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Timber frame building: materials specification

This Wood Information Sheet (WIS) outlines the materials normally specified for conventional timber frame buildings. Some variations will occur according to the structural design and detailing requirements of specific projects. Many of the components are also used in innovative forms of construction such as engineered stud and twin stud walls, cross-laminated timber and structural insulated panel forms.

Many components, such as cladding materials and joinery, are not specific to timber frame and are therefore not covered in detail here.

Timber frame houses built under housing warranty schemes should also satisfy the scheme detailed requirements, which may not be covered in this Sheet.

This WIS is an overview of the subject with signposts to more detailed sources that are listed at the end.

TRADA Technology recommends *Eurocode 5 Common rules and rules for buildings* [1] for structural design of timber. However, this WIS includes a summary of variations when using *BS 5268-2 Structural use of timber. Code of practice for permissible stress design, materials and workmanship* [2], which the BSI has withdrawn.

Contents

Figure 1: Timber frame with OSB sheathing, glulam beams and trussed rafters

Key points

- The design of the structural framework of timber frame follows Eurocode 5.
- All timber for structural purposes should be strength graded and clearly marked with the grade and/or the Strength Class and CE mark.
- Structural framing is normally softwood of strength class at least C16. Structural timber composites or engineered structural components can also be used.
- Structural softwood for use in buildings (Service Classes 1 and 2 in Eurocode 5) is strength graded at an average moisture content of 20% and marked DRY or KD.
- The need for preservative treatment depends on the durability of the timber used and an assessment of the risk of decay or insect attack.
- For most structural softwoods which are durability class 4 (slightly durable) or Class 5 (not durable) treatment of timber frame construction is either essential or recommended as insurance.
- CE marking is essential for timber trussed rafters, wood-based panels for structural sheathing and floor decks, thermal insulation, wall ties, lintels for masonry cladding and plasterboard.

Timber frame construction

Most timber frame building manufacturers in the UK supply factory-assembled, open-framed, sheathed panels of a size that can be manhandled into position on site. 'Closed panel' systems with the insulation, services, vapour control layer, internal linings, and possibly also the joinery and cladding all applied in the factory, can achieve higher levels of prefabrication. In the UK, some manufacturers produce such panels but specifiers should consider carefully the effects of weather on materials and details of erection on site.

In either case the specifier need not be concerned with the specialist methods used in making the panels but only with the quality of the manufactured component and the materials used. It is reasonable for a prospective or nominated manufacturer to provide, for inspection, a sample panel which is representative of the workmanship and materials to be expected in the contract.

The platform frame method of construction, using single storey-height panels, is almost universally used in the UK. Each floor forms a platform on which the next storey is erected. The method is outlined in TRADA's *WIS 0-3: Introduction to timber frame construction* [3] and is described in detail in TRADA's book *Timber frame construction, 5th edition* [4], which shows typical details for 'open' panel timber frame wall panels for houses requiring 30 minutes fire resistance and for flats requiring 60 minutes fire resistance.

TRADA Technology's *Site manager's pocket guide to timber frame* [5] covers the most important aspects of assembling the frame on site.

An important consequence of the *Construction Products Regulation* [6] (CPR, 2011) is that from 1st July 2013 all products, for which a harmonised Product Standard exists, must be CE marked. Manufacturers must also supply data for use with Eurocode 5. Manufacturers must have a Declaration of Performance and technical information on their product. TRADA's *WIS 2/3-56: CE marking: implications for timber products* [7] explains the CPR and how it affects timber products.

Framing

Structural framing is normally softwood of strength class at least C16, with the strength properties listed in *BS EN 338 Structural timber. Strength classes* [8].

The design of the structural framework of timber frame follows *Eurocode 5 Common rules and rules for buildings,* with loads derived from *Eurocode 1 [9, 10].*

Design for fire follows *Eurocode 5, Structural fire design* [11]. The structural calculations will determine the grades and section sizes of timber to be used. In addition to structural requirements, stud sizes may be determined by thermal and acoustic requirements.

