BRE

digest

Guide to machine strength grading of timber

Digest 476

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Machine strength grading of timber has been used commercially for at least 30 years, but, for many people involved with the process, it has remained a specialised subject. Timber enters a grading machine at one end and leaves the other having been given a strength class with no obvious means of how this is achieved.
Without knowing the theory and practice of grading, misunderstandings are likely to arise. The main aim of this Digest is to improve knowledge of the process of machine strength grading and to highlight the benefits.
It also explains some aspects of statistics, the concept of distribution, and modification and adjustment factors which are integral to timber grading practice.

Timber is one of the UK's most important raw materials. It is also one of its major imports. When timber is considered as a structural material, specifiers will be concerned mostly with its strength and stiffness properties, although its light weight and ease of cutting and fixing are important advantages compared with steel, concrete and other materials.

When structural timber is produced at the sawmill, some pieces can be eight or more times stronger than others of the same size and species mainly owing to differences in density of the fibre material and the presence, to a greater or lesser extent, of defects such as knots and sloping grain. It is this strength variability which poses the greatest impediment to the efficient use of timber as a structural material. The only way to overcome this and create a basis for achieving greater efficiency in use is to sort timber into grades based on strength. The pieces which qualify for the better grades are assigned higher working stresses and can be therefore used in smaller sections or over longer spans. The process of sorting timber on the basis of strength is known as strength grading*. Two methods of strength grading are available: one is based on visual inspection and the other by using a grading machine.

While visual grading is better than no grading at all, a disadvantage of visual strength grading is that it is rather inefficient since wood structure and density (which influence strength) may not be sufficiently taken into consideration by visual inspection. Another disadvantage is that economic constraints do not allow for slow deliberate examination of each piece and consequently only a rough estimate can be made of the more obvious defects. Therefore the grading rules must be set conservatively. Clearly a machine grading process which minimises the need to assess these factors visually is preferable and in some cases necessary.

Machine strength grading usually sorts timber directly into classes. These classes are divisions of timber strength into which 'species and grade' combinations of similar strength are allocated.

* Formerly referred to as stress grading.

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The essentials of machine grading of timber: a summary

- A single timber grade, or a strength class such as C16, includes pieces of timber with a range of timber strength above the grade minimum.
- Machine grading physically tests timber by measuring a particular 'indicating parameter' which is related to the strength of the timber. In the case of bending type grading machines, this parameter is either a variable reaction force for a fixed deflection or a variable deflection for a fixed applied force.
- The assignment of a piece of timber to a particular strength class or grade is based on the weakest section of the timber within its length which, in turn, is based on the value of the indicating parameter at that point.
- The relationship between the indicating parameter and bending strength is established by laboratory testing of samples containing a total of at least 450 specimens of timber drawn from the geographic and quality range of a species for an agreed source such as the UK.
- Each grading machine in commercial use needs regular calibration to ensure accurate measurement of the indicating parameter. Standard 'settings' for each of the bending type grading machines are produced for a range of sizes for each of the recognised species of softwood for each of the strength classes.
- Because of the design of bending type grading machines, about 0.5 m at each end of a specimen of timber cannot be tested. Any major defect in either end is therefore subject to a visual check and may override the grade allocated by the machine.
- Timber may be graded wet or dry but will be stronger in a dry condition. If graded dry, this will result in higher yields for any particular strength class. To be stamped 'dry', timber must be at or below 20% moisture content.
- The machine may be set to grade to a single strength class; for example C16. Those timber pieces that do not reach C16 are classed as 'reject'. But the C16 stamped timber may include timber that would be strong enough to be in another higher class.

Therefore machines are often set to grade to two strength classes (and reject) together (ie in one pass). The ranges of actual strength for the two classes may overlap. If two classes are close together, the stronger pieces in the range for one will overlap with the lower end of the range of the next. The net effect of this is that machine settings for either of the two classes are different from those used when only one of those classes is being graded as a single class.

- Whether grading a single class or two classes together, the rejects will comprise a strength distribution that is outside the range of any distribution already used to establish the acceptable range for even the lowest strength class. **For this reason, rejects must never be graded again in an attempt to obtain more graded timber**. To do so would have safety implications for machine graded structural timber, because the proportion of weaker timber in the resulting strength distribution of the desired strength class would be too high.

General principles of grading

A grading machine does not measure the overall strength of a piece of timber directly, but gives an accurate assessment of local stiffness – modulus of elasticity – and this provides an estimate of the strength.

Most of the grading machines in use today are the so-called bending machines. These determine average bending modulus of elasticity in the direction of the weaker axis over short lengths.

