

Dry-graded structural softwood

What is dry-graded softwood?

Under Building Regulations (England, Wales and Northern Ireland) and Building Standards (Scotland) and the codes of practice for the use of structural timber, BS 5268-2 or Eurocode 5, all timber used for structural purposes in the UK must be strength graded and marked. Most structural timber used in buildings is softwood.

Dry-graded softwood is strength graded at a moisture content of 20% or less in accordance with the requirements laid down in British Standards explained below.



Example of marking on dry graded softwood

Why is dry grading important?

Moisture content is fundamental to the performance of timber in use. It affects the size, shape and weight of timber components; it affects their strength and durability; it affects machining and finishing; it affects treatments and processing, such as preservatives, paints and glues; it can also affect fastenings and the cost of transport.

Timber when first cut from the tree contains significant amounts of water. Most of this water is lost through drying (or 'seasoning') until the water in the timber is in balance with the water in the surrounding atmosphere. This balance point is known as the 'equilibrium moisture content'.

During the first stage of drying, water is lost from the spaces inside the cells until the wood reaches the so called 'fibre saturation point' when there is no more 'free' water in the cell spaces, at around 25-30% moisture content. Below this level, water is lost from

the cell walls and the timber starts to shrink. Fibre saturation point is significant for other reasons too. The fungi, which can attack timber and cause decay, need free water in the cells on which to live. So timber which is kept dry, ie well below fibre saturation point at 20% or less, will not decay.

Being a natural material, timber can continue to absorb or lose moisture in line with changes in the atmosphere and will swell or shrink accordingly. This 'movement' of timber is not an instant response but dry timber placed in a wet or damp situation, eg left outside or in a building with wet concrete and plaster for long periods will absorb water and swell. Similarly, wet timber placed in a dry environment will shrink.

Therefore, in order to minimise movement, timber should be installed in buildings at a moisture content close to that which it will reach at equilibrium. For many structural

applications in buildings, a moisture content of 20% or less is appropriate. Timber in covered but unheated areas, eg ventilated roof spaces above the insulation, eventually reaches an average moisture content of about 18%. Within the heated space, eg intermediate floor joists etc, the average is lower, at about 12%, so, even using dry-graded timber in these areas, some shrinkage may still occur.

The strength of timber increases as the timber dries; the bending stresses for wet-graded timber are only 80% of those for dry-graded timber.

What is strength grading?

Strength grading provides a means of assessing the strength of a piece of timber. This can be carried out visually or by machine.

Visual strength grading rules define the size, type and number of strength-reducing characteristics allowed in each grade. Strength-reducing characteristics include natural features such as knots, wane and slope of grain, plus splits and shakes which may have developed as a result of drying. The grader assesses each piece and stamps it with the appropriate mark.

Machine grading is based on the relationship between strength and stiffness. The machine grades each piece and stamps it with the appropriate mark. An additional visual assessment takes account of strength-reducing characteristics not automatically sensed by the machine.

The rules governing strength grading are laid down in British and European standards:

BS EN 518: 1995 Structural timber - Grading - Requirements for visual grading standards.

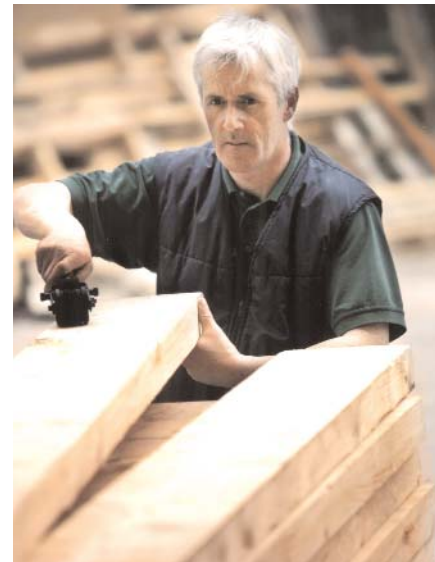
This standard defines the requirements for visual grading rules to be acceptable in Europe; it does not define grading rules itself.

BS 4978: 1996 Visual strength grading of softwood.

This standard defines the rules used in the UK for visually strength grading softwoods. The rules comply with BS EN 518.

