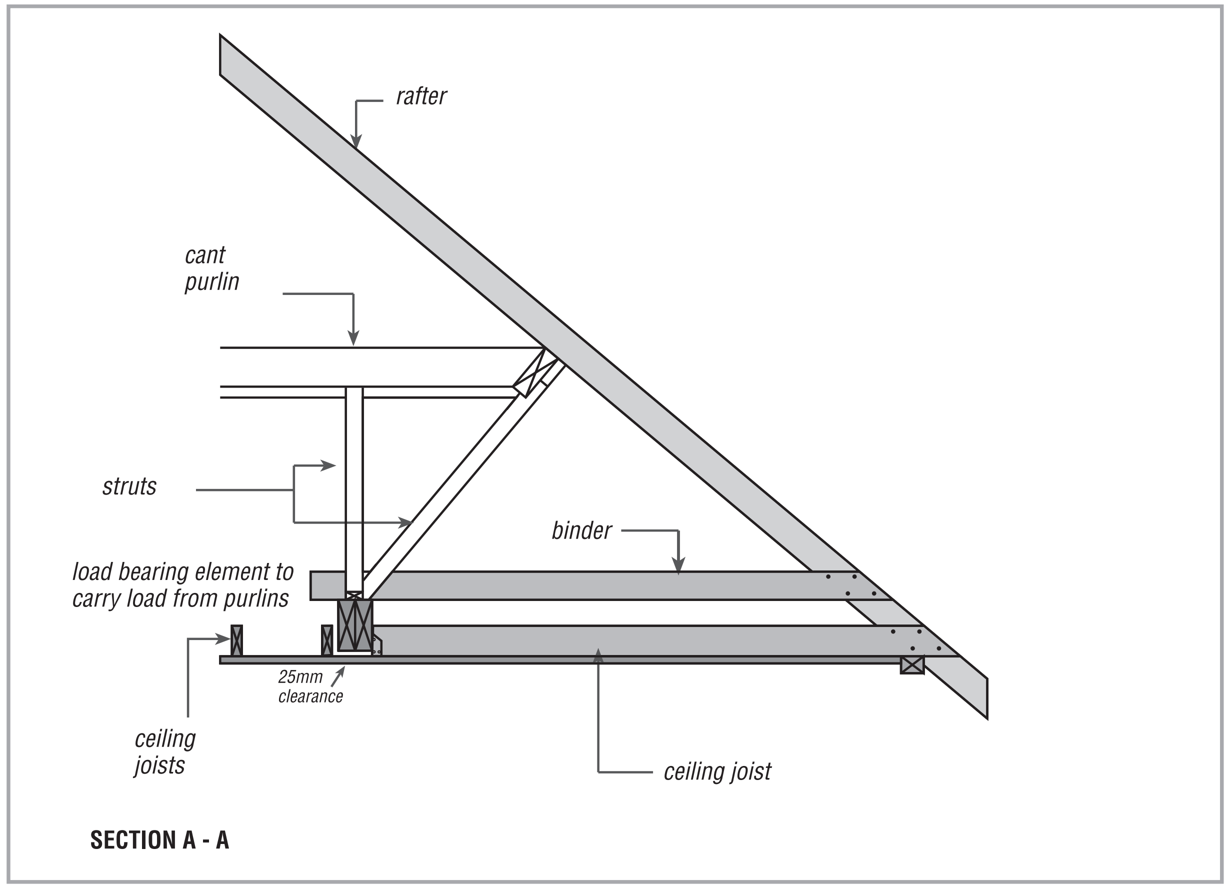
Cantilevered purlin

The hipped rafter must be adequately supported by the purlins at their intersection. The purlins should be mitred and securely nailed together. Purlins should not cantilever by more than 900mm and the struts should be supported by load-bearing members. Any cantilevered purlin should be continuous over the cantilevered support.

The hip board is usually birdsmouthed over the purlin so as the purlin provides support to the board.

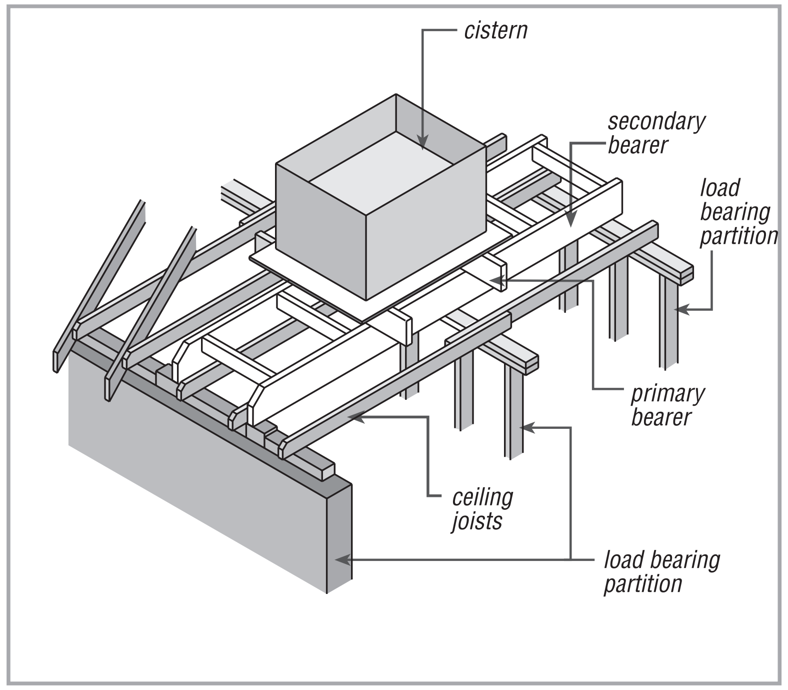


DETAIL B 1.3.3 Typical hip end purlin detail



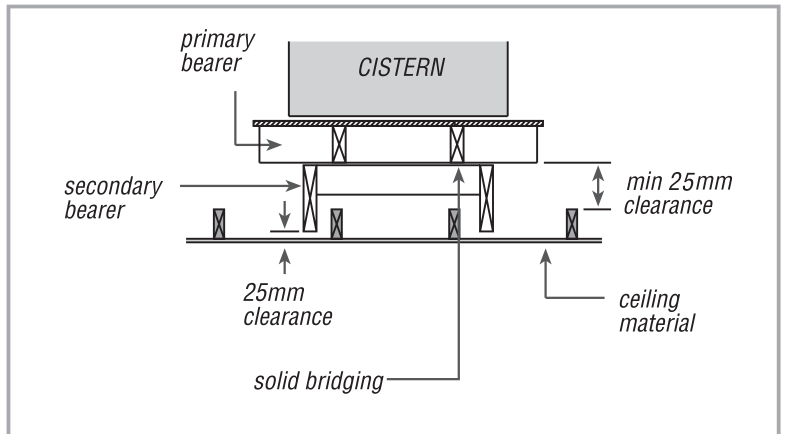
DETAIL B 1.3.4 Cantilevered purlin detail

B 1.4 CUT ROOFS - WATER CISTERN SUPPORT



DETAIL B 1.4.1 Water Cistern Support over Partition

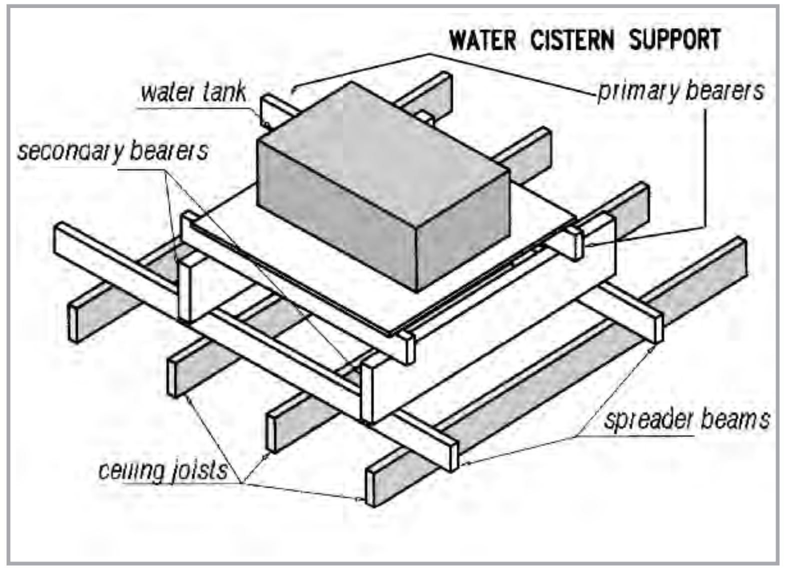
Water cistern support
The water cistern in a cut timber roof should be supported by a framework directly over and off load bearing walls. Alternatively the framework can transfer the cistern loads to a supporting wall or structure. The design of the framework will depend on the size of the cistern and the distance it has to span.



Water tank supported independently of ceiling joists

DETAIL B 1.4.2 Water Cistern Support

Typically twenty five millimetres clearance should be left between the underside of the framework and the ceiling slab, to allow for deflection. (Detail B1.4.2).



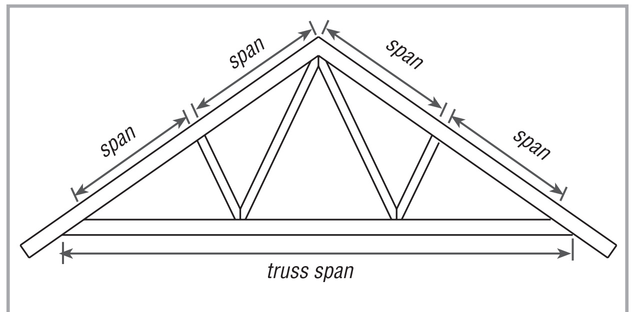
DETAIL B 1.4.3 Ceiling Joist Supporting Tank

An alternate arrangement could involve spreading the load of the tank over ceiling joists as shown in B1.4.3. The spreader beams should span at least four joists; the framing and the joists must be designed for the cistern size and appropriate spans. See detail 2.5.3 for water tank supports on roof trusses.

B2 Trussed rafter roofs

B 2.1 GENERAL

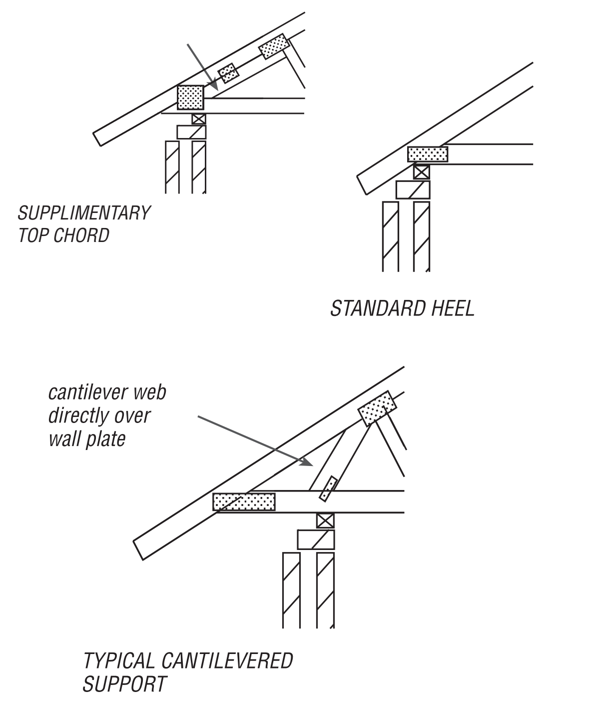
Swift 5 provides Non-Contradictory Complimentary Information (NCCI) for designs to Eurocode 5; this information includes limits on bay lengths related to timber sizes. In the UK similar information is included in PD 6693. The system owners (see below) have design software for Eurocode 5 and can still provide designs to the permissable stress standards IS193 and BS5268-3.



FINK TRUSS
The most commonly used truss shape. Easily accomodates a water tank.

DETAIL B 2.1.1 Fink Truss

EAVES DETAILS



DETAIL B 2.1.2 Truss Support

Spans
The selection of truss configuration is dependant on a number of factors

- Span
- Loadings
- Timber size and strength class
- Roof profile

When measuring the span of a truss, measure between the intersection points of the lower edges of the rafters and ceiling ties.

Support
For a trussed rafter to perform satisfactorily, adequate restraint (usually through the use of bracing, straps and truss clips) and bearing must be provided. Truss designers should check bearing, wall plates and specify its' minimum strength class; typically C14 or C16.

To allow for tolerances, consider increasing the span by 25mm on either side to allow for adjustment on the wall plate.

Care should be taken not to introduce internal supports for roof trusses where the trusses have not been designed for such supports. In addition where trusses pass over non-load-bearing partitions, a gap (usually about 25mm) should be left between the top of the partition and the underside of the truss to allow for the thickness of plasterboard and truss deflection.

Design of overall stability
To act as a single structural unit the trussed rafters should be braced in accordance with the recommendations of the truss, roof and building designer.

It is the responsibility of the trussed rafter designer to design the individual roof trusses and if requested the overall roof. The building designer may require additional bracing (for example to stabilise walls) in the roof structure.

Strength classes
Most roof trusses use C24 or TR26 timber. However, other strength classes may be used and the minimum strength class recommended for roof truss design and fabrication is C16.

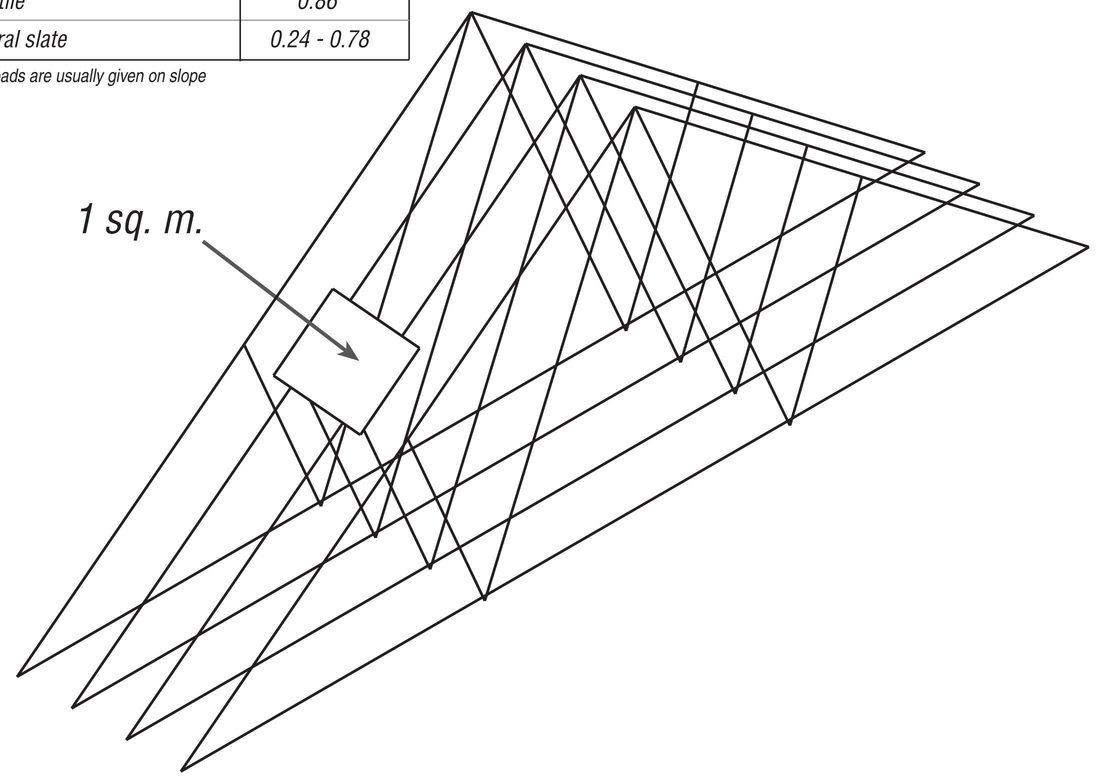
Approved manufacturers
It is recommended that roof trusses be manufactured under a quality system subject to monitoring by an appropriate third party. The National Standards Authority of Ireland (NSAI) operates a Roof Truss Manufacturers Approval Scheme and maintains a National Register of approved manufacturers; this register is available on the NSAI website. There are similar schemes in the UK operated for example by TRADA.

System owners
'System owner' is the term used to describe a company that provides truss fabricators with the design system, engineering backup, software and punched metal plates used in truss joints.

B 2.2 TRUSSED RAFTER ROOFS - DESIGN INFORMATION

roof covering	Typical load kN/m^2
asbestos slate	0.17 - 0.24
concrete tile	0.42 - 0.68
clay tile	0.86
natural slate	0.24 - 0.78

These loads are usually given on slope



DETAIL B 2.2.1 Roof Covering

EN14250, IS193 & BS 5268-3

Prior to the introduction of Eurocode 5, roof trusses were designed using permissible stress standards; IS 193 (Timber trussed rafters for roofs) in Ireland or BS 5268: Part 3 (Structural Use of Timber - Code of Practice for Trussed Rafter Roofs) in the U.K. In both cases the trusses should have been manufactured to EN 14250: Timber structures - Product requirements for prefabricated structural members assembled with punched metal plate fasteners.

In Ireland IS 193 has been withdrawn and designs should now be carried out to Eurocode 5. In the U.K. designs may be undertaken to Eurocode 5[2] or BS 5268-3 depending on the specification. For designs to Eurocode 5, reference should be made to not only the relevant National Annexes but also any Non-Contradictory Complimentary Information (NCCI) documents such as Swift 5 in Ireland and the proposed PD 6693 in the U.K.

For concrete roof tiles IS 193 gave a minimum dead loadings of 0.685kN/m^2 for rafters [2](measured on slope) and 0.25kN/m^2 for ceiling ties. The appropriate load from a standard 270 litre cistern should be taken as acting on the ceiling tie unless the cistern is larger. However, roof trusses should be designed for the actual weight of the roof covering and ceiling loads; heavier finishes will result in greater loads while lighter finishes may result in roof uplift and stress reversal.

This includes 0.11kN/m^2 for the weight of supporting structure.

The building designer should specify the proposed dead load or roof covering, water cistern capacity and geographical location to the truss rafter manufacturer.

The trussed rafter designer should be made aware of the geographical location to enable correct the design to take account of the topography and correct local wind speed.

Wind speed maps are given in EN 1991-1-4 for designs to Eurocode 5 and were located in Technical Guidance Document A (Structure) to the 1997 Building Regulations for designs to permissible stress.

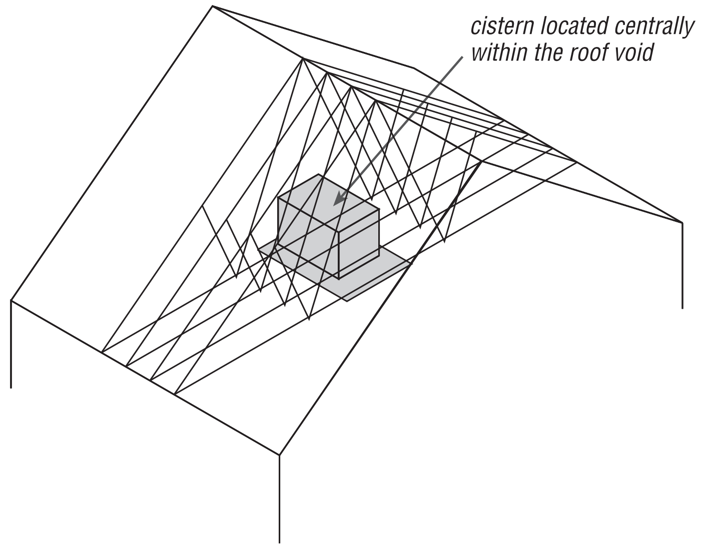
[2]The revised Technical Guidance Document A due to be published in 2012 will specify a date where designs must be to Eurocode 5. For the U.K. consult approved Document A or Building Control.

B 2.2 TRUSSED RAFTER ROOFS - DESIGN INFORMATION (CONTINUED)

Water cisterns

Where possible the water cistern should be placed centrally within the roof void and be supported by over a minimum of four trusses. Cistern supports should be provided to transfer the cistern load to node points of the supporting rafters.

Locating tanks in hipped ends should generally be avoided unless special provision is made for support.



DETAIL B 2.2.2 Water Cistern Location

Chimney and roof lights

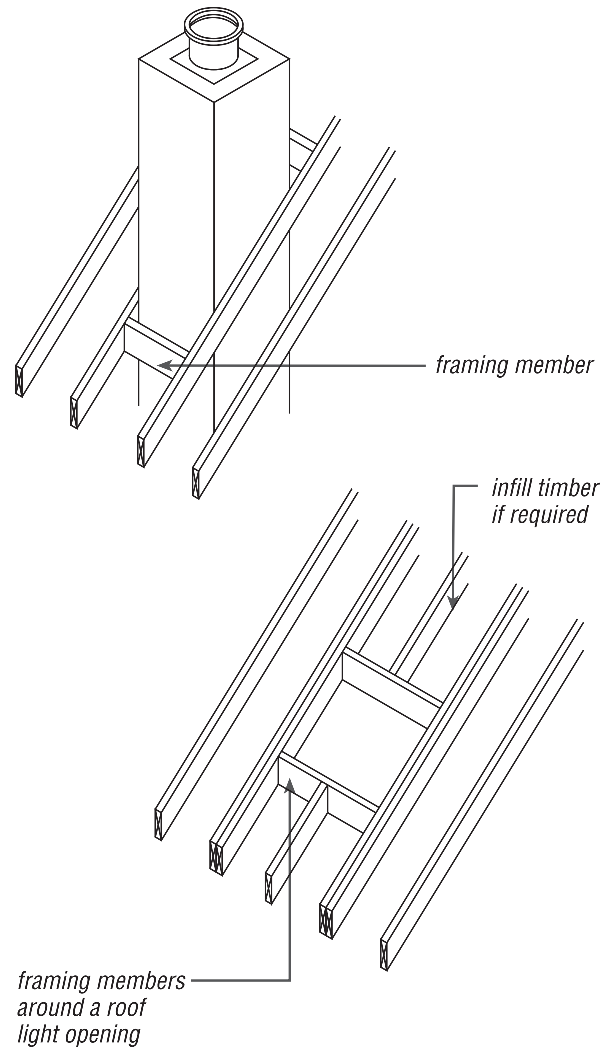
Where possible accommodate chimney, roof windows etc., in the standard spacing between trusses, and provide appropriate framing members.

Careful consideration at design stage should ensure that roof lights, dormer windows, chimneys, etc., do not coincide with the location of hipped or valley rafters and multiple trusses.

Technical Guidance Document J (Heat producing appliances) requires that there should be a 40mm space between combustible roof members and a chimney where the distance to the flue is less than 200mm. Any metal fixings should be at least 50mm from the flue. Similar requirements apply in the U.K.

It is recommended that cut rafters and framing members are supported by metal shoes rather than by skew nailing.

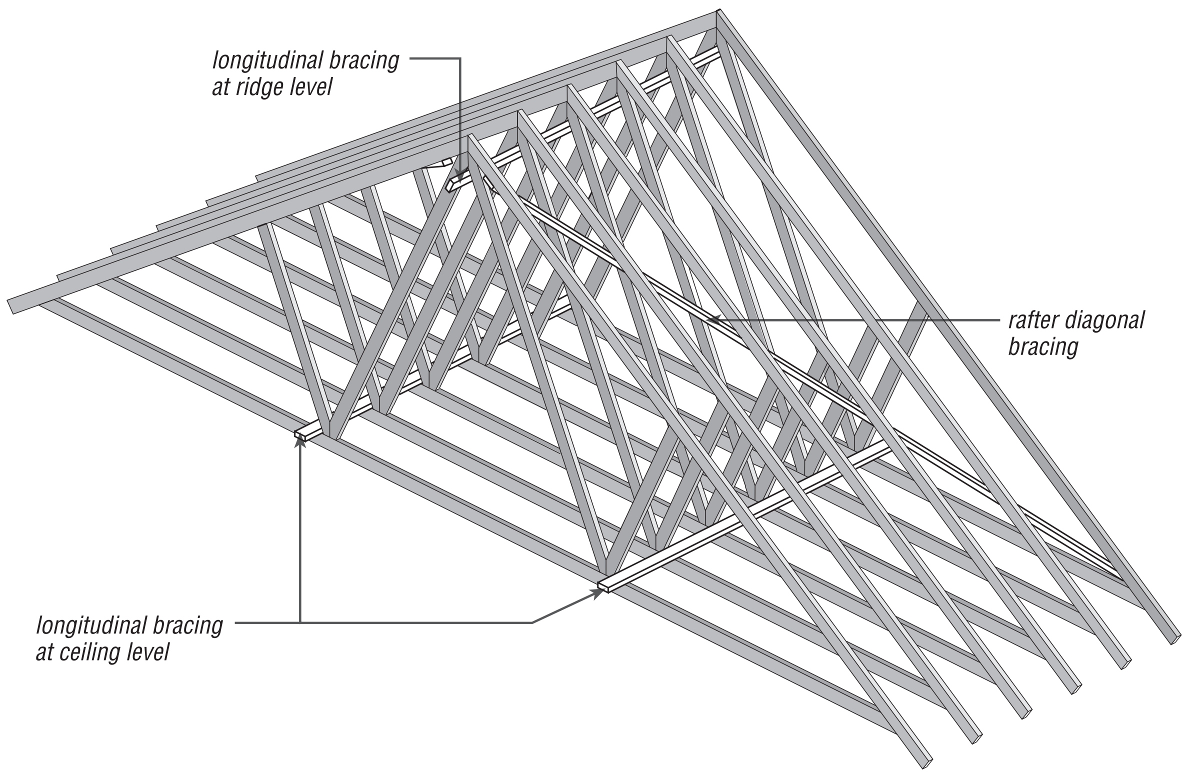
Refer to Section B6.6, drawings B6.6.5 to B6.6.7.



DETAIL B 2.2.3 Chimney& Roof Lights

B 2.3 TRUSSED RAFTER ROOFS - BRACING

DETAIL B 2.3.1 Prefabricated Roof Trusses - Minimum Bracing



Caution: length of roof with unsupported shear walls should be considered at design stage

General

Adequate bracing should be used to ensure that the prefabricated trussed roof acts as a single unit. The design of the bracing members is usually the responsibility of the roof designer and/or the truss manufacturer.

The recommended minimum bracing details for the majority of prefabricated trusses spaced up to 600mm are outlined in detail B2.3.1.

Longitudinal bracing (binders):
Located at ceiling level and at internal node points, they add to the overall roof stability and help with the truss erection. They run at right angles to the trusses and should extend the whole length of the roof, finishing tight against the party or gable wall. Longitudinal bracing should be installed at the ceiling tie junctions with the struts and at the rafter apex.

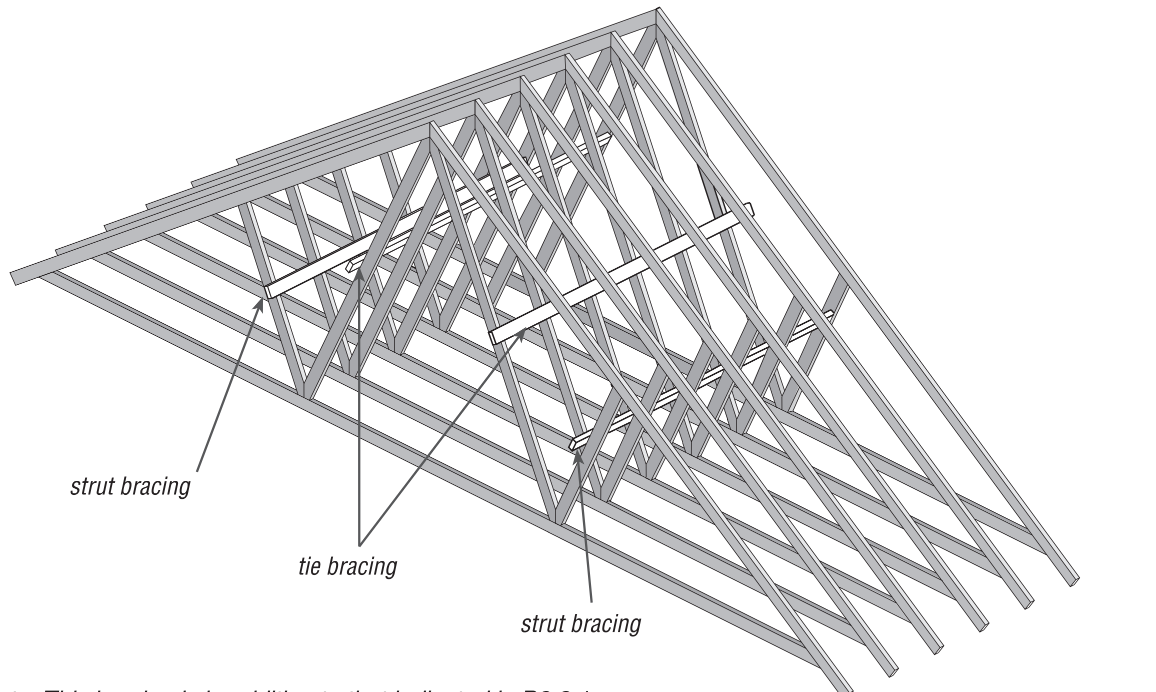
It is common now to brace all node points including the rafter and strut junctions. In steep roofs tension members (e.g. a queen tie) sometimes have longitudinal bracing at mid-span to cater for stress reversal from wind loads. Heavily loaded compression members (struts) may also require additional longitudinal bracing. Examples of additional longitudinal bracing are shown in Details B 2.3.2 and B 2.3.3.

Rafter diagonal bracing:
They run from eaves to rafter apex on both sides of the roof, and help to provide resistance against lateral (sideways) buckling. The rafter diagonal brace is nailed to the underside of the rafters, is often fixed to the wall plate and runs up to the rafter apex at an angle of between 35 and 50 degrees on plan. Longitudinal and diagonal bracing should extend over the whole length of the roof, with a minimum of four diagonal braces being provided in the roof.

Chevron bracing:
Examples of chevron bracing are shown in details B 2.3.3 and B 2.3.4 and usually are required when additional longitudinal bracing is inserted at the mid-point of members. Chevron bracing also helps to stabilise the whole roof but is rarely continuous over the whole roof usually being placed only at the roof ends.

B 2.3 TRUSSED RAFTER ROOFS - BRACING (CONTINUED)

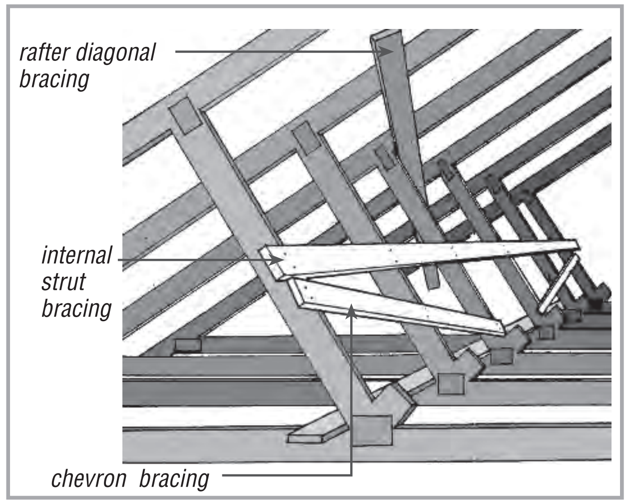
DETAIL B 2.3.2 Prefabricated Roof Trusses - additional bracing



Note: This bracing is in addition to that indicated in B2.3.1

Bracing is usually specified by the truss fabricator/designer and relates to the individual trusses and their erection. Swift 5 and BS 5268-3 (as did I.S. 193) specify a minimum amount of bracing. However, the roof designer and building designer may specify additional bracing e.g. to cater for roof diaphragm action and for wall stabilisation.

DETAIL B 2.3.3 Internal Bracing



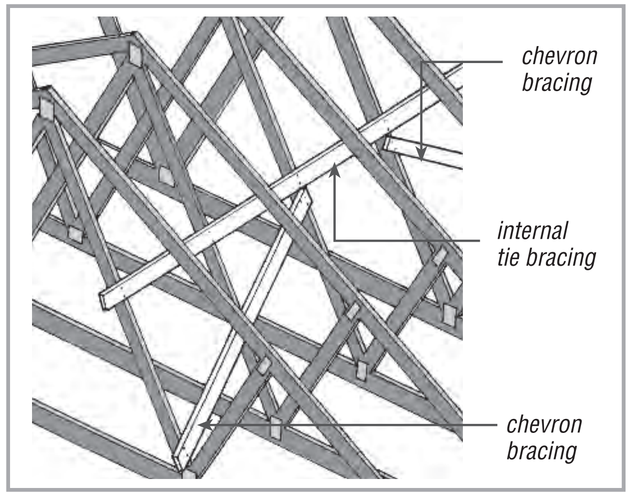
Fixing bracing

Bracing timbers should be at least 97 x 22mm, free from major strength reducing defects and fixed with 2 No. 75mm x 3.1mm galvanised nails to every rafter.

Any laps in bracing members should be carried over at least two trusses, see Detail B2.3.5.

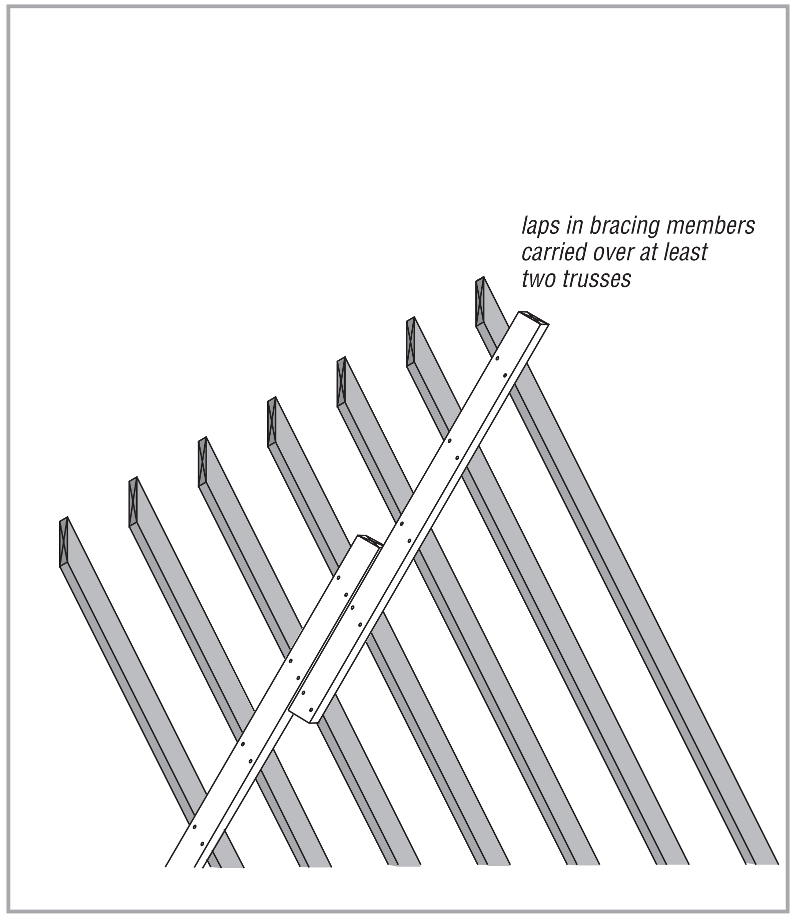
Where diagonal braces intersect, the junction should be completed with a splice plate at least 1200mm long, see Detail B2.3.6.

DETAIL B 2.3.4 Internal Bracing



B 2.3 TRUSSED RAFTER ROOFS - BRACING (CONTINUED)

DETAIL B 2.3.5 Fixing Bracing

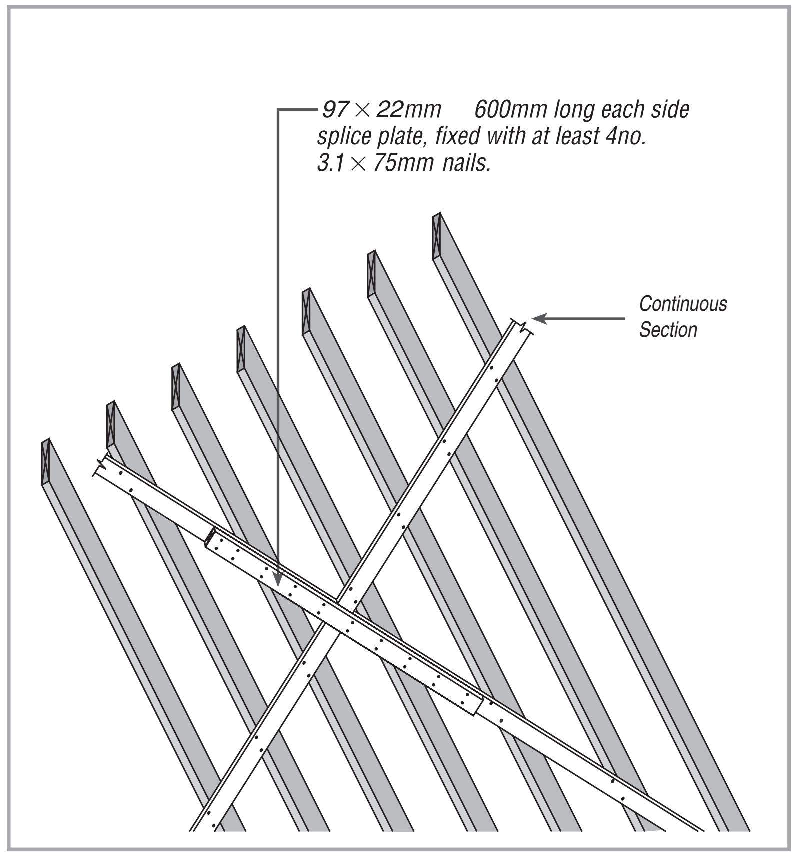


Fixing bracing

Bracing timbers should be at least 97x22m, free from major strength reducing defects and fixed with two 75mm galvanised nails.

Any laps in bracing members should be carried over at least two trusses, Detail B2.3.5.

DETAIL B 2.3.6



Where diagonal braces intersect, the junction should be completed with a splice plate at least 1200mm long, Detail B2.3.6.

B 2.4 TRUSSED RAFTER ROOFS - ANCHORING DOWN

Truss fixing

Prefabricated trusses are subject to wind uplift and they should be anchored to the supporting structure. The preferred method for fixing a truss to a wall plate is to use proprietary truss clips. All the nail holes should be utilised using appropriate nails in accordance with the manufacturer's recommendations (B2.4.1).

An alternative method is to use a twist strap to provide a positive fixing between masonry and truss.

Skew-nailing should only be considered where the workmanship on site is of a standard high enough to ensure nail plates, joints and timber members will not be damaged by inaccurate positioning or overdriving of the nails. A minimum of two galvanised round wire nails of at least 4.5mm diameter and 100mm long should be used to secure each truss to the wall plate, one driven from each side.

Where nailing through the plate cannot be avoided the nails should be driven through the holes in the fasteners (B2.4.2).

Wall plate fixing

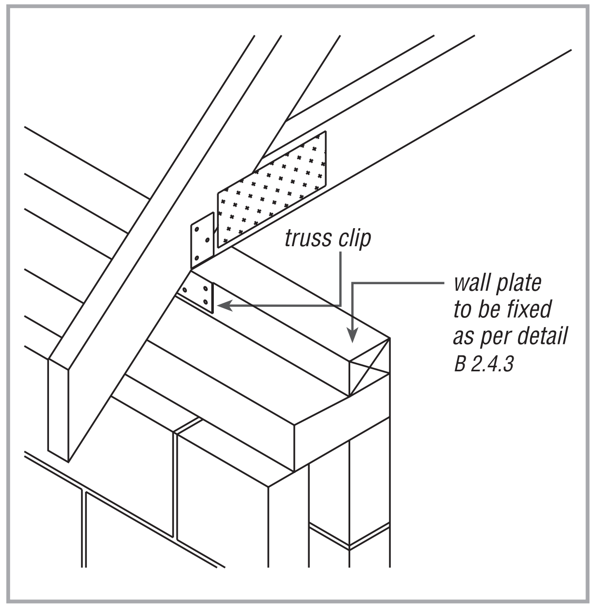
Wall plates should be fixed to the supporting structure usually by metal straps (or commonly bolts with concrete ring beams). When using straps they should be a minimum of 1000mm long, 30x5mm in cross section, galvanised or stainless steel and located between 1200mm and 2000mm centres. Straps should be fixed to masonry by means of suitable shot-fired nails, screws or have tail built into the mortar bed joint. A minimum of three fixings should be made to the masonry, at least one of which should be located within 150mm of the bottom of the strap (B2.4.3). Wall plates in contact with masonry should receive preservative treatment and it is good practice to place a DPC under the wallplate.

Care should be taken not to fix nails or screws into mortar.

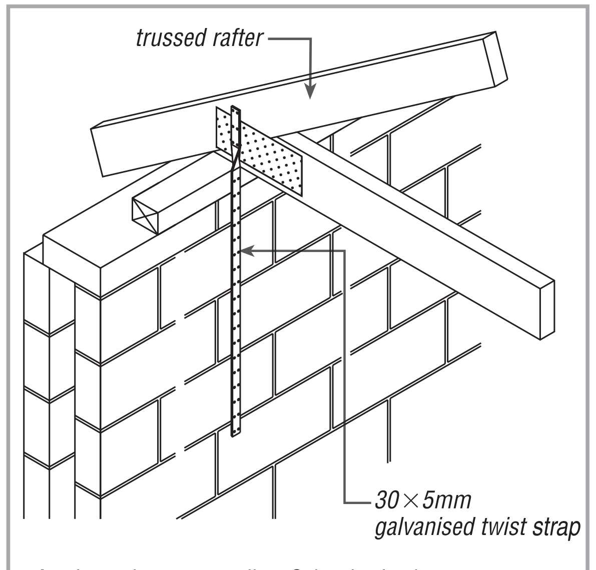
All holding down straps should conform to EN 845-1 (which refers to test standards). The fixings should be in accordance with the strap manufacturers' recommendations and should be specified by the design engineer for the forces acting on the trusses and roof.

The amount of galvanising should be specified by the building designer, and austenitic stainless steel can be used for increased durability.

Fixings should be compatible with the strap to avoid electrolytic corrosion.



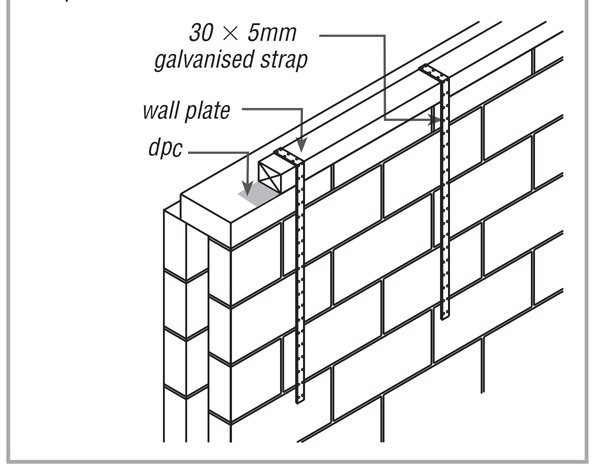
DETAIL B 2.4.1 Truss Fixing



An alternative to truss clips. Galvanised twist strap, 1000mm long min. Note: spacing of straps depends on wind loading.

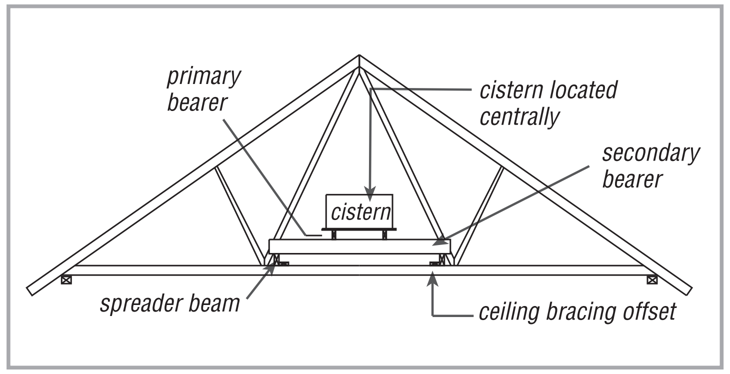
DETAIL B 2.4.2 Truss Fixing

Straps located at 1200 to 2000mm centres.

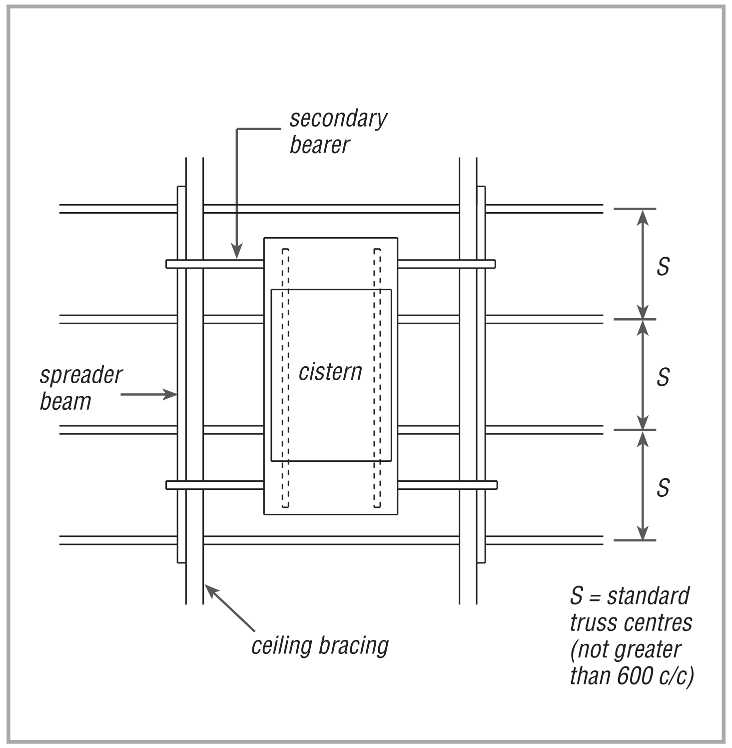


DETAIL B 2.4.3 Wall Plate Fixing

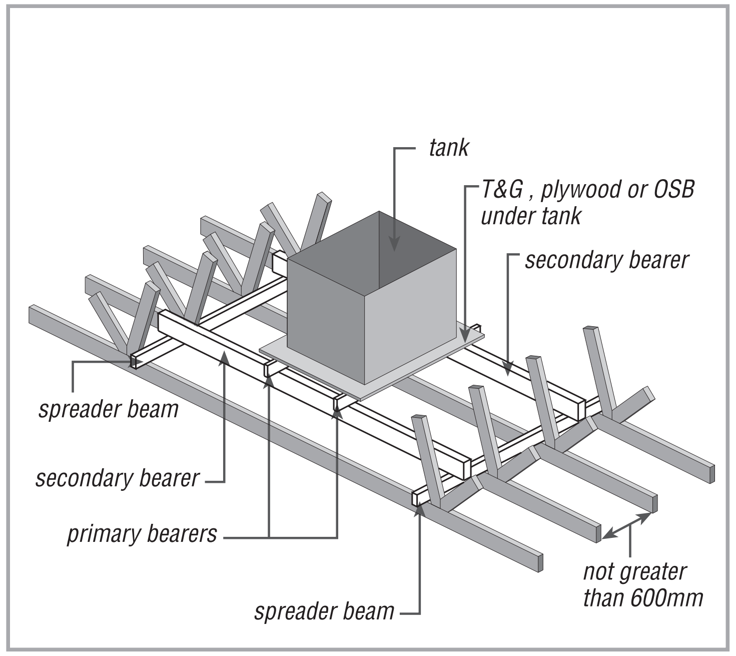
B. 2.5 TRUSSED RAFTER ROOFS - WATER CISTERNS



DETAIL B 2.5.1 Arrangement



DETAIL B 2.5.2 Plan



DETAIL B 2.5.3 Location

Support

To reduce the likelihood of local deflection and ceiling cracking, the water tank should be supported on a system of spreader beams and bearers. These provisions are adequate for the majority of standard conditions.

The spreader beams should be located as near to the node points as possible (B2.5.1).

HOUSE TYPE	CAPACITY
3 bed	270 litres
4 bed	340 litres

Water tanks with a nominal capacity of up to 270 litres should be spread over four trusses.

Support for larger capacity tanks requires special design (B2.5.2).

Location

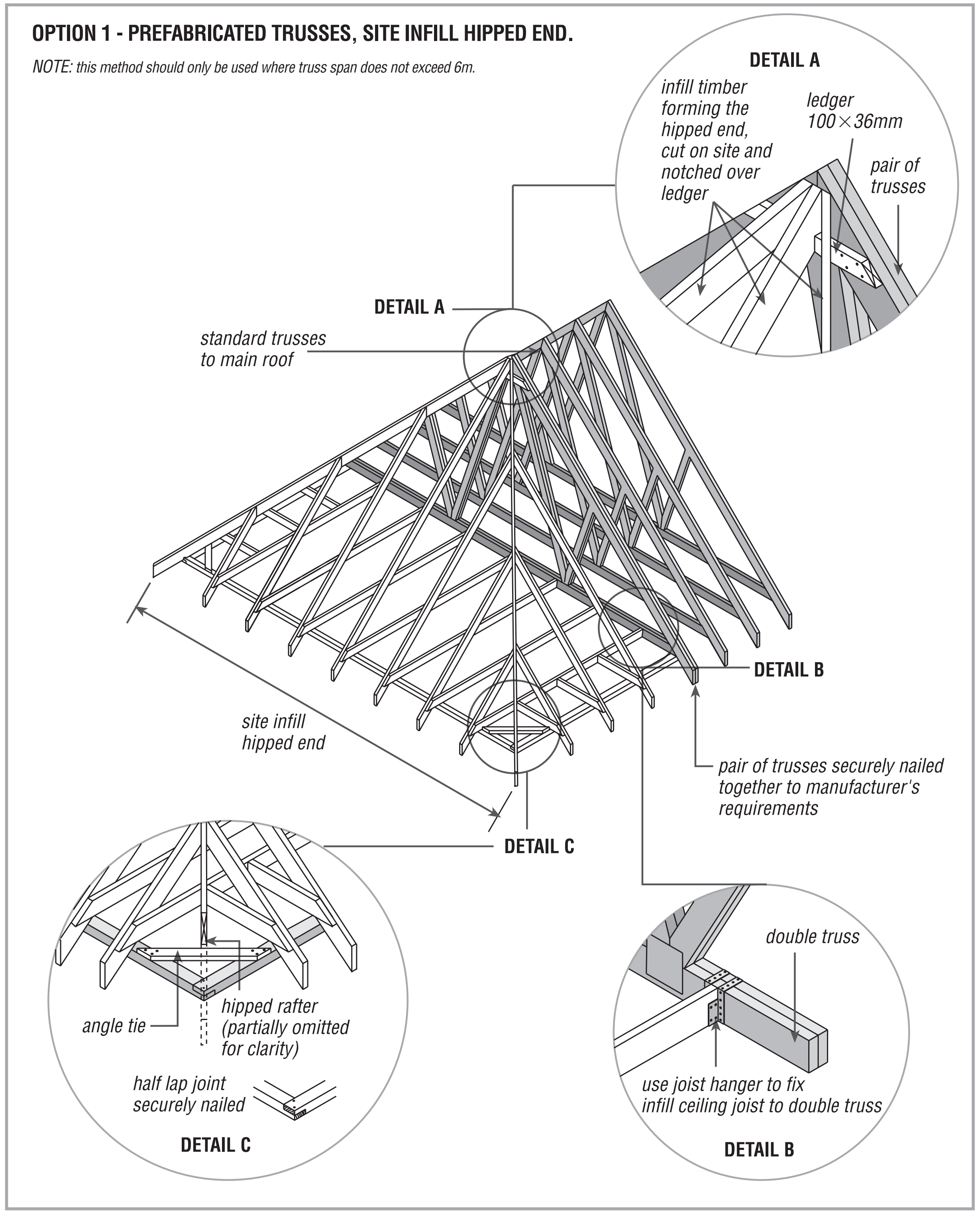
The water tank should be placed centrally within the bay, as illustrated in Detail B2.5.1, with the spreader beams located as close to the node points as possible. Skew-nail the secondary bearer to the spreader beam and the primary bearer to the secondary bearer (B2.5.3).

Where more than one water tank is required, no less than four trusses should carry the load of each tank (unless designed otherwise). The size of the tank support members can be taken from the table assuming the water tank itself is relatively light and its size is not greater than 270 litres; the minimum strength class should be C16.

minimum size of support members for 270L water tank

limit of span of truss	primary bearers	secondary bearers	spreader beams
m	mm	mm	mm
8.0	36 × 100	44 × 175	44 × 100
11.0	36 × 100	75 × 150	44 × 100

B 2.6 TRUSSED RAFTER ROOFS - HIPPED ENDS



DETAIL B 2.6.1 Typical Site Infill Hipped Ends

General

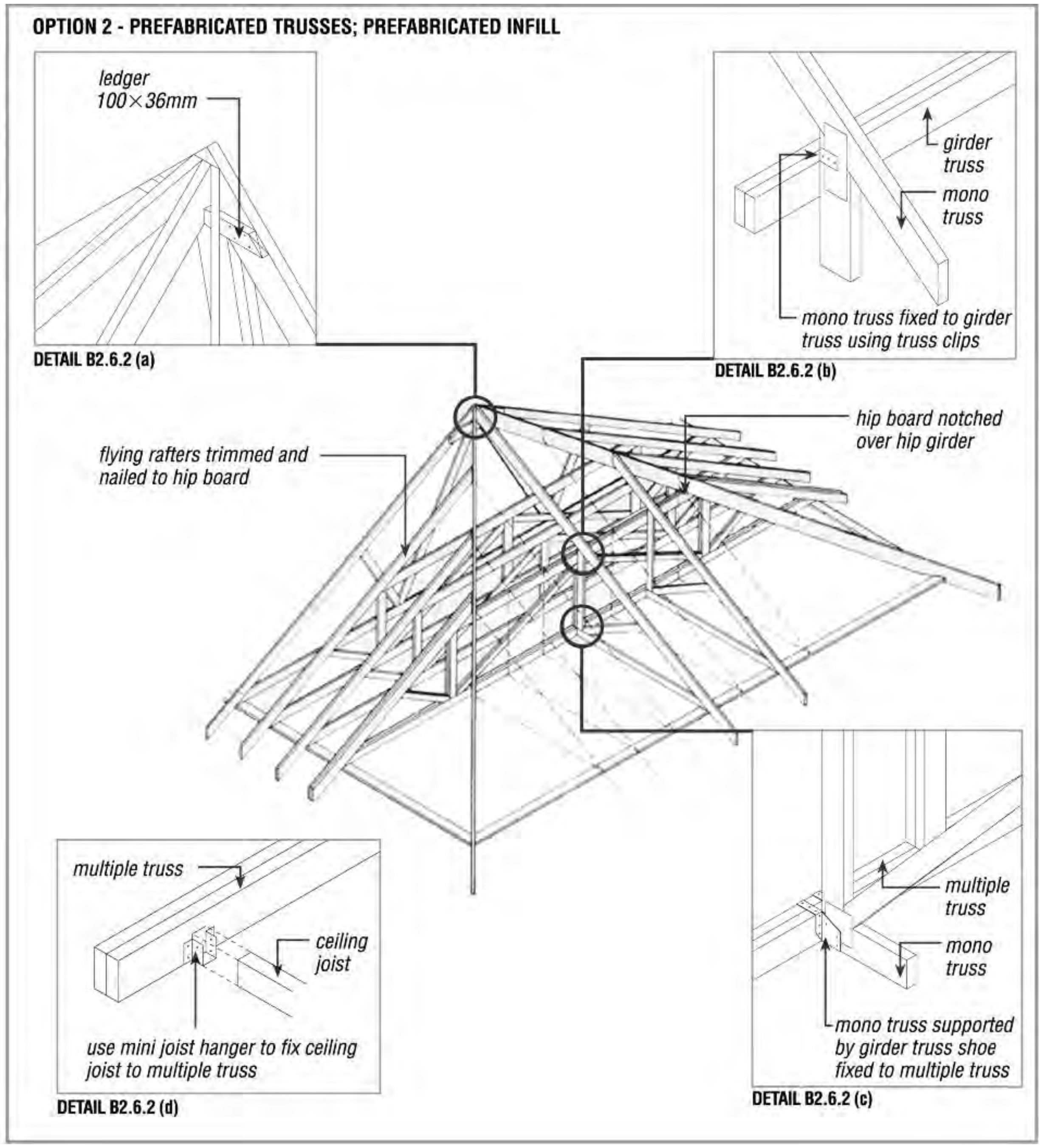
Hipped ends in a prefabricated trussed rafter roof can be formed in two ways:

1. Using site infill timbers to form the hipped ends, see Detail B2.6.1. This method should only be used where the span does not exceed 6m.

2. Using specially designed mono-pitch trusses, see Detail B2.6.3.

B 2.6 TRUSSED RAFTER ROOFS - HIPPED ENDS (CONTINUED)

DETAIL B 2.6.2 Prefabricated Hip



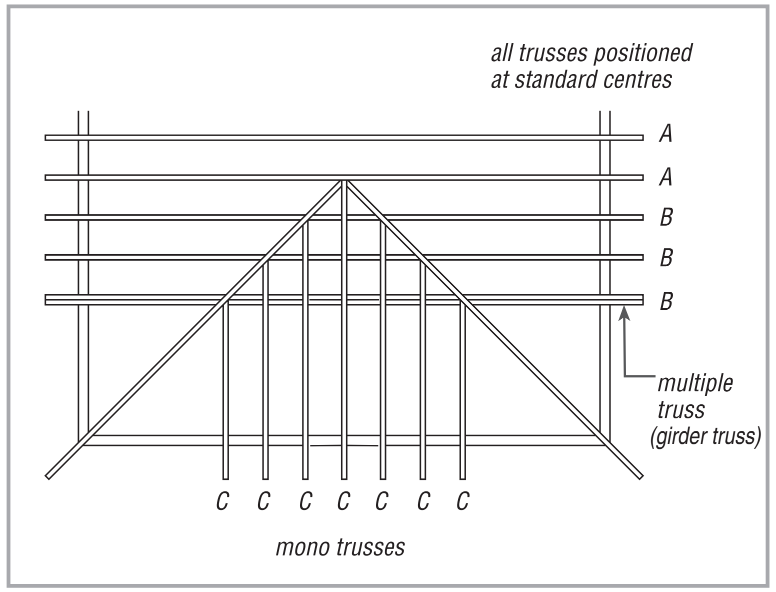
For trussed rafters with spans greater than 6m a common form of construction for a hip end comprises of a number of identical flat top hipped trusses, spaced at the same centres as the main trusses, and a multiple girder of the same profile supporting mono-pitch trusses.

The flying rafters on the hip and mono-pitch trusses are usually supplied full length and are cut back on site to ensure that they meet the hip rafter. The hip rafter is notched over the hip girder to provide a support and is taken to the apex of the hip, where it is usually supported on a ledger fixed to the last full profile truss.

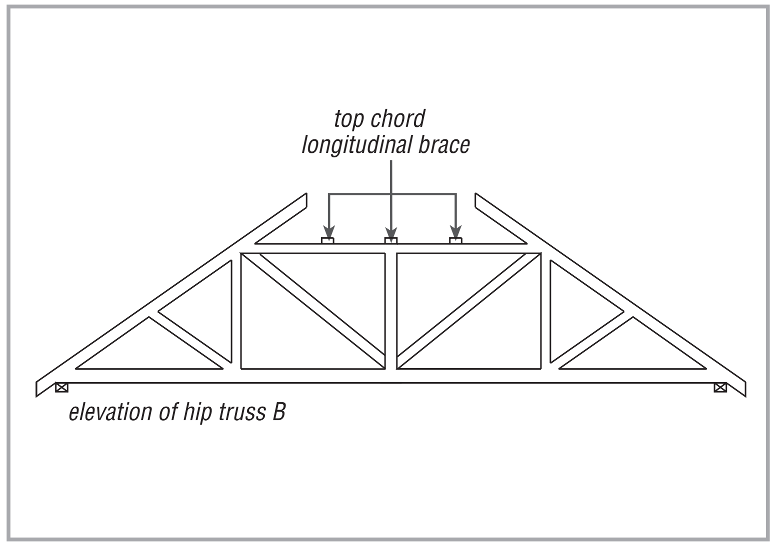
The corner areas of the hip are completed by using site cut rafters onto the hip rafter and infill ceiling joists spanning onto the hip girder.

B 2.6 TRUSSED RAFTER ROOFS - HIPPED ENDS (CONTINUED)

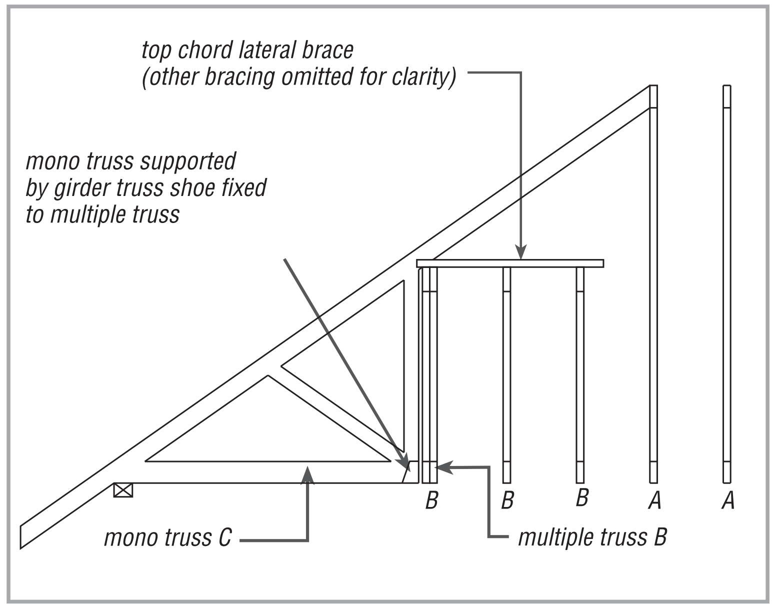
The horizontal top and bottom chords of the flat top hip trusses are usually braced of each other and also are braced to the hip girder truss (see Details B 2.6.4 and B 2.6.5).



DETAIL B 2.6.3 Girder Based Hip



DETAIL B 2.6.4 Two Stage Hip

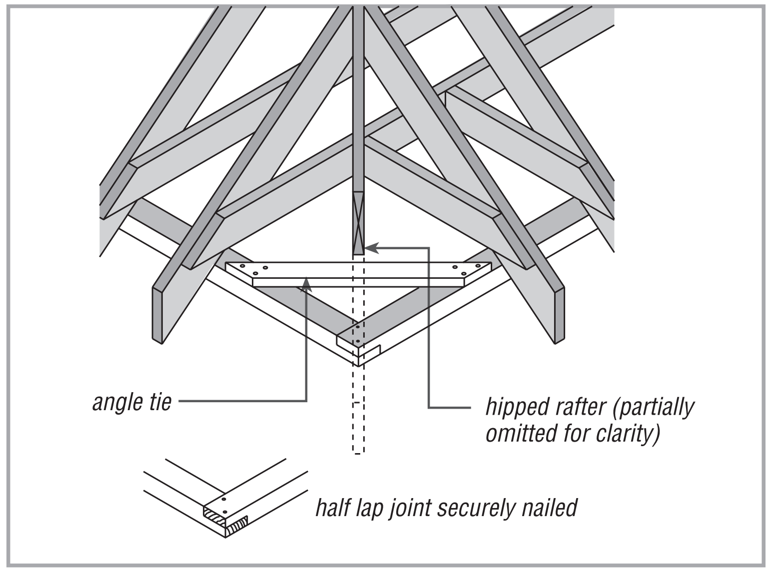


DETAIL B 2.6.5 Standard Setback Hip

Generally the ceiling joists of all trusses should be the same depth to aid the run and fixing of bracing. Flat-topped trusses should have the same configuration so that they can be braced off each other.

B 2.6 TRUSSED RAFTER ROOFS - HIPPED ENDS (CONTINUED)

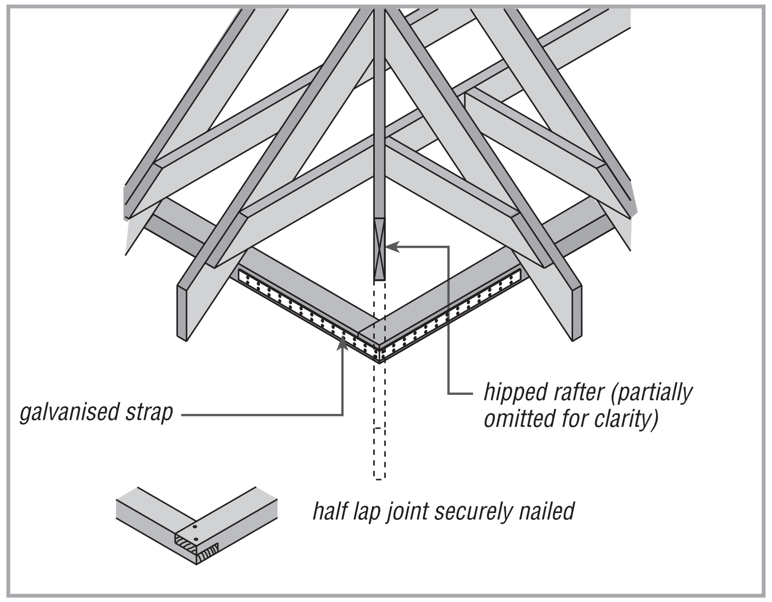
DETAIL B 2.6.6 Corner Details



Corner details

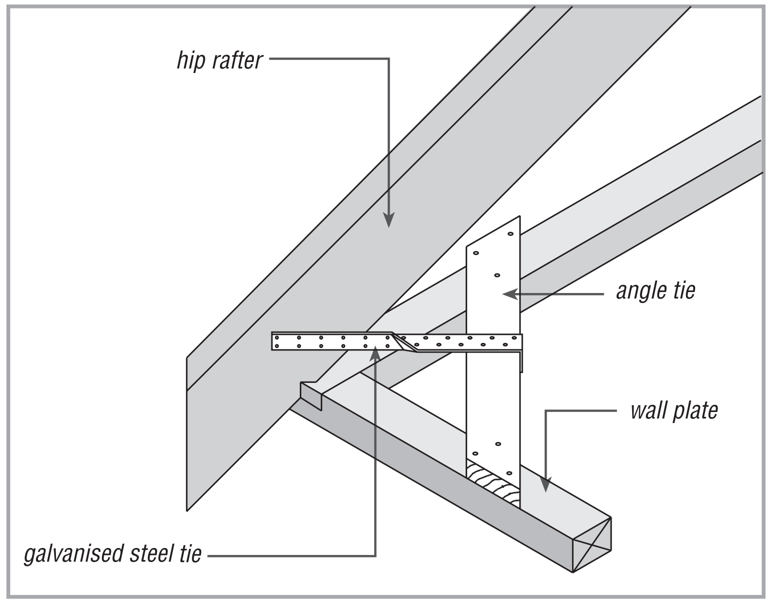
To cater for outward thrust at the corner under the hip, the wall plates should be half lap jointed and securely nailed.

DETAIL B 2.6.7 Corner Details



The corner should then be reinforced by means of an angle tie (Detail B2.6.6) securely nailed to the wall plates and/or a galvanised steel strap can be used to reinforce the corner. (Detail B2.6.7)

DETAIL B 2.6.8 Corner Details



A galvanised steel dragon tie may also be used to reinforce the corner junction (Detail B2.6.8).

Where there is a greater risk of corrosion consideration should be given to using austenitic stainless steel rather than galvanised steel whose durability is dependent on the amount of galvanising present on the strap.

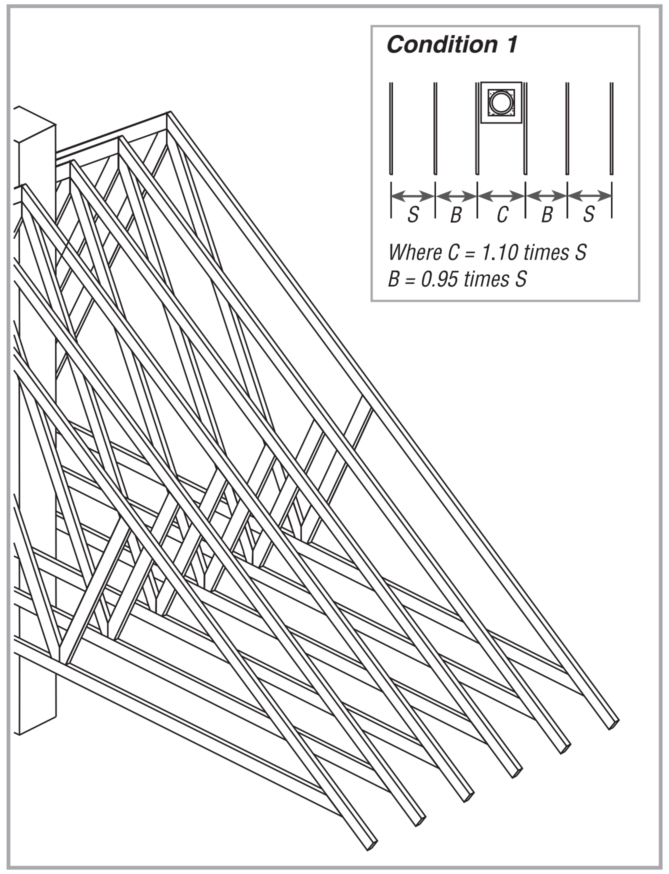
Do not mix metals: use galvanised nails with galvanised straps and austenitic stainless steel nails with austenitic stainless straps.

B 2.7 TRUSSED RAFTER ROOFS - SPACING CONDITIONS

Condition 1: Truss spacing up to 660mm

At openings increasing truss centres by up to 10% (i.e. 660mm approximately for 600mm centres) causes no significant over-stressing of the tiling battens or truss.
(See B 2.7.1)

Definitions:
S = standard truss spacing (normally 600mm)
C = increased truss spacing
B = reduced truss spacing

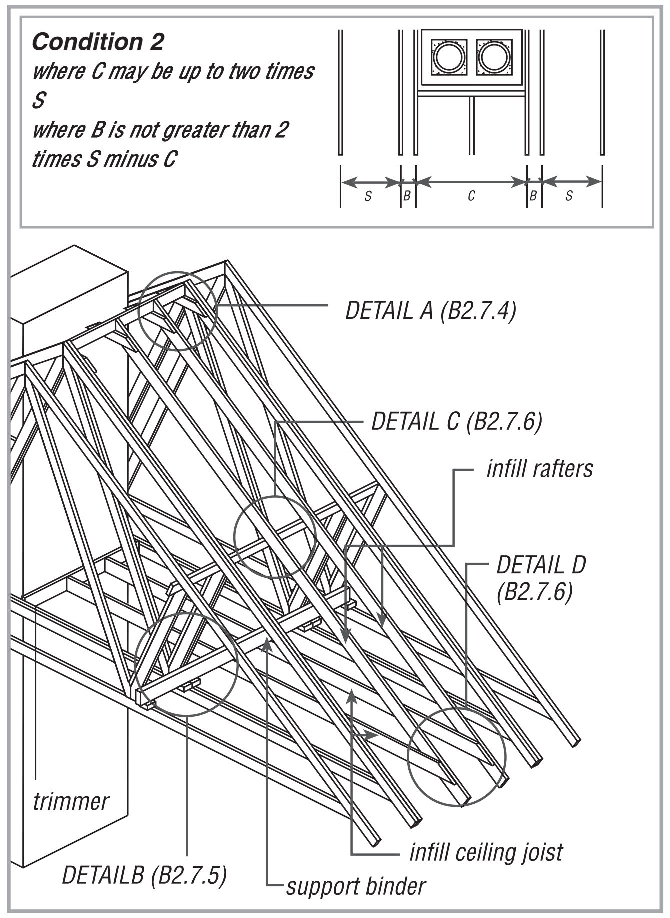


DETAIL B 2.7.1 Condition 1. Truss Spacing up to 660mm

Condition 2: Truss spacing between 660 and 1200mm

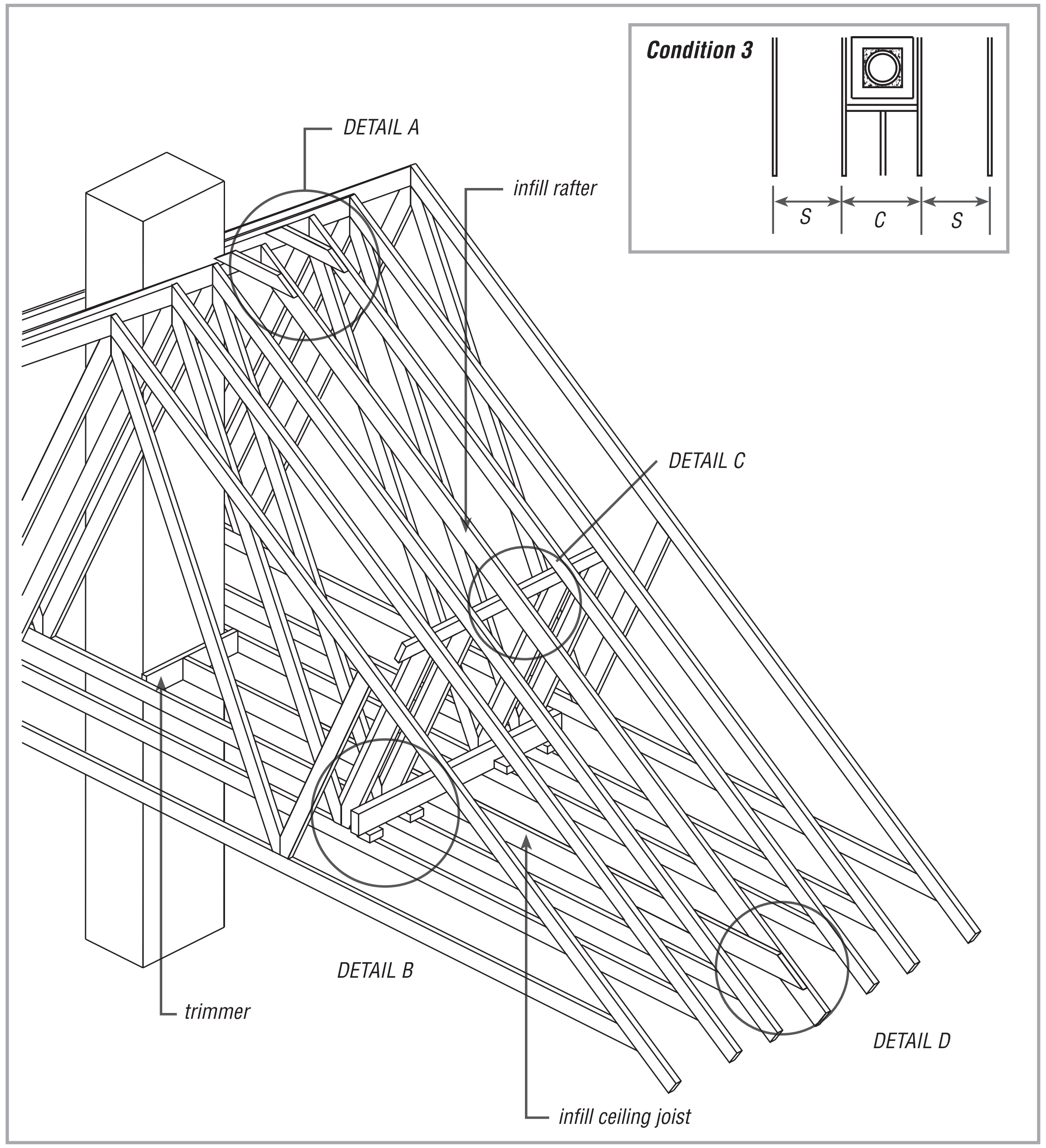
This caters for spacing adjustments for openings greater than 10% standard spacing and up to twice standard spacing (i.e. between 660mm and 1200mm). The roof and ceiling should be given extra support provided by infill rafters and ceiling joists (see B2.7.2). Support of the infill timbers is provided by purlins, binders and ridge boards and by trimmers at the actual opening. See Details B2.7.4/.5/.6.

The truss designer usually designs the above supports and supplies details for use on site.



DETAIL B 2.7.2 Condition 2. Truss Spacing between 660mm & 1200mm

B 2.7 TRUSSED RAFTER ROOFS - SPACING CONDITIONS (CONTINUED)



DETAIL B 2.7.3 Condition 3. Truss Spacing between 1200mm & 1800mm

Condition 3: Truss spacing between 1200mm and 1800mm

Spacing adjustments for openings greater than twice standard truss spacing and up to three times standard truss spacing (i.e. between 1200mm and 1800mm) usually require multiple trusses to be used on either side of the opening (see B. 2.7.3).

If girder trusses are used then they must be fixed together in accordance with the truss designers instructions. Tiling battens and ceiling material should be given extra support provided by infill rafters and ceiling joists.

Support of the infill timber is provided by purlins, binders and ridge boards and by trimmers around the opening.

The truss designer usually designs the above supports and supplies details for use on site and should always be consulted for the precise details.

Condition 4: Truss spacing over 1800mm

The truss designer can supply special details for opening over 1800mm; usually these will be similar to those shown in detail B.2.7.3.

The truss designer should always be consulted for the precise details where large openings are used and the roof and building designer may have additional requirements.

B 2.7 TRUSSED RAFTER ROOFS - SPACING CONDITIONS (CONTINUED)

Site cut infill support

Where truss centres are increased to accommodate openings, trimming may be unavoidable in some cases. Under these circumstances, full site instruction must be obtained from the truss and/or roof designer. All site work should be supervised by appropriate personnel.

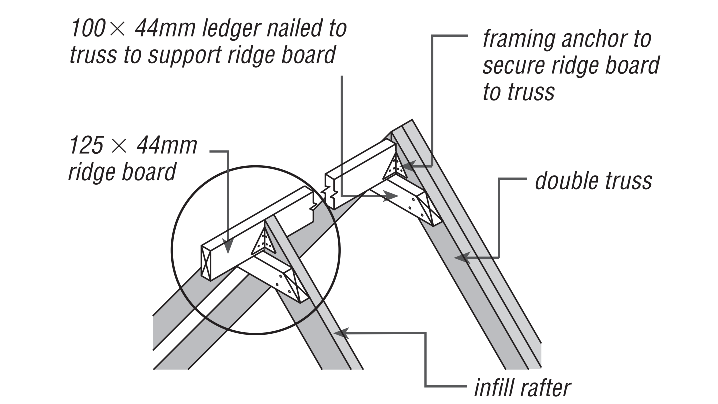
Note:

1. Infill rafter sizes must be designed and should be at least 25mm deeper than the rafters of the trusses to allow for a birds mouth at the wall plate.

2. For fire safety reasons all timber should be at least 40mm clear of the chimney where the distance to the flue is less than 200mm. It is recommended that timber members are not fixed directly to the chimney.

Where the supporting strut is not at right angles to the rafter/purlin, the purlin may have to be notched into the rafter or timber wedges used to provide adequate bearing. A qualified engineer should be consulted.

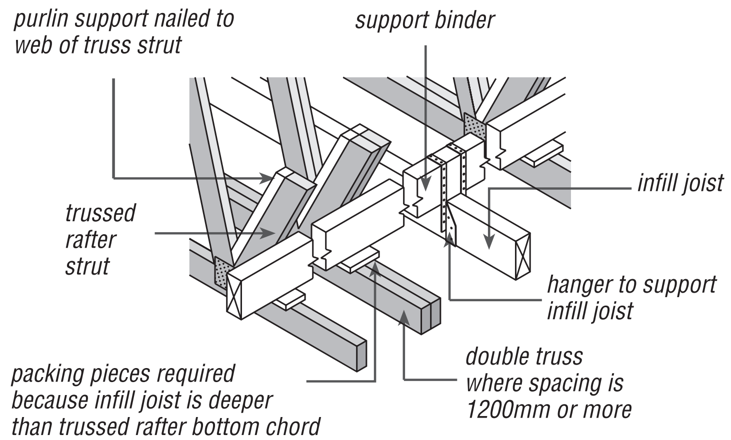
DETAIL A - ridge level



Infill rafter supported by purlin and fixed by skew nailing or metal shoes. Purlin size and strength class should be designed, a minimum 125 x 44mm C16 should be used.

DETAIL B 2.7.4 Ridge Level

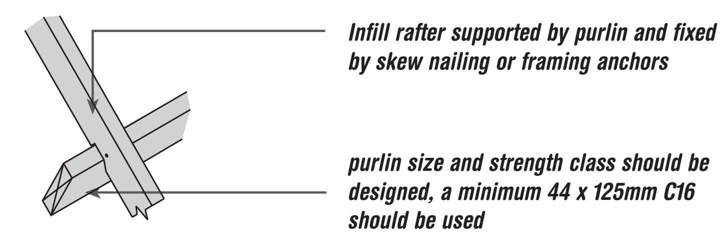
DETAIL B - support of infill joist



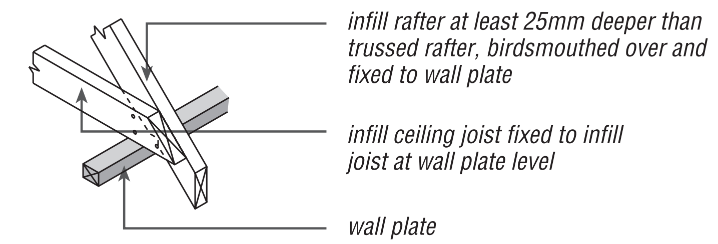
The loads on the infill timbers are transferred to the trusses on either side of the opening.

DETAIL B 2.7.5 Support of Infill Joist

DETAIL C - support of infill rafter at purlin

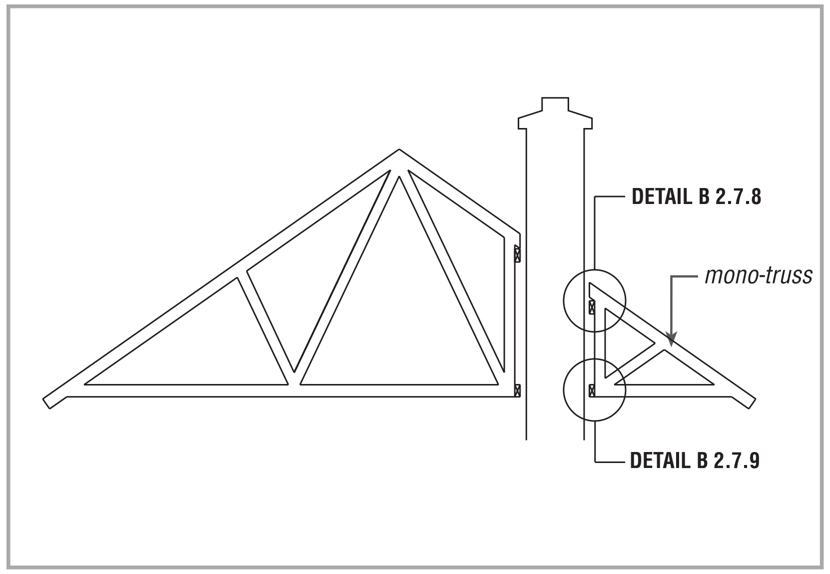


DETAIL D - support of infill rafter at wall plate

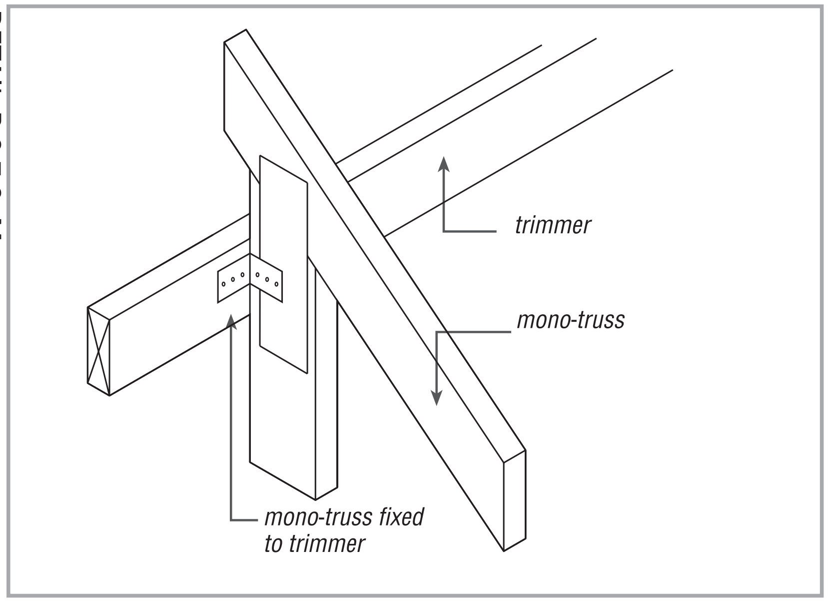


DETAIL B 2.7.6 Support of Infill Rafter

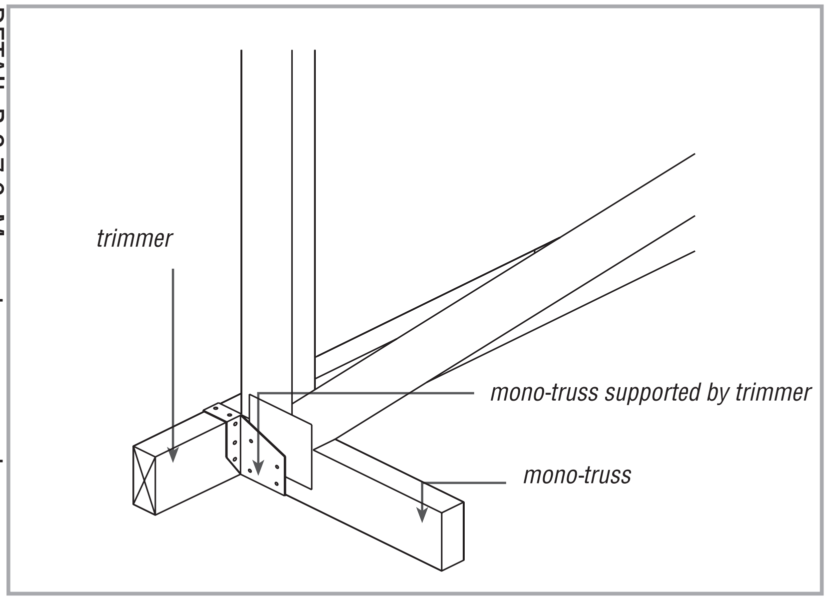
B 2.7 TRUSSED RAFTER ROOFS - SPACING CONDITIONS (CONTINUED)



DETAIL B 2.7.7 Special mono-truss



DETAIL B 2.7.8 Mono-truss support



DETAIL B 2.7.9 Mono-truss support

Prefabricated infill support

As an alternative to using site cut infill timber around an opening, specially designed mono-trusses may be used.

As an alternative to using site cut infill timber around an opening, specially designed mono-trusses may be used.

The trusses should be specially designed and fabricated for such locations and not be adapted from an ordinary truss by site cutting. (See Details B 2.7.7 to B 2.7.9).

In some circumstances the truss and/or roof designer may permit ordinary trusses to be cut. However, the designer should provide full site details for this work and the work must be properly supervised.

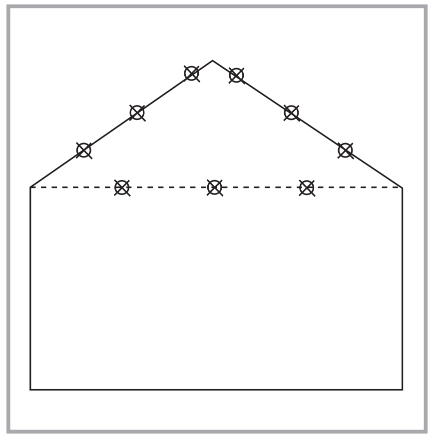
Truss shoes should be specified by the truss designer.

B 2.8 TRUSSED RAFTER ROOFS - LATERAL RESTRAINTS

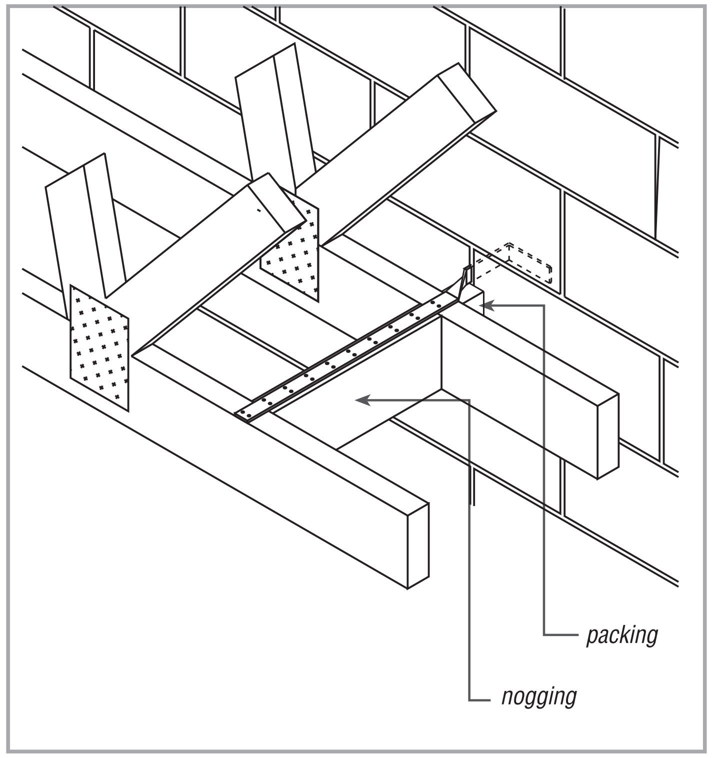
General

The prefabricated trusses should be adequately fixed to the gable wall to provide the necessary lateral support to the wall at roof and ceiling level.

Note that different details are applicable to timber frame construction where the timber frame manufacturer will provide details for the support of gable walls.



DETAIL B 2.8.1 Strap Solutions



DETAIL B 2.8.2 Lateral Restraint

Location of straps

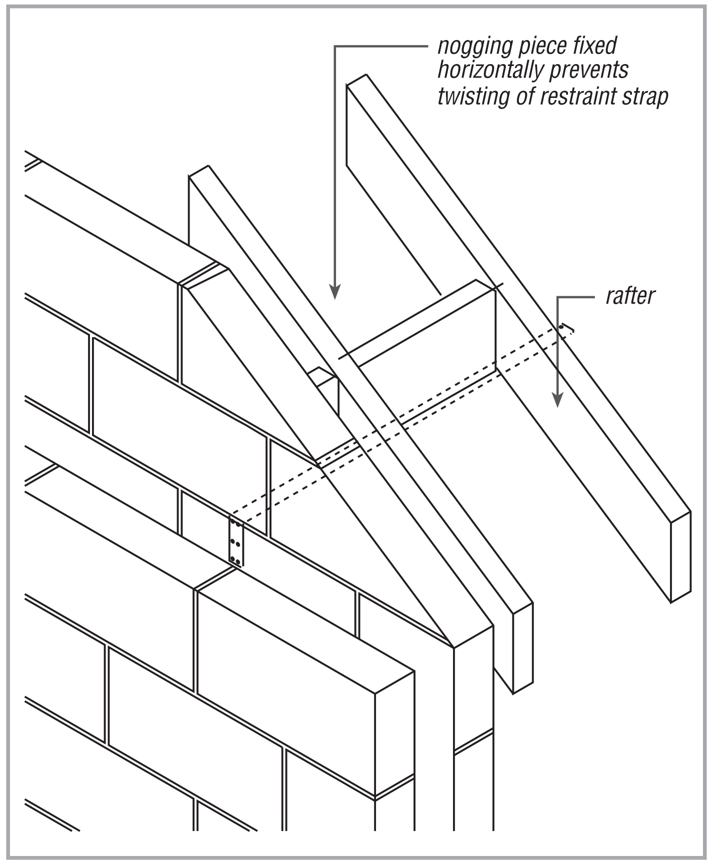
Straps should be provided at rafter and ceiling level, as illustrated by Detail B 2.8.1.

Straps should be 30 x 5 mm in cross section, galvanised and carried over a minimum of two trusses. Solid packing and noggins are to be securely fixed with 50mm long wire nails, at least one of which should be in the second joist or rafter. The nail diameter should relate to the size of the nail hole in the strap.

Straps should be located at a maximum of 2m centres.

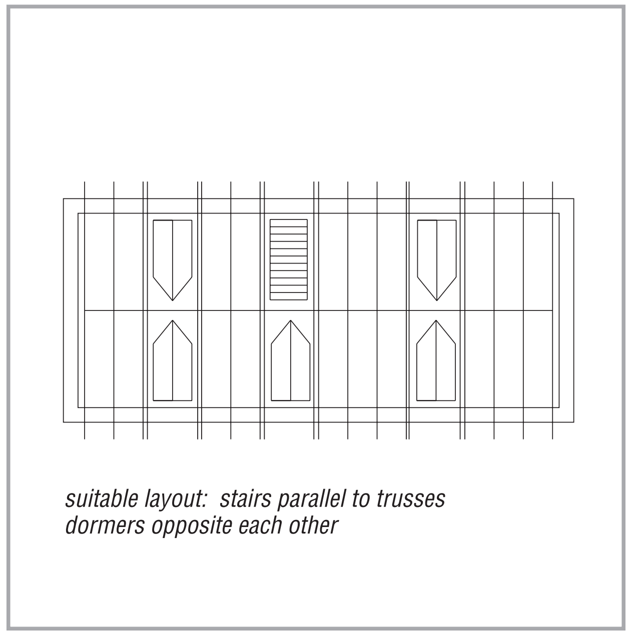
The requirements for strapping at rafter level depends on the height of the apex and wall thickness, as specified in *Technical Guidance Document A* of the Building Regulations. In general it is required in all standard pitched roofs in domestic masonry construction.

Similar information is given in the U.K. approved Documents.

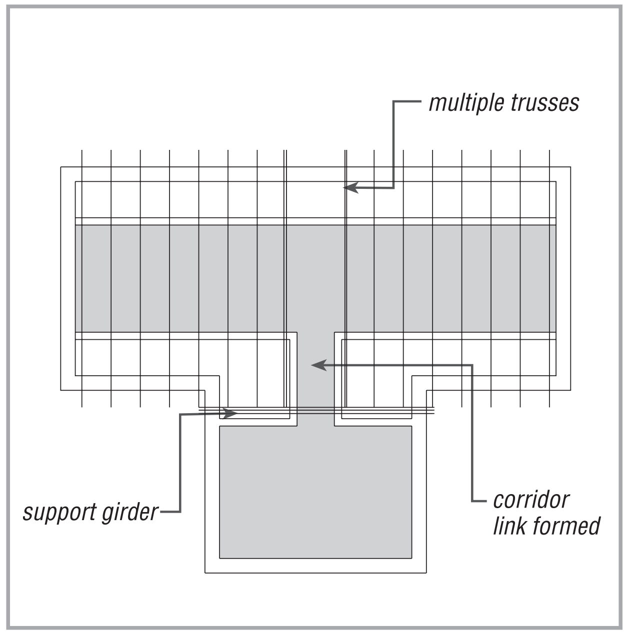


DETAIL B 2.8.3 Location of Straps

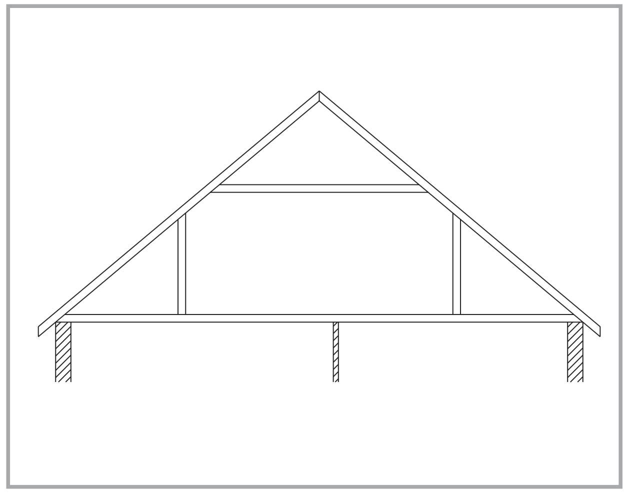
B 2.9 TRUSSED RAFTER ROOFS - DORMER TRUSSES



DETAIL B 2.9.2 Dormer & stairs layout



DETAIL B 2.9.3 Truss configuration

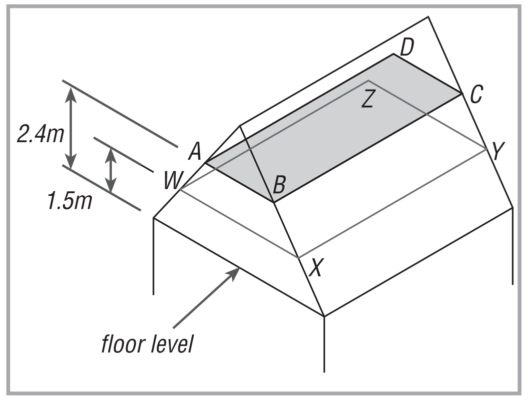


DETAIL B 2.9.4 Attic truss support

Arrangement

The prefabricated dormer truss often referred to as "Room-in-the roof" combines a structural floor and roof in the same component. This type of roof construction generally offers no restriction on the location of ground floor walls, as the trusses span onto the external walls, which in turn offers greater freedom to plan first floor layout.

Technical Guidance Document F (Ventilation) requires that the minimum ceiling height for any habitable room is 2.4m. In an attic truss the minimum ceiling height of 2.4m should be equal to or not less than half of the area of the room measured on a plane 1.5m above finished floor level, i.e. area ABCD to be at least half the area of WXYZ (see Detail B2.9.1).



DETAIL B 2.9.1

Design

The application of a few basic principles at design stage can maximise the use of prefabricated components and minimise loose infill timber.

Dormer windows and stairwell openings should have multiple trusses either side with appropriate site cut infill timber between. Stairwells should be parallel to trusses and windows positioned opposite each other (Detail B2.9.2)

Where attic trusses are provided for future roof conversions, girder trusses must be provided for the future framing of the stair opening. The cutting of standard trusses should be avoided at all costs.