All timber for structural purposes should be strength graded and clearly marked with the grade and/or the Strength Class and CE mark. The harmonised Standard for strength grading is *BS EN 14081-1 Timber structures. Strength graded structural timber with rectangular cross section. General requirements* [12], which is in four parts and covers visual and machine grading.

In the UK, softwood is visually strength graded according to *BS 4978 Visual strength grading of softwood. Specification* [13]. Other national grading rules recognised in *BS EN 1912 Structural Timber. Strength classes. Assignment of visual grades and species* [14] are also acceptable. TRADA's Wood Information Sheet *WIS 4-7: Timber strength grading and strength classes* [15] gives more details.

Variation when using BS 5268 (now withdrawn)

Structural design follows:

- BS 5268-2
- *BS 5268-3 Structural use of timber. Code of practice for trussed rafter roofs* [16]
- *BS 5268-6.1 Structural use of timber. Code of practice for timber frame walls. Dwellings not exceeding seven storeys* [17]
- *BS 5268-6.2 Structural use of timber. Code of practice for timber frame walls. Buildings other than dwellings not exceeding four storeys* [18]
- *BS 8103-3 Structural design of low-rise buildings. Code of practice for timber floors and roofs for housing* [19]

Design for fire follows:

- *BS 5268-4.1 Structural use of timber. Fire resistance of timber structures. Recommendations for calculating fire resistance of timber members* [20]
- *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* [21]

Loads are given in:

- *BS 6399-1 Loading for buildings. Code of practice for dead and imposed loads* [22]
- *BS 6399-2 Loading for buildings. Code of practice for wind loads* [23]
- *BS 6399-3 Loading for buildings. Code of practice for imposed roof loads* [24]

Structural timber composites or engineered structural components can also be used provided they comply with relevant standards. They must carry a CE mark or have independent third party certification for the application proposed. Products include glulam, laminated veneer lumber (LVL), parallel strand lumber, laminated strand lumber and I-beams manufactured with the flanges of softwood or LVL and the webs of plywood, OSB or hardboard. Other configurations that combine timber flanges with metal strutting webs are also available.

Timber sizes

BS EN 336:2003. Structural timber. Sizes, permitted deviations [25] shows target sizes for structural softwoods at a moisture content of 20%. The National Annex lists sizes commonly available in the UK and allowable tolerances. See also TRADA's *WIS 2/3-37: Softwood sizes* [26].

Wall framing

Timber for wall framing is usually surfaced on all four sides, often with rounded arrises. Known as CLS/ALS sizes, these are produced in Canada (Canadian lumber size), the USA (American lumber size), in the UK and in the Nordic countries.

The sizes most commonly used for studs in the UK are CLS/ALS; 38mm x 89mm or 38mm x 140mm. Other sizes available are 38mm x 63mm, 184mm, 235mm and 285mm.

I-studs or metal web studs are sometimes specified where high levels of thermal insulation are required.

Floor joists

In platform frame, floor joists are of the same nominal depth throughout in order to standardise wall panel heights. Joist depths are made uniform by machining the top and/or bottom faces to provide an even surface for floor and ceiling finishes. Alternatively ALS/CLS surfaced timber may be specified for joists.

Select joist sizes for solid timber members in floors, ceilings and roofs (excluding trussed rafter roofs) of dwellings from TRADA Technology's *Eurocode 5 Span tables, 3rd edition* [27]. Alternatively calculate these using Eurocode 5 or TRADA Technology's software *Timbersizer* [28].

Variation when using BS 5268 (now withdrawn)

Spantables, 2nd edition [29] (BS 5268 edition)

I-beams and metal web joists are increasingly being used for floor joists since they combine larger span capabilities with low moisture content. Follow the manufacturer's literature for spans and detailed technical guidance.

Moisture content of framing timber

Structural softwood for use in buildings (Service Classes 1 and 2 in *Eurocode 5*) is strength graded at an average moisture content of 20% and marked DRY or KD. Protect it from wetting and high humidity during storage.

Timber that is more than 100mm in thickness is difficult to dry and will normally be graded and marked WET. In this case base design calculations on wet stresses.