A timber section (Figure 1) is fed continuously through the grading machine (Figure 2). The machine bends each section, in the direction of the weaker axis, between two roller supports which are usually between 0.8 and 1.2 m apart. The machine measures either the applied load required to give a fixed deflection or the deflection under a particular fixed load.

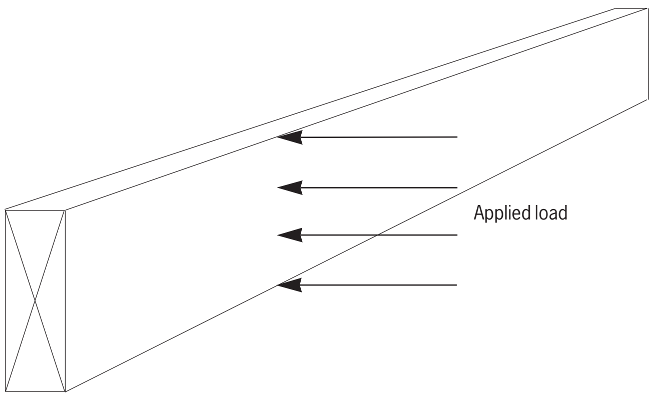

Figure 1 A timber section loaded in the direction of the weaker plane (ie as a plank)

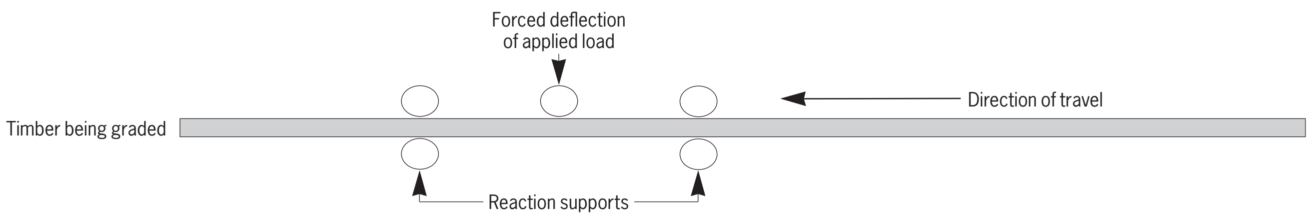

Figure 2 A schematic diagram of a grading machine seen from above

From these measured values a local modulus of elasticity can be calculated taking into account the cross-sectional dimensions and natural bow (natural distortion) of the piece of timber; the effect of natural bow is either measured or eliminated by deflecting the section in both directions. The elimination method is done by feeding the piece of timber through the machine and then again after rotating the piece of timber through 180°. Predicting the bending strength of a piece of timber, as a joist, comes from a direct relationship between machine modulus of elasticity and bending strength. This relationship is illustrated in Figure 3. The bending strength values for determining the relationship are obtained by laboratory testing of a large number of specimens.

The measurement of local stiffness is carried out at intervals along the length of the specimen being graded. The minimum value of stiffness gives an estimate of the bending strength, as a joist, at the weakest point. Reliance is therefore placed on a good correlation between local stiffness, as a plank, and bending strength, as a joist.

For the strength test shown in Figure 4, the weakest point identified by the grading machine is placed centrally between the loading heads.

The bending type grading machines measure over a short span (ie it is a local measurement) because this effectively isolates the defect causing the most severe weakness and gives an acceptable indication of the strength of the timber which is generally governed by its weakest link. Measuring over a short span also has the benefit of keeping the ungraded portions, at the ends of the specimen, to an acceptable minimum length.

If bending over a short span as a joist (ie in the strongest axis) was adopted, this would require very much greater forces to be used resulting in large and much more heavily constructed machines without a proportional gain in strength prediction.

One important difference between visual and machine grading is that, with visual grading, it is possible to check at any time the correct assignment of the nominal grade – even for timber in service. This of course depends on the adequacy of access for a clear view of the timber component. With machine grading this check is not possible, and the grade stamp may not be visible.

For this reason there have to be regular and frequent checks on the reliability of machine grading. Two types of machine grading systems and associated checks have been developed:

- output control;
- machine control.

The output control system was developed in north America and is based on the frequent testing to failure of samples of machine graded timber. This system is relatively costly but permits a modification of machine settings in the sawmill to optimise yields. The timber graded by this method is known as MSR (machine stress rated) lumber. To be economical, the method requires large quantities of timber of the same size to be graded to consistent grades or strength classes.