BS EN 519:1996 Structural timber - Grading - Requirements for machine strength graded timber and grading machines.

This defines the requirements for grading machines and details the additional visual assessment required for machine strength graded timber.



Visual grading to BS 4978

All timber graded to BS 4978 must be marked so that specifiers, inspectors and site staff are able to identify immediately the grade and moisture content level of the timber supplied. Timber not displaying a grade mark should not be used for structural purposes, unless special arrangements have been made, for example where the structure is a decorative feature.

Two principal grades are defined; GS - General structural and SS - Special structural, which can be graded at two levels of moisture content; dry and wet.

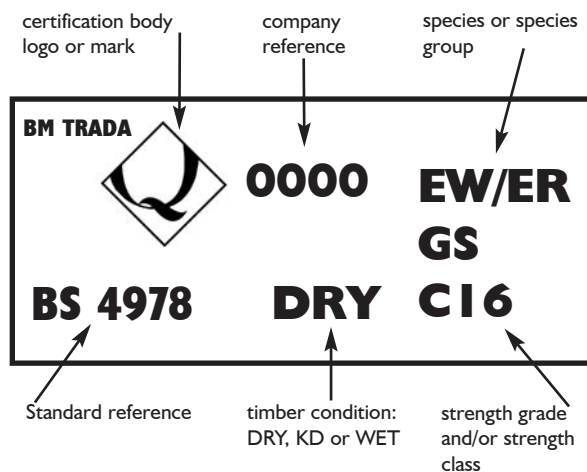
Dry-graded timber is assessed when the batch of timber has an average moisture content of 20% or less, with no reading exceeding 24%. Note: timber over 100 mm thick is difficult to dry to this level and is normally supplied and marked wet. Dry graded timber is marked DRY or, if it has been kiln dried, it may be marked KD.

All timber graded at a moisture content above 20% is defined and marked as WET.

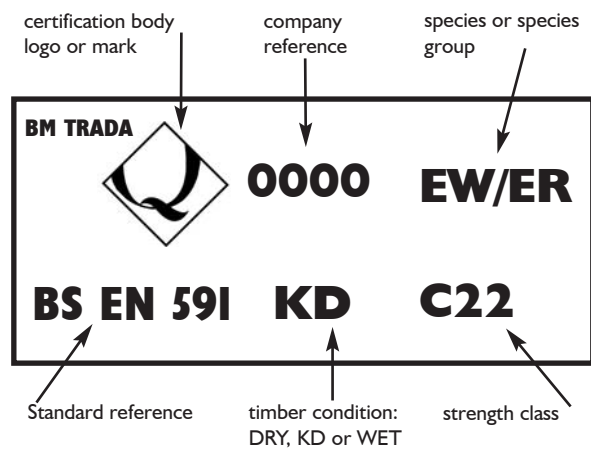
Marking

Each piece of visually strength graded softwood will be stamped indelibly on one face with:

- ◆ the grade (the strength class may also be marked)
- ◆ the species or species combination
- ◆ information to identify the company responsible for the grading
- ◆ the certification body
- ◆ the British Standard number ie BS 4978
- ◆ if dry graded timber, the word DRY or if kiln dried, KD
- ◆ if wet graded timber, the word WET.



BM TRADA Certification grade mark on visually graded timber



BM TRADA Certification grade mark on machine graded timber

The standard makes allowance for marking to be omitted for aesthetic reasons. In these circumstances a certificate of compliance can be issued for each parcel of a single grade of softwood.

Machine grading to BS EN 519: 1996

BS EN 519 recognises two types of strength grading machine: output controlled and machine controlled.

Most strength grading machines in the UK are machine controlled and operate by applying a defined load to each piece of timber. The resulting deflection indicates the grade which is then marked on the piece. The machine settings need to be strictly assessed and controlled to maintain consistency of grading.

Softwood strength graded by machine in the UK or in Europe to BS EN 519: 1996 is graded to the strength limits laid down for the 9 softwood strength classes defined in BS EN 338 (see below). In addition, special grades can be developed and defined for particular purposes, such as TR 26, which has been introduced for the manufacture of trussed rafters.