Structural softwood installed at 20% moisture content will still shrink as it dries down to its equilibrium moisture content in the heated building. For intermediate floor joists this can be as low as 8%–10%.

A 'rule of thumb' for shrinkage in solid softwood is a 1% change in dimension for every 4% change in moisture content. The majority of this shrinkage occurs across the grain. The timber frame design must allow for this shrinkage potential. This effect is most significant in multi-storey buildings where walls shrink in relation to cladding and building services. By minimising the use of horizontal cross-grain timber, shrinkage can be maintained at manageable levels. An alternative approach is to use engineered timber structural components that are manufactured at low moisture contents. Chapter 4 of *Timber Frame Construction* contains guidance.

Preservative treatments

The need for preservative treatment depends on the durability of the timber used and an assessment of the risk of decay or insect attack.

BS EN 335 Durability of wood and wood-based products. Use classes: definitions, application to solid wood and wood-based products [30] defines use classes for assessing the protection needed against biological attack. Follow *BS 8417 Preservation of wood. Code of practice* [31] to specify a suitable preservation system.

BS EN 350-1 Durability of wood and wood-based products. Natural durability of solid wood. Guide to the principles of testing and classification of natural durability of wood [32] defines durability classes.

For most structural softwoods which are durability class 4 (slightly durable) or Class 5 (not durable) timber frame construction needs treatment in two categories:

Treatment essential:

- sole plates
- bottom members of loadbearing wall frames or joinery resting directly on the damp proof course (DPC)
- timber cavity barriers in external cavity walls (also to be protected by separate DPC)
- timber in cold design flat roofs
- cladding fixing battens
- tiling battens.

In addition, the Building Regulations (England and Wales) require all softwood roof timbers in specified areas of England to be treated against attack by the house longhorn beetle.

Treatment recommended as insurance:

- joists in suspended timber ground floors
- loadbearing timber external wall frames.

The recommendation in the Building Regulations (England and Wales) that material exposed to and likely to be adversely affected by moisture implies that external cladding with slightly durable (or not durable) species of wood requires preservative treatment.

Methods of treatment are outlined in *BS 8417*. See also the Wood Protection Association's *WPA Manual: Industrial wood preservation specification and practice, 2nd edition* [33].

Chromated copper arsenate (CCA) preservatives are no longer permitted in residential or domestic structures. However, sole plates may be treated with copper-containing preservatives.

Treatment of individual members in the manufactured components listed above is most often carried out using micro-emulsion based wood preservatives. These formulations are applied using double vacuum/low pressure treatment methods. They have largely replaced 'traditional' light organic solvent preservative formulations in structural applications.

Alternatively, if timber treated at source by the boron diffusion process is available, this may be specified. Many of the preservative formulations in use today contain water as a solvent or carrier. Take care to ensure that treated timber is not used until its moisture content is below 20%.

The housing warranty organisations may have specific requirements for preservative treatment of timber components. Check their current requirements.

Timber should not be cut or drilled after preservative treatment. However, if this is unavoidable, treat the cut ends or holes by brushing or swabbing liberally with appropriate preservative.

Timber trussed rafters

Timber trussed rafters must comply with the harmonised Standard *BS EN 14250 Timber structures. Product requirements for prefabricated structural members assembled with punched metal plate fasteners* [34] and be CE marked.

These components should be designed and manufactured to *Eurocode 5*. Bracing is essential and must be continuous over the length of the building. See also TRADA's *WIS 1-29: Trussed rafters* [35].

Sheathing

Material for structural sheathing must comply with the harmonised Standard *BS EN 13986 Wood-based panels for use in construction. Characteristics, evaluation of conformity and marking* [36] and be CE marked. The board should be suitable for structural use in a humid (or exterior) environment.