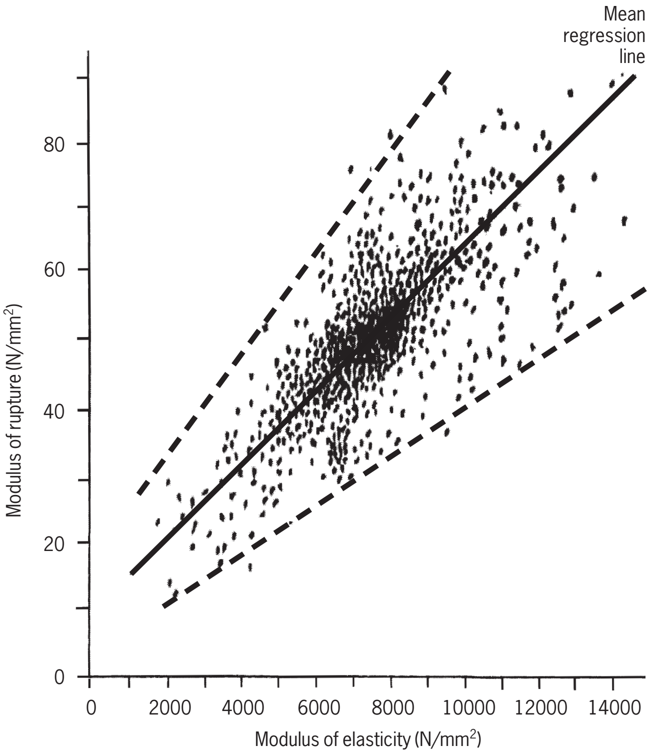

Figure 3 Modulus of rupture (bending strength) against modulus of elasticity (plank stiffness, E_p): scatter diagram of test values

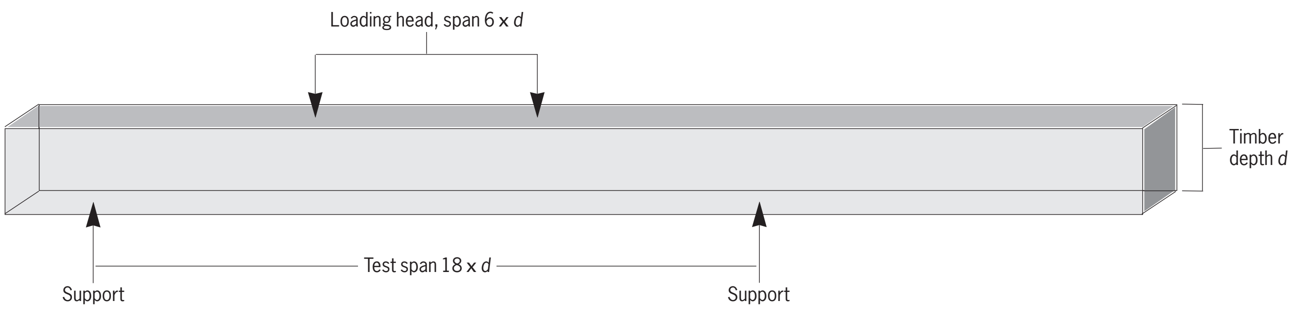

Figure 4 Schematic diagram of a bending strength test carried out on a timber specimen loaded as a joist

The conditions suitable to output control rarely exist in Europe, especially in the UK, where a wide variety of sizes, species and grades in smaller quantities are typical. For these conditions the machine control system is used in which sawmills generally do not test the graded timber but rely on the strict assessment and control of the machines. The machine settings for any given size grade and species remain constant until such time, where positive evidence exists, that adjustments to the settings are required.

The quality control procedures used in machine grading of timber involve calibrating the grading machines. Current methods of static calibration are time consuming and not simple to carry out accurately; dynamic methods, although available, are not specified and therefore infrequently used. For this reason, since 1995, research has been undertaken using 'calibration planks' to produce a suitable specification for constituent materials and design of planks.

Details of design and construction of these planks are contained in Annex C of prEN 14081-3. It should be noted that Parts 1, 2 and 3, and a planned Part 4, of prEN 14081 will replace BS EN 519. The use of control planks is specified in Annex B of prEN 14081-3. At present, using control planks is not mandatory.