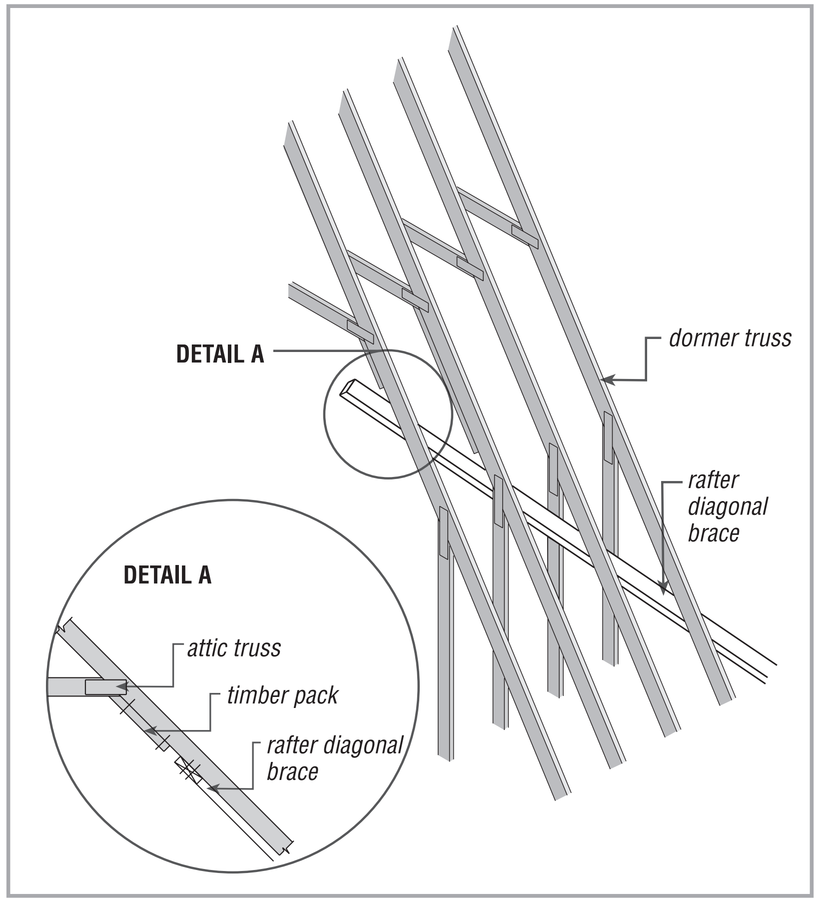
At T-junctions provide a corridor link between room areas as in Detail B2.9.3; this will reduce the number of site cut infill members. Use ground floor loadbearing walls to provide additional support to the attic trusses (see Detail B2.9.4).

B 2.9 TRUSSED RAFTER ROOFS - DORMER TRUSSES (CONTINUED)

Bracing

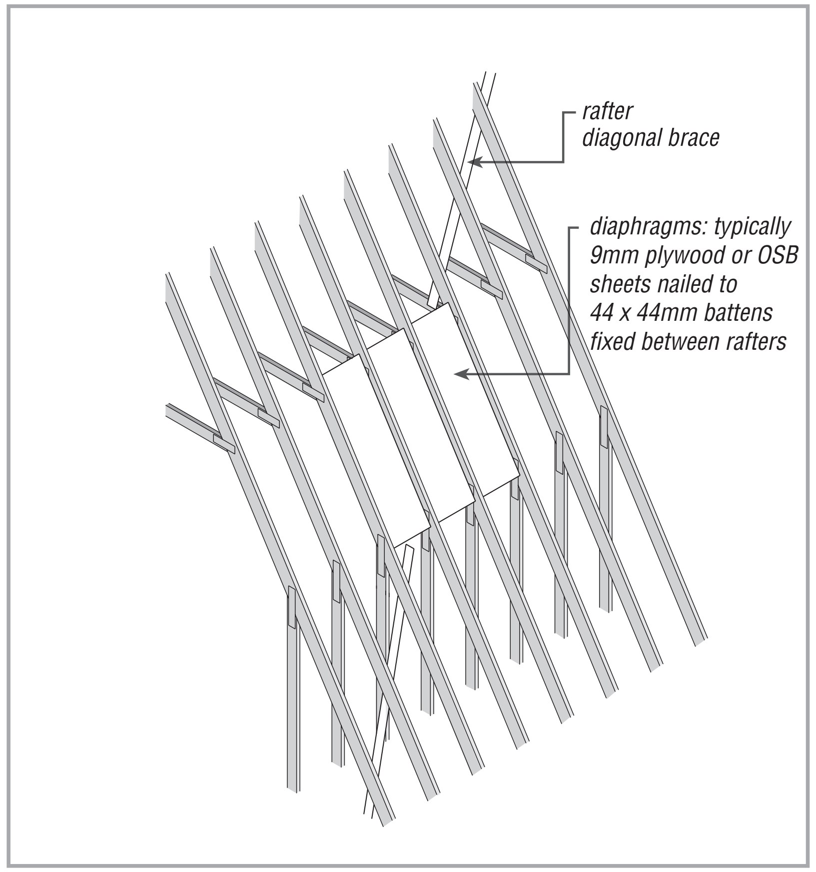
The bracing requirements for dormer trusses are the same as conventional truss roofs as shown in Details B2.3.1 to B2.3.6, the only essential difference being the location of the rafter diagonal brace. Where this particular bracing member protrudes into the room area this may be overcome by packing out the rafter by using a pack the same thickness as the bracing member (Detail B 2.9.5).

Bracing details should be provided by the truss and roof designer. The building designer may have additional requirements.



DETAIL B 2.9.5 Dormer Truss - Bracing

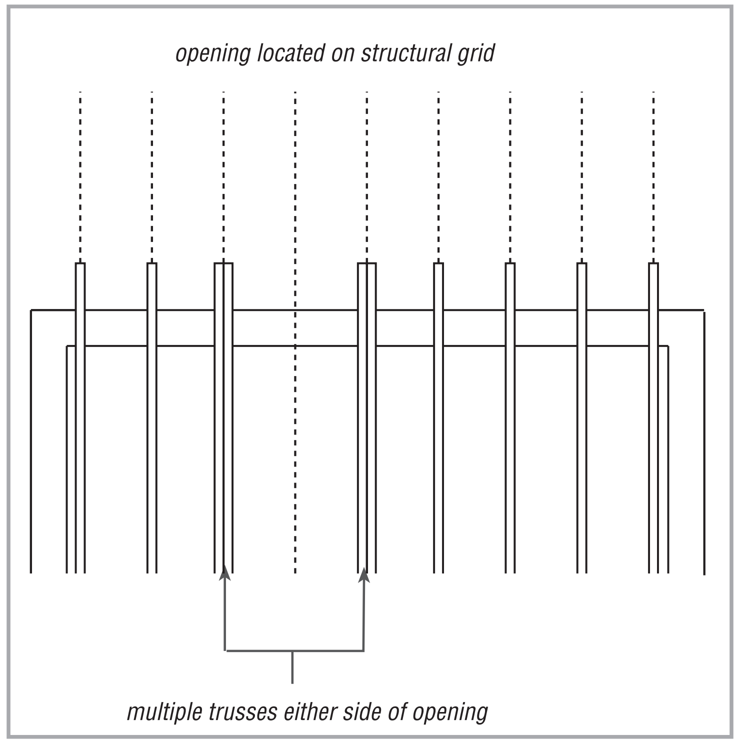
Alternatively, plywood or OSB diaphragms fixed to battens and inserted between the rafters may be used over the room area of the dormer truss. Sufficient diaphragms should be provided to allow the line of action of the brace to be continuous (Detail B 2.9.6).



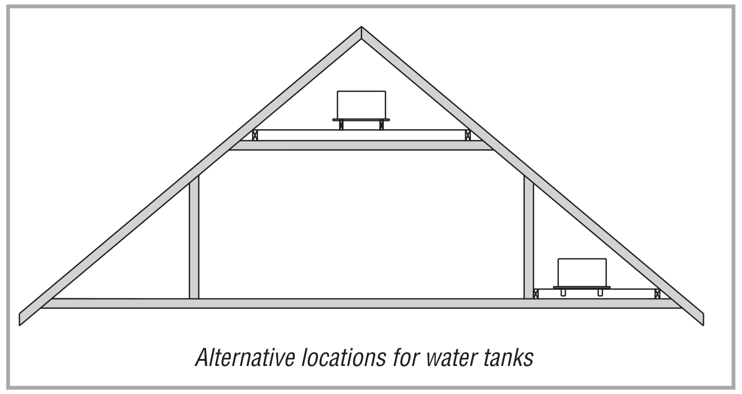
DETAIL B 2.9.6 Dormer Truss - Bracing

B 2.9 TRUSSED RAFTER ROOFS - DORMER TRUSSES (CONTINUED)

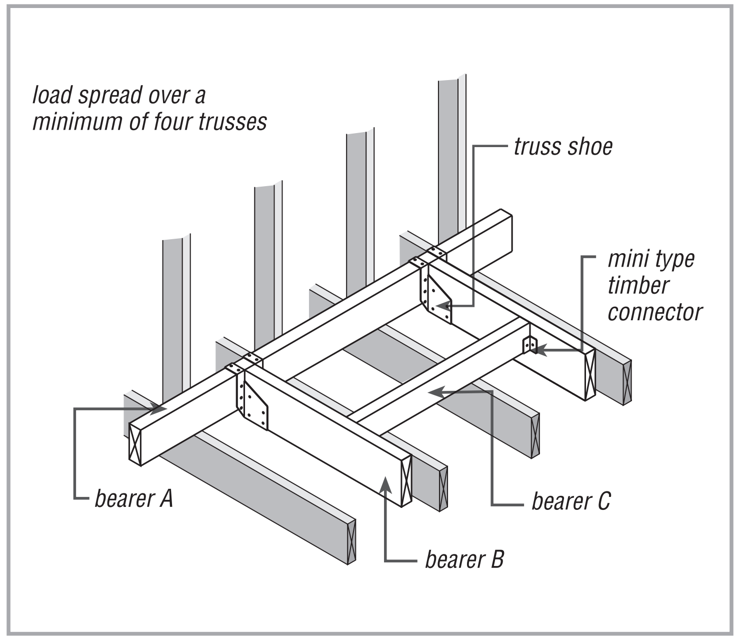
DETAIL B 2.9.7 Openings in grid



DETAIL B 2.9.8 Cisterns



DETAIL B 2.9.9 Water cistern support



Where possible, locate openings on the structural grid (usually 600mm) to match the truss spacing, this will reduce the amount of site cutting (Detail B 2.9.7).

Ventilation

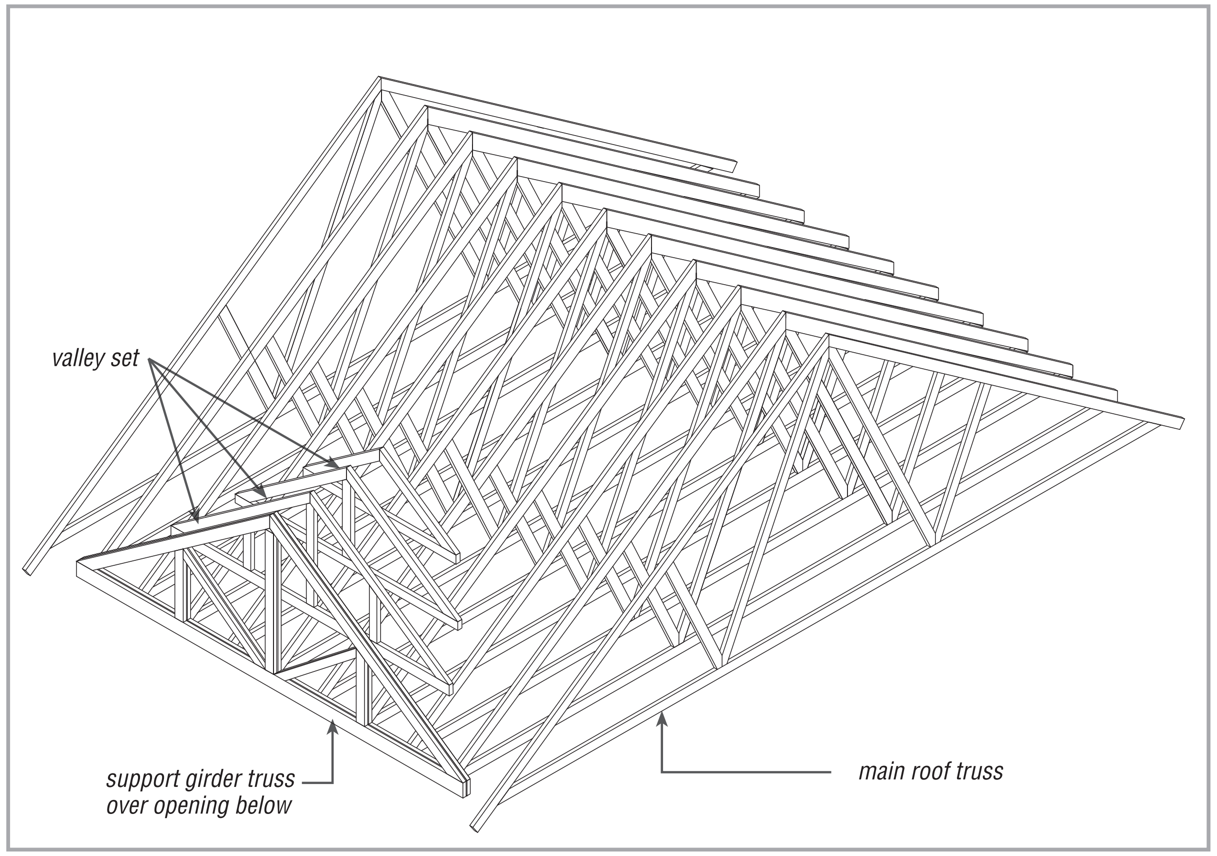
To ensure adequate airflow there should be a 50mm gap between the insulation and the top of the rafter/roof lining along the slope of the rafter.

Water cistern

Detail B 2.9.8 illustrates alternative locations for the water cistern in a dormer truss. Where space is limited, two or more tanks in tandem may be required. The roof designer should inform the trussed rafter designer of the number of tanks, their location and capacity. Tanks may be supported as illustrated by Detail B 2.9.9. A minimum of 25mm should be provided between bearer B and the ceiling, to allow for long term deflection. Bearer C should be clear of the ceiling ties by a minimum of 25mm for the same reason. The cistern support should be designed by the truss or roof designer.

Care should be taken to ensure that all plasterboard edges are backed by timber. Particular attention should be made to ensuring an air tight construction between the room and the ventilated spaces; service penetrations should be sealed.

B 2.10 TRUSSED RAFTER ROOFS - VALLEYS



DETAIL B 2.10.1 Valleys - Arrangement

Arrangement

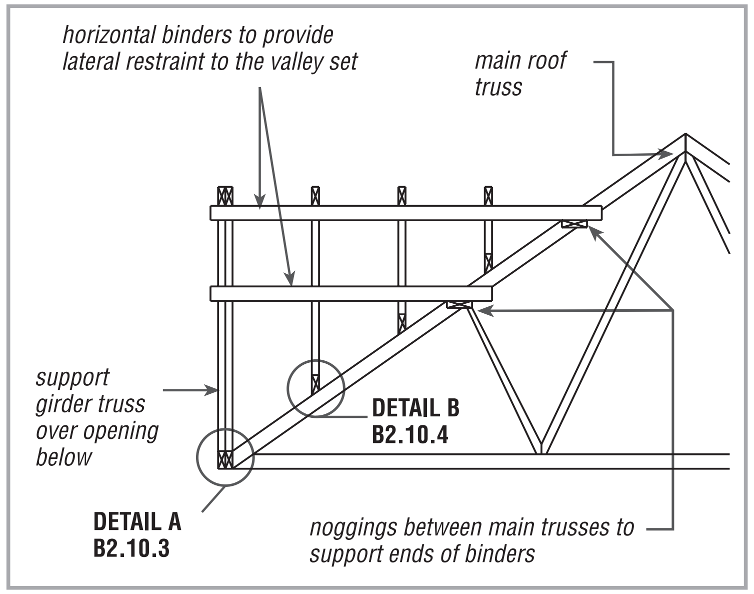
A valley intersection is formed by a series of specially fabricated diminishing trusses collectively called a valley set. The valley set transfers the rafter loads down to the underlying trusses in a uniform manner, by incorporating vertical webs normally at 1200mm centres. Each valley set truss in the set must be secured to each rafter it crosses

Design

Special instructions will need to be given to the manufacturer on the use of intersecting valley infill rafters.

The truss designer should specify site details such as the restraint of the trusses under the valley set. Particular attention should be made to catering for wind forces especially uplift forces.

B 2.10 TRUSSED RAFTER ROOFS - VALLEYS (CONTINUED)



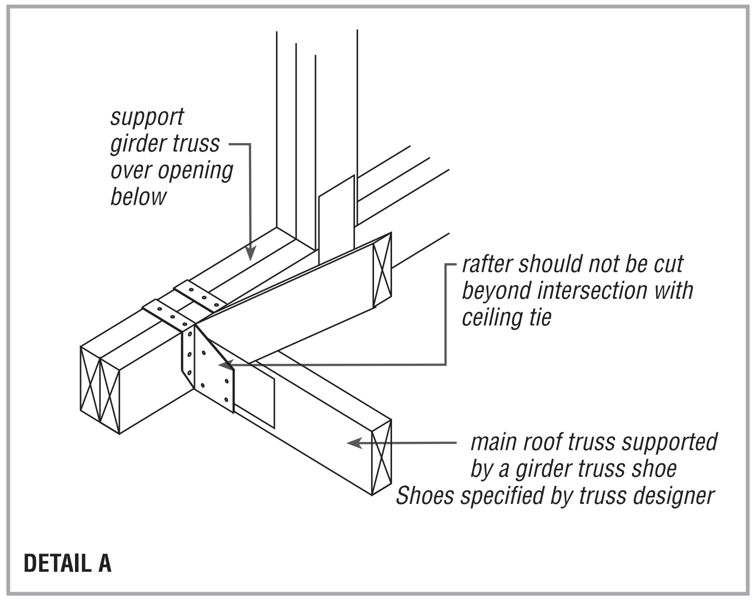
DETAIL B 2.10.2 Support over openings

Connections

Where the ends of the valley frames do not coincide with the rafters of the main trusses, additional support should be provided in this location by means of noggings between the main rafters, (Detail B 2.10.5).

Over openings, support of the main roof trusses is provided by a proprietary girder truss shoe securely connected to a multiple girder truss (Detail B 2.10.3).

Girder trusses must be fixed together in accordance with the truss designers requirements.

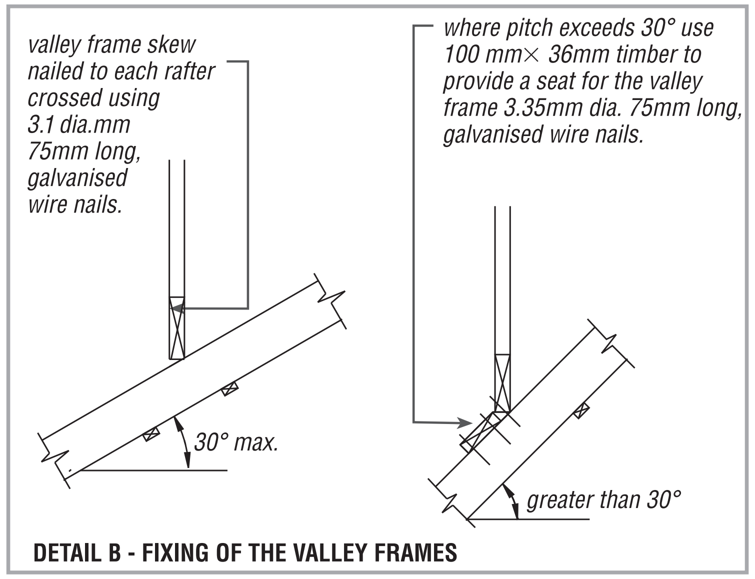


DETAIL B 2.10.3 Support details

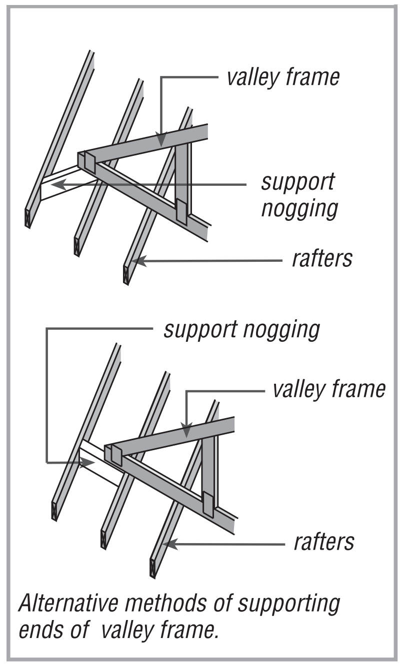
Bracing

Bracing of the valley set is usually provided by horizontal binders fixed to the vertical webs and then fixed back to the main roof (Detail B 2.10.2). If the horizontal binders do not coincide with the rafters of the main roof then noggings should be provided to enable adequate connections to be made.

In addition, tiling battens or bracing members can be fixed to the underside of the rafters of the main roof and extend 1200mm beyond the valley line as a means of additional stability to the main roof.



DETAIL B 2.10.4 Fixing of Valley Frames



Alternative methods of supporting ends of valley frame.

DETAIL B 2.10.5 Alternative Supports

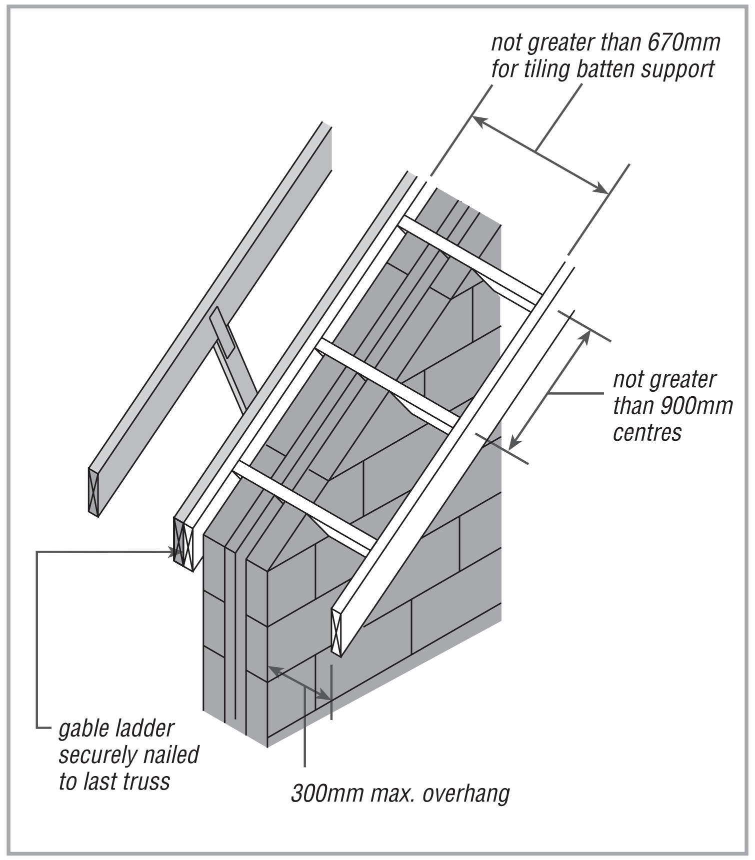
The bottom of the valley trusses may need to be chamfered to the roof angle. Roof battens may need to be continued across the valley trusses to brace the rafters of the main trusses.

B 2.11 TRUSSED RAFTERS ROOFS - AUXILIARY DETAILS

Gable ladders

Where a gable ladder is used, it should be nailed to the last truss with nails at 400mm maximum centres and be evenly supported by the gable blockwork. All components should be preservative treated.

Gable ladders should be designed for wind uplift forces and may need to be fixed to the external walls.



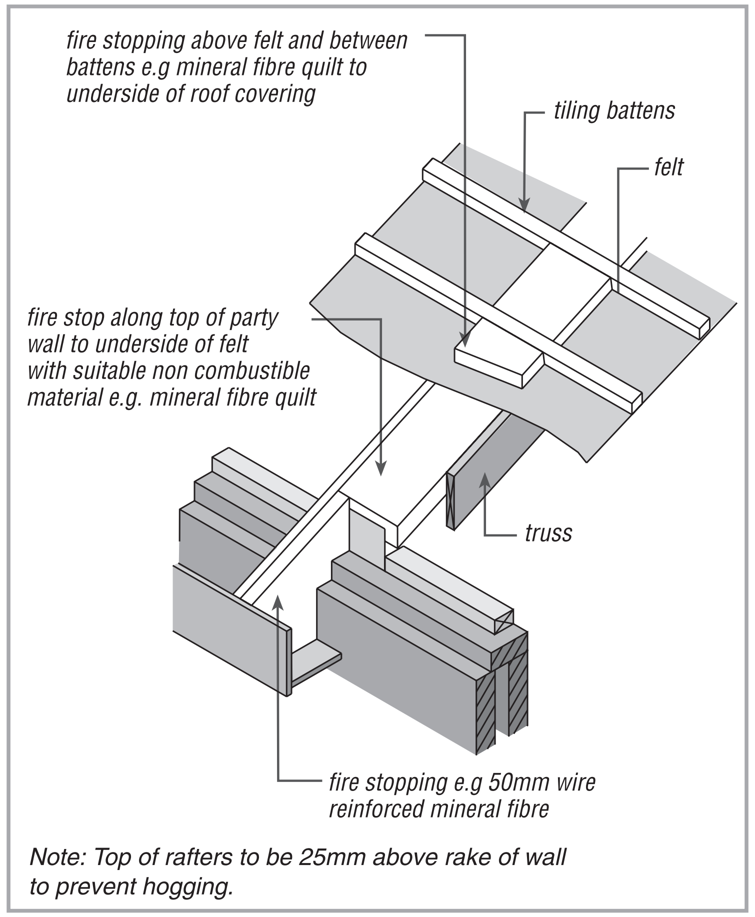
DETAIL B 2.11.1 Gable Ladders

Separating wall fire protection

To prevent the spread of fire between dwellings, ensure the party wall is completed along the line of the slope of the roof and adequately fire-stopped with a suitable material.

Proprietary fire stopping systems should have appropriate third party certification such as that provided by the Agrément Board.

Note: *Detail B 2.11.2 is not appropriate for all buildings. Refer to Technical Guidance Document Part B (Fire Safety) of the Building Regulations.*



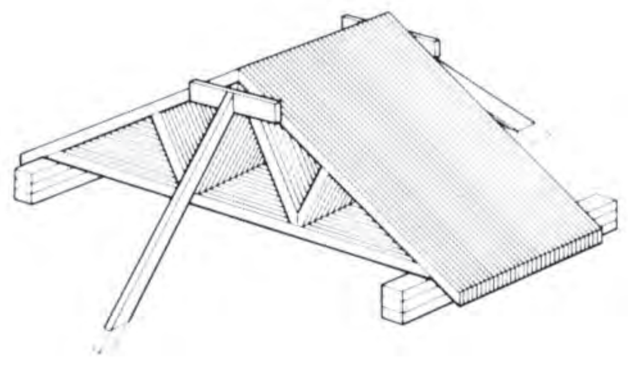
Note: Top of rafters to be 25mm above rake of wall to prevent hogging.

DETAIL B 2.11.2 Typical Separating Wall Fire Protection (From TGD 'B')

B 2.12 TRUSSED RAFTER ROOFS - SITE PRACTICE

DETAIL B 2.12.1 Vertical

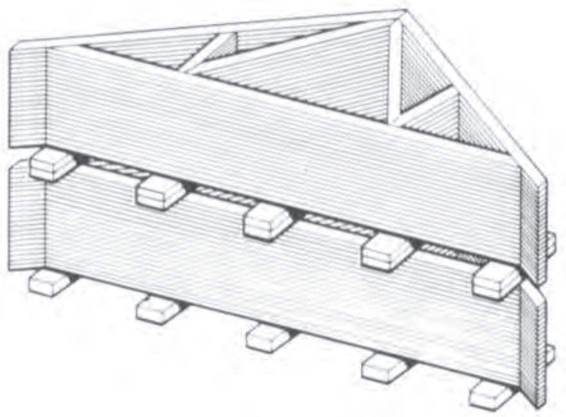
VERTICAL STORAGE



keep overhangs clear of ground and vegetation

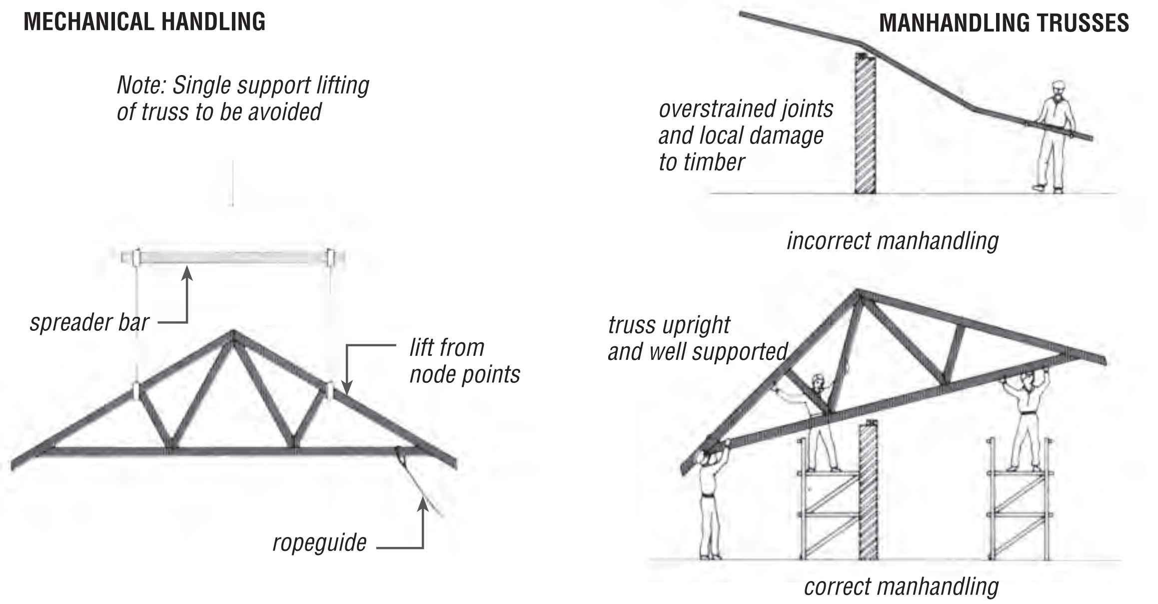
DETAIL B 2.12.2 Horizontal

HORIZONTAL STORAGE



ensure all bearers are level

DETAIL B 2.12.3 Handling



Site storage

Site storage should be kept to the minimum. Store trusses clear of the ground, on bearers located at the support points, with suitable props provided where required (Detail B2.12.1).

Where trusses are laid flat, bearers at close centres should be provided to ensure level support (Detail B2.12.2). Where bearers are placed at different heights they should be vertically in line with those underneath. The timing of erection of the roof should be such that the trusses are exposed to the elements for the shortest possible time.

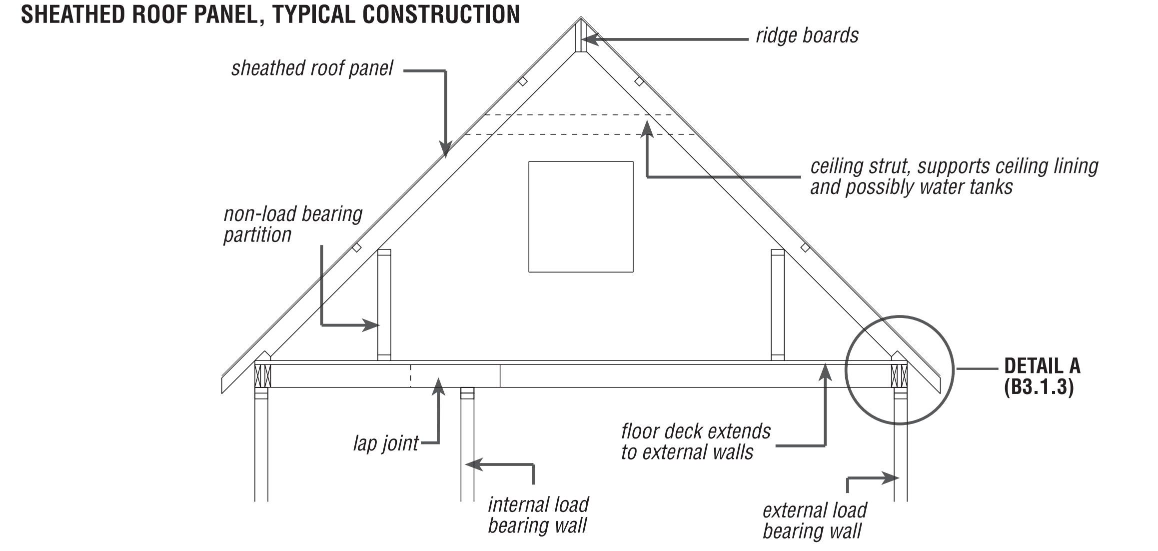
Where trusses are covered, the protection should be arranged so that there is adequate ventilation and any accumulated water can drain away.

Handling

The greatest stress at truss joints is generally caused by handling. Handling of trusses should be planned to take into account weight, size, access, lift height and whether manual or mechanical handling is required. Where possible trusses should be lifted at node points, with the apex upright (Detail B2.12.3).

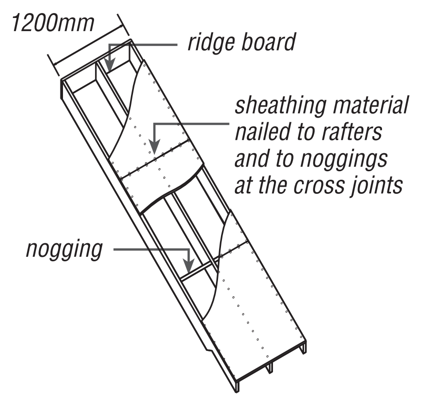
B 3 Panel roofs

SHEATHED ROOF PANEL, TYPICAL CONSTRUCTION



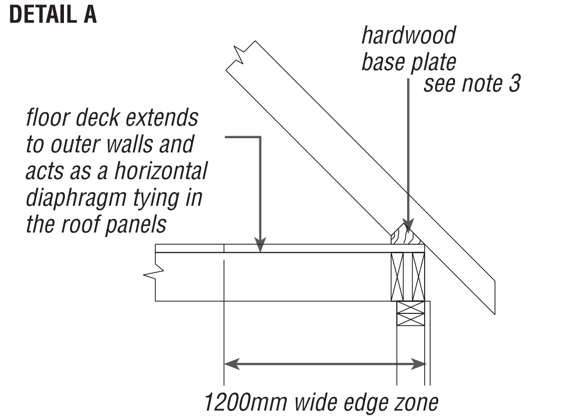
DETAIL B 3.1.1 Sheathed Roof Panels

TYPICAL PANEL DETAIL



DETAIL B 3.1.2 Panel Detail

DETAIL A



DETAIL B 3.1.3 Detail A

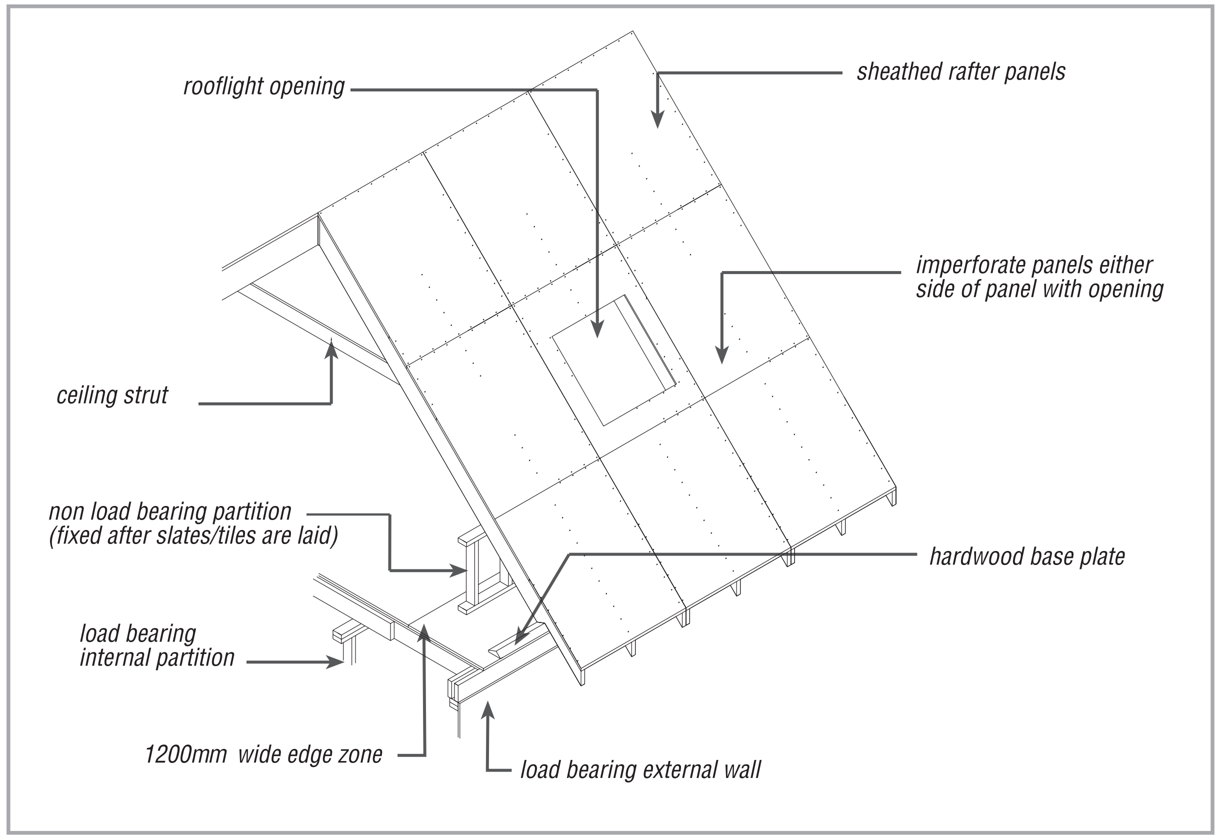
B 3.1 DESIGN AND LAYOUT

Sheathed roof panels may be used as an alternative to dormer trusses. They can provide a completely clear triangulated roof space free from struts, ties or bracing, and are suitable for most domestic dwellings, typically with horizontal spans between 6-9m and pitches of 35-50 degrees. The structure of the sheathed panel roof relies on four elements.

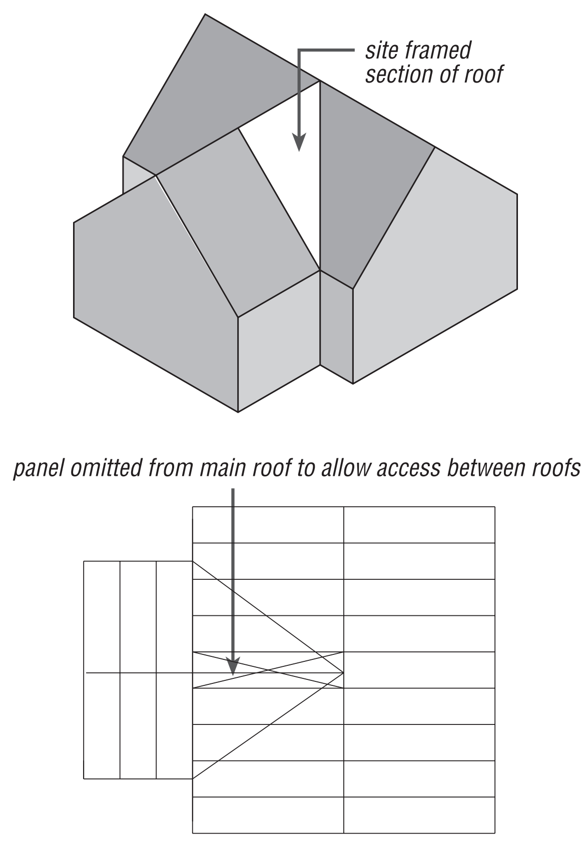
1. The floor structure, including lapped joints in the floor joists, act in tension to restrain the outward force of the roof panel at the eaves. A load-bearing internal wall is normally required to reduce the floor joist spans (Detail B3.1.1). Openings in the floor framing must not interrupt this function, unless they are specially designed. The stairwell opening should preferably be located parallel to the floor joists. Where the longer length of the stairwell is located perpendicular to the span of the floor joists, a special design will be required for the opening to transfer the horizontal and vertical loads safely into the adjacent floor joists and sheathing.
2. The panels are sheathed on top of the rafters to resist rafter buckling and racking forces. Some designs are conservative and ignore the structural contribution from the sheathing.
3. The horizontal thrust at eaves level is taken out by the floor structure. A common detail here is to use a hardwood base plate fixed to the floor sheathing, the baseplate and fixings must be designed. The floor sheathing is in turn fixed to the floor joists. The fixing and nailing pattern must be designed and carried out in accordance with the engineer's instructions.
4. The upper ceiling joist and small stud wall can be used structurally although this is not common. To limit any loads coming onto these members they should be fixed after the roof is fully loaded, the load coming on to them through wind, snow and long term deflection will be thereby reduced.

B 3.1 PANEL ROOF - DESIGN AND LAYOUT

DETAIL B 3.1.4 Roof Panels



DETAIL B 3.1.5 T-junction Detail



T JUNCTION DETAIL IN A PANEL ROOF

The sheathed roof panel system is most suitable for roofs with gable ends, but T-junctions can also be accommodated (Detail B 3.1.5). Rafter size varies according to loading and span (the thickness of the thermal insulation can also affect the depth). Insulation can be placed either between the rafters and sometimes rigid battens are fixed to the underside of the rafters to accommodate the thickness of the thermal insulation.

Panels may be trimmed subject to design and manufacture to permit a rooflight window or dormer to be incorporated. Where openings are formed for dormers the rafters on either side should be doubled up (large openings will require to be designed and may require additional trimming members and fixings). The trimmer loads are transferred to the supporting walls and may also require additional studs to provide support. (Detail B 3.1.4).

Panel roofs must be designed especially where the openings are large or where there are a number of openings close together.

To facilitate drainage, should any moisture penetrate the roof covering, the sarking felt/breather membrane should be tacked to counter battens, parallel to and in the same position as the rafters.

B4 Flat roofs

B 4.1 FLAT ROOF TYPES

In domestic construction there are three common flat roof types.

Cold deck
The most common form of domestic flat roof construction (Detail B 4.1.1), is where the insulation is provided between the joists. A 50 mm minimum unobstructed air void must be maintained between the top of the insulation and the underside of the roof decking and be vented to the exterior. Glass fibre or mineral wool quilts are the most common type of insulations used. Provide a solar reflective finish as for warm deck roofs.

The vapour check must be used to prevent interstitial condensation and any openings in the ceiling must be sealed.

Generally this type of roof should be avoided because the risk of interstitial condensation is relatively high, where this type of roof cannot be avoided it is essential that moisture entering the roof is minimized and that adequate ventilation is provided. If condensation does occur, it will normally be at the underside of the roof decking or waterproof finish.

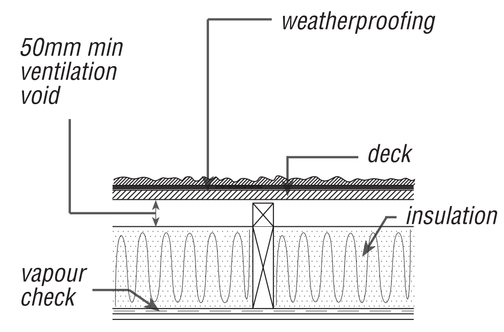
The vapour control layer should have a resistance of at least 250 MNs/gm, and should have sealed laps to preserve its integrity over the whole roof. Gaps in the ceiling should be minimized and service openings should be avoided; it is recommended that a service cavity be used so that the vapour control layer remains intact.

Ventilation openings should be provided to every roof void along two opposite sides of the roof and should be equivalent in area to a continuous opening of not less than 25 mm at each side. Adequate cross ventilation can be difficult to achieve with spans in excess of five metres; in these situations, both the openings and airspace over the insulation should be substantially increased. Where fire stops obstruct the cross ventilation, it will be necessary to provide ventilation through the roof covering; the use of a warm roof should be considered in these situations.

Timber not rated moderately durable or better should be preservative treated. During its life, it is likely that the decking will be subjected to periods of elevated moisture and the decking should be chosen accordingly.

Surface condensation on the ceiling is unlikely to occur due to the fast thermal response, provided there is adequate insulation over the whole ceiling and steps have been taken to minimize thermal bridging, especially at external wall/ceiling junctions.

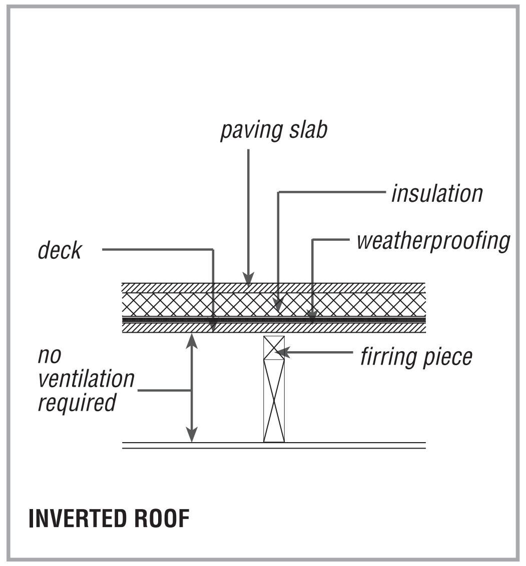
DETAIL B 4.1.1 Cold Deck



COLD DECK

Using a service cavity will help to ensure that the vapour check will remain imperforate.

DETAIL B 4.1.2 Inverted Deck

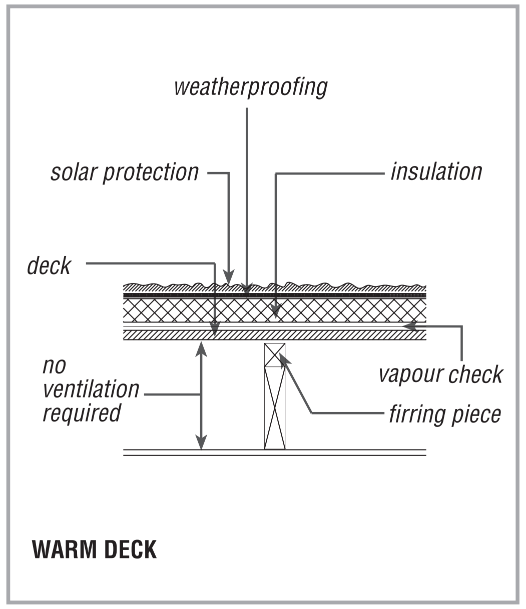


Inverted deck
Insulation is provided above the weather-proofing in this type of roof. The insulation must be of a type unaffected by moisture and the weather. To keep the insulation in position, ballast material can be used consisting of paving slabs or a similar material recommended by the manufacturer.

There is usually no need to provide a vapour check with this type of roof but this can be confirmed by a condensation risk analysis.

Surface condensation is unlikely to occur due to the fast thermal response, provided that there is sufficient insulation to maintain the weatherproof finish above the dewpoint over the whole roof. With this type of roof, rainwater seeping below the insulation will cool the waterproof membrane intermittently, increasing the risk of condensation on the membrane. When calculating the risk of interstitial condensation the thickness of insulation should be assumed to be 80 % of the actual thickness.

DETAIL B 4.1.3 Warm Deck



Warm deck
Like the inverted roof, insulation provided above the deck level but unlike the inverted roof the insulation is under the weather-proofing membrane. Insulations include polyurethane, polyiso-cyanate, glass fibre, rock fibre and cork board. Provide a solar reflective treatment of roof membranes in accordance with manufacturers' instructions.

Weather proofing
Suitable weatherproofing or roof covering materials must be used.

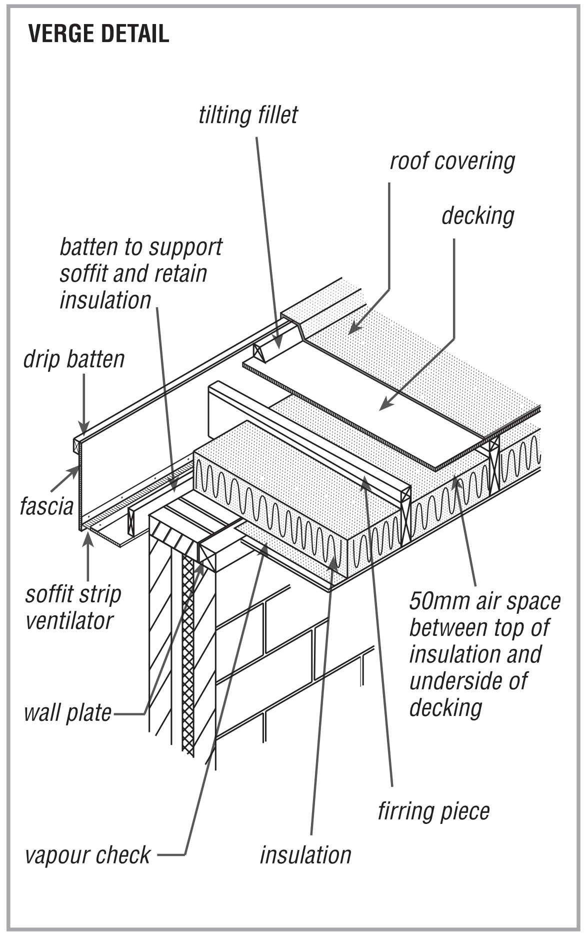
Proprietary membranes should be approved by a body such as the Agrément Board or have appropriate certification such as an ETA with accompanying information showing compliance with the Building Regulations.

Decking materials
- Moisture resistant chipboards
- OSB 3
- Plywood to EN 636-2/3
- Preservative treated T&G boarding

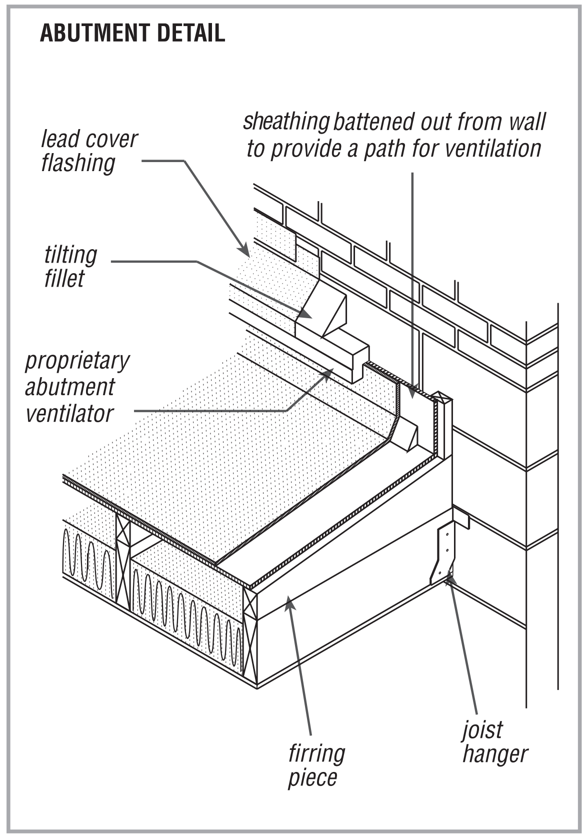
The onus is on the designer to specify the correct grade of material suitable for end use.

B 4.1 FLAT ROOF TYPES (CONTINUED)

DETAIL B 4.1.4 Verge Detail

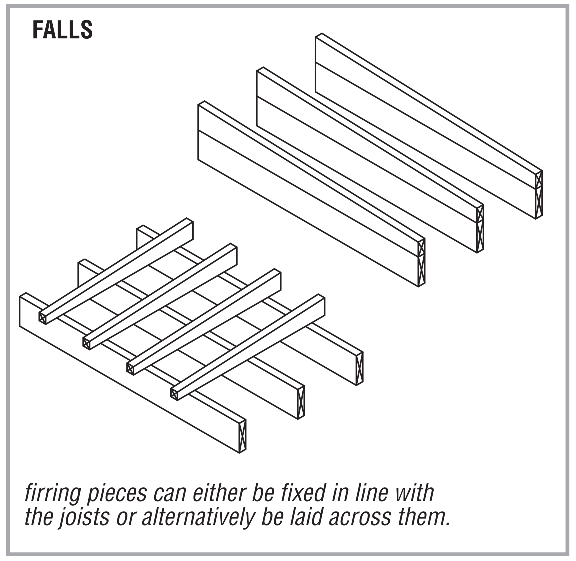


DETAIL B 4.1.5 Abutment Detail



Roof falls
Firring pieces should be provided to give the roof a minimum fall of 1 in 40. Care should be taken to ensure that drainage is adequate and cannot be blocked and that water cannot collect on the roof.

DETAIL B 4.1.6 Firring Pieces

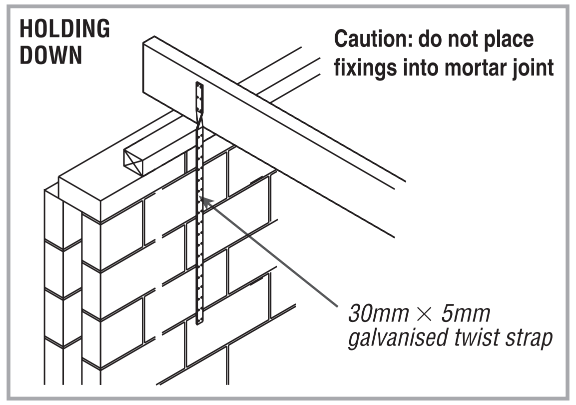


Holding down
Holding down requirements should be designed to Eurocode 5 (or BS 5268-2 if permissible stress design is used) and if appropriate to the relevant masonry standard (EN 1996 or BS 5628).

Holding down straps are typically 30x5mm in cross section, at least 1m long and provided at between 1.2 m to 2 m centres. Straps should be fixed to the masonry walls (in timber frame the design engineer should provide details of the fixing) by means of masonry nails or wood screws into plugs. The number of fixings should be in accordance with design requirements, with a minimum number of three, one of which should be at least 150mm from the bottom of the strap. The straps should be corrosion resistant and the fixings should have a similar protection. Note that often the holes in these straps are quite large and the fixings should be of a similar diameter.

Austenitic stainless steel is much more durable than galvanised steel.

DETAIL B 4.1.7 Holding Down



Where there is a greater risk of corrosion consideration should be given to using austenitic stainless steel rather than galvanised steel whose durability is dependent on the amount of galvanising present on the strap.

Do not mix metals: use galvanised nails with galvanised straps and austenitic stainless steel nails with austenitic stainless straps.

B 5 Flooring

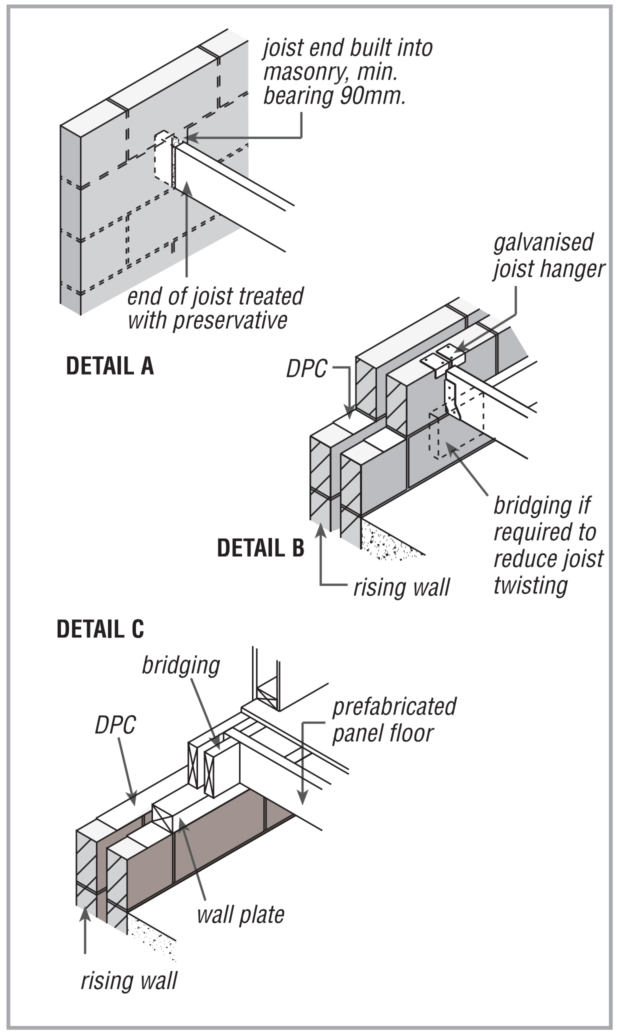
B 5.1 FLOORING - CONNECTION DETAILS

Bearing

Where floor joists are built into external masonry walls, a minimum of 90mm bearing should be provided and the joist should be totally surrounded by mortar (Detail B 5.1.1A.) Alternatively, joists can be supported by proprietary galvanised joist hangers (Detail B 5.1.1B). Bridging pieces should normally be installed between the ends of the joists to provide support to the edges of the flooring material and as an added precaution against joist rotation. First floor joists will also require timber noggins between the joist ends to provide support to the edges of the plasterboard ceiling. In all cases where timber joists are built into the masonry wall the ends should be adequately treated with preservative. It is normal practice for all ground floor joists, wall plates and bridging to be treated with timber preservative.

In timber frame construction, suspended timber floors are generally supplied as prefabricated panels. (Detail B 5.1.1C).

The designer/specifier should always specify which components are to be treated and the treatment type. It is recommended that all timber in a ground floor be treated with a timber preservative; the manufacturer of proprietary joists should be consulted for their advice on the need for treatment. Floor decking is not usually treated but again the manufacturer can be consulted for advice.

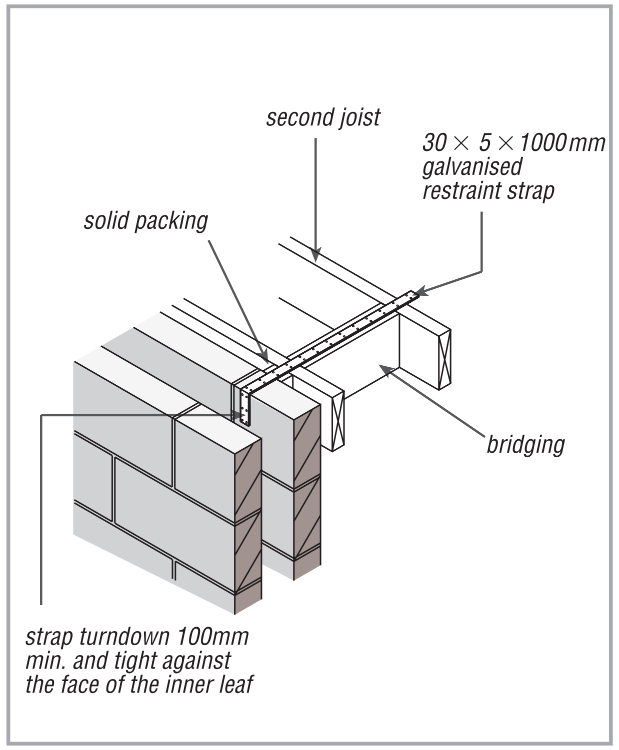


DETAIL B 5.1.1 Joist Support Detail

Lateral restraint

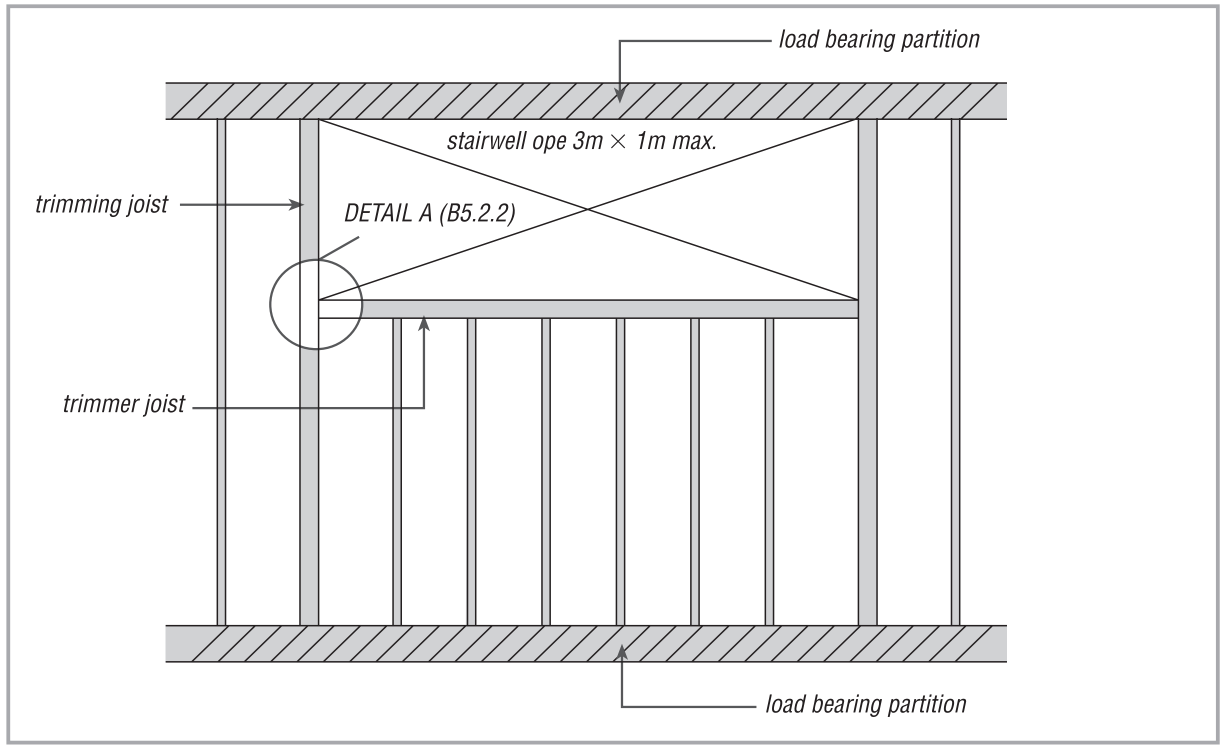
Floors, other than ground floors, should provide lateral restraint and support to external walls by means of galvanised straps, 30x5mm in cross section, carried over and securely fixed to at least two joists, packing and bridging. (See Detail B 5.1.2). The straps should be located at 2m max. centres. Where continuity is disrupted by openings e.g. a stairwell, the opening should not exceed 3m in length and strap centres on either side of the opening should be reduced to compensate for those omitted along the opening (Detail B 5.1.2).

In two-storey domestic construction, straps are usually not required in the longitudinal direction of the joists, providing the requirements of *Technical Guidance Document A (*Structure) are met.

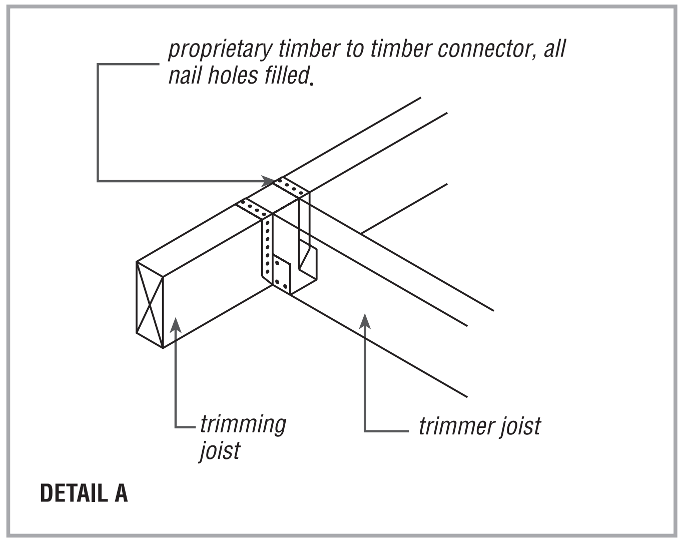


DETAIL B 5.1.2 Lateral Restraint

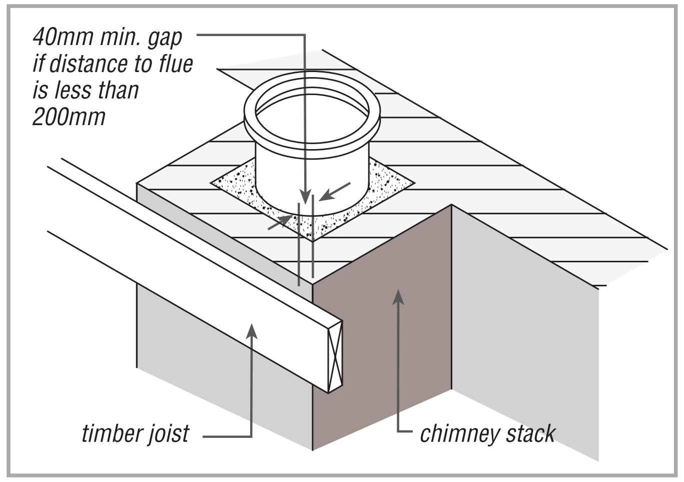
B 5.2 FLOORING – OPENINGS



DETAIL B 5.2.1 Trimming Openings



DETAIL B 5.2.2 Stairwell Trimmers



DETAIL B 5.2.3 Trimmer Joists

Trimming around openings

Stairwell openings in domestic construction should generally not exceed 3m in length and 1m in width and should be trimmed by trimmer/trimming joists of a suitable size and strength class.

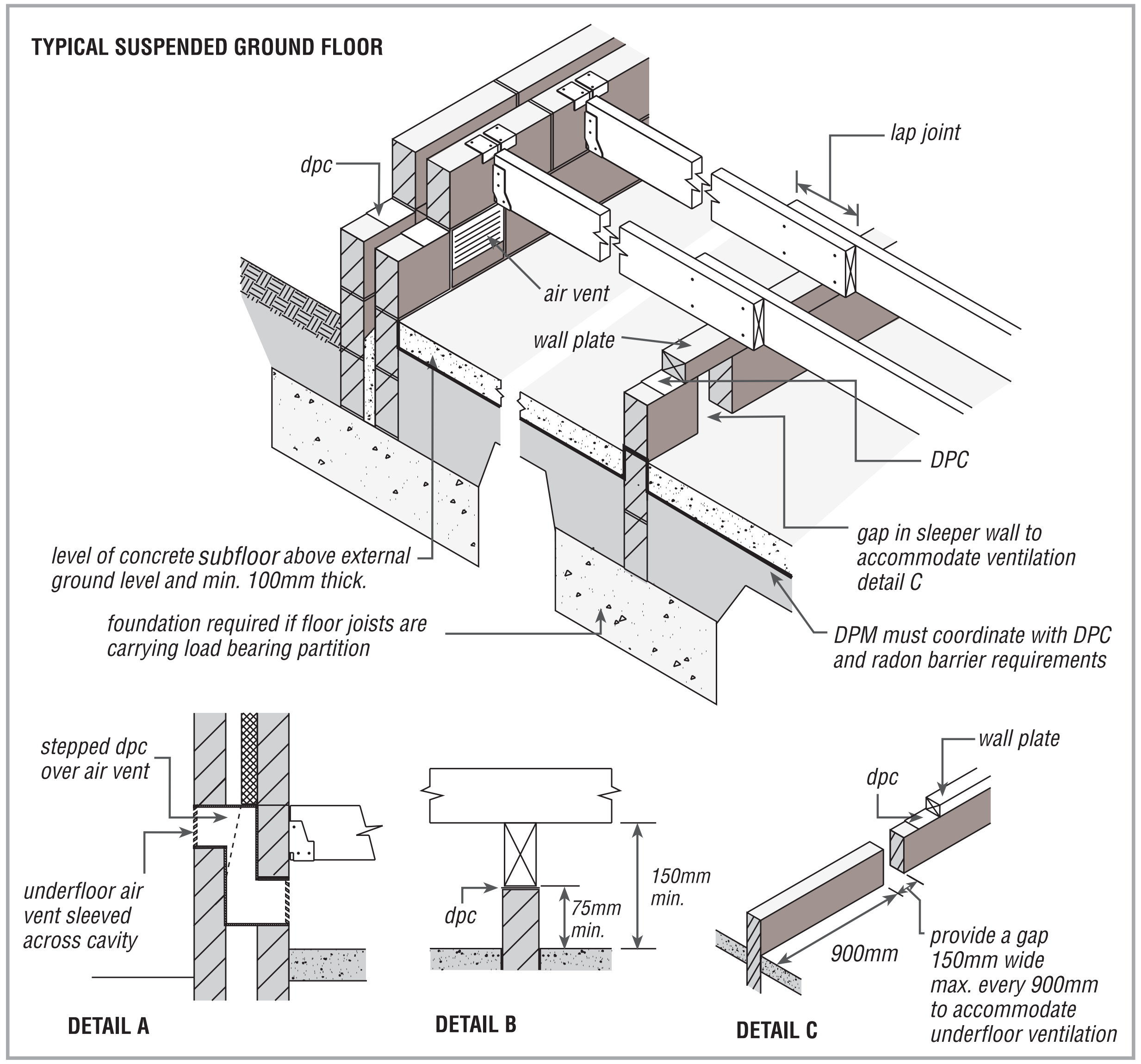
Trimmer joists can be supported by proprietary timber connectors or by a ledger nailed to the face of the trimmer joist (Detail B5.2.2). The size and ledger fixing must be designed.

When using a pair of joists to form trimmer joists they should be nailed at least at 450mm centres, 20mm from top and bottom edges of the joist. Alternatively they can be bolted on the centre-line at approximately 1m centres. Heavily loaded or large span trimmers may require a special design.

If the distance from the joist (or other combustible material) to the chimney flue is less than 200mm there must be a 40mm gap between the chimney and joist (or other combustible material).

Excluded from this requirement are floor boards, skirting, dado or picture rails, mantle shelf or architrave.

B 5.3 GROUND FLOOR REQUIREMENTS



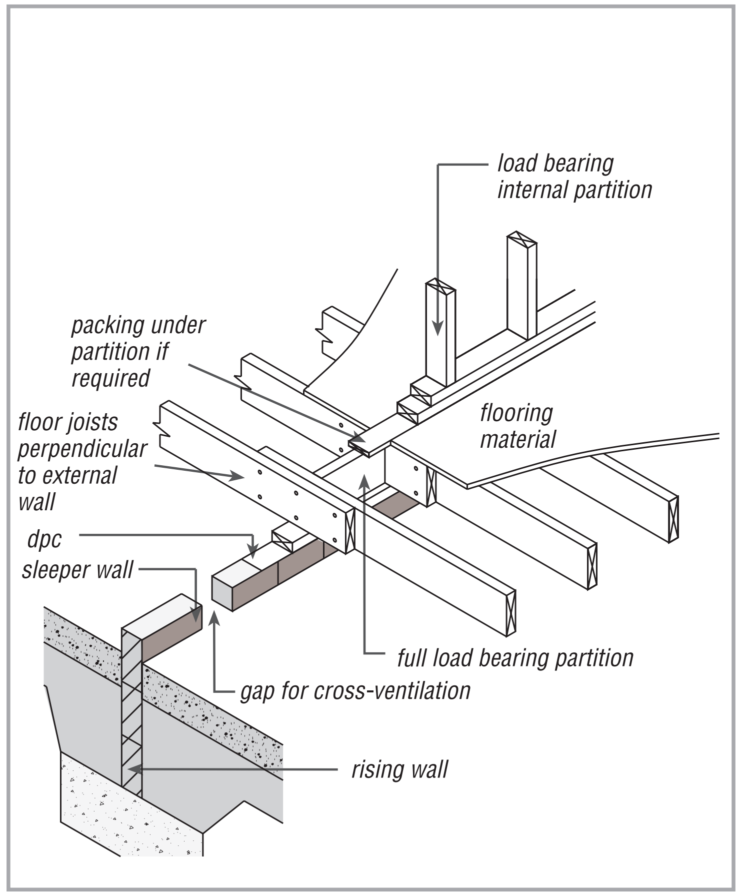
DETAIL B 5.3.1 Typical Suspended Ground Floor

In suspended timber ground floors the following should be adhered to:

- Underfloor ventilation openings are required in external walls. The frequency of the openings should be such as to provide an opening equivalent to 1500mm² for each metre run of wall. Any pipes needed to carry ventilating air should have a diameter of at least 100mm and extend across the cavity. Proprietary vent systems, including periscope vents, may be used.
- Provide a stepped DPC over the air vent (Detail B5.3.1A).
- Provide an unobstructed air space of at least 75mm from the top of the concrete subfloor to the underside of the wall plate and at least 150mm to the underside of the suspended timber floor (or insulation if provided in this location (Detail B5.3.1B).
- Provide a DPC to the underside of any wall plate (Detail B5.3.1B).
- The depth of concrete subfloor should be a minimum of 100mm. The level of the top of the subfloor should be higher than the finished external ground level.
- Honeycombed sleeper walls should be provided with an appropriate footing only where the floor joists are carrying a load-bearing partition, and provided with a gap not greater than 150mm at approx. 900mm centres to accommodate ventilation (Detail B5.3.1C).
- Refer to Building Regulations requirements for radon barriers.
- Care should be taken with the level of the subfloor and external ground so that there is no sump effect.

B 5.4 GROUND FLOORS – PARTITIONS

DETAIL B 5.4.1 Joists Perpendicular to Support



Suspended timber floors

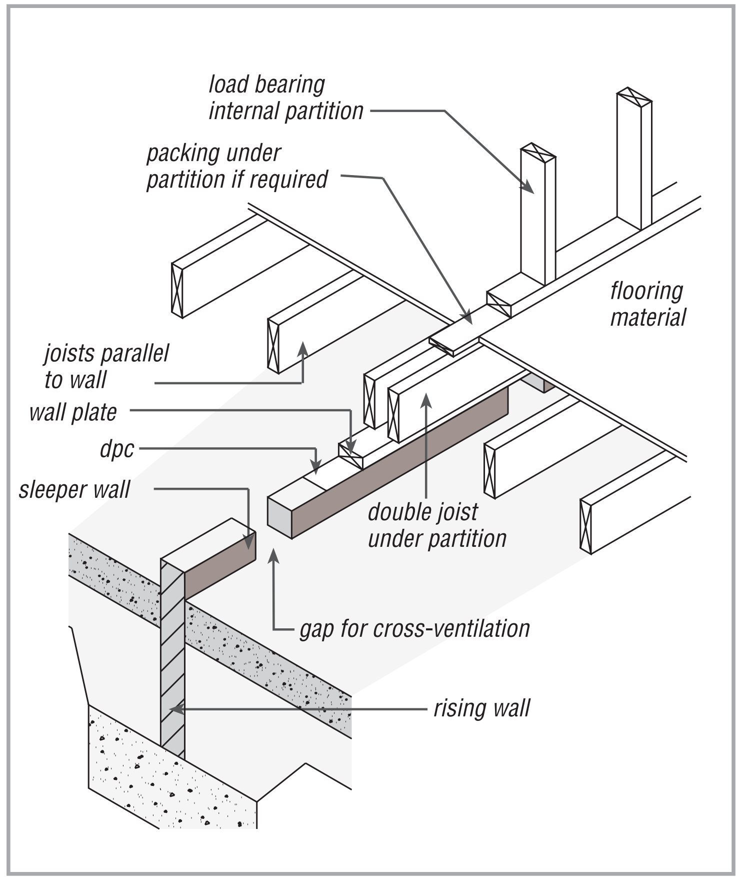
Where a suspended timber floor meets an internal load-bearing partition, bridging pieces or additional joists may be required to transfer the loads to the rising wall.

Detail B 5.4.1 illustrates this junction with the joists perpendicular to wall.

Gaps 150mm wide should be left in the sleeper wall to accommodate underfloor ventilation.

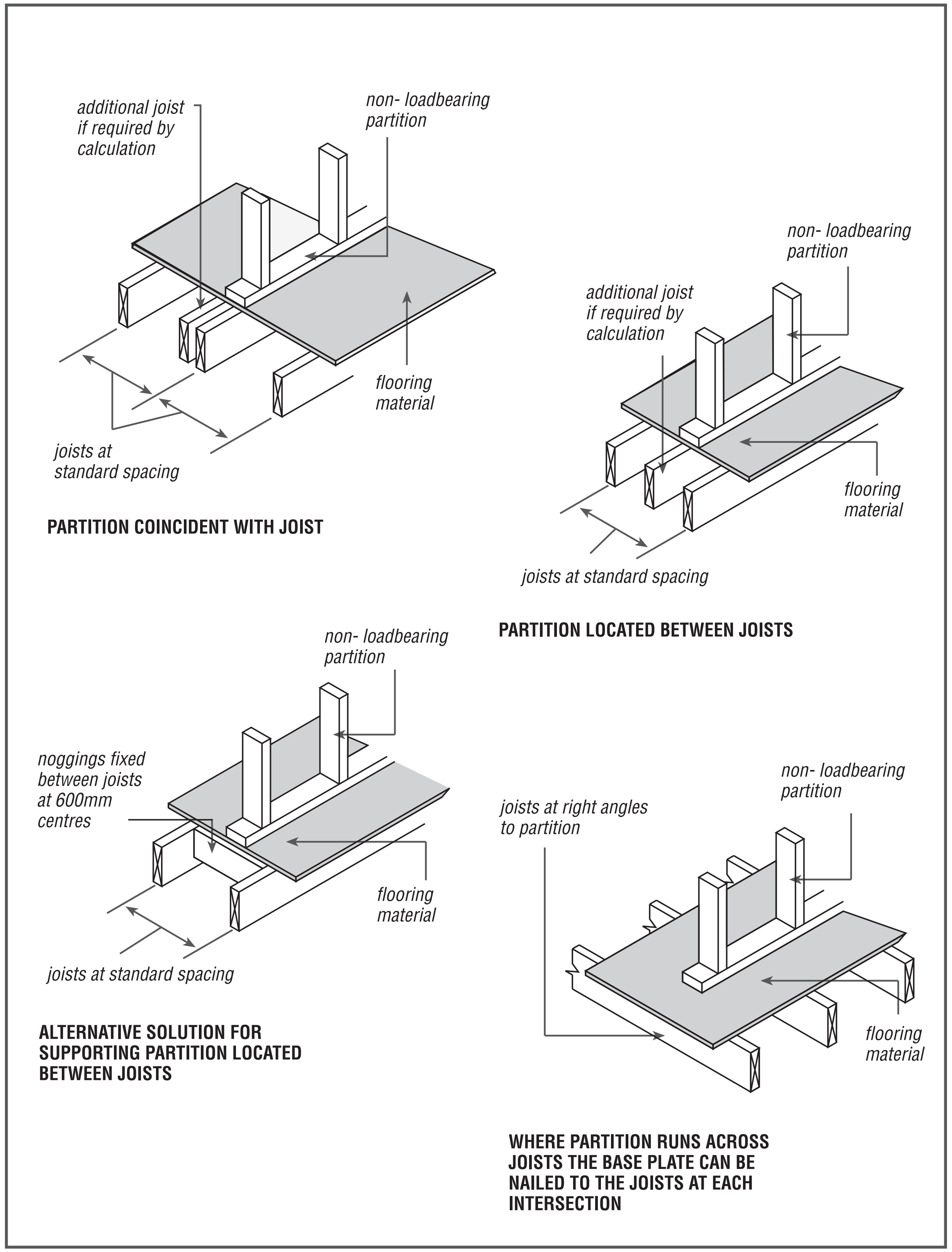
Where flooring material is fixed before the partition is erected, a single joist or bridging piece under the partition should generally be sufficient.

DETAIL B 5.4.2 Joists Parallel to Support



Detail B 5.4.2 illustrates support for a load-bearing partition where the joists run parallel to the partition and rising wall.

B 5.5 SUPPORT OF PARTITIONS



DETAIL B 5.4.3 Non-loadbearing Stud Support

Support for non load-bearing partition

Non load-bearing partitions should be supported off suspended timber floors in accordance with Detail B5.4.3.

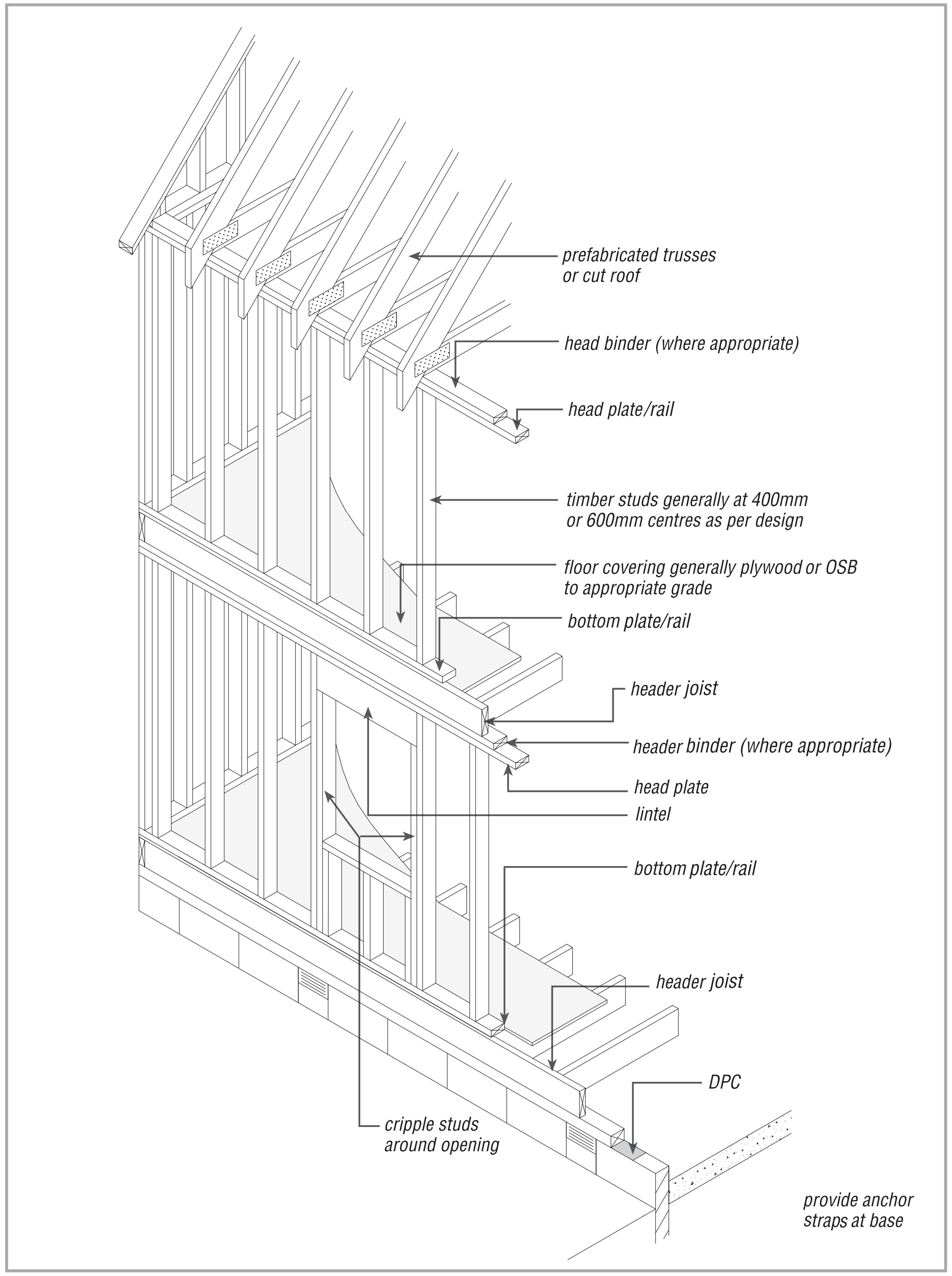
Partitions should not be supported by flooring material only; partitions should be fixed through the flooring into timber.

B 6 Timber frame

B 6.1 TIMBER FRAME - COMPONENT ELEMENTS

Details of a typical platform method of timber frame construction are shown below in Detail 6.1.1.

DETAIL B 6.1.1 Timber Frame Component Elements



External wall – platform construction

Detail of typical wall platform construction method.

Typical two storey timber platform frame construction.

(note: breather membrane and sheathing material removed for clarity as is external masonry leaf).

B 6.2 TIMBER FRAME - ACCURATE SETTING OUT

Panel erection

Accurate setting out of the sub-structure on which the timber frame sits is vital to ensure that the wall panels bears properly on the sub-structure.

A dimensioned baseplan (usually supplied by the timber frame manufacturer) with diagonal measurements for cross checking the sub-structure should be used to ensure accuracy. This baseplan should be marked up (usually by the builder or agents of the timber frame manufacturer) and returned to the timber frame manufacturer. It is important that not only individual houses be checked but also that terrace housing be checked across a number of houses to ensure that the block of houses does not `run off'; this can lead to problems with the location of soil vent pipes and other services. Where panels have to be altered on site this should only be carried out under strict supervision and under written instructions from the timber frame manufacturer.

It is important that panels are squared and plumbed. Panels should not be out of plumb more than 10mm in any floor and not by more than 10mm over the full building height (these are maximum figures, the aim should be to have effectively a tolerance of 0mm). If the panels are out of plumb by more than 10mm the timber frame manufacturer should be contacted for advice.

If wall cavities run off (whether from poor setting out or panels being out of plumb) this can affect the appearance of the building, the ability of the cavity to provide an adequate barrier against wind driven rain and also affect the performance of cavity barriers and wall ties.

Wall ties and cavity barriers are readily available for cavity widths of 50, 75 and 100mm, the usual cavity barriers and wall ties delivered to site are normally suitable for 50mm cavities. Most wall ties, anchor straps, cavity barriers and fire stops have a range of effective cavity widths; where cavities are outside the normal 50mm then contact the timber frame manufacturer for advice and if needed alternative products can then be supplied,

Sole plate (when used)

Where no separate soleplates are used, the bottom rail of the panel will act as the soleplate. Level the sole plate before fixing wall frames; if the sole plate is not level it may be supported on a mortar bed (and slate if necessary). The mortar bed should be not more than 10mm thick and should extend the full width of the sole plate, where this is not the case the timber frame manufacturer should be contacted for advice.

The packing should be uniform under the sole plate rather than intermittent; it is important that any gaps in the external wall and in particular the party wall be sealed. There should be no need for packing at first floor or roof level if the base is properly levelled.

The fixing of the soleplate to the rising walls or substructure should be specified by the design engineer in the Site Fixing Schedule (supplied by the timber frame manufacturer). The type and thickness of packing can affect the performance of the fixings and it is recommended that the timber frame manufacturer be consulted where the packing is in excess of 10mm.

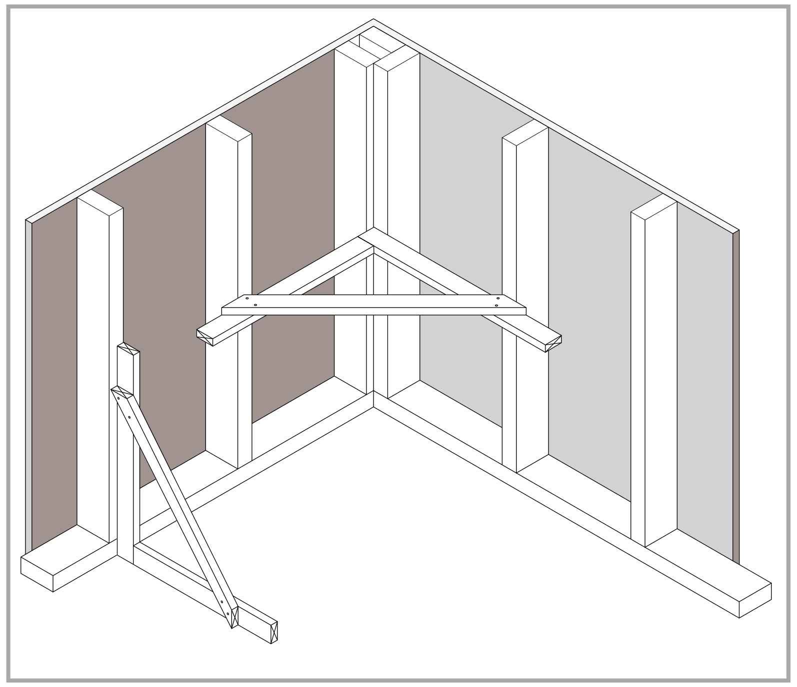
Care should be taken to ensure the level of the concrete slab as any rise in the concrete slab may result in non-load bearing walls becoming load bearing.

The sub-structure and concrete slab should be level to within +/- 6mm and a good builder should aim for less than half this value.

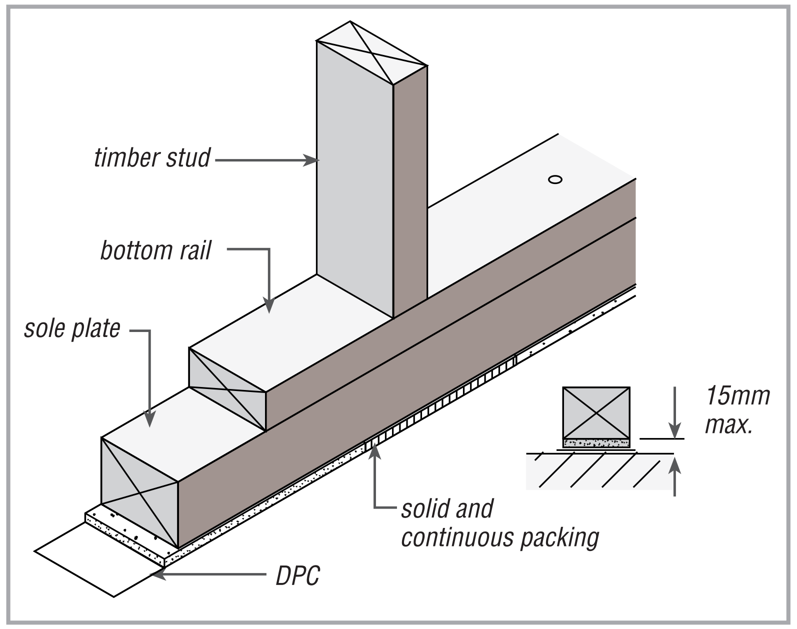
Sole plate overhangs

The sole plate should not overhang the sub-structure on which it sits by more than 12mm. On the cavity side, where ledges cannot be avoided they should be protected by the breather membrane; the membrane should always extend below the DPC (to the soleplate) by at least 50mm.

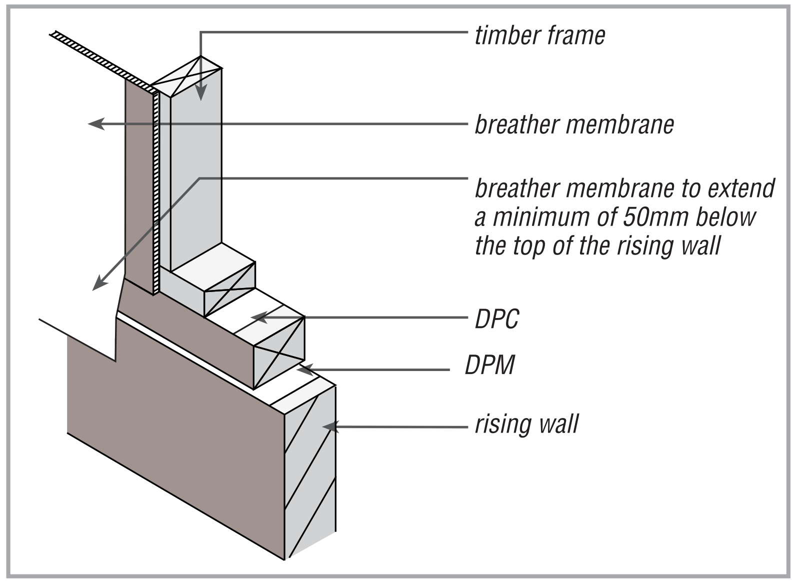
Where the soleplate bearing on the sub-structure varies by more than 12mm the timber frame manufacturer should be contacted.



DETAIL B 6.2.1 Set Out



DETAIL B 6.2.2 Level Sole Plate



DETAIL B 6.2.3 Overhangs

B 6.3 TIMBER FRAME - INSULATION DETAILS

Thermal insulation

The most common type of thermal insulation used in timber frame external walls is glass fibre. The glass fibre comes in rolls and is often compressed in the roll; care should be taken that the insulation is `fluffed out' to its proper thickness before it is used. The rolled type must be supported and is normally stapled to the studs to hold it in place and to prevent it from sagging. Care should be taken to ensure that there are no gaps in the insulation (to avoid cold bridging) and if the insulation is fitted in small sections that each section is supported. It is recommended that each space between the studs is filled with a single piece.

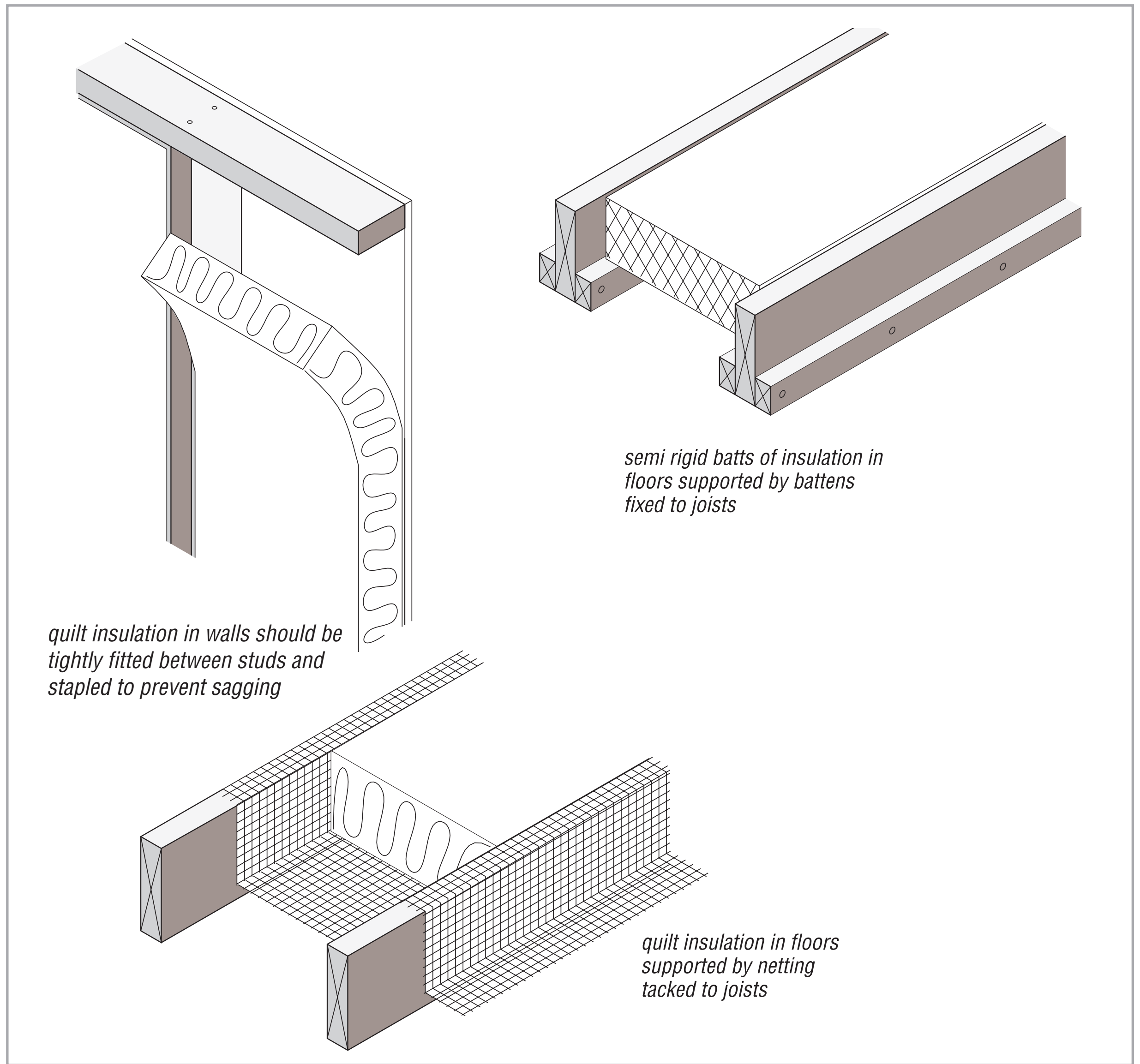
Semi-rigid insulation may be tightly wedged between studs (filling any gaps with foam). In floor construction, quilt insulation may be supported by netting and semi-rigid insulation supported by battens. The insulation should fit neatly between the joists without leaving any gaps.

It has become more common to fix a vapour control layer (VCL) to inside face of the timber studs and then add battens to the studs to create a cavity between the plasterboard and VCL. The services can run in this internal cavity and it can also be filled with thermal insulation to increase the wall's U-value; the VCL is not pierced by the services and it is protected from damage. The VCL is usually taped to the concrete ground floor to improve air-tightness. Some systems also use a wood fibre board on the outside (protected by a breather membrane) for added thermal insulation.

While fully filling the wall cavity with insulation is not recommended, some timber frame systems partially fill the wall cavity usually with a rigid insulation usually a close celled polyurethane board. These systems tend to use a cement boards fixed to battens for weather protection with a cavity between the weatherboard and the insulation. Care has to be taken to ensure that the insulation is fixed to the timber frame, that the battens are adequately fixed to the timber frame and that the weatherboard is properly fixed to the battens, The battens should be treated and the fixings should have a suitable durability as well as strength. This type of system reduces cold bridging and adds insulation without reducing the internal volume/area of the building. However, a condensation risk analysis should always be carried out with these forms of construction.

A condensation risk analysis should be carried out where necessary – generally where the VCL has a vapour resistance less than 250 MNs/g and/or where added insulation is placed outside the studs or where the construction does not follow standard practice.