Table 1: Materials which may be specified for sheathing

Panel type	Standard
Oriented strand board (OSB): OSB3 or OSB4	*BS EN 300:2 Oriented strand boards (OSB). Definitions, classification and specifications* [39]
Plywoods of grade EN 636-2 or EN 636-3	*BS EN 636 Plywood. Specifications* [40]
Oil tempered hardboard grade HB.HLA2	*BS EN 622-2 Fibreboards. Specifications. Requirements for hardboards* [41]
High density medium board grades MBH.HLS1 or MBH.HLS2	*BS EN 622-3 Fibreboards. Specifications. Requirements for medium boards* [42]
Impregnated softboard grade SB.HLS	*BS EN 622-4 Fibreboards. Specifications. Requirements for softboards* [43]
Particleboards grades P5 or P7	*BS EN 312 Particleboards. Specifications* [44]

Sheathing must also comply with *BS EN 12871 Wood-based panels. Performance specifications and requirements for load bearing boards for use in floors, walls and roofs* [37]. This requires testing to *BS EN 594 Timber structures. Test methods. Racking*

strength and stiffness of timber frame wall panels [38]. The CE mark should include the words 'Wall sheathing' to show that the required tests have been carried out.

TRADA's *WIS 2/3-57 Specifying wood-based panels for structural use* [45] contains guidance on racking resistance.

Floor decks

Wood-based panels for structural floor decking must comply with the harmonised Standard *BS EN 13986* and be CE marked. The board should be suitable for structural use in a humid (or exterior) environment.

Panels for floor decks must also comply with *BS EN 12871* and the CE mark should include the word 'Flooring' to indicate that BS EN 12871 point load and impact tests have been carried out. The impact part is a pass or fail test; the point load test will give the load category for use in design.

Materials which may be specified for floor decking (subject to wood-based panels also meeting the requirements outlined above) include:

- chipboard for flooring: Type P5 or P7 to *BS EN 312*
- oriented strand board for flooring: OSB3 or OSB4 to *BS EN 300*
- plywood for flooring: grade EN 636-2S or EN 636-3S to *BS EN 636*.

The design of domestic floor decking is based on an imposed load of 1.5 kN/m^2. Undertake detailed design calculations for floor decking in other building types. Wood-based panel manufacturers will provide test results for panel thickness and joist spacings.

Thermal insulation

This normally takes the form of mineral fibre (glass or rock) or cellulose fibre. The density and thickness will depend on the level of insulation required. A range of other insulation products can also be specified. Materials should be appropriate for use in timber frame buildings and must comply with the harmonised Standards listed in Table 2 and must carry a CE mark.

Table 2: Insulation types for timber frame buildings and Standards

Panel type	Standard
Mineral wool	*BS EN 13162 Thermal insulation products for buildings. Factory made mineral wool (MW) products. Specification* [46]
Expanded polystyrene	*BS EN 13163 Thermal insulation products for buildings. Factory made expanded polystyrene (EPS) products. Specification* [47]
Extruded polystyrene foam (XPS)	*BS EN 13164 Thermal insulation products for buildings. Factory made extruded polystyrene foam (XPS) products. Specification* [48]
Rigid polyurethane foam (PUR)	*BS EN 13165 Thermal insulation products for buildings. Factory made rigid polyurethane foam (PU) products. Specification* [49]
Phenolic foam (PF)	*BS EN 13166 Thermal insulation products for buildings. Factory made phenolic foam (PF) products. Specification* [50]
Cellular glass (CG)	*BS EN 13167 Thermal insulation products for buildings. Factory made cellular glass (CG) products. Specification* [51]
Wood wool	*BS EN 13168 Thermal insulation products for buildings. Factory made wood wool (WW) products. Specification* [52]
Wood fibre	*BS EN 13171 Thermal insulation products for buildings. Factory made wood fibre (WF) products. Specification* [53]

Vapour control layer

Where the wall design requires a vapour control layer specify a minimum 125 micron (500 gauge) polyethylene or a proprietary vapour control plasterboard. TRADA's *WIS 4-15: Condensation control in dwellings* [54] describes the function of the vapour control layer.

Breather membranes

BS EN 13859-2 Flexible sheets for waterproofing. Definitions and characteristics of underlays. Underlays for walls [55] replaces *BS 4016 Specification for flexible building membranes (breather type)* [56] which has now been withdrawn. Nevertheless there are some aspects of BS 4016 that remain useful for designers.