A National Annex to BS EN 519 for the UK defines Dry machine graded timber and Wet machine graded timber in the same way as for visually graded timber in BS 4978 (see above).

Marking

Each piece of machine strength graded timber will be marked with

- ◆ the strength class
- ◆ the species or species combination
- ◆ the Standard number ie BS EN 519

- ◆ information to identify the company and the machine responsible for the grading.
- ◆ the name or mark of the certification body
- ◆ for dry graded timber, the word DRY; if kiln dried, KD may be used
for wet graded timber, the word WET.

Like BS 4978, BS EN 519 allows marking to be omitted in exceptional circumstances for aesthetic reasons and replaced by a certificate of compliance for each parcel of timber of a single strength class.

Sizes and processing

BS 4978: 1996 allows a minimum cross sectional area of 2000 mm² and a minimum thickness of 20 mm for strength graded softwood. BS EN 519 does not stipulate a minimum size but requires timber to meet the requirements of BS EN 336 which includes a National Annex which gives sizes of structural softwood customary in the UK. It also includes permissible deviations and processing reductions for constructional timber.

Both standards allow a reduction in size by surfacing or resawing of a maximum of 3mm on sections up to and including 100mm and 5mm on sections over 100mm after grading, although marks must be reinstated if they have been removed. Timber which is processed outside these limits must be regraded.

Quality assurance and certification

The grade marks on structural timber include the name or mark of the Certification body.

Certification bodies oversee the training and certification of graders and the operation of grading machines. They also monitor the quality of grading carried out by the companies under their control.

The certification bodies are approved by the UK Timber Grading Committee and are listed in a leaflet *Approved Certification Bodies for the supply of strength graded timber*, published by the Timber Trade Federation.

BM TRADA Certification Ltd is an Approved Certification Body for timber strength graded both visually and by machine. Certified graders are based in UK companies and in supplying countries. Timber graded under BM TRADA Certification Ltd product schemes will be stamped with the Q-MARK illustrated.

How is strength-graded timber used?

Timber for structural use is designed in accordance with the structural timber code of practice, BS 5268-2 *The structural use of timber. Permissible stress design, materials and workmanship*.

For simple components, such as floor joists, rafters, purlins etc, for use in small buildings such as houses, design calculations in accordance with the code have been undertaken to provide span tables. These are included in the Approved Documents (England and Wales) or Technical Booklets (Northern Ireland) to the Building Regulations, in the Technical Standards for Scotland and in British Standards. For more complex structures, a structural engineer will undertake the design.

Factors affecting strength

The strength of timber is governed by a number of factors, the most significant being species and moisture content.

Species

The strength of timber species is closely related to density. The strongest, densest hardwoods are more than 10 times as strong as the lightest weakest species. The structural softwoods fall into the mid-range of density and strength. They offer an appropriate combination of strength and stiffness for a wide range of applications. Variation within species is taken into account by the strength grading systems outlined above.

Since the strength of timber is related to species, the same grade (eg visually graded GS, SS) in different species will have different strengths. This results in a very wide range of combinations of species and grade. For example, the strength of SS grade British grown spruce and of SS grade imported Western red cedar is equivalent to the GS grade of Southern pine from the United States.

To simplify design and supply, species/grade combinations of similar strength have been grouped together into Strength Classes, defined in BS EN 338 *Structural Timber. Strength classes*.

Nine strength classes are defined for softwoods, although only seven are commonly used. Structural designs can be based on the stresses for a strength class. From a purely structural point of view, any of the species/grade combinations within that strength class can be supplied to meet the specification. In practice, there may be other requirements, such as durability or finishing parameters, which influence the final choice.

Moisture content

Timber increases in strength and stiffness as it dries. BS 5268-2 sets out three 'Service Classes' for timber:

Service Class 1

Characterised by a moisture content corresponding to a temperature of 20° C and the relative humidity of the surrounding air only exceeding 65% for a few weeks each year. In such conditions most timber will attain an average moisture content not exceeding 12%.

Service Class 2

Characterised by a moisture content corresponding to a temperature of 20° C and the relative humidity of the surrounding air only exceeding 85% for a few weeks each year. In such conditions most timber will attain an average moisture content not exceeding 20%.