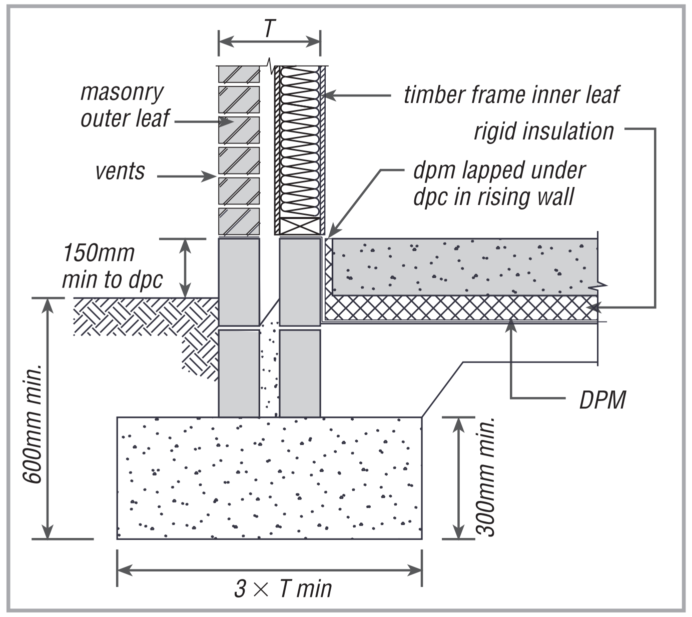
DETAIL B6.3.1



B 6.4 TIMBER FRAME - FOUNDATIONS/SUBSTRUCTURE

Foundations

The most common type of foundation is the continuous concrete strip formed centrally under load-bearing and external walls depth, thickness and width of all foundations are dependent on the nature of the ground that the foundation bears on.

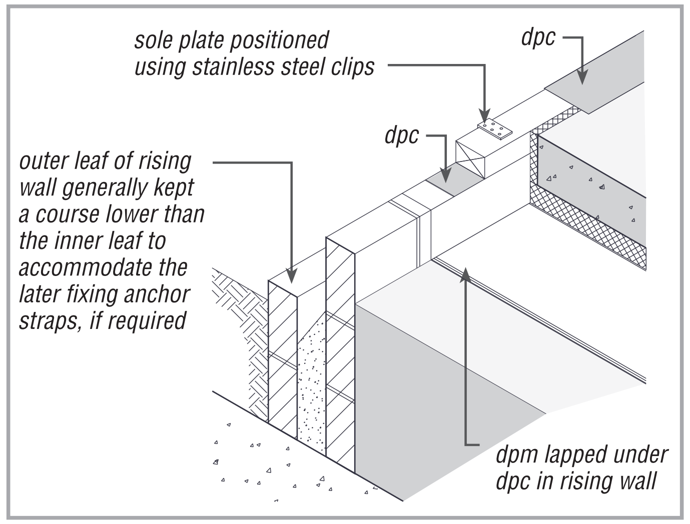


DETAIL B 6.4.1 Foundations

Rising walls

The sole (or the panel bottom rail) can be fixed to the rising wall by means of austenitic stainless steel fixing clips located at 1200mm centres; the clips should also be fixed in place with austenitic stainless steel nails. The function of the sole plate is to:

- Provide an accurate positioned base on which the timber frame and any timber suspended ground floor can then be fixed.
- Provide a nailing plate for the timber frame wall panels or ground floor joists.
- Secure and protect the DPC, DPM and/or radon barrier.

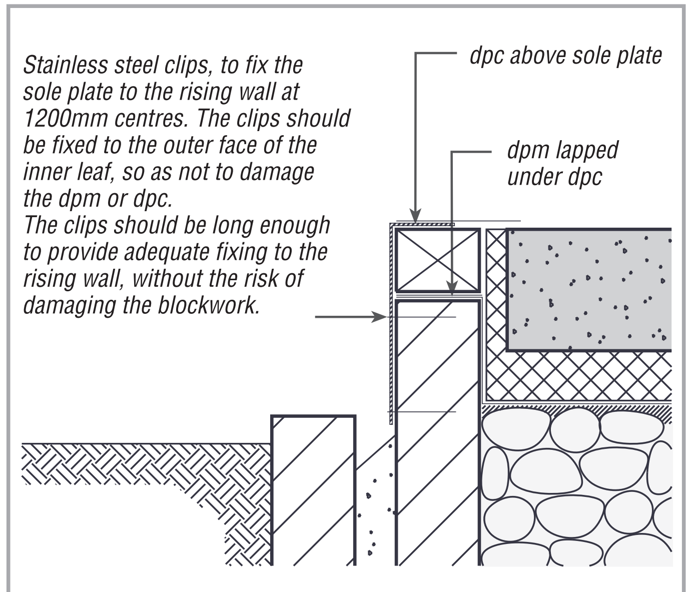


DETAIL B 6.4.2 Rising Walls

The soleplate may be fixed to the rising wall with appropriate nailing. The fixing of the sole plate (whether austenitic stainless steel nails or fixing clips) should be in accordance with the Site Fixing Schedule supplied by the timber frame manufacturer.

Sole plates should be pressure treated with preservatives. See *Designing for Durability in Section A4.*

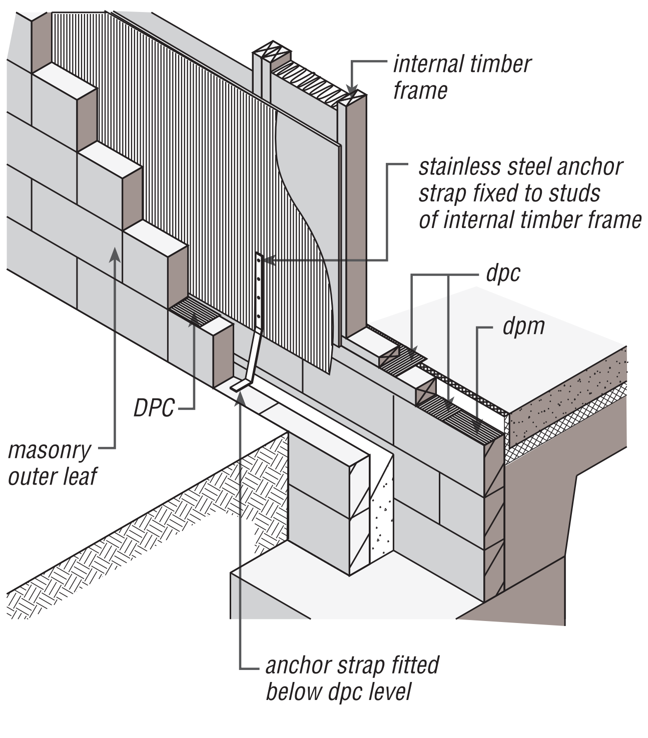
The cavity void in timber frame construction must be drained and ventilated. This can be achieved by providing the equivalent of 1 open brick perpend (about 650mm^2 normally by the use of proprietary ventilators providing both functions) at 1500mm horizontal centres below DPC level in the external masonry leaf. These ventilators must be kept free of debris such as mortar droppings as should the wall cavity in general. It is also usual to provide wall vents at eaves level and if specified by the building designer on either of a cavity barrier at compartment floor level. The centres of the vents can be in proportion to the area of the vents but in general weep holes should not exceed 1500mm.



Typical sole plate fixing detail - minimum requirements

DETAIL B 6.4.3 Sole Plate Fixing

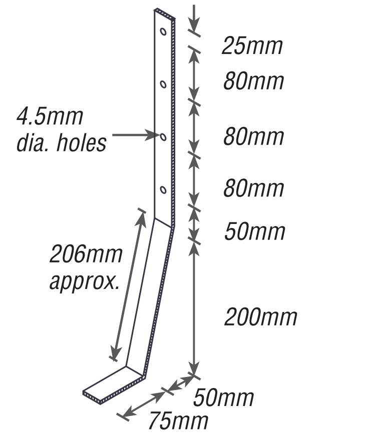
B 6.4 TIMBER FRAME - FOUNDATIONS/SUBSTRUCTURE (CONTINUED)



DETAIL B 6.4.4 Rising Walls

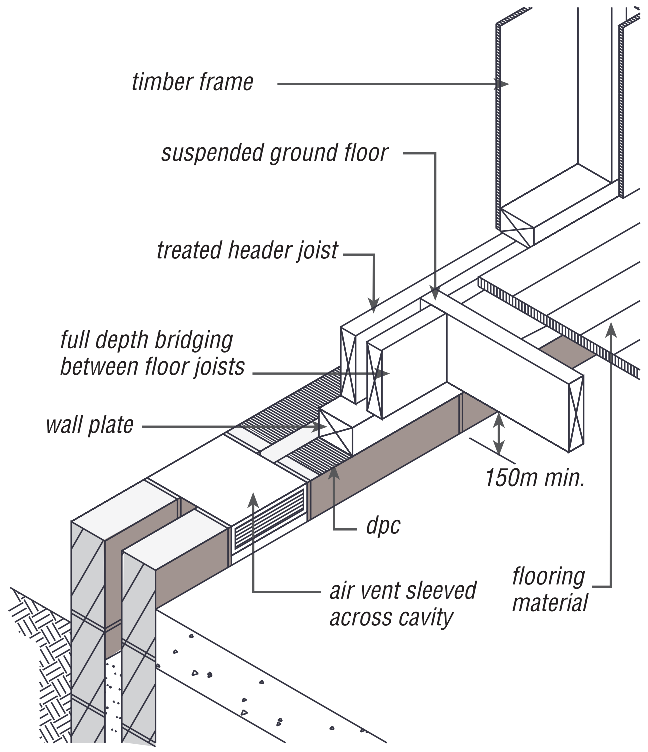
Rising walls (continued)

In certain cases timber frame wall panels may need to be anchored into the external masonry leaf, by means of stainless steel straps fixed to full height studs. The bend at the bottom of the strap bridges the cavity and is embedded into a horizontal bed joint, generally in the course below DPC level. It is recommended that anchor straps are located on either side of openings and at external corners and at a maximum of 1800mm or 1600mm centres depending on the stud spacing, The Site Fixing Schedule may detail additional holding down straps and may include the use of straps at higher levels.



MINIMUM REQUIREMENTS
Typical stainless steel holding down strap.
Cross section 30 x 2mm, overall length 600mm.

DETAIL 6.4.6 B Holding Down Strap



DETAIL B 6.4.5 Floor Types

Floor types

Timber-frame dwellings can be built with all the common types of ground floor.
The selection of appropriate floor type will depend on a number of factors including:
- End user requirements.
- Site conditions.
- Insulation standards.
- Contractor's preference.
- Availability.
- Cost.

B 6.5 TIMBER FRAME - EXTERNAL WALL COMPONENTS

The external walls consists of three elements, the load bearing timber frame inner leaf, the ventilated cavity and the external non-load bearing masonry leaf. As an alternative to masonry cladding appropriate timber cladding fixed to vertical battens, or render on stainless steel mesh, can be used, (see B8.1 to 8.4 cladding). Any proprietary rain screen should have been assessed by an appropriate body such as the Agrément Board.

Timber framing

The function of the timber framework is to:

- act as the vertical load bearing skeleton of the external wall.
- resist lateral wind loads.
- provide a framework for the fixing of sheathing, internal linings, etc.

Vertical loads on the wall panel such as those from floor joists or roof trusses should occur over the studs or be offset from the centre-line of the stud by no more than the stud thickness. Where walls are made up of a series of smaller a head binder should be used to connect the panels together; head binders should generally be positioned and fixed on site. A top/head rail and head binder allows generally loads from floor joists, rafters etc., to be borne between studs. Heavier loads from trimmers, beams etc., may require additional support.

Noggings

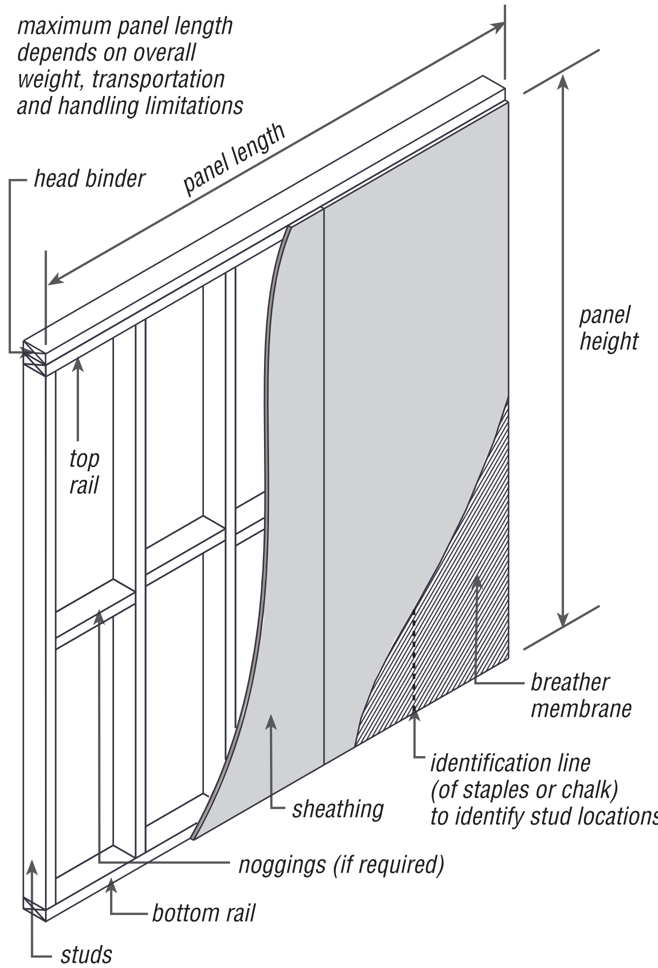
Generally are not required for structural purposes. Where they are used their function is to:

- provide support for partitions and/or plasterboard sheet edges.
- provide support for fixings and fittings.
- resist buckling of studs.
- support joints in external sheathing.

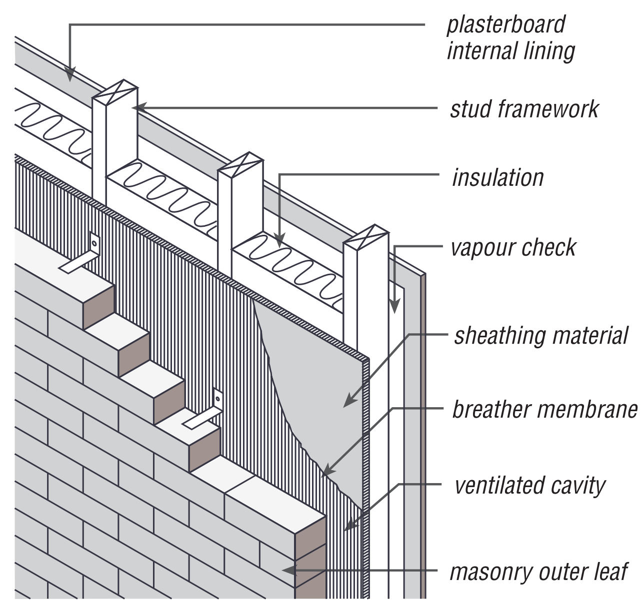
Sheathing

The function of sheathing is to :
- provide the necessary stiffness to resist lateral loads.
- resist wind penetration of the structure.
- enclose and support wall insulation.
- provide a solid background onto which the breather membrane is fixed.

Appropriate sheathing materials include sheathing grade plywood and oriented strand board (OSB3). Sheathing materials should have an appropriate certificate of approval from a body such as the Agrément Board and/or conform to EN 13986 (for permissible stress designs to BS 5268-6 reference should also be made any requirements specified in BS 5268-2); other methods of proving their suitability such as a valid ETA and CE marking (to EN 13986) may be acceptable (depending on the claimed end use and other marks e.g. plywood should bear the mark EN 636-2 or EN 636-3). All sheathing materials must be suitable for their end use.



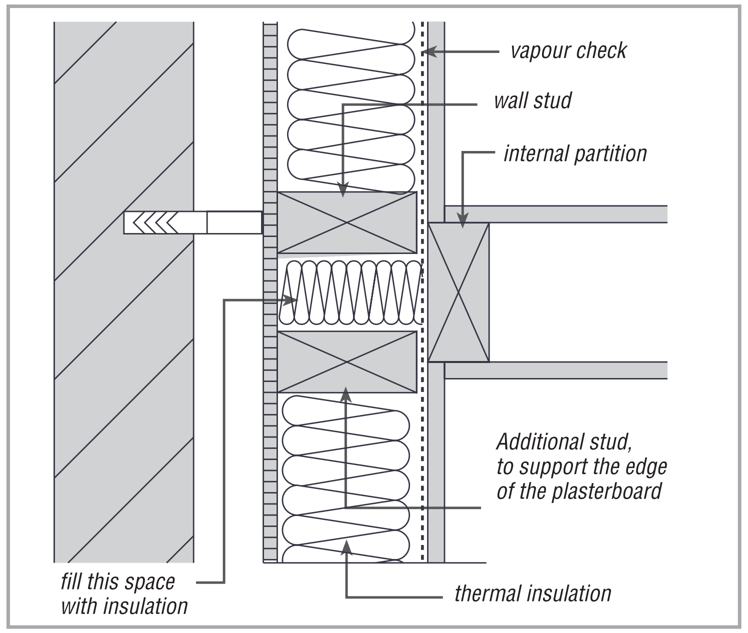
DETAIL B 6.5.1 Wall Panel Components



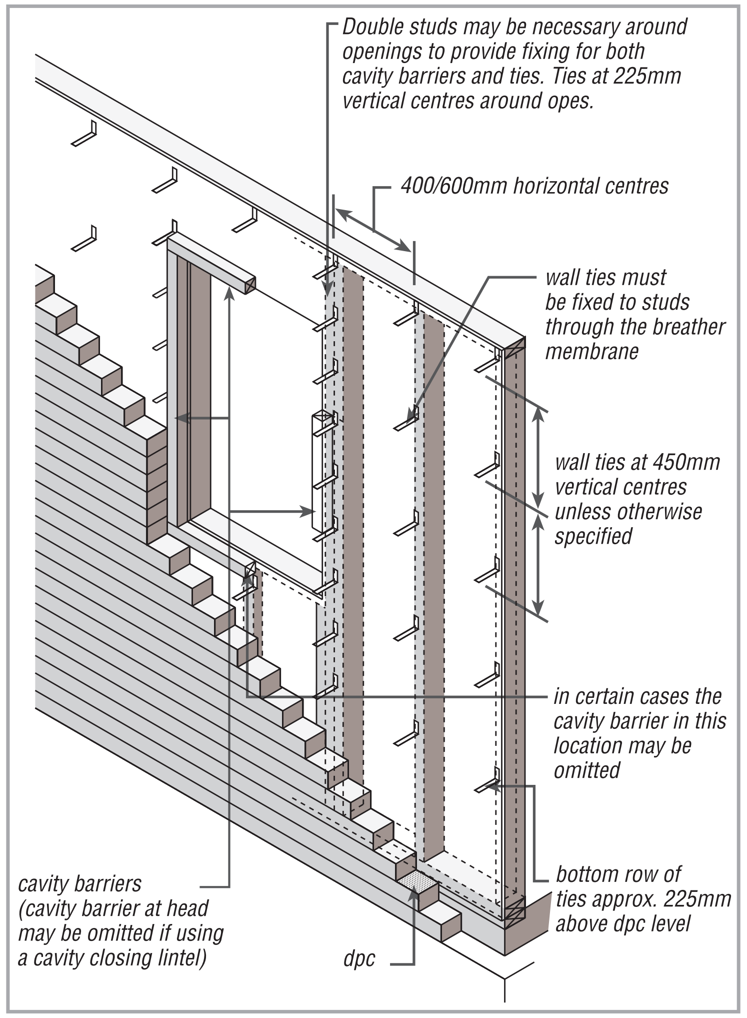
DETAIL B 6.5.2 Noggings

Where buildings are near the sea, sheathing fixings may need to be of austentic stainless steel and/or a reverse wall construction used.

B 6.5 TIMBER FRAME - EXTERNAL WALL COMPONENTS (CONTINUED)



DETAIL B 6.5.3 Plan View of Typical Wall Junction



DETAIL B 6.5.4 General Arrangement

Thermal insulation

Improved `U' values may be obtained by using a more efficient thermal insulation as well as by increasing the stud depth to allow extra insulation to be fitted.

Vapour check

By fitting a vapour check between the internal wall and warm side of the insulation the amount of water vapour passing through the wall and the likelihood of interstitial condensation occurring in the timber frame structure will be greatly reduced.

Suitable vapour checks commonly include 500-gauge un-recycled polythene. The use of vapour check plasterboard (which tend to have a considerably lower resistance to the passage of water vapour than polythene) is not recommended unless a condensation risk analysis is carried out.

Breather membrane

The external face of the sheathing material must be covered with a breather membrane. Its function is to protect the frame until the external cladding is complete and to provide a second line of defence against wind driven rain or moisture which may penetrate the outer cladding. The breather membrane must be waterproof but permeable to allow water vapour passing out through the inner leaf to enter the ventilated cavity.

It is recommended that the breather membrane should have a vapour resistance less than 0.6 MNs/g and comply with the requirements of BS 4016.

Wall ties

To assist the fixing of wall ties to studs the stud locations are usually identified on the outer surface by an indelible line, a line of staples or a tape of a different colour to that of the breather membrane.

Wall ties should have been tested to the relevant standards outlined in EN 845 and be manufactured from austenitic stainless steel (or a material with a similar degree of corrosion resistance). Wall ties should be nailed to the timber frame at stud locations and should not be fixed to the sheathing material only. The appropriate wall ties and fixings are usually supplied by the timber frame manufacturer.

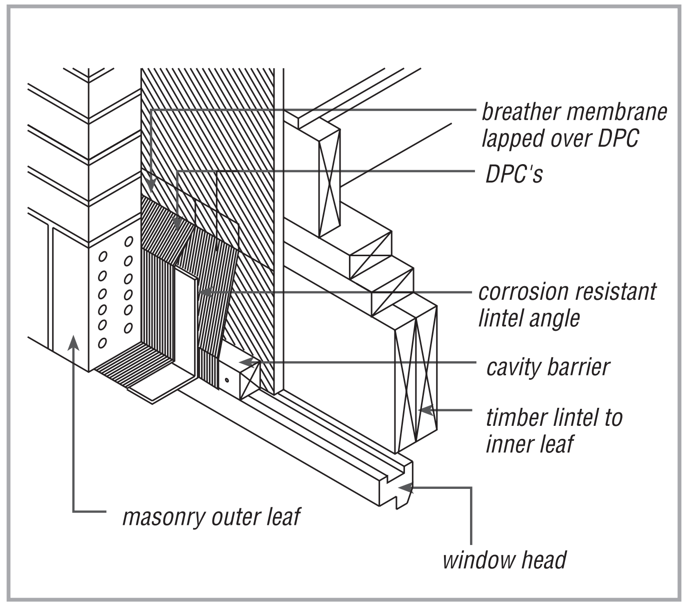
Wall ties are generally spaced at 450mm vertical centres, horizontally at stud centres (usually 400 or 600mm), and at 225mm vertical centres around openings and at expansion joints, unless otherwise specified. Wall ties must always be appropriate to the width of external wall cavity in which they are used.

B 6.5 TIMBER FRAME - EXTERNAL WALL COMPONENTS (CONTINUED)

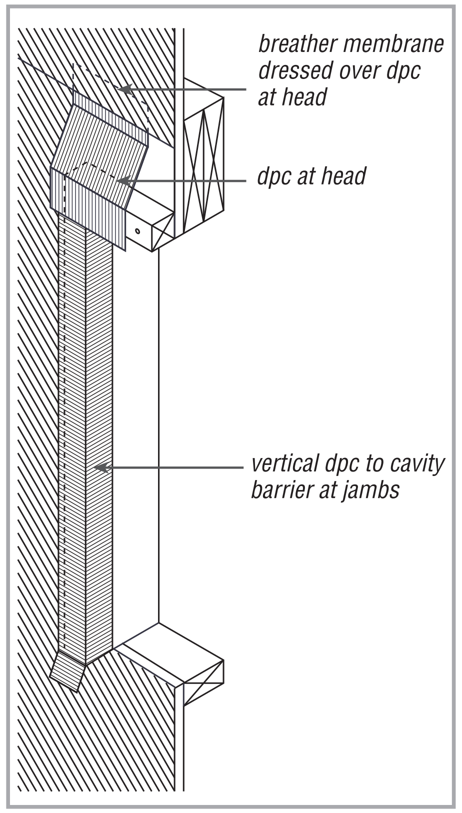
Damp proof course (DPC)

Timber frame panels usually come with a damp proof course fixed to their underside. The laps in the DPC at the panel ends should be released and used to provide a continuous barrier to moisture. The damp proof membrane (DPM and or Radon barrier) should be lapped with the DPC on the bottom of the sole plate across the full width of the internal wall leaf.

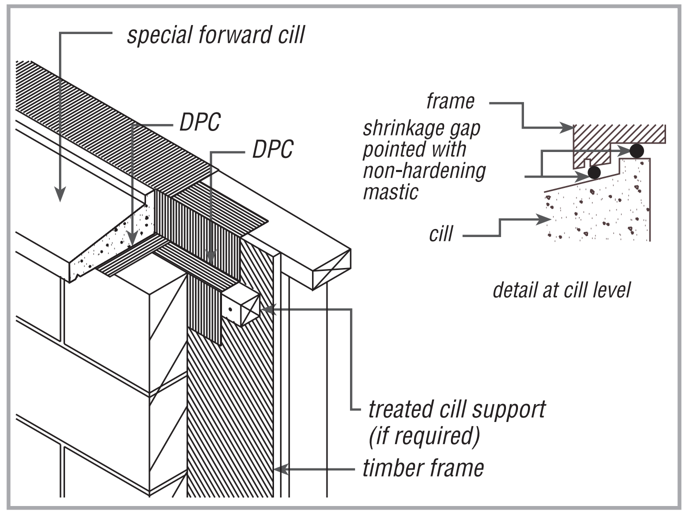
Damp-proof courses should be provided at all external openings and to all timber cavity barriers.



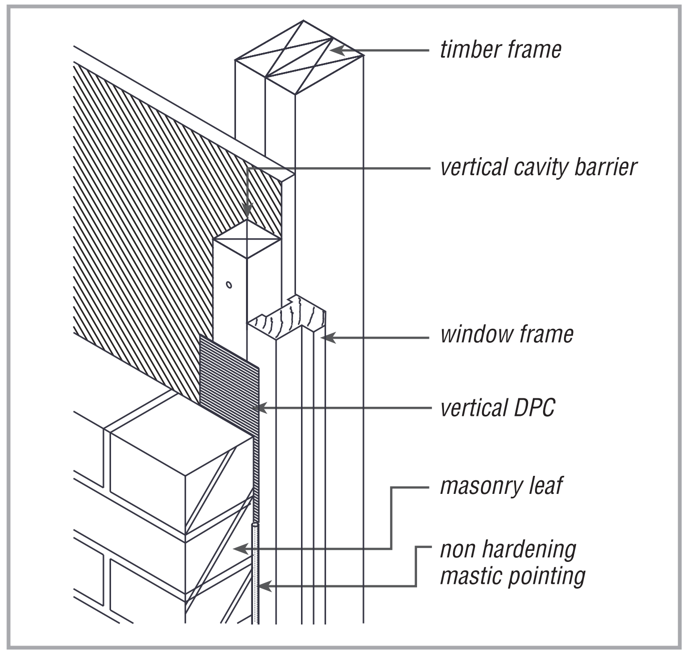
DETAIL B 6.5.6 Jamb Detail



DETAIL B 6.5.9 Damp Proof Course



DETAIL B 6.5.7 Cill Detail



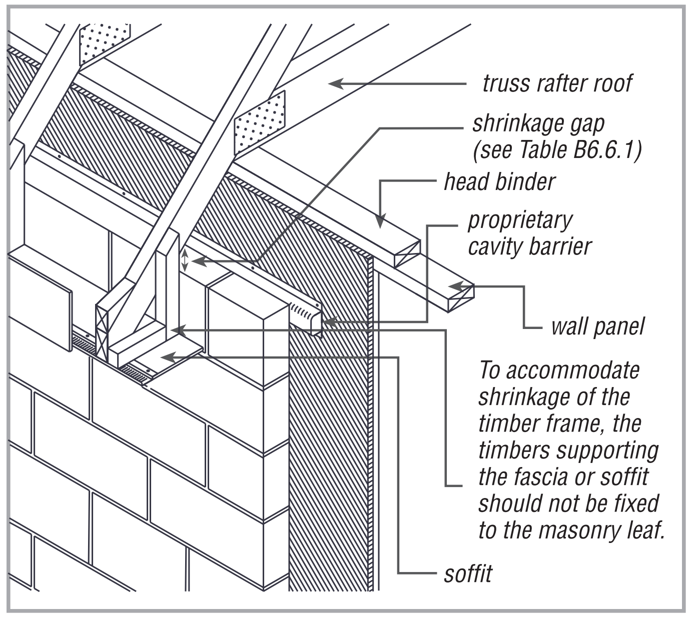
DETAIL B 6.5.8 Side Detail

Provide damp-proof course to the bottom, back and sides of all window sills.

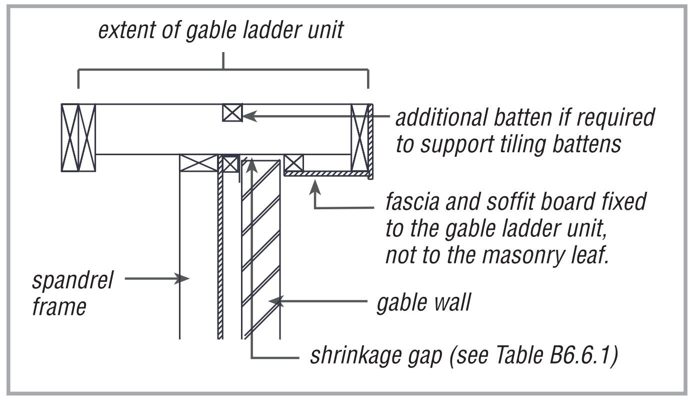
Damp-proof courses must be provided to all steel lintels and lintel angles. The breather membrane must be dressed over the damp proof courses provided to the lintel.

The DPC should always be fixed so as to shed water away from the frame.

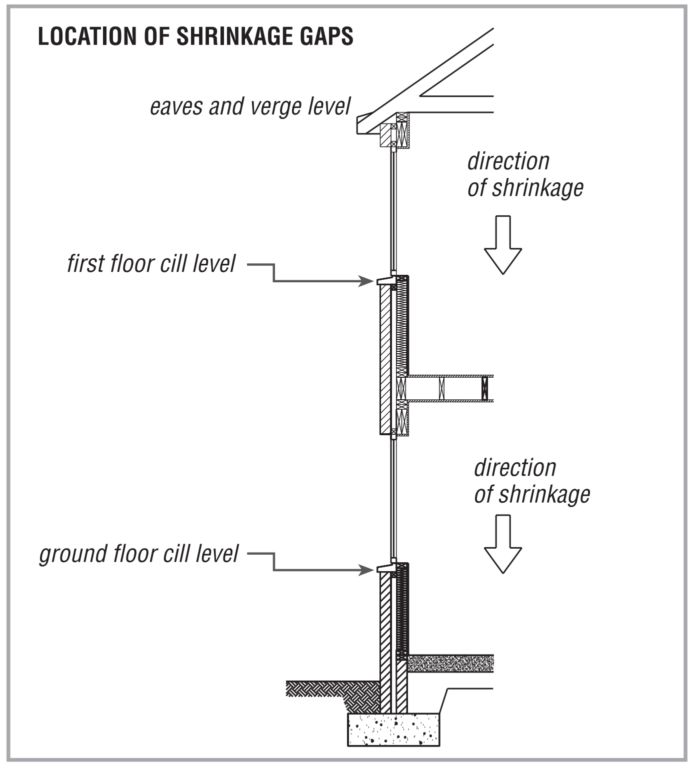
B 6.6 TIMBER FRAME - EXTERNAL WALLS



DETAIL B 6.6.1 Eaves Detail



DETAIL B 6.6.2 Gable Verge



DETAIL B 6.6.3 Shrinkage Locations

Eaves detail

At eaves, the soffit board should not be carried over the top of the masonry leaf. To accommodate natural shrinkage of the timber frame, a gap should be left between the roof timbers and the top of the masonry outer leaf. Typical dimensional requirements for this gap are outlined in Table B6.6.1.

Verge detail

Typical verge detail formed with gable ladder is shown in Detail B6.6.2. To accommodate natural shrinkage of the timber frame, a gap should be left between the roof timbers and the top of the masonry outer leaf and the underside of the gable ladder. Typical dimensional requirements for this gap are outlined in Table B6.6.1.

Shrinkage

To accommodate natural shrinkage of the timber frame, provide a gap at the locations indicated, dimensions of which can be taken from Table B6.6.1 below.

Table B6.6.1 *Typical dimensional allowances for shrinkage gaps*

	TYPES OF FLOOR CONSTRUCTION	
	Suspended timber ground floor *1	**Other ground floor construction *2**
allowances for ground floor openings	5mm	3mm
allowances for first floor openings	12mm	9mm
eaves and verge for a single storey house	8mm	6mm
eaves and verge for a two storey house	15mm	12mm

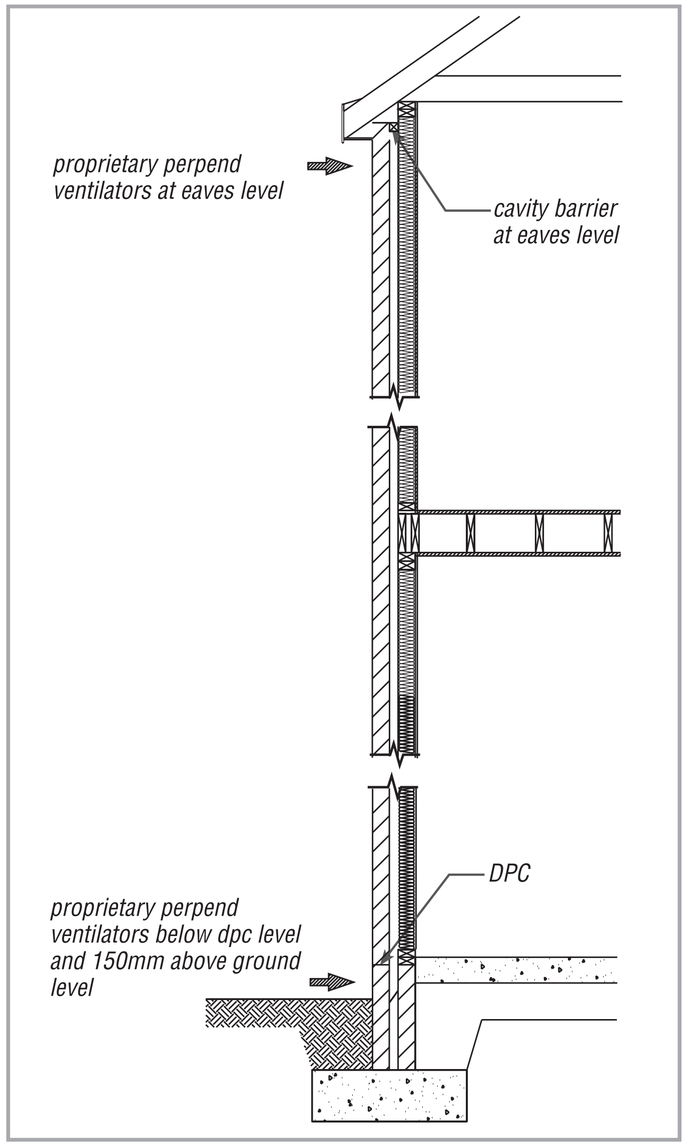
*1 *Where wall panels are supported on timber ground floor joists or perimeter joists*
*2 *i.e. where there is no movement associated with the ground floor or substructure.*

B 6.6 TIMBER FRAME - EXTERNAL WALLS (CONTINUED)

Cavity ventilation

The external wall cavity in timber frame construction must be ventilated in order to dissipate any moisture that may enter the cavity. Ventilation is generally provided by a proprietary perpend vents (i.e. about 10mm by 65mm) fitted at 1500mm horizontal centres in the masonry outer leaf in the locations indicated in Detail B6.6.4. Consideration must also be given to the location of cavity barriers as set out in Section B6.12.

Often the proprietary cavity vents also act as weep holes and allow liquid water to escape. In some situations weep holes nay be necessary in other locations such as over doors and windows. If larger vents (that the open perpend) are used at greater centres to give an equivalent ares per metre) then weep holes should be provided at closae centres.

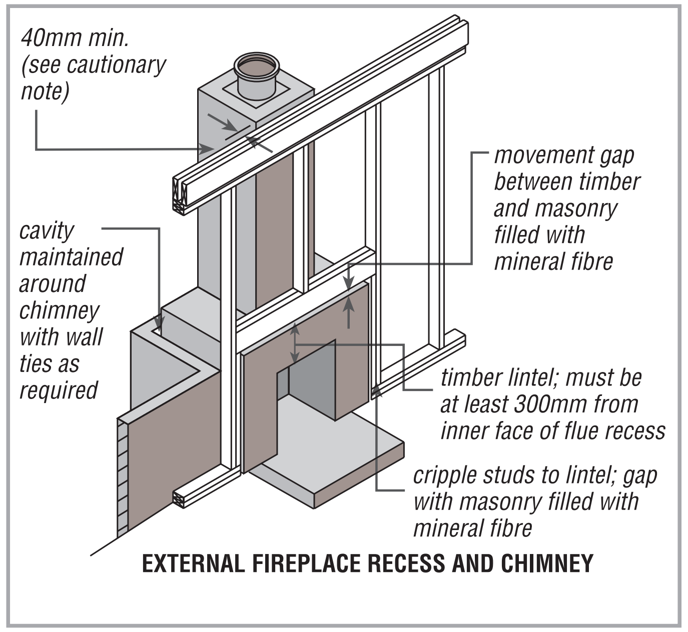


DETAIL B 6.6.4 Cavity Ventilation

Fireplaces and chimneys in external walls

Generally there are two main methods of constructing chimneys in external walls.

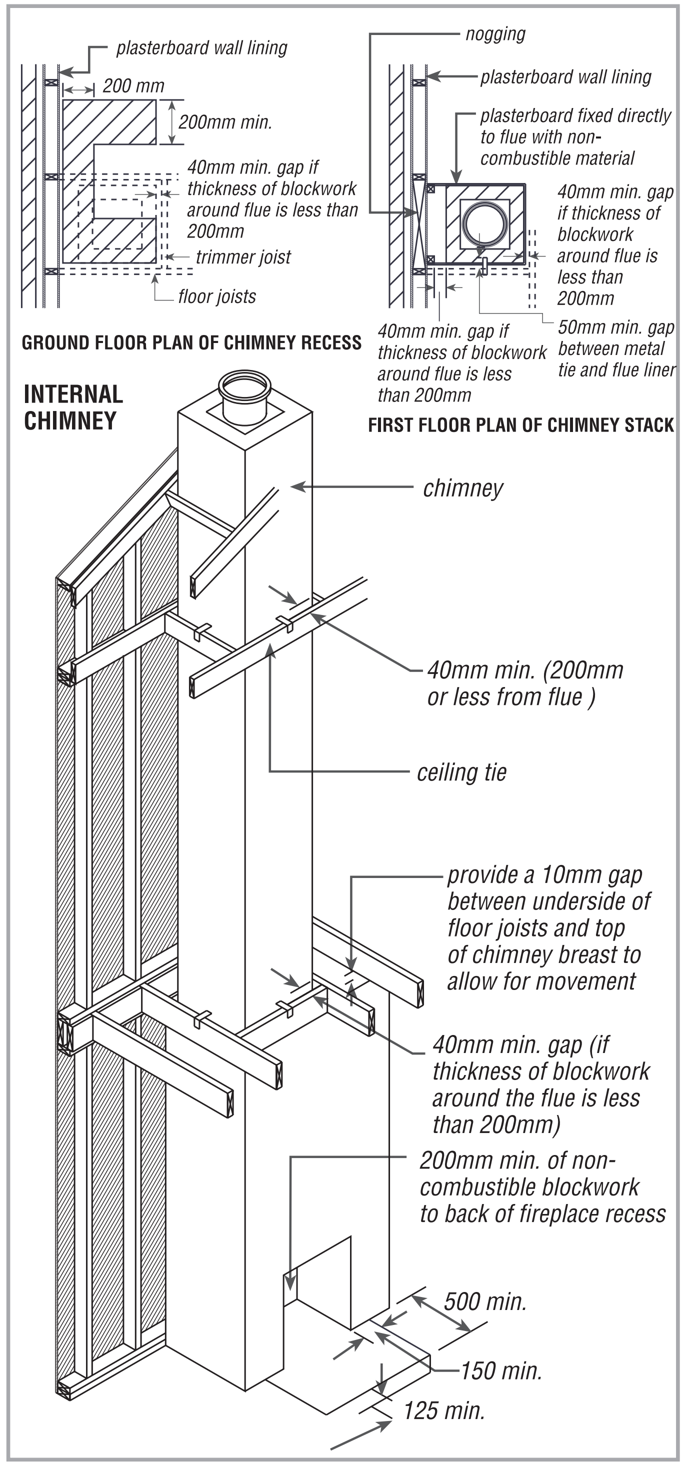
The fireplace and chimney stack can be located on the outside of the timber frame external wall panel. (See Detail B6.6.5) The fireplace is in a preformed aperture in the timber frame wall panel. The structural integrity of the timber frame is maintained and specially trimmed openings in the roof are avoided.



DETAIL B 6.6.5 Fire Places & Chimneys

B 6.6 TIMBER FRAME - EXTERNAL WALLS (CONTINUED)

DETAIL B 6.6.6 Fire Places & Chimneys



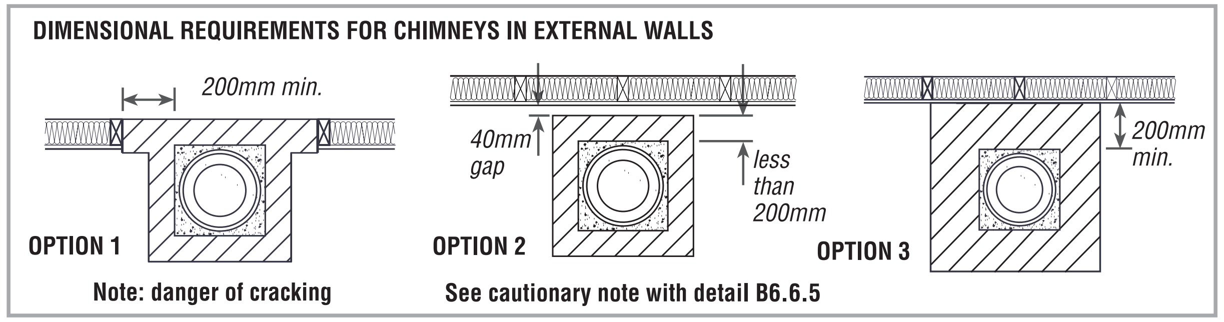
Fireplaces and chimneys in external walls (continued)

The fire place and chimney stack can also be built inside the room usually after the internal linings have been fixed. This type of construction requires that the floor and roof members be trimmed around the chimney stack (see Detail B6.6.6).Care should be taken at roof level when detailing flashings around the chimney to allow for movement of the timber frame. Where metal ties are required between the chimney stack and the floor and the roof timbers, these should be fixed in accordance with the chimney manufacturer's or design engineers' recommendations.

If the wall, floor or roof timber members are less than 200mm from the chimney flue there should be at least 40mm between these members and the chimney. More in formation is given in *Technical Guidance Document J*.

Where the chimney is built before the plasterboard or fire linings are put in place then there is a danger of the linings not being properly fixed; this is a particular risk for ground floor walls.

DETAIL B 6.6.7



B 6.7 TIMBER FRAME - SUPPORT TO OPENING LINTELS AND TRIMMER BEAMS

Lintels within timber frame panels

Openings in load-bearing wall panels will include a lintel at the head of the opening to transmit loads to cripple studs on either side of the opening. The number of cripple studs required depends on the size of the opening and the load being carried by the lintel.

Detail B6.7.1 shows typical load-bearing lintels in an external wall panel.

Detail B6.7.2 shows how heavy point loads from trimmer joists, multiple trusses, beams etc., are transmitted to the foundations by means of additional studs. The number of studs required is determined by calculation.

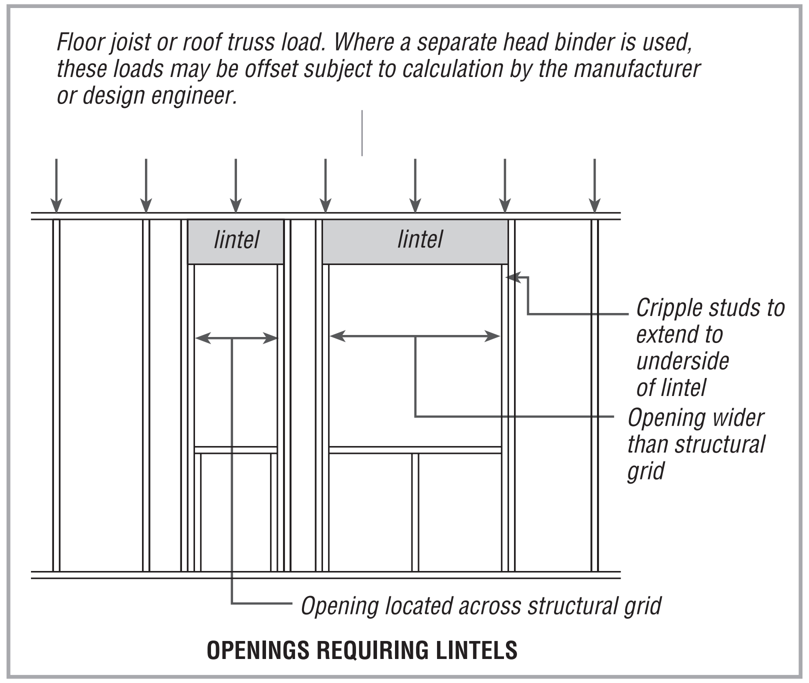
Detail B6.7.3 shows a typical load-bearing lintel in an external wall panel.

Occasionally steel columns may be required to transmit loads to foundations.

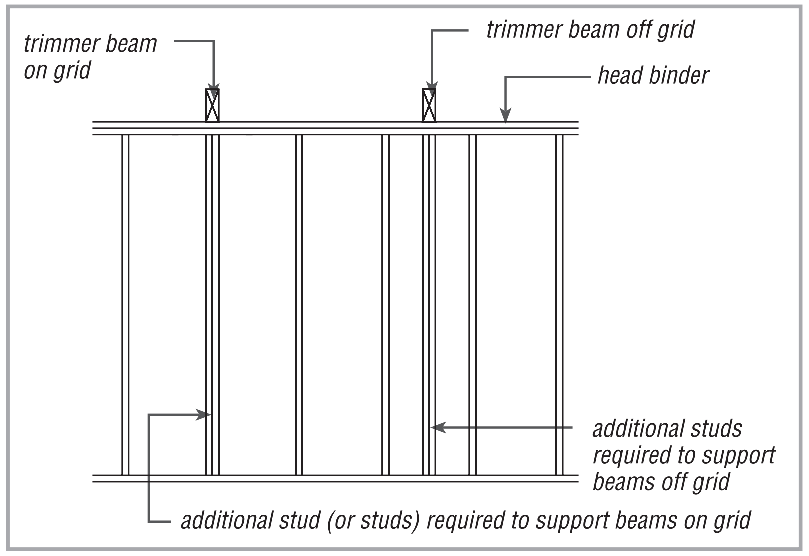
The timber frame panels will arrive on site with the stud supports already in place. Where studs are added on site (through error in manufacture or through mis-placement of the panel on site) they must be added in accordance with the timber fame manufacturer's instructions. Generally the sheathing should be fixed to all loose studs. If the sheathing cannot be accessed for nailing then all loose studs should be fixed together and timber bridging should be inserted between the additional studs and those held in place by the sheathing.

It is always a good idea to walk through a timber frame building and make sure that there is timber in place to transfer loads through floors and into lower wall panels. Multiple studs in an upper wall panel should normally have multiple studs directly below them in the lower wall panel and timber within the floor to transfer loads. A check should also be carried out at the same time to ensure that there is enough timber for plasterboard support and fixing.

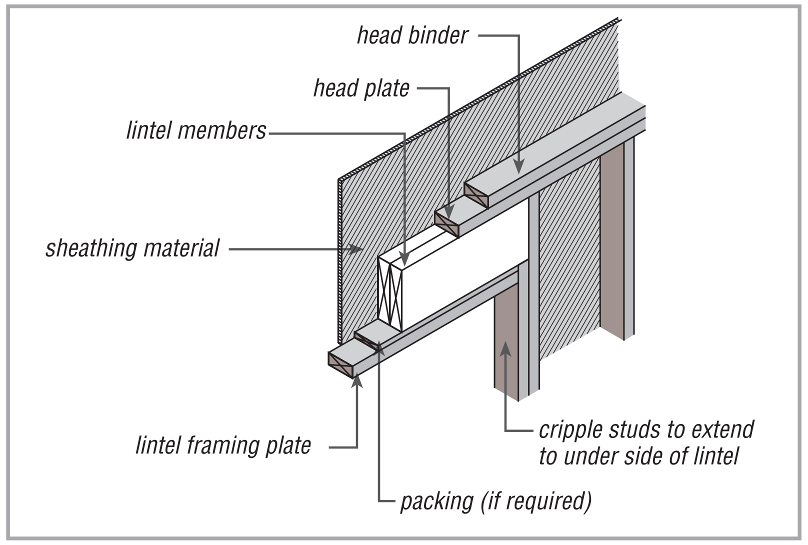
DETAIL B 6.7.1 Lintel Opening Supports



DETAIL B 6.7.2 Trimmer Beam Supports



DETAIL B 6.7.3 Load Bearing Lintel



B 6.8 TIMBER FRAME - PARTY WALL CONSTRUCTION

Party walls are normally formed by two independent wall frames. Detail B6.8.1 illustrates a typical vertical section through a party wall in a two-storey semi-detached or terraced house. The function of the party wall is to provide an effective barrier against fire and sound transmission.

- The party wall should be completely imperforate. Gaps, irrespective of size, should be fire stopped (and acoustically sealed as well if necessary).

- The two leaves of the party wall must be unconnected for their full height. Light weight thin metal ties may be used at 1.2m centres (usually as an aid to erection) subject to agreement with the timber frame manufacturer. There may be proprietary products that transfer load across party walls, care should be taken that they do not permit sound transferral.

- Electrical sockets, switches, services, etc., should not penetrate or be fixed to the party wall linings. Where service have to be on a party wall, the wall should be battened out to form a services' cavity leaving the main fire and sound protection intact.

- Services, including cables, ducting etc., must not be located in the party wall cavity.

- Adequate fire stopping must be provided at roof level (see Details B6.8.1 and B6.8.3).

- Note that HomeBond does not permit conventional masonry chimneys in timber frame party walls.

- Sound insulation quilt should be fixed to at least one of the party wall frames and it should be held in place.

The combined width of the two frames should not be less than 220 mm (i.e. face of stud to face of stud; two 90mm studs plus a 40mm cavity) but a width of 250mm is recommended for improved sound insulation.

For fire stopping, use wire reinforced rock fibre which must be thicker than the cavity to ensure that it completely seals the space (e.g. 65mm fire stop in a 50mm cavity).

The cavity at the top of the party wall must be closed and the wall/roof junction fire stopped. This is usually achieved by covering the top rail of the party wall spandrel with a 9mm non-combustible building board, which should extend over the width of the party wall.
The good sound performance of timber frame party walls depends on a number of factors:

- The structural isolation the two leafs.

- The use of dense wall linings usually plasterboard in two layers, with a combined minimum thickness of 30mm. In the roof spaces (i.e. between 2 uninhabitable areas) the plasterboard thickness can be reduced to 25mm.

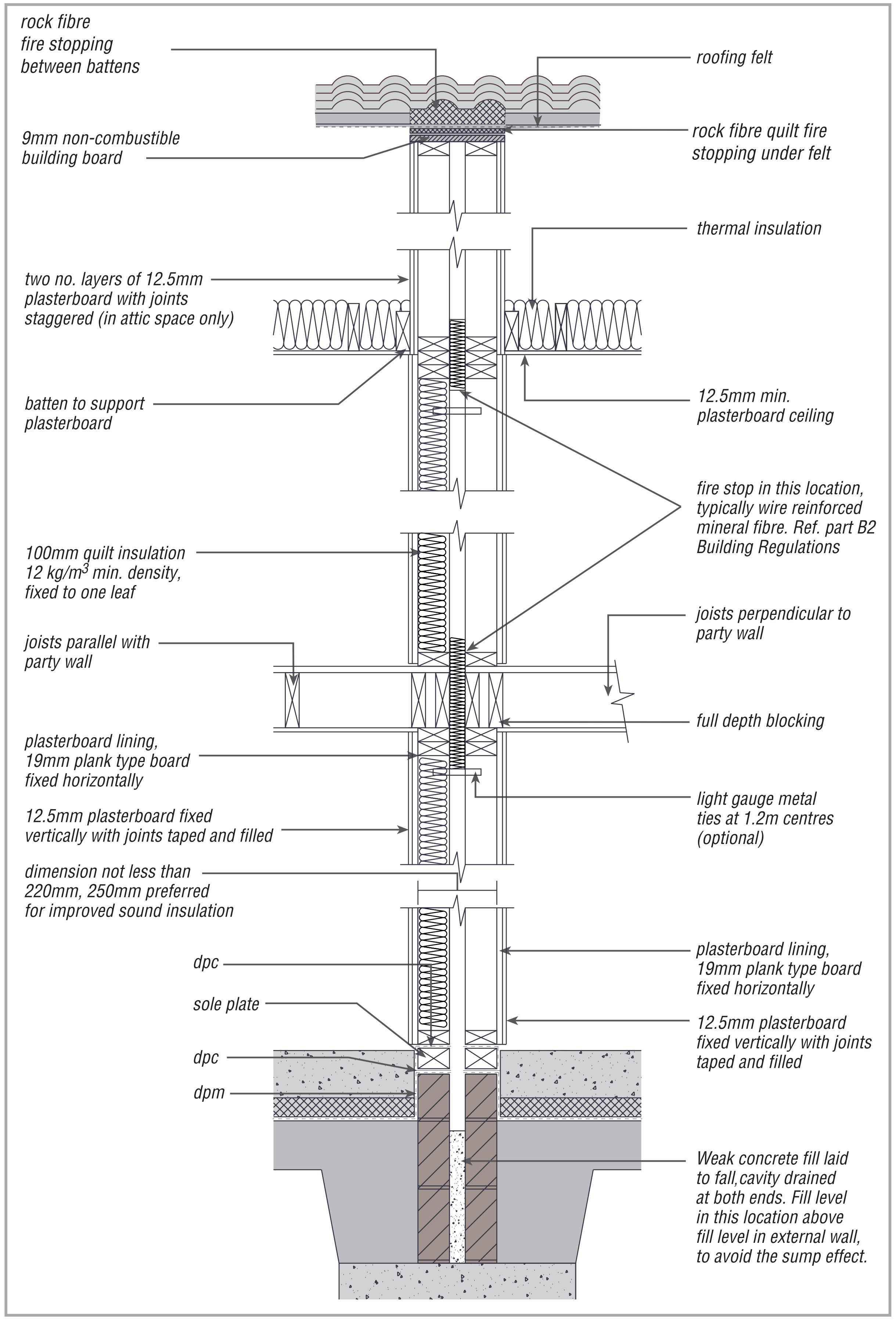
- The use, in at least one leaf, of sound insulation usually glass fibre with a minimum density of 12kg/m^3. Thicker and denser insulating material (such as rock fibre) will provide better sound insulation. The insulation must be supported and must be held in place without any gaps.

- The provision of a minimum distance between the inside (room) face of studs of 220mm: However the preferred recommended distance is 250mm.

It is not recommended that ordinary block chimneys be constructed within the party wall. The junction of the chimney with the timber frame is difficult to seal properly for sound and fire requirements. However there are a number of proprietary systems that have Agrément certification and which may be suitable for use in the party wall. There are also prefabricated systems (again a number have Agrément certification) that form a chimney stack on either side of the party wall leaving the party wall intact and some join the chimney stacks together at roof level to form a single stack. The fixing of plasterboard behind these chimneys usually has to be carried out before the chimney is built; at least at ground floor level as the chimney width at ground floor is often greater than the maximum centres for plasterboard fixing (~600mm).

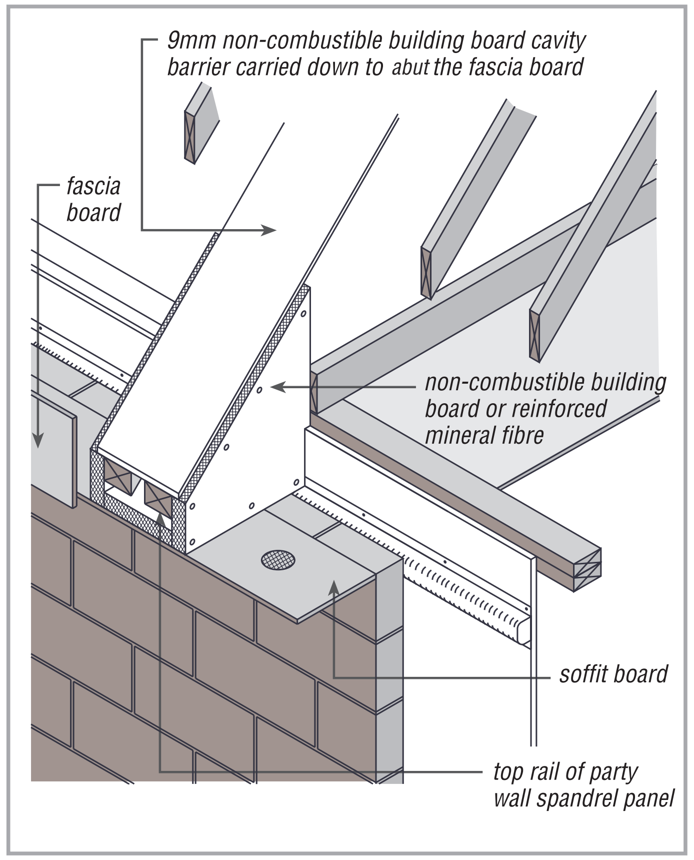
Party walls are required to be braced. This is usually carried out by fixing sheathing (normally plywood or OSB) to the ends of the panels; some manufacturers sheath the panels along the full length of the party wall.

B 6.8 TIMBER FRAME - PARTY WALL CONSTRUCTION (CONTINUED)



DETAIL B 6.8.1 Party Wall Construction

B 6.8 TIMBER FRAME - PARTY WALL CONSTRUCTION (CONTINUED)



DETAIL B 6.8.2 Fire Stopping at Party Wall

Fire stopping at eaves

The void formed by the slope of the rafters and the horizontal soffit to the eaves must be adequately sealed against fire spread at each party wall position.

This is usually achieved by nailing 9mm non-combustible building board to a framing around the eaves projection and filling the void with reinforced rock fibre mineral fibre. This is often referred to as the eaves box. (Detail B6.8.2 and B6.8.3).

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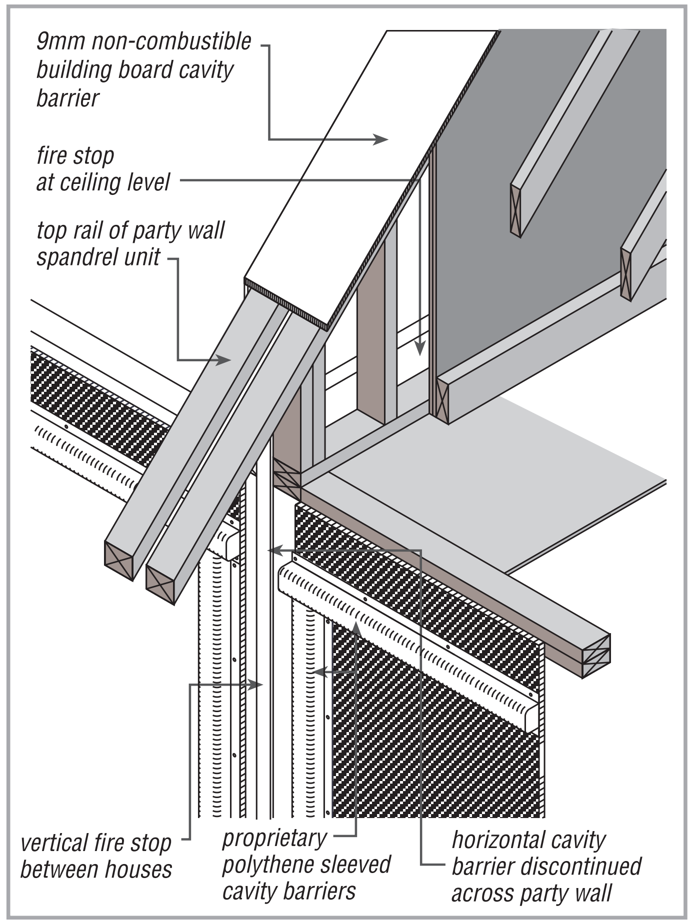
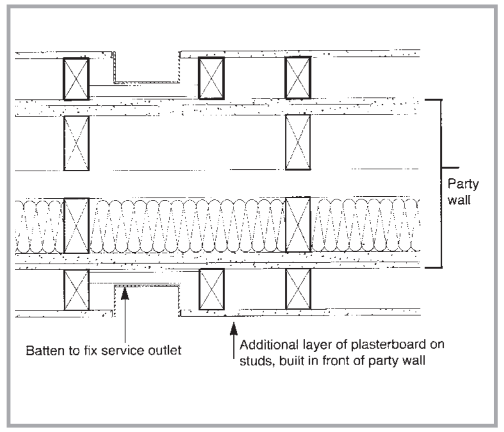


DETAIL B 6.8.3 Fire Stopping at Party Wall



DETAIL 6.8.4 Services

Services to party wall

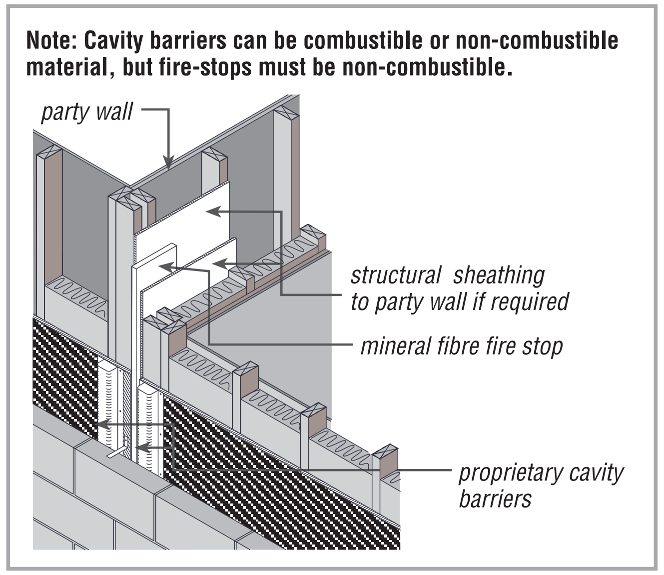
Detail B6.8.4 shows an acceptable method for providing services on the party wall. Services must not be built into the party wall and a service cavity must be used (the UK may not be as strict as this but the service cavity is sensible and represents good practice).

B 6.8 TIMBER FRAME - PARTY WALL CONSTRUCTION (CONTINUED)

Fire stopping

The cavity, between the timber-frame party wall and the external masonry leaf, must be closed with vertical cavity barriers (Detail B6.8.5). In addition to the vertical cavity barriers, a vertical firestop seals the junction between the two party wall frames. This is usually achieved by using 65mm thick (providing the cavity is not greater than around 50mm) wire-reinforced mineral fibre quilt, stapled or nailed to each of the frames. This vertical firestop should be carried up to the top rail of the party wall spandrel panel.

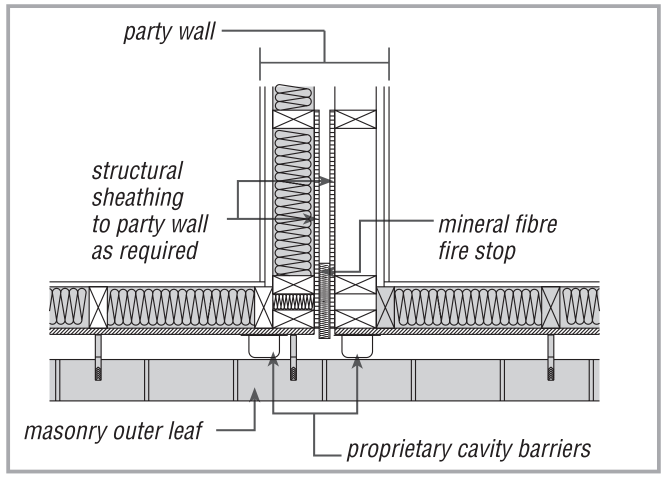
A horizontal firestop should be placed at floor level and similar protection placed at roof ceiling level. The fire stop depth should be sufficient to cover the depth of the floor construction. Firestops are required to have a higher degree of fire resistance than cavity barriers.



DETAIL B 6.8.5 Fire Stopping

Structural stability

Where additional structural bracing is required, this will usually be in the form of sheathing materials. Generally partial sheathing of the party wall frame is sufficient although in some situations the timber frame designer may require additional sheathing. See Details B6.8.5/B6.8.6.

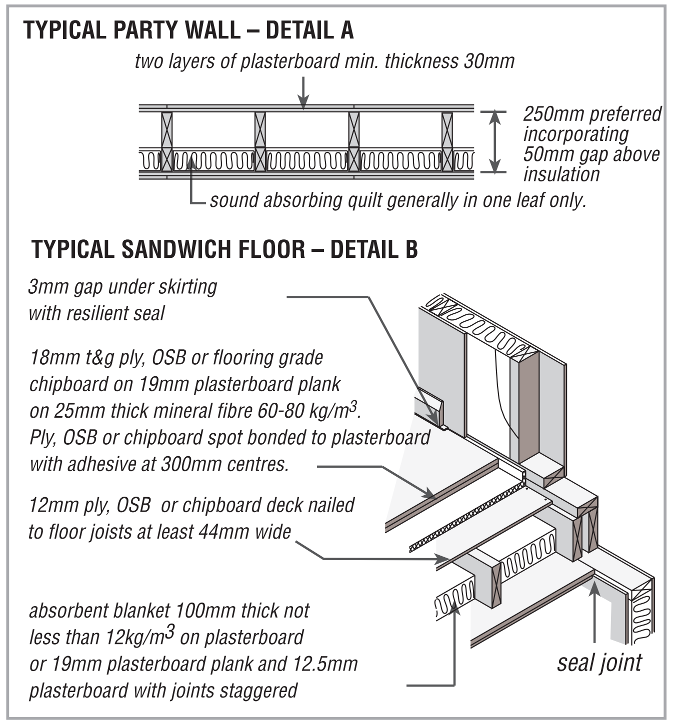


DETAIL B 6.8.6 Structural Stability

Sound insulation

Sound insulation of party walls uses the structural separation of the two separate timber frame leaves, mass (provided by the plasterboard) and sound-absorbent quilt to achieve sound reduction. (Detail B 6.8.7A). This type of construction provides reasonable resistance to airborne sound as outlined in *Technical Guidance Document E* (Sound) and the equivalent Approved Document or the UK. There are also specific details given in the Robust Detail Handbook which might be appropriate to a specific construction.

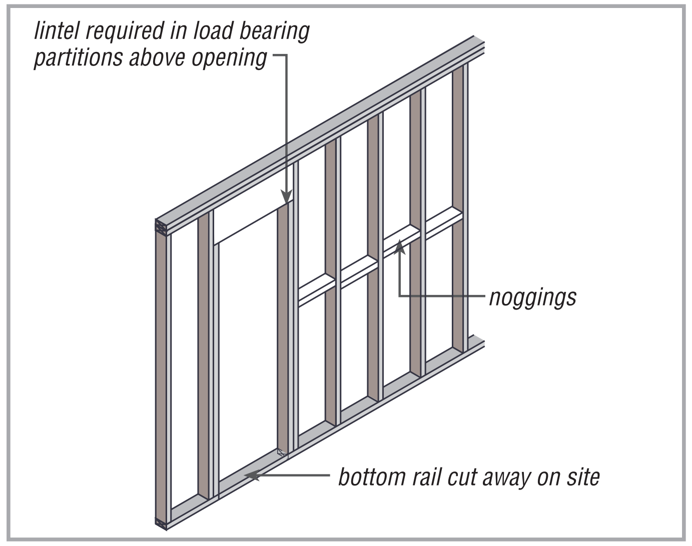
Where sound resisting floors are required, these may be achieved in a number of ways. Detail B6.8.7B illustrates one such type of construction, a sandwich floor. The mass of the floor and the sound-absorbent blanket reduces airborne sound while the floating layer of the floor serves to reduce the transmission of impact sound. The ceiling should be battened out to form a services cavity; this will protect the integrity of the two layers of plasterboard forming the main barrier to the passage of fire and sound. Detail B6.8.7 should be read in conjunction with Part E of the *Technical Guidance Document* of the Building Regulations (or the relevant Approved Document for the UK).



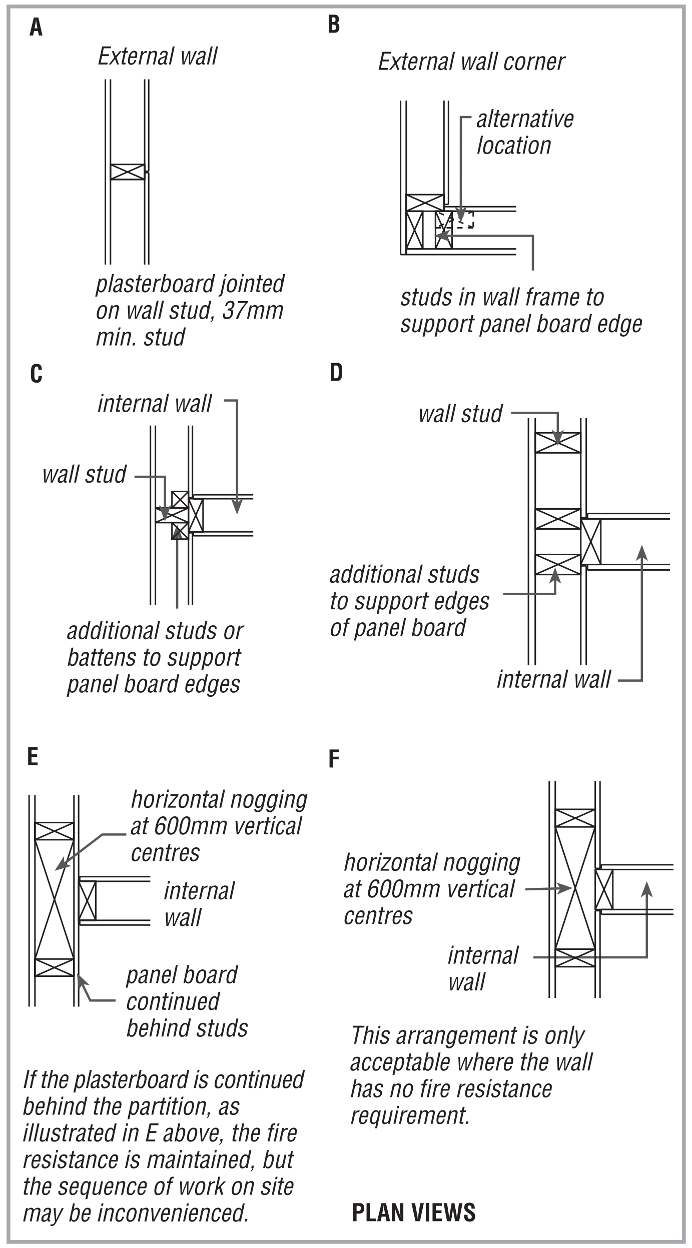
DETAIL B 6.8.7 Sound Insulation

B 6.9 TIMBER FRAME - INTERNAL WALLS

DETAIL B 6.9.1 Internal Walls



DETAIL B 6.9.2 Internal Wall Junctions – Plan Views



Internal wall construction is similar to external wall construction, with studs at either 400mm or 600mm centres. Often internal walls will be made with noggings (Detail B6.9.1) at mid-height; these can stiffen the panel for handling, can provide support to plasterboard edges and may be required to resist lateral buckling of the studs particularly for design of fire resistance. Internal load-bearing partitions are generally prefabricated by the timber-frame manufacturer and should be installed prior to the fixing of the ceiling plasterboard. A damp-proof course should be provided to the underside of all ground floor partitions when sitting on concrete or blockwork.

Internal partitions are usually lined with plasterboard, fixed in accordance with the plasterboard and/or timber frame manufacturer's recommendations. Load bearing walls should have the same fire resistance as the floor they support. The following is recommended:

- All plasterboard edges should be timber backed.
- Internal and external corner junctions must be arranged to provide support to both lining boards and may require an additional stud for this purpose. Usually about 20mm of timber is needed to ensure adequate timber and plasterboard edge and end fixing distances.
- Where internal wall junctions occur at stud centre-lines, additional studs or battens may be required to support adjoining board edges.

Screws provide a better fixing than nails and are more resistant to 'nail' popping. In general fixings should be simplified to no more than 2 centres and 2 lengths unless there is good quality control on site.

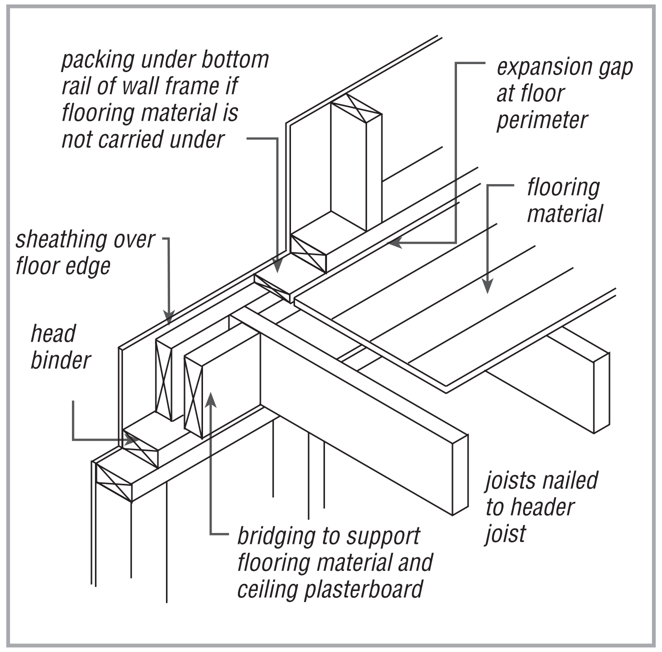
Care should be taken to ensure that non-load bearing walls do not interfere with the fire resistance of the floor.

B 6.10 TIMBER FRAME - INTERMEDIATE FLOOR CONSTRUCTION

Floor type

The most common type of intermediate floor in domestic timber-frame construction is the platform floor, so called because it acts as a working platform from which the first floor or upper floor wall panels can be erected. The platform floor is generally factory made as a floor cassette.

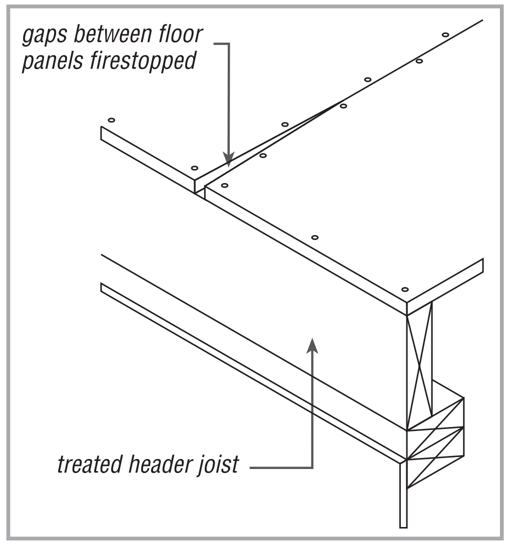
Details B 6.10.1 and B 6.10.2 shows the typical method of supporting a floor beam in a timber frame wall panel, using multiple studs or posts.



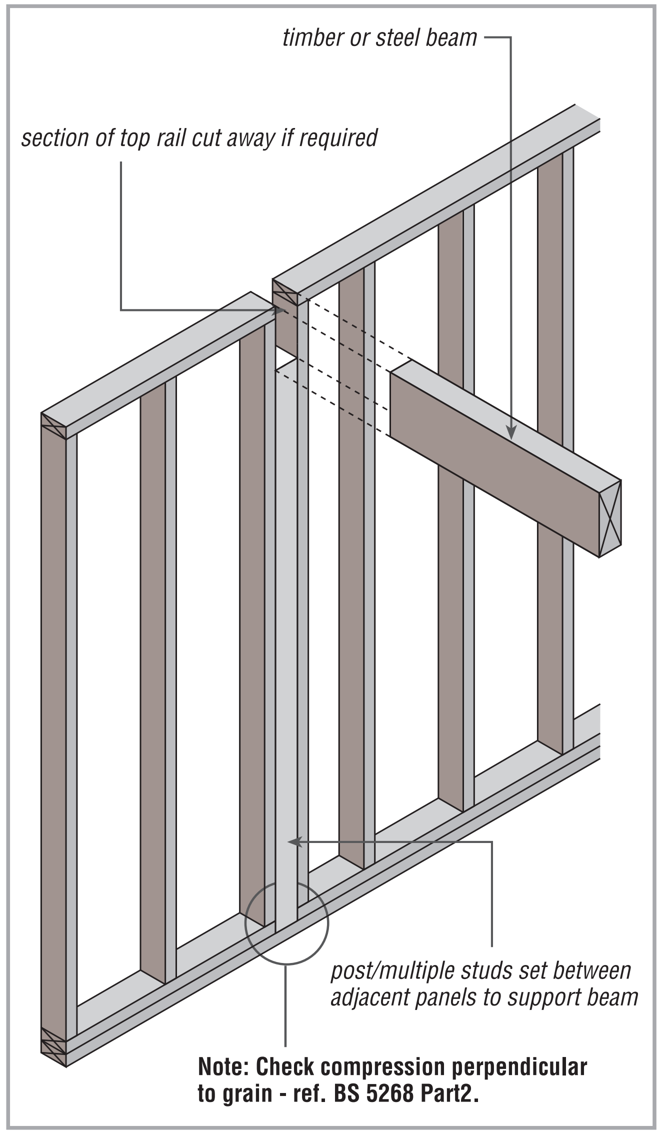
DETAIL B 6.10.1 Floor support on Wall Panel

Detail B 6.10.2 shows the typical method of supporting a floor beam in a timber frame wall panel, using multiple studs or a post.

DETAIL B 6.10.3



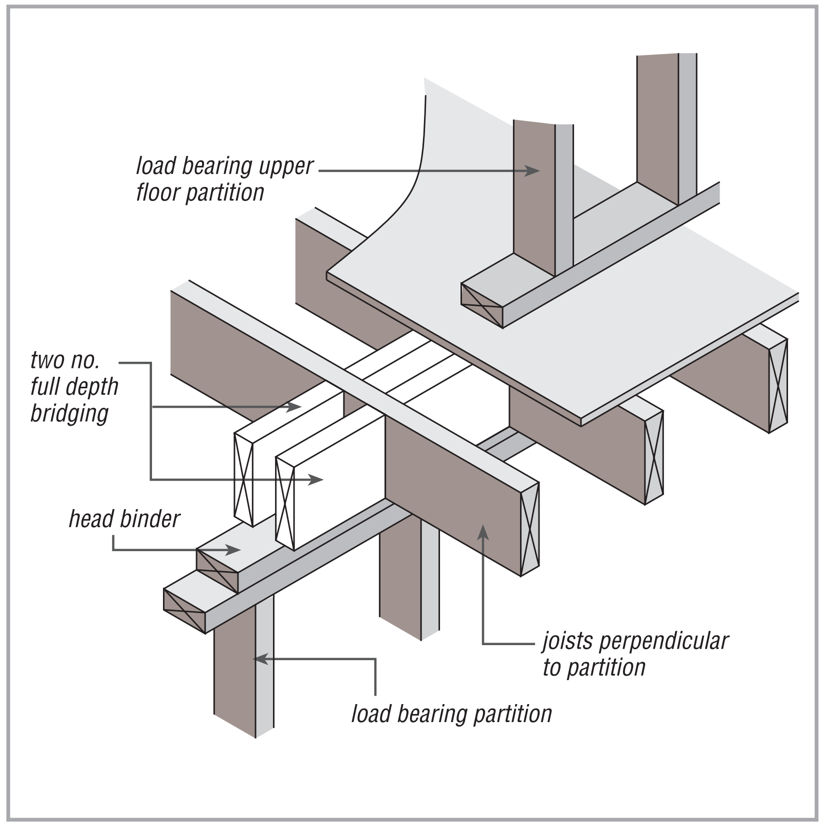
At party walls any gaps between the floor panels, irrespective of their size, should be fire stopped (and sealed acoustically). In external walls any gaps between panels could be sealed with a waist band (usually OSB forming a continuous band between the first floor wall panel and the ground floor wall panel). Small gaps in the floor sheathing may require to be sealed. (Detail B6.10.3). The exposed header joist should be treated with a timber preservative although this may need to be specified specifically or applied on site (it is not a requirement of I.S. 440).



DETAIL B 6.10.2 Floor Beam Support

B 6.10 TIMBER FRAME - FIRST FLOOR CONSTRUCTION (CONTINUED)

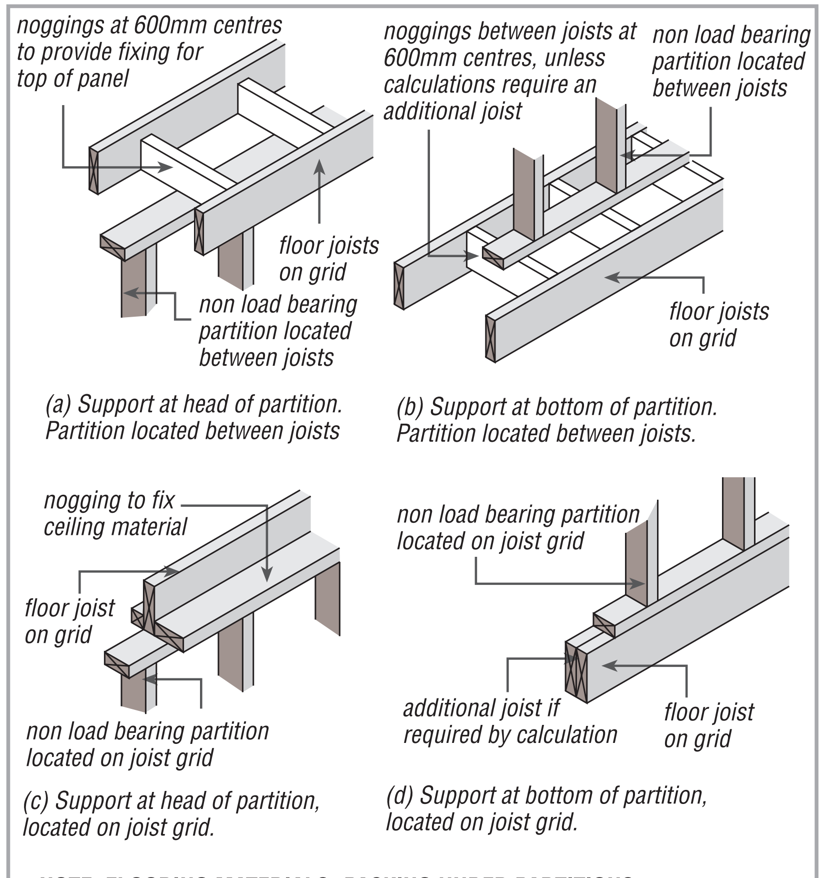
DETAIL B 6.10.4 Load Bearing Partitions



Support to internal partitions

Where load-bearing partitions occur above the floor, additional designed joists (if the partition is parallel to the floor joists) or full depth bridging (if partition is at right angles to floor joists) is are normally required to transfer loads to the partition below (Detail B6.10.4).

DETAIL B 6.10.5 Internal Non-load Bearing Partitions



NOTE: FLOORING MATERIALS, PACKING UNDER PARTITIONS AND CEILING MATERIALS HAVE BEEN OMITTED FOR CLARITY.

Additional joists may also be required to carry non load-bearing partitions which run parallel to the floor joists. Short lengths of non load-bearing partition can usually also be supported on noggings fixed between joists. The bottom rail of the partitions should be fixed to the joists or noggings (rather than only the flooring).

Internal non load-bearing partitions at right angles to the joist span can normally be carried by the joists, but the additional load of the partition must be allowed for when calculating joist sizes.

B 6.11 TIMBER FRAME - TYPICAL FIXING SEQUENCE

The timber-frame manufacturer/design engineer should ensure that the site-fixing details specific to the project are supplied to the site. Nails used in the external walls should be corrosion resistant, e.g. galvanised, copper, silicon bronze or austenitic stainless steel. A critical feature of timber-frame construction is the on-site nailing of the various timber components. When site fixing, it is important that the Site Fixing Schedule supplied by the timber frame manufacturer is followed. The recommended minimum site fixing is outlined below, it is a typical schedule and is subject to the supplied Site Fixing Schedule.

- **Sole plate to substructure**
  Sole plate located on rising wall by means of 4mm diameter stainless steel masonry nails at 300mm centres, long enough to provide a minimum penetration of 50mm into the rising wall. Alternatively stainless steel fixing clips located at 1200mm centres may be used. The clips should be long enough to provide adequate fixing into the face of the rising wall without damaging the blockwork (Detail B 6.4.3). The corrosion resistance of the fixings depends on the construction details and the level of risk to the exposure of moisture particularly to rising dampness. Austenitic stainless steel is more corrosion resistant than ferritic stainless steel and is usually recommended in these locations.

- **Bottom rail to the sole plate**
  4mm x 85mm long nails at 300mm centres.

- **Stainless steel holding down straps**
  fixed to the timber frame full length studs through the panel sheathing with the supplied strap manufacturer's stainless steel nails and fixed in accordance with their recommendations: 4 no. nails minimum.

- **External panel to external panel**
  4mm x 85mm nails at 300mm centres, skew nailed and staggered.

- **Head binder to wall panel**
  4mm x 85mm nails at 300mm centres the length should be long enough to provide a minimum of 38mm penetration into the panel top rail.

- **Header joist to head binder/top rail**
  4mm x 85mm nails at 300mm centres, skew-nailed.

- **Floor joist to header joist**
  4mm x 85mm nails 2 no. skew-nailed on each face.

- **Blocking pieces between floor joists**
  4mm x 85mm long nails 2 no. each face, skew-nailed.

- **Bottom rail to header joist**
  4mm x 85mm long nails, skew-nailed at 300mm centres.

- **Solid bridging or blocking to joists**
  4mm x 85mm nails 2 no. each end of blocking skew-nailed.

- **Herring bone strutting to joists**
  3.75mm or 4mm x 85mm nails 1 no. each side, skew-nailed.

- **Joists lapped over internal partitions**
  4mm x 85mm long face nailed.

- **Trimmers (i.e. two joists nailed together)**
  4mm nails at 300mm centres face nailed, long enough to provide 40mm point side penetration into the second joist.

- **Flooring material to floor joists**
  4 no. 4mm x 85mm nails at 300mm centres face nailed and staggered.

- **Floor panel to floor panel**
  3.25mm x 85mm nails at 300mm centres face nailed and staggered.

- **Trussed rafter to head binder or top rail over studs**
  Proprietary truss clips fixed in accordance with manufacturer's instructions or 2 no. (1 no. each side) 3.75mm x 85mm long nails skew-nailed so as not to damage the nail plate.

- **Bottom rail of spandrel panel to top rail/head binder of panel below**
  4mm x 85mm long nails face nailed at 300mm centres.

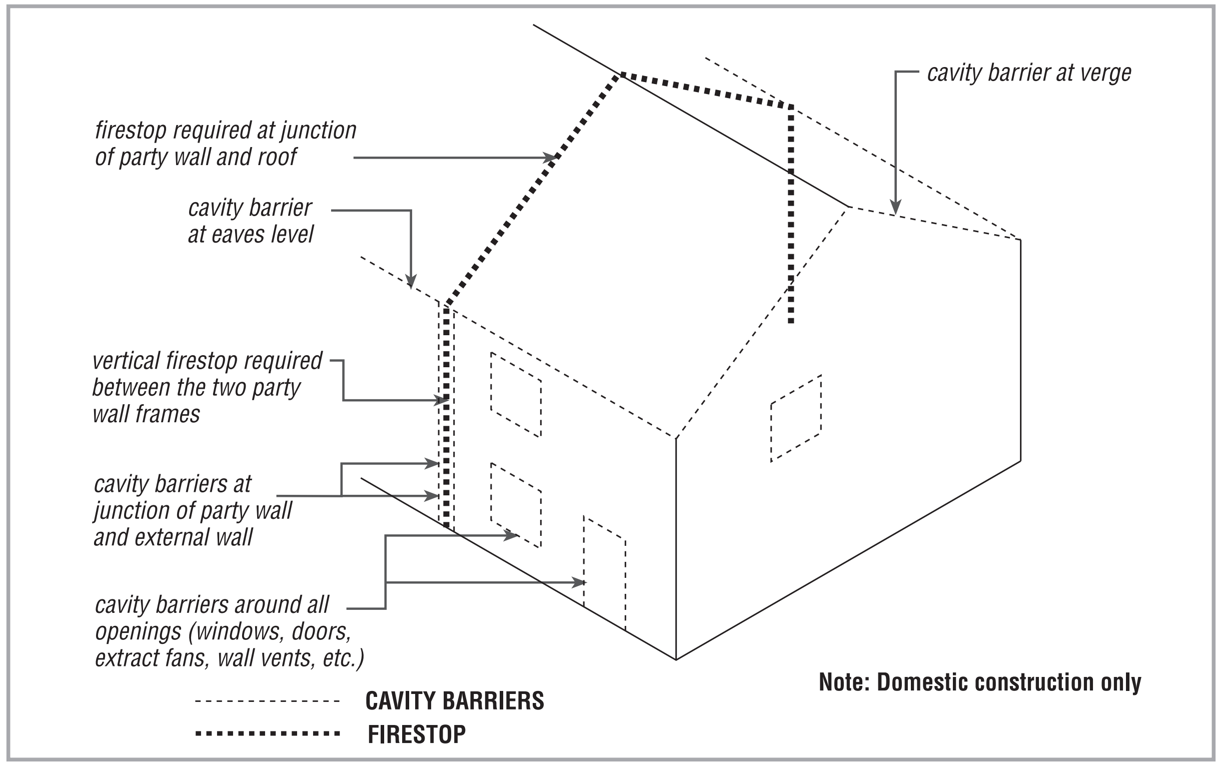
- **Gable ladder to spandrel panel**
  4mm x 85mm long nails 2 no. each side of gable ladder bridging pieces, skew-nailed.

- **Plasterboard fixings to party walls**
  Single layer 12.5mm plasterboard laid vertically, 2.65mm x 40mm nails at 150mm centres. All plasterboard edges must be backed by timber. See also B6.12

- **Plasterboard fixings to walls**
  All plasterboard edges should be backed by timber. Between habitable rooms:19mm plank type plasterboard laid horizontally, 2.65mm x 50mm at 150mm centres; 12mm plasterboard laid vertically 2.65mm x 65mm long at 150mm centres Between roof spaces: 12.5mm board. 2.65m x 40mm at 150mm centres; 12.5mm board on 12.5mm board 2.65mm x 50mm at 150mm centres. Stagger the vertical plasterboard joints. See also B 6.12.

Timber splitting can be reduced when hand nailing if the nails are blunted. Care should be taken to ensure that fixings actually go into timber and that they have adequate edge and end distances. Generally skew nailing should be used rather than face nailing (except when fixing plasterboard) especially when fixing panels together; skew nailing will help pull the panels together, however skew nailing will require longer nails. The fixings on site should be checked with what's specified in the Site Fixing Schedule and either the schedule should be altered (by the timber frame manufacturer and designer) or the correct nails obtained.

B 6.12 TIMBER FRAME - FIRE SAFETY



DETAIL B 6.12.1 Cavity Barriers & Fire Stops

Fire safety requirements for timber frame houses are the same as those for all other forms of house construction.

Fire resistance is a major means of specifying the performance of a building element (typically walls, floors and beams) in fire. Fire resistance is usually specified in minutes or hours; elements of a domestic dwelling are usually required to have a fire resistance of 30 minutes except for party walls (and compartment walls) which are required to have a fire resistance of 60 minutes.

Compartment floors (e.g. in an apartment) are required to have a minumum fire resistance of 60 minutes as are any elements supporting the floor (e.g. internal load bearing walls or external walls). Requirements for cavity barriers and fire resistance in *Technical Guidance Document* B vary with the building purpose group and the building height.

Fire resistance has 3 components: Stability, integrity and insulation. Stability means that the element will still be in place and able to carry load at the end of the specified period of fire resistance. Integrity refers to the passage of fire and smoke while insulation refers to the temperature rise on the unexposed face of the element.

The fire safety requirements for buildings are largely set out in *Technical Guidance Document* B and the equivalent UK Approved Document (there are some differences between the requirements for Ireland and the UK).

There are essentially three ways to demonstrate the adequate fire resistance of a component and particularly the plasterboard element; either by design, assessment or by fire test. Assessments are usually based on fire tests of similar components and perhaps design as well. Fire tests are either to the European Standards or to the relevant BS 476 part; the European Standards apply to designs to Eurocode 5 and the BS 476 tests apply to designs using BS 5268.

EN 1995-1-2 can be used for fire design (including the fire resistance of plasterboard) although it is probably more usual to use a mixture of the design standard and plasterboard fire tests. Designs to BS 5268 can use BS 5268 Part 4.1 and/or 4.2 to calculate fire resistance and the approaches are not too different to those in the EN.

Due to slight differences between the EN and BS fire tests there are slight differences in the specification of plasterboard. For designs based on fire tests, designs to Eurocode 5 usually require a 12.5mm Fireline board (or similar fire enhanced board) instead of the ordinary wallboard (this applies to single layer as well as two layers at party walls). However, the plasterboard manufacturer's requirements should always be referred to.

In obtaining a satisfactory degree of fire resistance and safety the following guidelines should be followed.

Cavity barriers

Detail B6.12.1 summarises the location at which cavity barriers occur in timber frame housing. To meet the recommendations for complying with Technical Guidance Document B, cavity barriers should be provided in timber frame walls as follows:

- around all openings, such as doors, windows, vents, openings for extract fans, meter cupboards etc
- in semi-detached and terraced units, at the junction of party walls and external walls. In the external wall on either side of a party wall.
- at eaves level.

Additionally I.S. 440 states that vertical cavity barriers should be placed at external wall corners and vertically at centres not exceeding 10m.

Apart from the cavity barrier practice set out above, the timber frame houses should, as a matter of course, incorporate all other relevant fire safety provisions indicated in

Technical Guidance Documents B and J to the Building Regulations particularly in respect of the following:

- means of escape
- Provision of fire alarms
- wall and ceiling linings
- Surface spread of flame
- Fire resistance
- integral garages
- roof covering
- radiation onto boundaries
- roof lights
- heating appliances, hearths, chimneys and flue pipes
- at the top of the external walls

Probably the most important aspect of fire safety is the provision of alarms and adequate escape routes.

Plasterboard fixing

Plasterboard (or similar fire resisting lining) provides the main protection to the timber framing in relation to fire and makes the largest contribution to fire resistance. For this reason it is important that the plasterboard is fixed properly particularly at party walls. Screws are generally recognised as a better fixing than nails; the recommendations for fixing screws are outlined below

The following is recommended (subject to the board manufacturer's recommendations or those of the timber frame manufacturer):

- *Screw lengths*
  Single layer 12.5mm and 15mm plasterboard - 36mm
  Single layer 19.0mm plank – 42mm
  12.5mm plasterboard on 12.5mm board – 50mm
  12.5mm plasterboard on 19.0mm plank – 60mm
  Each layer must be independently fixed

- *Centres*
  230mm for ceiling and 300mm for walls, 150mm in racking walls and around floor edges

- *Site control*
  Unless control on site is very good it is recommended that the screw fixing schedule is simplified. No more than two screw lengths should be used (42mm and 60mm) and all screws put in at 200mm centres (the assumption being that party walls are stiffened at their ends) but for internal racking walls (where the racking is provide only by the plasterboard) the centres should be reduced to 150mm.

- *Plasterboard joints*
  In general all joints and plasterboard edges should be timber backed (horizontal 19mm plank edges don't need to be timber backed providing both edges are bound edges). This applies especially to floor edges at the external wall, party wall and load bearing walls. In the party walls the 19mm plank should be laid horizontally with its vertical joints staggered if possible but the vertical joints must occur over timber. The 12.5mm fire enhanced plasterboard should be laid vertically; again the vertical edges should be staggered if possible with the vertical joints of the first board layer underneath. The vertical joints of the second 12.5mm board should be staggered with the vertical joints of an underlying 12.5mm board. It is good practice to have bound edge against bound edge; where boards are cut, the cut should always occur over timber.

- *3 Storey dwellings*
  These are required to have a full 30 minutes fire resistance and smoke doors. The stairwell walls are usually lined on both sides with a high performance lining such as Fireline or similar. In the ceiling to the roof space a similar high performance board is normally used.

- *Compartment floors*
  Compartment floors should be battened out to provide a service cavity. This means that lights and wiring can be placed within the services cavity without compromising the fire and sound performance of the floor. All joints of the plasterboard should be staggered and this requires careful planning of the plasterboard layout and the position of noggins to pick up the second layer of plasterboard. Any services within the floor (that is above the fire linings) should belong to the unit above the floor and not to the unit below the floor.