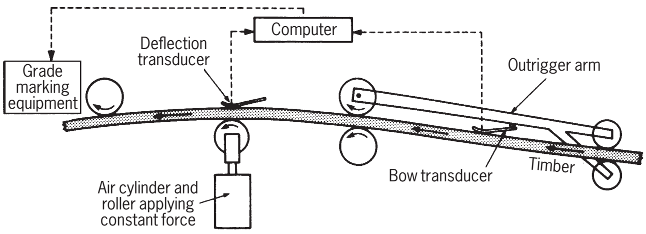

Figure 5 The MPC Computermatic grading machine

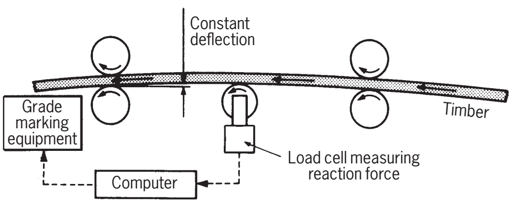

Figure 6 The MPC Cook-Bolinder grading machine

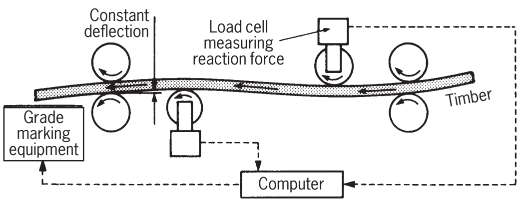

Figure 7 The Raute Timgrader grading machine

Grading machines in current use

The three bending-type machines approved for use in the UK and overseas under the control of UK certification bodies are:

- the MPC Computermatic and its variant the Micromatic;
- the Cook-Bolinder;
- the Raute Timgrader.

The first two are by far the most commonly used, not only in Europe but in other parts of the world.

The Computermatic/Micromatic machine (Figure 5) applies a fixed load for a given cross-sectional size and measures the variation in deflection to determine the stiffness indicator. The timber is deflected in 3-point bending over a span of 914 mm in a single pass. This means that the effect of bow can be assessed in the same pass by using an auxiliary bow measuring device whose measurements are incorporated with the deflection used for measuring stiffness.

The Cook-Bolinder machine (Figure 6) applies a fixed deflection for a given cross-sectional size and measures the variation in reaction force which becomes the stiffness indicator. Again the timber is deflected in 3-point bending over a span of 900 mm in a double pass. This means that in order to eliminate the effect of bow in the timber, the piece of timber has to be turned over and passed through the machine again. Alternatively two machines in tandem can be used.

The Raute Timgrader (Figure 7), made in Finland, applies fixed deflections over a span of 1020 mm, again dependent on cross-sectional size, and measures the variation in reaction force from two load sensing devices. The distance between one set of support rollers and its adjacent load roller is 255 mm. The timber is flexed in both directions in a single pass and so is bent into an elongated S-shape. The net average measurement then takes account of any natural bow in the timber.

Other grading machines based on bending are the CLT (Continuous Lumber Tester), which is the main stress grading machine in North America and is used for producing MSR lumber, and a later development from Sweden called the Ersson. The Swedish machine is believed to offer no significant advantages over the others and has not been manufactured in quantity.

Grading equipment using other technologies (eg X-rays and microwaves) is being developed. This includes French X-ray equipment for sawmill use and X-ray lumber grading equipment manufactured by Newnes in Canada for producing MSR lumber.

Stress wave technology, which is not a new idea, has been developed by Dynalyse AB in Sweden for grading some softwood species. The equipment, called the Dynagrade system, has been approved for use in Sweden and Norway, and by the United Kingdom Timber Grading Committee (UKTGC), for grading European redwood and whitewood for export to the UK.

Strength distribution

Since timber is a naturally variable material, the determination of strength values used in design first requires the estimation of minimum values associated with some designated level of confidence. For many years this was based on using the results of destructive tests on small size specimens of timber which are clear of defects. For these specimens variability could be adequately represented by a normal distribution, with parameters that are simple to calculate and minimum values that are easily obtained.

This approach has been superseded for some time. Consequently all current research work has been directed to obtaining more realistic strength values using the results of tests made on samples of timber in structural sizes with defects that occur naturally. Minimum values of ultimate strength must still be estimated but here the assumption of a normal distribution is no longer acceptable since typical sets of timber strength data usually exhibit skewness, mainly positive, and the application of normal distribution statistics can result in misleading conclusions. An example of this distribution is shown in the bar chart below (Figure 8).

Various alternative statistical procedures can be used for allowing for skewed variability, the main object being to derive a realistic minimum value (usually a 5th percentile) on which to base permissible strength values commonly called working stresses. The 5th percentile is the numerical value of a distribution below which only 5% of the values will lie.