Service Class 3

Characterised by higher moisture contents than Service Class 2.

The design stresses included in BS 5268-2 are based on a moisture content of 20% or less (ie on dry-graded material) and can be used to design timber for Service Classes 1 and 2. Timber for use in Service Class 3, or large section timbers, must be designed using the modification factors for wet stresses given in the code.

Availability of strength graded timber

There is a very large number of possible combinations of sizes, strength grades and species available in the UK. The availability of any particular species, grade and size may differ regionally throughout the country.

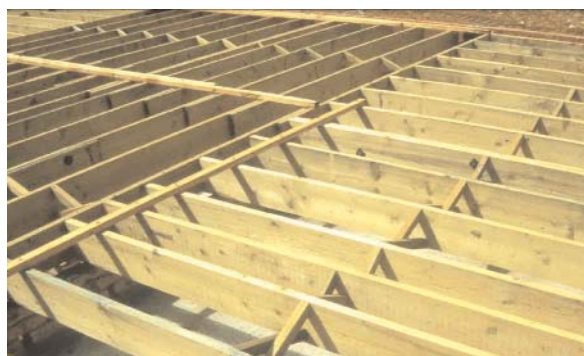


Table 1 shows how softwoods visually graded to BS 4978 are allocated into the strength classes. Machine graded timber is allocated directly to the appropriate strength class.

Table 1 Softwood visual grades (to BS 4978) allocated into strength classes

Species (source)	Grades to satisfy strength class						
	C14	C16	C18	C22	C24	C27	C30
British pine (Britain)	GS			SS			
British spruce (Britain)	GS		SS				
Caribbean pitch pine (imported)			GS			SS	
Douglas fir (Britain)	GS		SS		*		
Douglas fir-Larch (Canada, USA)		GS			SS		
Hem-fir (Canada, USA)		GS			SS		
Larch (Britain)		GS			SS		
Parana pine (imported)		GS			SS		
Redwood (imported)		GS			SS		
Sitka spruce (Canada)	GS		SS				
Spruce-pine-fir (Canada, USA)		GS			SS		
Southern pine (USA)			GS		SS		
Western red cedar (imported)	GS		SS				
Western white woods (USA)	GS		SS				
Whitewood (imported)		GS			SS		

Note: Timber from a strength class higher than the one specified may always be used.

* For sizes where the cross-sectional area exceeds 20000mm² SS grade British-grown Douglas fir may be allocated strength class C24.

North American softwoods

Timber imported from Canada and the USA may be graded to their national standards. Timber that is strength graded to the following standards is accepted by BS 5268-2: 2002 and by Eurocode 5.

National grading rules for dimension lumber. NLGA, Canada. 1994

National grading rules for softwood dimension lumber. NGRDL, USA. 1975

North American export standard for machine stress rated lumber. 1987 and supplement No 1: 1992.

Visually graded North American softwood

BS 5268 Part 2: 1996 provides stresses for visually strength graded softwoods. The grades included in BS 5268 are the same under both sets of rules:

Structural Joist and Plank:

Select structural (Sel), No 1, No 2, and No 3

Structural Light Framing:

Select structural (Sel), No 1, No 2, and No 3

Light Framing:

Construction (Const), Standard (Std) and Utility (Util)

Stud.

North American grading agencies approved to maintain grading standards of softwood exported to the UK operate under either the American Lumber Standards Board of Review or the Canadian Lumber Standards Accreditation Board. The certification bodies approved for supply of timber to the UK are listed in the UK Grading Committee leaflet.

Marking

Each piece of timber graded to NLGA and NGRDL rules will show:

- ◆ the grade (the strength class may also be marked)
- ◆ the species or species group
- ◆ whether surfaced dry or green
- ◆ the number of the mill or grader
- ◆ the registered symbol of the agency
- ◆ in addition the grading rule may also be shown.

Machine-graded North American softwood

Timber machine strength graded in North America is likely to have been graded in an output controlled machine. In this case sufficient load is applied to each piece of timber to induce a defined deflection. The load required indicates the grade, which is marked on the piece. The consistency and quality of grading is checked by measuring the strength of timber specimens from the daily output of the machine.