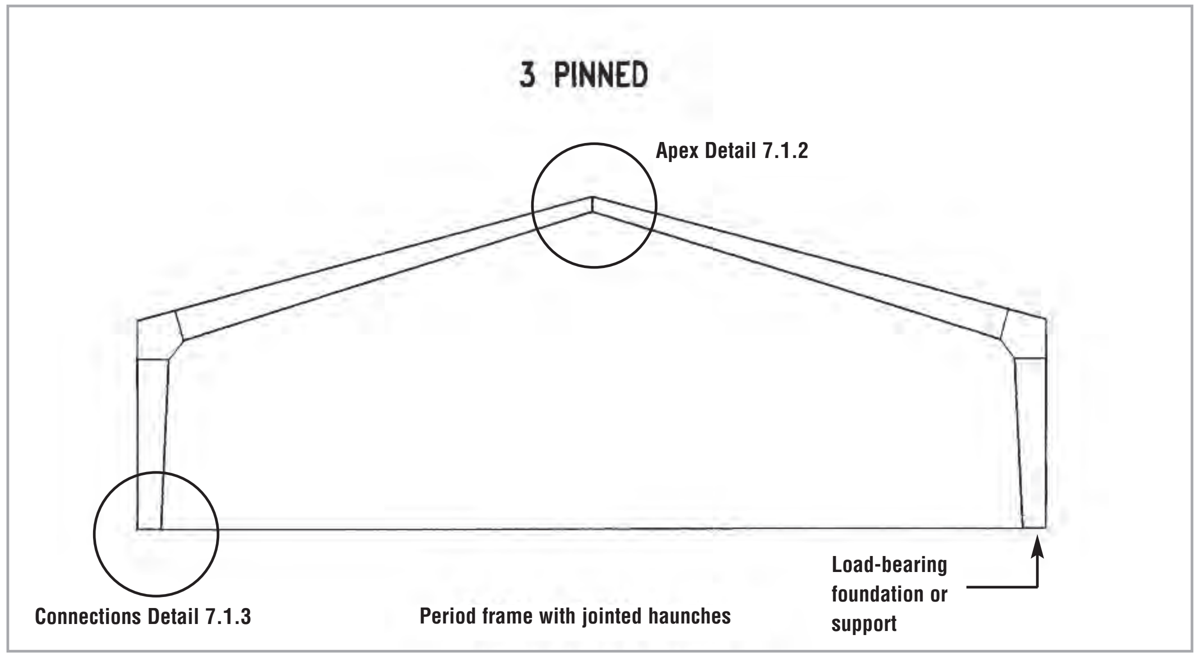
- *Compartment walls*
  Where services exist on these walls, like compartment floors these should be battened out to provide a service cavity. Party walls (also called separating walls) are a form of compartment walls.

Consideration could be given at the design stage to include a service cavity in the walls to allow for the future provision of services on a wall; this would be more appropriate to walls over 3m in length.

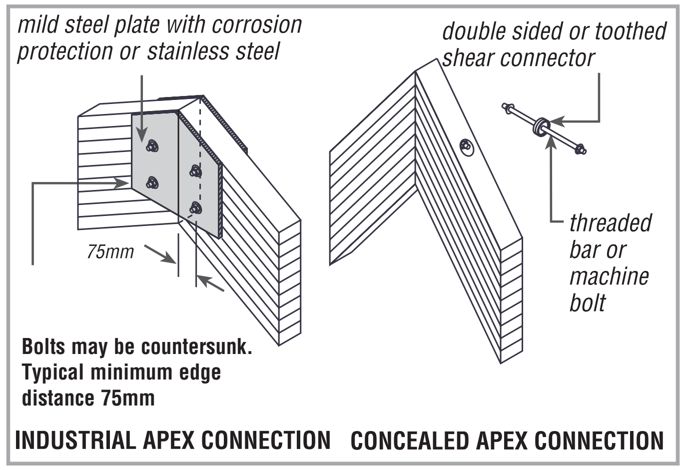
B7 Components and systems

B 7.1 GLULAM

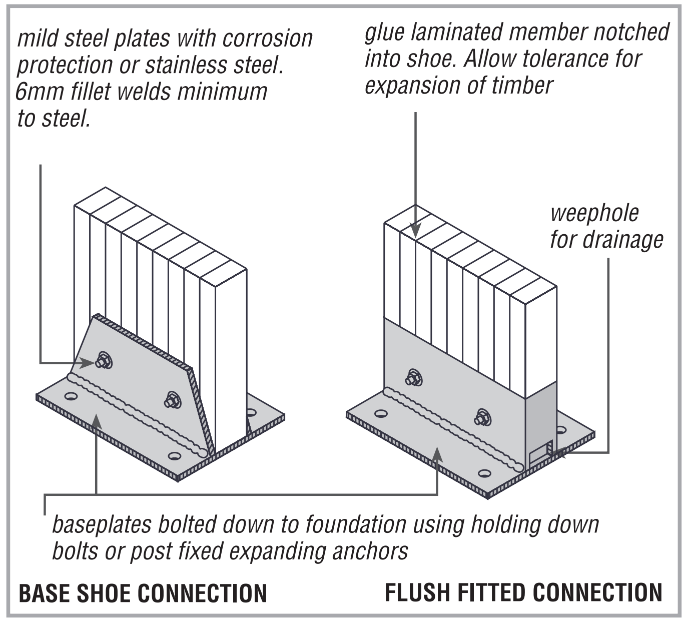
DETAIL B 7.1.1 Three Pinned Portal



DETAIL B 7.1.2 Apex Connections



DETAIL B 7.1.3 Connections



Glulam consists of sections of timber glued together to form a larger member. This process results in improved strength properties for the member as any weaknesses in the original smaller sections (such as knots) are distributed over the larger section. Glulam comes in a wide range of sizes and very large sections are available for heavy loading and long spans. In Ireland Glulam is commonly used for beams in timber frame construction as a replacement for steel beams.

All structural timber for glue-laminated elements must be strength graded as specified by the engineer. All glulam members must be designed by an experienced engineer and manufactured under an approved quality system.

All connecting plates should be neatly cut with smooth edges and where acceptable set flush with timber surface. The threaded section of bolts should not bear on timber or steel.

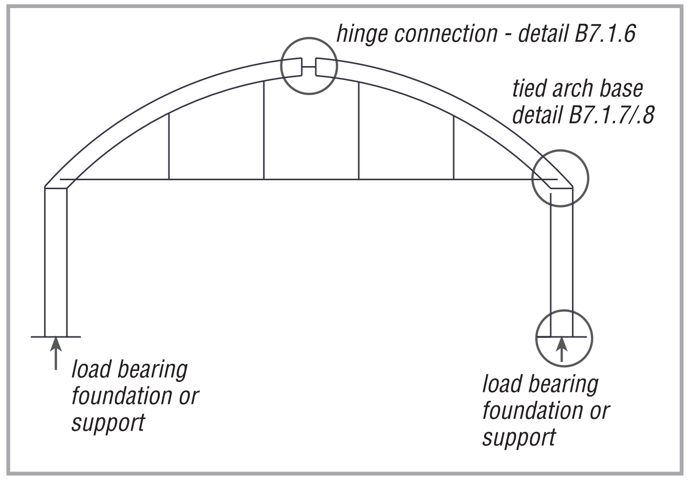
Stainless steel may deteriorate in the environment of a swimming pool and should only be used with great care in that environment.

Note: *In all cases shown grade of steel, strength of bolts and other such data are examples only.*

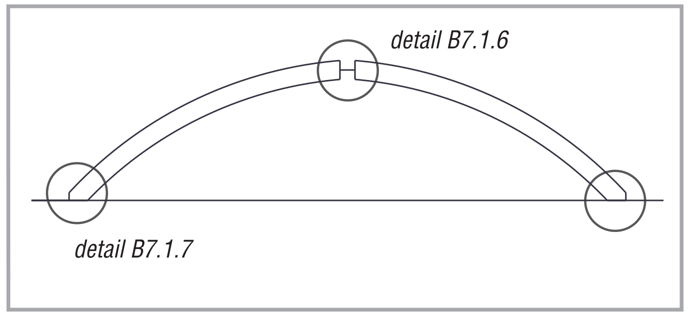
B 7.1 COMPONENTS AND SYSTEMS – GLULAM (CONTINUED)

Tying action may be achieved with reinforced concrete slab if the base of the arch is at ground level. There must be sufficient dead weight to anchor the timber structure.

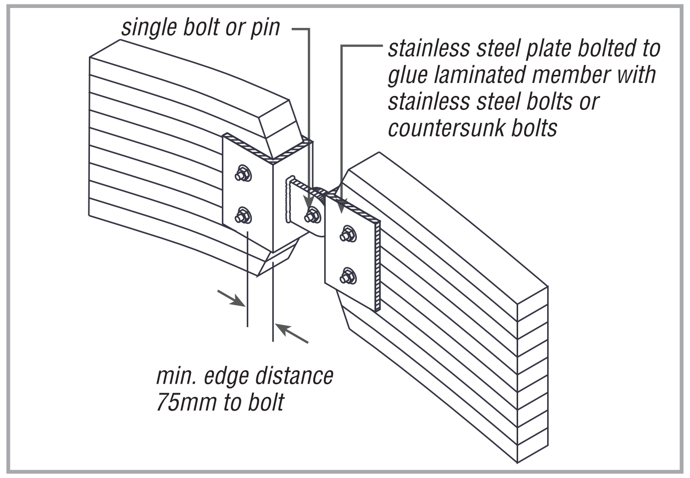
DETAIL B7.1.4 Tied Roof Arch



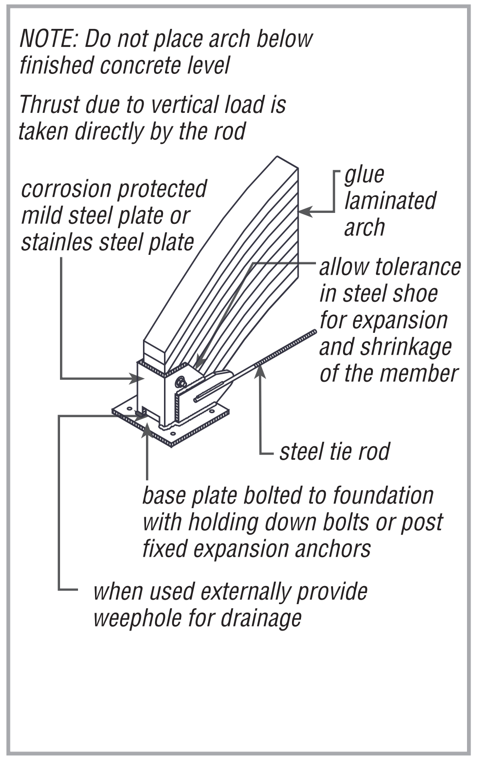
DETAIL B7.1.5 3 Pin Arch



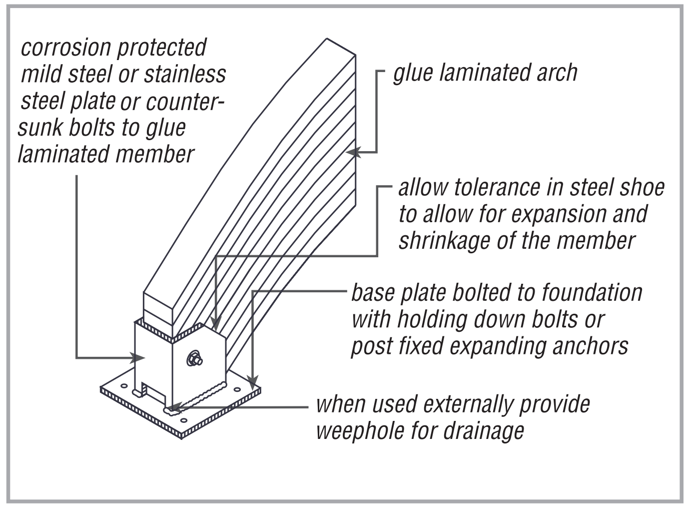
DETAIL B7.1.6 Apex Connection



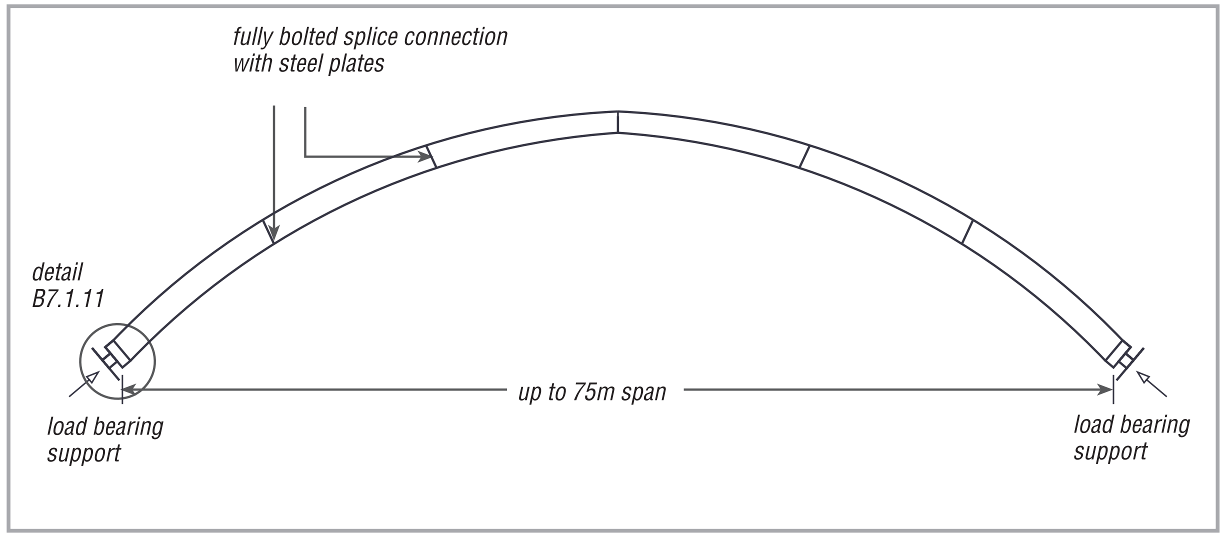
DETAIL B 7.1.8 Tied Arch Base Connection



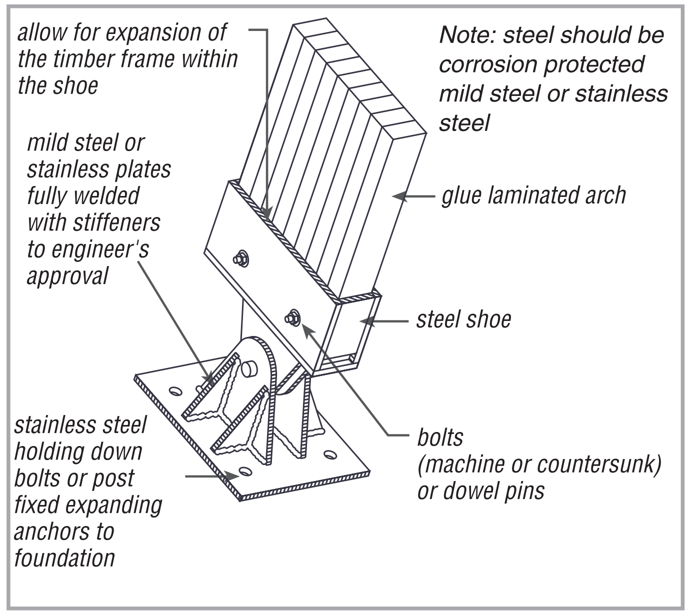
DETAIL B 7.1.7 Arch Base Connection



B 7.1 COMPONENTS AND SYSTEMS – GLULAM (CONTINUED)

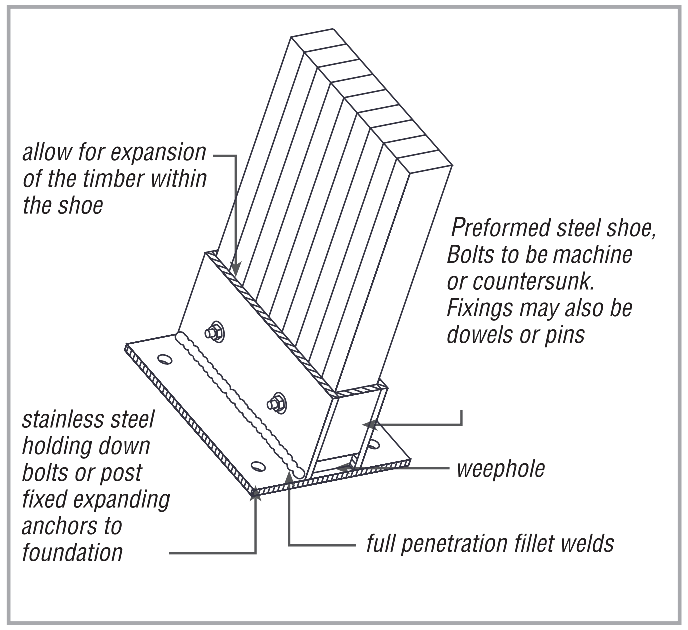


DETAIL B 7.1.9 Two Pin Arch



DETAIL B 7.1.10 External Hinge Anchorage for Arch

Where steel shoes are exposed externally, provisions should be made for the drainage of water. Where possible, recessed steel shoes to timber members should be used for a neater and more effective joint for weathering.

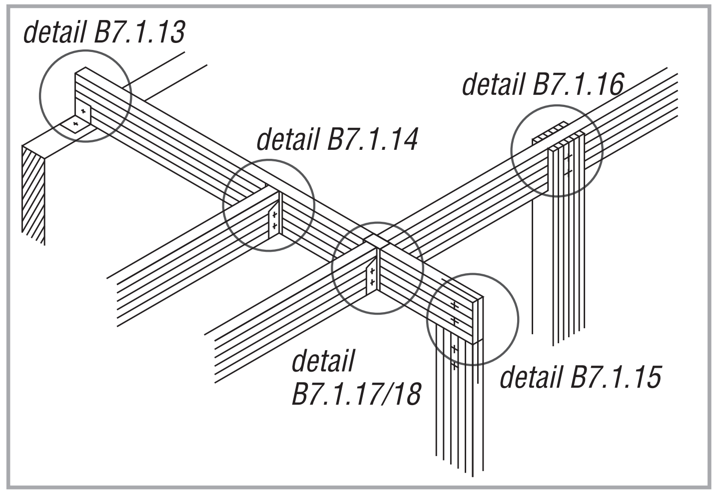


DETAIL B 7.1.11 External Anchorage for Arch

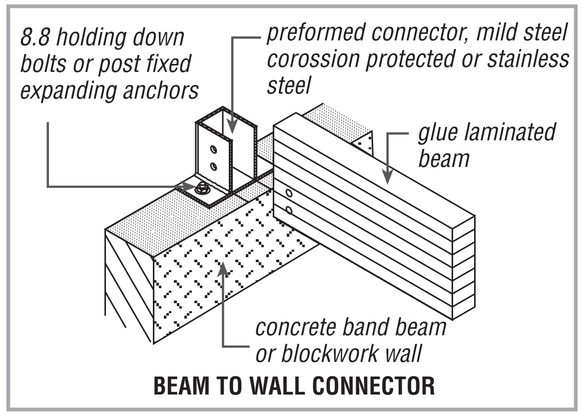
B 7.1 COMPONENTS AND SYSTEMS – GLULAM (CONTINUED)

Typical fixings of glulam beams to supports are shown in Details B7.1.12 to B7.1.18.

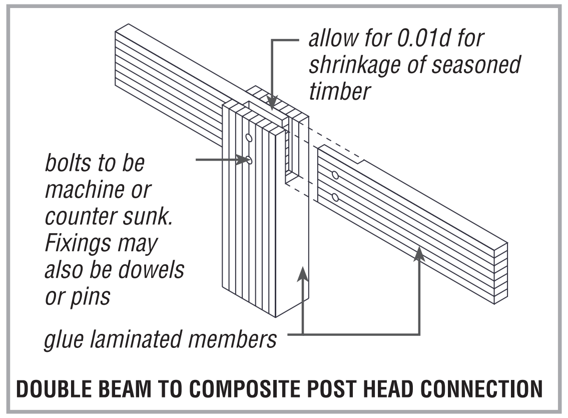
Refer to EN 386 for further details.
Note: All connections in metal work should be galvanised or of austenic stainless steel.



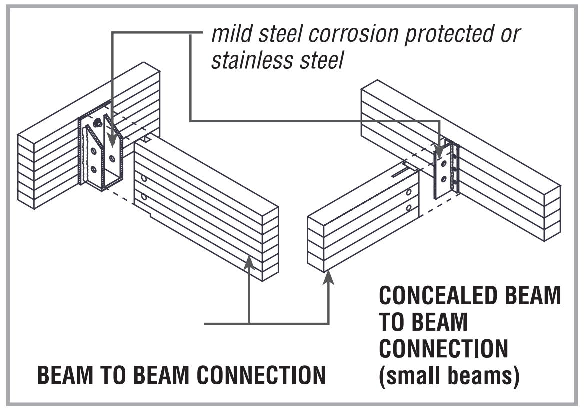
DETAIL B 7.1.12 Anchor Glulam Beams



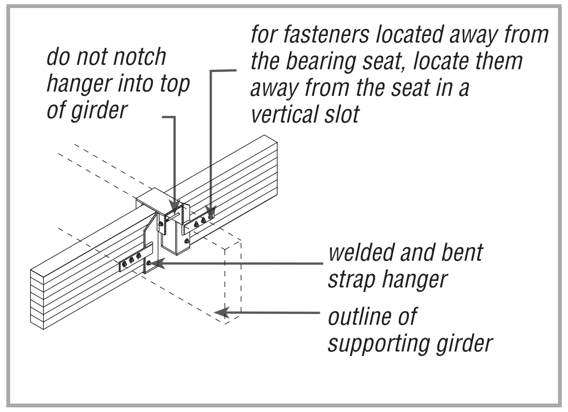
DETAIL B 7.1.13 Connectors



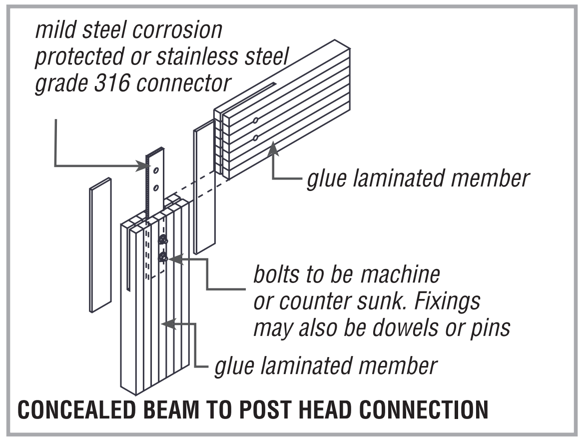
DETAIL B 7.1.16 Connectors



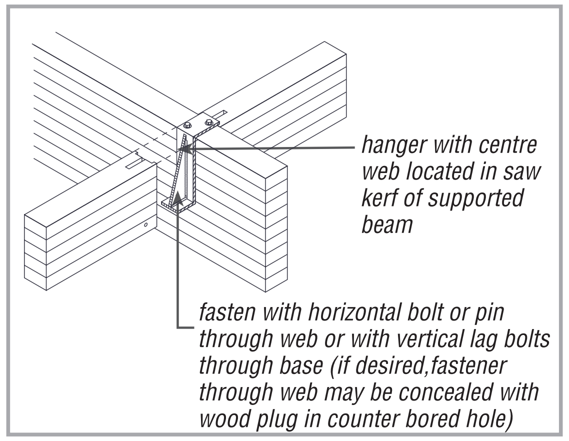
DETAIL B 7.1.14 Connectors



DETAIL B 7.1.17 Connectors



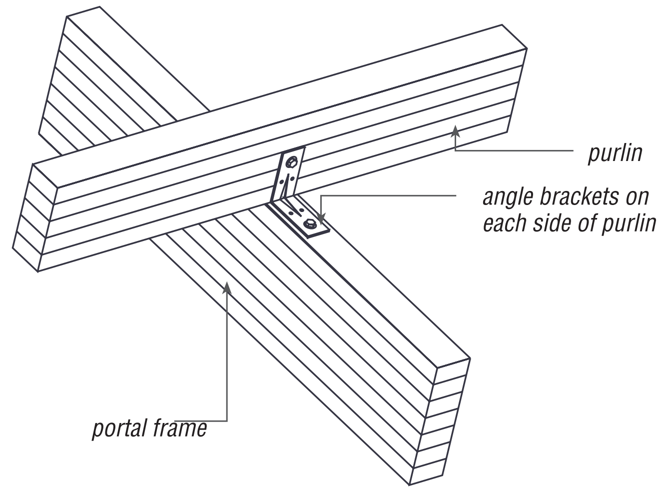
DETAIL B 7.1.15 Connectors



DETAIL B 7.1.18 Connectors

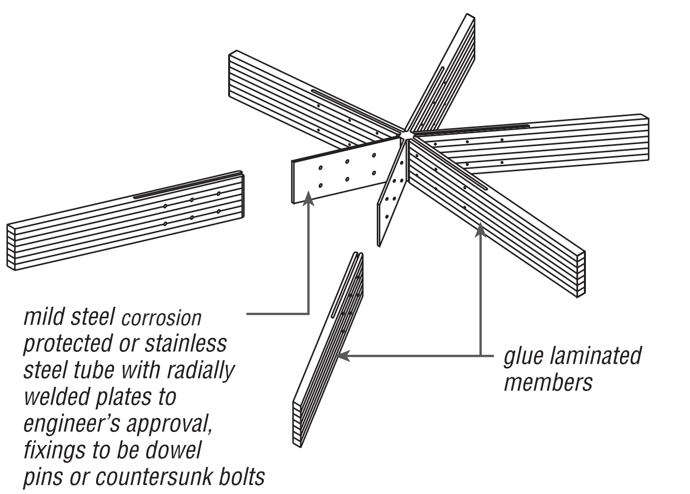
B 7.1 COMPONENTS AND SYSTEMS – GLULAM (CONTINUED)

DETAIL 7.1.19 Portal Frame Connection



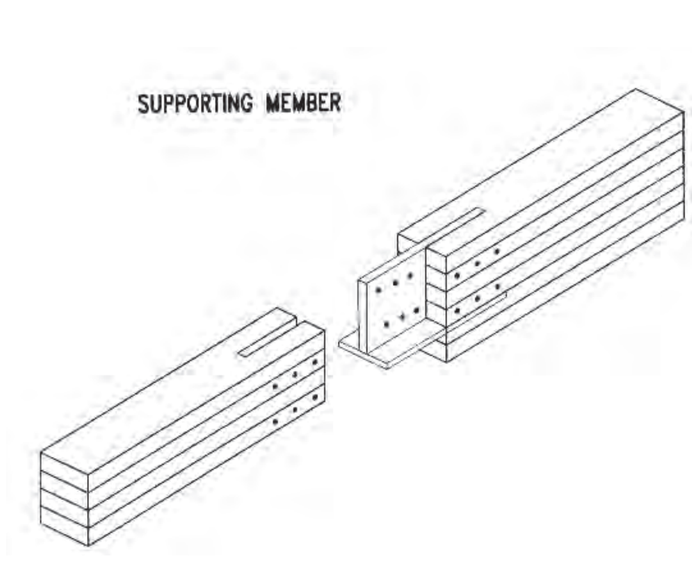
PURLIN TO PORTAL FRAME CONNECTION

DETAIL 7.1.20 Crown Joint at Dome



CROWN JOINT AT DOME/ARCH

DETAIL 7.1.21 Concealed Joint



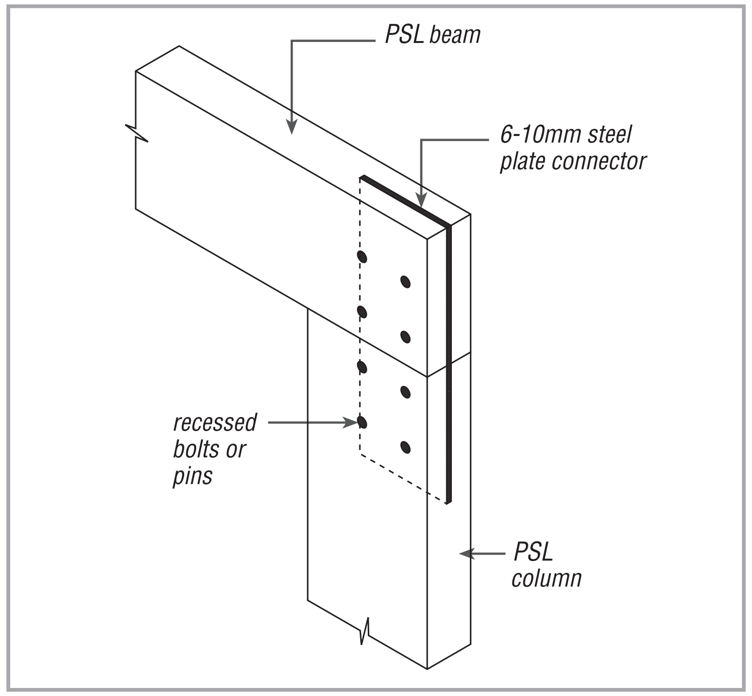
Details 7.1.20 and 7.1.21 allow the concealment of steel plate connections within the glulam member

B 7.2 COMPONENTS AND SYSTEMS PARALLEL STRAND LUMBER (PSL)

The most commonly available parallel strand lumber (PSL) is Parallam (a trade name). Parallam typically comes in the range of sizes shown below.

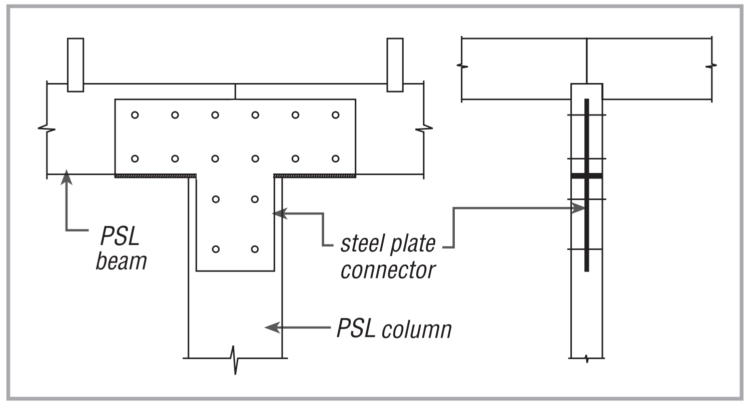
Width mm	Depth mm
15	241
68	302
89	356
133	406
178	457

Combinations of depths and widths are available.



DETAIL B 7.2.1 End Columns/Beam Support

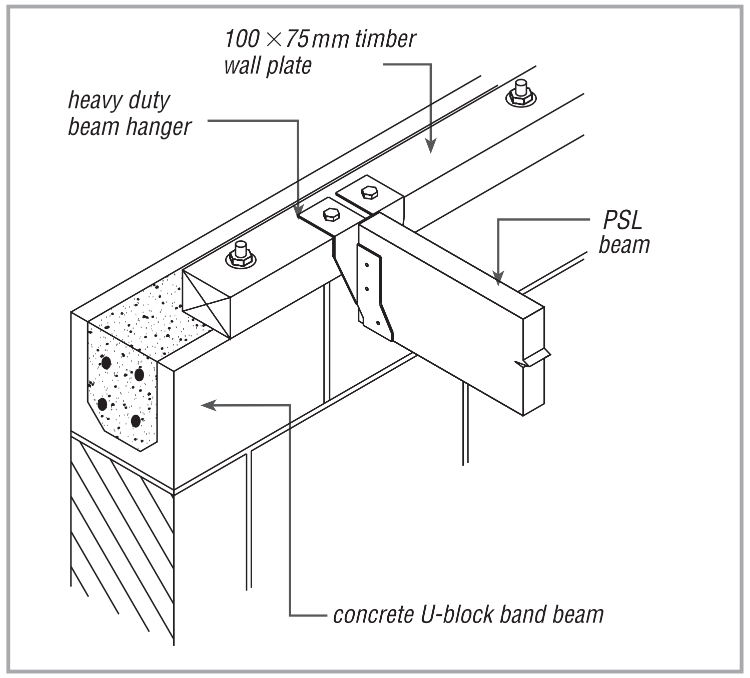
Joints may be formed using mild steel or stainless steel connector plates connected within PSL timber by means of bolts, nails, screws or dowels.



DETAIL B 7.2.2 Support

Beam support

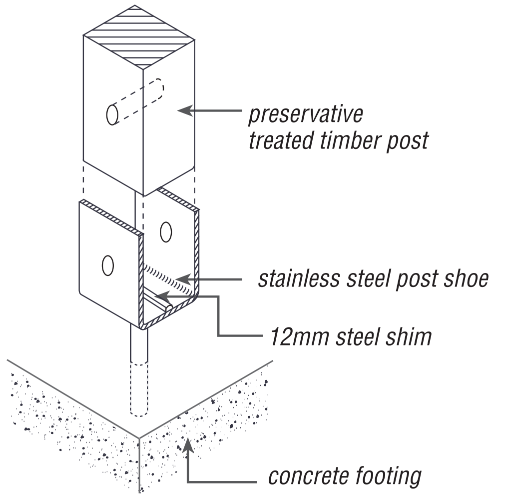
Floor joists may be seated on top or hung from steel hangers off the PSL beam.



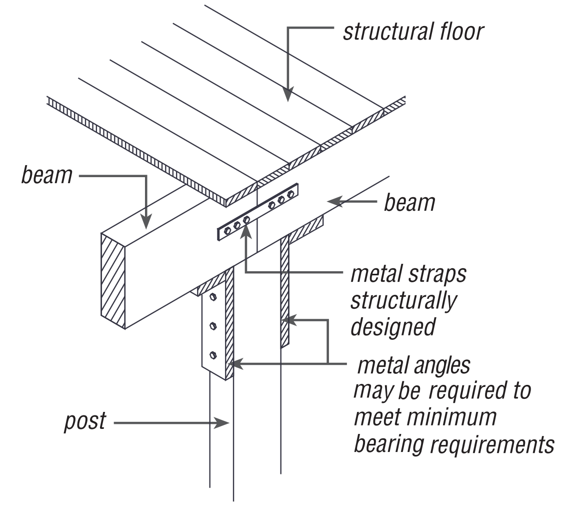
DETAIL B 7.2.3 PSL Structural Beam Support

B 7.3 COMPONENTS AND SYSTEMS - POST AND BEAM

DETAIL B 7.3.1 Post & Beam



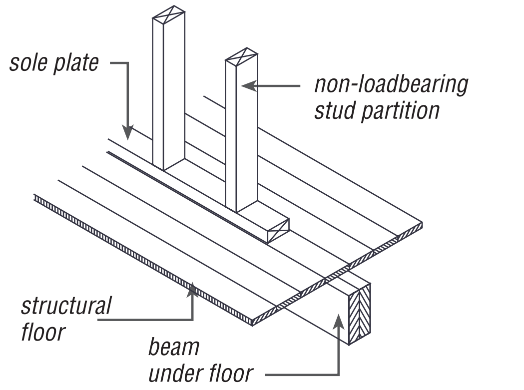
POST TO FOOTING CONNECTION



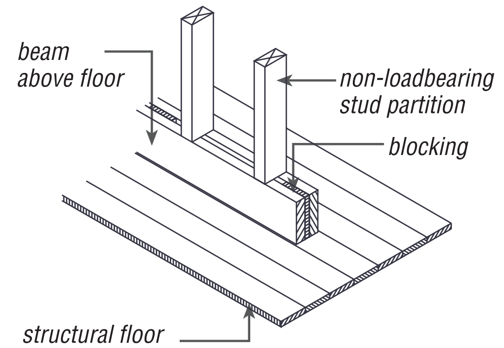
SOLID BEAM BEARING OVER POST

DETAIL B 7.3.2 Partition Supported by Beam

SUPPORT FOR NON-LOADBEARING STUD PARTITIONS PARALLEL TO PLANK



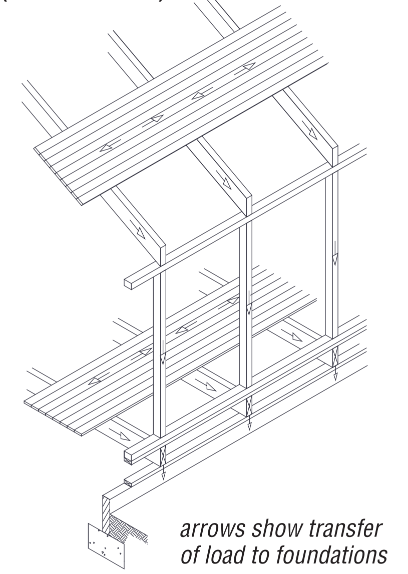
PARTITION SUPPORTED BY BEAM UNDER THE FLOOR



PARTITION SUPPORTED BY BEAM ABOVE THE FLOOR

DETAIL B 7.3.3 Partition Support by Beam

POST AND BEAM FRAMING
(transfer of load)



Details

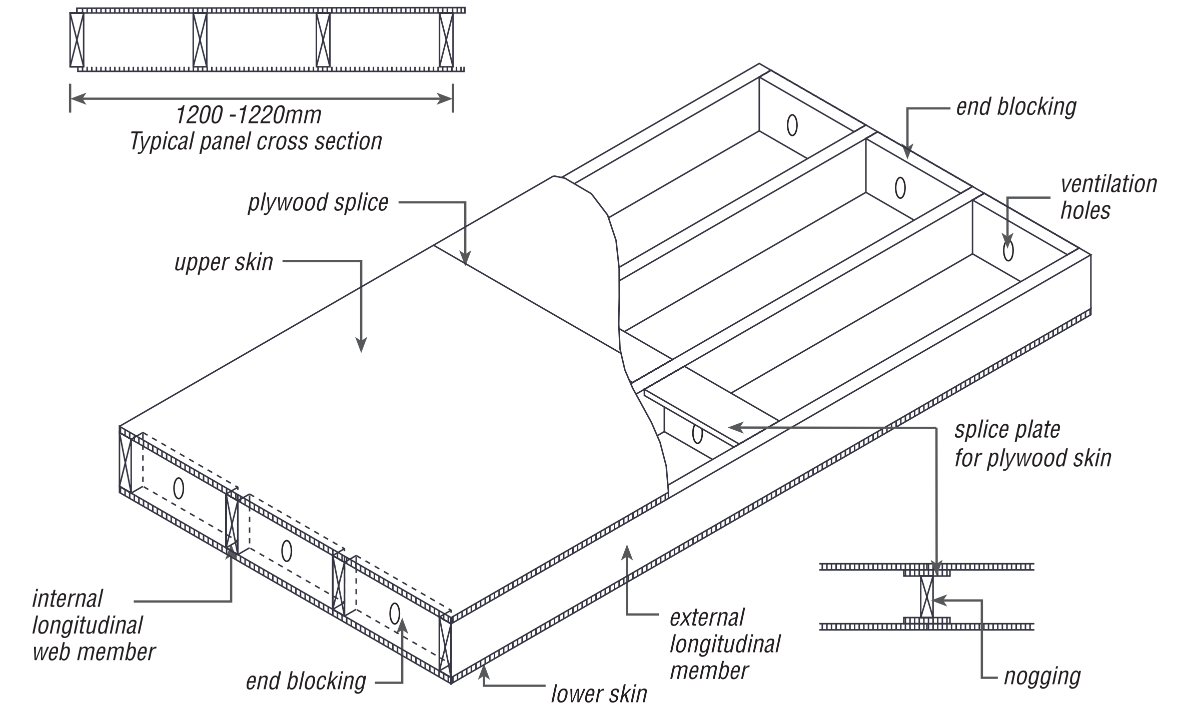
- To reduce the possibility of water entering the end grain at the base of posts, shoes or concrete footings can be used.
- Beams meeting at a post can be supported as shown in Detail B7.3.1.

Partitions

- Partitions in post and beam construction do not normally carry vertical loads.
- Where load-bearing partitions do occur they should be placed over beams or a number of floor joists which should be designed to carry this additional load.

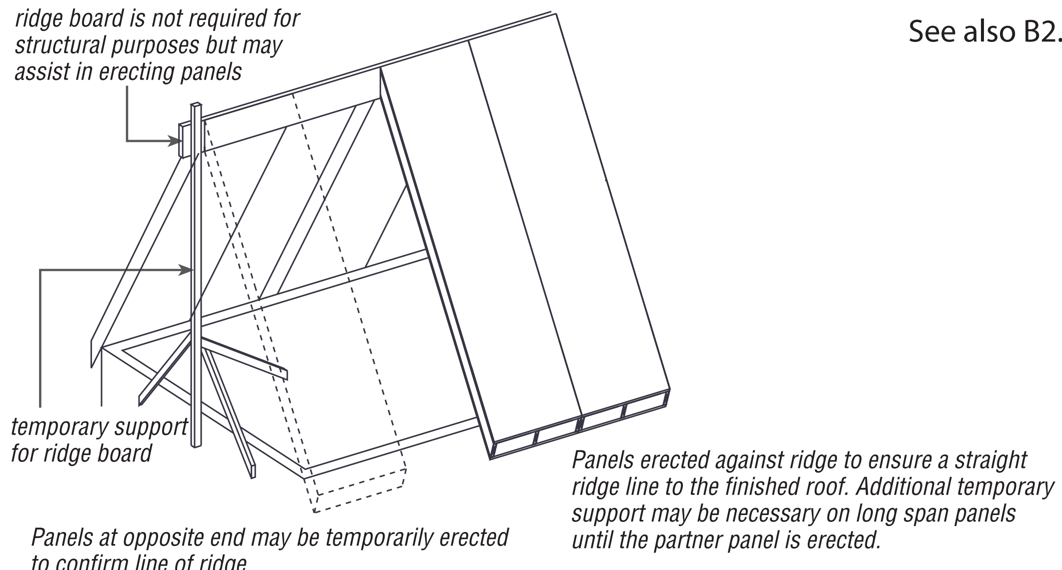
B 7.4 COMPONENTS AND SYSTEMS - STRESSED SKIN PANELS

DETAIL B 7.4.1 Stressed Skin Panels



DETAIL B 7.4.2 Stressed Skin Panel Roof

See also B2.9 and B3



ERECTING A STRESSED SKIN PANEL ROOF

Dimensions

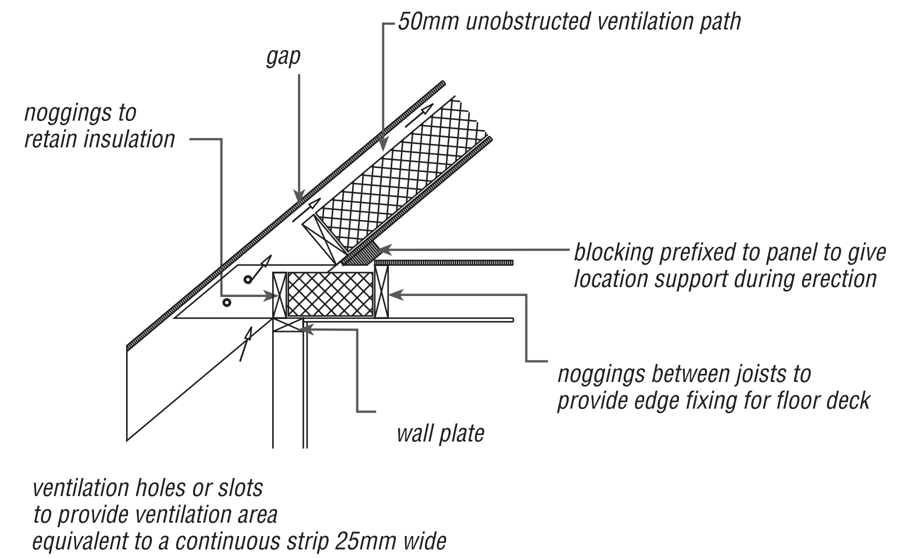
Panels are normally 1200mm or 1220mm wide with three or four intermediate strength graded timber web members. Web members can be finger jointed in accordance with the appropriate design standards. Web spacing, size and thickness of sheathing are related to the span and load. Panel length is dependent on design requirements with a structural joints being formed in the sheathing where appropriate.

Construction

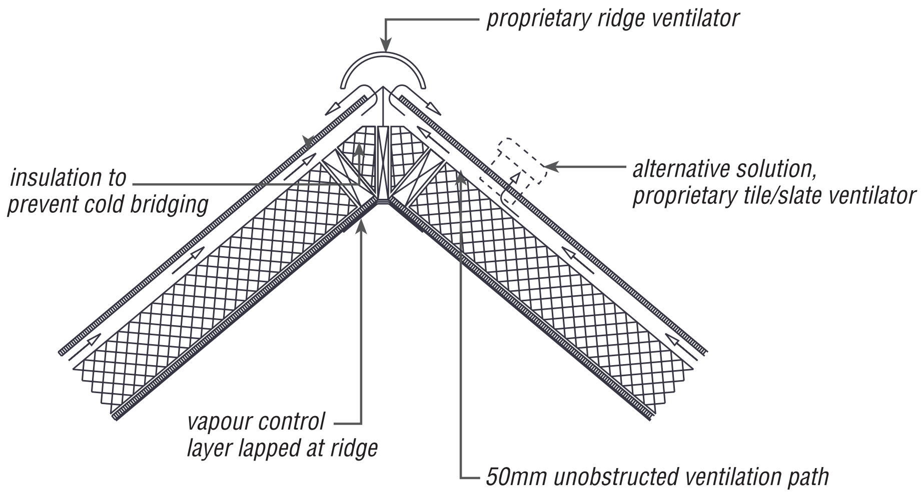
Panels are usually designed to span from eaves to ridge in dual pitch structures. Floor construction can be a conventional timber floor joists or a stressed skin panel system. Floor joists must generally span in the same direction as roof panels. Provision must be made to restrain the horizontal thrust at eaves level. Monopitch roofs can be constructed subject to any design constraints.

B 7.4 COMPONENTS AND SYSTEMS - STRESSED SKIN PANELS (CONTINUED)

DETAIL B 7.4.3 Ventilation at Eaves & Ridge



VENTILATION AT EAVES

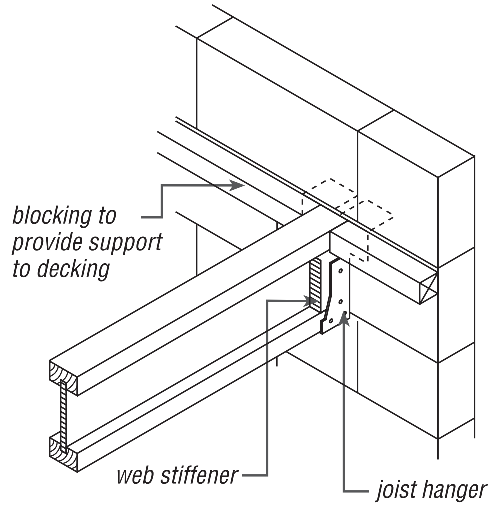


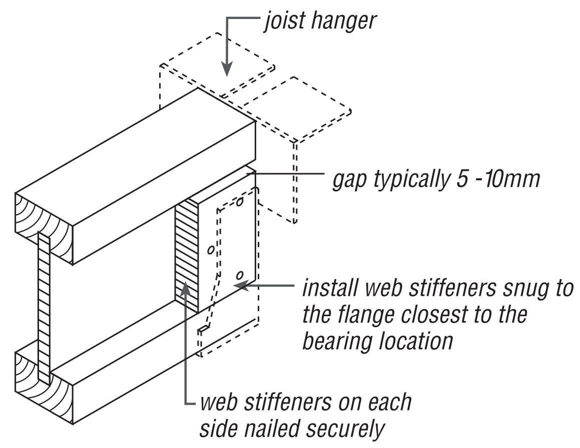
VENTILATION AT RIDGE

Specific details

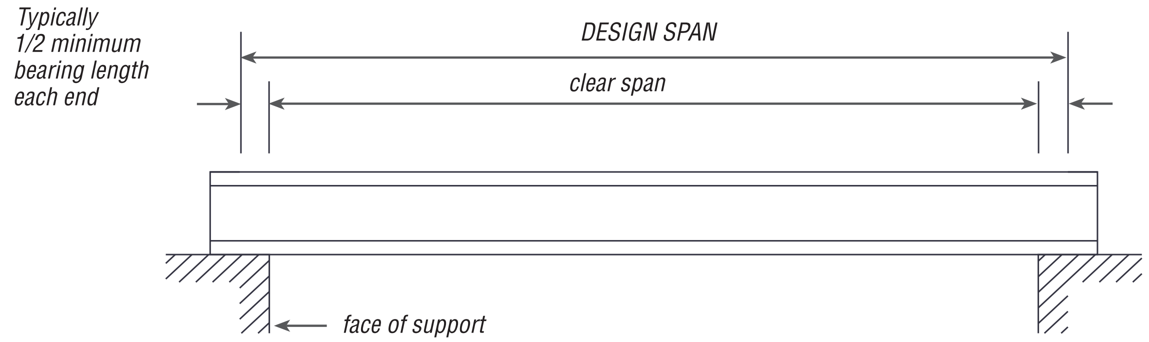
- 50 mm unobstructed ventilation space must be provided above the insulation layer.
- Roof windows and dormer window openings can be provided within the panels to suit design requirements.
- Plastic conduits can be incorporated into the panel during design and manufacture to accommodate services.
- See also sections B.3 (Panel Roofs) and B.4 (Flat Roofs).

B 7.5 COMPONENTS AND SYSTEMS - WOOD COMPOSITE I-JOISTS

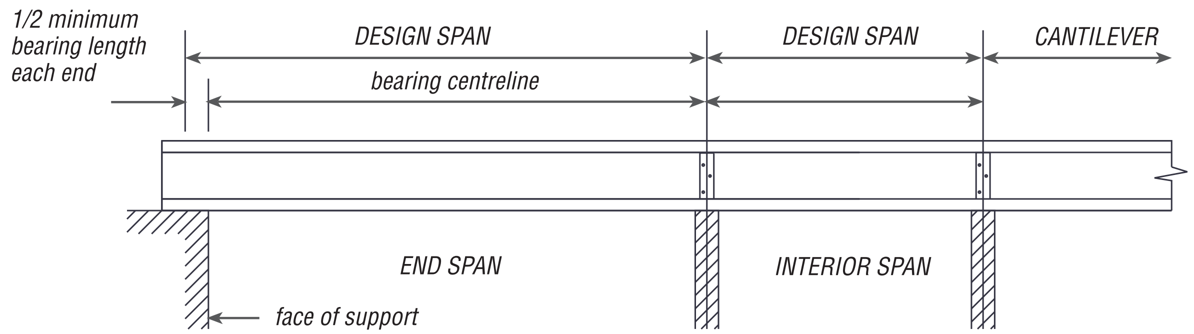




WEB STIFFENER DETAIL



SIMPLE SPAN CONDITION



CONTINUOUS SPAN CONDITION

DETAIL B 7.5.1 Spans

Spans (floors only)

- Typical masonry supports are outlined in B7.5.1.
- Maintain a single direction for the joists span wherever possible.
- Generally run the joists in short direction.
- Maintain constant depth and centres wherever possible.
- Joist hangers are usually part of the I joist system
- Joists should be designed and erected in accordance with the manufacturers recommendations
- Only joists with appropriate certification (e.g. Agrément Board) and/or ETA should be used

B 7.5 COMPONENTS AND SYSTEMS - WOOD COMPOSITE I-JOISTS (CONTINUED)

GENERAL

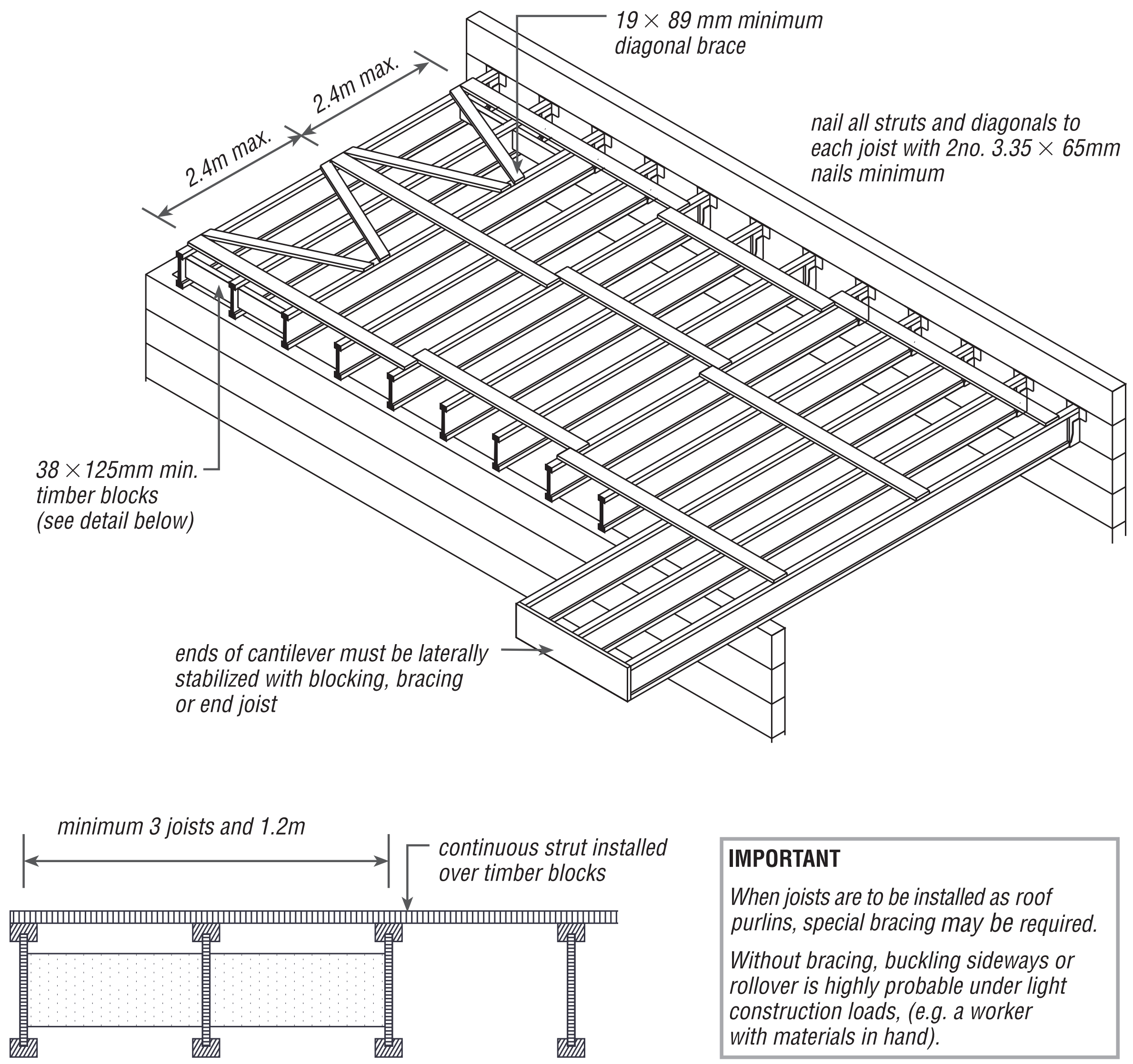
- Never cut a flange
- Never drill though a flange
- Make sure that the joists are restrained horizontally (usually by the flooring)
- Replace or repair (subject to design requirements) any damaged joists
- All joists must be designed

Timber frame

I-joists are widely used in timber frame construction as well as increasing on masonry buildings. One feature of I-joists in timber frame is the use of ‘rim boards’ as header joists (to run around the floor perimeter of a dwelling) which are the same depth as the I-joists and are usually made of LVL. The fire resistance of I-joists is largely based on the ceiling lining (usually plasterboard). The following recommendations are made in relation to timber frame construction:

- Header joists in the external wall should be LVL or solid timber rather than I-joists
- The header joist at the party wall should be LVL or solid timber rather than I-joists.
  Subject to design, party walls might have a header joist (LVL/solid timber) and a single I-joist.
- The connections between the first floor panel and the floor structure and between the floor structure and the ground floor panels must be designed taking into account the limitations in fixing into I-joists
- The plasterboard ceiling is of vital importance in relation to fire resistance. For 30 min. fire resistance 15mm plasterboard should be used or a special fire resistant lining used (e.g. Fireline or similar). Generally the plasterboard should be specified so that it alone provides the required fire resistance.
  Note: 12.5mm ordinary plasterboard is generally not suitable where European fire test standards are specified; the fire lining should always be specified by the designer. All openings (e.g. at light fixings) should be fire stopped.
- All plasterboard edges should be timber backed. Provide timber noggings between joists at the external wall perimeter, internal load bearing walls, at party walls and where the plasterboard is discontinued
- Fix the plasterboard with the correct fixings at the correct centres. Generally screws provide a better fixing than nails
- Do not alter any I-joists on site without written instructions from the manufacturer or design engineer All site remedial work should be carried out under supervision and in strict accordance with the issued instructions
- All fixings should be in accordance with the manufacturers’ recommendations. However, the design engineer may have additional fixing requirements
- Timber noggins should be inserted between joists at their ends to support the flooring
- If I-joists (or the LVL rim boards) are inserted between joists at their end, then these can be used to restrain the ends of the joists against twist, can support the plasterboard, can help transfer vertical load form the wall panel above and can help in providing space and a base for additional fixings.

B 7.5 COMPONENTS AND SYSTEMS - WOOD COMPOSITE I-JOISTS (CONTINUED)



Timber blocks are a minimum 38x125mm cut squarely and accurately to maintain joist spacing. Nail with minimum 2 no. 3.35x65mm long nails.
Timber blocks in the diagonally braced system are required at all joist ends or cantilever supports. Install blocks at those supports when total joist span exceeds 8m.
When joists abut on an internal support, block both ends of joists.

DETAIL B 7.5.3 Typical Erection Bracing

Bracing

- This covers only temporary bracing during erection.
- Joists are unstable until braced laterally

Douglas fir cladding
Coillte HQ, Newtownmountkennedy, Co.Wicklow.

B8 Cladding

B 8.1 GENERAL

Timber-frame construction is a method of building, not a system of building. As such it is flexible in its design and use. External timber cladding can achieve a wide variety of visual effects as well as giving a long lifespan on both timber-frame and conventional construction.

The three most important factors are:
- long term durability of cladding (50 years plus), either through the selection of naturally durable species or the preservative treatment of non-durable timbers with pressure impregnated preservative (minimum Use/Hazard Class 3A) or by heat treatment;
- control of moisture content through tight specification (16±3%) and site inspection;
- detailing of cladding to provide: an adequate air space behind the cladding for ventilation (minimum 25mm); end grain protection at all junctions; a board profile, thickness (minimum 25mm) and method of fixing (stainless steel or silicon bronze nails) that will shed water, give long life and visually weather well (vertical cladding weathers best).

Tests have shown that the heartwood of iroko, white oak and western red cedar will give 50 years service life without treatment if properly detailed and if kept out of ground contact. Other less durable softwoods such as Douglas fir, Scots pine and Norway spruce have been tested to a 50 year service life following high-quality pressure preservative treatment.

It is important to remember that it is only the heartwood of durable species which is durable. Sapwood for all species is not durable unless treated with pressure preservative treatment. We recommend pressure preservative treatment to minimum Use/Hazard Class 3A for all cladding timbers.

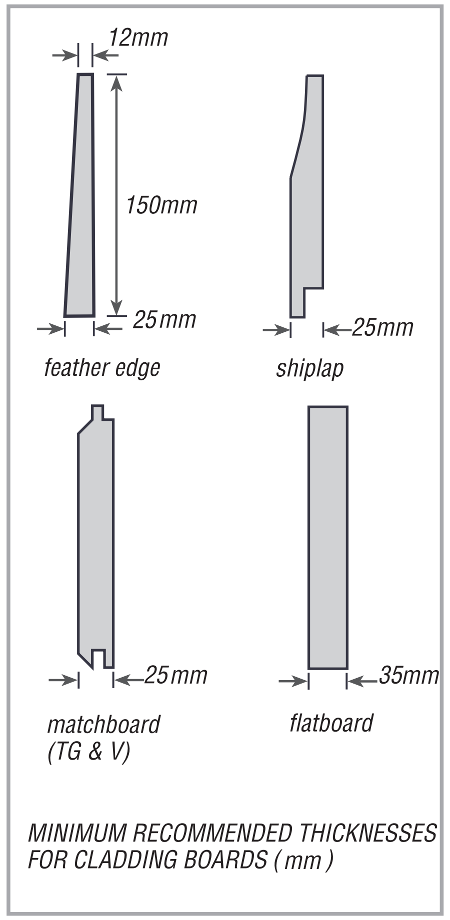
Durable and/or preservative treated species can be stained or allowed to weather naturally. The Irish climate is not conducive to natural weathering for most timber species due to its high relative humidity and discolouration can occur, especially on shaded surfaces.

Finishing systems should be applied to all surfaces of cladding boards before fixing. Any cut ends should be re-finished.

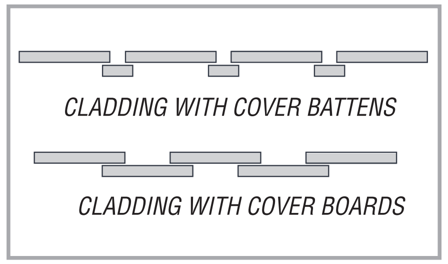
There are no current European standards for cladding board profiles. Some "typical profiles" are given in Appendix E of BS1186 Pt. 3 – "Specification for wood trim and its fixing". A number of conventional profiles such as matchboard and shiplap are available from timber merchants but it is possible to have your own designed sections machined to order by a joinery workshop.

The illustrated details give an idea of what is possible and what is good practice. Plywood cladding is generally not recommended due to problems of blistering, checking and edge/panel junction problems.

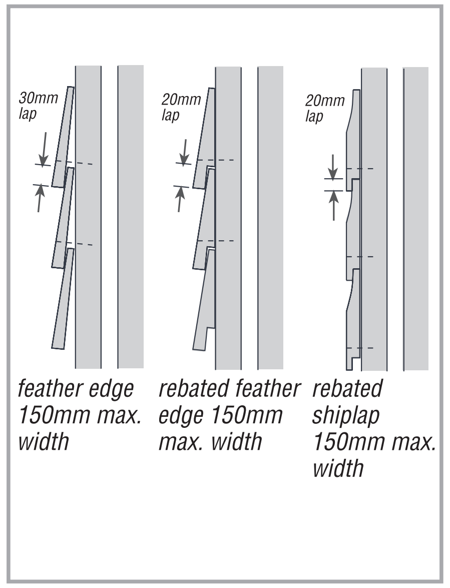
See B12.2 Working Details for examples of machined to order cladding boards.



DETAIL B 8.1.1 Board profiles

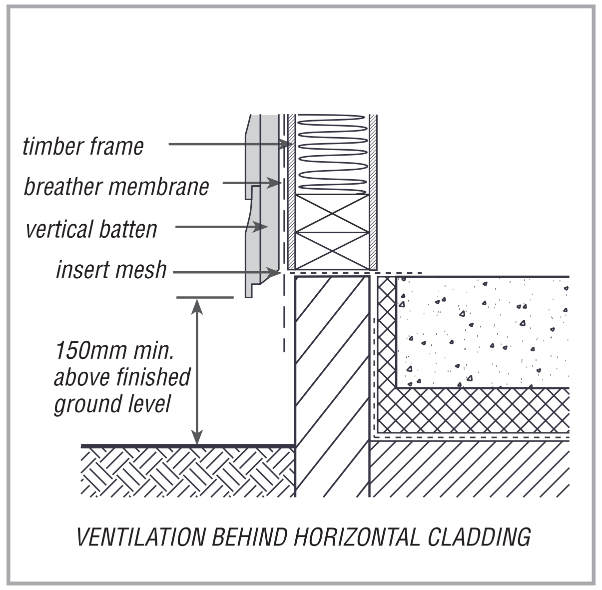


DETAIL B 8.1.2



DETAIL B 8.1.3 Fastening boards

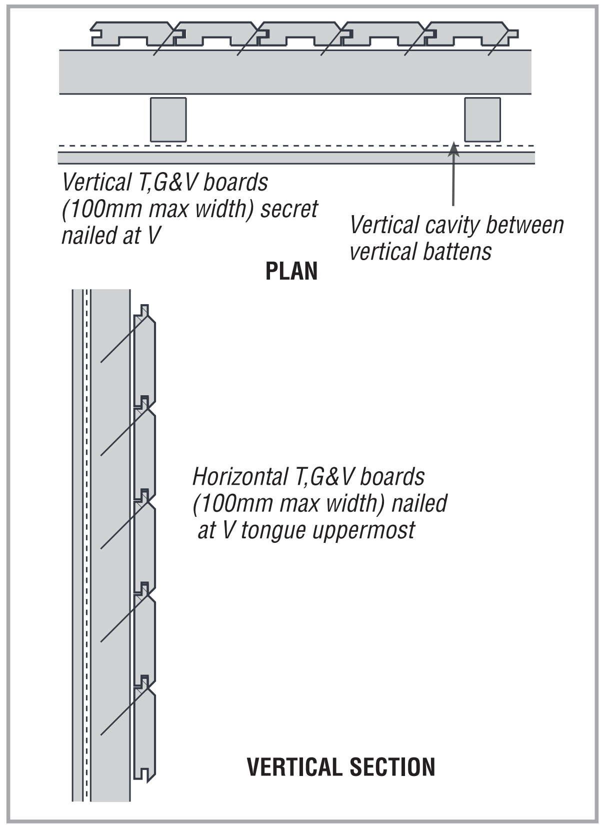
B 8.2 CLADDING - TONGUED, GROOVED AND V-JOINTED BOARDING



DETAIL B 8.2.1 Ventilation

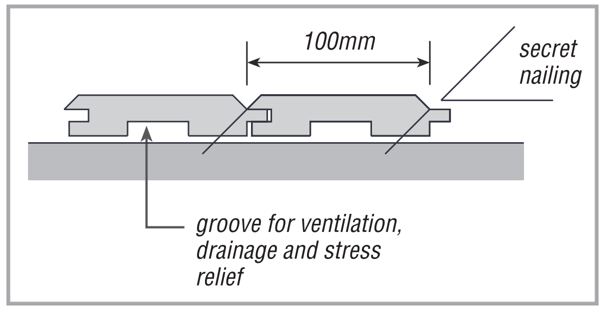
The bottom ends of vertical cladding boards should be splayed to shed water away from the end-grain. All sawn ends, drill holes etc. should be liberally treated with preservatives on site. When tongued and grooved boards are fixed, horizontally or diagonally, the groove must always face downwards to avoid water lodging. Ground contact should be avoided, all cladding should finish at least 150mm above ground level or other projections to minimise the effects of soaking due to rain splash-up.

Boards should be fixed with a 1mm gap at joints to allow for movement.



DETAIL B 8.2.2 TG&V boards

It is important that ventilation is not only to the outside surface through vapour permeable coatings, but also to the inside surface. This allows effective and quick drying of both surfaces of timber cladding after heavy rain conditions. A minimum of 25mm continuous clear cavity is recommended. Vertical battens are fixed over the breathing membrane to maintain this free air space. Where horizontal battens are required, they should be laid over vertical battens. The battens should not exceed 600mm centres. Battens should be at least 38mm wide and the depth 1.5 times the thickness of the cladding board. Battens should also be preservative treated to the same standard as the cladding.



DETAIL B 8.2.3

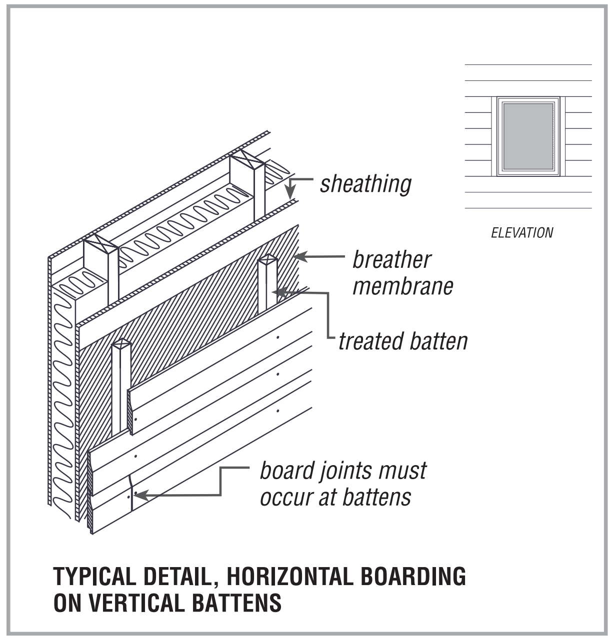
Tongued, grooved and V-jointed profile boards should be nailed with either stainless steel or silicon bronze ringshank nails. Provide a stress relieving channel or groove on the back face of the cladding board. This controls cupping and provides additional ventilation.

See working Detail B 12.2.4 for examples of board profiles and method of fixing.

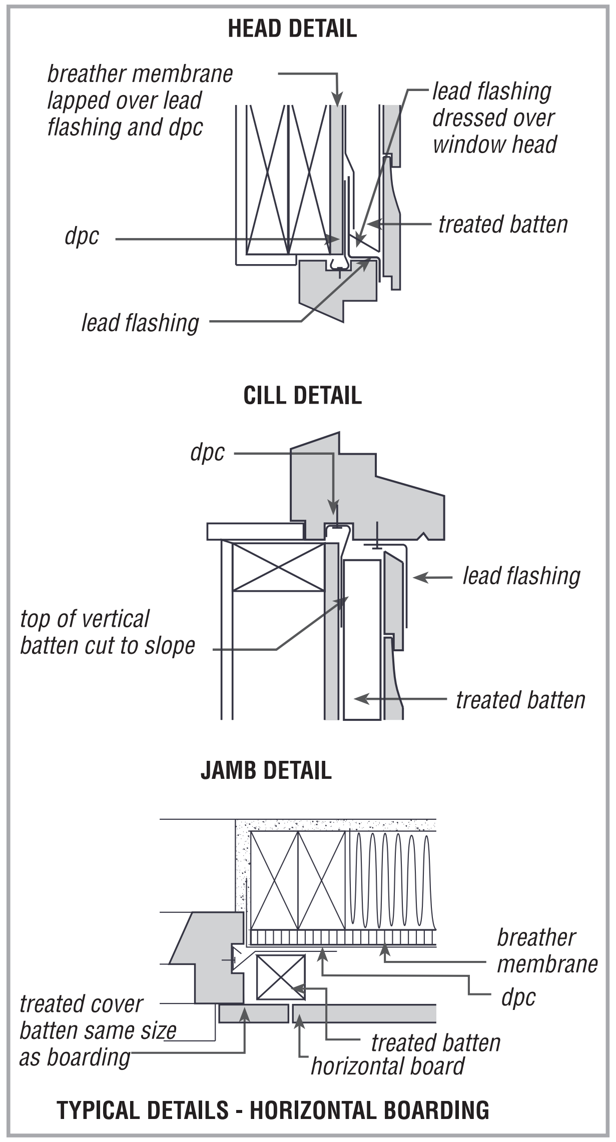
B 8.3 CLADDING - HORIZONTAL BOARDING

Horizontal cladding boards, other than Western red cedar, should have a minimum thickness of 25mm. The boards should be fixed to preservative treated timber battens. The battens are nailed to the studs in the timber frame panel. The vertical battens which support horizontal cladding (Detail B8.3.1) permit drainage of moisture which may penetrate the cladding.

External cladding boards should be fixed with stainless steel or silicon bronze ringshank nails. Do not use aluminium, wire or galvanised/sherardised nails as they will stain the cladding after a few years. Double nailing of boards across their width can cause splitting and so is not recommended. All external timber cladding should be carefully detailed around openings and corners. In the case of horizontal cladding the end grain is vulnerable and requires specific detail (see Detail 8.3.2 and 8.3.3). The design of a special window sub-frame as part of the joinery detail can solve the technical difficulty of cladding/window junctions (see Working Detail B12.2.2).

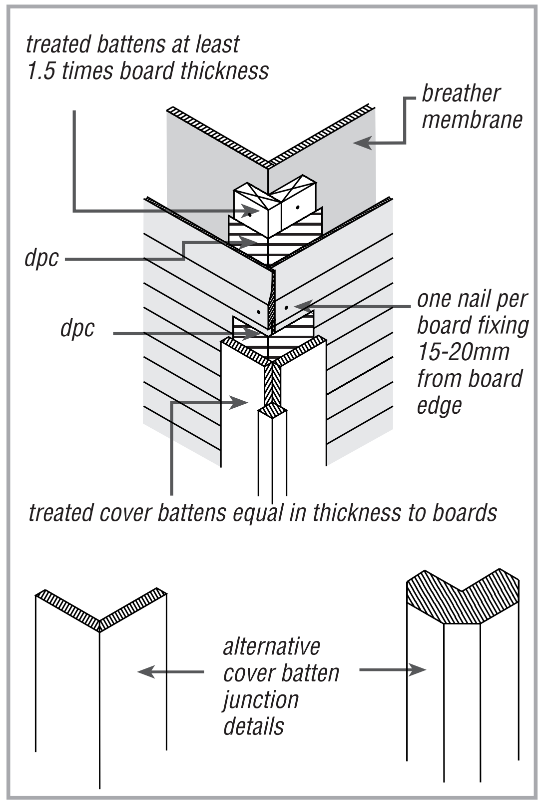


DETAIL B 8.3.1 Horizontal boarding



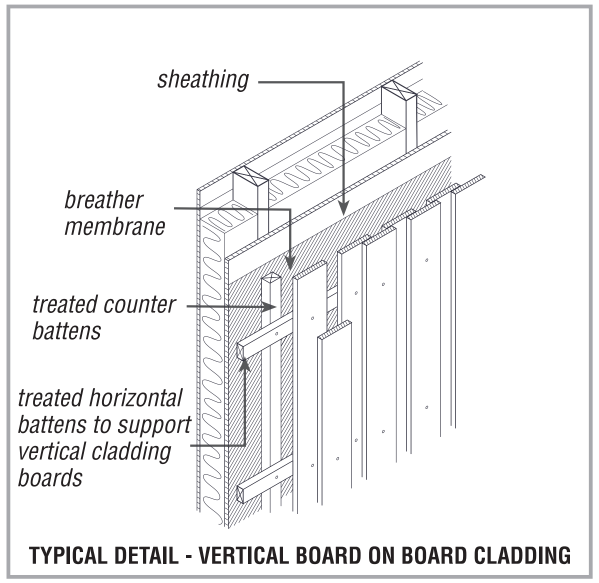
DETAIL B 8.3.2 Horizontal boarding - junctions

An alternative and more elegant detail to B 8.3.3 can be found in Working Details B12.3 detail 14.

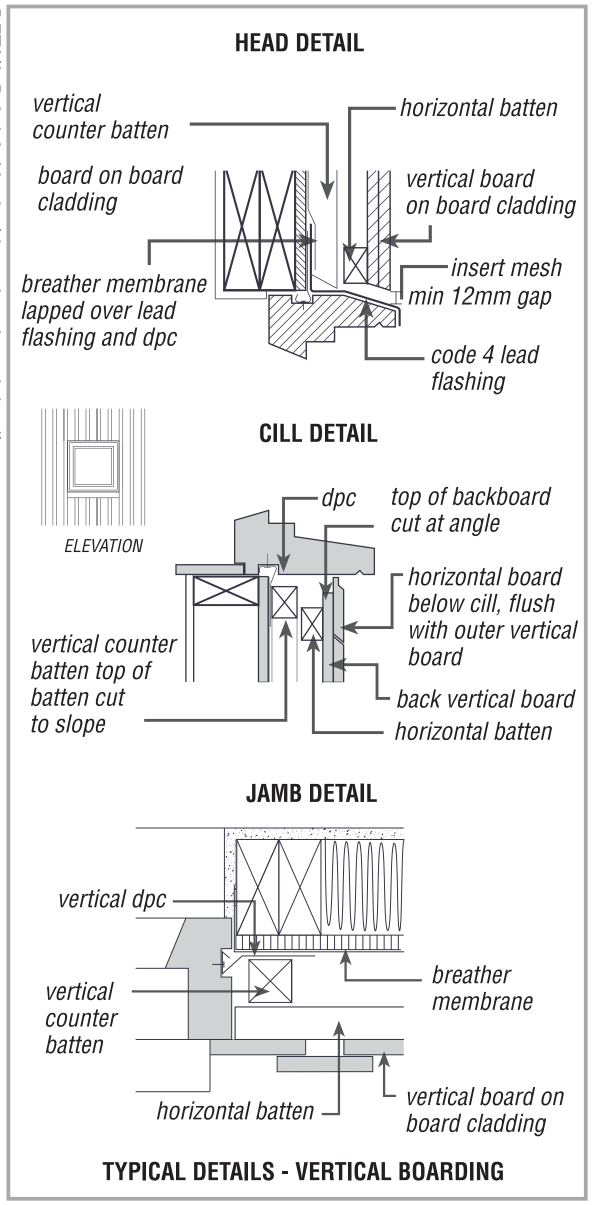


DETAIL B 8.3.3 Horizontal boarding - corners

B 8.4 CLADDING - VERTICAL BOARD-ON-BOARD



DETAIL B 8.4.1 Vertical boarding



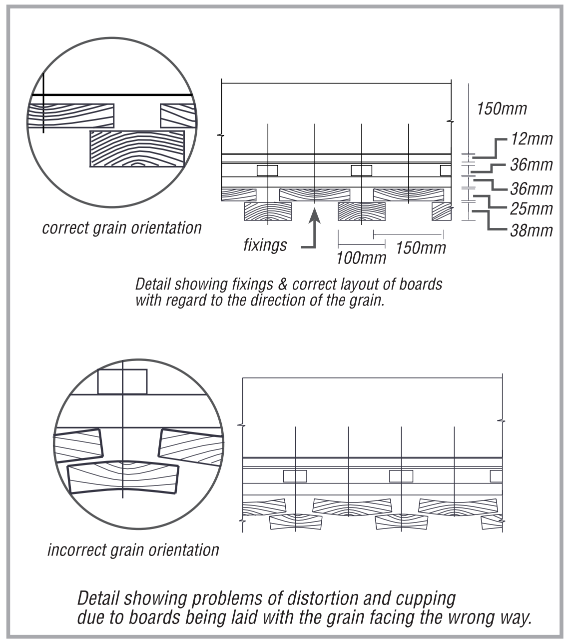
DETAIL B 8.4.2 Vertical board on board details

Vertical board-on-board external cladding should be carefully detailed around openings and corners. The inner boards should be fixed with corrosive resistant fasteners to the horizontal battens.

The detailing of external timber cladding at openings is important. The openings should be sealed; however, room for expansion of the boards has to be incorporated.

As the moisture content of exterior cladding varies considerably, adequate accommodation for moisture movement should be provided to avoid stress and eventual cracking. Cladding boards should be free to move independently of each other and where overlapping occurs, care should be taken to avoid nailing through underboards. Staggered nailing permits the timber to resist movement stress more easily. It is also important when laying vertical board-on-board to face the boards as shown in Detail B8.4.3, to avoid further problems with cupping and distortion of the timber sections.

Finished battens should be at least 36mm thick and 44mm wide to avoid splitting when nailing.



DETAIL B 8.4.3 Correct fixing

B 8.5 CLADDING - SHINGLES AND SHAKES

Shingles for roofing are sawn from selected western red cedar logs. They are produced in three grades:

- No. 1, Blue Label,
- No. 2, Red Label, and
- No. 3, Black Label,

with No.1 being the best quality.

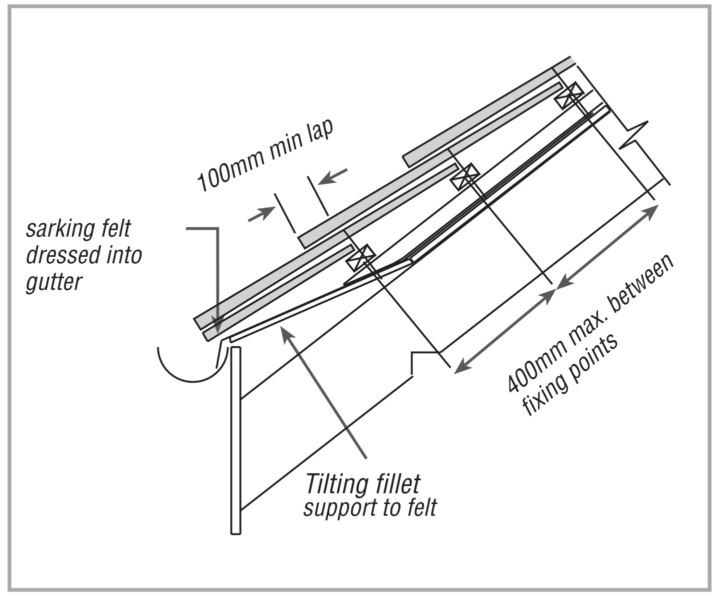
Experience has shown that untreated cedar shingles, when used as roofing, have a limited life in Irish conditions. Pressure treatment with an appropriate water-borne preservative is recommended. Untreated shingles used for vertical wall cladding have performed satisfactorily.

A good shingle roof is never less than three layers thick (2 ply) and the amount of shingle exposed should not exceed one third its length. Adequate roof ventilation must be provided in the ratio 3.35mm²/m² of ceiling area.

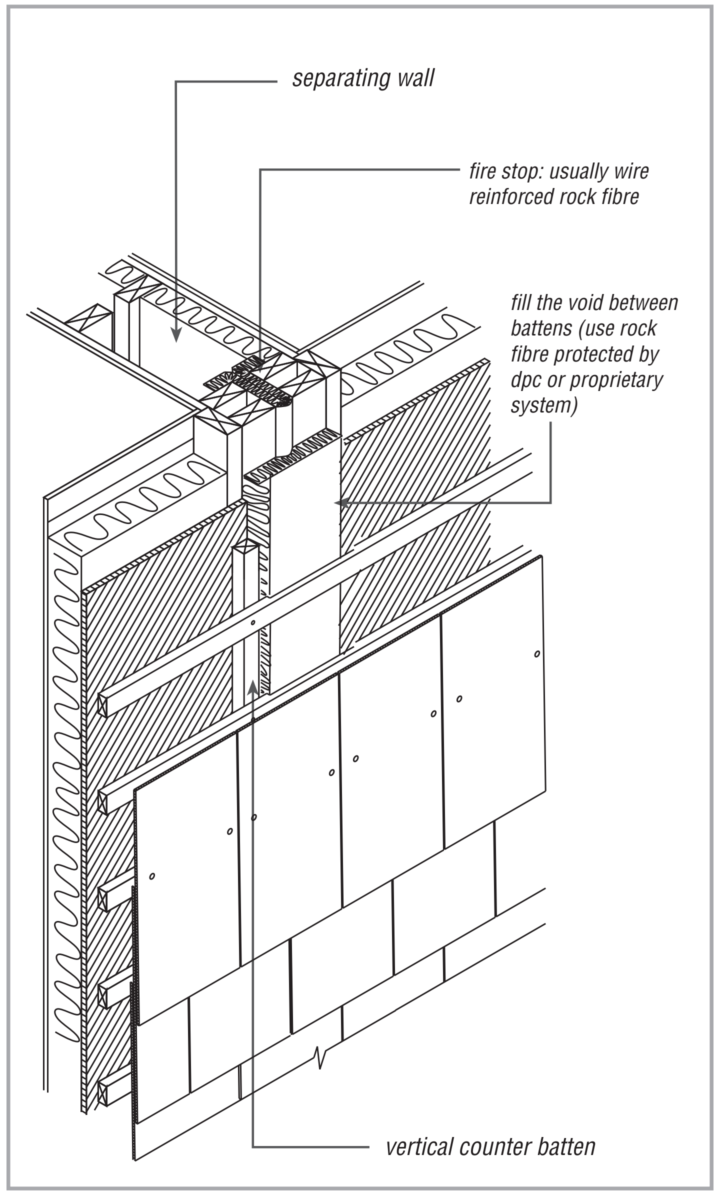
Shingles must be doubled along the eaves and tripled for a superior roof. Side joint spacing between adjacent shingles should be 5mm. Joints in any one course should be separated by not less than 40mm from joints in adjacent courses and joints in alternative courses should not be in direct alignment.

Each shingle should be fixed with two austentic stainless steel, silicon bronze or copper nails. Each nail should be placed 20mm from the side edge and 38mm above the butt-line. Nail lengths should be 32mm for both 400mm and 450mm shingles and 38mm for 600mm shingles.

All flashing materials should be bitumen based to avoid the corrosive action of western red cedar on most metals. Only steep roof pitches are suitable for shingle use. Refer to manufacturer's instructions for specialist detailing.



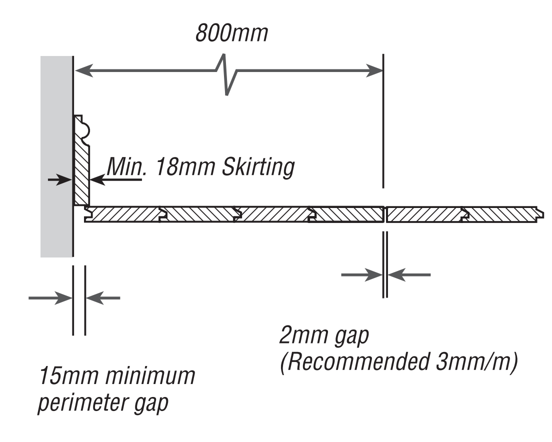
DETAIL B 8.5.1 Roof shingles



DETAIL B 8.5.2 Wall shingles

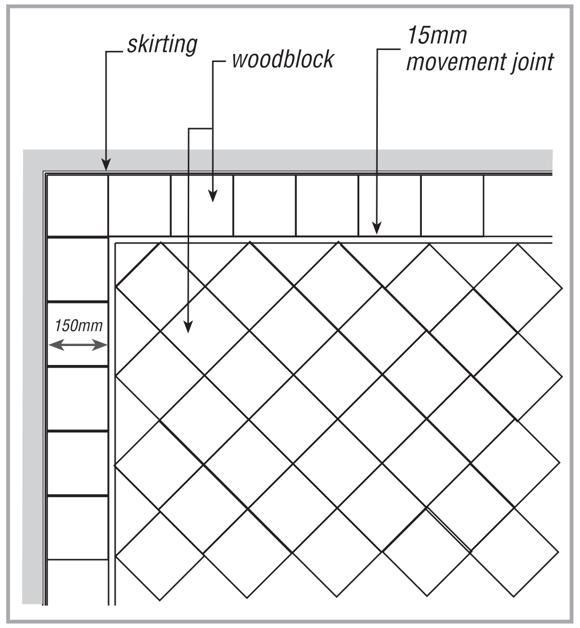
B 9 Flooring

DETAIL B 9.1.1 Expansion gap



Expansion allowance for hardwood strip floors

DETAIL B 9.1.2 Wood block floors



B 9.1 GENERAL

The standard for flooring is BS 8201 *Code of Practice for flooring of timber, timber products and wood-based panel products*, but other proprietary systems are also now available and some European Standards cover specific types of flooring. The standard contains tables relating to the suitability of different species of timber for particular levels of pedestrian traffic. Species such as hard maple and white oak are suitable for public areas provided they are protected from water and grit. See table A 11.2 for timber species selection. Wet trades must be completed, the heating system commissioned and moisture content of the sub-floor and timber material checked for compliance with specification prior to laying.

Special purpose floors such as sports halls and floors with underfloor heating have particular requirements which should be taken into account before installation. As a general rule the thicker and narrower the board the less movement problems will be encountered.

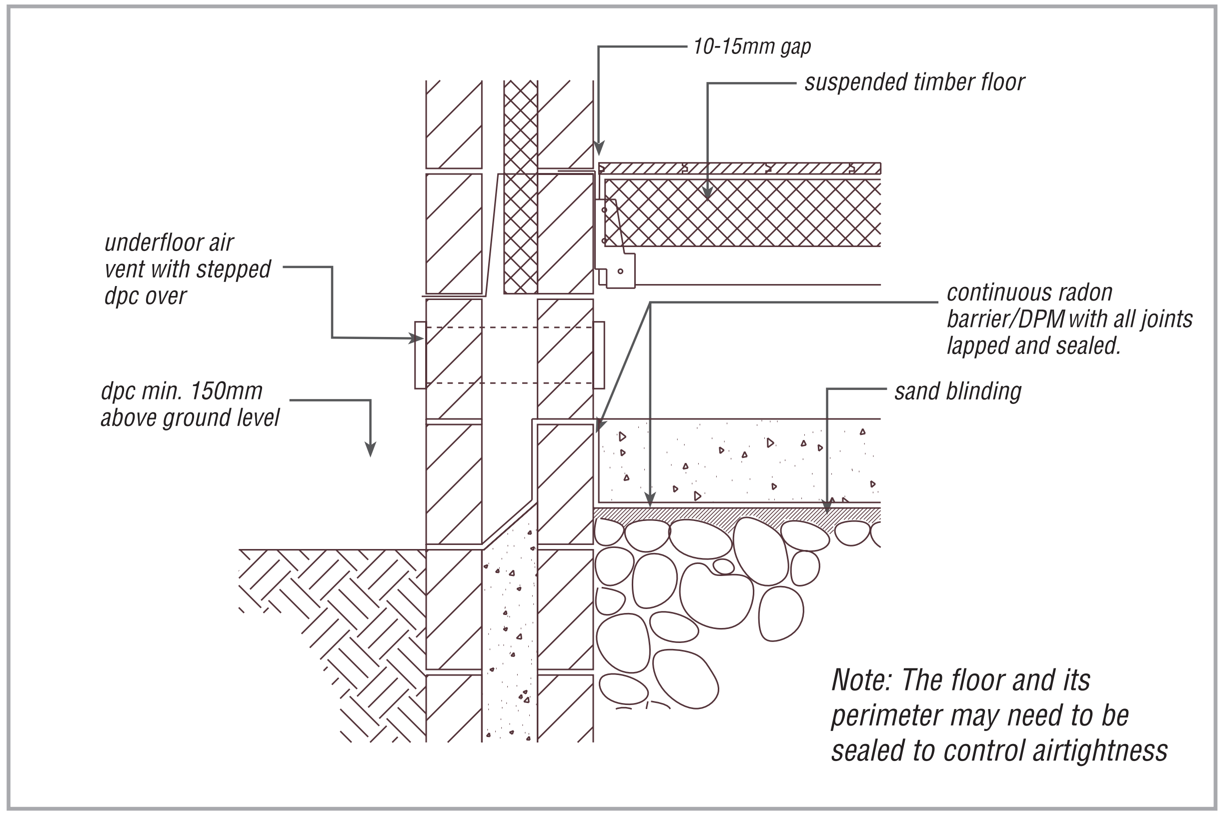
In general, allow a 15mm expansion gap at both sides of the floor, with intermediate gaps of 3mm per metre for large areas. Provide an expansion gap between dissimilar floor materials such as wood and tiling by use of a stainless steel or brass cover strip. Alternatively a profiled timber strip can be used. Where timber flooring abuts glazing without a skirting to mask the perimeter expansion gap at their junction, a neoprene, cork or similarly flexible joint insert can be used.

Consideration should be given to reducing footwear impact noise on hardwood floors by the use of an acoustic mat between (but not on top of) timber support battens. Alternatively, woodblock floors set in mastic will solve this problem on concrete sub-floors.

Sealing the timber floor is vital to its long term success. Many products are now supplied with a hard-wearing factory applied finish. Oils and wax finishes must be frequently maintained. For light-coloured woods such as hard maple in domestic situations, an acid catalysed lacquer, similar to that used on furniture, could be used as it does not yellow with age. However, the hardest-wearing site-applied finish is a two-pack product such as polyurethane and it should be used in public areas or hard-wearing domestic locations.

Narrow board sycamore hardwood floor laid with quick clip system

B 9.2 FLOORING - TONGUED AND GROOVED



DETAIL B 9.2.1 Suspended Timber Ground Floor Junction with External Wall

The most common type of softwood flooring; tongued and grooved boards, is designed to give a lap at joints, therefore reducing the risk of gaps and creaking. Tongued and grooved boards are normally fixed to joists but they can also be fixed to battens on concrete subfloors.

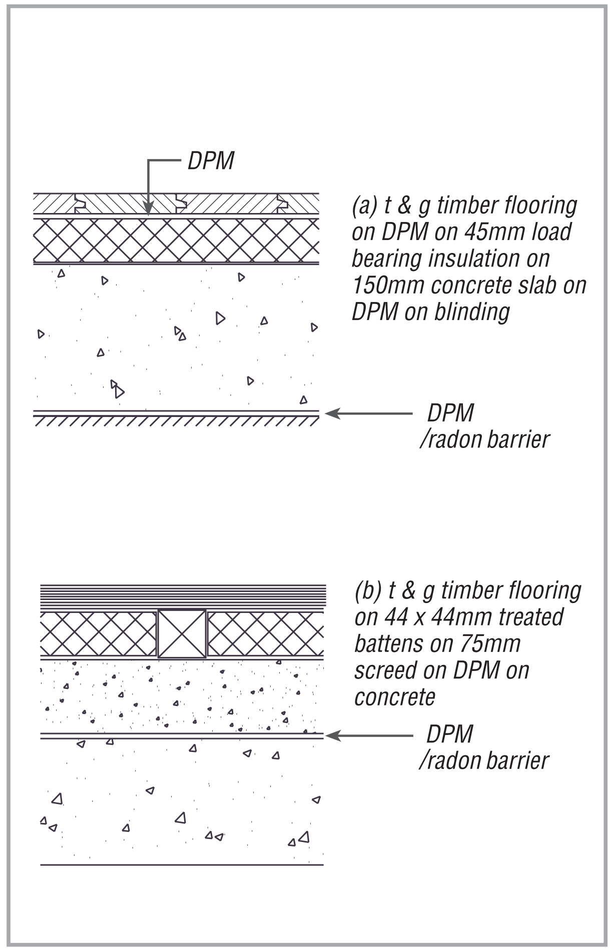
Joists or batten centres are recommended as follows:

Domestic floor	600mm max
Commercial floor	411mm
Sports floor	411mm

It is preferable that the DPM is laid beneath the screed as shown in Detail 9.2.2.

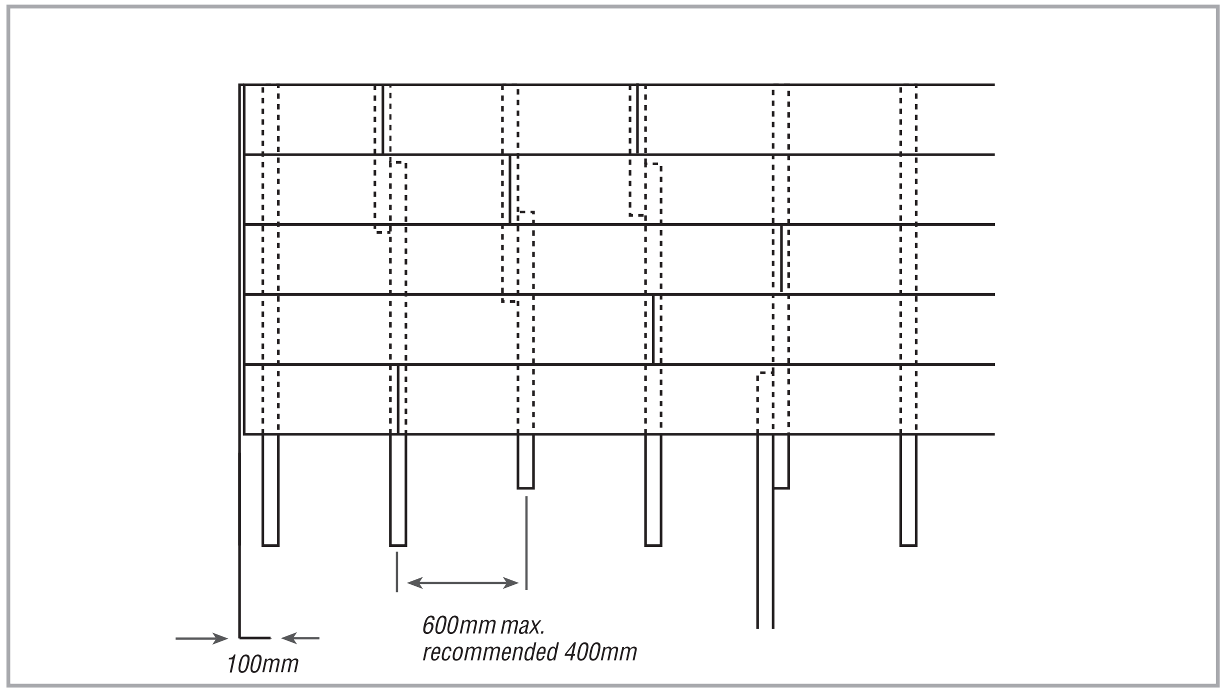
In standard domestic housing it is recommended that boards of finished dimensions 88x18mm be used. This will reduce the risk of distortion and gapping of boards in service due to movement. Cut steel flooring brads should be used.

"Allowance for moisture movement of the floor boards should be provided at the perimeter of the floor, typically 12-15mm or by calculation (particularly for wide areas). This gap is normally concealed by skirting boards. To meet the requirements for air infiltration in the Building Regulations a compressible strip or other seal may be necessary."