The vapour resistance of breather membranes should not exceed 0.6 MNs/g. For improved resistance to damage from wind, TRADA Technology recommends the use of reinforced or spun polypropylene material. Fixings should be austenitic stainless

steel. TRADA's *WIS 1-35: Breather membranes for timber frame walls* [57] explains the function and specification of breather membranes.

Cavity barriers and fire stops

Barriers are necessary in concealed spaces to restrict the passage of smoke and flame. Their positioning in external wall and party wall cavities is laid down in building regulations. Depending upon their position and fixing they may be mineral wool, mortar fill, non-combustible board material or in some cases, timber.

Various proprietary cavity barriers are available consisting of a mineral wool strip encased in a polyethylene sleeve. Cavity barriers may be of combustible material providing they achieve a minimum of 30 minutes fire resistance. They may be in timber not less than 38mm wide and fill the thickness of the cavity. They should be preservative-treated and separated by a damp proof course from any masonry. A strip of mineral wool insulation outside the DPC can ensure a tight seal with the cladding.

Fire stops around penetrations serve a similar function and follow a similar specification.

Intumescent cavity barriers, which expand to fill the cavity when heated, are increasingly popular when installing claddings supported by the timber frame because these afford continuous ventilation of the cladding that could deteriorate in excessive moisture. Specify independent third party certified products for the application proposed.

Cladding

The range of cladding materials suitable for timber frame buildings is wide and includes brickwork, blockwork, render systems and timber boarding. There must be a drained and vented airspace behind the external cladding to all timber frame walls. The specification of cladding materials is not peculiar to timber frame.

Wall ties

Masonry cladding is secured to the timber studs with flexible, stainless steel ties, using stainless steel fixings.

Wall ties must comply with the harmonised Standard *BS EN 845-1 Specification for ancillary components for masonry. Ties, tension straps, hangers and brackets* [58] and be CE marked. For timber frame the ties should be of a movement-tolerant type. The manufacturer should declare the maximum permissible range of movement that the tie can accommodate. The designer should ensure that the tie can accommodate the degree of differential movement anticipated in the building.

Lintels for masonry cladding

Proprietary steel lintels should be purpose-designed for timber frame and have independent third party certification.

Lintels must comply with the harmonised standard *BS EN 845-2 Specification for ancillary components for masonry. Lintels* [59] and be CE marked.

Wall linings and ceilings

Plasterboard is commonly used to line walls and ceilings and contributes significantly towards achieving the required period of fire resistance. Plasterboard must comply with the harmonised Standard *BS EN 520 Gypsum plasterboards. Definitions, requirements and test methods* [60] and be CE marked.

Taper-edged boards with a thickness of 12.5mm or 15mm are normally specified for walls and ceilings in dwellings up to three storeys. Specify additional or thicker layers if needed to achieve the required fire resistance and/or acoustic performance in walls and floors in houses over two storeys and in party walls and floors in flats and hotels. Fix overlain sheets with staggered joints. Follow individual manufacturer's recommendations for fixing and finishing.

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About TRADA

The Timber Research and Development Association (TRADA) is an internationally recognised centre of excellence on the specification and use of timber and wood products.

TRADA is a company limited by guarantee and not-for-profit membership-based organisation. TRADA's origins go back over 75 years and its name is synonymous with independence and authority. Its position in the industry is unique with a diverse membership encompassing companies and individuals from around the world and across the entire wood supply chain, from producers, merchants and manufacturers, to architects, engineers and end users.

Our aim

To provide members with the highest quality information on timber and wood products to enable them to maximise the benefits that timber can provide.

What we do

We seek to achieve this aim through active and on-going programmes of information and research. Information is provided through our website, an extensive collection of printed materials and our training courses.

Research is largely driven by the desire to update and improve our information so that it continues to meet our members' needs in the future.

TRADA Technology is contracted by the Timber Research and Development Association to prepare and publish all Wood Information Sheets.

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