BS 5268-2: 2002 includes stresses for softwoods machine graded to the North American Export Standard for machine stress rated lumber. The grades included are:

900f - 1.0E
1200f - 1.2E
1450f - 1.3E
1650f - 1.5E
1800f - 1.6E
1950f - 1.7E
2100f - 1.8E.

Marking

Timber machine stress rated in North America will be marked with

- ◆ the grade
- ◆ the species or species combination
- ◆ whether surfaced dry or green
- ◆ the phrase 'machine rated' or 'MSR'
- ◆ the name or number of the mill
- ◆ the registered symbol of the agency.

Table 2 shows how North American softwoods are allocated to strength classes.

Table 2 North American softwoods allocated to strength classes graded to NLGA/NGRDL Joist and plank rules (J & P*) and to the North American Machine stress-rated rules (NAMSRS).

Species (Source)	Grade rules	Strength class						
		C14	C16	C18	C22	C24	C27	C30
Douglas fir-larch (Canada, USA)	J & P NAMSRS	1200f-1.2E	No1,No2 1450f-1.3E		1650f-1.5E	1800f-1.6E	1950f-1.7E	2100f-1.8E
Hem-fir (Canada, USA)	J & P NAMSRS	1200f-1.2E	No1,No2 1450f-1.3E		1650f-1.5E	1800f-1.6E	1950f-1.7E	2100f-1.8E
Sitka spruce (Canada)	J & P	No1,No2		Sel				
Spruce-pine-fir (Canada, USA)	J & P NAMSRS	1200f-1.2E	No1,No2 1450f-1.3E		1650f-1.5E	1800f-1.6E	1950f-1.7E	2100f-1.8E
Southern pine (USA)	J & P NAMSRS	1200f-1.2E	No3 1450f-1.3E		No1,No2 1650f-1.5E	1800f-1.6E	1950f-1.7E	Sel 2100f-1.8E
Western white woods (USA)	J & P	No1,No2		Sel				

* Joist and Plank rules apply only to timber not less than 38 x 114 mm

References

British Standards

BS EN 336: 1995 Structural timber. Coniferous and poplar. Sizes. Permissible deviations.

BS EN 338: 1995 Structural timber. Strength classes.

BS EN 518: 1995 Structural timber. Grading. Requirements for visual strength grading standards.

BS EN 519: 1995 Structural timber. Grading. Requirements for machine strength graded timber and grading machines.

BS 4978: 1996 Specification for visual strength grading of softwood.

BS 5268-2: 2002 The structural use of timber. Code of practice for permissible stress design, materials and workmanship.

TRADA Wood Information Sheets

1 - 37 Eurocode 5 - An introduction

4 - 14 Moisture in timber

For details visit the Bookshop at www.trada.co.uk or a Catalogue of Publications is available from TRADA Technology.

Timber Trade Federation

UK Timber Grading Committee.

Approved Certification Bodies for the supply of strength graded timber.

Copies available from TTF, Clareville House, 26/27 Oxenden St, London SW1Y 4EL.

Telephone: 020 7839 1891



The Northern Ireland Timber Trade Association represents the leaders in the local imported timber industry. The individual members collectively import more than 80% of the timber brought into Northern Ireland. It is because of this that the Association has taken the lead in the provision and promotion of the highest quality timber and wood products.

Established almost 35 years ago in 1967 the Association currently has a membership of 12 timber importers who cover the whole province offering specifiers, architects, the building trade and the general public an unrivalled level of knowledge and expertise in the most versatile construction material.

Ten timber agents from both sides of the Irish Sea are also represented by the NITTA.

The aim of the Association and its members is to provide expert advice on the correct species and installation of timber and wood products as well as supplying the highest quality raw materials and finished goods.

One major step towards this was the agreement among members in October 2000 to import and supply only kiln dried timber for constructional purposes. This significant decision meant that the Association and its members had gone beyond the minimum legal requirements as laid down in the Building Regulations (Northern Ireland) : Schedule D. As part of an integrated marketing and promotional campaign, this initiative marked the beginning of an on-going drive to minimize the amount of incorrectly graded or specified timber used for structural purposes.

For further information on the NITTA and its members contact:

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