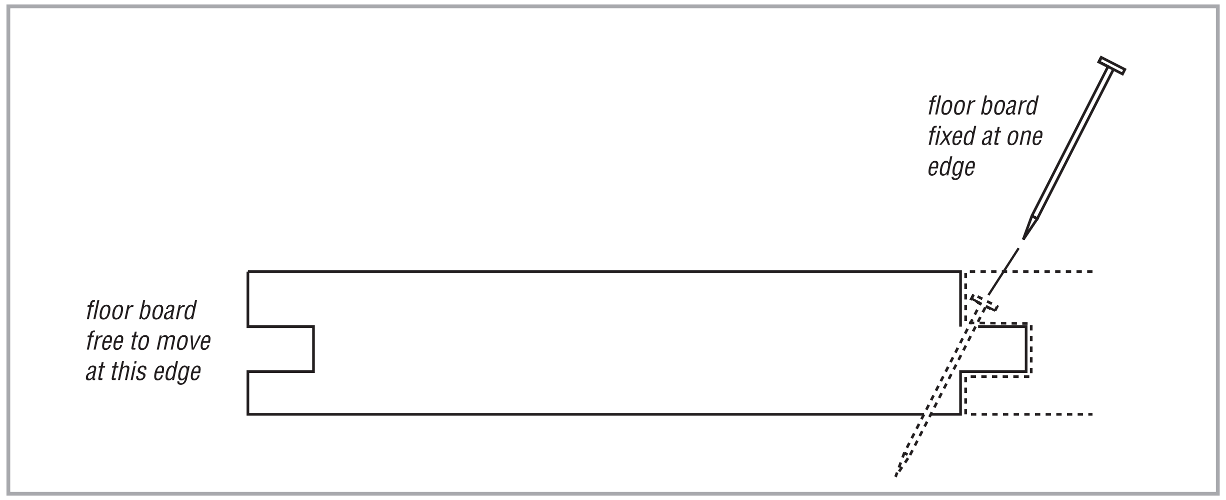


DETAIL B 9.2.2 Typical Floating Floor Details

B 9.2 FLOORING - TONGUED AND GROOVED (CONTINUED)



DETAIL B 9.2.3 Joist Supports



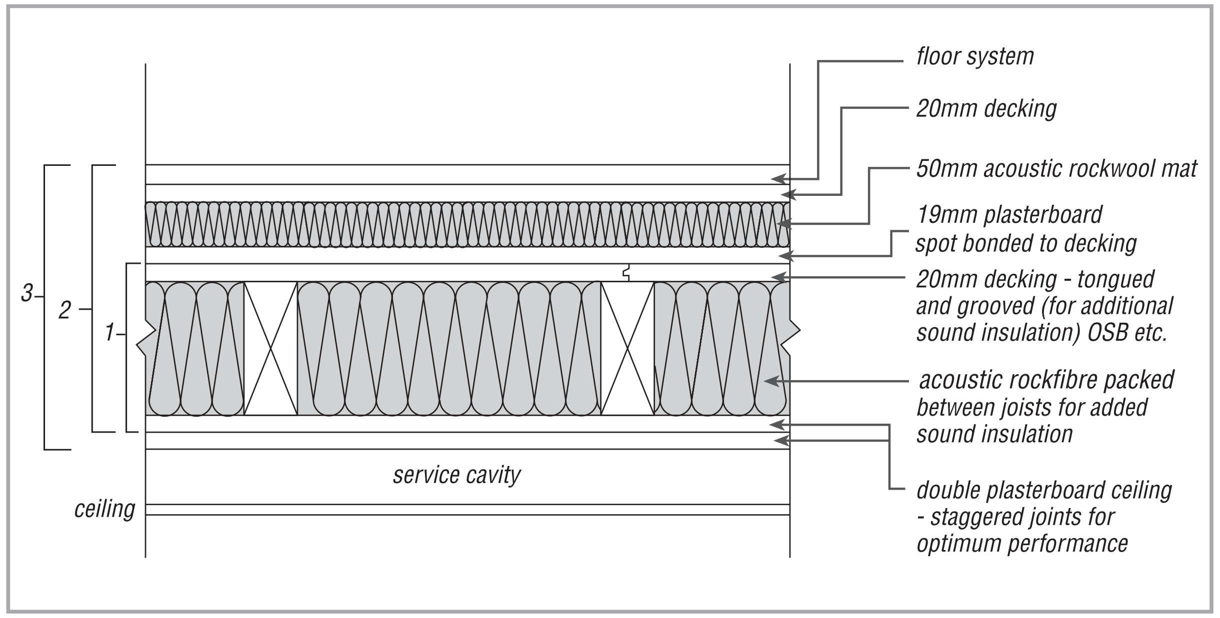
DETAIL B 9.2.4 Nailing

The boards should be laid at right angles or diagonally to the joists. Boards should be laid to give a random joint pattern. This is normally achieved by using the offcut of one row of boards to start the next row. Adjacent strip end joints must be a minimum of 80mm from each other. Board end joints must fall in line no closer than at intervals of three boards. All header joints should bear directly on a joist or batten to give the maximum bearing. This is essential for square-ended boards.

An expansion gap of 15mm min should be allowed on all sides. This can be covered later by a skirting board which should be fixed independently 2mm above the floor. A cork or rubber foam can be used to fill the expansion gap (see B9.2.3).

The boards can be either face nailed or secret nailed to the joists or battens. If the floor is to be left exposed it is advisable that the boards be secret nailed at an angle of 45° through the top of the tongue using 50mm or 65mm lost head ring shank wire nails (see B9.2.4).

B 9.2 FLOORING - TONGUED AND GROOVED (CONTINUED)



DETAIL B 9.2.5 Sound Insulation

Sound insulation

The biggest problem affecting suspended timber floors is the transmission of sound. There are different options which can help in the sound insulation of a timber floor.

Option 1

involves insulating between the joists with acoustic rockfibre – in order for this to be effective the rockfibre should be packed tightly between the joists (allowing no gaps); the rockfibre should also be packed up behind the skirting. This method reduces transmitted sound. In order to soften impact sound a build-up of layers is necessary. These are described below as Option 2.

Option 2

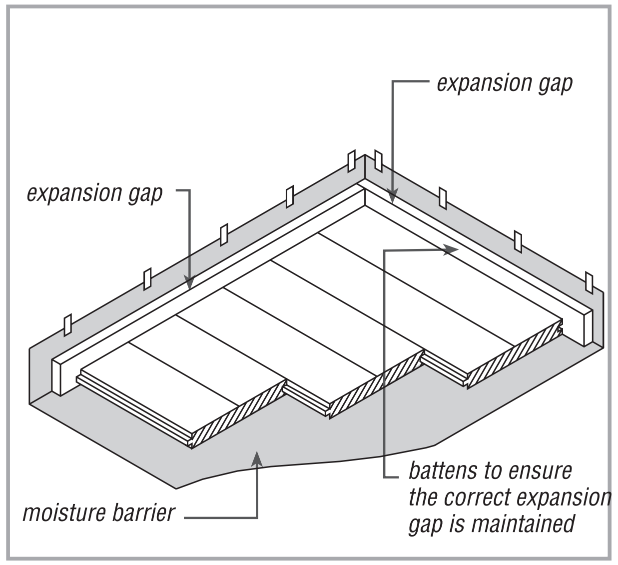
- Acoustic rockfibre as per option 1.
- 20mm decking (T&G for additional sound insulation)
- 19mm plasterboard
- 50mm acoustic rockfibre mat
- 20mm decking
- Chosen flooring system

Option 3

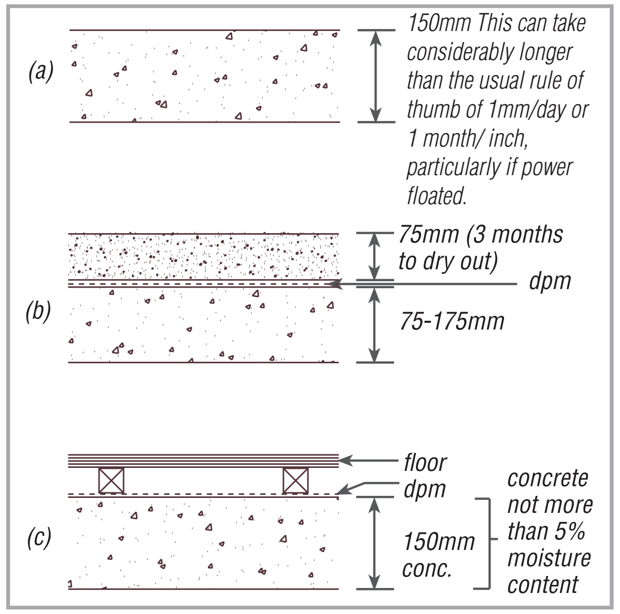
Detail B9.2.5, illustrates a third option which combines both Option 1 and Option 2. Option 3 involves the addition of a further layer of plasterboard to the ceiling, with staggered joints for optimum performance. If budget allows, Option 3 provides the best solution for sound insulation.

B 9.3 FLOORING - TIMBER FLOORING ON CONCRETE SUBFLOORS

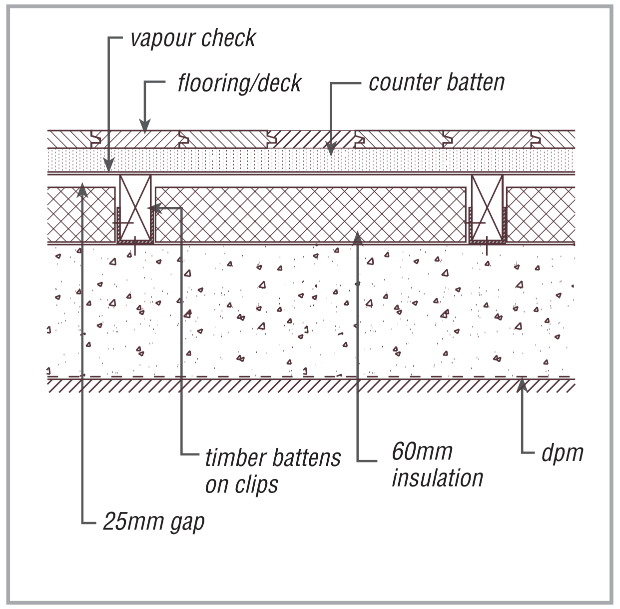
DETAIL B 9.3.1 Expansion gap



DETAIL B 9.3.2 Concrete moisture content



DETAIL B 9.3.3 Clip system



When a timber floor is to be laid on a concrete subfloor, it may be necessary to lay a moisture barrier first. This moisture barrier should be laid between the screed and the concrete floor slab. This offers protection to the moisture barrier and thus ensures its performance; however, in some cases, e.g. an existing floor, a moisture barrier may not have been laid. The moisture barrier should be unrolled and extended up the walls so as to finish just above the skirting finishing height. All edges should be lapped by 200mm and taped with waterproof tape. The underlay, if required, can be laid on top of this. There are products available on the market which incorporate both the moisture barrier and an underlay.

Temporary wooden spacers should be used to achieve the correct size of expansion gap, at the perimeter and all fixed points. These are removed at a later stage.

It is important that the concrete subfloor or screed is thoroughly dry before the timber floor is laid. Generally this means that the concrete floor should have a moisture content of 5%, but some suppliers require even lower values, particularly if underfloor heating is specified. Detail B9.3.2 shows the time suggested to allow a concrete floor to dry out.

When fixing a timber floor using a clip system, attention should be paid to the manufacturer's instructions and details as these proprietary systems differ from one manufacturer to another.

All board ends should be glued with an adhesive appropriate to the flooring system; this is usually recommended by the manufacturer. The adhesive should never be applied along the long joint as this would restrict the movement of the floor. End joints within the floor must be staggered to produce a random strip pattern similar to that as described for tongued and grooved boarding.

B 10 Windows

B 10.1 GENERAL

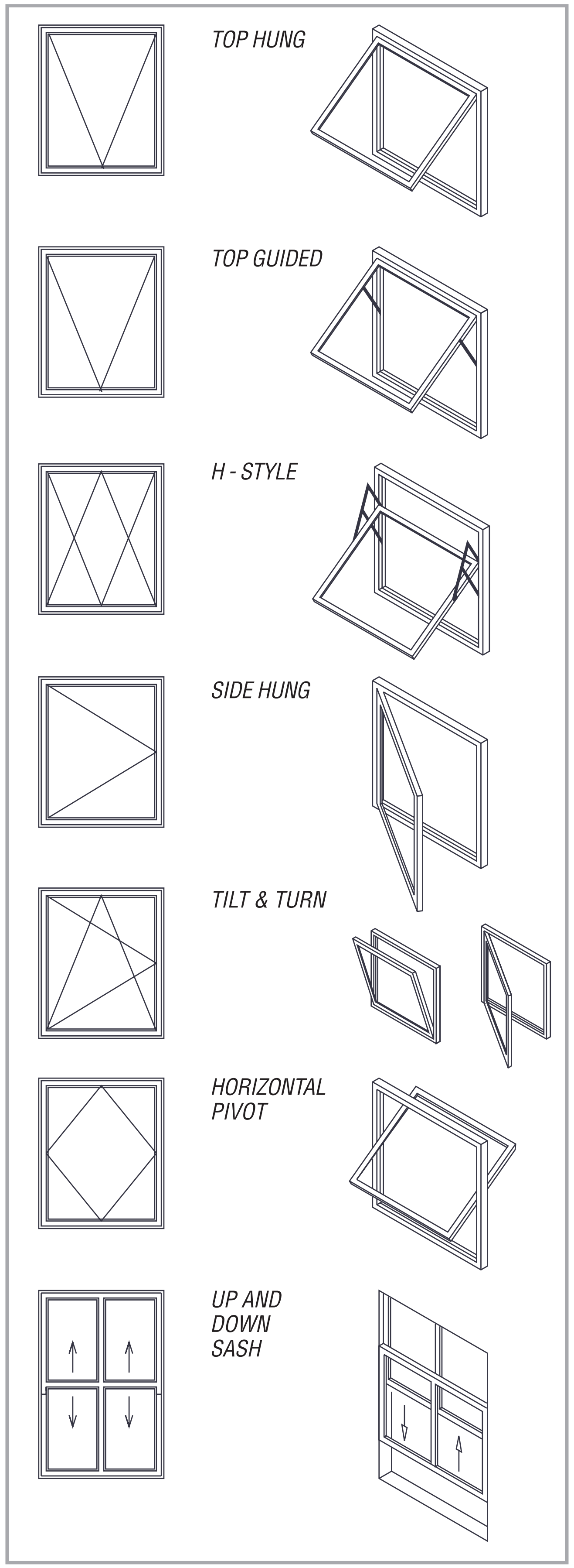
Common styles of window

Some of the most common styles are listed below. When selecting a particular style the following criteria should be considered.

- Durability
- Location
- Ease of maintenance
- Aesthetics
- Ventilation
- Security

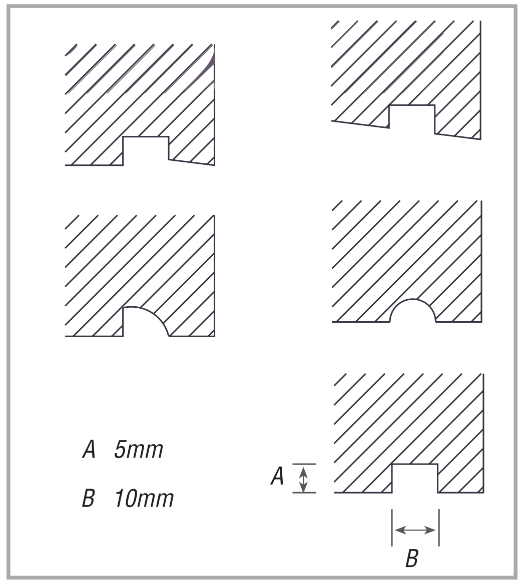
For example if a window is located on an upper floor a 'H-style' window may prove preferable as both sides can be cleaned from the inside.The commonly used and available styles illustrated opposite are:

- Top hung
- Top guided
- H-style
- Side hung
- Tilt and turn
- Horizontal pivot
- Up and down sash

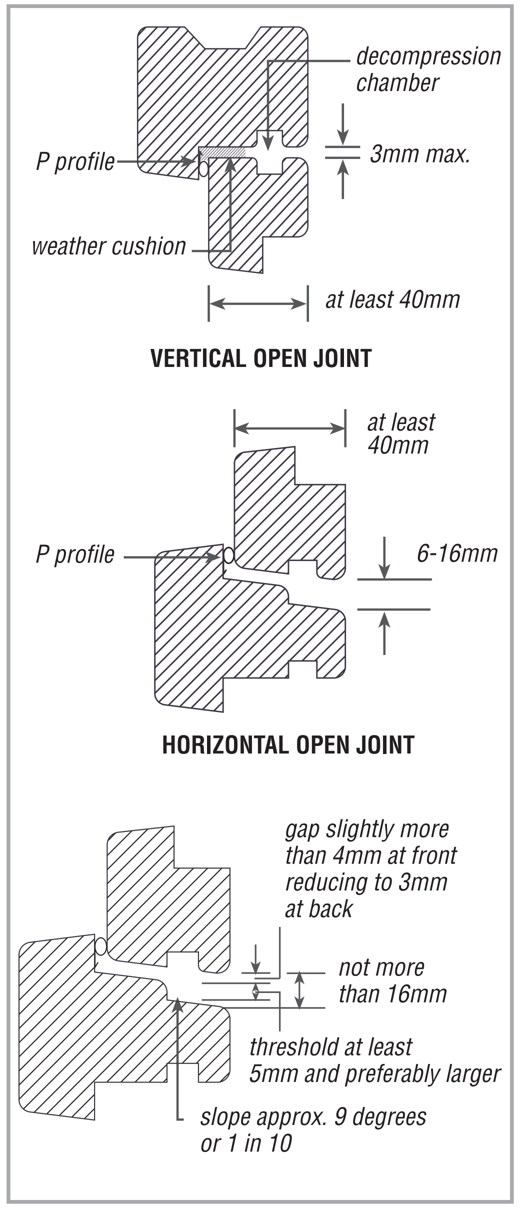


DETAIL B 10.1.1 Common Styles

B 10.1 WINDOWS – GENERAL (CONTINUED)



DETAIL B 10.1.2 Weather Drips



DETAIL B 10.1.3 Open Joints

Weather-tightness

Air and water-tightness are the basic requirements of window design. In Irish climatic conditions, adequate and effective detailing capable of protecting against wind and rain penetration is essential. The critical areas are the junctions between opening sections and fixed lights. Mastic and glazing beads must provide the necessary sealing.

Weather drips

Weather drips should be fitted to the underside of horizontal joints to prevent rain being held underneath by surface tension and blown towards the joint. Weather bars and down-stands will also improve this performance.

Weather seals

Weather seals fitted to the rebate of the fixed frame should be correctly positioned, well back from the exposed face to be kept dry, and an 'air cushion' created in the joint. Proprietary neoprene weather seals, in the form of a 'P' profile, should be fitted into a groove at the rebate of the fixed frame.

'Open' joints

'Open' joints between fixed frame and opening section provide a capillary break which prevents water seeping in and lodging in the joint. These open joints can also be covered with an external rebate to provide further protection against wind-driven rain.

Water channel

A water channel should be grooved into the top and sides of the opening section to drain water that enters the joint and form a decompression chamber that prevents driving rain from reaching the sealed joint. The top of horizontal members exposed to weather should have a run-off of not less than 1:10.

Weather strips

Plant-on horizontal weather strips can be glued and pinned to the lower part of the outside surface of an upper section to provide extra weathering and protection. Reference: *Design Principles of Weather-sealed Timber Windows* – The Swedish Finnish Timber Council.

B 10.2 WINDOWS – TYPICAL SECTION

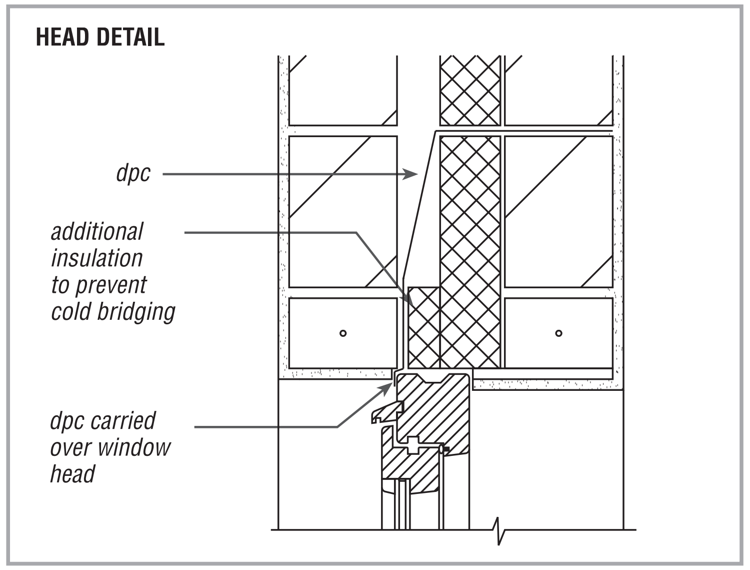
The detailing of a timber window is crucial to its performance and durability. Many manufacturers and joiners provide good details, which can be incorporated into the working drawings. The main areas, which require careful attention are:

- DPC and insulation
- junction between window frame and structure
- opening section

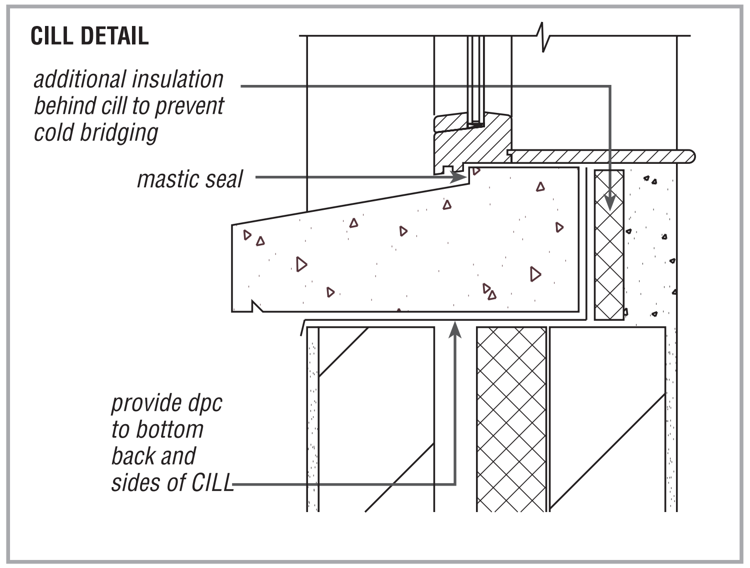
The DPC should always be lapped and sealed by 150mm at all joints. It is also advisable that the DPC is continued between all masonry and the timber window frame. The DPC should not, however, be fixed to the timber frame, but a 10mm gap should be allowed which provides for the ventilation of any moisture that may become trapped. A seal should be provided on the inside of this joint, and a trim to the outside of the DPC should be carried throughout the insulation to wrap around the block above the lintel. The insulation should be carried down to meet the head of the window, so as to avoid any cold bridges. Particular attention should be paid to open joints and weather drips. These weathering details are shown in B10.2.1/.2/.3.

Reference: *Design Principles of Weather-sealed Timber Windows* – The Swedish Finnish Timber Council.

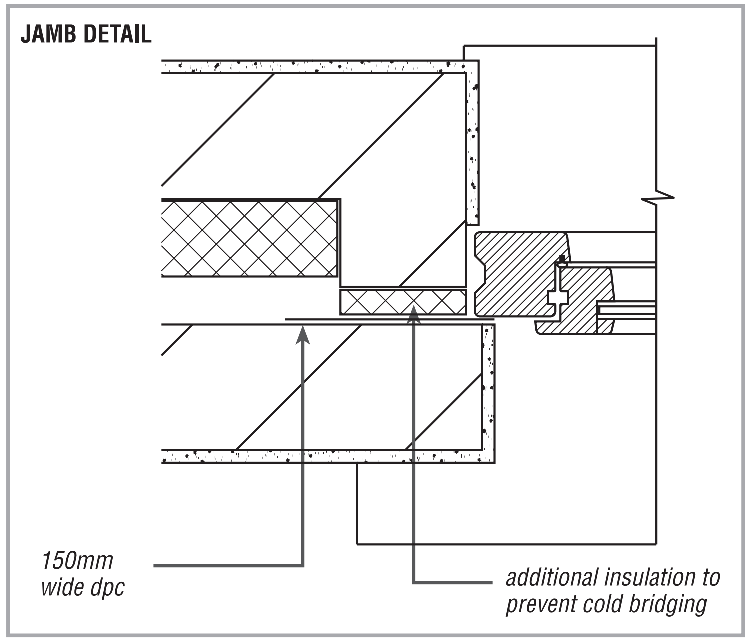
See section B12, *Working Details*, for proven window detailing for simple windows and for a glazed screen, as an alternative to metal curtain walling.



DETAIL B 10.2.1 Head Detail

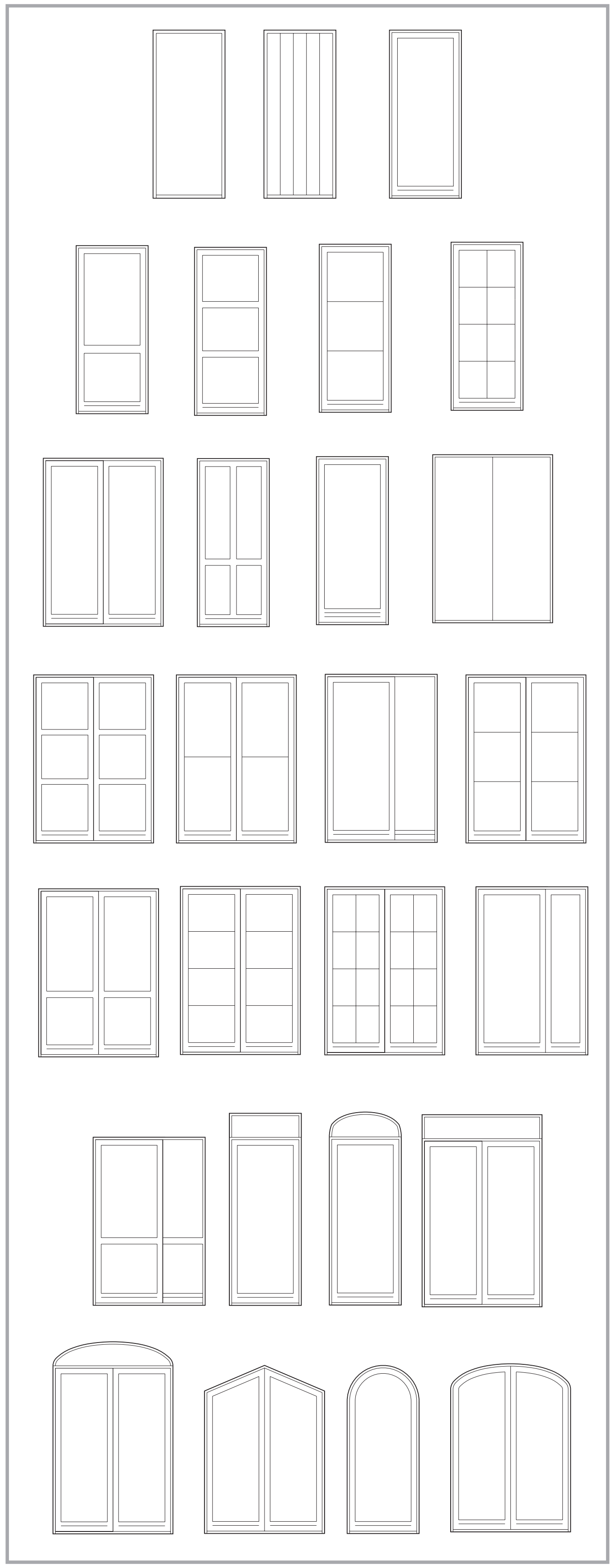


DETAIL B 10.2.2 Cill Detail



DETAIL B 10.2.3 Jamb Detail

B 11 Doors



DETAIL B 11.1.1 Styles of Door Available

B 11.1 GENERAL

External doors form a barrier between two different climates. They are similar in their design and construction to that of windows. Particular attention may be necessary in the detailing of the threshold, which can be the most vulnerable area of a door. Details vary from door to door but the obvious differentiation is that between inward and outward opening doors.

Types of doors

- Panelled door
- Framed and glazed door
- Ledged and braced
  - – framed
  - – unframed
  - – hollow core
  - – pressed panel hollow core (Masonite type)
  - – solid core

Door opening systems

Hinged

- Single swing
- Double swing
- Folding
- Stable door type

Sliding

- Single leaf door (with fixed side panel)
- Double leaf doors (with concealed sliding gear mechanism)

Components of doorsets

- Door leaf or leaves
- Fixed door frame and linings
- Saddle/Threshold
- Architrave
- Ironmongery

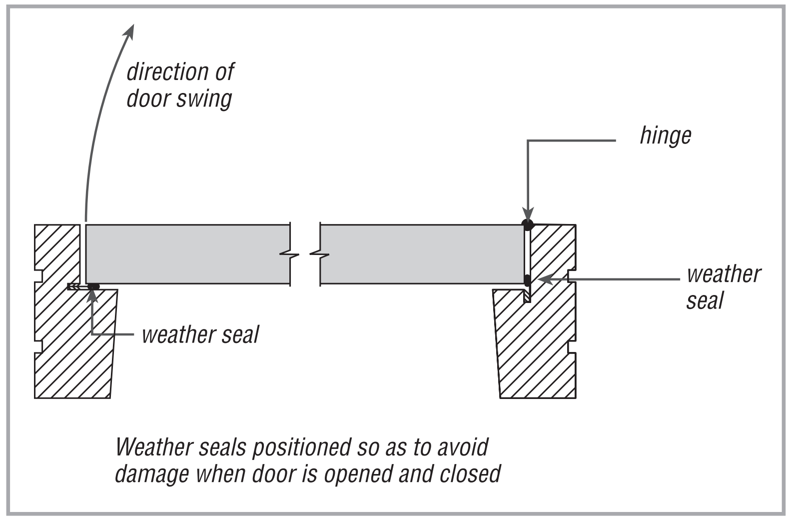
B 11.2 DOORS - EXTERNAL DOORS

Direction of opening

As mentioned previously there are two basic types of external door, which require different detailing:

- Inward opening
- Outward opening

In both of these cases it is important that the weathering profile is placed in a secure and effective position where it will not be damaged on the opening and closing of the door.

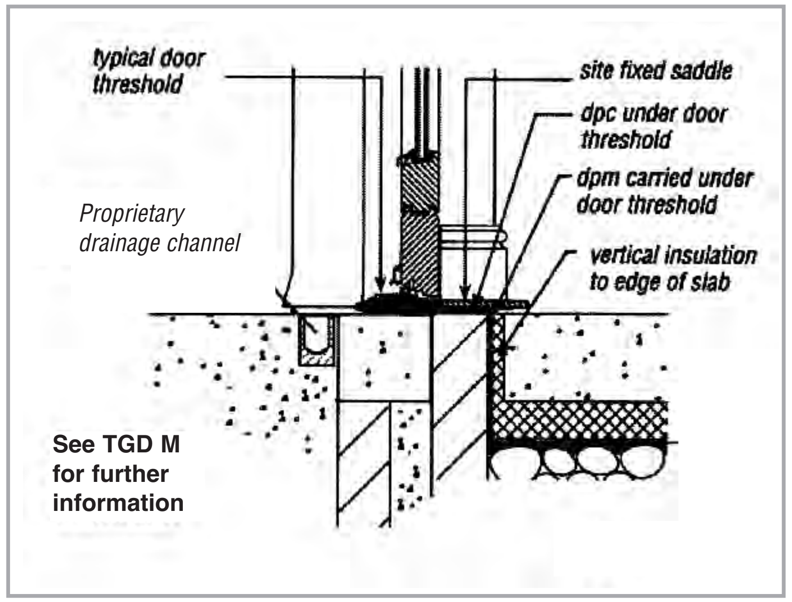


DETAIL B 11.2.1 Direction of Door Opening

Threshold

The threshold detail is particular to different proprietary door systems. Again there are differences between the detail of an inward opening external door and that of an outward opening external door.

Section B12 *Working Details*, shows an example of an external sheeted timber door, and related details.



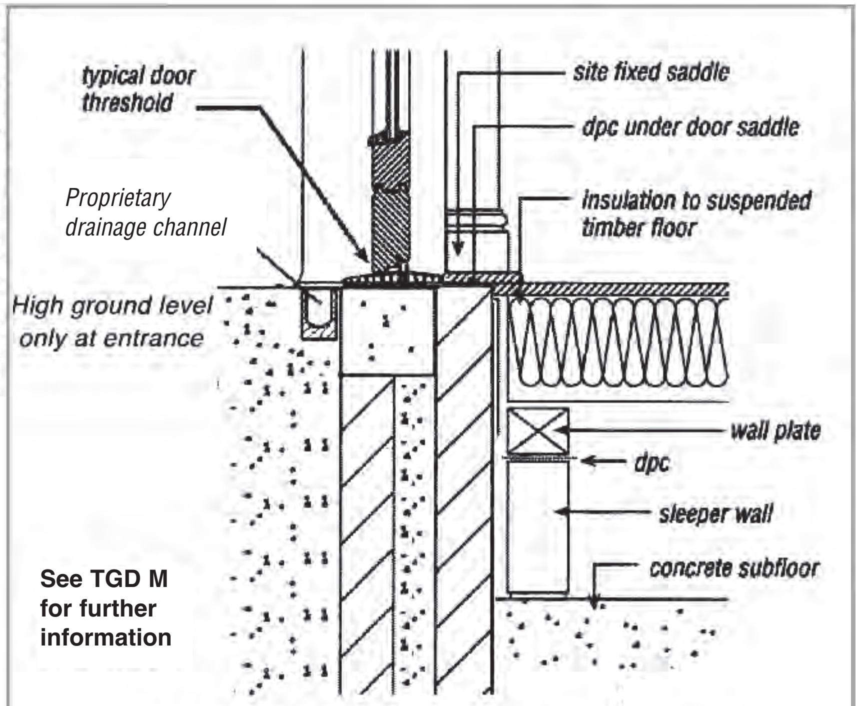
DETAIL B 11.2.2 Typical Threshold Detail for Concrete Floor (Inward Opening Door)

Access for all

Under part M of Technical Guidance Documents access for all requires that there be no step at external doors in order to assist wheelchair access. Particular care is needed in regards to the overlap of the dpm and door dpc. Specialist door thresholds are recommended. The ground level externally should fall away from the door threshold.

B 11.2 DOORS - EXTERNAL DOORS (CONTINUED)

DETAIL B 11.2.4 Door threshold



TYPICAL DOOR THRESHOLD DETAIL -
SUSPENDED TIMBER FLOOR (OUTWARD OPENING DOOR)

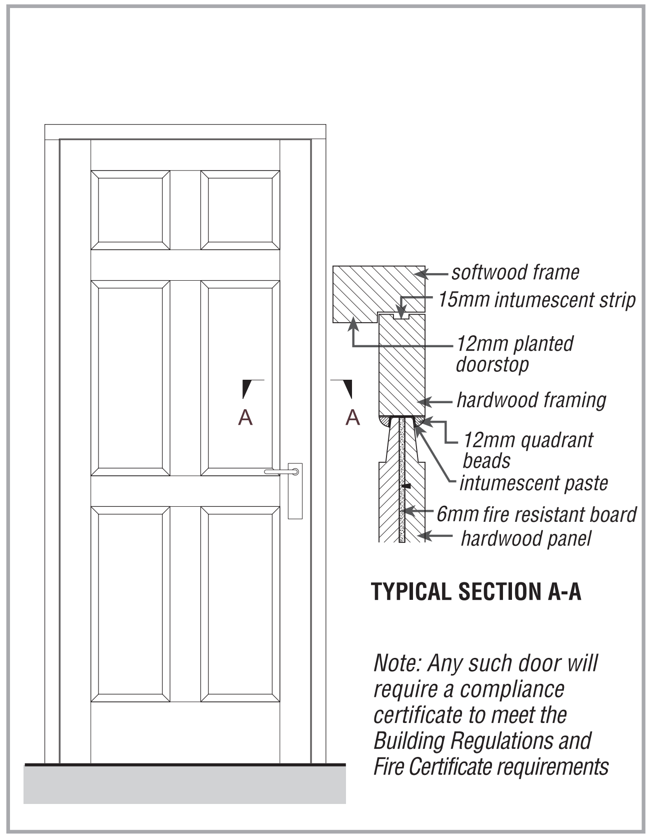
Note: *Detail at threshold only: drainage & ventilation of sub-floor must be considered*

Dimensional stability

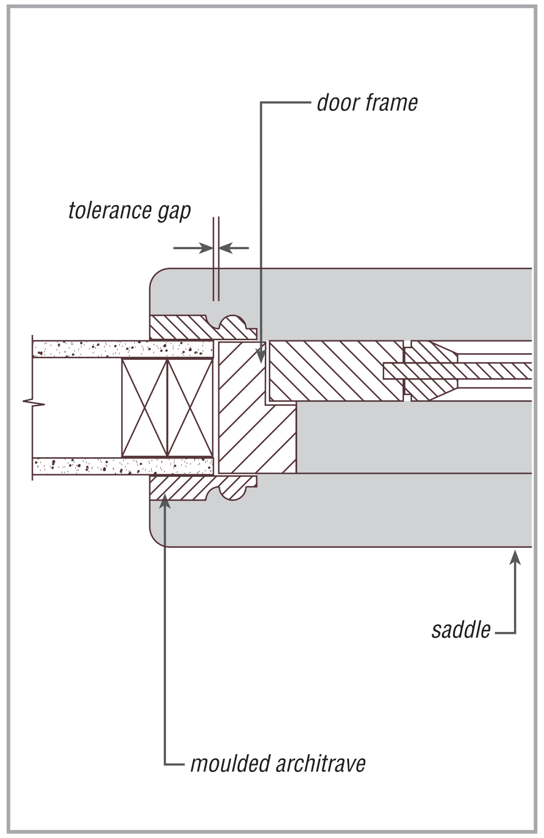
Exterior door-faces are exposed to significantly different interior /exterior environmental conditions on both surfaces. This can cause differential movement resulting in possible distortion. Care should be taken to shelter, weather and protect exterior doors, thereby minimising this distortion.

Special tanking details will be required for high ground levels. A sump effect should be avoided where possible; the sub-floor will need to be drained and ventilated.

B 11.3 DOORS – INTERNAL DOORS



DETAIL B 11.3.1 Internal Door



DETAIL B 11.3.2 Plan

Frame

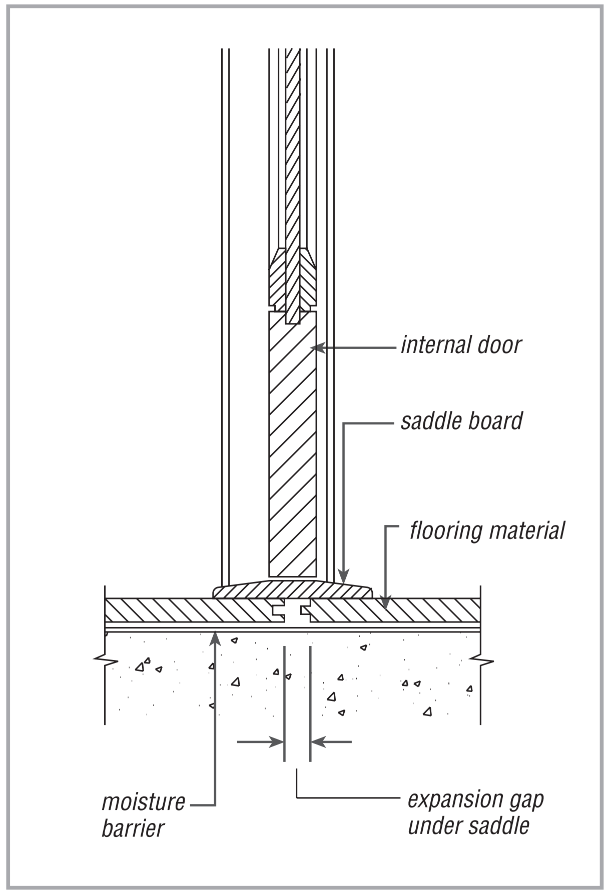
The timber should be sized to suit the door, allowing room for expansion. For side-hung single-swing openings, a rebate or planted stop is fitted. To achieve a more effective draught or sound sealing, a second rebate can be fitted between the door and the frame.

Saddle

The saddle is fitted under an internal door. It is designed to raise the bottom edge of the door so that it can clear the floor finish, it also closes the gap thereby reducing draughts. It is important to allow enough of a gap between the base of the door leaf and the saddle to ensure free movement. In some cases the designer may prefer to omit the saddle and carry the floor finish through the doorway. In this case, a slightly larger gap will be necessary at the base of the door. The saddle should only be fixed to the flooring at one side to allow for movement.

If this is done, consideration must be given to the overall width of the floors and the need to provide for movement. Proprietary metal or wood strips,shallower than saddles, are available to cover expansion gaps at doorways.

Section A–A in Detail B11.3.1 shows a traditional raised and fielded internal door with upgraded fire resistance properties.



DETAIL B 11.3.3 Saddle Door

B 11.4 DOORS – FIRE DOORS

All fire resisting doorsets require intumescent seals which vary in size, thickness and location depending on the performance of the door. These proprietary strips are fitted into grooves in the door jamb and frame to seal the gap between the door and the frame from spreading fire. They swell up to close the gap typically at temperatures of 150˚C or above. Intumescent seals can be fitted with brush pile draught seals that control cold smoke from leaking.

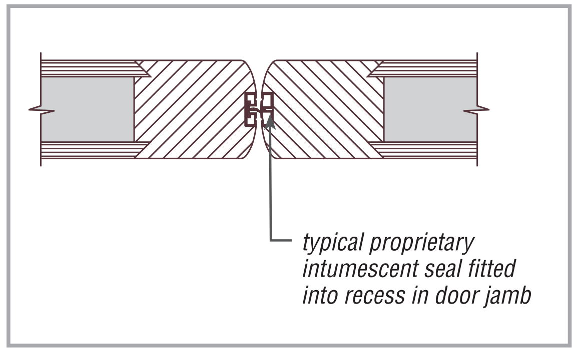
Glazed viewing panels fitted in fire resisting doors are essential in many locations to alert occupants of the fire conditions beyond the door, thus allowing proper judgment for escape routes. They should be fitted at suitable heights allowing children and the physically impaired, as well as adults, adequate viewing. To achieve the required performance, the glass should be fitted using proprietary fire channels.

Any gaps between the rear of the door frame and the wall opening should be sealed with an intumescent mastic, plaster or paste which is injected into the gaps before the architraves are fitted, subject to the fire test report. Gaps of up to 5mm between the door leaf and the door frame or usually between leaves may be tolerated. These gaps are necessary to allow for swelling/shrinkage cycles and prevent jamming. The intumescent and some brush pile seals will swell in fire to seal this size of gap. Shrinkage of doors leaving gaps in excess of 5mm, can cause a breach of 'integrity' and insulation.

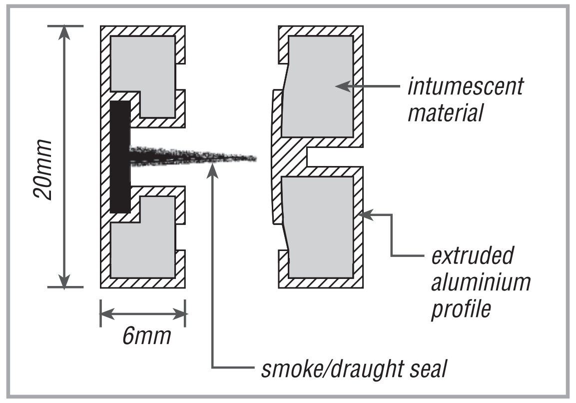
When specifying a fire door it is essential to check with the manufacturer that the door complies with the relevant fire test standard (see A.5. Fire Perormance, Fire Door Sets), for the specified minimum fire resistance in minutes (i.e. the door's integrity). All fire doors shall have the appropriate performance outlined in *Technical Guidance Document B, Appendix B, Table B1* of the Irish Building Regulations or the appropriate Approved Document in the UK. Any reference to a fire door is intended to mean a complete door assembly which includes the door leaf or leaves, the door frame, ironmongery and any seals.

Where restricted to smoke leakage at ambient temperatures is needed an additional classification of 'Sa' is used for doors for fire tests to the European Standarda and 'S' for tests to BS476 Part 22.

Note: *Any such door will require a compliance certificate to meet the Building Regulations and Fire Certificate requirements.*



DETAIL B 11.4.1 Firedoor



DETAIL B 11.4.2 Firedoor

B 12 Sample Working Details

The working details illustrated in this section are based on the experience of built examples in Ireland, and are sets of drawings which aim to respond to the most frequently asked queries of architects interested in the use of timber. They relate to the principles shown in the previous design and detail sections and translate them into scaled technical drawings. They show the architectural intent of the designer and craft ability of the joinery workshop, and acknowledge the requirements of site buildability and long term durability. These drawings should be read in conjunction with the Specification Section.

Double vacuum preservative treatment will greatly improve the performance of all non-durable species suitable for external cladding (when protected by a finish). Clear or very light wood stains are not as ultra violet protective as reds or browns, while varnish is unsuitable for use in the Irish climate. If specifiers wish to omit wood-staining maintenance or have an aged 'natural look' then preservative impregnation is even more important to prevent deterioration and control surface mould growth. Preservative treatment should be to a minimum of Hazard Class 3A. External joinery timber should be specified as having a moisture content of 16±3%. Metal fixings should be either steel or silicon bronze to avoid corrosion problems especially from acidic timbers such as oak and Western red cedar. Do not use aluminium, wire or galvanised sherardised nails as they will cause staining. If stainless steel bolts are used for connecting timber to galvanised or mild steel columns or beams, remember to use isolation sleeves to avoid bimetallic corrosion.

Screen details

The group of six drawings, B12.1 (pages 223–228), shows how timber can compete with any other man-made material in providing a repetitive glazed screen or curtain walling system. The 'assembly' drawing, B12.1 (page 224), illustrates the integration of the primary steel structure of a single storey building with the glazed timber screen. The steel is designed and assembled to facilitate the architectural intent of a visually light screen. The timber screens are fixed to the steel columns by fixing cleats. Adjoining timber screens are joined together along the line of the vertical column cleats. A hardwood T-section, fixed and bedded in mastic, is covering the jointing of adjoining screens, while at the same time allowing for moisture/thermal movement along the overall length of the screen and on-site ease of assembly. A steel cross rail provides additional wind restraint and is integrated and concealed within the overall timber screen construction.

Suitable hardwood timber species include Irish or American white oak, teak and iroko. Western red cedar has similar natural durability as these species but would require larger section sizes to carry the imposed wind loading and the dead weight of large double-glazed units. The low density of western red cedar of 390kg/m³ compared to American white oak's 770kg/m³ means that abrasion, indentation and its poorer ability to hold fixings can be a problem.

Suitable preservative-impregnated softwoods include Douglas fir, larch, pitch pine, Scots pine and Norway spruce. All profiling mortising and tennoning must be carried out prior to preservative treatment. Assembly of the components takes place after preservative treatment. See Section C Sample Specification for further information.

Timber frame

This set of four drawings, B12.2 (pages 229–232) illustrates timber as the structural framework and material for external and internal cladding and joinery. Drawing B12.2 (page 229) shows a breather membrane layout for junctions and overlaps although other practices and layouts may be used. Timber frame panels should come from the factory with the breather membrane already attached as this maximises the protection to the panels form the breather membrane. A breather membrane complying with BS 4016 should be used.

Drawing B12.2 (page 230) illustrates the junctions of an individual window set into a timber frame wall. Of particular interest is the use of the timber sill section for the side reveals and its adaptation for the head detail. This detail provides end grain protection to the adjoining vertical or horizontal cladding while giving additional framing definition to the window within the wall cladding. The junction between the external breather membrane and internal vapour check should be noted as well as the option of providing a 'services' void behind the internal wall finish to protect the vapour check from mechanical damage while providing a concealed route for building services.

Drawing B12.2 (page 231) shows bespoke external and internal corner junctions using stainless steel trims to give a visually lighter corner detail than the more conventional corner junctions.

The junction detail between the timber-frame construction and an adjoining blockwork wall, shown in detail B12.2 (page 231), allows for differential movement between the two materials. Note should be taken of the interface between the folded vertical DPC of the masonry wall and the breather membrane to the timber wall. Semi-rigid insulation batts suitable for timber frame construction should be specified.

Drawing B12.2 (page 232), illustrates a variety of cladding profiles. The external vertical cladding board shown here has a 25mm finished thickness as against the more conventional UK and Irish 16mm. The 25mm board is derived from Swedish building regulations and is to be recommended from built examples here in Ireland. Each board is fixed with one ringshank nail (silicon bronze or stainless steel) per batten. The fixing is made through the v-joint which has two distinct advantages over more conventional face nailing. Firstly it allows the cladding board to move according to seasonal variations in relative humidity without causing stress-induced cracking. Secondly, the visual impact of the nail fixing is greatly reduced by virtue of its location in the v-joint.

Stress relieving channels on the inside face of external cladding boards may help to reduce cupping and also assists ventilation to the batten cavity behind the cladding. When used in this manner, in association with staggered battens, adequate ventilation can be achieved without the use of counterbattens, so that the vertical and horizontal cladding can be used on the same level surface without difficult junction problems.

The profile of the internal cladding boards for walls or ceilings allows for concealed fixing. Depending on their end-use location and extend fire-retardant treatment to Class 1 or Class 0 will be required.

Rainskin

This group of three drawings (B12.3.1-B12.3.3) illustrate the novel use of timber as a 'rainskin' cladding to a non-timber structure behind the cladding. A cavity wall type of construction is provided without the need for an additional external masonry wall. Detailing is otherwise similar to timber frame construction except where shown. A pressed and folded stainless steel flashing could be used in lieu of lead flashing shown in detail B12.3.3.

External timber door

This drawing (B12.4.1), shows a sheeted timber door. To achieve a door resistant to moisture movement, the thickness of sheeting is equal on both sides of the concealed framing. The profile of the bottom rails is designed to protect end-grain and avoid capillary water attraction.

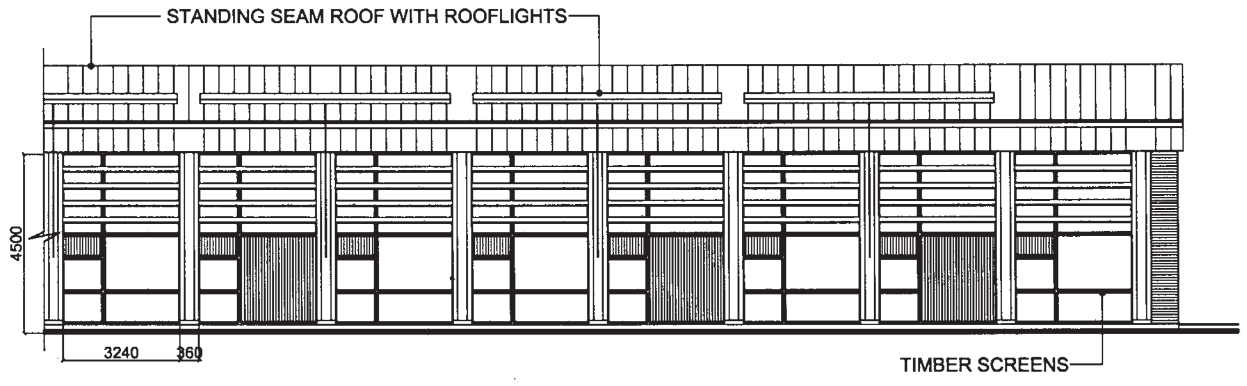
Column base

These details (B12.5.1-B12.5.2), illustrate a steel base detail suitable for post and beam or pergola column construction. It has the advantage of keeping the timber column out of ground contact. It also allows the beams for floor or roof support to pass through the split and makes their interconnection very simple. A series of these bases can give a timber post and beam house an elegant connection with the landscape, as the building appears to hover above the ground.

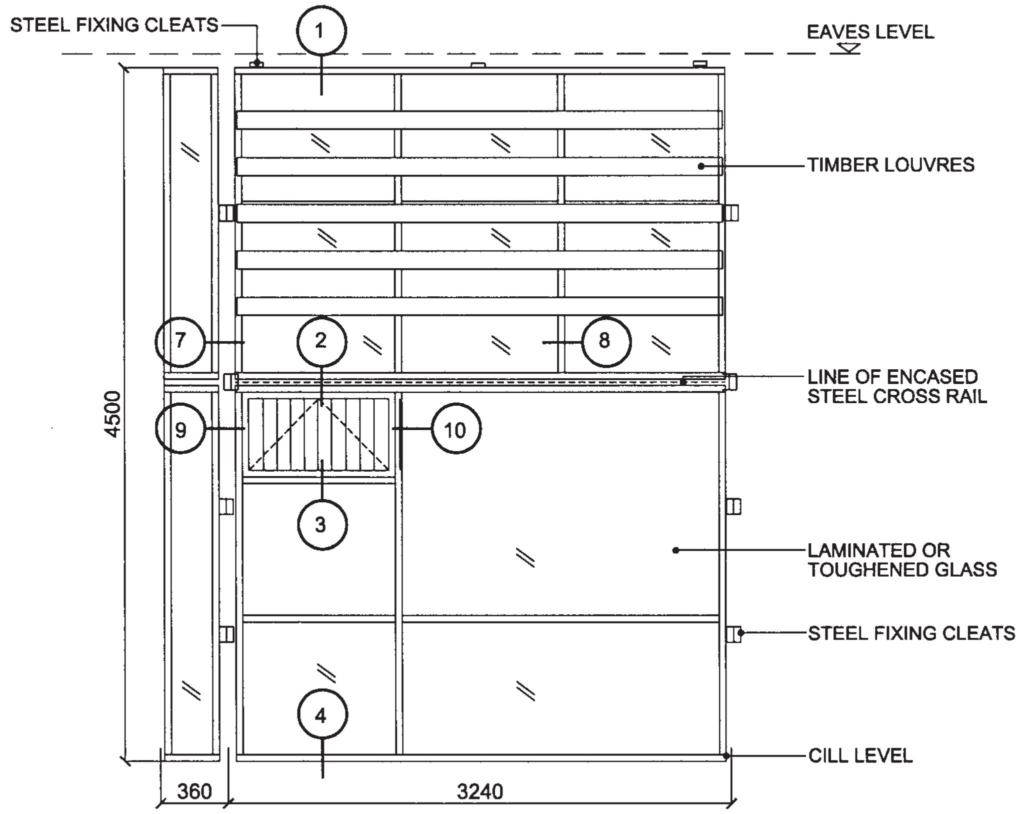
B 12.1 WORKING DETAILS - GLAZED SCREENS

European Commission Food and Veterinary Office, Grange, Co.Meath.

Evening view of dining hall elevation. The opening sections are expressed by using solid timber cladding within frames.



SAMPLE ELEVATION SHOWING REPETITIVE TIMBER SCREENS
SCALE 1:200

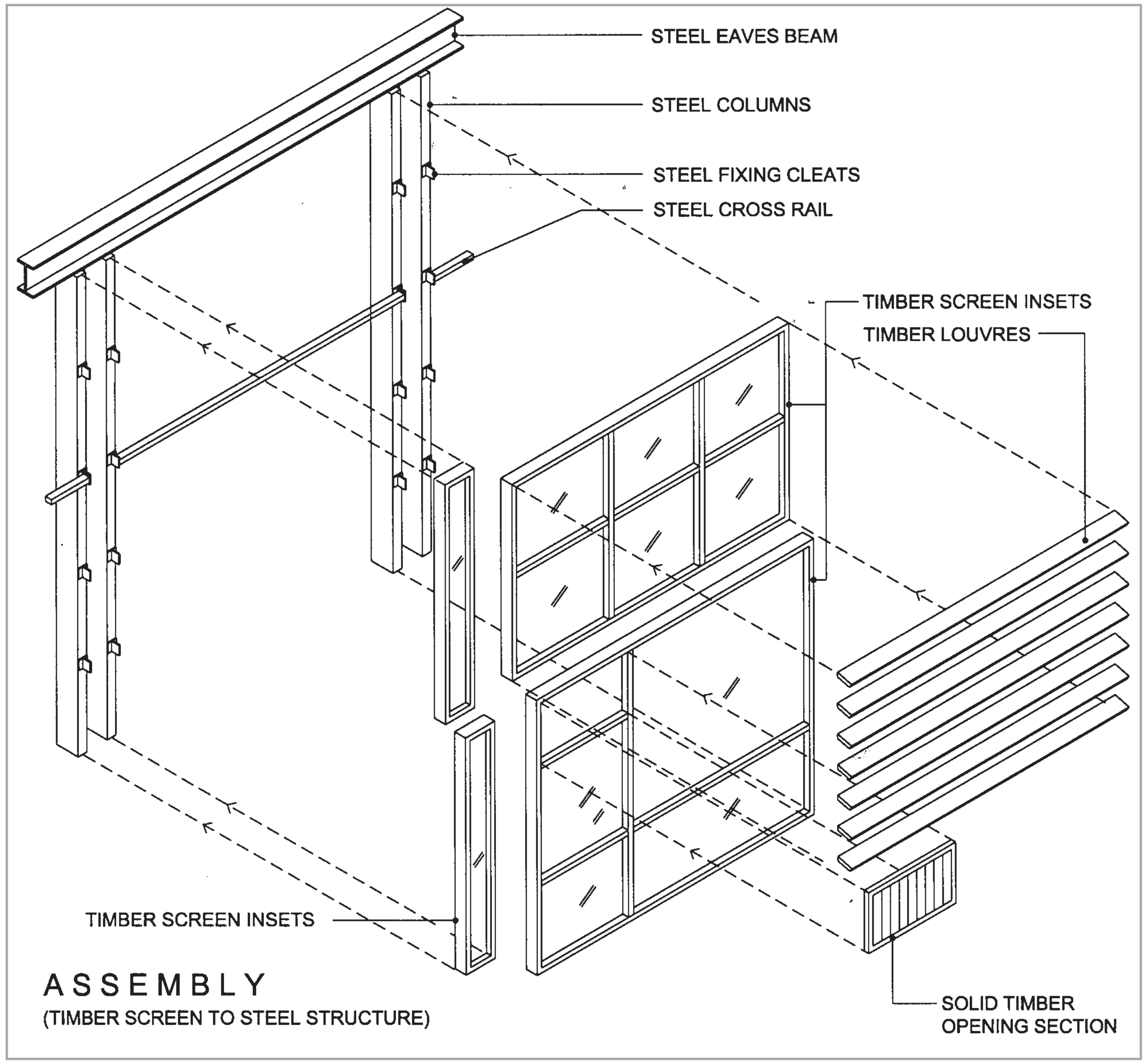


TYPICAL GLAZED TIMBER SCREEN ELEVATION
WITH REFERENCE KEYS ATTACHED
SCALE 1:50

DETAIL B 12.1.1

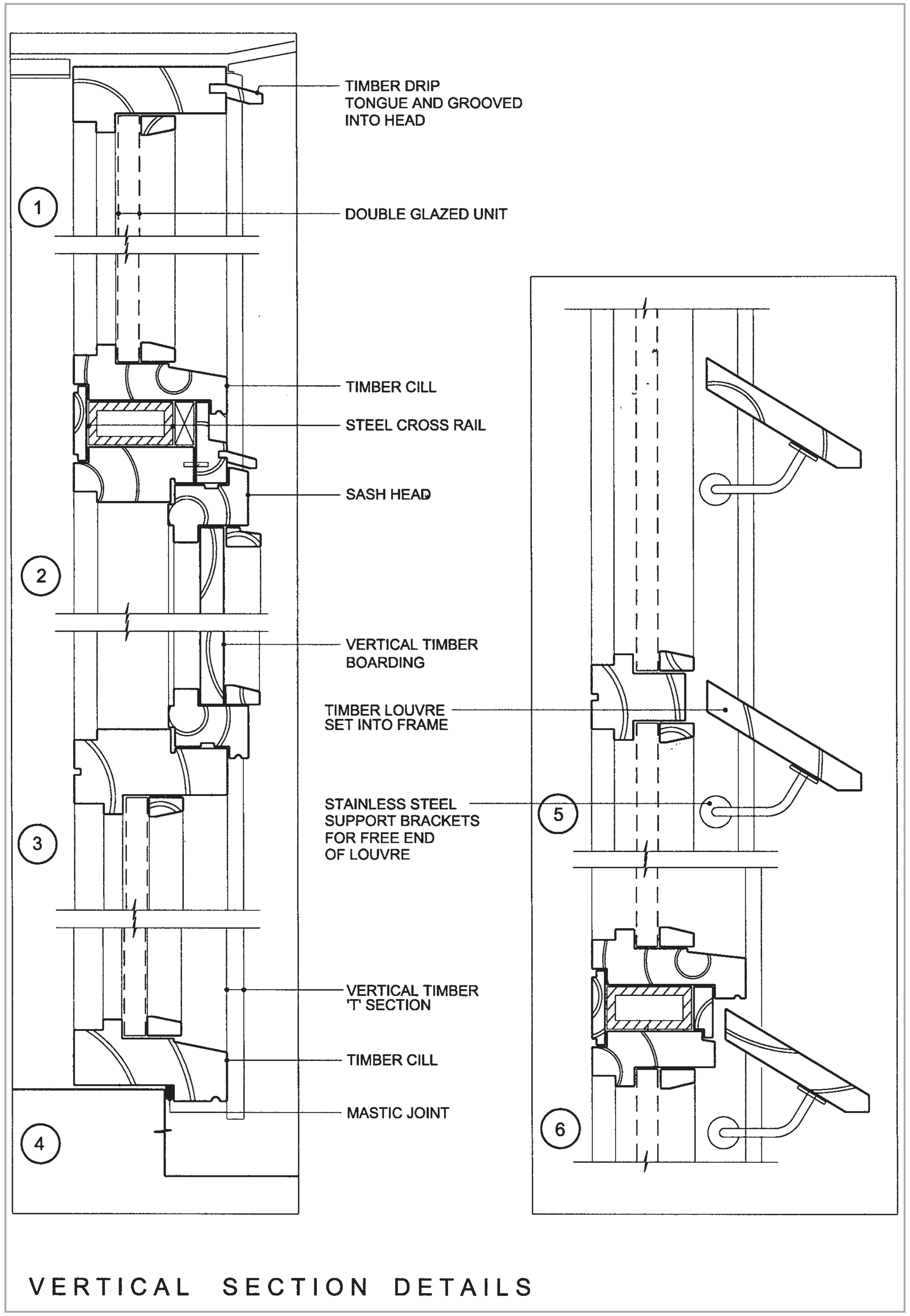
B 12.1 WORKING DETAILS - GLAZED SCREENS (CONTINUED)

European Commission Food and Veterinary Office, Grange, Co.Meath. View of internal courtyard and timber screen with integrated louvres.



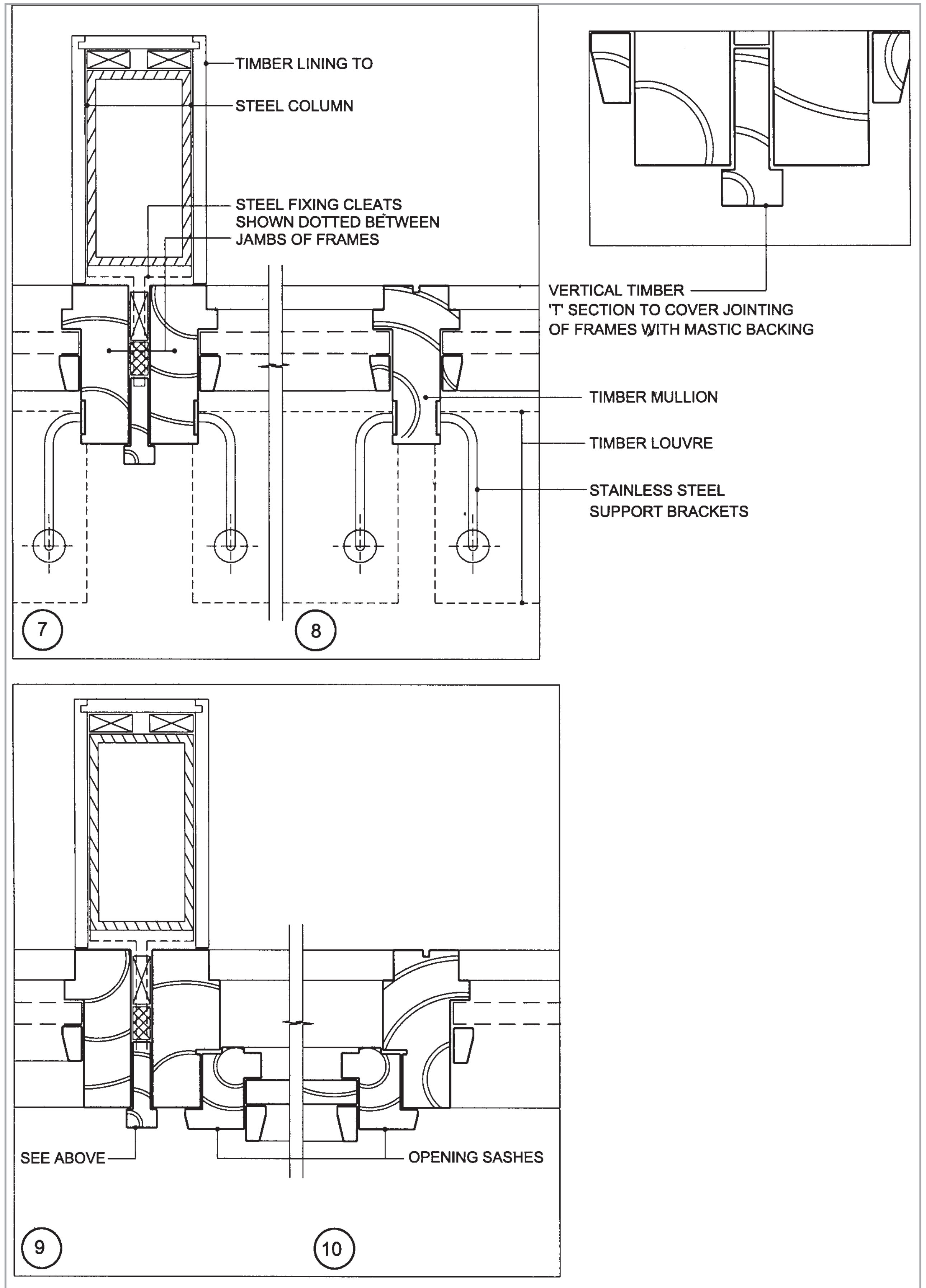
DETAIL B 12.1.2

B 12.1 WORKING DETAILS - GLAZED SCREENS (CONTINUED)



DETAIL B 12.1.3

B 12.1 WORKING DETAILS - GLAZED SCREENS (CONTINUED)

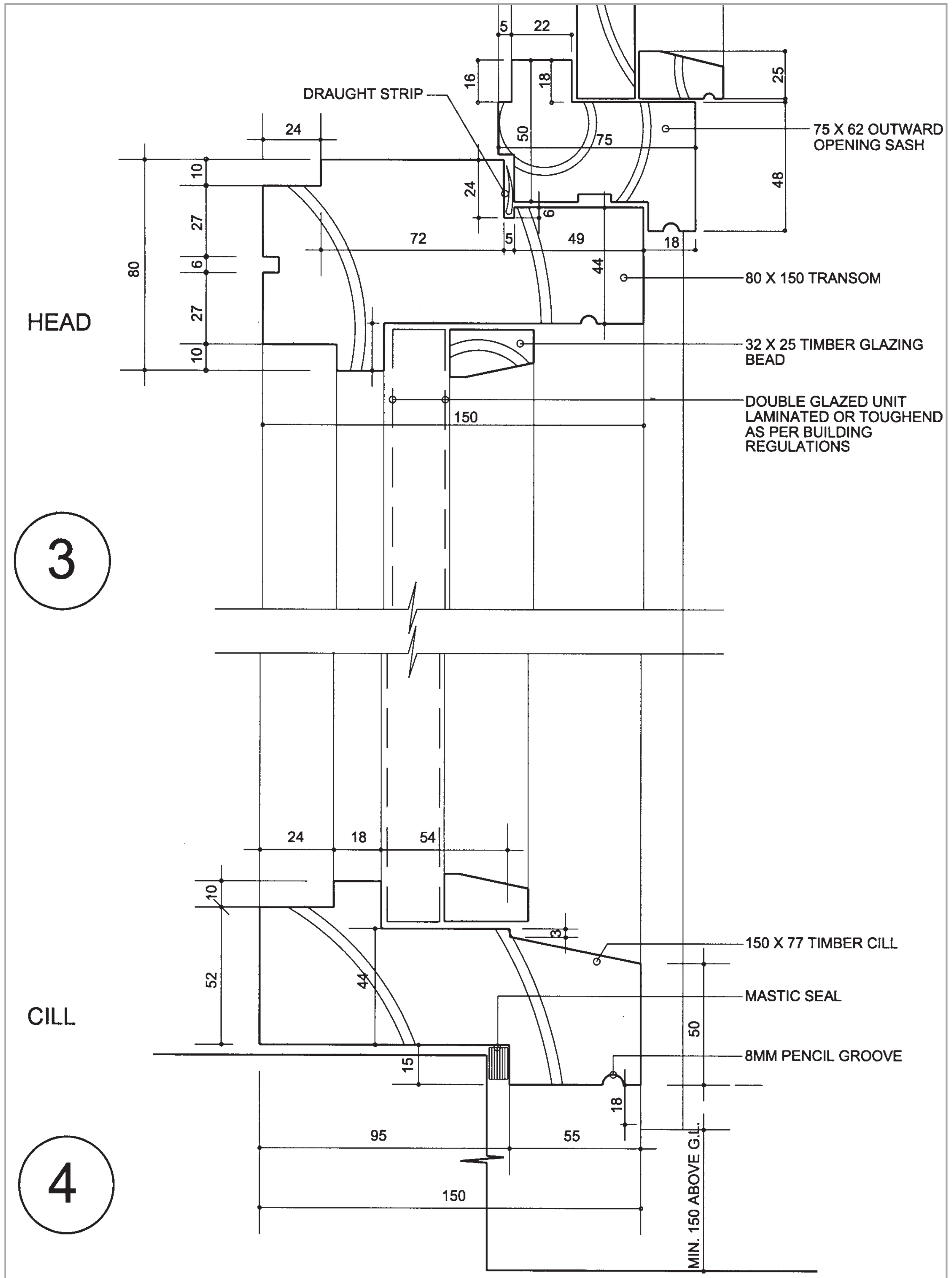


HORIZONTAL SECTION DETAILS

SCALE 1:5

DETAIL B 12.1.4

B 12.1 WORKING DETAILS - GLAZED SCREENS (CONTINUED)

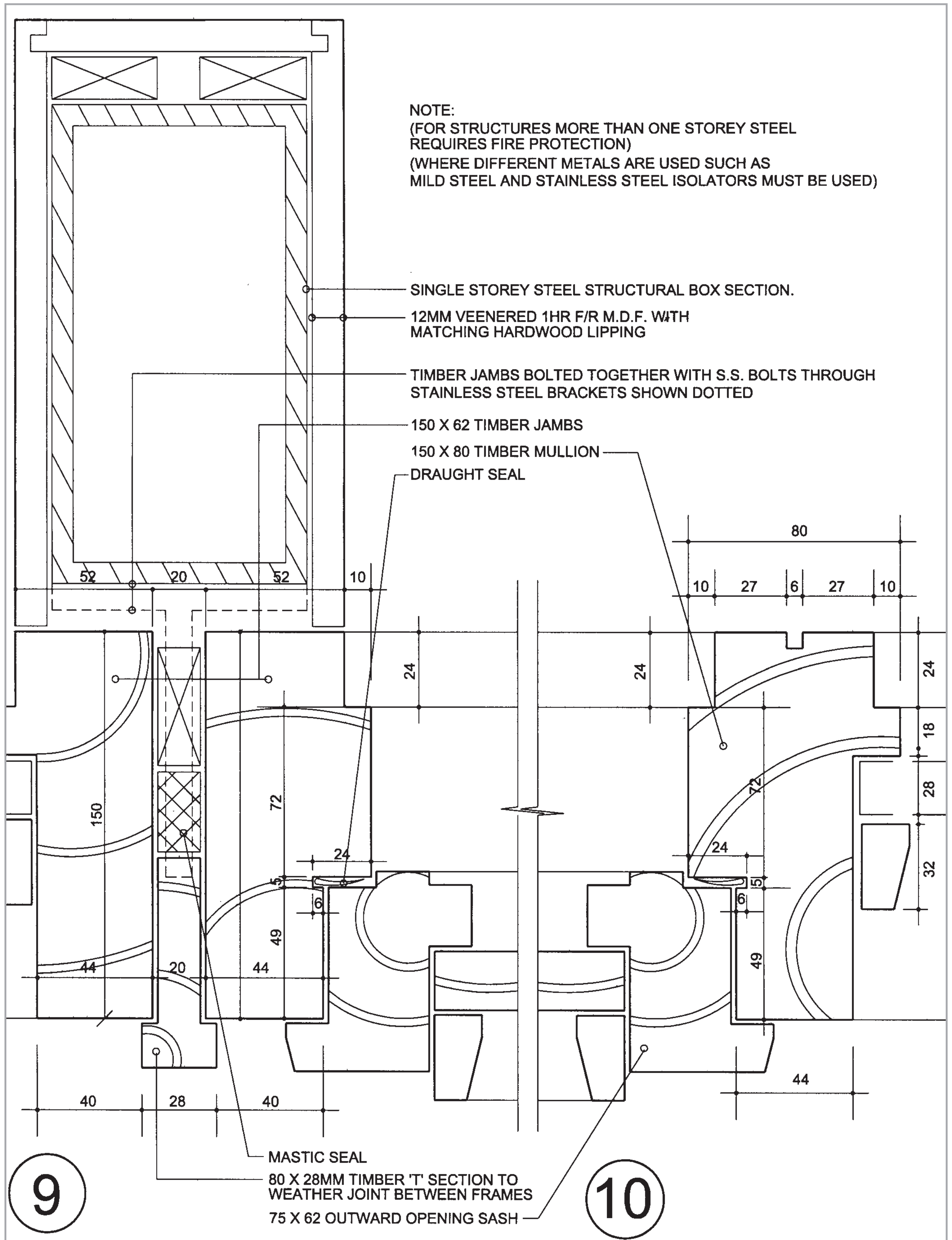


DIMENSIONED VERTICAL SECTIONS

SCALE 1:2

DETAIL B 12.1.5

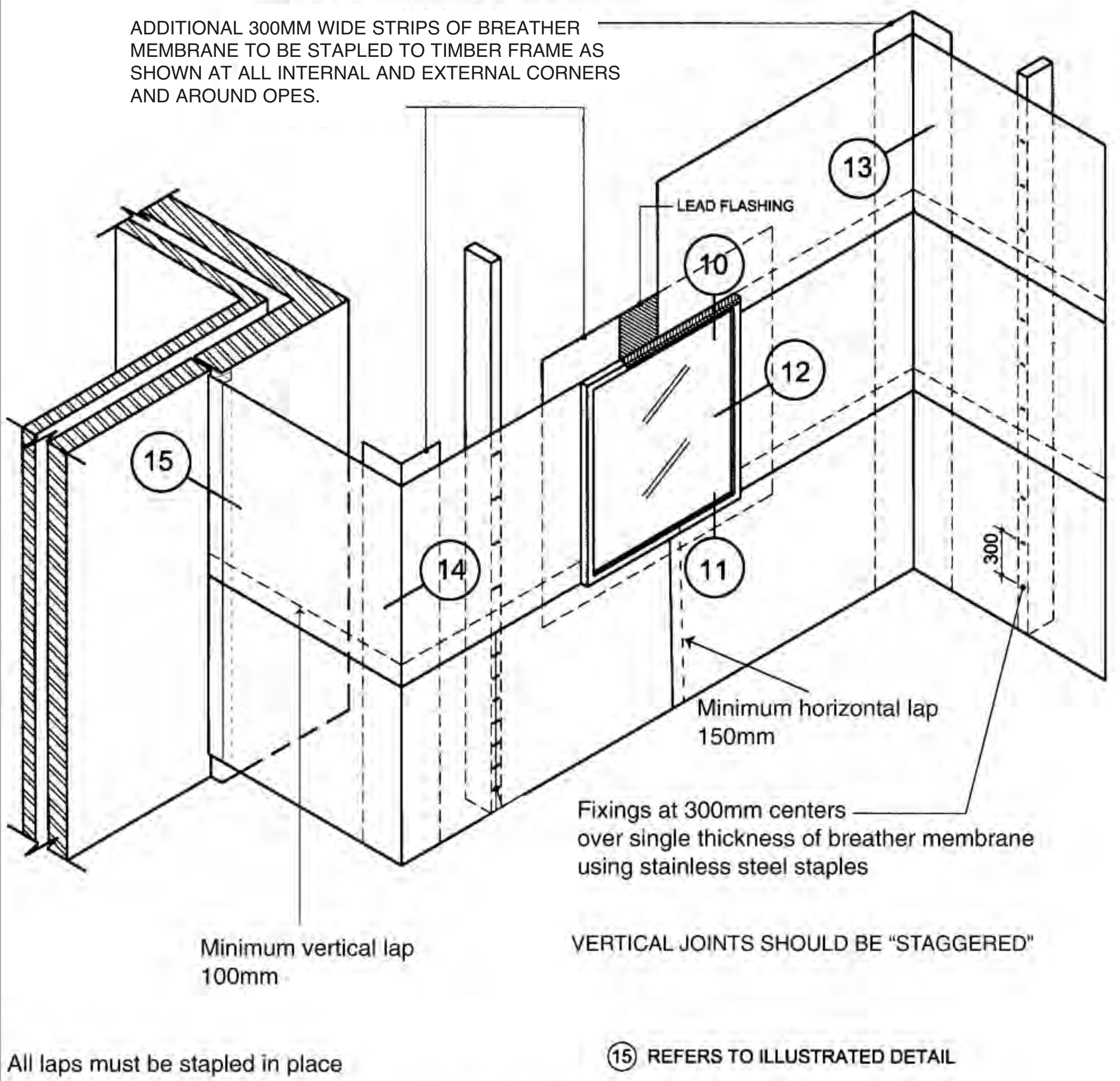
B 12.1 WORKING DETAILS - GLAZED SCREENS (CONTINUED)



DIMENSIONED HORIZONTAL SECTIONS SCALE 1:2

DETAIL B 12.1.6

B 12.2 WORKING DETAILS - TIMBER FRAME



BREATHER MEMBRANE LAYOUT

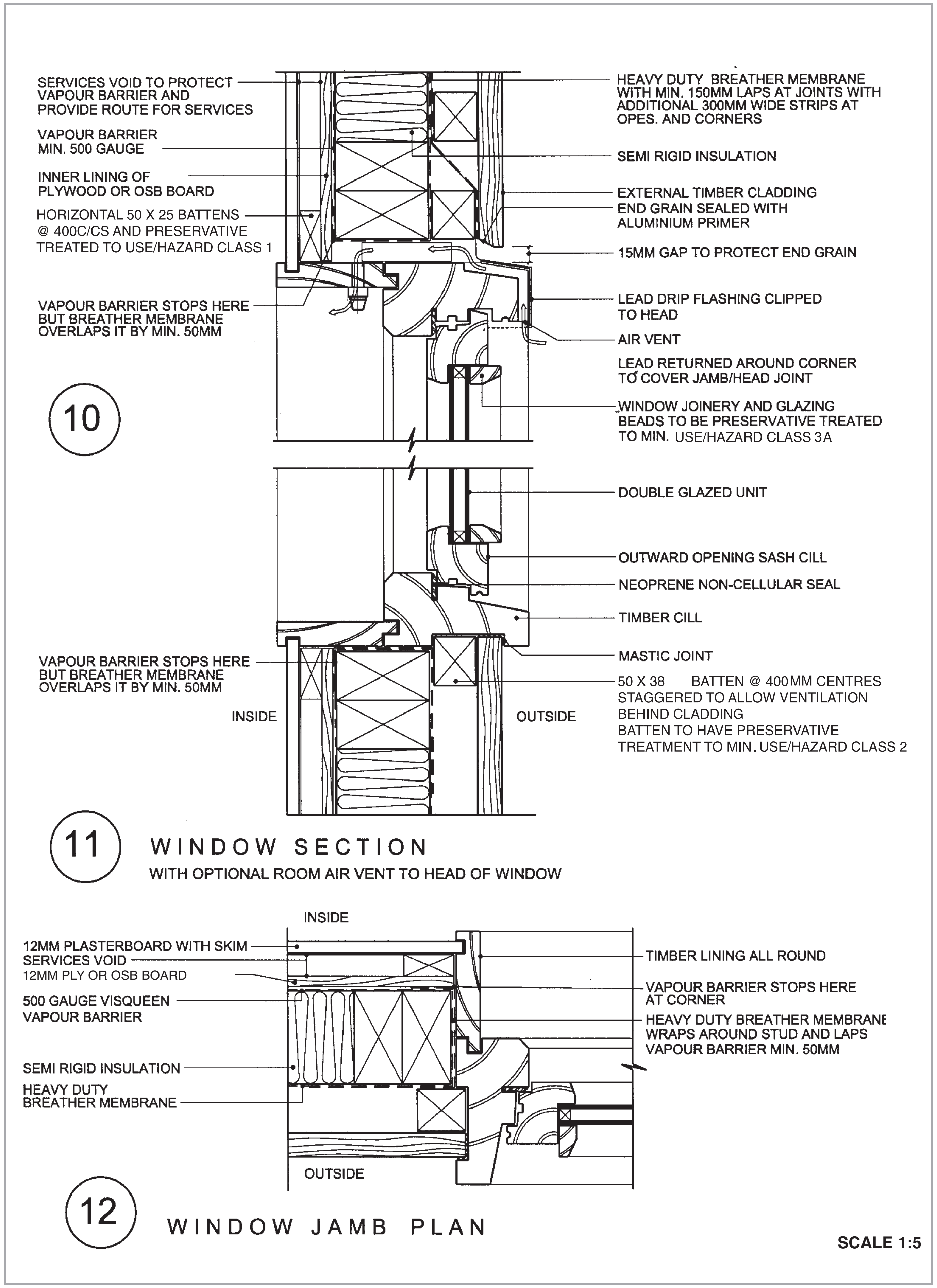
JUNCTIONS AND OVERLAPS

EXTERNAL CLADDING, BATTENS AND PART OF COMPLETE WALL CONSTRUCTION OMITTED FOR CLARITY

DETAIL B 12.2.1 Breather Membrane (Site Fixed)

NOTE: *The layout shows guidelines for the fixing of a breather membrane on site. However, in line with good practice, most timber frame buildings have the breather membrane fixed in the factory and only the laps need to be secured. To ensure airtightness and weathertightness the breather membrane should always be backed by board materials such as sheathing.*

B 12.2 WORKING DETAILS - TIMBER FRAME (CONTINUED)I

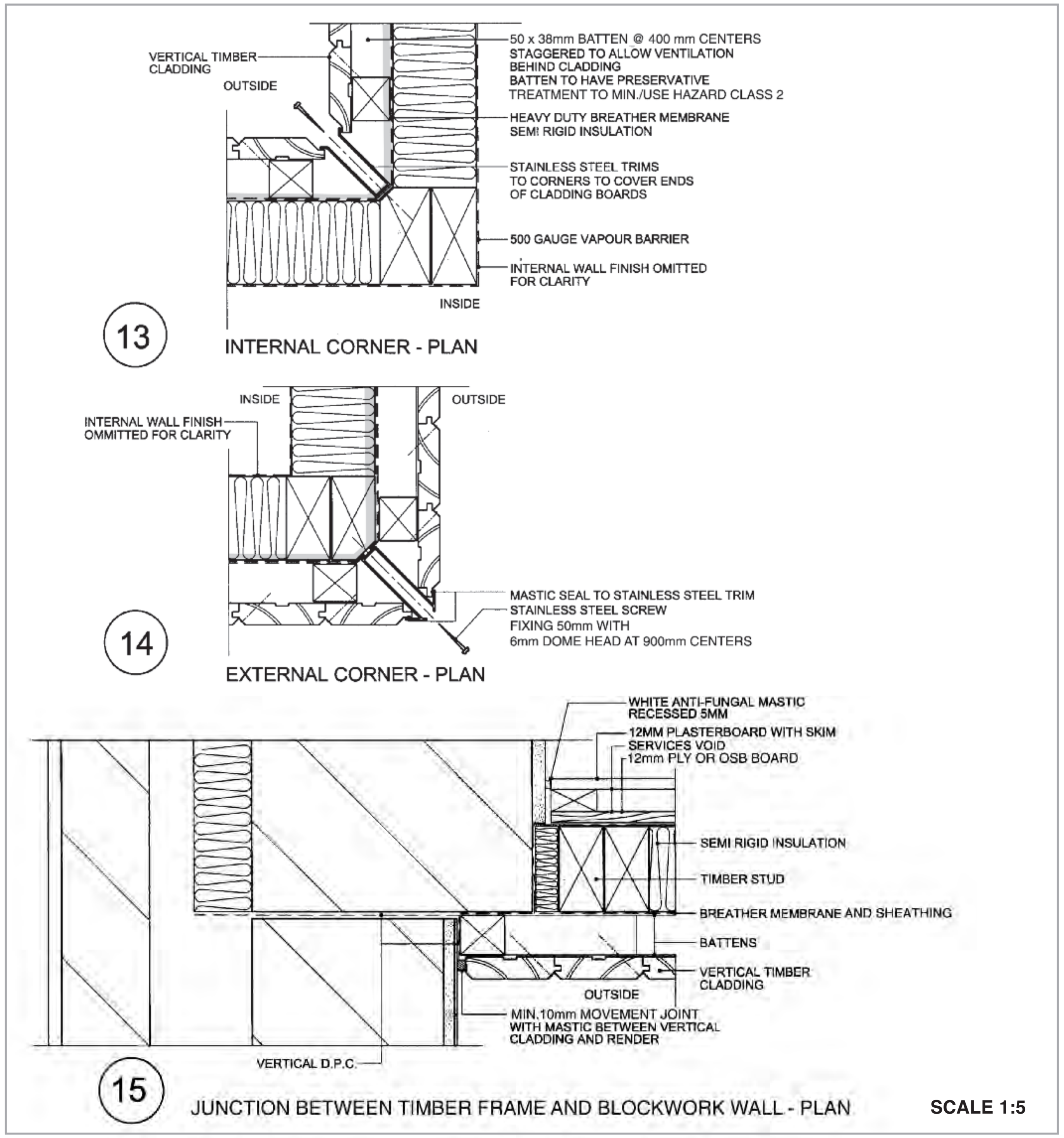


DETAIL B 12.2.2

B 12.2 WORKING DETAILS - TIMBER FRAME (CONTINUED)

European Commission Food and Veterinary Office, Grange, Co.Meath.

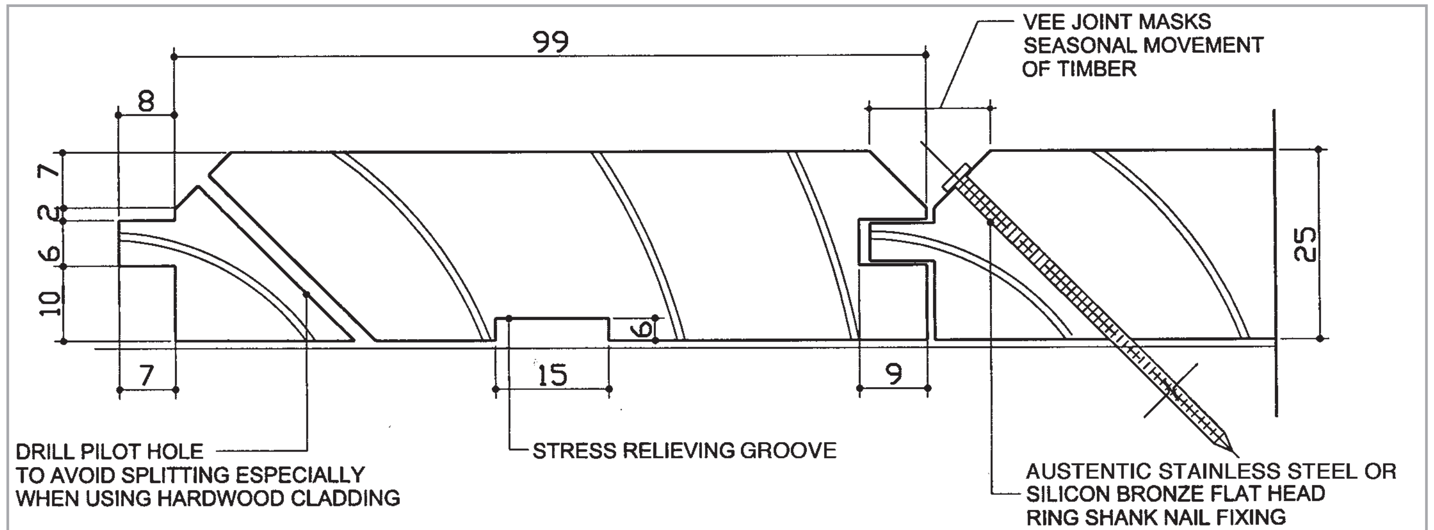
Detail of cladding to external corner to service building. The timber louvres are used as a scaling device and to hide the aluminium louvres behind.



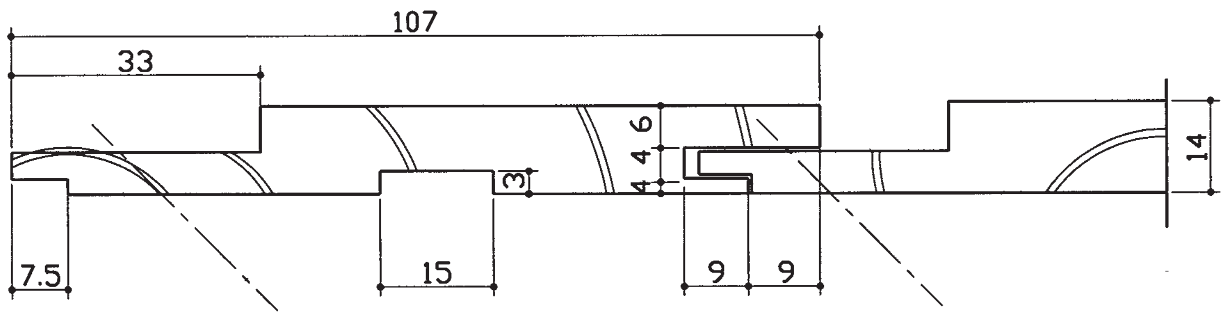
NOTE: *The layout shows guidelines for the fixing of a breather membrane on site. However, in line with good practice, most timber frame buildings have the breather membrane fixed in the factory and only the laps need to be secured. To ensure weather-tightness the breather membrane should always be backed by board materials such as sheathing.*

DETAIL B 12.2.3

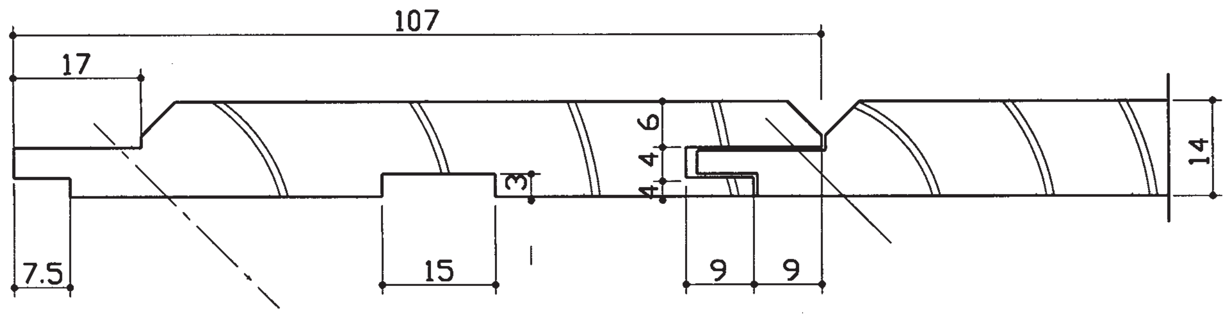
B 12.2 WORKING DETAILS - TIMBER FRAME (CONTINUED)



EXTERNAL VERTICAL CLADDING



INTERNAL CLADDING



INTERNAL CLADDING

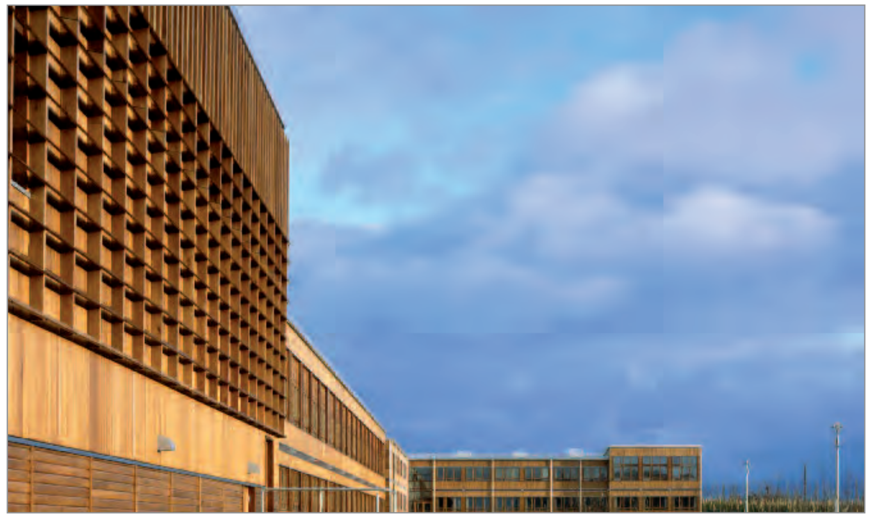
SCALE 1:1

NOTE : ALL DIMENSIONS ARE FINISHED DIMENSIONS NOT EX-TIMBER DIMENSIONS

INTERNAL TIMBER CLADDING WILL REQUIRE FIRE RETARDANT TREATMENT IN MOST SITUATIONS IN ORDER TO MEET BUILDING REGULATION REQUIREMENTS - SEE SPECIFICATION FOR FURTHER DETAILS

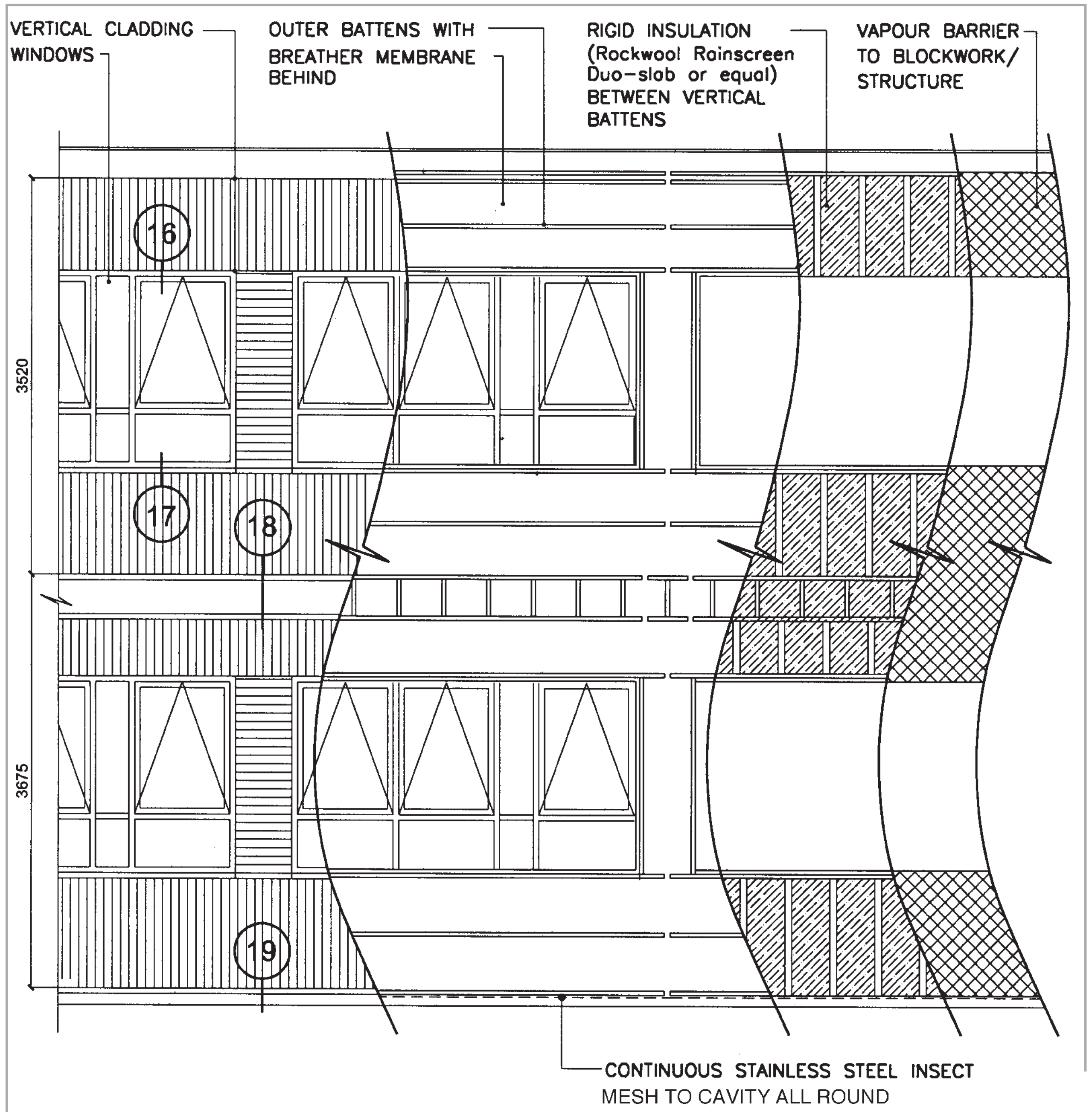
DETAIL B 12.2.4

B 12.3 WORKING DETAILS - TIMBER CLADDING - BLOCKWORK WALLS



European Commission Food and Veterinary Office, Grange, Co.Meath.

View of the timber cladding to the south-west elevation of the building.

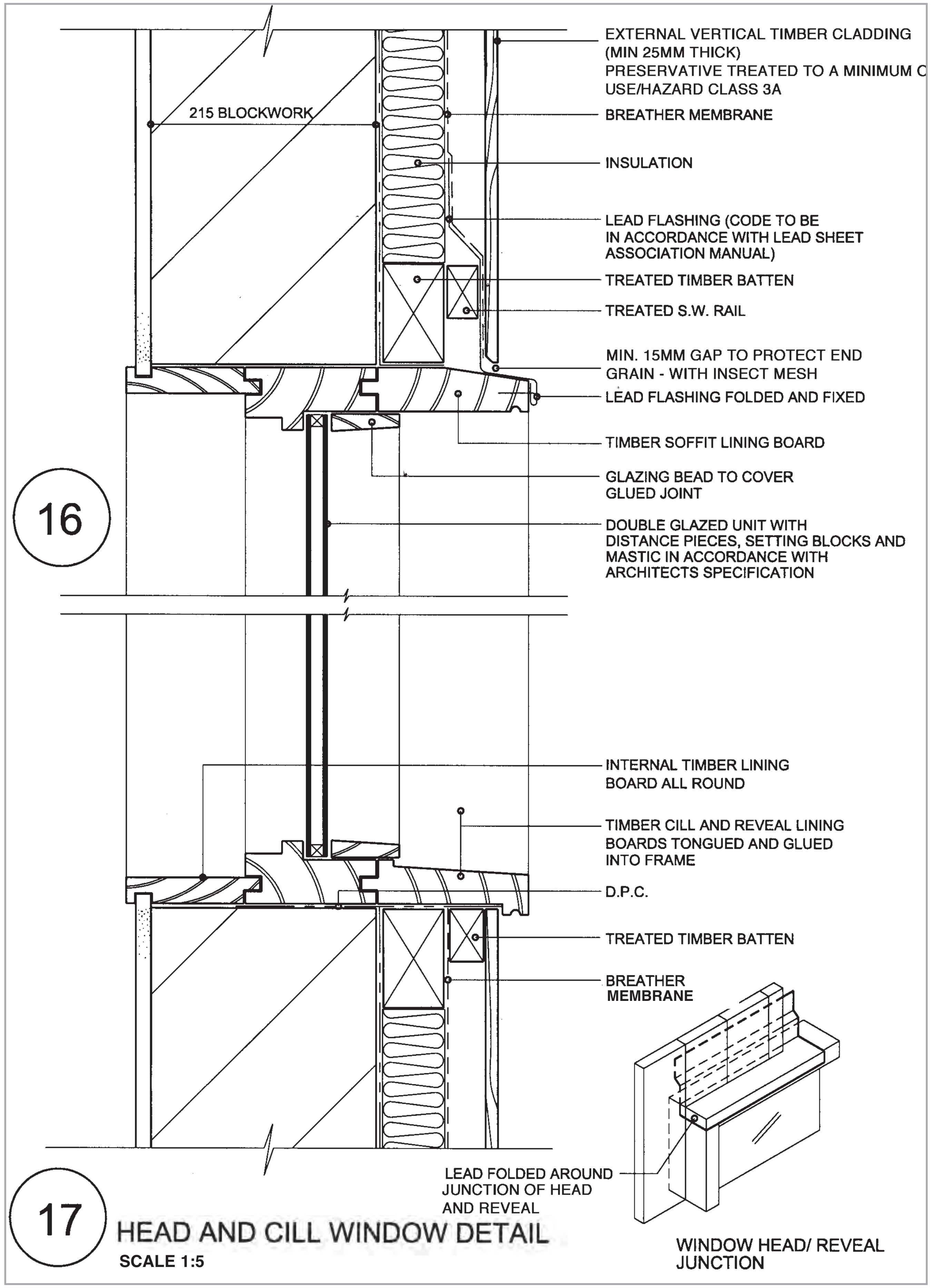


ELEVATION OF WALL - CUTAWAY VIEW

SHOWING MAKE-UP OF WALL CONSTRUCTION FROM FINISHED EXTERIOR CLADDING AND JOINERY TO STRUCTURAL MASONRY WALL BEHIND CLADDING

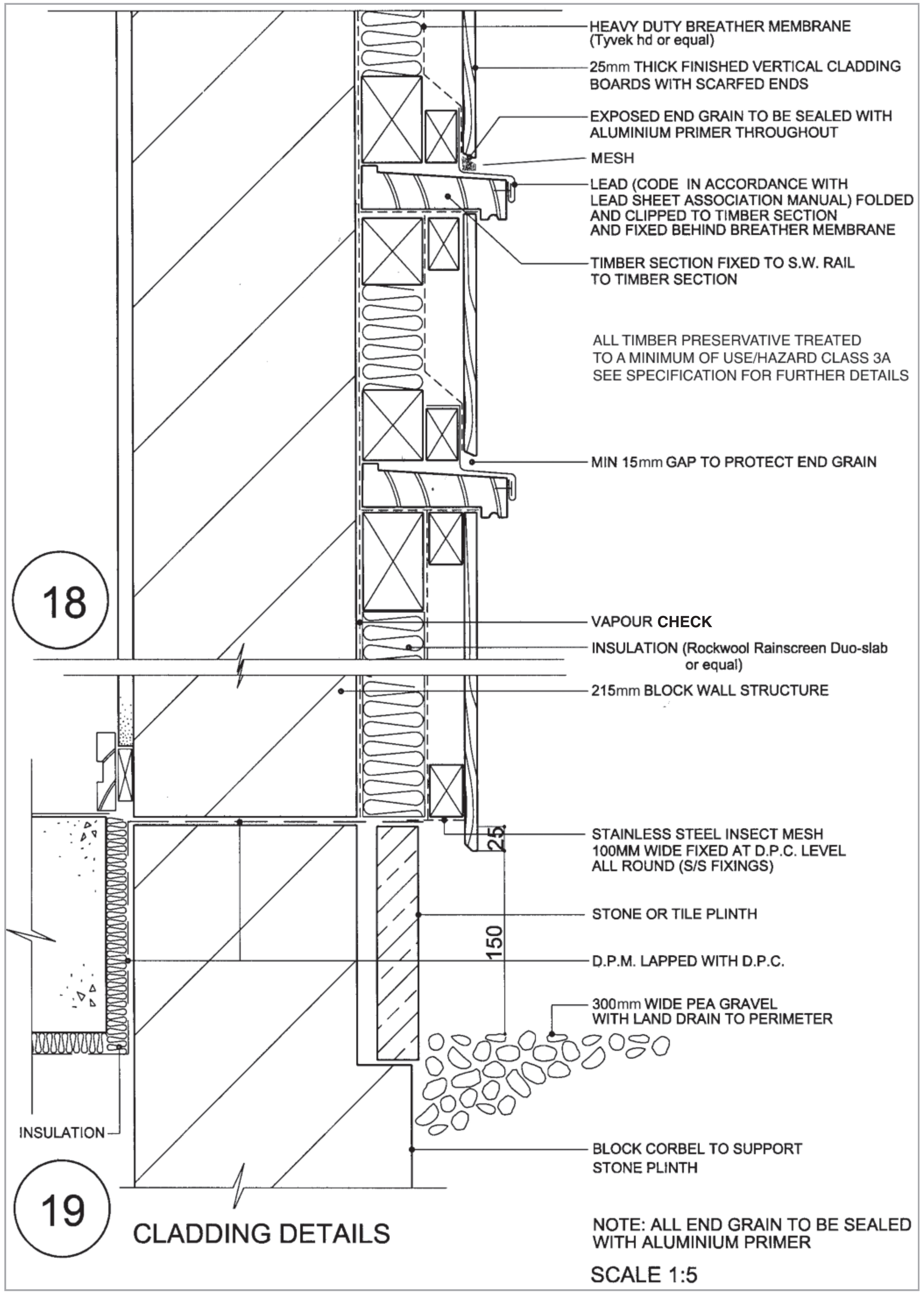
DETAIL B 12.3.1

B 12.3 WORKING DETAILS - TIMBER CLADDING - BLOCKWORK WALLS (CONTINUED)



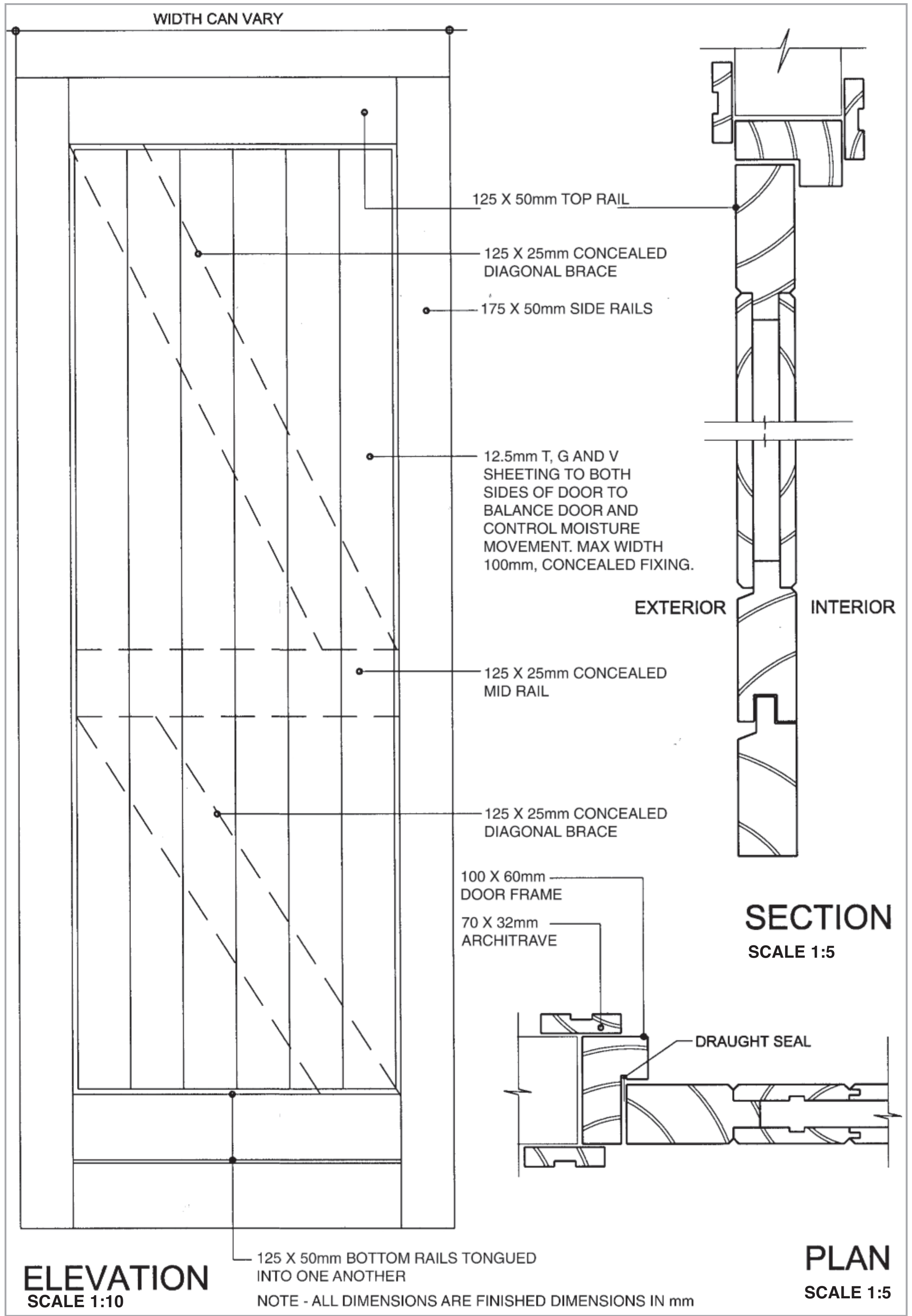
DETAIL B 12.3.2

B 12.3 WORKING DETAILS - TIMBER CLADDING - BLOCKWORK WALLS (CONTINUED)



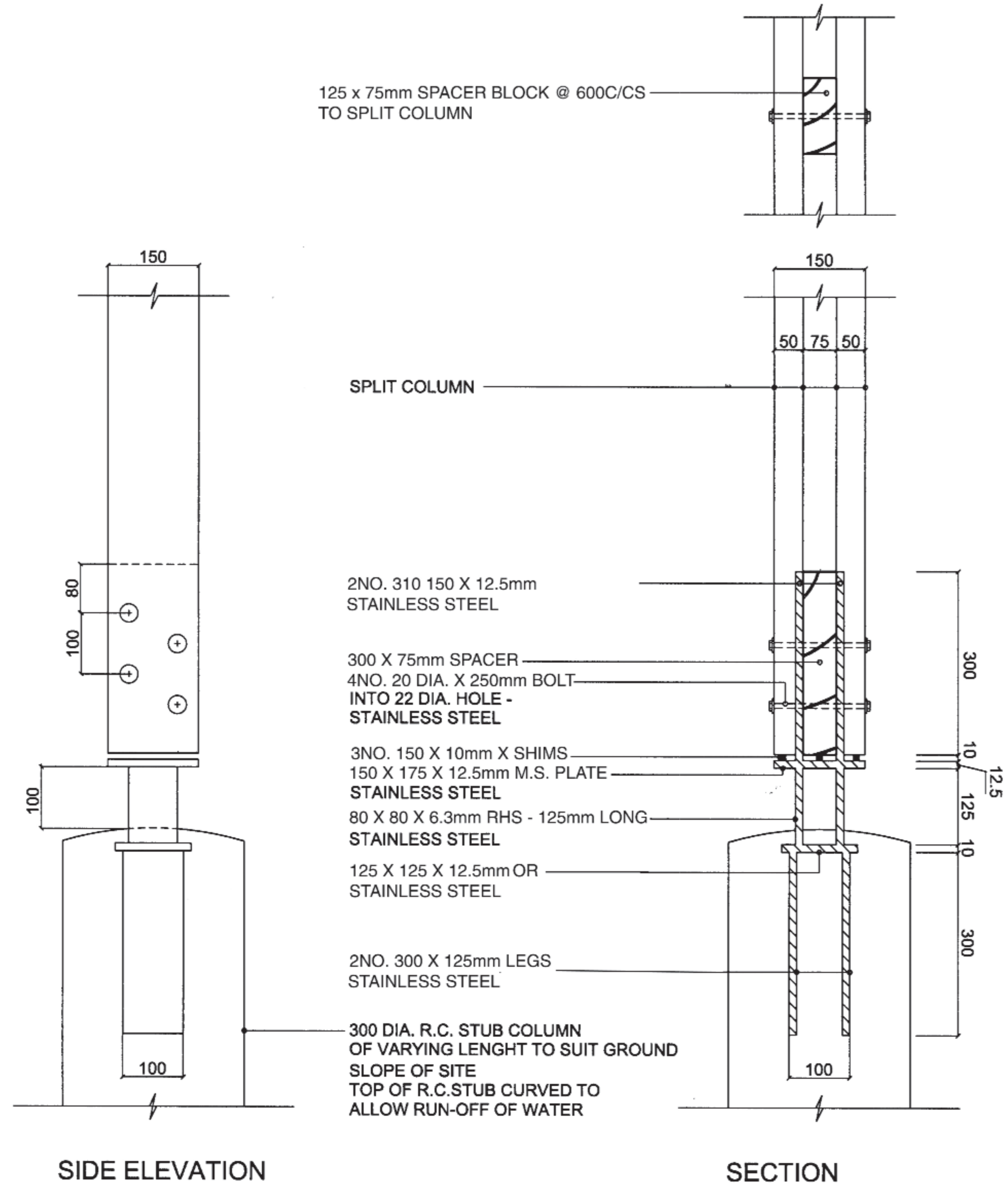
DETAIL B 12.3.3

B 12.4 WORKING DETAILS - TIMBER DOOR DETAILS



DETAIL B 12.4.1 Sheeted door detail

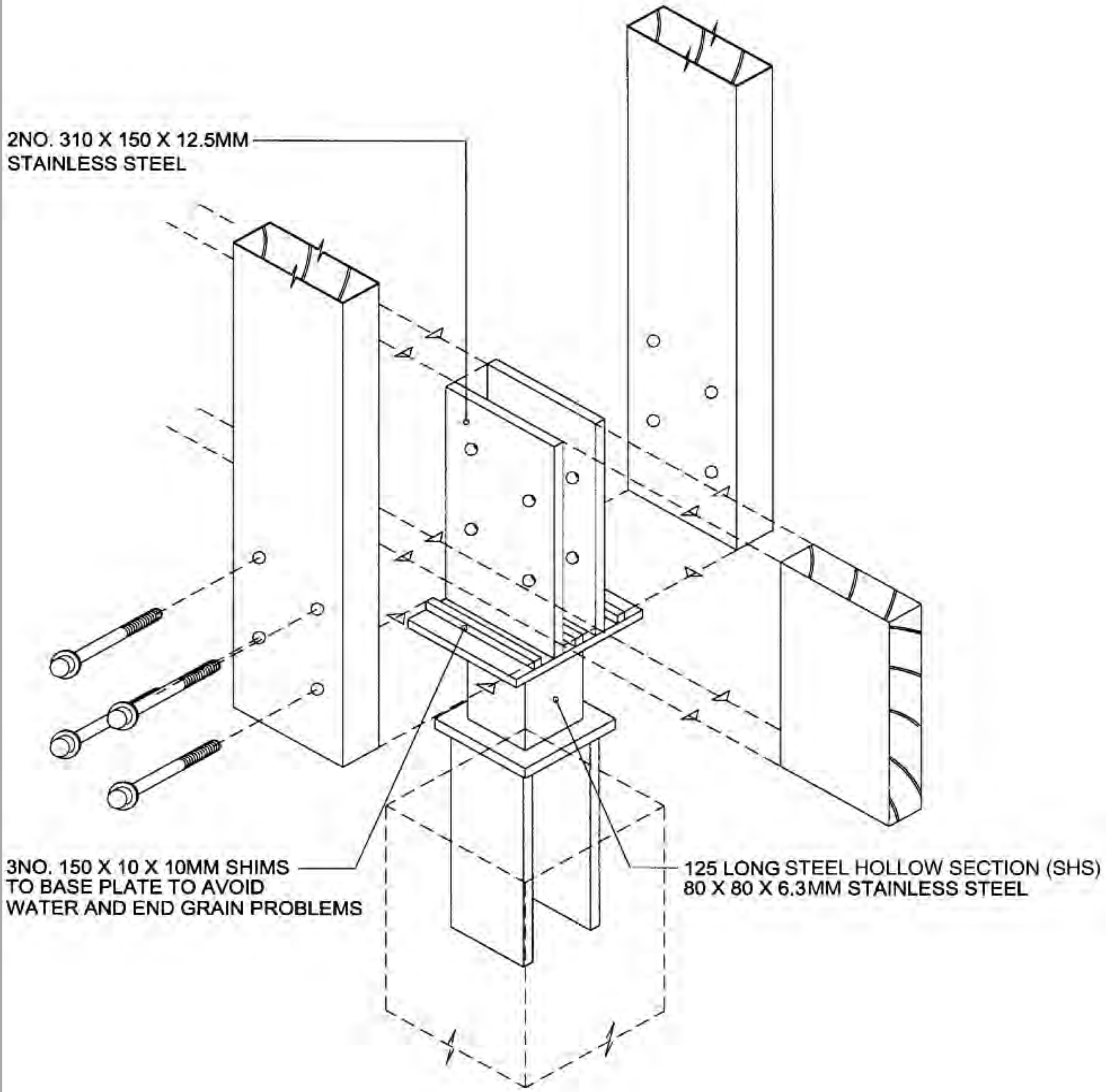
B 12.5 WORKING DETAILS - A TIMBER COLUMN BASE DETAIL



Detail to ensure that timber is kept out of ground contact
and end grain of column is ventilated
It is recommended that the base plate and lever case fixings are austentic stainless steel.
Scale 1:10

DETAIL B 12.5.1 Typical Column Base Detail

B 12.5 WORKING DETAILS - A COLUMN BASE DETAIL CONTINUED



ISOMETRIC VIEW

Detail to ensure that timber is kept out of ground contact
and end grain of column is ventilated
It is recommended that the base plate and lever case fixings are austentic stainless steel.

DETAIL B 12.5.2 Base Assembly

Section C *Sample Timber Specifications*

Introduction

This sample specification should be beneficial for everyday timber specification and general Bill of Quantities use. It indicates the essential timber specification elements but could be supplemented with additional clauses from the Building Specifications (Section D) where appropriate.

BS 5268 Part 2 was a permissible stress standard and was the main design standard used in Ireland (I.S. 444 was based on BS 5268-2) and the UK. However the equivalent European standard, Eurocode 5 (formally designated EN 1991-1-1 and EN 1995-1-2) is a limit state code and will increasingly come into use, replacing BS 5268. Italics are generally used in the following where a specific material or dimension is specified and which may be altered at the discretion of the specifier as long as it complies with good practice or the appropriate standards. Some British standards have been quoted even though they may have been withdrawn as some of these standards may still be in use particularly in the UK.

USE OF STANDARDS

In presenting broad-based specifications considerable reference has to be made to appropriate standards particularly the European Standards, known as Euro Norms (ENss) which have superseded many national standards. It is very important to check that quoted standards are current or if they have been revised; certain national standards may no longer apply and many European standards have already undergone revision.

In Ireland and the UK the national design standards have been withdrawn since 2010 (in Ireland, I.S. 444 and I.S. 193 and in the UK BS 5268 in its various parts) and are no longer supported by NSAI or BSI. A decision has to be made on which standard should be used for design and Technical Guidance Document A (Structure), [or Approved Document A in the UK] should be consulted.

It is important to note that, whereas both standards (Eurocode 5 and BS 5268) may be acceptable for design, they are not interchangeable as parameters within the standards differ. Where IS444 (or BS 5268) and Eurocode 5 are quoted they are mutually exclusive and either the Irish Standard/British Standard or Eurocode 5 may be used but not both. Generally the design and loading codes or standards (e.g. the wind codes) are separate and incompatible but with some exceptions. However, some European product standards are applicable to the Irish or British Standards (e.g. the plywood standard EN 636 and the standard on timber tolerances EN 336). The mixing of the new European standards with the old National standards (I.S. or BS) must be undertaken with care and generally the only mixing that should be undertaken is within the product standards.

All European Standards are quoted as EN followed by the appropriate number. These ENs when adopted by member states receive a further designation denoting their acceptance as a standard by a particular country. For example, when adopted by Ireland an EN will become I.S. EN; similarly an EN adopted by Britain becomes BS EN, thus the ENs also become National Standards. Because of the rate of promulgation of ENs, the process of adoption is on-going.

This Guide does not show the national prefix but I.S. ENs apply to Ireland and BS ENs apply to the UK (See section E4).

A number of standards allow a National choice in specifying certain values, these National values are contained in the different National Annexes (NAs) to the ENs; it should not be assumed that the Irish and British National Annexes are the same (although in many cases there are few differences).

The Irish National Annex should be used in Ireland and the British National Annex should be used in the U K.

In addition Non-Contradictory Complementary Information (NCCI) is allowed to be produced by a member state. NCCIs contain additional guidance on the Eurocodes but are voluntary and are not compulsory. In the UK PD 6399 contains supplementary information while in Ireland two documents have been produced to

replace I.S. 444 and I.S. 193. These have been provisionally designated Swift 6 and Swift 5 but may be produced as Irish Standards but even as Standards they will still be regarded as NCCI's.

Alternative standards to National Standards and Euro Norms are quoted in certain circumstances and it is important to ensure that these standards are current and appropriate to the work in hand.

The main examples shown in this document are based on Eurocode 5 but in some cases Irish and British Standards and in particular BS 5268 Part 2 have also been referenced; for example the nail and screw centres and edge distances come from Eurocode 5 as well as BS 5268 Part 2. In many cases Eurocode 5 (all of its parts) has very similar approaches to design as the different parts of BS 5268 (including designing for fire) and many of the example specification clauses here have an exact equivalent in the Eurocode.

C 1 Materials

1.1 TIMBER GENERALLY
All timber and timber based products including timber boards shall be properly certified and marked according to the relevant standards.

All timbers should be legally logged and forest managed under principles of sustainability in accordance with international guidelines. In Ireland and the UK the two main schemes certifying companies and allowing them to demonstrate appropriate chain of custody in relation to forest management are PEFC (Programme for Endorsement of Forest Certification) and FSC (Forest Stewardship Council). More information on these organisations can be obtained on their websites.

Timber shall be conditioned to a moisture content appropriate to its end use and free from defects or combination of defects, including decay, rendering it unsuitable for the purpose intended.

Structural timber shall be visually strength graded to comply with I.S. 127 (or for the UK BS 4978) or machine graded to comply with EN 14081.

Joinery timber shall comply with EN 942. (Note; this Standard is similar in many respects to BS 1186 Part 1. That Part 1 has been withdrawn but Parts 2 & 3 are still current.)

1.2 HARDWOOD
Hardwood joinery which is exposed to view in woodwork shall be totally free from the following defects: knots, sapwood, wane, warping, pith, brittle heart, decay, stain and beetle attack.

All hardwood shall be accurately cut and shall be in conformity with samples approved by the architect prior to commencement of work.

1.3 SOFTWOOD
Softwood joinery timber which will be exposed to view shall be European redwood, Class J10 of EN 942. The following defects shall not be permitted: pith shown on the surfaces; sloping grain exceeding one in eight; checks, splits and shakes in excess of those permitted by Class J10 of EN 942; knots, excepting isolated sound tight knots of less than 20 mm diameter; any evidence of beetle attack or decay.

Softwood not exposed to view will be accepted with minor defects with the exception of active beetle attack or decay.

1.4 MOISTURE CONTENT
The moisture content of woodwork after manufacture and/or kiln drying shall comply with EN 942. Structural timber shall comply with EN 1995-1-1 or BS 5268 Part 2 (for permissible stress designs) for the relevant service or use class.

Unless specified to the contrary, moisture content of timber at time of erection or assembly shall be within the following limits.

Internal joinery/flooring	External joinery/cladding
With intermittent heating 15+/-2%	Normal structural timber 18+/-2%
With heating up to 20°C 12+/-2%	External cladding 18+/-2%
With heating over 20°C 10+/-2%	External joinery 16+/-3%

Note: *Flooring for use with under-floor heating should have a moisture content of 7 +/-1% or as required by the specialist floor manufacturer and conditioning may be required prior to installation.*

1.5 PLYWOOD
Plywood generally shall comply with EN 13986 and EN 636; BS 1088 parts 1 and 2 specifically cover marine plywood. Marine plywood is to be used where specified.

Notes:
All plywood shall be properly certified as required by EN 13986 and it should be CE marked.

If the plywood has an ETA (European Technical Approval) and/or is CE marked then there will be accompanying documentation giving additional information on the plywood (generally the marks on individual boards is limited). Accompanying information should be requested and the information on the boards and/or accompanying documents should be sought. The body responsible for monitoring the manufacture of the plywood will be a notified body but can be an approved body in the case of CE marking based on an ETA. The identification mark of the body should be on the boards or on the accompanying documentation. A company distributing any board material must be able to demonstrate the fitness of use of the board and must be able to supply the board information and supporting documentation.

As a further check confirmation of the plywood and associated information should be sought from the third party monitoring the manufacture of plywood (this is often the same party been responsible for confirmation of the physical properties and/or the production of an ETA) to confirm the certification and validity of the plywood.

1.6 ORIENTED STRAND BOARD (OSB)
OSB shall comply with EN 300.

Note: *There are a number of plants producing OSB in Europe and generally a specifier can have confidence in OSB certification.*

1.7 PARTICLE BOARD
Particle board (chipboard) shall comply with EN 312.

Note: *Particle board is similar to OSB in relation to production and confidence in certification.*

1.8 MEDIUM DENSITY FIBREBOARD (MDF)
MDF shall comply with EN 622.

Note: *MDF is similar to OSB in relation to production and confidence in certification.*

1.9 WOOD VENEERS
Wood veneers shall be prime quality, a sample of which shall be submitted and approved by the architect. The architect is to be informed when the whole of the stock is ready for his inspection and approval before work commences.

1.10 GLUES
Glues shall be of synthetic resin adhesive to EN 301. Type I/II as appropriate.

1.11 TIMBER SIZES
All joinery and furniture dimensions on architect's drawings are finished dimensions.

Structural timber shall be specified by the target size and tolerance class (to EN 336). Any timber that is regularised, planed or otherwise altered shall be designated with a new target size and tolerance class.

Note: *The grading standards give tolerances for re-worked timber where re-grading is necessary.*

C 2 Preservative treatment

2.1 GENERAL INFORMATION

As explained in the *Design Guidance* section A4, new European Standards have been introduced which have replaced the existing process-type specification with a results-type specification system. Specifiers should check with timber treatment plants and the relevant preservative company's technical departments whether existing British Standards or new European Standards methods of treatment are in use. Both systems depend on preservative penetration and retention in order to be effective. With either the EN or BS system the specifier must decide:

- The desired durability required and assess the likely Use/Hazard Class
- The relevant code of practice
- The type and method of preservative treatment

There are 4 main types of preservatives:

- Water-borne Micro-Emulsions to EN 599 e.g. Prevac or Vac-Vac
- Organic Solvents to EN599 e.g. Prevac or Vac-Vac
- Tar Oil Preservatives to BS 144 Creosote (but not recommended, only for specific exterior applications)
- Organic or inorganic waterborne to EN 599 e.g. Copper Triazole or ACQ

The three most widely used methods of preservation are

(i) immersion/ deluging
(ii) organic solvent or water-based emulsion double vacuum treatment for timber not in ground contact and
(iii) water-based pressure treatment for timber in ground contact.

Organic solvent preservation does not have a timber/metal reaction problem and it does not affect timber moisture content (i.e. there is no need for re-drying). It does not cause dimensional change to timber sections and has little effect on timber colour. It should be specified for close-fitting joinery such as doors and windows.

The specification clauses which follow give the European and British Standard approaches to joinery and timber preservation. Specify one system only. Generally do not mix the BS and EN systems together but some of the newer British Standards do refer to the EN Use/Hazard Class system.

Note: BS 8417 is a good standard that gives good overall advice and there is not yet a single EN that has the same information in one place. The term Use Class is replacing Hazard Class but the two terms are essentially synonymous and both terms have been used here.

2.2 ORGANIC PRESERVATIVE TREATMENT IN ACCORDANCE WITH EXISTING BRITISH STANDARDS FOR OUT OF GROUND CONTACT

2.2.1 Treatment methods and timber to be treated

Double Vacuum organic solvent wood preservative treatment shall comply with EN 599 i.e. fungicide plus insecticide and timber should be treated in accordance with BS 8417 Table 6.

2.2.2 Double vacuum schedules

The schedule shall be appropriate to the end use and shall comply with BS 8417

2.2.3 Treatment processing records (charge sheets)

Treatment certificates that make reference to the processing record shall be provided with all deliveries, copies of which shall be sent to the architect. A treatment docket is not acceptable unless specifically agreed beforehand with the architect. A full treatment processing record (charge sheet) with complete information is required to be provided to the satisfaction of the architect.

2.3 PRESERVATIVE TREATMENT IN ACCORDANCE WITH EXISTING BRITISH STANDARDS FOR OUT OF GROUND CONTACT BELOW DPC LEVEL AND HAZARDOUS END USES

2.3.1 Copper organic

Treatment with copper organic based wood preservatives should be in accordance with BS 8417. The determination of preservative retention (R) is specific to each preservative formulation and will vary according to the Hazard/Use class and wood preservative used.

2.4 PRESERVATIVE TREATMENT IN ACCORDANCE WITH EUROPEAN STANDARDS EN 335, EN 599.

GENERAL INFORMATION

Both the European and British Standards relate the risk of timber decay (whether through fungal or insect attack) to the situation where it is being used. Timber used below DPC level in has a higher risk than timber used internally within a building or for timber use above DPC level. EN 335 describes 5 Use/Hazard Classes ranging from Use/Hazard Class 1, where timber is essentially not at any risk of timber decay but may be subject to insect attack, to Use/Hazard Class 5 where timber is permanently exposed to salt water and at its greatest risk of decay. There are three parts of EN 335:

EN 335-1 Durability of wood and wood-based products. Definitions of use classes. General

EN 335-2 Durability of wood and wood-based products. Definition of use classes. Application to solid wood

EN 335-3 Hazard classes of wood and wood-based products against biological attack. Application to wood-based panels

Use Class is replacing Hazard Class as a term but they can be considered as synonymous.

The European standards require a demonstration of proof that the treatment used has produced the specified results. This can only be achieved through reference to chemical analytical methods. The preservative penetration and retention are intended to be the same as those achieved by the British Standard based processes. Preservatives such as inorganic concentrates and organic solvent types will continue to be used as they are today. However, water-based micro-emulsion preservatives have been developed (these are also referenced in BS 8417 rather than BS 5268-5) and are available to respond to the requirement for more environmentally compatible preservative treatments. These preservatives can fulfil the role of traditional ones in many circumstances.

Where sapwood is present, or heartwood which does not have adequate natural durability for its intended end use, preservative shall be applied according to its Use/Hazard Class, as defined in EN 335 Definition of Use/Hazard Classes. Other European Standards relevant to the determination of appropriate treatment are;

EN 350 Natural Durability Classes, EN 351 Penetration and Retention Classes and

EN 599 Performance Tests for Preservatives.

A certificate of preservative treatment shall be attached to each delivery of each Use/Hazard Class and copies sent to the architect - see 2.2.3. The moisture content of the timber to be delivered to site shall not exceed that specified.

2.4.1 USE/HAZARD CLASSES IN SERVICE – Examples

Use/Hazard Class 1:
Floor-boards, floor joists (excluding ground floor), timber above ground floor not built into external walls.

Use/Hazard Class 2:
Ground floor boards and joists, frame timbers in timber-frame houses, roof timbers, timbers built into external walls.

Use/Hazard Class 3:
External cladding, joinery, fascias, bargeboards, soffits and valley gutter timbers (coated).

Use/Hazard Class 4:
Sole plates below DPC, fence posts; playground equipment (if in ground contact).

Use/Hazard Class 5:
Marine, salt water contact.

Note: A more detailed table and additional information can be found in the Design Guidance section for designing for durability (A4). Use/Hazard classes and typical situations are also described in more detail in Table 1 of BS 8417.

2.5 RE-TREATMENT OF CUT SURFACES

All cutting, machining, profiling and notching must be completed prior to treatment. Any cutting of treated surfaces must have the architect's approval. Where the architect gives such approval, all exposed surfaces shall be retreated with a liberal brush or spray application of a suitable preservative.

Ripsawing, planing and heavy sanding will not be permitted unless the timber is returned for re-treatment after such work has been completed.

C 3 Fixings

Metal fasteners shall comply with the requirements of EN 14592 and metal connectors with EN 14545. All fasteners and connectors shall comply with the design requirements of EN 1995-1-1.

3.1 SCREWS AND NAILS

In general screws shall comply with BS 1210 and nails with I.S. 105 or BS 1202. In every case the size and material of screws and nails shall be as specified and comply with the relevant design standard (Eurocode 5 or BS 5268-2). Screws, nails or metal fastenings in hazardous locations or conditions must be non-ferrous, e.g. austenitic stainless steel, silicone bronze, no other screws or nails are permitted.

The fixing of external cladding, joinery or window beads shall be with stainless steel or silicon bronze screws, nails or fixing pins.

3.2 Bolts

Bolts shall comply with EN ISO 898-1; black hexagonal bolts shall comply with BS 4190 for designs to BS 5268.

All bolts, nuts and washers described on drawings as galvanised shall be hot-dipped galvanised, and those of stainless steel as austenitic stainless steel.

Bolt holes shall be drilled to diameters as close as possible to the nominal diameter of the bolt and in no case more than 1.0 mm larger than the bolt diameter or 2.0 mm for designs to BS 5268. A minimum of one complete thread shall protrude from the nut. Care shall be taken to avoid placing a bolt in any end split. The washer should be 3 times the bolt diameter and have a minimum thickness of 0.3 times the bolt diameter. Generally the smooth load bearing element of the shank shall be in full contact with the jointed members across the full width of the joint.

3.3 Connectors

All toothed-plate connectors are to comply with EN 912 and EN 14545 or BS 1579 for designs to BS 5268. All toothed-plate connectors together with bolts and washers are to be hot-dipped galvanised to EN 1461 or austenitic stainless steel or/and as specified. The connectors shall be fitted and embedded as described in the relevant design standard (Eurocode 5 or BS 5268-2). The washer size and thickness shall comply with Eurocode 5 and its referenced standards or BS 5268-2 and/or BS 1579.

3.4 Brackets, joist hangers, plates

Proprietary brackets, joist hangers, plates and the like shall be approved by the architect or the engineer before any assembly commences. All brackets, joist hangers plates, etc. shall be hot-dipped galvanised using double-dipped process to EN 1461 or stainless steel as described in drawings.

3.5 Tightening of bolts or connectors

Care must be taken to avoid the over-tightening of bolts in bolted or connector joints so that no crushing of the wood occurs under the washer.

3.6 Adhesives

Adhesive shall be Adhesive Type I to EN 301. PVA glues shall not be permitted. The mixing of the adhesive elements shall be carried out in clean containers; mix proportions, method of mixing, air temperature, method of application, rate of spreading, method of clamping including any pressure requirements, curing etc., shall be strictly in accordance with the adhesive manufacturer's instructions.

Adhesive spreading shall be carried out within the manufacturer's stated `open storage' time and any adjustments in alignment or clamping after the two mating surfaces have been brought into contact, shall be carried out within the manufacturer's stated `closed storage' time.
At the time of adhesive application the moisture content shall comply with the manufacturer's requirements.

The surfaces of the timber to be fixed with adhesive shall be machined and the application of adhesive carried out within 48 hours of machining. Care shall be taken that the adhesive to be used is compatible with any treatment applied to the timber (e.g. a preservative or fire retardant).

Where any adhesive joints occur on exposed areas of timber, the exposed areas shall be removed by light planing or sanding after the adhesive has set such that all adhesive which has been `squeezed out' of the joint is removed to the satisfaction of the architect.

C 4 Fire-retardant treatment requirements

4.1 FIRE-RETARDANT TREATMENT

4.1.1 Internal walls and ceilings

Where specified internal timber wall cladding and timber ceilings (excluding proprietary fire-rated panel systems) shall be treated with a suitable fire retardant. The fire retardant shall be as specified by the architect, and unless agreed otherwise the treatment shall be pressure applied in accordance with the manufacturer's instructions.

The flame retardant used (and its method of application) shall have an ETA (European Technical Assessment with appropriate supporting documentation) and/or be certified by a suitable body such as the Agrément Board.

Note: CE marked timber treated with a fire retardant requires a higher level of attestation than untreated timber.

4.1.2 Preparation for treatment

1. Timber and plywood should preferably be new, clean and unpainted. All inner and outer bark must be removed from solid timber prior to treatment.
2. The moisture content must not exceed 22% or lower if specified by the treatment manufacturer or required by their end use.
3. As far as possible all ripping, planing, profiling and extensive machining should be completed before treatment. Slight dimensional changes may occur during treatment and the treatment plant should be consulted beforehand
4. To obtain a rapid treatment service it is advisable to contact the treatment plant to establish the best method of parcelling timber to suit the plant dimensions and handling equipment.

4.1.3 Quality control

Full details of every phase of fire-retardant treatment are to be recorded for each charge treated. (**Note:** This will help to ensure that the treatment conforms to specification and that the correct treatment has been followed).

The specifier may, on demand, obtain a copy of this Charge Sheet record or he may ask for a Certificate of Treatment.

Note: See also section 4.7.

4.2 GLUING

When fire-retardant treated material is to be glued, the glue manufacturer should be consulted for appropriate recommendations.

The method of gluing should be in accordance with the glue manufacturer's recommendations.

Note: Phenol formaldehyde, melamine formaldehyde or resorcinol types may be recommended depending on the end use of the product.

4.3 SAWN ENDS

Surfaces exposed by cross-cutting, drilling, notching etc. must be liberally brushed with a fire-retardant concentrate. Rip sawn pieces must be returned for re-impregnation.

Note: *It is important that solid timber is cut to size as far as is practical prior to treatment and that rip-sawing on site is avoided. Cross-cutting plywood in any direction is permissible, but edges should be brushed with a fire-retardant concentrate.*

4.4 HANDLING AND USE ON SITE

When storing treated wood, the material should be kept off the ground and covered to shield it from the weather or direct wetting.

Fire-retardant treated wood should be installed so that it will not be exposed to the weather or direct wetting.

When painting or staining, the paint or stain manufacturer's recommendations should be followed. As with untreated wood, the surface should be clean and dry. Light sanding may be necessary.

Appropriate precaution should be taken when using and handling the product. Dust masks and eye protection devices are recommended to avoid possible irritation from dust or chips and gloves will help avoid splinters; hands should be washed after doing construction work.

The nature of the chemicals used in the fire-retardant treatment process should be ascertained and the treated wood products should be handled with whatever precautions are recommended by the manufacturer. The user should be aware of proper handling and personal hygiene practices.

4.5 DECORATING

It must be ascertained whether the fire retardant treatment affects the appearance of the timber to determine if it may be used unpainted or if it requires a protective coating. If it is to be painted by conventional methods, the manufacturer's recommendations should be followed.

It should be established that any finishes applied do not affect the spread of flame control achieved by the fire-retardant treatment. Highly flammable finishes such as nitrocellulose-based lacquers must not be used.

4.6 FIRE DOORSETS AND SCREENS

Fire door sets and screens shall be classified in accordance with EN 13501-2 and shall comply with the relevant fire tests including EN 1634 Part 1, 2 and 3 (or BS 476

Parts 20 and 22 and BS 8214 for designs to BS 5268-2) .
Manufacture of fire-doors and screens shall be carried out by an approved joinery manufacturer who can produce an appropriate Certificate of Fire Resistance to the satisfaction of the architect.

4.7 TIMBER VENEER WALL PANELS

4.7.1 General

Wall panels to be flush veneered laminated panels, manufactured and supplied by (state brand name), or equal and approved by the architect.

Wall panels shall meet Class C – s3,d2 or Class B –s3,d2 to the European class system (or if BS 476 is appropriate, Class1 rating or Class 0 as defined by the Technical Guidance Documents or for the UK the Approved Documents to the Building Regulations), at the locations shown on the architect's drawings.(Note; the areas could also be specified as below).

Panels to the circulation, foyer and concourse areas shall have a Class B-s3, d2 rating (or if appropriate Class 0).

Panels to the interiors of other rooms shall have a Class C-s3, d2 rating (or if appropriate a Class 1 surface spread of flame rating).

An appropriate ETA (with supporting documentation) and/or an Agrément Certificate of compliance shall be provided by the manufacturer.

Notes:
Class C-s3,d2 is approximately equivalent to Class 1 and Class B-s3,d2 to Class 0. The European class system is described under the term ‘Reaction to fire’ and is similar to BS 476 term ‘Surface spread of flame’.

Appropriate locations and classification system to be substituted as required. Larger rooms will also require Class B-s3.d2 or Class 0 surface spread of flame rating.

The drawings submitted for a Fire Certificate should include the ratings for different areas and the final work should comply with the issued Fire Certificate.

4.7.2 Panel size

(State brand name), 18mm thick veneer panels, or equal and approved by the architect, with dimensions as shown on the architect's interior wall elevations, shall be used throughout.

4.7.3 Panel core

Panel core shall be *(state brand name)*, or equal and approved, solid timber core of narrow laminate spruce strips faced on both sides with high-density chipboard.

4.7.4 Lippings

Lippings to edges shall be a minimum 10mm thickness in matching timber species supplied to all edges before veneering. All lippings to be square and true.

4.7.5 Veneers

Veneers shall be from selected prime quality logs. Cherry and beech quarter-sawn veneer shall be laid “bookmatched” vertically.

4.7.6 Finish

Veneer panels shall be fully finished before delivery to site with a specifically formulated pre-catalysed lacquer applied in two/three coats to give a semi-matt finish to the satisfaction of the architect.

4.7.7 Fixing method

Panels shall be fixed in full accordance with the manufacturer's instructions and the architect's detailed drawings.

Notes:
The ‘surface spread of flame’ term has been replaced by ‘reaction to fire’ in the new European testing and classification system.

Timber treated to improve its reaction to fire classification has a higher level of attestation (level 1) and therefore site applied treatments are unlikely to be CE marked (a mark does not have to be on the product). At present there appears to be no treatment plants in Ireland and most timber is treated in the UK.

C 5 Workmanship

5.1 STORAGE
Timber on the site shall be stored under cover, clear of the ground and protected from dampness. Timber shall be stored on level bearers located at centres sufficiently close to prevent distortion. Timber that is not stored in this manner shall be rejected.

5.2 GENERAL
Wall plates, ceiling joists, etc., shall be in one length where possible. All joints shall be made directly over supports. Structural timber shall be as specified by the design engineer; generally members shall be in one length and joints shall comply with the requirements of the design engineer.

All joinery is to be finished with a smooth wrought face.

Surfaces to be painted with a matt paint, shall have a finish such that any imperfections will not be apparent. Surfaces for gloss or matt transparent finish shall be such that when so finished no imperfections shall be apparent.

Joinery intended to be painted is to be fixed by stainless steel nails. Nail heads are to be punched below the surface and are to be filled with leadless paste filler. Joinery intended for transparent finishes is to be secretly fixed. Heads of screws are to be countersunk and pelleted in the same wood and with matching colour and grain. In general all fixings are to be stainless steel or silicon bronze unless otherwise stated.

Unless timber is impregnated with preservative, the backs of frames etc., to be fixed to walls and all other bedding surfaces are to be painted with two coats of preservative before priming. All work to be painted is to be treated with knotting as necessary and given one brush coat of primer to all faces. Surfaces to be joined are not to be primed. The number of coats and methods of application of all finishes are to be as specified.

5.3 DEFECTIVE WORK
Should any shrinkage or distortion occur or any other defects appear in the joinery work before the end of the Defects Liability Period, such defective work is to be taken down and renewed to the architect's satisfaction, and any work disturbed in consequence must be made good at the contractor's expense.

5.4 PLUGGING
The term ‘plugging’ shall mean the provision and fixing of hardwood or approved proprietary plugs and includes any necessary wedging and drilling of wood, concrete or brickwork.

Where plugging and screwing of door or window frames is measured this shall be deemed to include plugs and screws of adequate size and strength to suit the frame size including proprietary frame fixings as manufactured by (state brand name), or equal and approved.

5.5 WORKMANSHIP AND MANUFACTURE
The joinery shall be constructed as indicated on the architect's details and the manufacturer is to be responsible for the sound construction of the components using recognised forms of joints in appropriate positions.

Workmanship in general shall be in accordance with BS 1186, Part 2, and in particular with Clauses 2.1; 2.2.1; 2.3.4; 2.4.2; 2.5 and 5.

Joiners' full-scale setting out drawings and construction details must be seen and approved by the architect before work begins. Facilities are to be given for the architect to inspect all work in progress in the manufacturing shops and on the site.

5.6 HANDLING, STORAGE AND PROTECTION
The completed doors, windows and panels shall at all times be protected from the weather and stored under cover and clear of the ground. Transportation shall be in covered trucks. Every possible care and precaution must be taken to avoid damage to framing, all surfaces and arrises during handling and storage.

Any preservative treatment shall be applied and allowed to dry fully before installation and painting to ensure all surfaces are treated.

Doors, windows and panels shall be protected against moisture penetration and coated with paint or other surface coatings as soon as possible after installation. Protection against damage must be maintained until handover.

C 6 Definitions

6.1 FINISHED SIZES
The term 'f' qualifying an expression of size means that the work shall be finished to the size given. The term 'f sizes' means that all dimensions contained in an expression so qualified are finished dimensions. The tolerances on the timber size should be specified with the finished size.

Note: All joinery dimensions on architect's drawings are usually finished dimensions.

6.2 EXACT SIZES
The term 'exact' qualifying an expression of size means than no deviation from the size given is permitted. The term 'exact sizes' means that all dimensions contained in an expression so qualified are exact.

6.3 HARDWOOD OR THE LIKE
The term 'hardwood or the like', which is used as a statement of background to which ironmongery is to be fixed, is deemed to include plywood and other manufactured materials except where these materials are faced with metal, laminated plastics or the like.

6.4 FIRE DOORS AND SCREENS
Notwithstanding the information provided on drawings or in the Bill of Quantities, where doors or screens are described as fire resistant, the contractor shall provide everything necessary (including intumescent fire and smoke seals, bedding ironmongery in intumescent paste - which are not measured), in order to achieve the fire rating specified and shall be required to produce an Approval Certificate (a fire certificate from a recognised fire testing house for the fire doors and screens) The contractor will be deemed to have taken this into account in pricing his tender.

C 7 Specification for structural timber

7.1 MATERIALS
Materials shall comply with the requirements of Eurocode 5 or BS 5268 for permissible stress designs. Note. The specifier should delete the standard that is not appropriate.

7.2 SOFTWOOD SPECIES AND GRADE
Structural timber shall be strength graded to comply with EN 14081 (Note. Generally in Ireland visually graded timber will be to I.S. 127 and in the UK to BS 4978; imported timber can be graded to National Standard of the country of production subject to the requirements of EN 14081 and the contents of EN 1912. Machine grading in both Ireland and the UK is usually to EN 14081-4).

Where a particular timber species is specified then this shall be confirmed by an independent specialist.

7.3 HARDWOOD SPECIES AND GRADE
Structural hardwoods shall be strength graded to EN 14081-4 or BS 5756. Where a particular hardwood is specified then the species of the supplied material shall be confirmed by an independent specialist.

7.4 SIZES AND SURFACE FINISH
Target sizes may be considered as the finished size subject to permitted tolerances to EN 336 or to those specifically specified by the architect or engineer. Tolerance Class 1 is usually applied to sawn timber while Tolerance Class 2 is usually applied to processed timbers such as those used for roof trusses or timber frame construction.

Glulam sizes shall comply with EN 390.

7.5 MOISTURE CONTENT
Moisture content shall be specified in accordance with the Service Class outlined in Eurocode 5 (or BS 5268 Part 2) or as required by the end use. Maximum moisture content in general shall be as required by the end use and Eurocode 5 (or BS 5268 Part 2), but note that in general structural timbers shall be kiln-dried to a maximum of 20%.

7.6 STORAGE
Materials shall be stored on level bearers, under cover, out of ground contact, protected from the weather and shall be kept free from damp.

7.7 PRESERVATIVE
Where necessary, timber shall be pressure impregnated with an approved preservative as specified by the architect. All ends cut on site shall be treated before fixing with an appropriate preservative or preservative concentrate. See also Section C2.

7.8 GLULAM (GLUED LAMINATED TIMBER)
Glued laminated timber at the time of assembly shall comply with EN 386 and EN 390.

All timbers used for lamination shall be of the one species, shall be in the longest possible lengths with finger joints where ends of lengths meet and shall be planed to equal finished sizes before gluing. Glue shall be spread evenly and the timber sections immediately placed in position and clamped tightly together until the glue has fully set. On completion of all gluing, the laminated member shall be planed all over to the exact sections and contours shown on the detailed drawings. Only adhesives of the Phenol/Resorcinol type shall be used. Adhesives are to be applied in accordance with manufacturer's instructions. The moisture content of the timber shall conform with the adhesive manufacturer's recommendations.

Note: Subject to design and ascetic requirements different strength classes and species can be used but most 'off the shelf' Glulam is of a single species and strength class.

C 8 Finishing

8.1 FINISHING METHODS
Two pack polyurethane matt finish shall be applied to timber floors and stairs. Both manufacturer and supplier are to be approved by the architect prior to application.

8.2 STAIN FINISH
(State brand name), or equal and approved microporous wood stain in the selected colour shall be applied in strict accordance with manufacturer's instructions/recommendations. A minimum of three coats is required.

Note: *An aluminium primer is to be applied to all end grain of external timber to architect's satisfaction, ensuring that no primer appears on exposed faces. Particular attention should be given to the recommended time scale and sequence of painting especially with regard to window installation and glazing rebates.*

C 9 Cladding

9.1 VERTICAL TG AND V TYPE
External cladding shall be tongued, grooved and v-jointed vertical Douglas fir pressure impregnated to a minimum of Use/Hazard Class 3.2 in accordance with EN 335, EN 350 and EN 351. Following preservative treatment the timber shall be re-dried to a moisture content of 16±3%.

Cladding boards shall be 100x25mm (see B12.2.4, 18mm minimum thickness for cedar) finished dimensions, with a stress-relieving back groove, all as shown in the detail cladding board profile drawing. Boards shall be fixed through the v-joint with silicon bronze or austenitic stainless steel ring shank nails, to 50x36mm horizontal battens and vertical counter battens at a maximum of 450mm centres treated to hazard class 2 (minimum). All end grain to be sealed with aluminium primer. Counter battens shall be used with vertical cladding.

9.2 VENTILATION
Provide a 25mm minimum continuous clear cavity behind the cladding boards. Stainless steel insect mesh shall be fitted to all ventilation openings to the wall cladding.

9.3 BREATHER MEMBRANE
The breather membrane shall comply with BS 4016 and/or shall be of a type specified by the architect. The breather membrane shall be fixed with stainless steel staples at 300mm centres (or as specified by the manufacturer) with minimum overlaps of 150mm at junctions in the horizontal direction and 100mm in the vertical direction. The breather membrane shall also be turned-in at window openings so as to properly lap with the internal vapour control layer, and run below DPC at ground level. See Section B for details of breather membrane/DPC interfaces.

9.4 FILLERS
No wood fillers shall be used externally. Internally no wood fillers may be used where a translucent wood finish is used. Fillers may only be used in other situations with the architect's permission.

C 10 Flooring

10.1 ACOUSTIC PERFORMANCE

The Building Regulations (through the Technical Guidance Documents) require certain sound insulation standards for floors especially in relation to compartment floors in multi-use or multi-occupancy end use. For example at present in Ireland the maximum individual transmission values are 65dB for impact sound and a minimum of 48dB for airborne sound (TGD E 1997 - there are also requirements for mean values depending on the number of rooms tested, the UK has similar requirements in their Approved Documents, and Robust Details Limited provides construction details and a means of certification scheme for acoustic performance). To achieve these requirements both the structural subfloor and the decorative floor finish must be acoustically evaluated to ensure an effective performance. An underlay with a specific acoustic performance is normally required.

10.2 SUB-FLOORS

Sub-floors shall have not more than a 3mm gap under a 3m straight edge. Where gaps exceed this requirement a self-levelling screed, with low moisture content, shall be used for a concrete sub-floor. For a timber sub-floor additional levelling pieces and an 18mm OSB3 base shall be required where the sub-floor shall be allowed to dry fully before laying timber structure deviates by more than 3mm over 3m to achieve a level floor.

Concrete floor bases, their preparation and moisture content shall conform with BS 8201 and shall have a suitable damp-proof membrane underneath.

10.3 WOODBLOCK

The floor shall be tongued and grooved oak blocks measuring 225x56x19mm or similar and fixed with approved adhesive in accordance with the manufacturer's instructions. The laid floor shall be lightly sanded and finished with two-pack polyurethane all in accordance with the manufacturer's instructions. The moisture content shall be between 8 and 12% in conventionally heated buildings. For areas with underfloor heating the moisture content shall be between 6 and 8%. Wood shall be sourced from sustainable and managed forests.

10.3/10.4
Woodblock and strip flooring come in several species and the examples quoted in these clauses are oak and maple. Other species may be specified but it is important to specify precisely the species and grade required.

10.4 HARDWOOD STRIP FLOORING ON BATTENS

The floor shall be solid, prime grade, hard maple, tongued and grooved and end matched boards. The boards shall be 20mm thick by 57mm wide or similar and approved by the architect. The boards shall be laid across level battens or joists at maximum centres of 400mm. The boards shall be secret nailed to every batten at an angle of 45° through the top of the tongue using lost head nails, 2.8x63mm or machine nails 2.9x63mm, with ring shanked or serrated edges.

10.5 HARDWOOD STRIP FLOORING ON CLIP SYSTEM

The floor system shall be an approved system installed according to the manufacturer's specification laid on an underlay and moisture barrier which shall be taped and lapped by 200mm at all joints and turned up at perimeter walls. The clip system shall be as recommended by the flooring manufacturer. The clip size shall suit the proposed heating system and expected relative humidity of the space in which it shall be installed, all in accordance with the manufacturer's instructions.

10.6 HARDWOOD STRIP FLOORING FOR SPECIALIST SPORTS USE

The specialist sports floor shall meet BS 7044 or DIN 18032 Part 11 requirements and be approved by the architect.

Supporting battens and specialist pads shall be provided where floor-boards are cut at walls, goal post supports, etc.

The boards shall be secret nailed at an angle of 45° through the top of the tongue using 2.9x63mm special machine nails. Where the floor is wider than 12m the board laying shall start in the centre of the floor with the tongue of the boards pointing towards the side walls. A loose tongue shall be glued to both centre boards along their full length. Allowance for natural movement and ventilation of the floor shall be in strict accordance with the specialist manufacturer's instructions. A certificate of compliance with BS 7044 or DIN 18032 Part 11 shall be provided by the specialist flooring contractor.

10.7 APPROVED FLOOR SAMPLE

A control sample floor area, which may become part of the finished floor, shall be provided for the architect's approval prior to the commencement of the entire floor area.

10.8 EXPANSION ALLOWANCES

Expansion gaps shall be provided at wall junctions, floor junctions and pipe locations. A 15mm minimum expansion gap shall be provided at these locations or 1.5mm for every metre of floor width, whichever is the greater. In addition, expansion between boards shall be a minimum of a 2mm gap every five boards, or 0.4mm between every board. In intermittently heated spaces with 60 - 90% RH a 2mm gap every two boards shall be required. Boards shall not be too tightly cramped together when fixing with mechanical nailing systems. (In spaces which are heated constantly 24 hours per day, such as hospitals, allowances should be made for shrinkage and the appropriate clearances calculated).

Note: *The expansion gaps are dependent on species, moisture content of timber as supplied and on the expected in-service moisture content, and the figures quoted above are for guidance only. There may be a need for the specifier to supply the flooring contractor with exact details for expansion requirements.*

10.9 CONSTRUCTION EXPANSION GAP

Where a construction expansion gap occurs in a concrete sub-floor, the overlaid timber floor shall be provided with an expansion joint to coincide with the concrete construction/expansion gap and this joint shall extend the full thickness of the timber floor and its support system. A compliant joint material shall be used to the satisfaction of the architect.

10.10 FLOOR FINISH

A factory applied two-pack polyurethane matt finish or a specialist light oil finish shall be applied in accordance with the manufacturer's instructions to the satisfaction and approval of the architect.

Note: See also C8 and 10.3.

10.11 PROTECTION ON FLOORING

All efforts shall be made to protect laid floors from damage, dirt, moisture and thermal shock. The heating system shall be commissioned prior to the floor being laid and kept running thereafter. No trades shall work above the floor while flooring work is in progress. The laid floor shall be protected by hardboard laid loose, but taped at all junctions, until the issue of the Practical Completion Certificate by the architect.

10.12 COMPLIANCE

Aspects of flooring shall comply with the following codes and standards, as relevant: Eurocode 5 or BS 1297; BS 8201; BS 5268 Part 2.

10.13 MAINTENANCE

The specialist timber flooring contractor shall hand over the technical data sheets relating to cleaning and maintenance of the floor at Practical Completion stage to the architect.

C 11 Joinery elements

11.1 WINDOWS

Timber main frames and casements shall be of Douglas fir complying with Class J10 of EN942, all in accordance with architect's drawings and details. Timber glazing beads shall be of Douglas fir complying with Class J2 of EN 942 and be fixed with stainless steel pins. Lamination of sections is permitted. Finger jointing of individual laminae is permitted, but not of whole sections or on exposed surfaces intended for a natural or satin finish. Plugs and fillers are not permitted. There shall be no signs of insect attack. Moisture content of timber at time of installation shall be 16±3%. Resin adhesives shall comply with grade D4 of EN 204. Workmanship shall be in accordance with BS 1186: Part 2. Safety devices shall be in accordance with BS 5588: Part 1. Preservative treatment shall be to the requirements for Use/Hazard Class 3 in accordance with BS 8417 (table 6 for organic solvents and table 9 for water based treatments).Note: Use/Hazard class for joinery falls into Use Class 3.2 in EN 335-2.

11.1.1 Glazing and full beading

Double-glazed units as noted on architect's drawings shall be hermetically sealed employing the `Double Seal System' and in accordance with BS 5713 – Specification for hermetically sealed flat double glazing units.

The units shall be full bedded with an approved mastic compound. The compound manufacturer's instructions must be followed. With timber frames, faces in contact with the compound must be completely sealed with an appropriate sealer to prevent oil absorption from the compound. Some preservation treatments used for timber frames can adversely affect compounds. However, two coats of recommended sealer on the relevant frame surfaces are a suitable precaution with most treatments. Nevertheless, exceptions exist, e.g. wax or silicone-based water repellents and water-based acrylic primers. The space between the edge of the unit and the rebate must be completely filled with compound before fitting the beads. The beads must be well bedded with compound to both frame and unit. Exposed edges of compound both inside and outside must be chamfered, so as to shed water. After bedding the glazing with mastic until it is exposed for chamfering allow for a second external face sealing with approved mastic using a narrow finishing nozzle to ensure a complete waterproof window. No linseed oil putty may be used. The unit must be secured in the frame by sprigs or spring clips.

Edge clearance, which must not be less than 3mm, must be maintained by distance pieces of non-absorbent non-compressible material. They should be placed opposite each other on each side of the unit, not more than 300mm apart, opposite the securing points of the beads but not immediately above setting or location blocks. They should be approximately 40mm long, 3mm thick and a breadth of 3mm less than the rebate depth.

Distance pieces are not necessary with mastic strip designated as load bearing by the manufacturer.

11.1.2 Approved mastic

The following, approved mastic may be used: *(state brand name)* with primer as required, or equal and approved by the architect.

11.1.3 Setting blocks

Setting blocks shall be of a minimum length 30mm/sq. m of glass in plasticised P.V.C (to BS 2571 softness No. 35-45) or of neoprene to Shore hardness No. 80-90.

11.1.4 Location blocks (to casements or the like)

Location blocks shall be of a minimum length 25mm in plasticised P.V.C. (to BS 2571 - softness No. 35-45) or neoprene to Shore hardness No. 80-90.

11.1.5 Distance pieces

Distance pieces shall be of a minimum length 25mm in plasticised P.V.C. (to BS 2571 - softness No. 35-45) or neoprene to Shore hardness No. 80-90.

11.2 DOORS, DOORSETS AND FIRE-RESISTANT SCREENS (See also 4.6)

11.2.1 External doors

External doors shall be of *European* or *American white oak* with TG&V panels fixed to framing with stainless steel or silicon bronze nails. Stiles and rails shall be jointed with stub tenons or non-corrosive mechanical devices. The framework shall be square when assembled in a true plane, and the parts shall match each other in thickness. Minimum door thickness shall be 50mm, and all in accordance with architect's detailed drawings. Preservative treatment shall be provided to minimum Use/Hazard Class 3.2. The door locking mechanism shall be of the “three point type” to eliminate warp and provide additional security. Moisture content shall be 16±3%. A full size prototype to be made up by the joinery works for approval by the architect prior to fabrication of all the doors. Glazed external doors shall have a minimum timber thickness of 55mm.

11.2.2 Interior doors

Interior panel doors shall be made of *Scots pine* to Class J10 of EN942. Glazing beads, where required, shall match and shall be supplied loose. Door frames and linings to match and suit finish and thickness of door. Minimum thickness 45mm. Moisture content 12±2% at time of manufacture and site installation. Workmanship shall be in accordance with BS 1186 Part 2.

11.2.3 Flush solid door

Solid core doors shall consist of a suitable 100% core of solid timber covered on both sides with facings of minimum 6mm plywood or other architect-approved material; with or without apertures for glazing or ventilation louvres. Quarter-sawn *American white oak* veneer to be used throughout or as detailed on architect's drawings.

Note: For Fire-rated doors and fire-resistant screens see section 4.6.

11.2.4 Fire resistant glass

Supply and fit *(state brand name)* or equal and approved by the architect multi-laminated glass assembled with clear intumescent interlayers in accordance with the manufacturer's written instruction to meet the integrity and insulation criteria, according to EN 1363-1/2 and EN01364-1 or BS 476: Part 22 and the safety requirements of BS 6206 *(delete those not applicable)*. Note the fire-resistant glass cannot be cut on site and the edge protection tape must not be removed or damaged.

In addition the following glazing instructions must be adhered to.

- Do not allow any contact of the glazing’s edges with water.
- Do not install fire-resistant glass in locations where the glass temperature might exceed 40°C.
- Always refer to the fire test reports.
- Avoid all glass to metal contact.
- Do not exercise any restraint on the glazing.
- Do not damage the glazing’s edges or the protection tape.
- Keep the rebates dry and free from aggressive products (acids, organic solvents, etc.).
- Use hardwood setting blocks or equivalent (Shore hardness A75).
- Provide an edge clearance of 4-5mm.
- Provide front and back clearances of 4-5mm, using closed cells foam tape.
- Provide a rebate depth of minimum 20mm.
- Apply a neutral silicone sealant immediately after sealing.
- All installation to be in accordance with the manufacturer’s/supplier’s instructions.

11.3 STAIRCASES

11.3.1 Softwood staircases

Strings shall be *Scots pine* to Class J30 of EN 942 where not exposed. Handrails, balustrades, newels, treads and risers shall be Class J30 of EN 942 where painted or Class J10 when exposed and decorated with a clear polyurethane finish.

Sizes and tolerances shall comply with BS 585: Part 1 for domestic use only. Workmanship shall be in accordance with BS 1186: Part 2. Adhesive shall be one-part polyvinyl acetate complying with EN 204. The moisture content at the time of manufacture and installation shall be 12±2% and all in accordance with the architect's detailed drawings.

11.3.2 Hardwood staircases

The hardwood staircases shall be constructed from prime quality American white oak with approved joints and adhesives all in accordance with architect's detailed drawings, including slip resistant inserts to tread nosing and two-pack matt polyurethane finish. Moisture content at the time of manufacture and installation shall be 12±2%.

11.3.3 Building regulations

Landings, balusters, handrails, and step rise and going shall comply with the current Technical Guidance Document (Note: Approved Documents in the UK) to the Building Regulations for their respective end use and as specified by the architect.

Section D *Timber Building Specifications*

Note: The clauses used in this Timber Building Specification can be used to supplement the Sample Timber Specification of Section C where further detailed information is required. Alternatively they may be used as individual specification clauses as deemed appropriate by the specifier.

D 1 General

1.1 COMPLIANCE

1.1.1 **The design engineer:** Shall comply with the requirements and recommendations of EN 1995-1-1 (Eurocode 5)*; and other relevant standards and Codes of Practice pertaining to structural timber, board materials, relevant legislation and current building regulations.

**If permissible stress design is considered appropriate then BS 5268 should be used.*

1.1.2 **The engineer:** Shall comply with the architect's instructions and specifications.

1.1.3 **The contractor:** Shall comply with all engineer's and/or architect's instructions, construction drawings and refer any discrepancies to the engineer or architect for direction prior to construction and/or manufacture.

> **1**
> Continual changes are taking place with respect to the introduction of new European standards. The designer should be aware and check the currency of National and European standards.

> **1.1.2**
> Structural timber is strength graded and species with similar strength properties are grouped together into strength classes. Each strength class includes a number of species of varying visual appearance.
> The engineer may have to specify a particular species to satisfy the architect's aesthetic requirements or to take account of natural characteristics such as durability.

1.2 CONSTRUCTION STABILITY

1.2.1 **The contractor's responsibility:** Shall maintain and ensure the overall stability of structural elements during construction of the building.

1.2.2 **The contractor:** Shall undertake any necessary temporary works which are required to hold and maintain structural elements in position during the construction stage.

1.2.3 **Prior to the construction:** The contractor shall agree the sequence, order and methods of assembly of structural elements, to ensure that the structural integrity of individual and pre-fabricated elements and the overall stability of the building is not compromised or endangered during construction.

1.2.4 **Special attention:** Shall be given by the contractor to the sequence of erection of the elements which shall be subject to the approval of the architect/engineer, prior to commencement of the works.

1.2.5 **Structural elements:** These include masonry and concrete which support other structural elements, shall attain the required strength prior to erection of remaining elements unless special written agreement for an alternative arrangement is obtained from the architect/engineer.

> **1.2.3**
> Structural elements such as Trussed Rafters, Timber Frame, wall and floor panels, glue-laminated elements may contribute to the stability of other elements, such as masonry, and as such the order and sequence of assembly may need special consideration prior to commencement of works on site.

D 2 Handling and on-site storage

2.1 GENERAL

2.1.1 **Precautions:** Shall be taken during storage on site to minimise changes in moisture content due to the weather, and in particular, rain, damp, direct sunlight or excessive heat.

2.1.2 Undue distortion of components during transportation and handling and storage shall be avoided.

2.1.3 Where design assumptions for long, flexible or heavy components dictate certain methods of handling, lifting points shall be marked on the components and methods of lifting shall be shown on the fabrication and site drawings.

2.1.4 **Materials and components:** Shall be stored on dry bases and shall be evenly supported on bearers with spacer battens at regular intervals, placed one above the other. Stacks shall be protected with tarpaulins or other impervious material, so arranged to give full cover but at the same time to permit the free passage of air around and through the stack.

> **2.1.1**
> Materials and components should be thoroughly checked upon delivery to ensure that they conform to specification and that none of the elements have been damaged in transit.
> Where warranted, non-compliant or damaged components shall be returned to supplier/manufacturer.

2.1.5 **Suitable conditions:** Must be maintained where it is essential that materials and components are not exposed to high moisture. Deliveries should be scheduled to coincide with assembly and erection activity.

2.1.6 Where carcassing timber is to be stored on site it shall be delivered to site protected by a suitable material such as a breather membrane. Where plastic packaging is used, the packaging shall be removed and the timber open stacked and suitably protected. Subject to the weather conditions, timber may be left unprotected but only for very short periods.

2.1.7 **Plywood and other wood-based sheet materials**: Whether packaged or otherwise, shall be stored under cover.

2.1.8 Installed materials and components shall be protected from the weather. Appropriate ventilation shall be provided to reduce the uptake of moisture.

2.2 PANEL PRODUCTS

2.2.1
Edge stacking is not recommended.

2.2.1 Boards shall be adequately protected from the effects of the weather during transportation. Edges shall be protected from damage and all boards shall be stored flat to avoid distortion. Details of the type and quantity of the boards shall accompany each delivery.

2.2.2
Boards are manufactured to dimensional tolerances to allow close fit to be achieved on jointing. Conditioning allows boards to gradually attain the moisture content dictated by the atmosphere within the building.

2.2.2 Boards shall be stacked flat on bearers on a level surface. Spacing between bearers shall be such that there is no damage from sagging. Bearers shall be aligned vertically over each other to help prevent distortion.

2.2.3 Only when the boards are required for conditioning shall any protective wrapping be removed. Boards shall be conditioned as far as possible to the equilibrium moisture content likely to be attained in service and/or as directed by the architect.

2.3 TRUSSED RAFTERS

2.3.1
Damage resulting from poor storage can cause the springing of nails.

2.3.1 **Handling:** Trusses shall be handled and stored so as to prevent damage. Particular attention should be paid to handling trusses in their flat, weaker plane.

2.3.2 **Horizontal storage:** Trussed rafters shall be stored horizontally on levelled bearers at close centres, or vertically with supports provided only at node points.

2.3.3 **Ground clearance:** Trussed rafters shall be stored clear of the ground and covered to prevent damage from the weather. Stacks shall be adequately ventilated.

2.3.4 Trusses shall be lifted into place taking care to follow good health and safety practices. If needed the truss manufacturer/designer should be contacted to identify the appropriate lifting points.

2.4 QUALITY CONTROL AND TESTING

2.4.1 Quality control

2.4.1.1 On arrival on site, all materials shall be inspected by the contractor for damage and conformity to specification

2.4.1.2 Timber shall be delivered to site clean and properly protected and bound.

2.4.1.3 If deviations outside the allowed tolerances occur in more than 10%, or as previously agreed, of any parcel of timber or wood based panels, that parcel shall be rejected.

2.4.1.4 Structural components shall be manufactured under an approved quality control system.

2.4.1.5 The contractor shall appoint a suitable person to supervise on-site quality control procedures, which shall be approved by the architect/engineer, prior to commencement of the works.

2.4.2 Testing

2.4.2.1 Provision shall be made for the selection of samples of timber components and isolated elements for test, if and when requested by the architect/engineer.

2.4.2.2 Testing of timber and wood based materials and structural elements shall be in accordance with Eurocode 5 (or BS 5268 if appropriate) and/or the appropriate component or product standards, or as agreed with the engineer/architect.

2.4.2.3 Testing of timber and wood based materials and structural elements shall be carried out by an independent organisation agreed with the architect/engineer prior to undertaking such work.

D 3 Materials

3.1 TIMBER

3.1.1 Selection

3.1.1.1 Structural timbers used as an architectural material, and expressed as a finished element, shall be finished according to the architect's directions.

3.1.1.1
When structural timber is exposed to view it should show features such as grain, colour and texture. The sample chosen shall be representative of the species under consideration and be of adequate size.

3.1.1.2 The species shall be as specified by or as agreed with the architect and/or engineer.

3.1.1.2
Timbers available on the Irish market are described and illustrated in Section E2. Irish and other suppliers can identify and source other Irish-grown or imported timbers of character.

3.1.2 Grading and strength classes

Hardwoods used in construction shall be machine strength graded to EN 14081-4 or visually strength graded to BS 5756 and classified into strength classes as per EN 1912, or the permissible stress values determined from testing may be used.

3.1.2.1 Structural timber may be of the following strength classes:

Structural Softwoods:
C14, C16, C18, C22, C24, C27*, C30*, C35*, C40*
*not readily available on the Irish market.

BS 5268 Part 2 has 2 additional strength classes TR 26 (primarily for trussed rafters) and TR20 (*not readily available in Ireland*). TR 26 is a machine grade and is included in EN 14081-4.

Structural Hardwoods:
D30, D35, D40, D50, D60, D70

3.1.2.2
Structural softwood timber is strength graded to IS 127 or EN 519. Strength classes are listed in BS 5268: Part 2, and IS 444. In older buildings you may encounter the previous BS 5268 strength classes, (SC1, SC2,SC3,SC4, SC5) or the SR 11 strength classes (SCA, SCB, SCC).
The visual strength grades GS & SS do not change.

3.1.2.2 All structural softwood timber shall be visually strength graded to IS 127 (or BS 4978) or mechanically strength graded to EN 14081-4.

3.1.2.3 Structural softwood shall conform to a strength class as listed in EN 338 (or BS 5268: Part 2 if appropriate), or as specified and noted on drawings.

3.1.2.4
Hardwoods used in construction shall be machine strength graded to EN 519 or visually strength graded by BS 5756 and classified into strength classes as per EN 1912 or the permissible stress values determned from testing may be used.

3.1.2.4 Hardwoods used in construction shall be machine strength graded to EN 14081-4 or visually strength graded to BS 5756 and classified into strength classes as per EN 1912, or the permissible stress values determined from testing may be used.

3.1.2.5 The designer shall note the design strength class and/or species and grade on appropriate drawings and documentation.

3.1.2.6
Hardwoods in the medium to high density range, when compared to softwoods, have
- greater strength and stiffness which can lead to smaller cross sections being used for load bearing elements
- availability in longer lengths and larger sections
- higher density, giving superior fire resistance
- they are correspondingly more expensive

3.1.2.7
In certain circumstances (eg. where timber is to be finished with a clear finish and exposed to view),the end use may require markings to be omitted for aesthetic reasons. In such cases a certificate of conformance shall accompany the timber.
The engineer may request additional infomation such as tolerance class which may prove useful.

3.1.2.6 All structural timber shall be marked in accordance with the strength grading standards, which typically include:
- The monitoring authority/Certification body
- The Company Registered No.
- Graders/Machine Identification No.
- Strength class and/or visual grade
- Species/Species group
- Grading standard
- Source code

3.1.2.7 Where markings have been omitted, each parcel of timber of a single grade shall be despatched under the cover of a certificate of compliance typically stating the following information;
- Serial no. & date of cert.
- Grading company & customer's name & address
- Purchase order no.
- Timber dimensions
- Date of grading
- Strength grade & species
- Strength class
- Signature of the grader, countersigned by the supervisor

3.1.3 Dimensions

3.1.3.1 All dimensions quoted, and referred to on drawings, are target sizes.

3.1.3.2 Structural softwood timber shall be clearly specified by the designer by reference to strength class or by species and strength grade.

3.1.3.3 All softwood structural timber shall comply with the tolerances given in EN 336 and listed in table D 3.1.3.3.2 below.

3.1.3.2
Common softwood sawn lengths currently available are:
3, 3.3, 3.6, 4.2, 4.8, 5.4, 6, 6.6, 7.2m.
Less common:
3.9, 4.5, 5.1, 5.7m.
Commercial stock sizes available in Ireland may differ from those available in the UK and Northern Ireland.

Table D 3.1.3.3.1 *Common structural sizes available*

	WIDTH*mm						
THICKNESS*mm	100	115	125	150	175	200	225
36	✔	✔	✔	✔	✔		✔
44	✔	✔	✔	✔	✔		✔

CLS sizes 38 x 89 and 38 x 140 are readily available as well.

** Target sizes to EN 336*
The average dimension of a piece of timber must be the target dimension. Individual readings must lie within the Tolerance Class values

Table D 3.1.3.3.2 *Tolerance Classes (EN 336)*

Tolerance Class	For thicknesses and widths:	
	≤100mm	>100mm
1 (sawn)	-1 to +3mm	-2 to +4mm
2 (processed)	-1 to +1mm	-1.5 to +1.5mm

3.1.4
Moisture content needs to be specified and checked on site. Degrade and distortion can occur on drying out, if timber is not supplied, maintained and installed at the correct equilibrium moisture content likely to be attained in service. As wood-based panels are typically manufactured at low moisture contents they are required to be conditioned to a higher moisture content to avoid expansion problems.

3.1.4 Moisture content

3.1.4.1 The moisture content of structural timber shall comply with the categories listed in table D 3.1.4.1.1.

3.1.4.2 Timber shall be dried to an appropriate moisture content before strength grading and installation.

3.1.4.3 Moisture content may be measured using an electrical moisture meter with insulated probes used in accordance with the manufacturer's instructions.

Table D 3.1.4.1 *Moisture content recommendations (BS 5268 Pt. 2)*

Service Class	End use Condition	Average moisture content likely to be attained in service (%)	Moisture content which should not be exceeded in individual pieces at time of erection (%)
3	External uses, fully exposed	20 or more	-
2	Covered and generally unheated	18	24
2	Covered and generally heated	15	20
1	Internal uses in continuously heated buildings	12	20

3.1.5 Preservative treatment

3.1.5.1 See Section C: Sample Timber Specification

3.1.5
For more detailed information see Section A4- *Durability and Preservation.* For detail of preservation specification see *Section C - Sample Specification.*

3.1.6 Fire Resistance and treatment

3.1.6
The fire resistance of an element is assessed in relation to its ability to resist:
- structural collapse.
- perforation by flame or hot gases allowing the passage of heat.
- temperature rise on the non-exposed face.

3.1.6.1 Fire resistance of solid timber members shall be calculated in accordance with Eurocode 5 (EN 1995-1-2) or if appropriate BS 5268 Part 4 : Section 4.1, or Section 4.2.

3.1.6.2 Fire resistance of composite floor and wall elements shall be calculated in accordance with Eurocode 5 or if appropriate BS 5268 Part 4: Section 4.1, or. Section 4.2.

3.1.6.3 Where the methods outlined in 3.1.6.1 and 3.1.6.2 are not appropriate the fire resistance may be determined by assessment or by testing to the relevant EN or BS fire test standard.

3.1.6.4 The European classifications for fire spread of linings (reaction to fire) are described in EN13501-1. BS 476 provides similar classifications for the surface spread of flame of materials which are categorised as one of the following: Class 1, Class 2, Class 3 or Class 4. Technical Guidance Document B (Fire) specifies another class - Class 0 which is the highest class; the equivalent UK Approved Document has the same classification system.

3.1.6.5 Without treatment plywood, particleboard and hardboard are usually classified as Class D-s3, d2 or for the BS system, Class 3 surface spread of flame.

3.1.6.6 Most timbers are inherently categorised as Class D-s3, d2 or for the BS system Class 3 surface spread of flame classification.

3.1.6.7 Adhesives used for the assembly of fire-resistant elements shall be a type I conforming to EN 301.

3.1.6.8 All metal fasteners that contribute to the overall strength and stability of structural timber elements are required to be located below the anticipated char line, or have appropriate fire protection.

3.2 PANEL PRODUCTS

It is recommended that all panel products have a CE mark and that the CE mark be checked for its validity.

3.2.1 Plywood

3.2.1.1
When a plywood is referred to as an exterior grade of plywood, this refers to the durability of the adhesive and not to the durability of the species used in the plywood construction. Where a durable plywood is required, a plywood with a durable species or a treated less durable species shall be specified.

The appearance of face veneers is important for aesthetic reasons and it is prudent to check whether the description of the face veneer relates to both outer veneers or only to one face, the other outer veneer being referred to as the back veneer.

3.2.1.1 Plywood panel products for structural use shall conform to EN 13986 and EN 636. For designs to BS 5268 plywood may be selected from those listed in BS 5268 Part 2 or shall have certification from a suitable body such as the Agrément Board. Marine plywood shall comply with BS 1088: Marine plywood manufactured from selected untreated tropical hardwoods

3.2.1.2 Plywood designed to BS 5268 Part 2 shall be subject to the quality control procedures of one of the organisations listed in that standard, or to the controls listed by the certification body.

3.2.1.3 The specification for plywood shall state the following information where appropriate:
- Type
- Standard
- Grade
- Species
- Nominal thickness
- Number of plies
- Finish (sanded/unsanded)

3.2.1.3
Also consider specifying:
- Panel size
- Preservative treatment
- Moisture content
- Edge sealing treatment
- Bond quality
- Lay-up orientation

3.2.1.4 Plywood exposed to the weather shall have no open defects (e.g. checks, knots, holes, splits) on the exposed face(s) unless it is used only for a temporary application such as hoarding.

3.2.1.5 Prior to receiving a painted finish, plywood shall be adequately sanded.

3.2.1.6 All cut edges that may be subject to weather exposure shall be sealed with a suitable sealant or applied finish. Typically these shall be one of the following:
- Special sealing compounds, such as pitch epoxy
- Non-setting mastic, where the plywood is set in frames.
- Timber beading bonded with suitable adhesives.

3.2.1.4
Improved durability can be obtained by selecting specific wood species of suitable durability as outlined in EN 350-2. The application of hazard classes of biological attack to wood based panels is given in EN 335-1,2,3.

3.2.1.7 In construction the following procedures shall be observed:
1. Lower edges of boards shall be bevelled to promote shedding of water.
2. Plywood used as infill panels shall be fully painted before installation and/or assembly.
3. Cavities behind boards shall be adequately ventilated and drained to allow dispersal of moisture.
4. Clearance shall be allowed at selected joints to allow free drainage of water.
5. Plywood junctions with masonry shall provide adequate clearance to allow drainage, prevent capillary absorption of water and provide enough space for maintenance of edge sealing.
6. The bottom edges of boards shall stand well clear of flashings, roof coverings, sills, and the ground.
7. Exposed and/or inadequately protected fixings shall be of non-ferrous metals and have adequate corrosion resistance.

3.2.2 Other Board Materials

3.2.2.1 Table D 3.2.2.1 outlines the types and grades of boards commonly available in accordance with European standards.

Table D 3.2.2.1 *Types and grades of board*

Board type and grade description	Symbol	References
Particleboard		
• General purpose - dry	P2	EN 312-2
• Boards for interior fitments (incl. furniture) - dry	P3	EN 312-3
• Load bearing - dry	P4	EN 312-4
• Load bearing - humid	P5	EN 312-5
• Heavy duty load bearing - dry	P6	EN 312-6
• Heavy duty load bearing - humid	P7	EN 312-2
Oriented strandboard		
• General purpose and boards for interior fitments (incl. furniture) - dry	OSB/1	EN 300
• Load bearing - dry	OSB/2	EN 300
• Load bearing - humid	OSB/3	EN 300
• Heavy duty load bearing - humid	OSB/4	EN 300
Medium Density Fibreboard		
• General purpose - dry	MDF	EN 622-1
• General purpose - dry	MDF.H	EN 622-1
• Load bearing - dry	MDF.LA	EN 622-5
• Load bearing - humid	MDF.HLS	EN 622-5
Hardboard		
• General purpose - dry	HB	EN 622-2
• General purpose - humid	HB.H	EN 622-2
• General purpose - exterior	HB.E	EN 622-2
• Loadbearing - dry	HB.LA	EN 622-2
• Loadbearing - humid	HB.HLA 1	EN 622-2
• Heavy duty loadbearing - humid	HB.HLA 2	EN 622-2

Dry conditions - defined in terms of service class 1 of BS 5268 and EN 1995-1-1
Humid conditions - defined in terms of service class 2 of BS 5268 and EN 1995-1-1

3.2.2.2 All load-bearing boards shall be clearly and indelibly marked with the information required by the product standard and shall typically include the following information:
- Manufacturer's name, trade mark or identification mark
- Standard to which board is manufactured
- Type/Grade of board
- Nominal thickness
- Major axis (if not the length of the panel)
- Formaldehyde class
- Batch number or production week and year

3.2.3.1
The performance levels for each grade of board are based on various properties; effect of relative humidity change on length/width and thickness, water absorption and thickness swelling after immersion in water, bending strength, modulus of elasticity and internal bond.

3.2.3 Hardboard

3.2.3.1 Hardboard is generally unsuitable for use in wet or damp conditions and shall not be exposed to damp conditions during the construction process, unless there is a specific requirement for conditioning. Generally hardboard is only suitable for Service Class 1 conditions.

3.3 MECHANICAL FASTENERS

3.3.1 General

3.3.1.1 Table D 3.3.1.1 below outlines the various mechanical fasteners commonly available and the standard to which they must comply. In all cases, seek advice from the supplier/manufacturer with regard to suitability for the proposed end use.

3.3.1.2 Fasteners shall be compatible with any treatment or finish to the timber and with the service environment.

3.3.1.3 Metal timber connectors shall comply with EN 912 and shall be galvanised to 85 microns nominal thickness, unless specified otherwise. Where fasteners (e.g. nails, screws etc.) are designed to BS 5268-2, the fasteners shall comply with the requirements of that standard. Where fasteners (e.g. nails, screws etc.) are designed to BS 5268-2, the fasteners shall comply with the requirements of that standard.

3.3.1.4 Unless specified otherwise metal restraint straps shall be mild steel, galvanised and of cross-sectional size 50x2.5mm or 30x5mm.

3.3.1.5 Screws shall be turned and not hammered into predrilled holes. The hole for the shank shall have a diameter equal to the shank diameter and be no deeper than the length of the shank. The pilot hole for the threaded portion of the screw shall have a diameter of approximately 70% of the shank diameter.

3.3.1.6 The tops of counter sunk screws shall be no more than 1mm below the surface of the timber, unless the hole is to be plugged.

3.3.1.7 The end distances, edge distances, and spacings of screws shall be such as to avoid undue splitting and shall not be less than the values in Table D3.3.1.7.

There are a number of European Standards for timber fasteners (e.g. nails) and connectors (e.g. split rings) and these include:

EN 912 'Timber specification for connectors for timber'
EN 14545 'Timber structures – connectors –requirements'
EN 14592 'Timber structures – fasteners–requirements'

These have largely replaced the standards listed below, some of which may still be valid for designs to BS 5268 although they may not have been revised for some time.

Table D 3.3.1.1 *Fastener types*

Fastner Type	Reference Standard	Comments
Nails	IS 105 BS 1202: Part 1 Part 2 Part 3	Normally mild steel and available unprotected or corrosion resistant. Round wire nails suitable for small loads in shear. Oval wire nails suitable for joinery/carpentry where structural design of the joint is not required. Cut nails suitable for nailing softwood flooring. Annular ring shank and helical threaded used in special circumstances.
Coach Screws	BS 1210	Requires screws to be inserted into predrilled holes
Bolts	EN 20898-1	Used for large connections and available unprotected or rust proofed. Washers normally 3 times the bolt diameter. Expanding bolts and nuts shall be of an approved type.
Toothed plate connector	BS 1579	Round or square and available single sided or double sided. Can be used in single shear or double shear.
Split ring connector	BS 1579	Used for high lateral load carrying applications. Normally available in two nominal diameters, 64mm and 104mm respectively.
Shear plate connector	BS 1579	Shear plate connectors must be given an anti-corrosion treatment. Normally available in two sizes, 67mm and 102mm, outside diameters.
Punched metal plate fasteners	–	Proprietary plates with integrated teeth used as gusset plates for truss rafters. Plates are pressed into the timber on each side of the joint.
Other connectors	–	Proprietary rawlbolts, ragbolts, dowels etc
Steel washers	BS 4320	Available square or round - visible washers shall be round.
Cup head square neck coach bolts	BS 4933	General Dimensions and Mechanical Properties.

Table D 3.3.1.7 *Distances of screws from end, edge and each other (Permissible stress design)*

Spacing	Distance of pre-drilled holes
End distance parallel to grain	10 (d)
Edge distance perpendicular to grain	5 (d)
Distance between line of screws perpendicular to the grain	3 (d)
Distance between adjacent screw in any one line parallel to grain	10 (d)

Note: 'd 'is the shank diameter of screw. Fastener spacing, end distances and edge distances ref er to distance from fastener centre line.

The above values are derived from BS 5268 - 2 and are not appropriate to limit state design where the values are related to screw diameter and whether or not the screws are taking axial load.

EN 1995 1-1 should be consulted where designs are undertaken to that standard.

3.3.2 Bolted joints

3.3.2.1 Washers with a nominal diameter and thickness of at least 3.0 times and 0.25 times the bolt diameter respectively, shall be fitted under the head of each bolt and under each nut unless the equivalent bearing is provided by a steel plate.

3.3.2.2 When tightened, a minimum of one complete thread shall be protruding from the nut.

3.3.2.3 Bolt spacing - end distances, edge distances and spacings given in table D 3.3.2.3 below shall apply to bolted connections in timber.

Table D 3.3.2.3. *Minimum bolt spacings*

Direction of loading	End distance		Edge distance		Distance between	
	Loaded	Un-loaded	Loaded	Un-loaded	Across grain	Parallel to grain
Parallel to grain	7d	4d	1.5d	1.5d	4d	4d
Perpendicular to grain	4d	4d	4d	1.5d	4d	5d*

*Where the member thickness is less than 3 times the bolt diameter, the spacing parallel to the grain for bolts loaded perpendicular to grain may be taken as the greater of *3d* or *(2+t/d)d*, where *t* is the member thickness and *d* is the bolt diameter.

The above values are derived from BS 5268-2 and are not appropriate to limit state design.

EN 1995 1-1 should be consulted where designs are undertaken to that standard.

3.3.2.4 The diameter of holes in either timber or steel plate shall be as close to the nominal diameter of the bolts as practicable and in no case greater than 2mm larger than the diameter of the bolt.

3.3.2.5 Timber shall not bear on the threads of bolts.

3.3.2.6 Where metal plates are used in a joint, the metal shall not bear on the threads of the bolt.

3.3.3 Steel dowel joints

3.3.3.1 Unless specified otherwise plain steel dowels should have a minimum tensile strength of 400N/mm².

3.3.3.2 The minimum diameter of plain steel dowels used shall not be less than 6mm (or 8mm for designs to BS 5268-2).

3.3.3.3 The specified tolerances on plain steel dowels shall be -0mm /+0.1mm.

3.3.3.4 Dowels shall be inserted into pre-bored holes in the timber members which shall have a diameter not greater than the dowel.

3.3.3.5 Where plain steel dowels are used in timber/steel plate joints and the steel plate forms the outer member, the outer steel plate is to be secured in position by nuts and washers on threaded ends of plain steel dowels.

Spacings of steel dowels shall be as per bolt spacings (Ref table D 3.3.2.3).

3.3.4 Toothed-plate connector joints

3.3.4.1 Toothed-plate connectors shall conform to EN 912 and be of the size and type specified.

3.3.4.2 Round or square washers shall be fitted between timber and the head and nut of the bolt. The size of washer shall be appropriate to the bolt and connector size as shown in table D 3.3.4.2

Table D 3.3.4.2 *Sizes of toothed-plate connectors and minimum sizes*

Connector Type	Nominal size of connection	Nominal size and thread diameter of bolt	Minimum size of round or square washers	
			Diameter or length of side	Thickness
	mm	mm	mm	mm
Round toothed plate, double and single-sided	38	M10	38	3
	51	M12	38	3
	64	M12	50	5
	76	M12	60	5
Square toothed-plate, double and single-sided	38	M10	38	3
	51	M12	50	3
	64	M12	60	5
	76	M12	75	5

3.3.4.3 Bolt holes shall be within 2mm of their specified position.

3.3.4.4 Bolt holes shall be as close as practicable to the nominal diameter of the bolt and in no case greater than 2.0 mm larger than the bolt diameter.

3.3.4.5 Connectors shall not bear on the threads of bolts.

3.3.4.6 Joint preparation - the positions of bolt holes shall be accurately set out with reference to the point of the centre lines of the members, unless directed otherwise by the engineer.

3.3.4.7 Connector spacing - the end distance, edge distance and spacing between connectors shall be as specified by the engineer.

3.3.4.8 In assembling a toothed-plate connector joint, the following procedure shall apply:

1. Assembly - toothed-plate connectors shall be embedded prior to the insertion of the bolt by using a high-tensile steel bolt with plate washers larger than the connectors between the timber surfaces and the nuts of the two end nuts.
2. For large connectors or multi-member joints, thrust bearings shall be used under each nut.
3. The bolt shall be tightened sufficiently to embed fully the connector teeth, and the washers used shall be of sufficient size to avoid undue crushing of the timber.
4. The joint shall be clamped before the bolt clamp is withdrawn and the permanent bolt with the appropriate size washers, is inserted.

3.3.4.9 Toothed-plate connectors may only be used where full embedment of the teeth can be achieved.

The above values are derived from BS 5268-2 and are not appropriate to limit state design..

EN 1995 1-1 should be consulted where designs are undertaken to that standard.

3.3.5 Split ring connector joints

3.3.5.1 Split ring connectors shall conform to EN 912 and shall be the appropriate combination of connector, bolts and washers as shown in table D 3.3.5.1.

Table D 3.3.5.1 *Sizes of split-ring connectors and minimum sizes*

Nominal size of connector mm	Nominal size and thread diameter of bolt mm	Min. size of round washers	
		Diameter/length of side mm	Thickness mm
64	M12	50	3
102	M20	75	5

3.3.5.2 Bolt holes shall be as close as practicable to the nominal diameter of the bolt, and in no case more than 2.0mm larger than the bolt diameter.

3.3.5.3 Round washers shall be fitted between the timber and the head and nut of the bolt.

3.3.5.4 Joint preparation - the position of the bolt holes shall be set out accurately with reference to the point of intersection of the centre lines of the members, unless specified otherwise by the engineer.

3.3.5.5 Bolt holes shall be within 2mm of their specified position.

3.3.5.6 The contact surfaces of the timber members shall be grooved to the dimensions given in table D 3.3.5.6.

Table D 3.3.5.6 *Circular groove dimensions for split ring*

Split	imensions of Groove (in mm)		
Diameter	Inside Diameter	Width	Depth
64	65	4.6	9.5
102	104	5.3	12.7

3.3.5.7 Connector spacing - ensure that the required minimum standard end distance, edge distance and spacing between connectors are at least those values listed in table D 3.3.2.3.

The above values are derived from BS 5268-2 and are not appropriate to limit state design.

EN 1995 1-1 should be consulted where designs are undertaken to that standard.

3.3.6 Shear plate connectors

3.3.6.1 Shear plate connectors shall be in accordance with EN 912 and conform to the sizes given in table D 3.3.6.1

Table D 3.3.6.1 *Sizes of shear plate connectors and minimum*

Nominal size of connector	Nominal size and thread dia of bolt	Min. size of round washers (mm)	
		Dia./length of side	Thickness
67	M20	75	5
102	M20	75	5

3.3.6.2 Bolts and Washers - the nominal diameter of the bolts to be used with shear plate connectors shall be those given in table D 3.3.6.1

3.3.6.3 Bolt holes shall be as close as practicable to the nominal diameter of the bolt and in no case more than 2.0mm larger than the bolt diameter.

3.3.6.4 Bolt holes should be within 2mm of their specified position.

3.3.6.5 Connectors shall not bear on the threads of bolts.

3.3.6.6 Joint preparation - the positions of the bolt holes shall be set out accurately with reference to the point of intersection of the centre lines of the members.

3.3.6.7 Connector spacing - the standard end distance, edge distance and spacing of connectors shall be those minimum dimensions listed in BS 5268 Part 2 and appropriate to the connector sizes, unless specified otherwise by the engineer.

3.3.6.8 Assembly - sawdust, chippings and shavings shall be removed before inserting the shear plate into the recess.

The above values are derived from BS 5268-2 and are not appropriate to limit state design.

EN 1995 1-1 should be consulted where designs are undertaken to that standard.

3.4 ADHESIVES

3.4.1 **Structural wood adhesives:** Shall comply with EN 301: *Adhesives phenolic and aminoplastic, for load-bearing timber structures: Classification and performance requirements.*

Type I adhesives, which will stand full outdoor exposure and temperatures above 50°C.

Type II adhesives, which may be used in heated and ventilated buildings and exterior protected from weather.

3.4.2 **Test methods for adhesives:** Shall comply with EN 302: *"Adhesives for load-bearing timber structures - Test methods", Parts 1-4.*

3.4.3 **Adhesives for structural purposes:** Shall produce joints of such strength and durability that the integrity of the bond is maintained in the assigned service class throughout the expected and/or design life of the structure.

3.4.4 **Adhesives:** The following adhesives may be considered subject to the design engineer's approval:
- Resorcinol formaldehyde and phenol resorcinol formaldehyde
- Phenol-formaldehyde, hot setting
- Urea formaldehyde
- Melamine urea formaldehyde
- Casein adhesives

3.4.5 **Surfaces for gluing:** Shall be flat, smooth and free from grit, dust or other matter detrimental to the efficacy of the bond. Bonding shall take place as soon as possible after planing/ sanding.

3.4.6 **Moisture content:** Timber shall be conditioned, to a moisture content corresponding to the average moisture content likely to be attained in service, prior to gluing.

3.4.7 **Treated timber:** Shall not be glued without prior approval of the engineer.

3.4.1/1
Acceptable strength and durability can be achieved by using a polycondensation adhesive of the phenolic or aminoplastic type as defined in EN 301. The adhesive shall meet the requirements for adhesive type 1 or 2 as appropriate to EN 301.

3.4.1/2
Not all adhesives can be classified in accordance with EN 301. It is the responsibility of the designer/engineer to ensure the adhesives selected are suitable for the specified service class and comply with current regulations.

For glulam members refer to EN 386 *Glued Laminated Timber* - performance requirements and minimum production requirements.

D 4 Workmanship

4.1 GENERAL

4.1.1 **Adequate supervision:** There shall be adequate supervision throughout the preparation and construction of the structure to ensure that it conforms to the principles and practical considerations of the design.

4.1.2 **Workmanship in fabrication and preparation:** Material shall conform in all respects to accepted good practice.

4.1.3 **Materials applied used and fixed:** Materials shall be applied, used and fixed in such a way as to perform adequately the functions for which they are designed and intended.

Reasonable access staging and platforms, shall be provided by the contractor to all the works and shall be complete and safe.

4.1.4 **Timber damaged, crushed or split:** Timber which is damaged, crushed, or split beyond the limits permitted for similar defects in the grading, shall be rejected or repaired to the satisfaction of the design engineer.

4.1.5 **Moisture content of timber:** Shall be checked upon delivery by a properly calibrated moisture meter, used in accordance with the manufacturer's instructions.

4.1.6 **Time of erection:** At the time of erection, the moisture content of timber shall not exceed the maximum permitted. (See Table D3.1.4.1).

4.2 ON-SITE CARPENTRY

4.2.1 General

4.2.1.1 Dimensions and spacing shall not be scaled from drawings.

4.2.1.2 Discrepancies and/or deviations from drawings and details are to be reported to the architect/engineer for his/her direction.

4.2.1.3 The size, shape and finish of all members and materials shall conform to the detailed drawings and specifications.

4.2.1.4 Connect timber roofs and suspended floors to walls in accordance with approved details, such as those recommended in Technical Guidance Document Part A to the Irish Building Regulations: subject to any requirements shown on the engineer's drawings.

4.2.1.5 Metal straps shall be fixed in accordance with the manufacturer's instructions and those of the design engineer.

4.2.1.6 Where timber members spanning parallel to a wall are to be restrained, the straps shall be attached to bonders or solid noggings fixed firmly to the joists. Additionally there shall be a packing piece between the wall and the nearest joist.

4.2.1.7 The maximum amount of machining should be carried out prior to preservative or fire-retardant treatment.

4.2.1.8 Where cross-cutting, boring, notching or other working is necessary after preservative treatment any exposed surfaces should be given two liberal brush coats of an appropriate preservative.

4.2.2 Load-bearing stud walls

4.2.2.1 Load-bearing stud walls shall be designed to EN 1995-1-1 or for permissible stress designs to BS 5268: Part 2.

4.2.2.2 Studs shall be bridged at mid-height, and contained between head and sole plates of the same cross-sectional dimensions. Two rows of noggins are required where the height exceeds 2.4m.

4.2.2.3 Loads from load-bearing elements shall be transmitted directly to studs and hence to a suitable foundations. Where loads are not transferred directly to a stud, a double head binder shall be used subject to the agreement of the design engineer.

4.2.3 Ceiling joists

4.2.3.1 Ceiling joists should be chosen from the span tables given in Swift 6 (for Ireland) or alternatively designed to EN 1995-1-1 or for permissible stress designs to BS 5268: Part 2.

4.2.3.2 Ceiling joists are generally not suitable to sustain loads from purlins or water tanks. An alternative means of support shall be designed by the design engineer. (See Detail B 1.4)

4.2.3.3 Where ceiling joists are used to triangulate the rafters together, suitable fixings shall be made at the joist-rafter connection and at any ceiling joist splices, to ensure the continuity of all components forming the triangulation.

4.2.3.4 Where ceiling joists run perpendicular to rafters (e.g. on a hip end roof) arrangements shall be made to tie hip end jack rafters with binders and diagonal ties in the plane of the ceiling.

4.2.3.5 Where joists, trimmers, etc. do not have direct bearing support, approved galvanised steel hangers shall be used in accordance with the manufacturer's recommendations.

4.2.3.6 Notching and drilling of joists may be carried out within zones as shown in Fig. A 2.1. In all other circumstances where it is necessary to pierce or notch a member, the engineer's prior approval shall be obtained. In existing buildings, the design engineer shall be advised wherever existing notching or drilling is found that does not comply with detail. Fig A 2.1.

4.2.3.7 All trimmers and trimming joists and their connections shall be designed to EN 1995-1-1 or for permissible stress designs to BS 5268: Part 2.

4.2.4 Purlins

4.2.4.1 Timber purlins shall be selected from tables given in Swift 6 (for Ireland) or alternatively, they shall be designed in accordance with EN 1995-1-1 or for permissible stress designs to BS 5268: Part 2.

4.2.4.2 Purlins that are aligned vertically shall have rafters birds-mouthed to fit over the top of purlin with a suitable connection and tie. Purlins shall be adequately supported by a wall or other suitable structure. Structural arrangements shall be approved by the engineer.

4.2.4.3 Purlins that are perpendicular to the rafter plane shall be supported with 75x100mm (minimum and subject to length) struts suitably restrained from horizontal movement. The loads shall be transmitted to load-bearing elements e.g., masonry, load-bearing partitions, timber or steel beams. Structural arrangements shall be approved by the design engineer.

4.2.5 Rafters

4.2.5.1 Structural timber rafters may be chosen from the span tables given in Swift 6 (for Ireland) or alternatively, shall be designed by the design engineer to EN 1995-1-1 or for permissible stress designs to BS 5268: Part 2.

4.2.5.2 Where lining is affixed directly to the bottom edges of rafters, these shall be of a suitable depth to accommodate insulation and a ventilation void of 50mm above the insulation. A vapour check should be fitted on the warm side directly behind the linings.

4.2.5.3 A suitable arrangement shall be made to restrain horizontal movement of rafters at eaves level.

4.2.5.4 Birdsmouthed notches in rafters over wall plates, purlins etc. shall be to a maximum depth of one-third of the rafter depth. Design of the rafters shall take into account the reduced depth.

4.2.6 Flat roofs

4.2.6.1 Flat roofs shall be laid at falls between 1 in 80 and 1 in 40 but in no case at less than 1 in 80.

4.2.6.2 Timber firring pieces shall be tapered to suit the fall and laid on all timber joists.

Decking shall be OSB 3 or plywood to EN 636 (-2 humid or -3 exterior use) laid on firring pieces.

4.2.6.3 Drainage shall be provided so that water will drain away without ponding.

4.2.6.5 For domestic roofs, provide a layer of chipping to felt roofs; alternatively provide ballast.

4.2.6.6 Where a cold deck flat roof is specified provide a minimum 50mm ventilation space between joists and over the insulation. A vapour check should be tacked to the underside of the joists.

4.2.6.7 Chipboard is not considered suitable for use as a decking in flat roofs.

4.2.6.8 Proprietary roof vents are available.

D 5 Prefabricated elements

5.1 GENERAL

5.1.1 Factory fabrication

> **5.1.1**
> The engineer should thoroughly check all calculations and shop drawings.
> Scheduled and unscheduled factory visits should be made to manufacturing plant by architect/engineer during the manufacturing of timber structural components.

5.1.1.1 Proposed changes in design, materials and/or component arrangement shall be reported to the architect/engineer for approval, prior to manufacture.

5.1.1.2 Detailed design calculations, and shop drawings, shall be submitted to the architect/engineer for approval, prior to manufacturing.

5.1.1.3 The architect/engineer shall be notified in writing by the manufacturer of the intended start and completion of the manufacture of components. They shall be invited to inspect and view the manufacturing process and the completed elements prior to dispatch to site.

5.1.1.4 When grade or other necessary identification marks are removed from timber components, provisions shall be made for remarking in accordance with EN 1995-1.1 (or BS 5268-2 for permissible stress designs), IS 127 (or BS 4978), EN 14081 or BS 5756.

5.1.1.5 Where preservation treatments or flame-retardant treatments are required, care shall be taken to ensure that all machining, notching, cutting and drilling has taken place prior to the application of such treatments.

5.1.1.6 The assembled component shall conform to the geometry and layout drawings as specified by the designer and is to be achieved correctly within the specified tolerances.

5.1.1.7 During assembly and erection, no forces shall be applied to components which could cause damage or the permissible stresses to be exceeded. Special care may be necessary when handling framed arches and shaped beams.

5.1.1.8 Dimensional tolerances of section sizes, the fit of assembled elements to each other and to secondary and primary elements shall comply with the specific requirements of the standard for the component require ments. Where no standard exists, the approval of the architect and engineer shall be sought prior to manufacture, assembly and erection.

5.1.2 Assembly

5.1.2.1 The method of assembly and erection shall be such as to ensure that the geometry and layout of the assembled components, as specified by the designer, is within the specified tolerances.

5.1.2.2 The contractor shall submit to the design engineer, for approval, the proposed method and sequence of erection of prefabricated elements.

5.2 GLUED LAMINATED MEMBERS

5.2.1 General

5.2.1.1 All structural glued laminated timber elements shall be designed to conform to the requirements of Eurocode 5 or if appropriate BS 5268: Part 2.

5.2.1.2 Glued laminated structural elements shall be manufactured to EN 386.

5.2.1.3 In accordance with EN 386, the following species are suitable for glued laminated elements: Douglas fir, European redwood, European white-wood, hemlock, Corsican pine, Austrian black pine, larch, maritime pine, poplar, radiata pine, western red cedar and Sitka spruce. Other species may be approved for use subject to agreement with the architect.

5.2.1.4 All structural timber shall be strength graded to IS 127 or machine graded to the appropriate part of EN 14081.

5.2.1.5 An approved fabricator shall be engaged by the main contractor to fabricate the glued laminated members.

5.2.1.6 Steel plates and brackets shall be cut and welded by an approved steel work fabricator. They shall be galvanised to a minimum of 85 microns nominal thickness unless otherwise specified.

5.2.2 Fabrication

5.2.2.1 Detailed shop drawings shall be prepared by the specialist fabricator where necessary; detailed calculations and specifications for all connections and bearings are to be prepared by the specialist fabricator to suit loadings specified by the engineer. Samples of steel connections and brackets shall be made up for the architect's approval. Adequate notice must be given to allow for inspection of the first fabricated member in the works by the architect and engineer.

5.2.2.2
The correct method of bracing is fundamental to the adequate stability of the roof structure.
For non-standard roof arrangements, an engineer should advise and supervise the bracing and general design of the roof.

5.2.2.2 Beams shall conform to the final dimensions shown on the work drawings. The exact beam profile shall be subject to agreement by the architect. Where applicable beams should be pre-cambered by the amount specified by the architect and agreed with the design engineer.

5.2.2.3 The required MC (moisture content) of the laminations at fabrication depends on whether or not the timber has been treated:

- Non-treated timber at assembly: the MC in every lamination shall be in the range 8-15%, with the range of MC in a glulam member not exceeding 4%.
- Treated timber at assembly: the MC in every lamination shall be in the range 11-18%, with the range of MC in a glulam member not exceeding 4%.

5.2.2.4 Maximum lamination thickness shall not exceed the values given in EN 386.

5.2.2.5 Sections shall be built up one lamination at a time.

5.2.2.6 Finger joints in laminations shall be staggered in adjacent laminae.

5.2.2.7
Acceptable strength and durability can be achieved by using a poly-condensation adhesive of the phenolic or aminoplastic type as defined in EN 301. The adhesive shall meet the requirements for adhesive type 1 or 2 as appropriate to EN 301.

5.2.2.7 Adhesives shall comply with type I or type II as outlined in EN 301. Typically glue to be resorcinol-formaldehyde (RF) type in accordance with EN 12765 and used strictly as recommended by the manufacturer. The adhesive shall be chosen considering the climatic conditions, species, preservative (if used) and production method.

5.2.2.8 All items shall be matched in the factory before fabrication in order to ensure correct fit.

5.2.2.9 Exposed faces of beams shall be finished to the architect's requirements. A sample beam will be required for approval by the architect which, if accepted, may be incorporated in the works.

5.2.3 Erection

5.2.3.1 Damaged or defective members shall be removed from site immediately and replaced with new ones to the architect's approval.

5.2.3.2 The frame, purlins, etc., unless otherwise agreed, shall be erected, plumbed, lined, levelled and finally fixed by the specialist fabricator on their supports as indicated on the engineer's drawing.

5.2.3.3 Sufficient temporary bracing shall be provided to ensure stability of frames, purlins etc.

5.2.3.4 All work including fabrication and site work shall be carried out by experienced personnel under the supervision of a foreman approved by the architect or engineer.

5.2.4 Finishes and marking

5.2.4.1 Finishes shall be in accordance with the architect's requirements.

5.2.4.2 Glued laminated structural elements shall be protected from damage and environmental degradation until handover of the building.

5.2.4.3 Glued laminated members shall be marked with the following information:

(a) name or identity of producer
(b) strength class and species of laminate
(c) adhesive type
(d) production week and year
(e) certificate number
(f) standard number

5.2.4.4 Where it is not appropriate to mark the member for aesthetic reasons, a certificate containing the information in clause 5.2.4.3 shall accompany the glued laminated members along with additional information requested by the architect or engineer.

5.3 PLYWOOD BOX AND I-BEAMS

5.3.1 Plywood box and `I' beams shall be designed in accordance with EN 1995-1-1 or if appropriate BS 5268: Part 2. These members should have an ETA (European Technical Approval) or an Agrément Certificate; usually these documents will have load span tables and additional information relevant to their use.

5.3.1
Manufacturers specify different requirements for web stiffeners for I-beams but typically stiffeners shall be provided on both sides of the web and fixed using 3.35mm diameter nails at 50mm centres. Stiffeners shall be min. 89mm wide and shall be fixed hard against the top surface of the bottom flange leaving a specified gap between the top of the stiffener and underside of the top flange.

5.3.2 For designs to BS 5268-2 manufacture shall be in accordance with BS 6446 "Specification for manufacture of glued structural components of timber and wood based panels".

5.3.3 Sawn timber shall comply with EN 336 and shall be planed within 24 hours prior to assembly. Flange members shall be strength graded to IS 127 or EN 519.

5.3.4 Plywood shall comply with the specification clauses 3.2.1.1 to 3.2.1.8 of this specification.

5.3.5 Glue shall meet the requirements of EN 301.

5.3.6 Preservation, if specified, shall be in accordance with the appropriate hazard class.

5.3.7 At the time of assembly, the moisture content of the timber shall be between 14 and 18%.

5.4
The maximum spans achievable are in the order of 7 - 9 metres. Stressed skin panels can be either single or double skinned.

5.4 STRESSED SKIN PANELS

5.4.1 Design and materials

5.4.1.1 Stressed skin panels shall be designed in accordance with BS 5268: Part 2

5.4.1.2 Materials for panel flanges shall be either plywood, OSB, particleboard or fibreboard. Plywood shall meet the requirements of Class 2 of EN 314-2. OSB shall be grade OSB/4, or better, in accordance with EN 300; particleboard shall be grade P7 in accordance with EN 312 and fibreboard shall be grade HB.HLA 1/2 in accordance with EN 622. Materials for the panel webs shall generally be softwood timber, strength graded either by visual or mechanical means to IS/127, EN 518, EN 519 or BS 4978, to the strength classes specified in IS 444.

5.4.2 Fabrication

5.4.2.1 Stressed skin panels shall be manufactured to BS 6446 *"Specification for manufacture of glued structural components of timber and wood based panels".*

5.4.2.2 Insulation shall be provided between the web members where appropriate to meet the minimum thermal performance requirements outlined in the Technical Guidance Documents of the Building Regulations or the client's requirements. The insulation must be a tight fit and must be restrained during panel transit and site handling.

5.4.2.3 A ventilation space shall be provided in roof panel construction. It must be unobstructed over the full panel length and must be open at each end by providing holes in the blocking pieces subject to approval by the engineer. 500-gauge polythene vapour check shall be placed on the warm side of the insulation with the joints lapped and sealed, stapled to the surface of the flange panel before installation of the internal lining board.

5.4.2.4 Surfaces to be glued must be free from oil, dust and foreign matter. The glue manufacturer's specifications must be strictly adhered to. Glue shall meet the requirements of EN 301.

For non-structural applications glue shall meet the requirements of EN 12765 if appropriate.

5.4.2.5 Moisture content of timber at time of prefabrication shall not exceed 14% where panels will be used in a normal internal (heated) environment. For panels used in roof construction the moisture content of timber shall not exceed 18%.

5.4.2.6 No alterations to the panels shall be made without the prior approval of the engineer.

5.4.2.7 For panels without tension flanges, intermittent blocking at intervals not exceeding 3m shall be provided. All blocking timber shall be the same size as the web members.

5.4.3 Erection

5.4.3.1 Where roof panels are erected against a ridge, temporary support shall be provided until the partner panel is in place.

5.5 TRUSSED RAFTERS

5.5.1 General

5.5.1.1
The design of truss rafters has been developed by the design system owners who may be the truss plate manufacturers. They have developed computer programmes to interpret loading conditions to produce a design for individual trusses, and roof systems.
These designs assume that adequate bracing, load distribution of water tanks and fixing takes place on site.

5.5.1.3
Note: The trussed rafter fabricator operates the design software.

5.5.1.4
Trussed rafters fall into Hazard Class 1 or 2 for preservative treatment.

5.5.1.1 Unless otherwise specified, trussed rafters shall comply with the recommendations of IS 193 or BS 5268: Part 3.

5.5.1.2 All trussed rafters shall comply with the requirements of the National Standards Authority of Ireland (NSAI) Roof Truss Manufacturers' Approval Scheme and each truss shall carry the NSAI Quality Truss Tag.

5.5.1.3 Responsibilities - The designer shall mean the building designer who shall, through the main contractor, make available all the necessary information, supplemented by site information provided by the main contractor, for the design of the trussed rafters and other elements to be carried out by the trussed fabricator (usually trained and using software supplied by the design system owner). The overall responsibility for roof design rests with the building designer. The trussed fabricator/design system owner shall be responsible for the design of the trussed rafters and shall provide a detailed design service and full manufacturing and assembly details for the fabricator in relation to each individual trussed rafter, compound girder, hip set assembly and valley set, their connections to each other and seating requirements.

5.5.1.4 The main contractor shall obtain for the architect and engineer, from the truss fabricator/design system owner, written certification that he has received all the necessary information to enable him to provide the specified design service. The trussed fabricator/design system owner shall state explicitly in writing whether or not he has assumed, or his design requires, any bracing, tying etc., additional to that called up on the engineer's or the architect's drawings and specifications, and shall describe such additional bracing, tying etc., to the main contractor to enable the work to be carried out on site. Copies of this information shall be sent to the architect/engineer to assist with any inspections carried out on site.

5.5.1.5 Only trussed rafters designed and fabricated under the NSAI scheme will be acceptable for use in Ireland.

5.5.2 Design

5.5.2.1 Design loadings - Trussed rafters and their connections shall be designed for the minimum loadings recommended in IS 193 or BS 5628: Part 3.

5.5.2.2 Detailed working drawings shall be submitted by the fabricator to the architect and engineer for approval, but this approval shall in no way relieve the main contractor, the fabricator or the design system owner of their responsibilities for the work. The drawings shall include a layout drawing and a drawing of each type of truss to be supplied. The latter shall show the strength class of the timber assumed in the design and the timber member sizes. At hipped roofs, details of supports for jack rafters, etc., shall be fully detailed on the drawings; at roof intersections details of compound trusses, special shoes etc., shall be detailed on the drawings. The drawings shall show for each truss type the type, dimensions and positioning of all metal plates or gussets together with the number of effective teeth, bursts or nails required in each member, at each joint.

5.5.2.3 All relevant dimensions and other particulars are to be checked and confirmed on site by the main contractor and the fabricator before fabrication of the trussed rafters commences.

5.5.3 Materials

5.5.3.1 Timber species and strength grade shall be as specified by the engineer and/or shall be of a strength class appropriate to the design. Where requested samples shall be delivered to the engineer for approval. Great care shall be exercised to ensure that timber with excessive splits, knots or twist, is not used.

5.5.3.2 Metal plates shall be of an approved type, hot dip galvanised and manufactured from steel with a minimum thickness of 0.91mm. Plates shall comply with the recommendations of IS 193 or BS 5628: Part 3.

5.5.4 Fabrication

5.5.4.1 Detailed shop drawings shall be prepared by the fabricator where necessary.

5.5.4.2 Detailed calculations and specifications for all connections and bearings are to be prepared by the fabricator to suit loadings specified by the engineer.

Steel plates and brackets shall be cut and welded by an approved steel work fabricator. They shall be galvanised to a minimum of 85 microns nominal thickness unless otherwise specified.

5.5.4.3 Samples of steel connections and brackets shall be made up for the architect's/engineer's approval.

5.5.4.5 The fabricator shall take the greatest care in the choice of timber, and assembly techniques shall be of the highest order to match design requirements. The fabricator shall take particular care to ensure that timber with splits, knots, twist etc., in excess of that permitted by IS 193 or (BS 5268) is not used; also that the correct strength class of timber and the correct member sizes as required by the design are used. After the trussed rafters are erected and bracing and other members fixed, the roof structure shall be inspected by the engineer to ensure compliance with the design requirements.

5.5.4.6 Moisture content shall be a maximum of 20% at time of fabrication.

5.5.4.7 All members shall be planed all over and section sizes quoted on the drawings shall be understood to mean finished sizes after planing.

5.5.4.8 All items shall be matched in the factory before fabrication in order to ensure correct fit.

5.5.5 Structural adequacy

5.5.5.1 Assessment of structural adequacy may be by any of the methods specified in IS 193 or BS 5268: Part 3. Full details shall be submitted to the engineer at his request. Where acceptance is based on tests on prototype units the test shall be carried out at the supplier's expense by an independent testing authority and the results shall be forwarded directly to the architect by the independent authority. Acceptance of test results shall be at the sole discretion of the engineer.

5.5.6 Workmanship on site

5.5.6.1

The following is a list of faults which render trussed roof rafters defective - the list is not exhaustive or complete:

- Plates not fully pressed home - a loss of even a few millimeters of penetration can seriously weaken a joint.
- Plates not the correct size or not located as shown on drawings.
- Plates with bent or flattened nails.
- Gaps between ends of abutting members at a joint in excess of 1.5mm.
- Plates not provided on both sides of a joint.
- Timber used with excessive splitting, knots or twisting, etc.
- Correct grade of timber not used.
- Member sizes not in accordance with the design.

5.5.6.1 Each individual trussed rafter shall be inspected by the main contractor on arrival on site. Bundles of rafters shall be opened and each truss inspected and re-stacked. These operations are essential and the contractor shall allow for their cost when pricing. The contractor's attention is drawn to damage that can occur by mishandling on site; trussed rafters are very flexible and if allowed to bend or whip the plates may loosen.

5.5.6.2 Defective truss rafters - damaged or defective trussed rafters shall be removed from the site immediately and replaced with new ones.

5.5.6.3 No modification to trussed rafters shall be carried out on site without the approval of the architect/engineer.

5.5.6.4 Trussed rafters may not be birdsmouthed or otherwise cut except where shown on the approved drawings.

5.5.6.5 The trussed rafters shall be fixed to the wall plates with approved galvanised holding down clips and used in accordance with the manufacturer's recommendation (Detail B2.4.1). The designer shall specify any special holding down fixings required to cater for any uplift forces.

5.5.6.6 The trussed rafters shall be fixed to the wall plates with approved galvanised holding down clips and used in accordance with the manufacturer's recommendation (Detail B2.4.1). Where uplift forces are likely to be experienced additional holding down devices in the form of vertical restraint straps, to conform to the requirements of Part A of the Building Regulations, shall be specified on the supplier's drawings and incorporated in the work on site. (Section B2.3).

5.5.6.7

The correct method of bracing is fundamental to the adequate stability of the roof structure.

For non standard roof arrangements , an engineer should advise and supervise the bracing and general design of the roof. (Section B 2.3).

5.5.6.7 Roof bracing and longitudinal binders shall be supplied and fitted by the main contractor as shown on the engineer's drawings and as specified. These members shall be a minimum of 97x22mm section finished size and shall be skew-nailed with galvanised round wire nails, the type, number, diameter and length being in accordance with IS 193 (or BS 5268-3) and/or the designers' requirements. Bracing should be generally in accordance with the technical handbook of 'The Trussed Rafter Association' and with details issued by the truss fabricator/designer.

The following requirements for bracing and longitudinal binders shall generally be complied with (B 2.3).

- Provide continuously throughout every roof (or section of roof between separating cross walls) 97x22mm raking main braces, twice nailed to the underside of rafters of every truss. The braces shall run at approximately 45 degrees from ridge to eaves as shown in detail B2.3.1.

- Provide, when the distance between centres of separating cross walls is not more than 1.2 trussed rafter span, at least two 97x22mm diagonal braces, twice nailed to every ceiling tie in every roof (or section of roof between cross walls). Where wall spacing exceeds 1.2 span, provide additional braces (totalling a minimum of four braces). Such diagonal braces to be in a 'W' formation on each side, at an angle of 35 to 50 degrees.
- Provide (unless trusses are less than 5m span), for every roof or section of roof between cross walls, 97x22mm raking bracing twice nailed to every internal strut (Detail B2.3.3).
- Provide longitudinal binders, 97x22mm, twice nailed and located at the node points as shown in detail B2.3.2. For this purpose each binder shall be in two overlapping lengths. Where binders cross main bracing the binders shall be interrupted and lap-jointed (Detail B2.3.6).
- All joints in braces and binders shall be lapped and nailed over at least two rafters (Detail B2.3.5).
- No bracing or binders shall penetrate a separating wall.
- Positioning of water tanks, pipes, flues etc., shall be arranged so as not to interfere with or prevent proper fixing of bracing or binders.
- Where additional bracing or longitudinal binders, which are to be fixed by the main contractor, are required by the truss and/or roof design, they shall be specified with details at the time of tendering.

5.5.6.8 Temporary stability - the main contractor shall be responsible for the trussed rafters in all temporary conditions until the structure is complete.

5.5.7 Finishes and protection

5.5.7.1 Protection and finishing on site by the main contractor shall comply with the architect's requirements.

5.5.7.1

Care should be taken to minimise uptake of moisture due to exposure to weather.

5.5.8 Inspection

5.5.8.1 The main contractor shall notify the engineer after the trussed rafters are erected and the bracing and other members are fixed to enable the engineer to inspect the roof structure, to ensure compliance with the design requirements.

5.6 LAMINATED VENEER LUMBER (LVL)

5.6.1 **LVL validation:** Only LVL validated by an Agrément Certificate or other authoritative assessment shall be used.

5.6.1

Due to the stringent requirements in manufacture and end-use applications LVL and Parallam need to be manufactured under the control of the Agrément Board or similar authority .

5.6.2 **LVL design:** LVL shall be designed in accordance with the Agrément Certificate and/or BS 5268: Part 2, using the grade stresses and moduli from the appropriate BS 5268 : Part 2

5.6.3 **Preservative treatment of LVL:** Shall be considered in accordance with the appropriate plywood treatments and hazard class.

5.6.4 **Cutting, notching or drilling:** Do not cut, notch or drill LVL without prior approval of the engineer. The manufacturer's technical literature usually outlines allowable hole locations and dimensions.

5.6.5 **Joints:** Shall be designed in accordance with the Agrément Certificate and/or BS 5268 Part 2. Maximum diameter of nails inserted parallel to the glue line should not exceed 4mm.

5.6.6 **Lateral support:** Lateral support of the beam compression edge shall be provided at intervals of 600mm or closer unless specified differently in the design.

5.6.7 **End bearing:** Requirements shall be in accordance with the manufacturer's recommendations.

5.7 PARALLAM

Parallam is a trade name; the generic name for the material is parallel strand board (PSB). Parallam has a BBA (at time of writing) and it is referenced below in the sense of the generic material.

5.7.1 **Validation:** Only PSB validated by an Agrément Certificate or other authoritative assessment shall be used.

5.7.2 **Design:** PSB shall be designed in accordance with the Agrément Certificate and/or BS 5268: Part 2.

5.7.3 **Dry exposure conditions:** PSB generally shall be used only in dry exposure conditions as defined in BS 5268: Part 2.

5.7.4 **The use of PSB:** Shall be restricted to areas where preservative treat ment is not required.

5.7.5 **Cutting, notching or drilling:** Do not cut, notch or drill PSB without prior approval of the engineer. The manufacturer's technical literature usually outlines allowable hole locations and dimensions..

5.7.6 **Joints made with nails or bolts:** Shall be designed in accordance with BS 5268: Part 2.

5.7.7 **Lateral support of beam compression edge:** Shall be provided at intervals of 600mm centres or closer unless specified differently in the design.

5.7.8 **End bearing requirements:** Shall be in accordance with the manufacturer's recommendations.

5.8
In general, joists are classified as non-durable/perishable in accordance with BS 5268 Part 5/BS 8417.

5.8 COMPOSITE I-JOISTS

5.8.1 **I-joist validation:** Only I-joists validated by an Agrément Certificate or other authoritative assessment shall be used.

5.8.2 **Storage:** Joists shall be stored clear of the ground and stacked on edge. Full cover shall be provided but with provision for air circulation. Operatives shall not be allowed to walk on the joists until braced.

5.8.3 **Moisture content:** Joists should arrive on site with a moisture content of 14 to18% and the moisture content shall be checked at the time of installation and shall be close to the moisture content likely to be attained in service. Some conditioning may be necessary to achieve this.

5.8.4 **Lateral restraint:** Shall be provided to the compression flanges by the provision of the fixing of boarding or battens at close intervals.

5.8.5 **Web stiffeners:** Shall be provided in accordance with the manufacturer's recommendations.

5.8.6 **Notching, cutting or drilling:** Do not notch, cut or drill the joists with out prior consultation with the engineer.

5.8.7 **Alignment:** If rigid service pipes are to be incorporated within the floor or roof void, passing through the hole 'knockouts' in the joists, careful alignment may be needed during installation.

D 6 Prefabricated systems

6.1 TIMBER-FRAME CONSTRUCTION

6.1.1 General

6.1.1.1 The structural framework of timber-frame buildings shall conform to the design engineer's requirements. The design shall be based on BS5268 parts 2, 4 and 6, loadings shall be based on TGD A and on BS 6399 parts 1 to 3. CP 3 Ch V Part 2 may be used instead of BS 6399 Part 2 at the engineer's discretion.

6.1.1.2 The design of a timber-frame structure shall be undertaken by an engineer, competent in timber design.

6.1.1.3 The manufacture of timber-frame elements shall take place in a controlled factory environment.

6.1.1.4 Timber-frame structural elements shall be manufactured by a NSAI approved manufacturer

6.1.1.5 The erection process and subsequent building envelope enclosure shall be supervised and approved by an engineer competent in this form of construction.

6.1.2 Materials

6.1.2.1 The common stud sizes are 38x89mm for internal and party walls and 38x140mm for external walls.

Table D 6.1.2.1 *Target sawn sizes of softwood*

Thickness	Widths mm						
mm	100	115	125	150	175	200	225
36	✓	✓	✓	✓	✓	✓	✓
44	✓	✓	✓	✓	✓	✓	✓
75	✓		✓	✓	✓	✓	

6.1.2.2 Preservative Treatment

(a) Exposed softwood timber elements, or those in contact with damp-proof courses or other elements likely to be exposed to direct weathering, shall be treated with a preservative to a schedule appropriate to timbers in Use/Hazard Class 3 or 3A as required.

(b) Concealed timbers and those which are protected from direct weathering, e.g. timber wall framing, flat roof, wall panels, ground floors, shall be treated with preservative to a schedule appropriate to timbers in Use/Hazard Class 2.

6.1.2.3 External walls- The following sheet materials may be used for external wall panels, subject to the Design Engineer's approval:

- Oriented Strand Board shall be grade OSB/3.
- Plywood shall be appropriate to structural design and shall be one of the structural grades listed in BS 5268: Part 2 or have appropriate certification (such as the Agrément Board), Plywood should conform to EN 636 and be suitable for the end environmental conditions.
- Exterior grade Canadian or American (U.S.A.) unsanded plywoods to the following standards are acceptable: CSA - 0121 - M 1978 Douglas Fir Plywood, CSA - 0151 - M 1978 Canadian Softwood Plywood, NBS PS -1-83 - 1983 US Softwood plywood. Plywoods manufactured to these standards shall be quality assured by COFI or APA and marked by the appropriate grade stamp.
- Swedish softwood plywood shall be Grade 30 or better.

6.1.2.4 Other panel products that may be acceptable in timber-frame construction are given in BS 5268 Part 6.

6.1.2.5 Thermal Insulation - materials shall be used that, together with external wall construction, which will give a performance 'U' value to comply with the Technical Guidance Document Part L to the Building Regulations or to a value agreed with the architect. Acceptable insulations are:
- Glass fibre - Rock fibre
- Other semi-rigid insulation boards may be used upon approval.

6.1.2.6 Breather membranes shall be in accordance with BS 4016, with a vapour resistance of less than 0.6 MNs/g.

6.1.2.7 Vapour Checks - shall have a minimum vapour resistance of 250 MNs/g and shall be either
- 500-gauge (125 micron) virgin polyethylene sheet,
- aluminium foil kraft paper laminates*, or
- vapour check plasterboard comprising metallised plastic laminate bonded to the back face of a plasterboard sheet.*

** Subject to the product having the required minimum vapour resistance. In all situations an independent vapour check is required.*

6.1.3 Fixing panels

6.1.3.1 Sheathing shall be fixed to studs by nailing at 150mm centres along board perimeters and at 300mm centres to intermediate studs using corrosion resistant nails, 50mm long, unless design dictates otherwise.

6.1.3.2 The nailing pattern for relevant sheeting material shall be determined by calculation as given in BS 5268: Part 6.

6.1.4 Fixing membranes and insulation

6.1.4.1 Breather membranes shall be fixed to sheeting with stainless steel staples.

6.1.4.2 Breather membranes shall be generously lapped at joints and fixed to ensure water is shed away from the building. Horizontal joint laps shall be at least 100mm and vertical laps shall be a minimum of 150mm. Breather membranes shall lap over damp-proof courses and membranes to ensure drainage of water to outside of the building fabric at DPC, at sole plates, window and door head openings, at vertical jamb wall closures and at cills.

6.1.4.3 The stud locations shall be clearly marked in the outside face of the wall panel.

6.1.4.4 Horizontal joints shall be taped or sealed or adequately fixed down. Small tears shall be repaired and holes sealed tightly around service connections.

6.1.4.5 Vapour checks shall be carefully cut and dressed into door and window reveals. They shall overlap in insulated ground floors, and be folded and extended into ceilings by a minimum of 75mm.

6.1.4.6 Where services are to be concentrated on or in external walls, avoid numerous punctures of vapour checks by providing a battened-out service zone of approximately 44mm between the face of vapour checks and backs of plasterboard..

6.1.4.7 Mineral fibre (glass or rock) shall be a nominal minimum of 150mm in thickness, cut neatly to fill the void between studs. It shall be stapled to tops and sides of studs to ensure it remains in position. Care shall be taken to ensure that the thickness of insulation is not decreased.

6.1.5 Openings

6.1.5.1 Openings in load-bearing walls - Where openings occur, they shall be spanned by suitably designed lintels with loads transmitted to foundations by cripple studs.

6.1.5.2 Lintels - shall be designed and determined by the likely dead and imposed loads in service.

6.1.5.3 Multi-member lintels shall be nailed and/or bolted together to an approved pattern.

6.1.5.4 Independent steel lintels or steel beams are generally required to carry external masonry cladding.

6.1.6 Intermediate floor panels

6.1.6.1 Floors shall be designed for imposed floor loadings specified in BS 6399.

6.1.6.2 Floor structures may be any of the following components or combinations:
- Individual joists and flooring
- fabricated joist panels (floor cassettes)
- Primary elements, e.g. glued laminated beams, I-joists, plywood box beams or steel beams
- Stressed skin panels

6.1.6.3 Alternative sizes for various spans, centres and strength classes may be chosen from IS 444. For other load conditions and complicated loading arrangements, joists shall be designed by a structural engineer to BS 5268: Part 2.

6.1.7 Notching and drilling

6.1.7.1 Joists – simply supported joists may be notched for services to the following limitations. For details see Fig A 2.1

(a) Holes of size not greater than 0.25 of depth of joist and located on the centre line/neutral axis, should be in the zone between 0.25 and 0.4 of the span from supports. There shall be at least be 3 times the hole diameter or 100mm between holes whichever is the greater.

(b) Notches of size not greater than 0.125 of the depth of the joist may be made on the top of the joist in the zone between 0.25 and 0.07 the length of the of span. Notches should be no more than 75mm long and there should be at least 150mm between notches.

(c) The distance between notches and holes shall be at least the depth of the joist.

Notches and holes outside the above limits or notches on the underside of the joist shall be designed.

6.1.7.2 Studs - unless otherwise justified by calculation, drilling of studs shall conform to the following requirements:

Holes of size not greater than 0.25 of depth of stud located on the centre line/neutral axis, in the zone between 0.1 and 0.25 of the length of the stud; no more than 2 holes at either end of each stud.

Notching is not permitted on studs unless specifically designed.

6.2 POST AND BEAM CONSTRUCTION

6.2.1 **Design:** Post and beam construction shall be designed to IS 444 or BS 5268: Part 2.

6.2.2 **Post and beam elements:** Shall be manufactured off site by a competent timber frame or joinery manufacturer.

All ground-bearing posts shall be protected from rising damp by fitting steel shoes, suitably fixed and so arranged and designed as to shed water if exposed to weather.

6.2.3 **Timber beams:** Where exposed to view, shall be neatly connected to posts.

6.2.4 **The structural frame:** Shall be made stable by one or a combination of all of the following stability features:

(a) Independent inset wall panels in two vertical planes, and horizontal floor panels.

(b) Independent core capable of providing stability.

(c) Diagonal bracing.

6.2.5 **Structural elements:** Supporting floors are required to have a fire resistance appropriate to the proposed end use.

6.3 PRINCIPAL RAFTER AND PARALLEL CHORD TRUSSES

6.3.1 **Timber species:** For principal rafter and parallel chord trusses shall be approved by the architect and engineer.

6.3.2 **Principal rafter and parallel chord trusses:** Shall be manufactured by an approved timber frame, trussed rafter or joinery manufacturer.

6.3.3 **Workshop drawings:** Shall be approved by the architect and engineer prior to manufacture.

6.3.4 **Careful attention:** Is required to ensure correct fabrication of joints for both structural and architectural reasons.

6.3.5 **Stability bracing where required:** Shall be neatly made and connected to rafters to both architect's and engineer's approval.

6.4 FOLDED PLATE AND SHELL CONSTRUCTION

6.4.1 **All elements for folded plate and shell construction:** Shall be designed by the engineer and be factory manufactured in prefabricated elements by a suitable timber frame, trussed rafter or joinery manufacturer approved by the architect and engineer.

6.4.2 **Fixing of panels to framing:** Shall comply with the engineer's details for nailing/adhesive patterns.

6.4.3 **Due consideration:** Shall be given to restraint of folded plate construction panel elements and the structure on which they are founded.

D 7 Cladding

7.1 CLADDING SYSTEMS

Vertical 'board-on-board' cladding can be used provided its stepped arrangement in plan form is catered for at eaves, under junctions and at DPC level with regard for insect mesh, ventilation and end grain protection. See B8.4

7
7.1.1, 7.1.2, 7.1.3, 7.1.4.1 are sample specifications only. Sizes may vary according to design and availability. Alternative species, sizes and fixings can be found in the sections below:

Species Selection	7.2.1
Sizes	7.3.2
Fixings	7.3.3

7.1.1 'Board-on-board'

7.1.1.1 External wall cladding shall be '*board-on-board'* vertical cladding European larch pressure impregnated with a suitable timber preservative, comprising inner boards at *200mm* centres with *50mm* between boards, and *100x38mm* outer boards fixed with silicon bronze annular ring shank nails or austenitic stainless steel nails on *50x22mm* pressure treated horizontal battens on *50x22mm* vertical counter battens. Preservative treated timber is to be re-dried after treatment to a moisture content of 16±3%.

7.1.2 Horizontal 'Shiplap'

When specifying horizontal 'shiplap' external timber cladding it is important that the end grain is always protected as its exposed location in horizontal cladding could lead to early deterioration of the timber.

7.1.2.1 External wall cladding shall be horizontal shiplap boarding, *Douglas fir* pressure treated with timber preservative, comprising *175x25mm* profile boards laid at *135mm* centres fixed with austenitic stainless steel or silicon bronze nails on *50x22mm* vertical battens which shall be pressure preservative treated. Preservative treated timber to be re-dried following treatment to a moisture content of 16±3%. See B8.2 & B8.3

7.1.3 Vertical/diagonal TG&V

Tongued and grooved boards for external timber cladding should always be designed with a sufficient V joint so as to reduce moisture entrapment. See B8.2.

7.1.3.1 External wall cladding shall be tongued, grooved and v-jointed boards of *western red cedar*, laid horizontally, vertically or diagonally, comprising *100x20mm* boards secret nailed with austenitic stainless steel or silicon bronze ringshank nails on *44x35mm* (minimum) pressure impregnated vertical battens. When laid diagonally or horizontally the groove should be located above the tongue.

7.1.3.1
Where vertical TG&V boards are specified horizontal battens shall be laid on vertical counter battens. (See Details B8.2.1, 8.2.2 and 8.2.3).

7.1.4 Shingles/shakes

Timber shingles and shakes are only suitable for roofs with pitches greater than 45°. In pitches lower than this rain can drive up under the shingles and cause moisture entrapment and possibly early deterioration. See B.8.5. Preservative treatment is recommended in all cases.

7.1.4.1 Timber roof cladding shall be shingles or shakes of *western red cedar*, double-lapped (laid similar to slating) with a minimum head lap of *150mm*, fixed with copper nails onto horizontal battens *50x22mm* on counter battens *50x22mm* laid on a reinforced breather membrane/ roofing felt. The battens shall be pressure treated with a suitable timber preservative. If a 30 year anticipated service life is required, then pressure treatment is recommended.

7.2 MATERIALS

7.2.1 Species selection

The two most important factors concerning species selection are the aesthetic quality of the timber and its durability. Table A 10.1, which can be added to the specification, is provided to aid the designer in selecting a suitable species for external timber cladding.

7.2.1.1 Non-durable species or the sapwood of any species must not be used for cladding exposed to inclement weather without adequate preservative treatment. (See C2 for preservative treatment.)

7.3
Avoid fixing cladding boards to each other. Instead they should be fixed independently to the batten framework behind, allowing the free movement of individual boards.

7.3 WORKMANSHIP AND CONSTRUCTION

It is important when fixing timber cladding that the boards are always allowed to move independently of each other.

7.3.1 General

7.3.1.1 Adequate supervision shall be provided throughout the preparation and application of the cladding to ensure that it conforms to the principles and practical considerations of the design.

7.3.1.2 Workmanship in fabrication and preparation of materials shall conform in all respects to accepted good practice.

7.3.1.3
Butt-joints shall be avoided as they generally cause problems of decay by capillary action.

7.3.1.3 Where joints occur, they shall be scarf-jointed and protected by a cover trim or overlapped.

7.3.1.4 The end-grain of vertical cladding shall not rest on horizontal surfaces. A 12mm anti-capillary gap shall be provided and the bottom ends of the vertical members shall taper outwards to form a drip.

7.3.1.5
This permits boards that have already cupped to be nailed flat at the time of erection. These stress relieving grooves can also form ventilation paths behind the cladding.

7.3.1.5 Stress-relieving grooves shall be machined in the back face of cladding boards prior to preservative treatment.

7.3.1.6 When grade markings or other necessary identification marks are removed, provision shall be made for remarking in accordance with I.S. 127, EN 519, or BS 5756.

7.3.1.7
Where a decorative wood stain is specified each board should be fully coated before being fixed. Where sawing is required on site, all sawn ends must be treated on site, before fixing of timber.

7.3.1.7 Where preservation treatments are required, care shall be taken to ensure that all machining, cutting, notching and drilling has taken place prior to the application of such treatments. Where such work is unavoidably carried out on site, the timber shall be treated with 2 liberal brushed on coats of timber preservative or as directed by the architect.

7.3.2 Sizes and spacings

Ideally, when designing cladding, all boards and battens should conform to standard sizes available.

7.3.2.1 The size, shape and finish of all members and materials shall conform to the detailed drawings and specifications.

7.3.2.2 Dimensions and spacings shall not be scaled from drawings.

7.3.3 Metal fixings

The designer should ensure that all metal fixings chosen will not stain the timber cladding. This is especially applicable when a light coloured timber species is being used.

7.3.3.1 Austenitic stainless steel or silicon bronze ringshank nails shall be used for all external cladding, fascia and eaves board, nail lengths shall be a minimum of 2.5 times the thickness of the board. The use of galvanised steel, aluminium or mild steel nails shall not be permitted. The end distances, edge distances, and spacings of nails should be such as to avoid undue splitting and should be not less than the values as set out in table 7.3.3.1 for timber to timber joints.

Table D 7.3.3.1 ***Nail spacing***

Spacing	Without predrilled holes	With predrilled holes
End distance parallel to grain	20 (d)	14 (d)
Edge distance perpendicular to grain	5 (d)	5 (d)
Distance between line of screws perpendicular to the grain	10 (d)	3 (d)
Distance between adjacent screw in any one line parallel to grain	20 (d)	10 (d)

Note: "d" is the nail diameter.
For timber to steel or board materials see BS 5268 Part 2
Note: Where designs are undertaken to EN 1995-1-1, that standard should be consulted for nail spacing.

7.3.3.2 Austenitic stainless steel or silicon bronze ringshank nails or screws shall be used for all external cladding, fascia and eaves board, nail or screw lengths shall be a minimum of usually 3.0 times the thickness of the board. The end distances, edge distances, and spacings of nails or screws should be such as to avoid undue splitting and should be not less than the values as set out in table 7.3.3.2.

Table D 7.3.3.2 ***Screw spacings***

Spacing	Distance of Pre-drilled holes
End distance parallel to grain	10 (d)
Edge distance perpendicular to grain	5 (d)
Distance between line of screws perpendicular to the grain	3 (d)
Distance between adjacent screw in any one line parallel to grain	10 (d)

Note: "d " is the shank diameter of screw. Fastener spacings, end distances and edge distances, refer to distance from fastener centre line.
Note: Where designs are undertaken to EN 1995-1-1, that standard should be consulted for screw spacing.

7.3.4 Jointing, fitting and fixing

7.3.4.1 For species other than Western Red Cedar a minimum of 25mm finished thickness shall be used. Western Red Cedar cladding shall have a minimum thickness of 18mm.

7.3.4.2 A minimum of 22mm continuous clear cavity is required behind the timber cladding.

7.3.4.2
All external cladding material and systems require an uninterrupted air space behind the cladding. The cavity acts as a moisture break to prevent capillary action or driving rain reaching the structure. It is also necessary to provide a path for ventilation, thus allowing the building structure and fabric to breathe
The gap is necessary to provide drainage of rainwater which may otherwise become trapped on the inside surface of the cladding.

7.3.4.3 Stainless steel insect mesh shall be fitted to all openings and gaps in wall cladding.

7.3.4.4 In accordance with BS 4016, a weather-resistant breather membrane approved by the architect shall be provided between the wall structure and the cladding battens to allow internal water vapour to permeate to the exterior. Bitumen-type breather paper/membrane shall not be used.

7.3.4.5 All end grain shall be preservative treated in-situ, where cut on site. End joints shall be tightly fitted.

7.3.4.6 Moisture content at time of fixing shall be 16±3% or as specified by the architect.

7.3.4.7 Boards shall be fixed securely and independently to battens to give a flat and true surface free from undulations, lippings, splits, hammer marks and protruding fastenings. Position heading joints centrally over supports and not less than two board widths apart on any one support.

7.3.4.8
This allows for movement of boards and fastenings to prevent cupping, spring and excessive opening of joints or other defects.
Boards to be laid according to architects' drawings in order to avoid problems of cupping. (See detail B8.4.3) This permits boards that have already cupped to be nailed flat at the time of erection. Stress relieving grooves can also form ventilation paths behind the cladding. (See detail B8.2.3)

7.3.4.8 Boards less than 50mm wide that are not restrained by other boards, may be fixed with one nail at each support point. Unrestrained boards over 50mm should be twice nailed at each support, and nails not spaced more than 50mm apart.

7.3.4.9 Restrained boards, such as T&G or shiplap, shall be up to a maximum width of 100mm. They shall be singly fixed and nails shall be concealed.

7.3.4.10 The head of the nail shall finish flush with the surface of the boards, with out any indentation of the surface or hammer marks.

7.3.4.11 Where a translucent wood stain is to be used, no fillers for timber shall be permitted.

7.3.4.12 If an opaque finish (external paint) is to be used, the nails shall be punched below the board surface and stopped with a suitable moisture-resisting filler before finishing.

7.3.4.13 External timber shall be separated and raised from the ground by at least 150mm clear, to protect from ground splashing and capillary action.

7.3.4.14 Timber shingles/shakes shall be laid on battens to separate them from the breather membrane or sarking felt. Where sheathing (sarking board) is laid on top of rafters, counter-battens following the roof slope shall be fixed before tiling battens are fixed in position.

7.3.4.15 Shingles/shakes shall be double lapped, twice fixed with copper nails and spaced to allow a minimum 20mm gap.

7.3.4.16 For roof pitches of 45° or greater and where exposure conditions are moderate, the head-lap shall be a minimum of 100mm and the side-lap shall be half the single width.

7.3.4.17 Shingles/shakes shall be free to move independently of each other to avoid moisture movement stress and cracking, therefore they shall not be nailed where over-lapping occurs.

7.3.4.18 Discrepancies and/or deviations in drawings and details are to be reported to the architect/engineer for their direction.

7.3.5 Battens and counterbattens

Battens are primarily used to fix the cladding system away from the structure of the building, allowing ventilation and drainage. For this reason it is important that there is always a clear vertical space behind the cladding boards. When using vertical boards the fixing battens will have to run horizontally, so vertical counter battens will also have to be used.

7.3.5.1 Battens and counterbattens shall be to sizes as described in architect's drawings/details and to be pressure treated with a suitable preservative.

7.3.5.2 Exposed ends of joints shall be treated in-situ by painting ends prior to fixing.

7.3.5.3 Battens to be fixed with non-corrosive metals such as austenitic stain less steel or silicon bronze ringshank nails the length of which to be twice the thickness of the batten.

7.3.5.4 Battens/counterbattens to be fixed horizontally and vertically, correctly and evenly spaced throughout. The size, number and location of the fixings shall be as specified by the architect/engineer.

7.3.5.5 Moisture content of battens shall be 18±2% at time of fixing.

7.3.5.6 Battens to be regularised softwood free from decay, insect attack and with no knot wider than half the width of the section.

7.3.6 Surface coatings

Unprotected timber cladding is exposed to changes in moisture content which can lead to surface cracking, while ultra-violet degradation by sunlight can lead to the loss of the timber's natural colour. The high relative humidity in Ireland throughout the different seasons of the year is conducive to mould grown on timber. Only the heartwood of naturally durable timbers such as Irish oak, American white oak, iroko, teak or western red cedar should be considered for external cladding unprotected by preservative or a timber stain. Free-draining dry areas of cladding will eventually go grey but any ledges, damp areas or tight abutments will go a darker colour due to mould growth. Western red cedar ages well provided it does not suffer abrasion, is detailed properly, has a minimum finished thickness of 18mm and is not exposed to extreme weathering. Its low density of 390kg/m³ compared to American white oak's 770kg/m³ means that abrasion, indentation and its poor ability to hold fixings can be a problem. Pressure impregnated preservative will greatly improve the performance of all species suitable for external cladding (and is necessary for all sapwoods). Timber stains will help maintain the surface protection of cladding from ultra-violet degrade and mould growth but need maintenance usually every 3 to 5 years. Clear or very light wood stains are not as protective as the darker reds or browns.

Varnish is unsuitable for external use in the Irish climate.

7.3.6.1 Cladding shall be given 1 protective coat of selected pigmented microporous finish all round prior to site fixing, followed by 2 coats all in accordance with the manufacturer's instructions to the satisfaction of the architect. Any ends cut on site shall be re-finished.

7.3.7 Site protection

Storage time on site should be minimised and every effort should be made to schedule delivery and erection times together.

7.3.7
Where it is essential that materials and components have low moisture contents, it may be necessary to maintain suitable conditions on site, and/or to schedule deliveries to coincide with assembly and erection activities.

7.3.7.1 Transportation of cladding to site storage and handling shall be in accordance with BS 5268.

7.3.7.2 Any damage, incorrect fixing or increase in moisture content may lead to the condemning and rejection of installed cladding.

7.4 PERFORMANCE SPECIFICATIONS

7.4.1 Quality and classification

7.4.1
There is no Irish or British standard code of practice for exterior cladding. Therefore there are no standard grades or profiles.
BS 1186: *Quality of timber in joinery* may be used as a basis to specify timber cladding. Class 2 and 3 of this code are generally suitable for external cladding and trim and are obtainable in commercially available softwood and hardwood. Class 3 is normally accepted as a serviceable quality for most cladding applications.

7.4.1.1 Timber used fo external cladding shall comply with BS 1186.

7.4.2 Moisture content

Cladding moisture content can vary depending on seasonal changes and the orientation of the building. Pressure-preserved and stained timber varies less than untreated timber. Species selection, detailed design of cladding board profiles and junctions will also assist in controlling moisture movement.

7.4.2.1 Moisture content of external cladding shall be 13 to 19% in accordance with EN 942.

7.4.2.2 Cladding treated with preservative shall be re-dried to 13 to 19% moisture content.

7.4.2.3 The moisture content of timber is to shall be checked upon delivery by a properly calibrated moisture meter, used in accordance with the manufacturer's instructions. The moisture content readings shall be recorded for inspection by the architect if requested.

7.4.3 Fire

The construction of external walls and the separation between buildings to prevent external fire spread are closely related, Technical Guidance Document B Fire Safety lays down requirements for external walls in relation to their surface spread of flame classification and their fire resistance. In determining fire safety requirements it always advisable to consult TGD B and where necessary the local fire officer. The advice below is taken from TGD B (1997).

In relation to surface spread of flame, the external walls of buildings less than 1m from the relevant boundary should have a surface spread of flame classification of 0 up to a height of 30m, after 30m the external wall surface should be non-combustible. TGD B gives permitted limits on the amount of unprotected areas which may be disregarded for space separation purposes. Effectively timber cladding is not permitted where the building is less than 1m from the relevant boundary.

The performance of external walls 1m or more from the relevant boundary depends on the purpose group of the building. For buildings such as flats or maisonettes, residential (institutional), other residential, assembly or for recreational purposes; then the external wall surface if 10m or less above ground level (or above a roof or any part of a building where people have access) is required to have an index of performance (I) not more than 20 but timber cladding at least 9mm thick is acceptable. This index of performance requirement is applicable to all building types up to a height of 20m. Between 20m and 30m for all building types the external surface should be Class 0 and above 30m the external surface should be non-combustible.

Unprotected areas include those parts of an external wall which are:
- A window, door or other opening
- Any part of the external wall which has less than the required fire resistance
- Any part of the external wall which has combustible material more than 1mm thick attached or applied to the external face whether from cladding or any other purpose

Table D 7.4.3.1 indicates the separation distances on external timber cladding and is based on the table in Method 1 in TGD B setting out the permitted unprotected areas in small residential buildings. The further the timber-clad building is from the relevant boundary the less restrictions there are on the extensive use of timber. TGD B should be consulted on the precise rules governing space separation and for other calculation methods for different building types.

Table D 7.4.3.1 *Fire restrictions on external timber cladding*

Min. distance from boundary (m)	Max. length of wall (m)	Max. total unprotected area (m^2)
1.0	24	5.6
2.5	24	15
6.0	24	No limit

7.4.4 Preservative treatments
New European standards for preservation treatment have been introduced. For additional information see Section A Design Guidance (A4) and Section C, Sample Timber Specification (C2) for treatment specifications.

> **7.4.4**
> Documented evidence should be provided with the delivery of treated timber, specifying the preservation type, % salts retention and treatment cycle.

7.4.5 Maintenance

7.4.5.1 All external timber shall be regularly inspected for signs of decay. Where decay is identified the causes should be remedied as soon as possible.

7.4.5.2 Fungal, mould or moss growth on damp timber work shall be removed and the timber preservative treated by brush application.

7.4.5.3 Particular attention should be paid to treating and sealing exposed end-grain.

7.4.5.4 Fissures, shakes, cracks and loose knots should be liberally treated with preservative, where appropriate.

7.4.5.5 Metal fasteners should be checked for corrosion and stress weakening. These shall be immediately replaced if necessary.

7.4.5.6 The erosion and fading of surface coatings such as emulsion paints and wood stains is caused by weathering and should be expected. The surface may require reapplication of surface coatings every three years, or less in exposed locations. Properly applied microporous finishes have a longer life, typically 3-5 years.

> **7.4.5.6**
> The preparation for re-staining consists of a rub-down with a stiff brush to remove dust and a washdown with white spirit or an ammonia/water solution. Avoid wire-brushing which leaves wire fragments which will rust.

7.5 GENERAL

7.5.1 Compliance

> **7.5.1**
> There is no Irish or British standard code of practice for exterior cladding, however, BS 1186:"*Quality of timber in joinery*" is sometimes used as a basis for specifying exterior timber cladding or *EN 942*

7.5.1.1 Comply with the requirements and recommendations of BS 1186 and other relevant standards and Codes of Practice pertaining to external timber cladding, board materials, relevant legislation and current building regulations.

7.5.1.2 The Building Regulations require materials fit for their intended purpose. Materials adversely affected by moisture shall be protected by damp-proof courses, detail design and preservative treatment.

7.5.1.3 All dimensions shall be finished dimensions as detailed in drawings.

7.5.2 Architect's requirements

> **7.5.2**
> When choosing cladding as an exterior finish, it is desirable that the building design provides protection by overhanging eaves and that it is protected throughout construction to its completion.

7.5.2.1 Comply to the specifier's requirements with regard to product selection, fixing and surface coatings.

7.5.2.2 Proposed changes in design, materials and/or component arrangement shall be reported to the architect/engineer for approval, prior to manufacture.

7.5.2.3 Samples and dimensions of cladding shall be submitted to the architect /engineer for approval prior to installation.

8
Specifications 8.1.1.1 – 8.3.1.3 are sample specifications only. Alternative sizes, species and fixings can be found in the sections listed below:

Species selection	8.2.1
Sizes/spans	8.3.1
Fixings	8.3.2

D 8 Flooring

8.1 FLOORING SYSTEMS

The most important factor affecting the behaviour of timber flooring is moisture movement so adequate room for expansion must be allowed. Particular care should be taken when laying wood over underfloor heating systems to ensure that the entire sub-floor, and not just the top screed, is thoroughly dry. As the seasonal fluctuations in moisture, and hence movement, is greater than with radiator heating, it is advisable to use narrow and/or engineered boards.

8.1.1
This is a sample specification only which applies to finished decorative softwood floors. Scots pine is a popular choice for a floor finish but other suitable species may be selected from table A11.2. Floorboards which form part of the finished surface should be secret nailed for aesthetic reasons.

8.1.1 Softwood flooring

Typically all softwood floor boarding is tongued and grooved to reduce gaps, creaking and improve jointing. When specifying standard softwood flooring it is important to understand that it is only suitable for light residential type uses as a finished decorative floor. This is due to softwoods' low resistance to indentation from point loads such as high heels, legs of furniture and grit. In heavy duty uses it requires protective coverings, e.g. carpeting.

8.1.1.1 Flooring shall be Scots pine (red deal) tongued and grooved boards with a thickness of 18mm and a face width of 90mm. The boards shall be secret nailed along the tongued edge at an angle of 45° at 400mm centres (assuming the supporting joists are at 400mm centres) with flat-cut collated nails.

8.1.1.2
This is a sample specification only. It applies to floors where the intention is that they shall be covered. It should be noted however that T&G boarding is not suitable where tiles or a thin covering are to be laid due to the number of joints and potential for movement.

8.1.1.2 Flooring shall be Sitka or Norway spruce (European whitewood) tongued and grooved boards with a thickness of 18mm and a face width of 113mm. The boards shall be face nailed to each joist with 2 no. flat-cut collated 63mm length nails at 400mm maximum centres. The nail heads shall be punched below the surface.

8.1.2 Hardwood flooring

Hardwood flooring generally gives a more durable finished surface than softwood flooring. Hardwood flooring can be laid in a number of different forms including wood block, strip, parquet and mosaic. This gives the designer a range of options for different finishes.

8.1.2.1
This is a sample specification only which applies to a finished decorative hardwood floor. The floor boards can also be laid on a concrete subfloor if battens are laid at spacings similar to that of the joists. When laying on a concrete sub floor it is important that the floor is thoroughly dry, especially if new or recent work has been carried out. The moisture content of the sub-floor should be checked and a moisture barrier should be laid under 50mm screed. It is important that this screed is allowed to dry out to a moisture content below 5%. When fixing hardwood tongued and grooved boards to an existing softwood t&g floor the boards should be laid at right angles to the existing boards, which must be in good condition. The boards should be fixed at a minimum of 50mm from the ends of the boards.

8.1.2.1 *Hardwood strip flooring on battens*
Flooring shall be *hard maple* tongued, grooved and end matched boards. The boards shall be 18mm thick and 75mm wide. The boards shall be laid across the joists at maximum centres of 400mm. The boards shall be secret nailed to every joist at a 45° angle through the top of the tongue using 63mm flat-cut collated nails.

8.1.2.2
This is a sample specification only for a decorative hardwood floor fixed by spring clip. It should be noted that the strips should be laid so that the end joints are staggered. Whilst the end joints may be glued, the long joints should never be glued. It is important to refer to the manufacturer's instructions when laying this type of system as different flooring systems have different fixing/clip systems.

8.1.2.2 *Floating strip flooring*
Flooring shall be 20x90mm Irish oak tongued and grooved strips. The strips shall be laid on an underlay and moisture barrier which shall be lapped by 200mm at all joints. The strips shall be laid using a clip system which shall be spaced and laid according to manufacturer's instructions.

8.1.2.3
Engineered strips consist of a wear layer of usually 4mm with a central core at 90° to the top layer and a backing layer. The total depth may range from 8 to 22mm.

8.1.2.3 *Parquet*
The floor shall be 14mm engineered oak strips laid on a plywood base. The strips shall be fixed to the base by means of glue and pins according to the manufacturer's instructions.

8.1.2.4 *Wood block*
Hardwood blocks should be between 200mm and 500mm long with a face width not greater than 90mm and thickness not less than 20mm with at least 9mm of clear wearing thickness above the interlocking system. Mosaic fingers should be 100mm to 165mm long with a thickness of 6mm to 10mm and width of 20mm to 25mm.

The floor shall be tongued and grooved *oak* blocks measuring *225x75x25mm*. Blocks shall be laid on a level dry screed and fixed with flooring mastic as per manufacturer's instructions. The laid floor shall be lightly machine sanded and finished with a polyurethane seal. The moisture content shall be between 8-12% in conventionally heated buildings. For areas with underfloor heating the moisture content shall be between 6-8%.

8.1.3 Wood-based panel floors

Wood-based panel products for flooring are available as square edged or tongued and grooved boards (usually only along the long edges). This may affect the design as square edges must be fully supported at all edges on joists or noggings. Tongued and grooved boards are laid with the long edges across the joists and the short edges falling centrally on a joist or supported on noggings. These two approaches are dealt with in sample specification clauses 8.1.3.1 and 8.1.3.2.

8.1.3.1
This is a sample specification only and applies to a wood-based panel product being used as a finished floor surface. When specifying sanded plywood it is important to ensure that the thickness reduction due to sanding does not affect the structural stability of the floor.

Plywood
8.1.3.1 Plywood generally shall comply with EN 636-2. Flooring shall be tongued and grooved Douglas fir plywood sheets and suitable for humid use. The plywood sheets shall be 18mm thick fixed with annular ring shank nails at 150mm centres along the joists and at 300mm maximum centres lengthways across the joists. The plywood floor shall be sanded to give a smooth finish.

8.1.3.2
This is a sample specification only and applies to a wood-based panel floor which will be covered. The board joints should be glued so as to produce a more rigid floor surface suitable for a tiled finish.

Chipboard
8.1.3.2 Chipboard generally shall comply with EN 312 Part 4 or 5. Flooring shall be square edged type P4/P5 particle sheets. The sheets shall be 18mm thick and 2400x1200mm. The boards shall be fixed 20mm from the edge along their length with annular ringshank nails at 300mm centres to the joists and at 400mm centres along the intermediate supports.

8.1.3.3 Design and installation of flooring shall be in accordance with BS 7916 and shall comply with the recommendations outlined in the manufacturer's Agrément Certificate or other appropriate certificate. BS 7916 covers the following categories of floor:
- Domestic flooring : floating floors on a continuous support.
- Domestic flooring : suspended floors.
- Non domestic flooring : floating floor constructions and other special floors with restricted deflection.
- Non domestic flooring : composite floors in which the boards are only partially loadbearing.
- Non domestic flooring : light duty suspended floors.
- Non domestic flooring : heavy duty suspended floors.

Table D 8.1.3.3 *Selection of boards according to category for domestic flooring.*

Conditions of use	Particleboard	OSB
Installed dry, with no risk of wetting in service	P4 to EN 312-5 P6 to EN 312-7	OSB/2, OSB/3, OSB/4 to EN 300
Risk of wetting during installation or risk of occasional wetting or condensation in service	P5 to EN 312-5 P7 to EN 312-7	OSB/3, OSB/4 to EN 300

8.1.3.4 In general, boards shall be laid with the major axis of the boards crossing the joists.

8.1.3.5 Square-edged boards shall be supported continuously on all edges. All cut edges which are not supported with joists and all edges of square-edged boards, shall be supported on noggings or counter battens.

8.1.3.6 Cross joints on the board shall be staggered and the joints between the boards shall be glued (on tongued and grooved boards).

8.1.3.7 Where boards abut any rigid upstand, provision must be made for expansion of not less than 10mm. Large floors may need intermediate expansion gaps for a possible expansion of 2mm per metre length of floor. Check and comply with manufacturer's instructions.

8.1.3.8 Application of boards for sheathing, flat roof construction, pitched roof construction, furniture and built-in fitments shall comply with the requirements of BS 7916 and recommendations outlined in the manufacturer's Agrément, or other appropriate certificate.

8.2 MATERIALS FOR TIMBER FLOORING

8.2.1 Species selection
Typically Norway spruce (European whitewood) is used in flooring when the boards are to be covered with a protective covering, e.g. carpet. If, however, a more decorative, hard-wearing surface for heavy duty is required then a more hard-wearing softwood species like Scots pine, larch and Douglas fir or hardwood species should be specified.

Refer to table A 11.2 for details of timber species

8.2.2 Wood-based panel products
Panel products react differently from one another and consequently their movement behaviour varies. For specific details refer to the manufacturer's instructions. In floors using particleboard, plywood or OSB a normal expansion gap should be provided.

8.2.2
Selection of the correct flooring grade of panel product is very important. Inappropriate grades of particle and fibre boards swell and lose strength and plywoods delaminate, if exposed to wet conditions.

8.2.2.1 Where chipboard is used the width of the expansion gap should be increased all around by 1mm for every metre in excess of 12m in either width or length of the floor. In floors using hardboard an expansion gap is not usually necessary except where rebated hardboard panels are used on floating floors. Floating floors of this sort should be provided with an expansion gap or gaps of 6mm all round at the wall edges. The rebated edges of the hardboard should be glued to each other to form a continuous surface. Hardboard must be conditioned prior to laying.

8.3 WORKMANSHIP AND CONSTRUCTION

8.3.1 Sizes, spacings and tolerances

8.3.1.1 The board thickness shall determine the maximum allowable span from joist centre to centre. (See table D 8.3.1.1).

Table D 8.3.1.1 *Joist centres for T&G boards*

Nominal board thickness in mm	Nominal board width in mm	Recommended span in mm
22	100	400
22	125	400
22	150	400

8.3.1.2 Joists shall be made level and checked before the boards are laid. All bridging shall be in place.

8.3.1.2
This allows for the edge of the flooring and surounding expansion gap to be concealed under the skirting.

8.3.1.3 A spacing of 2mm shall be allowed between the bottom of the skirting and the flooring.

8.3.1.4 Joist spans to support chipboard flooring shall not exceed those in table D 8.3.1.4.

8.3.1.4
When specifying chipboard floors the intended loads must be catered for in the specified spans and thickness as laid out in table D 8.3.1.4.

Table D 8.3.1.4 *Maximum spans for chipboard domestic floors*

Thickness mm	Max. Imposed load KN/sq m	Max Span mm
18	1.5	450
22	1.5	600
22	2.0	450

Tolerances
8.3.1.5 A perimeter expansion gap of 12mm shall be provided in addition to a 2mm expansion gap which shall be provided every 3-5 boards (depending on width of board). Special care is to be taken where a concrete subfloor or structural slab has a construction/expansion gap and a timber floor is to be overlaid. The overlaid timber floor shall be provided with an expansion joint to coincide with the concrete construction/expansion gap and this joint shall extend the full thickness of the timber floor and its support system. A compliant joint material shall be used to the satisfaction of the architect. Where there is continual heating, e.g hospitals, manufacturer's advice should be sought in relation to expansion gaps.

8.3.1.6 A manufacturing deviation of ±0.5 mm shall be allowed for all finished sizes after processing.

8.3.1.7 A continuous tapered brass strip shall be provided to conceal gaps where timber flooring abuts tiling.

8.3.2 Laying and fixing flooring

General
8.3.2.1 All proprietary flooring systems should be laid according to the manufacturer's instructions.

8.3.2.2 Where an existing wood floor is to be used as a base for a new wood floor, the existing floor shall be inspected for loose boards, dampness, decay and insect attack and shall be treated appropriately

8.3.2.3 Defective or worn boards shall be removed and replaced by new where the floor cannot be adequately regularised by sanding.

8.3.2.3
It is important when laying a new floor on an existing timber floor that problems with ventilation do not start as a result of the old floor being sealed in.

8.3.2.4 Where evidence of active insect infestation exists, all defective flooring shall be replaced and the whole area, including the joists, shall be liberally sprayed with an approved insecticide.

8.3.2.5 All building operations shall, as far as possible, be completed and heating commissioned before the flooring is laid.

8.3.2.5
Wood flooring should never be laid until the building is weathertight and enough time has elapsed to allow the building to dry out and there is adequate background heat and ventilation to avoid high humidity conditions.

8.3.2.6 The fixing of skirtings and other similar finishing shall be deferred until after the floor has been laid and sanded.

8.3.2.7 Flooring boards shall be laid at right angles to or diagonally to the direction of the joists and not parallel.

8.3.2.8 All floorboards shall be cramped tight prior to fixing to avoid uneven gaps between boards. Allow for movement every 5th board by providing a gap of a 1mm smooth washer, unless specialist manufacturer of flooring system provides an alternative method of movement control.

8.3.2.8
T&G flooring boards shall be tightly butted together before nailing down and floor clamps are commonly used for this. Boards nailed down without clamping can result in excessive gaps between the boards when they dry to the equilibrium moisture content. This can occur when central heating is in action.

8.3.2.9 All header joints if not end-matched shall bear directly on a joist or batten to give the maximum bearing area and shall be staggered so that end joints are at least two board widths apart.

8.3.2.9
Where the end joint of a board does not fall directly on a joist it may require a nogging for support. Some T&G systems also tongue and groove the end joints which allows the boards to form a rigid joint where a joist does not occur for support.

Screed
8.3.2.10 The boarding shall be laid on a concrete subfloor which shall consist of the following layers: concrete slab, covered by a moisture barrier which shall be protected by a 50mm screed.

8.3.2.11 Moisture barriers on concrete subfloor shall comply with IS 57 (see part C of Building Regulations).

8.3.2.11-12
It is essential that adequate ventilation of the void between the concrete sub-floor and the timber floor structure is provided to prevent a build-up of moisture and/or moisture vapour.

8.3.2.12 The screed shall be allowed to dry to a maximum moisture content of 5% as measured by the method described in BS 8201.

8.3.2.13 In accordance with BS 8201, if there is any question about the dryness of the screed, a damp-proof membrane shall be applied before the floor is laid.

8.3.2.14 The concrete or screed base shall be adequately flat and level (maximum 2mm gap under a 2m straight-edge).

8.3.2.14
Before new flooring is laid, any unevenness shall be eliminated. One way of accommodating some limited unevenness, is the use of an underlay or other form of resilient layer.

Softwood flooring

8.3.2.15 Boards shall be face nailed to every joist or batten.

8.3.2.16 Boards up to and including 125 mm wide shall be fixed at a minimum of 15mm from the board edge using two nails, or secret nailed if tongued and grooved.

8.3.2.17 Lost head nails shall be punched below the surface.

8.3.2.17
Where a more decorative finish is required boards under 100mm in width can be secret nailed.

8.3.2.18 Screws shall be used for fastening boards over electric cables, over pipework and in particular over junction boxes to which access may be needed.

8.3.2.18
This clause only applies when square edged floor boards are used.

8.3.2.19 Screws shall be countersunk and (except at access points) all holes should be pelleted with matching timber.

8.3.2.20 Tongued and grooved boards of 100mm or less in width shall be secret nailed through the tongued edge at each intersection with a joist or batten in order to minimise disfiguration.

Hardwood Flooring
Laying hardwood floors is generally considered to be a specialist job and it is recommended that these floors are always laid by a specialist hardwood flooring contractor.

Strip Flooring

8.3.2.21 Hardwood strip flooring shall be secret nailed through the tongue into the battens or joists.

8.3.2.22 The boards shall be laid in random lengths with the board ends staggered; no board to be left floating between the joists; each board to be supported by at least one batten or joist.

8.3.2.22
Hardwood strip flooring is usually end matched which enables boards to be joined at any stage, thereby eliminating wastage as boards do not need to be cut so as to join over a joist or batten.

Hardwood Block Flooring

8.3.2.23 Hardwood blocks shall be laid from the centre line outwards.

8.3.2.23
Blocks are laid in this fashion until they reach the perimeter where an expansion gap is left. The centre line is defined as the line dividing the narrowest width of the area to be covered

8.3.2.24 The underside of each individual block shall be dipped in adhesive and placed in position without undue sliding.

Mosaic fingers

8.3.2.25 The panels shall be laid from the centre line outwards.

8.3.2.26 When applying paper-faced mosaic, the paper shall be removed from the surface as the work proceeds.

8.3.2.26
The paper may need to be damped to facilitate its removal during this procedure. If paper is not removed until later it may prove difficult when scuffed and walked into the timber.

Parquet

8.3.2.27 Overlay shall be fixed by secret pinning to a wood base through the tongue.

8.3.2.27
This is usually a thin boarding approximately 8mm to 12mm thick tongued and grooved with ends matched.

8.3.2.28 Proprietary systems of engineered parquet and overlay shall be laid in accordance with the manufacturer's instructions.

8.3.2.29 End joints between panels shall be staggered transversely across the floor, all longitudinal joints shall be in line.

Battens

8.3.2.30 Battens shall be laid at maximum centres of 400mm (Detail B 9.2.3).

8.3.2.31 *General*

Flooring shall not be laid until all wet trades are completed, the plaster and concrete dry and the heating is switched on.

8.3.3 Metal fixings

8.3.3.1 Care shall be taken to ensure compatibility of metal fixings when used with preservative treated timber.

8.3.3.2 Nails and pins shall comply with the requirements of BS 1202: Part 1.

8.3.3.3 Collated flat nails used for secret nailing of floor boards shall be 2.5 times the thickness of the flooring board. In the case of thin sheet materials ring shank or serrated nails may be used when the minimum penetration into the timber support base shall be 19mm.

8.3.3.3
Normal or improved nails may be either hand driven or machine applied. The greater holding power of improved nails much increases resistance to 'nail-popping' but may add to the risk of the wood splitting.

Screws

8.3.3.4 Screws shall be not less than size no. 8 and shall have a length of at least twice the thickness of the flooring being fixed, except in the case of thin sheet materials when the minimum penetration into a timber base shall be 19mm to comply with BS 1210.

Floor Clips

8.3.3.5 Floor clip systems vary from one manufacturer to the next. When installing a floor using this type of system, as with any other proprietary system, the floor shall be installed according to the manufacturer's instructions.

8.3.4 Adhesives

8.3.4.1 Parquet panels or parquet flooring (other than proprietary materials for which the manufacturer's recommendations advise otherwise) shall be fixed to concrete using a cold adhesive complying with the requirements of either BS 1204 or BS 4071.

8.3.4.2 The adhesive shall be spread evenly on mosaic fingers using a serrated trowel.

Serrations shall be U-shaped, measuring 3mm deep by 3mm wide, and be spaced at 8mm centres. Serrations shall be maintained accurately to size in order that the correct amount of adhesive is applied.

8.3.4.3 Adhesive shall be applied to no more than 4m² of the base of the flooring at any one time.

8.3.4.3
This enables the panels to be bedded accurately and firmly into position before the adhesive dries .

8.3.4.4 The panels shall be bedded firmly in the adhesive with the edges tightly butted to form a continuous pattern.

8.3.4.5 Complete adhesion shall be obtained by pressing down with a roller weighing about 65Kg or by other suitable means within 30 min of being laid.

8.3.4.6 Engineered overlay shall be spot glued on the side tongues and grooves and where ends match.

8.3.5 Surface coatings

The choice of the initial surface treatment and subsequent maintenance procedures depends on the type of building and wood, nature of occupancy and traffic, availability and efficiency of staff and equipment for initial treatment and maintenance.

Seals (such as lacquers) penetrate wood, reinforce its structure and leave a protective coat on its surface. Once sealed this way, the floor surface needs comparatively little maintenance. Eventually the seal will wear and the wooden flooring must then be re-treated, before the wood is exposed, to avoid the need to resand the floor. Some proprietary systems have a pre-oiled finish which needs weekly maintenance, but does not need re-sanding.

8.3.5.1 Hardwood strip and board flooring shall be sanded and finished with a seal. The boards shall be either wax polished or given an oil treatment.

8.3.5.2 Softwood strip flooring shall be sanded and finished with a seal. Subsequently, it shall be either wax polished or given an oil treatment.

8.3.5.3 All seals shall be applied in accordance with BS 8201

8.3.5.4 Seals used in flooring shall be one or two part polyurethane. Two-part polyurethane is the hardest wearing finish.

8.3.5.5 Any surface irregularities e.g. cupping, unevenness or sharp edges shall be removed by a light sanding.

8.3.5.6 A primer shall be compatible with the seal. One coat of primer shall be applied after sanding followed by the seal coat.

8.3.5.7 The primer shall be quick drying, easy to apply and shall not discolour the flooring.

8.3.5.8 A liquid wax compatible with the selected finish shall be applied immediately after laying the blocks.

8.3.5.2
This only applies if the boards are to be left exposed.

8.3.5.4
One-part seals have advantages on a building site because they are ready to use. Seals used in newly installed floors may produce 'fissure cracking'. Careful and regular maintenance will retard the rate of surface wear of a timber. The degree of retardation depends on the surface conditions and the type of finish. Epoxy finishes are the hardest wearing.

8.3.5.6
Where it is desired to treat new flooring wood blocks and mosaics before the moisture content has reached equilibrium with its surroundings one of the following methods of pre-treatment may be considered:

- Pre-treatment by the use of a special primer.
- Pre-treatment by the use of a thin liquid wax.

8.3.5.8
After the wax is applied the floor is then sanded in the normal manner. This removes the wax from the surface, leaving the wax only between the joints of the flooring. The wax prevents the seal hardening in the joints and thus prevents adhesion.

8.3.6 Site protection

Absorption of moisture on-site causes swelling. In order to avoid the damage from this as well as from grit, soiling and spillages, the floorboards should be laid as late as possible in the construction stage. It is also important to prevent wood shavings and other debris from accumulating under a floor as this may lead to a fire hazard or to infestation by vermin.

8.3.6.1 In compliance with BS 8201, all materials on-site intended for flooring shall be stacked carefully to retain flatness.

8.3.6.2 Materials shall be stored in a warm (approximately 10°C to 20°C), dry environment under conditions that will maintain the moisture content at the level recommended for laying.

8.3.6.3 Delivery shall be programmed to ensure the shortest possible storage period.

8.3.6.4 The moisture content of timber and wood products shall be checked immediately upon receipt on site.

8.3.6.5 Once the flooring is laid it shall be kept clean and free from cement, plaster droppings and other debris likely to cause damage.

8.3.6.6 Trestles, ladders or steps which shall be used on a laid floor shall have protective padding.

8.3.6.4
If the timber is well protected by moisture-resistant wrapping, its moisture content should also be checked when unwrapped.

8.3.6.5
As the flooring is laid, it should be protected progressively with polyethylene sheets or other similar material and scaffold boards should be placed over it to reduce the risk of slipping.

Flooring should be maintained by background heat and ventilation in a low relative humidity environment. In order to avoid over-stressing the timber, the heating should be brought up slowly to the required temperature.

8.3.6.7 Use hardboard as a temporary protective surface to laid floor until handover of project.

8.4 PERFORMANCE SPECIFICATIONS

8.4.1 Quality and classification

In order to ensure the quality of the floor it should be checked upon delivery, during construction and hand-over.

All wood flooring shall be free from:
(a) rot or mould staining.
(b) active insect attack.
(c) natural and drying defects that detract from the suitability of the flooring, e.g. excessive splits and shakes.
(d) loose knots or knot holes.

8.4.1.2 All work shall be inspected whilst in progress and after completion, special attention being paid to the possibility of defects.

8.4.1.3 Timber shall be inspected on its arrival for defects.

8.4.2 Moisture content

The importance of using wood at correct moisture content cannot be over-emphasised. If, at the time of fixing the moisture content is too great, shrinkage is inevitable, which results in unsightly open joints; if the moisture content is too low, swelling may occur resulting in bowing, lifting and buckling. When heating is applied to occupied buildings the relative humidity reduces and the moisture content of the timber responds by decreasing. Buildings that are suddenly heated on occupation will result in surface shrinkage, differential stress and distortion of the timber work. It is very important to gradually heat, control humidity and condition the interior spaces to their design/comfort conditions. When the design conditions are achieved and remain constant, the timber will reach an equilibrium state compatible with the ambient relative humidity. Timber species vary in their lateral shrinkage on drying and their movement (expansion and contraction with increase or decrease in atmospheric humidity). They range from small (up to 1.5%) to large (3+%) movement and it is important to know the movement rating of the selected species and allow accordingly.

8.4.2
For underfloor heating, a low moisture content is essential. Boards at a moisture content of 6% to 8% are available by special order only and as such they require special attention in storing and laying. The manufacturer should give instructions on how to handle these boards.

Table D 8.4.2.1 *Average moisture content of floor boarding in service (BS 8201).*

Unheated building	17±2%
Intermittent heating with a substantial drop in temperature between periods of heating	12±2%
Continuous heating with the temperature maintained day and night throughout the year at a reasonably constant level	10±2%
Under-floor heating	7±1%

8.4.2.1 The moisture content at delivery and installation on site shall be in accordance with the in-service percentages listed in table D 8.4.2.1.

8.4.2.2 Timber shall be checked for moisture content using an electrical moisture meter.

8.4.2.3 Floor boarding shall be laid only when the heating system is operating and the building has fully dried out.

8.4.3 Fire

8.4.3.1 Timber floors shall comply with the Building Regulations Part B.

8.4.4 Preservative treatments

Consideration should be given to the pre-treatment of flooring timber and its support system (if any), to ensure adequate durability. See Section A4 for additional advice and detail with regard to potential hazard classes and possible preservative treatments. For example, softwood flooring laid on suspended timber ground floors, or on ground floor concrete slabs, require treatment to Use/Hazard Class 2, whereas similar floor construction above ground floor level would be treated to Use/Hazard Class 1.

8.4.4.1 All boarding shall be kept clear of masonry walls, to protect from dampness and condensation.

8.4.4.2 Timbers to be used in ground floors, suspended or laid on concrete slab, shall be deemed to fall into Use/Hazard Class 2 and be treated accordingly.

8.4.4.3 Timber floors above ground floor level shall be deemed to fall into Use/Hazard Class 1 and therefore do not require specific preservative treatment.

8.5 GENERAL

8.5.1 Compliance

8.5.1.1 Aspects of flooring shall comply with the following codes and standards, as relevant:

BS1297: Tongued and grooved softwood flooring.

BS 8201: Code of Practice for flooring of timber, timber products and wood-based panel products.

BS5268: Code of Practice for permissible stress, (Part 2) design, materials and workmanship.

8.5.2 Architect's requirements

8.5.2.1 Floors shall comply with architect's requirements or where otherwise stated with manufacturer's or supplier's requirements.

D 9 Joinery

9.1 JOINERY ELEMENTS

9.1.1 General

The uses of joinery vary considerably, for example, doors may require different specifications depending on use, e.g. fire-resisting door or an external door. Furthermore, the frequency of use has implications for the design and specification and the potential of abuse has to be catered for. Different environmental aspects also play a part in the specification of joinery. In this section we deal with both internal and external joinery.

9.1.1.1
The strength required of external joinery will depend on the following:
- Exposure condition to wind loads
- Size of glazed area
- Pressure exerted by people in the form of vertical or horizontal loads
- Weight of glass (if applicable) to be supported
- Accidental loads

9.1.1.1 Timber sections shall be designed to withstand dead loads, mainly the weight of glass and applied loads, which is the wind pressure/suction coupled with sudden impact loads.

9.1.1.2 Exterior joinery shall be protected from the elements before and during the construction.

9.1.2 Windows

Timber window design is a specialised area necessitating good practice, proper detailing and performance testing before the launch of a durable and efficient product. There are many proprietary systems on the market so it is advisable to deal with a reputable manufacturer who has a proven track record and whose products have been independently tested and certified. It is important that proprietary systems are specified in accordance with manufacturers' instructions so as to ensure their optimum performance. At the design stage there are certain aspects of glazing which must be kept in mind. Orientation greatly influences the comfort conditions of a building. In some cases exposure to too much sun can create unwanted heat energy. Reflective or tinted glazing will help reduce over-heating. Another important aspect of glazing is thermal insulation, as a large proportion of the total heat loss of a building is through windows. Heat transmittance from the interior heated environment can be reduced by increasing the performance of the glazing system. The thermal transmittance of single glazing is very high (U-value 5 W/m^2K), standard double glazing will reduce this heat loss to a U-value of 3 W/m^2K approx. High-performance energy-efficient double glazing, with a wide cavity (24mm), Argon-gas filled, and low emissivity reflective coating on the inner surface of the outer pane, will reduce the energy loss to approx. 1.4 W/m^2K. This is less than one third of the heat loss of single glazing and performs better than standard triple glazing. Skilled Irish joinery work shops can produce bespoke small and large-scale windows, glazed screens, doors and stairs to architectural detail design drawings.

9.1.2.1 Timber in main frames and casements shall be *European redwood*, *Douglas fir*, *Scots pine* or *larch*, complying with J10 of EN 942. Timber glazing beads to comply with Class J2. Laminating of sections is permitted. Finger jointing of individual laminates is permitted, but not of whole sections nor on exposed surfaces intended for a clear or stain finish. Inserts and fillers are not permitted. There should be no signs of active insect attack; pinhole borer holes on exposed surfaces are not permitted. Moisture content of timber at the time of installation is to be 16%. Adhesives shall comply with the requirements of class D4 of EN 204.

9.1.2.1
This is a sample specification only. An alternative species may be selected from table A 12.1. The class of timber is explained in D 9.4.1.
Plugs to replace knots are permitted as long as they are of the same timber with the direction of the grain matched.

9.1.2.2 All windows shall be fitted according to manufacturer's instructions.

9.1.2.3 The structural openings shall not measure more than 16mm larger than the size of the unit, allowing joints of 8mm to 15mm.

9.1.2.4 Joints between the structure and frame shall be packed with *wood wool* wadding and covered with an elastic weather seal mastic.

9.1.2.5 Weather drips shall be cut in to the underside surface of horizontal planes.

9.1.2.6 A water channel shall be grooved into the top and sides of the opening section.

9.1.2.7 The top of horizontal members exposed to weather shall have a run-off slope of at least 1:8.

9.1.2.8 Glass shall be bedded in mastic - 2mm thick - between the timber rebate and the glass.

9.1.2.8 Glazing Beads
A 2mm-thick bedding mastic shall be placed between the glass and the bead to seal. The bottom bead shall be raised on spacers (200 mm centres) to allow drainage and ventilation and this bead shall be tapered to fall and extend beyond the face of the timber cill to weather same.

9.1.2.9 Glazing sprigs shall be non-corroding and fitted at max. 400mm centres.

9.1.2.10 Timber glazing beads shall be double-vacuum treated with preservative in accordance with BS 8417 and manufacturers instructions and fixed with non-ferrous panel pins or screws at 200 mm maximum centres and not more than 50 mm from each corner.

9.1.2.11 Glazing beads shall not be mitred but the top and bottom beading shall run full width and be bedded in mastic with the vertical beads cut to fit.

9.1.2.12
Laminating sections can provide greater stability to the components. The practice requires care and proper quality control.

9.1.2.12 Laminating of sections is permitted and advisable. Finger jointing of individual laminates is permitted, but not of whole sections. Splits, shakes, checks and plugs are to comply with the requirements of J10 of EN 942. Fillers are not permitted. Plugs of the same material (to replace knots) are permitted.

9.1.2.13 Safety
This specification is in accordance with BS 5588: Part 1: 1990 and Building Regulations 1997 Part B1.5.1.7.
Windows in upper floor levels shall be at least 900mm above floor level to guard against children falling through glass or openings. Where windows are fitted below this level, they shall be fixed-lights or fitted with a child-proof lock or guarded with a rail or balustrade. The glass shall be a minimum of 6 mm plate or laminate glass.

9.1.2.13 At least one opening sash shall be provided in all habitable rooms of residential buildings. This window shall provide an unobstructed opening not less than 850x500 mm. The bottom of any such window shall be not less than 600mm nor more than 1100mm from the floor of the room in which it is situated. Safety glazing shall be installed in accordance with current guidelines.

9.1.2.14 Openings shall be securable and their size shall be adjustable.

9.1.2.15 Trickle Vents
This specification is only applicable where this type of permanent ventilation is desired. Vents are normally listed as an additional feature to most proprietary systems.

9.1.2.15 Trickle vents for controlled permanent ventilation shall be fitted to the top horizontal member of the fixed frame.

9.1.2.16 The joiner shall ensure that all weathering surfaces, throatings, grooves, open joints etc. shall be properly executed to specification and shall function as a weathertight element.

9.1.3
Duty performance is graded:
Light duty (LD), Medium duty (MD), Heavy duty (HD) and Severe duty (SD)

9.1.3 Doors

External door-faces are exposed to significantly different interior/exterior environmental conditions on both surfaces. This causes differential movement resulting from differences of humidity, temperature, and dampness on either surface. Resulting swelling and shrinkage may cause doors to twist and create gaps, allowing rain and draughts to penetrate. Care should be taken to shelter, weather and protect exterior doors, thereby minimising distortion. As with windows, specialist advice should be sought in the design, specification and installation of doorsets.

9.1.3.1
This is a sample specification only. Sizes should be referred to the manufacturer's standard sizes.

Internal doorsets

9.1.3.1 Internal panel doors shall be *1981x762x45mm thick. Scots pine* to class J10 of EN 942. Glazing beads shall match and shall be supplied loose. Door frames and linings shall be rebated and sized to suit finished wall thickness. Moisture content shall be 12% ± 2% at time of manufacture and delivery to site.

9.1.3.2 All doors shall be fitted according to manufacturer's instructions.

9.1.3.3
A solid core door performs better than a hollow core door with regard to fire resistance, sound insulation and structural strength.

Internal flush doors

9.1.3.3 Flush doors shall be lipped with solid timber (not less than 6mm thick) glued along the edges of both stiles, and shall also be lipped on the bottom and top. Where the door leaf is supplied pre-fitted, as part of the doorset, the thickness of the lipping shall be reduced to 6mm.

9.1.3.4 Blockings shall be provided in hollow core doors to receive special items of hardware, such as mortice locks, overhead closers, security fittings and coat hooks.

9.1.3.5 Lock blocks shall be positioned in accordance with IS 196: Part 1 and glued or stapled securely to the stiles.

9.1.3.6 The facing shall be 6mm plywood, glued to the core and framework in a suitable press without framing showing through.

9.1.3.7 Openings shall be framed in the core, rebated and provided with mitred glazing beads in eight pieces (four each side) loosely pinned to the framing. The glazing beads shall be rebated to overlap the edges of the facings by at least 3mm.

9.1.3.8 A solid core door shall consist of a suitable core of solid timber, covered on both sides with facings of plywood or other suitable material, with or without appertures for glazing or ventilation louvres.

External Doors

9.1.3.9 All metal fixings to external doors shall be corrosion resistant, durable and sufficiently strong and suitable for their intended exposure conditions and usage. The door-locking mechanism shall be three point to eliminate warp and provide additional security.

9.1.3.10 Frames shall be wedged and securely fixed with metal fasteners at the level of the top hinge, lock (intermediate rail) and bottom.

9.1.3.11 Glass shall be a minimum of 6mm plate (tempered) glass, preferably laminated and shall be double glazed for external doors or sound insulating doors.

9.1.3.12 Stiles and rails shall be jointed with stub-tenons or mechanical devices. The framework shall be square when assembled, in a true plane, and the parts shall match each other in thickness.

9.1.3.13 The framework of flush doors shall be ventilated by means of a 5x5mm groove in each stile or four 6mm diameter holes in each rail to give a total area of 100mm².

9.1.3.14 Door frames shall be secured by non corrosive screws or specialist proprietary fixings in accordance with manufacturer's instructions.

9.1.4 Staircases

9.1.4.1
This is a sample specification only. Where treads are to be exposed and left finished, they should be of hardwood such as oak, ash or beech or iroko and fitted with slip resisting edgings or propietary carborundum strips. Alternative species, and adhesives may be selected from the following sections

Species	Table A 12.1
Adhesive	D 9.2.3

Panel products, particularly MDF, are being increasingly used in stair manufacture due to:
- limited availability of boards of adequate width;
- uniformity of product;
- ease of machining

9.1.4.1 Strings, handrails, balustrades, newels and risers shall be Scots pine (European redwood). Treads shall be of MDF. Timber quality shall conform to J30 of EN942. Sizes and tolerances shall comply with BS 585: Part 1. Workmanship shall be in accordance with BS 1186: Part 2. Adhesive shall comply with EN 204 type D3 or D4. The moisture content at time of manufacture and delivery on site shall be 12%±2%.

9.1.4.2 Staircases, landings and galleries shall comply with BS 585

9.1.4.3 Staircases shall be constructed according to detail drawings.

9.1.4.4 Treads, risers, balusters, handrails and newel posts shall be sanded smooth, end-grain chamfered and finished with specified resin/lacquer finish.

9.1.4.5 Landings, balusters, handrails, and step rise and going to comply with the current Building Regulations for their respective end use.

9.1.4.6 Treads, risers and strings shall be housed into the newel posts.

9.1.4.7 Handrail shall be mounted to form a continuous rail, curved if necessary at junctions, and dowelled at joints.

9.1.4.8 Part M TGD shall be complied with for handrails, tread alert and visual definition.

9.2 MATERIALS FOR INTERNAL AND EXTERNAL JOINERY

9.2.1 Timber species selection

Choose from table A 12.1: Joinery species suitability.

9.2.2.3
There are many types of MDF. See *Design Guidance A9.3* for further details.

9.2.2.5
There are five principal veneer cutting methods namely, rotary, flat slicing, quarter slicing, rift-cut and half-round slicing. Don't just specify veneer as the different cutting methods will produce different visual effects, depending on how the log is cut (Ref. *'Saw to Site'*.)

9.2.2 Wood-based panel products

Plywood

9.2.2.1 Plywood shall generally comply with EN 636. All plywood shall be first grade and shall be faced with veneer as specified. One side shall be completely free from joints and surface defects. Joints and minor blemishes will be permitted on the reverse side only. Where both sides of the plywood are exposed these shall be totally free of joints and surface defects.

OSB

9.2.2.2 OSB shall comply with EN 300

Chipboard

9.2.2.3 Chipboard shall comply with EN 312

Fibreboard

9.2.2.4 MDF shall comply with EN 622.

Blockboard

9.2.2.5 Blockboard shall comply with BS 3444 Grade II veneer or with facing veneer as described.

Wood veneers

9.2.2.6 Wood veneers shall be prime quality *rotary birch* and *quarter-sawn oak*, a sample of which shall be submitted and approved by the architect. The architect is to be informed when the whole of the stock is ready for his inspection and approval before work is commenced.

9.2.3 Adhesives

The following two specifications give alternate approaches to specification of adhesives, the second one being more specific than the first.

9.2.3.1 Types and applications of adhesives for all framed, glued joints, finger joints and laminated timber shall comply with BS 1186: Part 2 and should be compatible with wood preservatives, if so required.

9.2.3.2 Adhesives shall comply with the appropriate class of EN 204.

9.2.4 Screws and nails

9.2.4.1 Screws shall comply with BS 1210 and nails with BS 1202. In every case the size and material of screws and nails shall be specified as appropriate to the nature of the fixing and of the materials involved. Screws, nails or metal fastenings in hazardous locations or conditions must be non-ferrous, e.g. stainless steel, silicon bronze. No other screws or nails permitted. The fixing of external cladding, joinery or window beads with non stainless steel or silicon bronze screws, nails or fixing pins will be rejected.

9.3 WORKMANSHIP AND CONSTRUCTION

To minimise damage from moisture movement due to humidity (swelling during construction, shrinkage and distortion later), it is advisable that doors be fitted after completion of building construction when the heating system is in operation and all wet trades are completed.

9.3.1 Jointing, fitting and fixing

The assembly of worked timber components can be off-the-shelf mass-produced items, custom-made in a joinery workshop, or assembled on-site. It is advisable that they be made under controlled conditions in a joinery workshop wherever possible.

9.3.1.1 Workmanship shall be in accordance with BS1186: Part 2.

9.3.1.2 Any plug or insert shall be as follows:
- Of the same species as the surrounding timber;
- Well secured by a MR or WBP adhesive;
- Occupy the full depth and surface area of the hole;
- Lie with its grain in the same general direction as the grain of the piece into which it is inserted;
- Be of width, i.e. the lesser dimension not greater than 6mm above the maximum limit of knot size for the specified surface category.

9.3.1.3 Any filler shall completely fill the hole, shake or check and shall be a timber filler compatible with the intended end-use of the timber.

9.3.1.4 Laminated, finger-jointed, edge-jointed timbers are acceptable in joinery, subject to compliance with BS 1186: Part 2.

9.3.1.5
Never glue solid timber panels in place.

9.3.1.5 Where a solid timber panel is fitted into grooves, the following requirements shall apply:
- The grooves shall be no less than 9mm deep.
- The faces of the panel shall fit closely to the sides of the grooves.
- In the direction of the grain, the length of the panel shall be shorter than the distance between the bottoms of the grooves, by no more than 3mm.
- Across the grain, the panel shall be less than the distance between the bottoms of the grooves to provide for expansion and contraction.
- The panel shall not be fixed in any way that will prevent its free expansion and contraction.
- Profiled boarded surfaces, such as tongued and grooved and rebated joints, shall comply with the requirements of BS 1186 Part 2.
- Fixed joints including doweled, mortised and tenon, combed, halving and dovetail joints shall comply with BS 1186: Part 2.

9.3.1.6 Jointing of framework shall be mortice and tenoned and glued to comply with IS 196: Part 6.

9.3.2 Tolerances

9.3.2.1 Allowable tolerances for the installation of doorsets:
- Clearance between leaf and jamb/head/transom: 2mm (+1mm,- 0.5mm)
- Clearance between leaf and cill/saddle: 3mm (+1mm,-0.5mm)

9.3.2.2 The deviation from squareness (at a point 500mm from any corner) shall not exceed 0.75mm.

9.3.2.3 Flatness
- The maximum permitted distortion for bow (along the length) and cup (across the face) is 2mm.

9.3.2.4 Local flatness:
- 0.2mm when measured on a 50mm base, 0.6mm when measured on a 200mm base.
- Tolerance for movement: 1.5mm at each junction of door leaf and fixed frame.

9.3.3 Site protection

The protection of joinery during transport, storage and after its fitting has to be carefully considered and provided for. The incomplete, often damp building environment can lead to swelling and deformation of timber, often followed by shrinkage stresses. Cement splashing and other damage risks can cause staining or breakage. Protective coatings or appropriate wrappings should therefore be applied in the fabrication workshop. If this is not done, a protective covering should be applied immediately on site. This will also retard the rate of moisture uptake on site.

9.3.3.1 The timber work shall be coated with wood stain before being fitted.

9.3.3.2 Staircase and other joinery elements shall arrive as late as possible on site.

9.3.3.3 Staircases, especially treads, shall be protected from construction traffic.

9.3.3.4 All joinery elements shall be protected from exposure to humidity and dampness until completion of construction.

9.3.3.5 All joinery elements shall be protected from exposure to damage (splashing, grit, staining, indenting, marking).

9.3.4 Surface preparation

9.3.4.1 All woodwork to be painted shall be knotted, stopped, primed and painted with two undercoats and one finishing coat.

9.3.4.2 Before fixing woodwork, all surfaces which will be visible after fixing shall be rubbed down and all knots and resin pockets shall be scorched back and coated with knotting. After priming and fixing, all nail holes and other imperfections shall be stopped and the whole surface shall be rubbed down and all dust brushed off.

9.3.4.3 All holes and other imperfections in wood surfaces to receive a clear finish shall be stopped and the whole surface shall be rubbed down and all dust brushed off.

9.3.4.4 Knotting/stopping for external timber work shall be white paste complying with BS 2029 or with BS 217 Type 2 and gold size complying with BS 311 and shall be tinted to match the surrounding woodwork.

9.3.4.5 The preparation of all surfaces must be seen and approved by the architect before any coatings are applied.

9.3.5 Surface coatings

Surface coatings to external, exposed faces of timber members are most important for the durability of the wood. Pigmented wood stains are most appropriate for a natural wood finish with ultra-violet protective finish coats. Inside surfaces are less critical and paints, stains and varnishes can be used.

9.3.5.1 Unless otherwise directed the surface coating treatment of components shall be as detailed in Table D 9.3.5.1

Table D 9.3.5.1 *Surface Coating Treatments*

COMPONENT	TREATMENT
External cladding, pergola	Pigmented microporous finish as per manufacturer's instructions, minimum 3 coats
Window joiner	Pigmented microporous finish as per manufacturer's instructions, minimum 3 coats
External doors	Pigmented microporous finish as per manufacturer's instructions, minimum 3 coats
Internal floors, doors, architrave, skirting	Sand down; one coat polyurethane primer; 2 coats of 2 pack polyurethane matt finish
Veneer finishes	As above or acid catalysed laquer

9.3.5.2 Unless otherwise prescribed, all coatings shall be applied by brush. Written permission must be obtained from the architect for the application of coatings by spray or roller where not so precribed and if permission is granted such application shall not result in extra cost to the employer.

9.3.5.3 If, by the time the work is to receive the first undercoat, the priming coat has in any way deteriorated or has been damaged, the affected portions, or the whole if necessary, shall be rubbed down and reprimed. In the case of articles primed at works, the priming shall be touched up where required with a similar primer.

9.3.5.4 All exterior coatings shall be vapour-permeable to allow vapour to migrate and prevent moisture becoming trapped in the timber behind the coatings.

9.3.5.5 Priming paint shall be lead free and comply with BS 4756 or BS 5082.

9.3.5.6 Primer for internal woodwork (other than internal surfaces of external doors, windows and their frames) shall be an approved leadless grey priming paint which shall be compatible with the subsequent coats and obtained from the same maker.

9.3.5.7 All paints, varnishes, and other surface coatings shall be delivered in sound and sealed containers, labelled clearly by the manufacturer, the label or decorated container stating:

- Type of product
- Use for which it is identified
- Brand name, if any
- The manufacturer's batch no.

The label shall be a printed one. The batch deliveries shall be dated and used strictly in order of delivery.

9.3.5.8 All materials shall be kept in a dry clean store, protected from frost.

9.3.5.9 The finished surface of the staircase shall be able to withstand indenting and scraping and shall not be liable to become slippy in wet or frosty conditions.

9.4 PERFORMANCE SPECIFICATIONS

The behaviour and performance of an item of joinery depends, amongst other factors, on the choice of species, the grade of timber, moisture content, protective coatings, and maintenance. Detailing and manufacturing can also seriously influence performance and longevity. Most importantly, the performance will depend on the appropriate application. 'Fitness for intended purpose' must be clearly defined, and the end-use condition foreseen, and the design, specification, manufacture and installation must carefully accommodate these requirements. Appearance and aesthetics, longevity, hardness, ergonomics, as well as maintenance are all to be considered.

9.4.1 Quality and classification

9.4.1.1 The quality of timber for joinery is subject to the criteria as set out in EN 942.

9.4.1.2 Knots to comply with the end use requirements given in EN 942.

9.4.1.3 Sapwood is acceptable in joinery. If present in external joinery the tim ber shall be preservative treated in accordance with BS 8417.

9.4.1
The quality of timber is assessed by a system of grading, expressed in "classes". As joinery depends greatly on appearance, it requires the precise selection of the appropriate class of timber for its intended use. EN 942 defines five classes of timber for use in joinery.
Class J2 and Class JIO are suitable for high quality or specialised joinery. They may require special selection and are usually more costly. Class J2 is not commonly available off-the-shelf in most timber species and needs to be investigated before specifying. There are 5 classes for exposed surfaces of timber suitable in the use of joinery. These are readily obtainable from commercially available grades of softwood and hardwood.
Knots or other surface defects may be acceptable depending on their location on the finished joinery and class specified. This is a sample specification only. The onus is on the designer to specify the required class of timber

9.4.1.4 The rate of growth (averaged over 75mm) when measured shall be limited as follows:
- In softwood for external use, not less than an average of 6 growth rings per 25mm.
- In softwood for internal uses, not less than an average of 4 growth rings per 25mm.

9.4.1.5 The slope of grain shall be not greater than:
- one-in-eight in hardwoods
- one-in-ten in softwoods

9.4.1.6 Exposed pith is acceptable on concealed surfaces and is also acceptable on exposed surfaces of Class J40 and J50, if made good with plugs, inserts or fillers.

9.4.2 Moisture content

Joinery is greatly affected by its initial moisture content. Once installed on site, the environmental conditions, such as high humidity, dampness and low temperature can seriously affect moisture movement and swelling. Later uncontrolled heating can cause rapid drying of surfaces which stresses the timber and leads to shrinkage and distortion, such as warping, cupping and cracking. The in-service environmental conditions affect the equilibrium moisture content of the timber.

9.4.2.1 The average moisture content of timber shall comply with EN 942, Table B.1

Table D 9.4.2.1 *Moisture content of solid timber by categories related to in-service conditions.*

Position	Use	Average moisture content %
External joinery	All external joinery	16±3
Internal joinery	Buildings with intermittent heating	15±2
	Buildings with continuous heating room temperature 12°C – 21°C	12±2
	Buildings with continuous heating room temperature in excess of 21°C	10±2

9.4.2.2 All joinery shall be protected, stored and installed in such a manner as to maintain the moisture content stated in the above table. The moisture content shall be checked at the time of hand-over from the manufacturer to the first purchaser and from subsequent suppliers to purchasers.

9.4.3 Fire-resistance treatments

Most non-domestic new buildings require a Fire Certificate application to the Local Authority. Specialist knowledge of an experienced architect, engineer or fire consultant is required in making such an application.

The information contained within this section must be correlated with the Fire Certificate requirements for each individual building.

The key fire-resistance aspects in joinery relate to fire doors and wall panelling.

Most timbers and wood-based boards fall into a Class 3 surface spread rating unless they have been treated with a flame retardant.

Solid timber requires fire-retardant impregnation to meet fire certification Class 0 or Class 1. Flame Retardant MDF board is available to Class 0 and Class 1 surface spread of flame rating. Proprietary veneered panel boards to Class 0 are available from specialist suppliers. For additional information see Section A5 and Section C, Sample Specifications, 4: Fire-Retardant Treatment requirements.

9.4.4 Preservative treatments

As explained in the Technical Information and Design Guidance sections, new European Standards are being introduced which will replace the existing process type specification with a results-type specification system. Specifiers should check with timber treatment plants and the relevant preservative company's technical departments whether existing British Standards or proposed. European Standards methods of treatment are in use. Both systems depend on preservative penetration and retention in order to be effective. With either the BS or EN system the specifier must decide:
- *the desired durability required;*
- *the relevant code of practice;*
- *the type and method of preservative application;*
- *compatibility with other specified materials;*

Internal joinery is categorised into Hazard Class 1 and external joinery into Hazard Class 3A for preservation purposes and must be treated accordingly. For additional information see Section A4 and Section C2 - Preservation Treatment, for sample specifications.

9.5 MAINTENANCE

As explained in the Technical Information and Design Guidance sections, new European Standards have been introduced which have replaced or which are replacing the existing process type specification with a results-type specification system. Specifiers should check with timber treatment plants and the relevant preservative company's technical departments whether existing British Standards or proposed European Standards methods of treatment are in use. Both systems depend on preservative penetration and retention in order to be effective. With either the BS or EN system the specifier must decide:
- *the desired durability required;*
- *the relevant code of practice;*
- *the type and method of preservative application;*
- *compatibility with other specified materials;*

Internal joinery is categorised into Hazard Class 1 and external joinery into Hazard Class 3A for preservation purposes and must be treated accordingly. For additional information see Section A4 and Section C2 - Preservation Treatment, for sample specifications.

Maintenance should be considered when designing and specifying joinery and other worked timber components. In today's busy world, low maintenance is favoured and all joinery should be capable of being easily and cost-effectively cleaned. Coatings protect against damage from dust, dirt, dampness and degradation. The choice of application determines the level of maintenance required.

9.5.1 **Fire doors:** Shall be thoroughly inspected every six months.

> **9.5.1**
> Routine inspection of fire-resisting doorsets is necessary to ensure their safe performance. Intumescent seals can come loose and should be replaced.

9.5.2 **Fire test certificates:** Shall be kept in the Health and Safety file.

9.5.3 **Staircases:** Shall be designed with regard for ease and safety of cleaning and maintenance.

9.5.4 **Space located beneath the staircase:** Shall be easily accessible to facilitate repairs.

9.6 GENERAL

9.6.1 Compliance

9.6.1.1 All aspects of joinery shall comply with the relevant requirements of the following standards:

IS 196	IS 131	IS 63	IS 142
BS 5082	BS 1204	BS 8417	BS 5707
BS 4756	BS 5750	BS 1186 (parts 2&3)	BS 1336
BS 476	EN 942		

Section E *Reference Materials*

About 3% of all world trade is in forest products compared with an 8% share for oil. The global forest resource has one of the widest range of product possibilities of any raw material source including structural and decorative timbers, furniture components, paper, panel products, chemical products for fabric, paint and solvent manufacture, rubber, food and pharmaceuticals. More than half of the global wood harvest is fuelwood.

Timber is a renewable resource. As such, its future can be assured in perpetuity. The proper management and maintenance of forests would ensure that virtually all the tree species that provide the diversity of timbers that we use could be available to timber users for as long as there is a need for them. Therefore, it is of immense strategic importance that the renewability of the timber resource be maintained, worldwide.

E1 Sources of timber supply

WORLD WOOD RESOURCE

Total forest area

The forests of the world are 3.4 billion ha. in extent, covering 27% of the land surface. Fifty percent of the world forest area consists of operable forests (i.e. where commercial cuttings have occurred or could occur). The forest area in developed countries amounts to 45% (about 2 billion hectares (ha)) of the total area, out of which 49% (940 million ha) is operable. In developing countries, forests cover 55% (2.2 billion ha) of the land area, of which 46% (about 1 billion ha) is operable. Predominant in developing countries are the tropical forests of Latin America, South-east Asia and Africa, accounting for 1.7 billion ha.

- Operable forests constitute just under 50% of total forest areas.
- Operable forest areas are slightly greater in the developing than the developed regions.
- In the developed world, the Russian Federation and N. America hold the bulk of the resource.
- In the developing world, Latin America holds 50% of the resource - mostly in the Amazon basin.

Main types of forest

There are three main types of forest: coniferous; temperate hardwood; and tropical hardwood. Coniferous forests chiefly occur in the cooler latitudes, mainly in the northern hemisphere. The main producing regions are Brazil, Ghana, Ivory Coast, Congo basin, Indonesia and Malaysia. Virtually all tropical timbers imported into Ireland is used for furniture and joinery production."

- The main regions of operable forest in the world are:
- Developed areas: North America, Europe, Russian Federation
- Developing regions: Latin America, Africa, Asia.

Temperate hardwoods, as their name implies, occur in the temperate regions of the world. They are characterised by mainly deciduous hardwood trees, which have distinct growing and dormant seasons corresponding to summer and winter. The main producing regions are the eastern states of the USA, the Russian Federation, France and Germany. Typically, temperate hardwoods are produced for joinery and furniture, such as oak, ash, beech and walnut. There can, of course, be mixtures of hardwood and conifer forests in these regions. Tropical hardwoods occur in the wetter areas north and south of the equator. The trees are evergreen and often show continuous growth throughout the year. The main producing regions are Brazil, Ghana, Congo Basin, Ivory Coast, Indonesia and Malaysia. The timbers are used locally in structures, joinery and furniture. Virtually all imported tropical hardwood is used for joinery and furniture production.

- 75% of growing stock is coniferous.
- Coniferous forests are often of a single species or a few species.
- Tropical forests may contain up to 2000 species.
- Sustainable yield from managed forests is far greater than from non-sustainably managed forests

Production forests

There are two types: natural forests and plantations. Most of the world's timber is still produced from its traditional source, which is the natural forest.

Natural forests

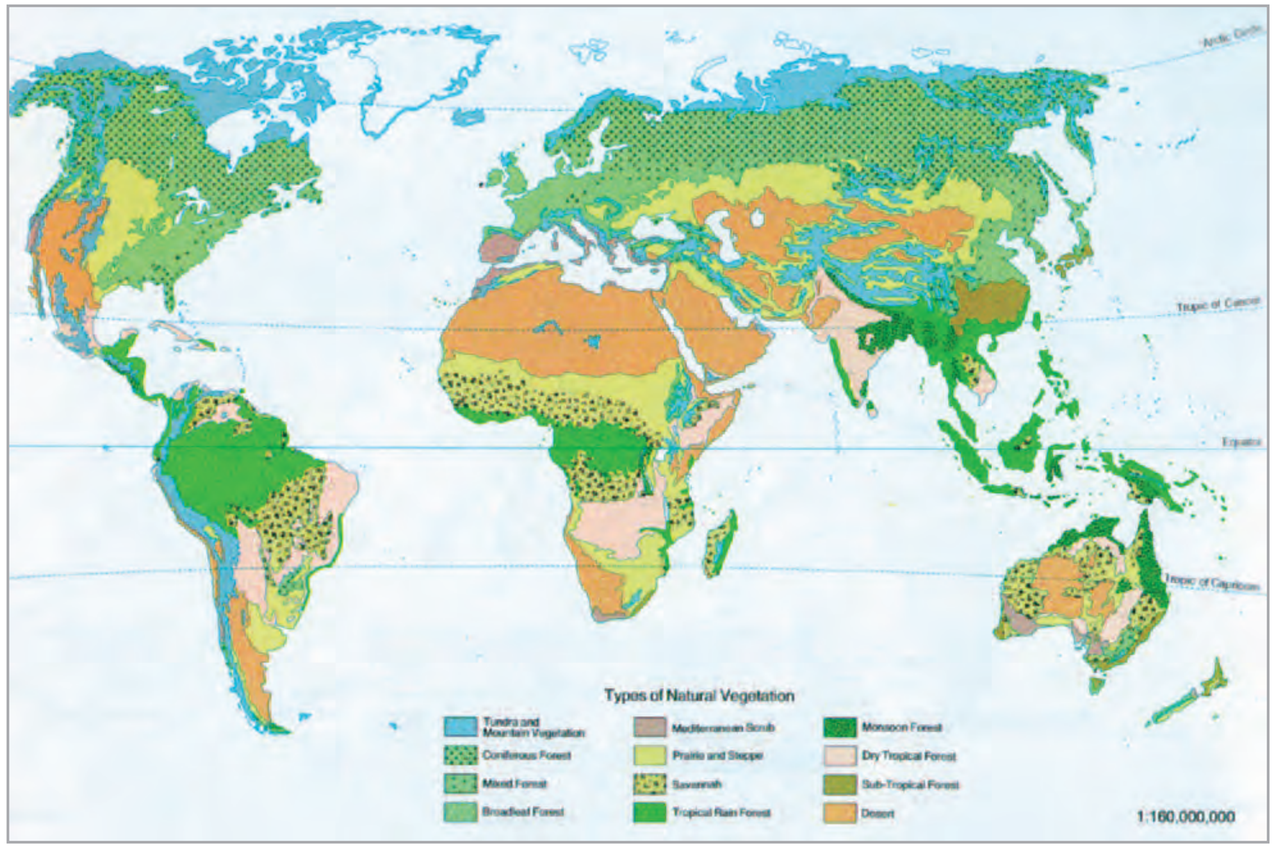
Most of the temperate region's natural hardwood and coniferous forests are subject to long-term management regimes and are generally protected from over-exploitation by legislation. Control is imposed on the amount of timber which may be felled in any period, thus ensuring the sustainable growth of the forest. Throughout most of Europe these systems have been in operation for centuries, so that there is a long history of managed forests with a strong commitment to their maintenance.

Many tropical hardwood forests have been seriously depleted, mainly due to the encroachment of agriculture, but also because they have been exploited for their highly prized timbers, with little attempt to regulate felling and manage the forest as a renewable resource.

Controls, such as restricting felling to trees above a certain size, are not always effective, with the result that tropical forests are a diminishing resource. Efforts are being made to establish maintenance systems, often incorporating 'enrichment' planting in cut-over forest, which would ensure the continuity of tropical forests as a sustainable resource. These are advanced in Malaysia and some other countries but are only being developed elsewhere.

CITES

To protect vulnerable or endangered species of plants and animals CITES - the Convention on International Trade in Rndangered Species of wild fauna and flora lists many species, including a small number of tree species, which are endangered for various reasons, including habitat loss or over-exploitation. Ireland ratified this treaty in 2002. *Afrormosia, Pericopsis elata*, and a rosewood species, *Dalbergia nigra*, formerly imported into Ireland, can no longer be traded, as is the case with one species of American mahogany, *Swietenia mahogonia*, from some countries.Species commonly imported into Ireland are not presently affected.



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Plantation forests

Plantation forestry is more recent, and has been introduced to promote afforestation or reforestation of denuded areas. Ireland exemplifies the latter; having been reduced to less than 1% of forest cover at the turn of the century, it currently stands at 11%, due to the establishment of plantations. Plantation forestry, whereby young trees are planted rather than waiting for natural seedings to replace felled timber, produces more uniform growth, and is more amenable to control.

Plantations are prevalent in Ireland, Britain, Chile, New Zealand and South Africa. In other countries they occur in conjunction with a programme of managed natural forests, such as in France and Germany, where there are moves to increase the forest reserve. Where forests have reached maturity, and are felled, the current practice is generally to plant the replacement crop rather than depend on natural regeneration which tends to be slower to establish. In parts of the USA plantations are replacing natural forests as a means of accelerating the rate of reproduction of trees and assisting mechanised harvesting systems. Plantations in the tropics are mostly at an experimental level, although there are producing plantations of introduced rapid-growing species of both softwoods and hardwoods, with Indonesia, India and Brazil accounting for 80% of tropical plantations.

Some hardwood species, such as teak and eucalyptus, have been widely planted in tropical and sub-tropical countries, and are contributing to the world timber supply.Hevea (rubberwood), originally planted for latex production, is now widely used in furniture manufacture, replacing species such as mahogany.'

However the management of plantation forests is changing. Where possible natural regeneration of continuous cover forest techniques are incorporated in silvicultural systems. In addition to traditional timber production forests are now valued for wood energy and non-wood services such as recreation and carbon sequestration.

Plantations will play a more important role in the 21st century, particularly in the tropics, as their value will be appreciated as a conservation measure to protect the dwindling natural forest resources. There is a growing awareness of the positive role the world's forests make in relation to climate change. Irish forests which are mainly plantation forests can contribute about 20% of the reductions in national greenhouse gas emissions that Ireland needs, to fulfil its obligations, to meet Kyoto targets.

FOREST PRODUCTS

About 3% of all world trade is in forest products compared with an 8% share for oil. The global forest resource has one of the widest range of product possibilities of any raw material source - structural and decorative timbers, furniture components, paper, panel products, chemical products for fabric, paint and solvent manufacture, rubber, food and pharmaceuticals. More than half of the global wood harvest is fuelwood.

Industrial wood production is roughly 70% coniferous and 30% non-coniferous. Global use of industrial wood is split between the major product groups as follows:
- sawnwood 55%
- panel products 12%
- paper 33%

The following table lists the timbers commonly available in Ireland. Among Irish grown timbers, Sitka spruce is the most readily available.

	Imported	Irish grown
Softwoods	European whitewood European redwood Oregon pine Western red cedar Southern yellow pine Larch	Sitka spruce Norway spruce Douglas fir Scots pine Lodgepole pine Larch species
Hardwoods	American oak (red & white) American ash European beech American cherry Maple (hard & soft) Tulipwood American walnut Lauan/meranti Obeche African mahogany Iroko Utile Sapele	Oak Ash Beech Sycamore

- The volume of coniferous sawnwood traded internationally is about 5 times greater than the volume of non-coniferous timber.
- International trade in coniferous sawnwood is dominated by Canada which accounts for about half the annual trade flows.
- The main destinations for the Canadian shipments are U.S.A, Europe and Japan.
- Canadian exports to regions other than the U.S.A, are very sensitive to movements in the U.S.A market, due to Canada's heavy reliance on the U.S.A market.
- Scandinavia (Sweden, Finland, Norway) export principally to W. Europe.
- The Russian Federation is a major exporter to W. Europe.
- China is now a major importer of hardwoods.

ENVIRONMENTAL AND ECOLOGICAL USES

Value of the forest resource

Timber is a renewable resource. As such, its future can be assured in perpetuity. The proper management and maintenance of forests the world over would ensure that virtually all the tree species that provide the diversity of timbers that we use could be available to timber users for as long as there is a need for them. Therefore, it is of immense strategic importance that the renewability of the timber resource be maintained, worldwide.

Sustainable forestry

In Europe exploitation has been curtailed over the centuries, to the point where virtually all the forests are under comprehensive sustained management, their future generally protected by law. On the North American continent such control was introduced much later. The urgent problem areas are in the tropical forests of the developing nations, where the rate of forest depletion is considerable. Inappropriate development policies and an inability to address social and economic problems outside the forest sector have frequently hindered the advancement of effective forest management programmes.

There are increasing efforts being made to address the problems and help to control the depletion of the forests, by felling and export control, improved forest management and plantation development. International organisations are striving to introduce methods of conservation, and attempts are being made to introduce eco-labelling of timber whereby timber should carry a certificate to prove that it comes from a sustainably managed forest.

- Support sustainably managed forests.
- Buy from such forest sources.
- Do not buy endangered or diminishing timber species.

Many countries now operate forest certification which is a system that verifies that forests and woodlands are managed according to principles of sustainable forest management (SFM). It proves that these woods have been independently inspected and evaluated according to strict environmental, social and economic principles and criteria as agreed by recognised accredited bodies. Certification extends beyond the forest and chain of custody certification is awarded to timber processors and manufacturers or others in the wood chain who have received certification from an accredited organisation. Businesses with chain of custody certification can stamp their products with the logo of accredited certifying body which in Europe is usually FSC or PEFC or SFI in America.
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How to support sustainable forestry
In the interests of protecting the future availability of tropical timber, specifiers and users of timber should express their concern that the wood must come from a properly managed forest where good practice ensures a supply of timber in perpetuity.

- Urge that forests be managed according to principles of SFM.
- Ensure that timber purchased comes from sustainably managed forests.

IRISH TIMBER

Irish forests have increased from 1% of land cover to 10% since the beginning of the 20th century. A number of State initiatives were set up from 1904 to address forest decline. These included the purchase of Avondale Estate and the establishment of a commission in 1908 which advocated that the State should carry out afforestation. For most of the 20th century the State was involved directly in forestry. It was then accepted that State forests were not to encroach on agricultural land and as a result forests were established on sub-marginal land, most often at higher exposed elevations and on peatlands. This imposed great limitations on what species could be used. Broadleaves would not grow on most of the acquired lands, and softwoods became the mainstay of Irish forestry.

Sitka spruce proved to be the species best suited to the available forest sites, with lodgepole pine planted on the poorest sites. Other species included Scots pine, Norway spruce, European and Japanese larch, Douglas fir and a range of exotic species. The planting of broadleaved species amounted to only 5% of annual planting. Up to the end of the Second World War afforestation was slow, but it accelerated from 1950 on and many excellent forests were established.

Since the 1980s there has been a dramatic change in forestry, both in ownership, species mix and type of land planted. Due to EU and State incentives, there has been considerable growth in private, mainly farmer planting, while State afforestation has practically ceased. The State forests have been transferred to Coillte the State Forestry Board, which in addition to managing its forests has acquired two major panel board mills. The forest estate amounts to about 760,000 ha and some 52% is owned by Coillte.

There is a growing awareness of the need to diversify forest species composition and broadleaf afforestation principally ash and oak has increased from 5% to 37% of annual planting. However, conifers will continue to be the mainstay of Irish commercial forestry.

Currently 4.0 million cubic metres of logs are produced annually north and south. Sitka spruce is the most abundant softwood timber on the market. Much of the mature wood is sold as structural and carcassing timber while small logs are used for panel board manufacture. Norway spruce (the same species that is known as European whitewood, or white deal) and Douglas fir are the next two most popular structural and building timbers. The former is popular for flooring, while Douglas fir makes good structural members but home grown timber is in limited supply. Lodgepole pine has been traditionally planted on the poorest sites and has been considered as a pioneer species, to be replaced by species such as spruce in the second rotation, but if grown on better sites can produce joinery quality timber. Broadleaved trees, or hardwoods, are available, but must be sought out. There are as yet very few mature quality broadleaved forests in Ireland of commercial size and therefore the market in Irish grown hardwood timbers is small. However, it is possible to obtain Irish hardwoods, particularly oak, ash and beech. With the current increase in broadleaf planting, the prospects for a useful future market in Irish hardwoods is promising.

E2 Properties of available timbers

NOTES:
The woods described below are those most commonly available on the Irish market. A wide range of other species, both homegrown and imported, may be available from time to time, or regularly in small amounts, or on order. Accompanying the photographs are brief descriptions of the timbers and their uses. The technical properties are summarily described, in tabular form, following the illustrations.

In relation to the properties of timber, the following points should be noted:

1. Because there are distinct winter and summer seasons in the temperate regions of the world, all timbers from those regions have visible annual growth rings, being very distinctive features in many species.

2. In general terms, there is a good positive correlation between wood density and strength, so the denser the wood the stronger, and harder, it will be.

3. The normal convention in measuring wood shrinkage is to calculate the percentage reduction in dimension along radial and tangential surfaces which occurs when wood dries from completely wet or ‘green’ to 12% moisture content.

4. Wood moisture content (MC) is calculated on the basis of its oven-dry weight; being a porous material many woods can exceed 100% MC when completely saturated.

5. Moisture movement refers to the change of dimension of wood in service due to changes in atmospheric humidity, the wood expanding with the absorption of moisture from the air in highly humid conditions.

6. Durability of wood refers to the durability of the heartwood; the sapwood of all timbers is perishable. Durability rating refers to the length of survival of timber intact when in ground contact as a stake.

7. The resistance to impregnation with preservatives (treatability) normally refers to heartwood, as the sapwood is generally permeable; spruce and some other species have fairly resistant sapwood.

8. Working properties are generalised, and the different aspects of workability may vary.

9. The availability of timber is a general expression and may vary from time to time depending on market circumstances.

2.1 Softwoods

DOUGLAS FIR (OREGON PINE) *(Pseudotsuga menziesii)*

Source
Western USA and Canada; old growth forests can produce large-dimensioned clear stock. Also grown in Ireland. The home-grown timber is always known as Douglas fir, and comes in smaller sizes.

Wood
Sapwood: whitish to pale yellow, or reddish white; slow-grown material has a narrower band of sapwood than fast-grown stock. Heartwood: variable, generally a pale reddish brown, but can range from yellowish to deep red; growth rings distinct; grain straight, even or uneven; texture uniform in slow grown stock, often uneven in faster-grown material; moderately durable.

Uses
One of the few conifers from which clear timber or baulks of large dimension in long lengths can still be obtained. Uses include: heavy construction; flooring; interior trim; window joinery; veneer; plywood; poles; piles; paper pulp, cladding.

LARCH, EUROPEAN *(Larix decidua)*

Source
Grown throughout Europe, including Ireland; not as abundant as spruce.

Wood
Sapwood: narrow, pale yellow; heartwood: pale reddish-brown to brick red, sharply differentiated from sapwood; clearly defined growth rings; contains hard knots; straight grained; resinous; moderately durable.

Uses
Boat building; flooring; transmission poles; fencing; piling; cladding; exterior construction and joinery.

PINE, LODGEPOLE *(Pinus contorta)*

Source
Lodgepole pine available in Ireland is Irish grown; it is native to western America from Alaska to Mexico.

Wood
Pale yellow, sometimes with brownish tinge, with little differentiation between sap- and heartwood; can have large knots; grain is straight; texture is fine and fairly even; growth rings distinct with darker latewood; resin canals show as faint streaks on side grain; non-durable.

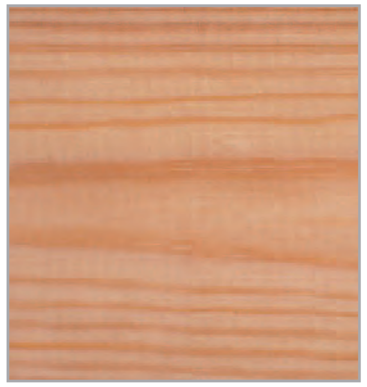
Uses
Construction; joinery; pallet wood; panel products; pulp; fencing

PINE, SOUTHERN YELLOW *(Pinus palustris, P. elliottii, P. echinata, P. taeda)*

Source
Eastern United States; timber from a range of closely related pines, normally plantation grown. Timber from old-growth trees is normally referred to as "pitch pine", and is more durable than timber from plantations.

Wood
Sapwood: whitish to yellowish of variable width; heartwood: light yellow to reddish brown; grain straight and uneven; highly figured due to contrast between early- and latewood in the growth rings; clear to knotty; medium texture; non-durable. Available material usually has a high sapwood content.

Uses
Beams; heavy construction; bridges; mine timbers; piling; poles; plywood and particle board; joinery; pallets



REDWOOD, EUROPEAN (SCOTS PINE or Red Deal) *(Pinus sylvestris)*

Source
Central and northern Europe, especially Scandinavia and Russia. Also grown in Ireland, where the wood is known as Scots pine.

Wood
Sapwood: straw coloured; heartwood: pale reddish brown. In Irish grown Scots pine, the sapwood is usually 50-100 mm wide, whereas in imported European redwood it is generally considerably less, especially in timber from northern regions. Annual rings clearly marked; non-durable.

Uses
Construction; better grades and slower grown for joinery, windows, furniture and turnery; railway sleepers; transmission poles; piles and pitprops; wood pulp.

SITKA SPRUCE *(Picea sitchensis)*

Source
Native to British Columbia and the northwest United States; grown extensively in Ireland, it is the most popular conifer here. Timber on the Irish market is home grown from sustainably managed forests, and is a substitute for European whitewood.

Wood
Sapwood: creamy white to light yellow and merges gradually into the heartwood, which is light pinkish yellow to pale brown with some irregular darker pink streaks; straight even grain; even, medium texture; somewhat lustrous. Irish timber is fast grown, light in weight and coarse in texture; non-durable.

Uses
Construction; formwork; packaging; pulp/paper products; poles; fence rails.

WHITEWOOD, EUROPEAN (NORWAY SPRUCE or White Deal) *(Picea abies)*

Source
North and central Europe, especially available from Scandinavia and the Russian Federation; also grown in Ireland.

Wood
Almost white to pale yellowish brown, with no discernible difference between sap- and heartwood; straight grained; fine textured; growth rings visible, but less prominent than in European redwood; slight natural lustre; non-durable.

Uses
Construction; joinery and carpentry; plywood; particle board and pulpwood; veneers; packaging.

WESTERN HEMLOCK *(Tsuga heterophylla)*

Source
Native to Alaska, British Columbia, and the northwest United States but also grown to some extent in Ireland.

Wood
A non-resinous, whitish or pale yellow wood with little distinction between heartwood and sapwood. Straight even grain, stable. Heavy sections can be difficult to dry uniformly. Non-durable, and resistant to preservative treatment.

Uses
Construction; internal joinery; pallets.

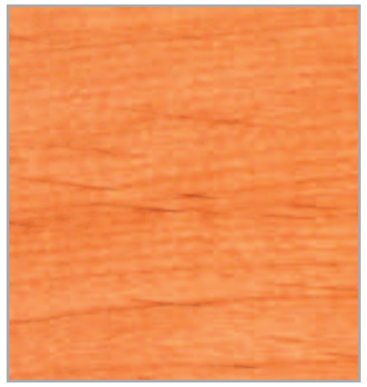
WESTERN RED CEDAR *(Thuja plicata)*

Source
British Columbia, and to some extent Washington, Oregon and southern Alaska.

Wood
Sapwood: whitish; heartwood: dark chocolate brown. May be variegated; ages to reddish brown; on weathering assumes a silver grey colour; straight even grain; texture medium; cedar-like odour; very durable; wood acidic and corrodes most metals when damp (except stainless steel, silicon bronze or copper).

Uses
External trim and cladding; posts and poles; shakes and shingles; boat building; packaging and decking.

2.2 Hardwoods



AMERICAN ALDER *(Alnus rubra)*

Source
Northwest America. Also commonly known as red alder. European alder ***(Alnus glutinosa)*** is grown in Ireland and is available in small quantities.

Wood
When freshly cut, alder is pale in colour but darkens in the light to a light red-brown colour, resembling cherry. There is little differentiation between heartwood and sapwood. It is straight-grained with an even texture and of relatively low density. It takes a good finish and can readily be stained and polished. Non-durable.

Uses
Furniture, especially kitchen cabinets, internal joinery, mouldings.

AMERICAN CHERRY *(Prunus serotina)*

Source
Eastern United States. Cherry is also available from Europe.

Wood
Growth rings evident but not well marked. Heartwood is a pale pinkish brown when first cut, darkening on exposure even to a mahogany-like colour, with the sapwood noticeably lighter; generally straight grained; moderately durable. Supplies of sawn wood may contain a proportion of sapwood, giving a marked colour contrast.

Uses
High-class joinery, cabinet making and furniture; panelling and veneers.

EUROPEAN ASH *(Fraxinus excelsior)*

Source
Throughout Europe, including Ireland. Ash is also available from America.

Wood
White to light brown, usually no distinction between sap and heartwood; growth rings distinct with band of obvious pores which give attractive figure on flat sawn surfaces; may have irregular dark brown to black heartwood which is sound and can give an attractive feature. Attractive joinery timber. Typically straight grained, it is tough and flexible; perishable.

Uses
Furniture and chairs; sports goods, agricultural implements and tool handles; gymnasium equipment; flooring; plywood and decorative veneer (panelling).

EUROPEAN BEECH *(Fagus sylvatica)*

Source
Mid to southern Europe, including Ireland, although we are near the northern limit of its range. Beech is also available from America.

Wood
No clear distinction between sap- and heartwood; pale reddish brown (deep reddish brown after steaming); growth rings evident, ray tissue showing as small spindle-shaped marks on flat sawn surfaces to dark irregular flecks on quarter sawn; no distinct figure; perishable. High movement.

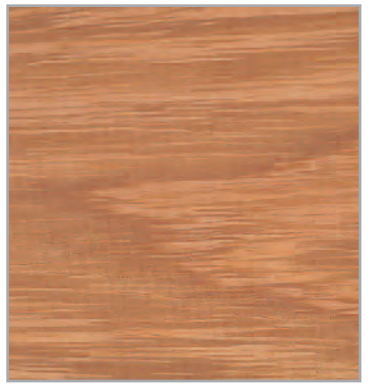
Uses
Furniture (solid and laminated) and interior joinery, construction and flooring; domestic woodware, tool handles and turnery; plywood.

BIRCH *(Betula spp.)*

Source
Birch is available from North America, Europe and in very small volumes in Ireland.

Wood
Birch is normally pale or light brown, frequently with darker streaks or flecks. The wood is hard, of high density and with good wearing properties. Non-durable.

Uses
Widely used in Europe for the manufacture of plywood, both throughout and as a facing veneer. Also used as flooring, furniture and for turned items.

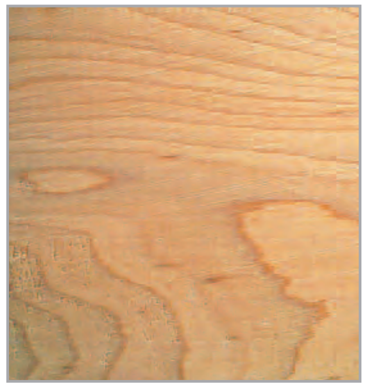


IROKO *(Milicia excelsa)*

Source
Tropical Africa 10° north and south of the equator, from Sierra Leone in the west to Tanzania in the east.

Wood
Freshly sawn heartwood is a distinct yellow, quickly changing to golden-brown on exposure to light. Sapwood narrow, pale and clearly defined. Grain interlocked and texture rather coarse but even; very durable.

Uses
Interior and exterior joinery; window frames and sills, stair treads, fire-proof doors; laboratory benches; piling, dock and harbour work.



MAPLE, ROCK (OR HARD) *(Acer saccharum)*

Source
Canada and the USA.

Wood
A close grained, fine and even-textured, pale-coloured temperate hardwood; annual growth rings are evident but not strongly marked. Sapwood: white with a reddish tinge; heartwood: pale or light tan, occasionally darker. Grain is generally straight, but can be curly or wavy; non-durable.

Uses
Flooring, furniture, cabinet making, trim, panelling, dowels, interior construction.

OAK, AMERICAN RED *(Quercus rubra, Q. falcata)*

Source
USA; in pure stands which regenerate easily.

Wood
Fast growing fairly tough timber; sapwood: white; heartwood: pink to light reddish brown; grain straight and open; flat sawn timber shows flared grain and quarter sawn shows silver grain, but, because the rays of red oak are short the silver grain is not so pronounced as in white or European oak, and is more ‘flakey’. Less durable than European or American White oak.

Uses
Furniture (one of the most popular in the USA), boats - frames and fittings, construction, dowels, flooring, joinery, musical instruments.

OAK, AMERICAN WHITE *(Quercus alba) and others*

Source
Widespread, mainly in east to mid USA; the classic white oak (***Q. alba***) ranges from Maine to Texas; supplies are available from sustainably managed forests.

Wood
Sapwood: whitish to light brown, variable width; heartwood: ranges from light tan to pale yellow brown to dark brown; may have pinkish tinge - the colour is more variable than European oak. Straight open grain; flat sawn boards have flared appearance due to prominent pores; quarter sawn boards show silver grain. Texture - medium to coarse; durable.

Uses
Furniture and cabinet making; joinery; flooring; panelling; construction; exterior trim and cladding; sleepers, shingles and shakes. Boatbuilding.

OAK, EUROPEAN *(Quercus petraea, Q. robur)*

Source
Grown throughout central and western Europe, and in Ireland. Can get clear boles up to 15m long. Much of the timber is produced in sustainably managed forests.

Wood
There is no difference between the wood of the two European species of oak. Sapwood is pale cream, 25 - 50mm wide; heartwood ranges from yellowish brown, light tan to deep brown. Growth rings are obvious due to alternating bands of large pored early wood and dense late wood, and produce a flare pattern on flat sawn surfaces. Distinct silver grain on quarter sawn surfaces. Fast-grown oak is tough and hard, slow grown is mild and easy to work; grain is normally straight, but may be irregular. The weight varies - northern and western European oak averages 720 kg/m^3 and that from central Europe is about 672 kg/m^3 after drying; durable.

Uses
Furniture and cabinet making; joinery and panelling; flooring; construction; veneers; exterior trim and cladding; boat building; fencing and railway sleepers.

OBECHE *(Triplochiton scleroxylon)*

Source
Tropical west Africa (mostly in Nigeria, Ghana, Ivory Coast and Cameroon), in transition zones between evergreen and semi-deciduous forests; some from sustainably managed forests; resource does not appear to be threatened.

Wood
Creamy white to pale yellow brown in colour with little or no distinction between sapwood and heartwood. Sapwood may be up to 150mm wide. Grain is interlocked, producing a faint striped appearance on quarter sawn surfaces, otherwise little decorative figure. Texture is coarse to moderately fine and even. A lightweight timber, brittle-heart is common in large logs; non-durable.

Uses
Light furnishings and cabinet making; display cases and materials; mouldings; veneer and coffins.

SAPELE *(Entandrophragma cylindricum)*

Source
An African tree, it extends from Ivory Coast to Cameroon and eastward through Zaire to Uganda. Some of the production forests are sustainably managed.

Wood
Sapwood: grey-pink or cream; heartwood: red-brown or purple-brown. Grain: moderately interlocked or wavy. Quarter sawn stock shows a regular stripe; wavy grain produces fiddle back and roe figure. Texture is moderately fine. The wood is lustrous with a cedar-like scent.

Uses
Joinery, furniture, boat building, panelling, veneer and plywood

TULIPWOOD *(Liriodendron tulipifera)*

Source
USA; from certified sustainably managed sources. Also known as Yellow poplar, though not a true poplar.

Wood
Sapwood: white or creamy coloured - usually variegated or striped; heartwood: pale olive green to yellow or brown, may be streaked with steel-blue to black - turns greenish on exposure; grain is straight, though it may show a blister figure; texture is fine and even; non-durable.

Uses
Joinery (including doors, interior trim); cabinet making, furniture and panelling; veneers, plywood and pulpwood.

UTILE *(Entadrophragma utile)*

Source
West and central Africa, especially Ivory Coast; some material available from sustainably managed forests.

Wood
Sapwood: light brown; heartwood: pink-brown to deep red-brown or purple-brown; grain broadly interlocked to give a ribbon figure or wide irregular stripe on quarter sawn surfaces; texture medium; a lustrous wood; durable.

Uses
Furniture, joinery, panelling, turnery, internal construction, veneer and plywood.

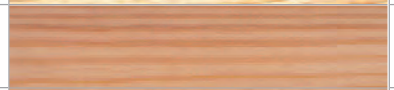
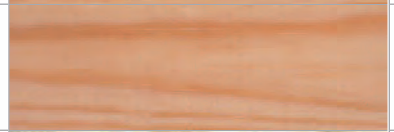
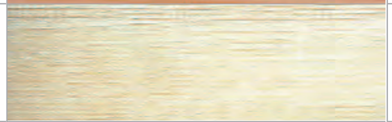
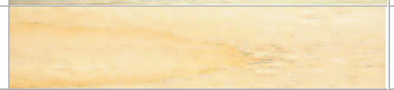
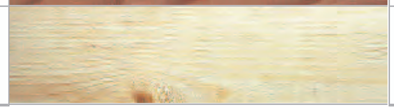
WALNUT, AMERICAN BLACK *(Juglans nigra)*

Source
East to midwest USA; not very abundant; some supplies from sustainably managed forests. Walnut (*Juglans regia*) is also available from Europe.

Wood
Sapwood: whitish to yellowish brown: heartwood: varies from light greyish brown to deep chocolate brown to almost black purplish brown; 'warm and inviting' appearance; grain is slightly open and usually straight, but may be wavy or irregular; famous for its wavy, curly or mottled figures - from burls, crotches and stumpwood; texture is coarse and uniform; moderately durable.

Uses
Cabinet making, fine furniture, specialty items, gunstocks, panelling, wainscotting, high-class veneers and flooring.

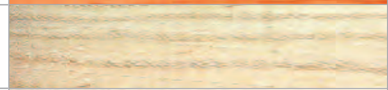
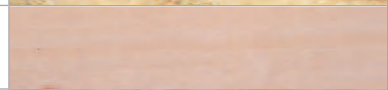
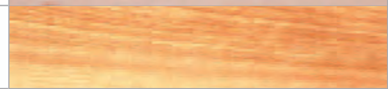
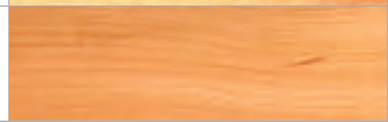
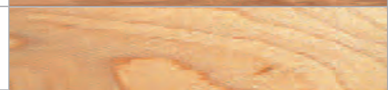
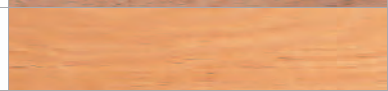
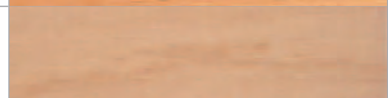
Table E 2.1 *Summary table of softwood timbers available on the Irish market.*

TIMBER	COLOUR	TEXTURE	DENSITY (kg/m³)	MOISTURE MOVEMENT	DURABILITY (of heartwood)	PERMEABILITY	WOOD SAMPLES	WORKING PROPERTIES	NAIL/SCREW HOLDING	GLUING	STAINING/ PAINTING	AVAILABILITY
Douglas fir (Ireland & US import)	reddish brown	fine to medium	530	small	moderately	resistant durable		good	good avoid splitting	satisfactory	satisfactory	Reasonable - large sizes hard to get
Larch (Irish, European or Siberian)	light reddish brown	fine	590	small	moderately	resistant durable		good	good avoid splitting	satisfactory	satisfactory	Reasonable - Irish source
Pine, lodgepole (Irish)	pale yellowish	fine	460	medium	non-durable	resistant		good	good	very good	good	Irish timber available -
Pine, Scots (Irish)*	pinkish brown	medium	510	medium	non-durable	moderate		medium	good	good - resin	satisfactory may impede	Irish stock not so plentiful
Redwood European⁺ (European imported)	pinkish brown	medium	540	medium	non-durable	moderate		medium	good	good - resin	satisfactory may impede	Readily available
Spruce Norway* (Irish)	whitish	fine to medium	420	small	non-durable	resistant		good	good	good	good	Reasonable
Spruce, sitka (Irish)	pinkish white	medium to coarse	410	small	non-durable	resistant		good	good	very good	satisfactory	Readily available
Western red cedar (Irish & imported)	reddish brown	medium	390	very small	very durable	resistant		good	fairly good	very good corrodes ferrous metal	good	Reasonable but Irish stock not regularly available
Whitewood, European (imported)	whitish to pale yellow brown	fine to medium	470	medium	non-durable	resistant		good	good	good	good	Readily available

⁺*Scots pine and European redwood are the same species* (Pinus sylvestris)*, the former being the name given to home grown timber, the latter the preferred name for imported. Also known as Red deal in Ireland.*

**Norway spruce and European whitewood are the same species* (Picea abies) *the former being the name given to home grown timber, the latter the preferred name for imported. Also known as White deal in Ireland.*

Table E 2.2 *Summary table of hardwood timbers commercially available on the Irish market.*

TIMBER	COLOUR	TEXTURE	DENSITY (kg/m^3)	MOISTURE MOVEMENT	DURABILITY (of heartwood)	PERMEABILITY	WOOD SAMPLES	WORKING PROPERTIES	NAIL/SCREW HOLDINGS	GLUING	STAINING/ PAINTING	AVAILABILITY
Alder American	light red-brown	even	500	small	non-durable	permeable		good	good	good	good	Reasonable
Ash American	greyish brown to light brown	medium	670	medium	non-durable	moderately resistant		medium	good	good	good	Readily available
Ash European	white to light brown	medium/coarse	710	medium	perishable	moderately resistant		good	good	good	good	Reasonable, some Irish stock available
Beech European	whitish to pale brown	fine	720	large	perishable	permeable		good	good	good	good	Imported from European continent - Readily Available
Birch	whitish to pale brown	fine	600	medium/large	non-durable	permeable		good	good	good	very good	Limited stocks
Cherry American (black cherry)	light to dark reddish-brown	fine	580	medium	moderately durable	moderately resistant		good	good	good	very good	Readily available
Iroko	yellow brown	medium	660	small	very durable	extremely resistant		medium/difficult interlocked grain may tear	good, requires pre-boring	satisfactory	good, may need filling	Readily available
Maple, hard	creamy white	fine	740	medium	non-durable	resistant		medium	good	good	very good	Readily available, often as flooring
Oak, American red	yellowish-brown with red tinge, variable	medium/ coarse	740	medium	non-durable	moderately resistant		good	pre-boring recommended	good	very good	Readily available
Oak, American white	pale yellow -brown to brown	medium to coarse	770	medium	durable	extremely resistant		good	good, corrodes ferrous metals	variable	very good	Readily available, not as abundant as red oak
Oak, European	yellowish brown	medium to coarse	700	medium	durable	extremely resistant		medium/difficult	good, corrodes ferrous metals	good	very good	Reasonable, some Irish stock available
Obeche	white to pale yellow	medium	390	small	non-durable	resistant		very easy to work	good	good	very good, may need light filling	Reasonable to good
Sapele	red-brown	medium	630	medium	moderately durable	resistant		good, may tear in moulding	good	good	good	Reasonable to good
Tulipwood	pale olive to brown	fine	450	small	non-durable	resistant		easy to work	nailing - good screwing - poor	good	very good	Readily available
Utile	dark reddish brown	medium	660	medium	durable	extremely resistant		medium	good	good	very good	Reasonable
Walnut, black	light to rich dark brown	medium	660	small/medium	moderately durable	permeable		medium to good	good	good	very good	Reasonable

Killykeen Holiday Homes, Lough Oughter, Co. Cavan. This was a research and development project designed to discover the potential of seven different species of Irish grown timber. Outside, the vertical Douglas fir cladding, joinery and beams are stained red while the interior timbers were left in their natural colours.

E3 Glossary and Abbreviations

GLOSSARY

Adult wood: (see mature wood)
Afforestation: Tree planting in bare land or land with previous crop other than trees.
Ambrosia Beetle (Pinhole borer). Insects which attack the sapwood of many species while the wood is still undried or "green". The attack ceases when the wood is dried and cannot recur. Of no structural significance but may be disfiguring on exposed surfaces.
Annual ring (annual growth ring): The layer of wood growth added each growing season to the diameter of the tree. In temperate regions, with distinct growing seasons, annual rings of most species are distinct, some very much so due to difference in cells formed early and late in the growing season. Many tropical timbers have no growth rings.
Anti-stain treatment: Fungicide solution applied to timber at some sawmills, to minimise staining during transit and storage.

Bark pocket: An opening between annual growth rings that contains bark – appearing as dark streaks on quarter sawn and rounded areas on flat sawn stock.
Beam: A structural member used horizontally acting alone and not in a load sharing system. Purlins and lintels are specific forms of beams.
Bearing: The contact area of a structural element (e.g. beam, joist, rafter etc.) at its point of support
Birdseye: Dimpling of the tangential surface of some hardwoods, notably hard maple, which forms small circular features which are decorative.
Bleeding: Diffusion of resin, such as from a knot, through paint or varnish resulting in discolouration.
Blue stain: Blue-grey discoloration caused by mould-type fungi in moist timber (above 20%); also known as sapstain.
Bow: A curve along the face of a plank normally due to growth stresses or poor stacking.
Box Beam: A built-up beam with wooden flanges and wooden panel webs (e.g. OSB or ply) on either side of the flanges.
Boxed heart board: A board in which the pith (see below) is enclosed; more liable to twist and fissure than other boards.
Brace, lateral: A continuous member connected to a truss chord to maintain the vertical position of the truss and assembly of trusses and/or to prevent buckling of compression members.
Broadleaved trees: A grouping of trees (botanically known as angiosperms), wide leaves (e.g. oak, ash, mahogany), often deciduous, which provide hardwood timber.

Camber: An upward vertical displacement built into a member to offset deflection.
Cambium: The layer of cells between the phloem and xylem (bark and wood) in a tree where growth occurs.
Cantilever: The part of a truss or structural member that extends beyond its support.
Case-hardening: Where the outer part of the wood has been dried too rapidly before the centre, and has become set in a stretched condition which causes stress between the outer and inner parts of the wood. The wood is likely to distort if further sawn or machined.
Cell: The minute structures of which wood is composed, including fibres, vessels and other elements.
Cellulose: The carbohydrate that is the principal constituent of wood. It has large, long-chain molecules which, when bonded together, provide a very strong framework to the wood cells.
Certification: A system that verifies that forests and woodlands are managed according to principles of sustainable forest management (SFM). It proves that these woods have been independently inspected and evaluated according to strict environmental, social and economic principles and criteria as agreed by FSC, PEFC or other recognised accredited body (see certification scheme).

Certification scheme: A market-oriented scheme used to certify that forests are managed on a sustainable basis.
Chain of custody certification: Awarded to timber processors and manufacturers or others in the wood chain who have received certification from an accredited organisation such as FSC and PEFC. It proves that their businesses have been independently inspected and evaluated according to strict environmental, social and economic principles and criteria as agreed recognised accredited body and also that their raw material has been sourced from certified forests. Businesses with chain of custody certification can stamp their products with a logo of an accredited certifying body which in Europe is usually the Forest Stewardship Council (FSC) or the Programme for the Endorsement of Forest Certification (PEFC).
Charring rate: The rate at which timber is carbonised or lost to fire under standard conditions expressed as mm/minute
Check: A separation of the fibres along the grain, forming a crack that does not extend through the timber.
Clear span: Horizontal distance between inner edges of supports.
Compression failure: Localised buckling of wood fibres, due to compression along the grain, caused by direct compression or bending; in planed timber may appear as fine wrinkles across the surface.
Compression wood: Dense, short-fibred wood occurring on leeward side of wind-stressed conifer trees; usually darker in colour; causes unequal shrinkage, distortion and reduced strength.
Concealed surface: As defined by BS 1186, a surface in joinery or trim which, after installation, will be concealed, not only by decoration.
Conifer trees: A grouping of trees (botanically known as gymnosperms) with needle or scale-like leaves (e.g. pine, spruce), most of which are evergreen, which provide softwood timber.
Cross-cut: A cut across the grain, to cut timber to length.
Cup: Curvature across the face of a plank.

Dead knot: A knot surrounded by bark, liable to loosen or fall out in service.
Dead load: A permanent load resulting from the weight of the building materials or installed equipment.
Decay: The decomposition of wood resulting from the action of wood-rotting fungi in damp/wet conditions; resulting in a loss of strength and weight, generally with a change in texture and colour.
Density: The mass of wood substance per unit volume; expressed as kilograms per cubic metre, at a specified moisture content, generally 12%; there is a strong positive correlation between density and strength.
Dry Rot: Decay of timber in service caused by the fungus *Serpula lacrymans*. Contrary to the common name, can only grow in moist wood.
Durability: The level of resistance to decay or insect attack of heartwood. The durability of timbers is given in years of life in moist conditions before deterioration, described as:
Very durable = > 25 yrs
Durable = 15 - 25 yrs
Moderately durable = 10 - 15 yrs
Slightly durable = 5 - 10 yrs
Not durable = < 5 yrs

Earlywood: Also known as springwood; the portion of the annual ring formed at the beginning of the growing season; generally of lower density and weaker than the latewood.(q.v.)
Edge: The narrower surface of a rectangular piece of timber.
Edge distance: The distance from the edge of the timber to the centre of the nearest fastening.
End distance: The distance measured at right angles from the end of the timber along its length to the centre of the nearest fastener.
Equilibrium moisture content: (EMC). The moisture content at which wood neither loses nor gains moisture when exposed to air at a constant relative humidity and temperature.

Face: The wide surface of a rectangular piece of timber; or any of the surfaces of a square piece of timber.
Fibre saturation point (FSP): The moisture content (MC) of wood at which all free water is lost from cell cavities, and only water bound within the cell walls remains; generally between 25 and 30% moisture content; shrinkage occurs only as wood MC drops below FSP.
Figure: The pattern produced, on the surface of wood, by growth rings, rays and variations in grain structure.
Fingerjoint: An end joint made by cutting wedges or fingers into the ends of boards, meshing them together and bonding with adhesive.
Fissure: A generic term to include checks, splits and shakes.
Fire Resistance: Relates to three criteria, stability, integrity and insulation. Stability relates to the ability of the construction to stay in place and carry load. Integrity relates to the passage of fire and smoke while insulation relates to the temperature on the unexposed (in terms of fire) side of the construction. Fire resistance usually relates to fire testing to the relevant parts of BS 476 or the relevant parts of I.S. EN 1363 to 1366 and I.S. EN 1634. However, the fire resistance of a construction can be assessed for example by estimating from fire tests carried out on similar constructions or from the use of standards such as BS 5268 Part 4. Fire resistance is usually expressed in minutes or hours.
Fire-resistance rating: The performance time, usually noted in minutes, that a material or structure achieves when exposed to a specified fire test.
Fire retardant: A chemical preparation which reduces flammability or retards the spread of flame over a surface.
Flat-sawn timber: Timber sawn so that the growth rings are at an angle less than 45° to the face.

Glulam: Structural wood products made by bonding together laminae of planed timber. May be straight or curved, and long spans can readily be produced.
Grading: The process whereby sawn timber is sorted into categories on the basis of appearance or strength.
Grain: Primarily, the direction of the main fibres of the wood; when qualified, may refer to their size, arrangement and/or appearance (see close, open, coarse grained).
Greenhouse gas emissions: Greenhouse gases include carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), which are released or emitted into the atmosphere as a by-product of natural and industrial processes. These emissions are regulated by the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC).
Green timber: Freshly felled or undried timber with its moisture content above fibre saturation point (qv).

Hardness: The capacity of the wood to resist indentation, usually classified by the "Janka" or "Brinell" hardness scales.
Hardwood: Timber of broad-leaved trees; the term relates to the botanical grouping of the trees and not to the hardness of the wood (some hardwoods, e.g. balsa, are softer than most softwoods).
Heartwood: Wood of the inner growth rings, extending from the pith to the sapwood; no longer participating in the life processes of the tree. The starches are depleted and often replaced with resins and other substances which may make the wood darker and more decay resistant.
Heel: Point on a truss where the top and bottom chords intersect.
Helsinki Process: The Ministerial Conference on the Protection of Forests in Europe is usually known as the Helsinki or Pan-European Process. It is one of a number of international fora that have developed criteria and indicators to assist in assessing success in implementing Sustainable Forest Management.
Honeycomb: Internal splitting in a plank as a result of drying stresses.

Intumescent: A fire protective coating which when heated swells and provides protection to the material underneath.

Joist: One of a series of parallel beams used to support floor or ceiling loads, which are themselves supported by bearing walls or other beams.
Juvenile wood: AThe cylindrical core of wood produced next to the pith during the first 10-20 years of the tree's life. Usually weaker and less stable than mature or adult wood.

Kiln-drying: The drying of sawn wood under controlled conditions of temperature, humidity and air flow in a kiln or chamber to achieve the desired final moisture content. The term "kiln-drying" does not imply any particular moisture content and the moisture content required should be stated by the specifier.
Knot: The portion of a branch that has been surrounded by wood in the subsequent growth of the stem. The shape of the knot on the surface of a plank will depend on the angle at which it is cut.
Knot area ratio (KAR): In a plank, the proportion of the cross-section at any point occupied by knots; used to assess the visual strength grade of timber.

Latewood: Also known as summerwood; the portion of the annual ring formed in the later part of the growing season; generally of higher density and stronger than the earlywood (q.v.).
Lignin: The second most abundant constituent of wood; a cementing substance that bonds adjoining cells and the cellulose framework.
Lintel: A load bearing beam over an opening such as a door or window.
Live load: Loading of a temporary nature such as wind, snow and construction loads; a similar term to imposed load.

Machine strength graded timber: Timber that has been mechanically evaluated for stiffness or other parameters from which its bending strength is automatically calculated resulting in the timber being assigned to a strength class formerly referred to as "stress-rated.
Make good: A term usually applied to repairing wood by means of a plug, insert or filler. In construction terms it is the same as reinstatement.
Mature wood: Also known as adult wood, is produced after the juvenile stage (in the case of Sitka spruce after 14 to 18 years). Mature wood has better strength qualities and is desirable for products that need strength and stability.
Medium density fibreboard (MDF): Reconstituted panel board of medium density manufactured mainly from spruce and pine fibres which are bonded together with synthetic resins.
Moisture content (MC): The weight of water in a piece of wood expressed as a percentage of the weight of the wood when oven-dry.
Movement: The change in width and thickness (movement along the length is negligible that accompanies normal fluctuations in relative humidity after wood is put in service; usually rated over a relative humidity (q.v.) change of 60 to 90% as follows:
small = < 3%
medium = 3 - 4.5%
large = > 4.5%

Nominal size: A term whose definition may vary; normally refers to the size by which timber is known and sold, which is often different from the actual size of the timber; or to the size to which tolerances apply, but the tolerances may exceed those of EN336.

Oriented strand board (OSB): Reconstituted wood panelboard manufactured from pulpwood logs by bonding peeled wood strands which are arranged in layers at right angles to one another to provide strength.
Oven dry weight: The weight obtained by drying wood in an oven at 105°C ±3°C until no further loss in weight occurs.

Panel boards: Wood products manufactured from wood chips and residues. Includes fibreboard, plywood, medium density fibreboard (MDF) and oriented strandboard (OSB).
Permeability: The capability of the wood to absorb preservative; often varies between sap and heartwood. The classification refers to heartwood only, as sapwood is generally permeable, and may vary with the preservative used and type of treatment.
Phloem: Bark tissue comprising various types of cells which transport dissolved organic and inorganic materials in vascular plants (see also xylem).
Pith: The core of a tree stem, consisting of dark-coloured very soft tissue; it can show on the surface of planks, taken from the centre of the tree, as a dark line of easily indented tissue.
Pitch pocket: An opening between growth rings which contains, or has contained, resin.
Pores: Openings of vessels on the surface of cut timber, occurring only in hardwoods, seen as minute holes on end grain or grooves on side grain.

Quarter-sawn timber (edge grain): Timber sawn so that the growth rings are at an angle greater than 45° to the face.

Rays: Bands of soft tissue vertically aligned and radiating from the centre of the tree; insignificant in softwoods and variable in hardwoods – if broad can produce distinctive figure - e.g. silver grain in oak.
Relative humidity (RH): The ratio of the amount of water vapour present in air to the amount which the air would hold if saturated at the same temperature.

Sapwood: Wood of the outer growth rings, extending from the heartwood to the bark; contains living cells, with carbohydrate food reserves, and conducts the sap up the tree; generally considerably wetter than heartwood when freshly felled, and is perishable.
Sawlogs: Logs larger than pulpwood or logs suitable for sawing. Broadly divided into large sawlog and small sawlog categories.
Large sawlog: Logs with a top diameter of 20cm or greater. Used mainly in construction including roof members and joists.
Small sawlogs: Logs with a top diameter between 14cm and 20cm. Suitable for pallets, crates, fencing and light construction.
Seasoning or drying: The process of removing moisture from green wood to improve its serviceability. Seasoning often refers to drying in the atmosphere; kiln drying to accelerated drying under controlled conditions in a drying chamber or kiln.
Shake: A separation of the fibres along the grain, if between the annual rings is known as ring shake.
Softwood: Timber of conifer trees; the term relates to the botanical grouping of the trees and not to the hardness of the wood (some softwoods, e.g. yew, are harder than many hardwoods).
Spiral grain: Growth of fibres in a spiral direction around the trunk of the tree; may cause twisting of timber during drying.
Spring: A curve along the edge of a plank; normally due to growth stresses, e.g. compression wood (q.v.).
Strength grading: The process where timber is visually or mechanically assessed and assigned a grade or strength class. Strength grading is based on known characteristics of the timber species.
Stress: The applied force per unit area; the primary stresses are bending, tensile, compression and shear.
Structural timber: Timber which carries load. Only timber which has been properly strength graded should be used structurally.

Sustainable forest management (SFM): The stewardship and use of forests and forest land in a way and at a rate that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national and global levels and does not cause damage to other ecosystems (Helsinki Process).
Alternative definition: SFM is the process of managing permanent forest land to achieve one or more clearly specified objectives of management with regard to the production of a continuous flow of desired forest products and services without undue reduction of its inherent values and future productivity and without undue undesirable effects on the physical and social environment (International Tropical Timber Organisation).
Sustained yield: The regular continuous supply of the desired produce to the full capacity of the forest without depletion.

Tension wood: Comparable to compression wood (q.v.) in conifers, it occurs in broad-leaved trees, on the upper side of leaning trees. Shorter gelatinous fibres cause unequal shrinkage, distortion and reduced strength.
Texture: The appearance of the timber produced by variations in the size of vessels and other cells, from fine (narrow vessels and rays) to coarse (wide vessels and rays).
Twist: Warping in which one corner of a plank twists out of the plane of the other three; associated with split and boxed-heart planks due to shrinkage of spiral-grained wood.

Visually strength-graded timber: Timber graded for strength based on visual assessment of limiting features (see KAR above).

Wane: The original rounded surface of a tree remaining (with or without bark) on timber after conversion.
Water repellent: A liquid that penetrates the wood and retards changes in moisture content while still allowing the wood to breathe; often incorporates a preservative, when it is known as a water-repellent preservative.
Wet Rot: A collective term for fungi causing decay of timber in service (other than Dry Rot [qv])
Workability: The degree of ease and smoothness with which wood can be sawn, planed and otherwise worked.

Xylem: Wood tissue consisting of various types of cells, which transport water and dissolved substances to the leaves.

E4 Standards and Codes

The following standards are referred to in *Woodspec* or are useful reference sources. As standards are continually revised and updated care should be taken to use the most recent revision.

CEN STANDARDS

CEN is the body responsible for the production of European Standards. These standards are initially produced as drafts and given designations such as prEN or ENV. ENVs tend to be voluntary and can be considered to be advanced drafts. Once a draft CEN standard has been voted on and approved by CEN members, the standard becomes a full standard with the formal designation EN (European Norm). After a period of time (usually 6 months) the national standards body of a CEN member state should adopt the standard and withdraw or amend any conflicting national standards. Once an EN is adopted by a member state the standard is given the national standard designation as well; in the case of Ireland the EN becomes I.S. EN and in the case of the UK BS EN. The content of the standards cannot be changed and the requirements laid out in the standards are therefore the same for all member states. However, member states are entitled to add National Annexes; these can only be informative and cannot alter the meaning or technical content of the standard.

Effectively design standards have a series of supporting standards; the supporting standards tend to deal with items such as products, various processes and workmanship. For example product standards I.S. EN 300 deals with OSB (Orientated Strand Board) and EN 14250 deals with the manufacture of roof trusses. EN14081 (all 4 parts) deals with timber strength grading and prEN 14372 when complete will deal with the manufacture of timber frame panels. The continuing introduction of EN standards creates difficulties for a timber specifier mainly because of the sheer volume of standards being issued and withdrawn but also a number of the older EN standards have been revised and re-issued (as have some Irish and British Standards to reflect the content of the EN standards). In addition some EN standards refer to draft standards which the normal user would not have access to (never mind the validity of using a standard that is a draft and which may contain incorrect information).

I.S. 444 and BS 5268 (Parts 2, 4 and 6) are the main design standards used in Ireland and are based on the permissible stress approach. Eurocode 5 (EC5) has the formal designation EN 1995-1-1 and 1995-1-2; these standards are limit state standards; 1995-1-1 is the approximate equivalent of BS 5268-2 and 1995-1-2 is the approximate equivalent of BS 5268-4. BS 5268 has been updated and is updated on a regular basis to reflect changes and the publication of EN standards (a similar process is has been completed for IS 193, the Irish standard on roof trusses). Generally those using BS 5268 (IS 444 is based on BS 5268) and EC5 are advised not to mix the two standards. However, both standards do refer to a number of the same EN standards (e.g. EN 636 for plywood specification). The two design standards refer to different loading standards and generally it would be wrong for example to design a beam to one standard and to design a supporting column to the other standard. Another example would be to design the size of a connection to one standard and to use the spacing requirements of the other standard.

One final issue relating to the EN standards, in Ireland a number of British Standards are used and this means that with the issue of an EN, Ireland can for the first time have its own standard – even if Ireland voted against the particular standard (standards are approved by CEN members using a weighted voting system). With the introduction of EC5 it could be argued that BS 5268 should no longer be used as it is not an Irish Standard. At present CEN member states are allowed to have existing national design standards running in parallel with the EN standards but the national standards are meant to be withdrawn by 2010. A pragmatic view would be that standards like BS 5268 are effectively Irish national standards as they have been used as such for quite a number of years. Certainly designers are familiar with BS 5268 and very few designers are familiar with EC5. In addition once EC5 become widely used, flaws in the document will become apparent and changes will be made. There are already proposals to amend parts of EC5 even though it has been only issued as an EN in late 2004.

The information in this Specification Guide has been updated but given the rather chaotic state of standards at present, there are bound to be incorrect or out dated references. Some standards have been revised and/or have been superseded during the course of working on this guide. EN 14081 (for timber grading) was introduced in 2006 but NSAI is working on the consequences of its introduction and its affect on I.S. 127 and its timber certification schemes. NSAI carries out its work through consultative committees and the consultation process can take some time. Rather than change every reference within the main body of this document, these standard references have been corrected in the standards summary in Section E4. The specifier should always check a standard reference (this applies not just to timber but to all materials) to see if a new standard has been issued or if the standard has been revised.

The design references in this guide refer mainly to the relevant Irish or British Standard (IS 444 and BS 5268); some of the advice on timber specification is applicable in principle to EC5 but changes would have to be made to some of the values and references.

It is important to monitor the situation with standards and to use and specify standards with care.

IRISH AND BRITISH STANDARDS AND BUILDING REGULATIONS

Some Irish Standards relating to joinery are obsolescent. Users of these standards should satisy themselves that they are appropriate for the intended end use. The Irish Standards used in Ireland tend to be very similar to those used in the UK. There are some product standards e.g. I.S. 193 (Trusses) which are almost identical to their British counterpart. There are a few design standards such as I.S. 325 (Masonry) which arose because of differences in materials but apart from design values for the material are again substantially identical to their British counterpart. Much of the advice given in this publication is applicable to use in the UK; obviously references to Irish Standards should be replaced by a reference to a British or European Standard.

The Building Regulations in Ireland are very similar to those in the UK. In Ireland the Technical Guidance Documents are the equivalent to the UK Approved Documents. There are significant differences between the Irish Technical Guidance Documents and the UK Approved Documents; mainly in the area of Fire Safety. In addition control of the timber industry in areas such as roof truss manufacture, timber frame manufacture and timber grading is probably tighter in Ireland than the UK. NSAI operate Approval Schemes in these areas and are involved in other areas of the timber industry.

The good practice guides given in this document are applicable to Ireland and the UK and are usually independent of standards and the Building Regulations.

IRISH STANDARDS AND CODES

Standard Number	Title
IS 16	Knotting
IS 105	Wire and cut nails for building purposes
IS 63 Pts 1 & 2	Wood windows
IS 96	Moisture content of timber for building
IS 126	Galvanised fencing wire
IS 127	Structural timber - visual strength grading
IS 130	Chain link fencing
IS 158	Closed string wood stairs
IS 193	Timber trussed rafters for roofs (superseded by EN 1995-1-1)
IS 196: Pts.1-6	Wood doors
IS 435 Pts. 1, 2 & 3	Timber post and rail roadside fencing
IS 436	Farm fencing
IS 437	Horse and stud fencing- timber post and rail
IS 440	Timber frame dwellings.
IS 444	The use of structural timber in buildings
IS 513, 514,515, 518 IS 575	Methods of testing windows.

BRITISH STANDARDS AND CODES

Standard Number		Title
BS 144:	1997	Specification for coal tar creosote for wood preservation.
BS 459:	1988	Specification for matchboarded wooden door leaves for external use.
BS 585-1:	1989	Wood stairs. Specification for stairs with closed risers for domestic use, including straight and winder flights and quarter or half landings.
BS 585-2:	1985	Wood stairs. Specification for performance requirements for domestic stairs constructed of wood-based materials.
BS 644:	2009	Timber windows. Fully finished factory assembled windows of various types. Specification.
BS 1088-1:	2003	Marine plywood. Requirements.
BS 1088-2:	2003	Marine plywood. Determination of bonding quality using the knife test.
BS 1186-2:	1988	Timber for and workmanship in joinery. Specification for workmanship.
BS 1186-3:	1990	Timber for and workmanship in joinery. Specification for wood trim and its fixing.
BS 1187:	1959	Specification for wood blocks for floors.
BS 1202-1:	1974	Specification for nails. Steel nails.
BS 1202-2:	1974	Specification for nails. Copper nails.
BS 1202-3:	1974	Specification for nails. Aluminium nails.
BS 1210:	1963	Specification for wood screws.
BS 1297:	1987	Specification for tongued and grooved softwood flooring.
BS 1892-1:	1986	Gymnasium equipment. Specification of general requirements.
BS 2482:	2009	Specification for timber scaffold boards.
BS 4050-1:	1977	Specification for mosaic parquet panels. General characteristics.
BS 4050-2:	1966	Specification for mosaic parquet panels. Classification and quality requirements.
BS 4072:	1999	Copper/chromium/arsenic preparations for wood preservation.
BS 4261:	1999	Wood preservation. Vocabulary.
BS 4512:	1969	Methods of test for clear plywood.
BS 4756:	1998	Specification for ready mixed aluminium priming paints for woodwork.
BS 4787-1:	1980	Internal and external wood doorsets, door leaves and frames. Specification for dimensional requirements.
BS 4978:	2007	Visual strength grading of softwood. Specification.
BS 5268-2		Structural use of timber. Code of practice for for permissable stress design, materials and workmanship.
BS 5268-3:	2006	Structural use of timber. Code of practice for trussed rafter roofs.
BS 5268-4.1:	1978	Structural use of timber. Fire resistance of timber structures. Recommendations for calculating fire resistance of timber members.
BS 5268-4.2:	1990	Structural use of timber. Fire resistance of timber structures. Recommendations for calculating fire resistance of timber stud walls and joisted floor constructions.
BS 5268-6.1:	1996	Structural use of timber. Code of practice for timber frame walls. Dwellings not exceeding four storeys.
BS 5268-6.2:	2001	Structural use of timber. Code of practice for timber frame walls. Buildings other than dwellings not exceeding four storeys.
BS 5395-1:	2010	Stairs. Code of practice for the design of stairs with straight flights and winders
BS 5395-2:	1984	Stairs, ladders and walkways. Code of practice for the design of helical and spiral stairs.
BS 5395-4:	2011	Code of practice for the design of stairs for limited access
BS 5534:	2003	Code of practice for slating and tiling (including shingles).
BS 5588-0:	1996	Fire precautions in the design construction and use of building. Guide to fire safety codes of practice for particular premises/applications.
BS 5588-1:	1990	Fire precautions in the design construction and use of building. Code of practice for residential buildings.
BS 5756:	1997	Visual strength grading of hardwood. Specification.
BS 6100-8:	2007	Building and civil engineering. Vocabulary. Work with timber and wood-based panels
BS 6150:	2006	Painting of buildings. Code of practice.
BS 6229:	1982	Code of practice for flat roofs with continuously supported coverings.

BRITISH STANDARDS AND CODES

Standard Number		Title
BS 6375-1:	2009	Performance of windows and doors. Classification for weathertightness and guidance on selection and specification.
BS 6375-2:	2009	Performance of windows and doors. Classification for operation and strength characteristics and guidance on selection and specification.
BS 6375-3:	2009	Performance of windows and doors. Classification for additional performance characteristics and guidance on selection and specification.
BS 6446:	1997	Specification for manufacture of glued structural components of timber and wood based panels.
BS 7359:	1991	Nomenclature of commercial timbers including sources of supply.
BS 7543:	1992	Guide to durability of buildings and building elements, products and components.
BS 7543:	2003	Guide to the durability of buildings and building elements, products and components.
BS 7664:	2000	Specification for undercoat and finishing paints.
BS 7719:	1994	Specification for water-borne emulsion paints for interior use.
BS 7913:	1998	Guide to the principles of the conservation of historic buildings.
BS 7956:	2000	Specification for primers for woodwork.
BS 8000–5:	1990	Workmanship on building sites. Code of practice for carpentry, joinery and general fixings.
BS 8000-7:	1990	Workmanship on building sites. Code of practice for glazing.
BS 8103-1:	1995	Structural design of low-rise buildings. Code of practice for stability, site investigation, foundations and ground floor slabs for housing.
BS 8103-3:	2009	Structural design of low-rise buildings. Code of practice for timber floors and roofs for housing.
BS 8201:	2011	Code of practice for installation of flooring of wood and wood-based panels
BS 8212:	1995	Code of practice for dry lining and partitioning using gypsum plasterboard.
BS 8214:	2008	Code of practice for fire door assemblies.
BS 8233:	1999	Sound insulation and noise reduction for buildings. Code of practice.
BS 8300:	2009	Design of buildings and their approaches to meet the needs of disabled people. Code of Practice.
BS 8417:	2011	Preservation of wood. Code of practice
BS 8529:	2010	Composite doorsets. Domestic external doorsets. Specification
BS 9250:	2007	Code of practice for design of the airtightness of ceilings in pitched roofs.
BS 9999:	2008	Code of practice for fire safety in the design, management and use of buildings

EUROPEAN STANDARDS AND CODES

Standard Number		Title
EN 300:	2006	Oriented strand board (OSB). Definitions, classification and specifications.
EN 309:	2005	Wood particleboards. Definition and classification.
EN 312:	2010	Particleboards. Specifications
EN 313-1:	1996	Plywood. Classification.
EN 313-2:	2000	Plywood. Terminology.
EN 315:	2000	Plywood. Tolerances for dimensions.
EN 316:	2009	Wood fibre boards. Definition, classification and symbols
EN 317:	1993	Particleboards and fibreboards. Determination of swelling in thickness after immersion in water.
EN 335-1:	2006	Durability of wood and wood-based products. Definitions of use classes. General.
EN 335-2:	2006	Durability of wood and wood-based products. Definition of use classes. Application to solid wood.
EN 335-3:	1996	Definition of hazard classes of biological attack. Application to wood-based panels.
EN 335-3:	1996	Definition of hazard classes of biological attack. Application to wood-based panels.
EN 336:	2003	Structural timber. Sizes, permitted deviations.
EN 338:	2009	Structural timber. Strength classes
EN 350-1:	1994	Durability of wood and wood based products. Natural durability of solid wood. Guide to the principles of testing and classification of the natural durability of wood.
EN 350-2:	1994	Durability of wood and wood based products. Natural durability of solid wood. Guide to natural durability and the treatability of selected wood species of importance in Europe.
EN 351-1:	2007	Durability of wood and wood-based products. Preservative-treated solid wood. Classification of preservative penetration and retention.
EN 351-2:	2007	Durability of wood and wood-based products. Preservative-treated solid wood. Guidance on sampling for the analysis of preservative treated wood.
EN 385:	2001	Finger jointed structural timber. Performance requirements and minimum production requirements.
EN 386:	2001	Glued laminated timber. Performance requirements and minimum production requirements.
EN 387:	2001	Glued laminated timber. Large finger joints. Performance requirements and minimum production requirements.
EN 390:	1995	Glued laminated timber. Sizes. Permissible deviations.
EN 391:	2002	Glued laminated timber. Delamination of glue lines.
EN 460:	1994	Durability of wood and wood-based products. Natural durability of solid wood. Guide to the durability requirements for wood to be used in hazard classes.
EN 599-1:	2009	Durability of wood and wood-based products. Efficacy of preventive wood preservatives as determined by biological tests. Specification according to use class.
EN 599-2:	1997	Durability of wood and wood-based products. Performance of preventive wood preservatives as determined by biological tests. Classification am labelling.
EN 622-1:	2003	Fibreboards. Specifications. General requirements.
EN 622-2:	2006	Fibreboards. Specifications. Requirements for hardboards.
EN 622-3:	2004	Fibreboards. Specifications. Requirements for medium boards.
EN 622-4:	1997	Fibreboards. Specifications. Requirements for softboards.
EN 622-5:	2006	Fibreboards. Specifications. Requirements for dry process boards (MDF).
EN 633:	1994	Cement-bonded particleboards. Definition and classification.
EN 634-1:	1995	Cement-bonded particleboards. Specification. General requirements.
EN 634-2:	2007	Cement-bonded particleboards. Specification. Requirements for OPC bonded particle boards for use in dry, humid and external conditions.
EN 635-1:	1995	Plywood. Classification by surface appearance. General.
EN 635-2:	1995	Plywood. Classification by surface appearance Hardwood.
EN 635-3:	1995	Plywood. Classification by surface appearance. Softwood.
EN 636:	2003	Plywood. Specifications.

EUROPEAN STANDARDS AND CODES

Standard Number	Title
EN 844-1: 1995	Round and sawn timber. Terminology. General terms common to round timber and sawn timber.
EN 844-10: 1998	Round and sawn timber. Terminology. Terms relating to stain and fungal attack.
EN 844-11: 1998	Round and sawn timber. Terminology. Terms relating to degrade by insects.
EN 844-12: 2001	Round and sawn timber. Terminology. Additional terms and general index.
EN 844-2: 1997	General terms relating to round timber.
EN 844-3: 1995	Round and sawn timber. Terminology. General terms relating to sawn timber.
EN 844-4: 1997	Terms relating to moisture content.
EN 844-5: 1997	Terms relating to dimensions of round timber.
EN 844-6: 1997	Terms relating to dimensions of sawn timber.
EN 844-7: 1997	Terms relating to anatomical structure of timber.
EN 844-8: 1997	Terms relating to features of round timber.
EN 844-9: 1997	Terms relating to features of sawn timber.
EN 845-1: 2003	Specifications for ancillary components for masonry. Ties, straps, hangers and brackets.
EN 912: 2011	Timber fasteners. Specifications for connectors for timbers
EN 927-1: 1997	Paints and varnishes. Coating materials and coating systems for exterior wood. Classification and selection
EN 942: 2007	Timber in joinery. General requirements.
EN 975-1: 1996	Sawn timber. Appearance grading of hardwoods. Oak and beech.
EN 975-1: 2009	Sawn timber. Appearance grading of hardwoods. Oak and beech
EN 975-2: 2004	Sawn timber. Appearance grading of hardwoods. Poplars.
EN 1001-1: 2005	Durability of wood and wood-based products. Terminology. List of equivalent terms.
EN 1001-2: 2005	Durability of wood and wood-based products. Terminology. Vocabulary.
EN 1072: 1995	Plywood. Description of bending properties for structural plywood.
EN 1084: 1995	Plywood. Formaldehyde release classes determined by the gas analysis method.
EN 1176-1: 2008	Playground equipment and surfacing. General safety requirements and test methods.
EN 1192: 2000	Doors. Mechanical strength. Requirements and classification.
EN 1195: 1998	Timber structures. Test methods. Performance of structural floor decking.
EN 1313-1: 2010	Round and sawn timber. Permitted deviations and preferred sizes. Softwood sawn timber.
EN 1313-2: 1999	Round and sawn timber. Permitted deviations and preferred sizes. Hardwood sawn timber.
EN 1315: 2010	Dimensional classification of round timber
EN 1316-1: 1997	Hardwood round timber. Qualitative classification. Oak and beech.
EN 1316-2: 1997	Hardwood round timber. Qualitative classification. Poplar.
EN 1316-3: 1998	Hardwood round timber. Qualitative classification. Ash and maples and sycamore.
EN 1611-1: 2000	Sawn timber. Appearance grading of softwoods. European spruces, firs, pines and Douglas fir.
EN 1910: 2000	Wood and parquet flooring and wood panelling and cladding. Determination of dimensional stability.
EN 1912: 2004	Structural timber. Strength classes. Assignment of visual grades and species.
EN 1927-1: 2008	Qualitative classification of softwood round timber. Spruces and firs.
EN 1927-2: 2008	Qualitative classification of softwood round timber. Pines.
EN 1927-3: 2008	Qualitative classification of softwood round timber. Larches and Douglas fir.
EN 1990: 2002	Eurocode. Basis of structural design.
EN 1991-1-1: 2002	Eurocode 1. Actions on structures. General actions. Densities, self-weight, imposed loads for buildings.
EN 1991-1-2: 2002	Eurocode 1. Actions on structures. General actions. Actions on structures exposed to fire.
EN 1991-1-3: 2003	Eurocode 1. Actions on structures. General actions. Snow loads.
EN 1991-1-4: 2005	Eurocode 1: Actions on structures - General actions - Wind actions.
EN 1991-1-5: 2003	Eurocode 1. Actions on structures. General actions. Thermal actions.
EN 1991-1-6: 2005	Eurocode 1. Actions during execution.

EUROPEAN STANDARDS AND CODES

Standard Number	Title
EN 1991-1-7: 2006	Eurocode 1:Actions on structures. General actions. Accidental actions.
EN 1995-1-1: 2004	Eurocode 5. Design of timber structures. Common rules and rules for building.
EN 1995-1-2: 2004	Eurocode 5. Design of timber structures. General. Structural fire design.
EN 1995-2: 2004	Eurocode 5. Design of timber structures. Bridges.
EN 10230-1: 2000	Steel wire nails. Loose nails for general applications.
EN 12152: 2002	Curtain walling. Air permeability. Performance requirements and classification.
EN 12207: 2000	Windows and doors. Air permeability. Classification.
EN 12208: 2000	Windows and doors. Watertightness. Classification.
EN 12210: 2000	Windows and doors. Resistance to wind load. Classification.
EN 12217: 2003	Doors. Operating forces. Requirements and classification.
EN 12219: 2000	Doors. Climatic influences. Requirements and classification.
EN 12369-1: 2001	Wood-based panels. Characteristic values for structural design. OSB, particleboards and fibreboards.
EN 12369-2: 2011	Wood-based panels. Characteristic values for structural design. Plywood.
EN 12369-3: 2008	Wood-based panels. Characteristic values for structural design. Solid-wood panels.
EN 12400: 2002	Windows and pedestrian doors. Mechanical durability. Requirements and classification.
EN 12466: 1998	Resilient floor coverings. Vocabulary.
EN 12490: 2010	Durability of wood and wood-based products. Preservative-treated solid wood. Determination of the penetration and retention of creosote in treated wood.
EN 12524: 2000	Building materials and products. Hygrothermal properties. Tabulated design values.
EN 12775: 2001	Solid wood panels. Classification and terminology.
EN 12825: 2001	Raised access floors.
EN 12871: 2010	Wood-based panels. Performance specifications and requirements for load bearing boards for use in floors, walls and roofs.
EN 13017-1: 2001	Solid wood panels. Classification by surface appearance. Softwood.
EN 13017-2: 2001	Solid wood panels. Classification by surface appearance. Hardwood.
EN 13168: 2001	Thermal insulation products for buildings. Factory made wood wool (WW) products. Specification.
EN 13183-1: 2002	Moisture content of a piece of sawn timber. Determination by oven dry method.
EN 13183-2: 2002	Moisture content of a piece of sawn timber. Estimation by electrical resistance method.
EN 13183-3: 2005	Moisture content of a piece of sawn timber. Estimation by capacitance method.
EN 13213: 2001	Hollow floors.
EN 13226: 2009	Wood flooring. Solid parquet elements with grooves and/or tongues
EN 13227: 2002	Wood flooring. Solid lamparquet products.
EN 13228: 2011	Wood flooring. Solid wood overlay flooring elements including blocks with an interlocking system.
EN 13271: 2002	Timber fasteners. Characteristic load-carrying capacities and slip-moduli for connector joints.
EN 13307-1: 2006	Timber blanks and semi-finished profiles for non-structural uses. Requirements.
EN 13329: 2006	Laminate floor coverings. Specifications, requirements and test methods.
EN 13353:2008+A1:2011	Solid wood panels (SWP). Requirements
EN 13354: 2008	Solid wood panels (SWP). Bonding quality. Test method
EN 13377: 2002	Prefabricated timber formwork beams. Requirements, classification and assessment.
EN 13442: 2002	Wood and parquet flooring and wood panelling and cladding.
EN 13488: 2002	Wood flooring. Mosaic parquet elements.
EN 13489: 2002	Wood flooring. Multi-layer parquet elements.
EN 13556: 2003	Round and sawn timber. Nomenclature of timbers used in Europe.
EN 13629: 2002	Wood flooring. Solid pre-assembled hardwood board.
EN 13629: 2012	Wood flooring. Solid individual and preassembled hardwood boards
EN 1363-1: 1999	Fire resistance tests. General requirements.

EUROPEAN STANDARDS AND CODES

Standard Number	Title
EN 13647: 2011	Wood and parquet flooring and wood panelling and cladding. Determination of geometrical characteristics.
EN 13696: 2008	Wood flooring. Test methods to determine elasticity and resistance to wear and impact resistance.
EN 13756: 2002	Wood flooring. Terminology.
EN 13810-1: 2002	Wood-based panels. Floating floors. Performance specifications and requirements.
EN 13810-1: 2002	Wood-based panels. Floating floors. Performance specifications and requirements.
EN 13986: 2004	Wood-based panels for use in construction. Characteristics, evaluation of conformity and marking.
EN 13990: 2004	Wood flooring. Solid softwood floor boards.
EN 14076: 2004	Timber stairs. Terminology.
EN 14080: 2005	Timber structures. Glued laminated timber. Requirements.
EN 14080: 2005	Timber structures. Glued laminated timber. Requirements.
EN 14081-1: 2005	Timber structures. Strength graded structural timber with rectangular cross section. General requirements.
EN 14081-2: 2010	Timber structures. Strength graded structural timber with rectangular cross section. Machine grading. Additional requirements for initial type testing.
EN 14081-3: 2005	Timber structures. Strength graded structural timber with rectangular cross section. Machine grading. Additional requirements for factory production control.
EN 14081-3: 2012	Timber structures. Strength graded structural timber with rectangular cross section. Machine grading; additional requirements for factory production control.
EN 14081-4: 2009	Timber structures. Strength graded structural timber with rectangular cross section. Machine grading. Grading machine settings for machine controled systems.
EN 14128: 2003	Durability of wood and wood-based products. Performance criteria for curative wood preservatives as determined by biological tests.
EN 14220: 2006	Timber and wood-based materials in external windows, external door leaves and external doorframes. Requirements and specifications.
EN 14221: 2006	Timber and wood-based materials in internal windows, internal door leaves and internal doorframes. Requirements and specifications.
EN 14250: 2004	Timber structures. Product requirements for prefabricated structural members assembled with punched metal plate fasteners.
EN 14250: 2010	Timber structures. Product requirements for prefabricated structural members assembled with punched metal plate fasteners.
EN 14279:2004+A1:2009	Laminated veneer lumber (LVL). Definitions, classification and requirements.
EN 14298: 2004	Sawn timber. Assessment of drying quality.
EN 14322: 2004	Wood-based panels. Melamine faced boards for interior uses. Definition, requirements and classification.
EN 14342: 2005	Wood flooring. Characteristics, evaluation of conformity and marking.
EN 14351-1: 2006	Windows and doors. Product standard, performance characteristics. Windows and external pedestrian door sets without resisitance to fire and/or smoke leakage characteristics.
EN 14354: 2004	Wood-based panels. Wood veneer floor covering.
EN 14374: 2004	Timber structures. Structural laminated veneer lumber. Requirements.
EN 1438: 1998	Symbols for timber and wood-based products.
EN 14519: 2005	Solid softwood panelling and cladding. Softwood machined profiles with tongue and groove.
EN 14545: 2008	Timber structures. Connectors. Requirements
EN 14592: 2008	Timber structures. Dowel-type fasteners. Requirements
EN 14600: 2005	Doorsets and openable windows with fire resisting and/or smoke control characteristics. Requirements and classification.
EN 14755: 2005	Extruded particleboards. Specifications.

EUROPEAN STANDARDS AND CODES

Standard Number	Title
EN 14761:2006+A1:2008	Wood flooring. Solid wood parquet. Vertical finger, wide finger and module brick.
EN 14762: 2006	Wood flooring. Sampling procedures for evaluation of conformity.
EN 14915: 2006	Solid wood panelling and cladding. Characteristics, evaluation of conformity and marking.
EN 14975: 2006	Loft ladders. Requirements, marking and testing.
EN 15060: 2006	Paints and varnishes. Guide for the classification and selection of coating systems for wood based materials in furniture for interior use.
EN 15146: 2006	Solid softwood panelling and cladding. Machined profiles without tongue and groove.
EN 15197: 2007	Wood-based panels. Flaxboards. Specifications.
EN 15228: 2009	Structural timber. Structural timber preservative treated against biological attack
EN 15269-1: 2010	Extended application of test results for fire resistance and/or smoke control for door, shutter and openable window assemblies, including their elements of building hardware. General requirements.
EN 1529: 2000	Door leaves. Height, width, thickness and squareness. Tolerance classes.
EN 1530: 2000	Door leaves. General and local flatness. Tolerance classes.
EN 1533: 2010	Wood flooring. Determination of bending strength under static load. Test methods
EN 1534: 2010	Wood flooring. Determination of resistance to indentation. Test method
EN 15644: 2008	Traditionally designed prefabricated stairs made of solid wood. Specifications and requirements.
EN 15736: 2009	Timber structures. Test methods. Withdrawal capacity of punched metal plate fasteners in handling and erection of prefabricated trusses.
EN 15737: 2009	Timber structures. Test methods. Torsional resistance of driving in screws
EN 26891: 1991	Timber structures. Joints made with mechanical fasteners. General principles for the determination of strength and deformation characterisitics.

EN/ISO CODES

Standard Number	Title
EN ISO 4618: 2006	Paints and varnishes. Terms and definitions.
ISO 8992: 2005	Fasteners. General requirements for bolts, screws, studs and nuts.
ISO 12578: 2008	Timber structures. Glued laminated timber. Component performance and production requirements.
ISO 13823: 2008	General principles on the design of structures for durability.
ISO 16893-2: 2010	Wood-based panels. Particleboard. Requirements
ISO 16894: 2009	Wood-based panels. Oriented strand board (OSB). Definitions, classification and specifications.
ISO 21581: 2010	Timber structures. Static and cyclic lateral load test methods for shear walls
ISO 22390: 2010	Timber structures. Laminated veneer lumber. Structural properties
ISO 27567: 2009	Laminated veneer timber. Measurement of dimensions and shape. Method of test Structural Timber Composites including Glulam .

E 5 Literature

3.1 BUILDING REGULATIONS AND APPROVED DOCUMENTS:

Amendments and revisions are issued from time to time. Care should be taken to refer to the latest version.

Building Regulations, 1997. Statutory Instrument No. 497 of 1997. 35 pp. The Stationery Office, Dublin.

Building Regulations, 2005. Technical Guidance Document A - Structure. 31 pp. Department of the Environment, Dublin.

Building Regulations, 2006. Technical Guidance Document B - Fire Safety. 159 pp. Department of the Environment, Dublin.

Building Regulations, 2004. Technical Guidance Document C - Site Preparation and Resistance to Moisture. 18 pp. Department of the Environment, Dublin.

Building Regulations, 2000. Technical Guidance Document D - Materials and Workmanship. 8 pp. Department of the Environment, Dublin.

Building Regulations, 2005. Technical Guidance Document E - Sound. 21 pp. Department of the Environment, Dublin.

Building Regulations, 1997. Technical Guidance Document F - Ventilation. 13 pp. Department of the Environment, Dublin.

Building Regulations, 2011. Technical Guidance Document G - Hygiene. 8 pp. Department of the Environment, Dublin.

Building Regulations, 2010. Technical Guidance Document H - Drainage and Waste Water Disposal. 22 pp. Department of the Environment, Dublin.

Building Regulations, 2005. Technical Guidance Document J - Heat Producing Appliances. 21 pp. Department of the Environment, Dublin.

Building Regulations, 2005. Technical Guidance Document K - Stairways, Ladders, Ramps and Guards. 31 pp. Department of the Environment, Dublin.

Building Regulations, 2008. Technical Guidance Document L - Conservation of Fuel and Energy. 55 pp. Department of the Environment, Dublin.

Building Regulations, 2010. Technical Guidance Document M - Access for People with Disabilities. 26 pp. Department of the Environment, Dublin.

3.2 OTHER PUBLICATIONS

Forest Products and Wood Science; an Introduction. By John G. Haygreen and Jim L. Bowyer. 1982. 495 pp. The Iowa State University Press.

Guide to Irish Hardwoods. By Gordon Knaggs & Stella Xenopoulou. 2004. COFORD

House Building Manual. HomeBond. 2004 (4th Edition) 465 pp. National House Building Guarantee Company Ltd., Dublin.

Science and Technology of Wood - Structure, Properties, Utilization. By George Tsoumis. Van Norstrand Reinhold.

Timber. Structure, Properties, Conversion and Use. By H.E. Desch and J.M. Dinwoodie. 1996 (7th Edition). McMillan Press Ltd.

E 6 Useful web addresses

These addresses are given for information only. Please note that *Woodspec* has no control over the contents of these sites and that some information on these sites may not relate to Irish conditions.

Conservation

Convention on International trade in Endangered Species (CITES)........................ www.cites.org
Forest Stewardship Counci....... ....www.fsc.org
Just Forests...www.justforests.org
Programme for the Endorsement of Forest Certification Schemes (PEFC) ....www.pefc.org
Sustainable Forestry Initiative SFI.(US) ....www.sfiprogram.org
Wood for Good...www.woodforgood.com

Timber and board suppliers and associations

Coillte... www.coillte.ie
American Hardwood Export Association. ....www.ahec-europe.org
American Plywood Association (now APA- the Engineered Wood Association)......www.apawood.org
American softwoods ....www.americansoftwoods.com
Finsa (Chipboard) . . ..www.finsa.es
Ghana Timber Marketing Board ....www.ghanatimber.org
Malaysian Timber Council ....www.mtc.com.my
Masonite . . . .www.masonite-europe.com
Nordic Timber Council. ....www.nordictimber.org
Smart*Ply* (OSB) . . ..www.smartply.com

Standards

British Standards Institute ....www.bsigroup.com
European Standards ....www.cen.be also
.... http://esearch.cen.be
National Standards Authority of Ireland.. www.nsai.ie

Organisations

Building Research Establishment ....www.bre.co.uk
COFORD...www.coford.ie
Department of the Environment (building regulations) ....www.environ.ie
Forest Service.. www.agriculture.gov.ie
Homebond..www.homebond.ie
Irish Agrement Board ....www.irishagrementboard.com
Irish Georgian Society...www.igs.ie
Irish Timber Frame Manufacturers Association ....www.itfma.ie
Irish Timber Growers Association ....www.itga.ie
Irish Timber Trade Association. ....www.itta.ie
International Tropical Timber Organisation ....www.itto.org.jp
National Standards Authority of Ireland. ....www.nsai.ie
NOFMA The Wood Flooring Manufacturers Association (US) ....www.nofma.org
Sustainable Energy Ireland ....www.sei.ie
Timber Decking Association ....www.tda.org.uk
Timber Research & Development Association (TRADA) ....www.trada.co.uk
Wood Marketing Federation...www.wood.ie