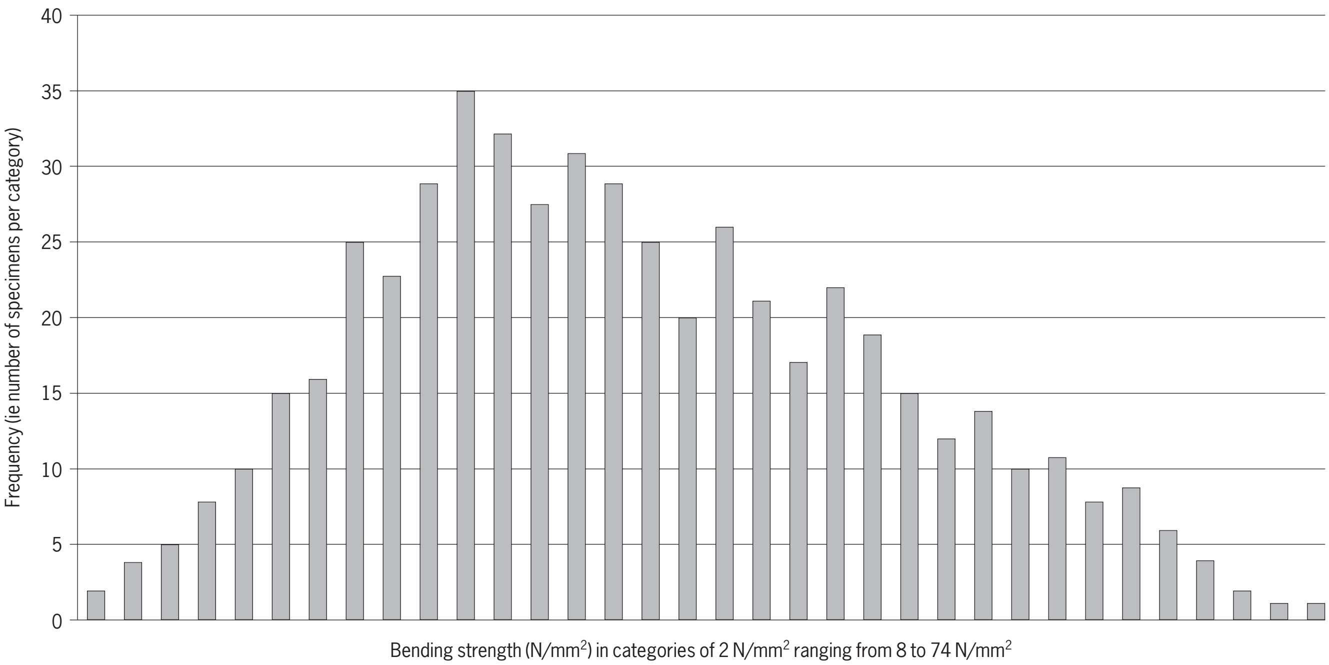

Figure 8 An example of a skewed frequency distribution of bending strength for an ungraded sample of softwood

Table 1 Softwood species and grade combinations which satisfy the requirements for strength classes graded to BS 4978‡

Common name of species	Strength class SC1	SC2	SC3	SC4	SC5
Imported					
Parana pine			GS	SS	
Pitch pine (Caribbean)			GS		SS
Redwood/Whitewood			GS/M50	SS	M75
Western red cedar	GS	SS			
Douglas fir-larch (Canada and USA)			GS	SS	
Hem-fir (Canada)			GS/M50	SS	M75
Hem-fir (USA)			GS	SS	
Spruce-pine-fir (Canada)			GS/M50	SS/M75	
Western whitewoods (USA)	GS		SS		
Southern pine (USA)			GS	SS	
British grown					
Douglas fir		GS	M50/SS		M75
Larch			GS	SS	
Scots pine			GS/M50	SS	M75
Corsican pine		GS	M50	SS	M75
European spruce	GS	M50/SS	M75		
Sitka spruce	GS	M50/SS	M75		

‡ This table has been abstracted from Table 3 of BS 5268-2:1991

Table 2 Grade and species combination relativities based on bending strength

Grade and species	Grade and species bending strength (N/mm²)	Class bending strength (N/mm²)	Assigned strength class
M75 R/W, M75 BG Scots	10.0	10.0	SC5
MSS R/W, MSS BG Scots	7.5	7.5	SC4
M50 R/W, M50 BG Scots, M75 BG Sitka	6.6		SC3
MSS BG D-fir	6.2		SC3
MSS BG Sitka	5.7		SC3
MGS R/W, MGS BG Scots	5.3	5.3	SC3
M50 BG Sitka	4.5		SC2
MGS BG D-fir	4.4		SC2
MGS BG Sitka	4.1	4.1	SC2

Strength classes

Strength classes are divisions of timber strength into which species and grade combinations of similar strength are allocated. High grades of strong species are assigned to a high strength class and low grades of weak species to a low strength class. An engineer or architect can then design to and specify a particular strength class, and allow availability and price at the time of purchase to determine the actual combination of grade and species to be used. Strength classes are therefore seen as as a simplification not only for designers and specifiers but also for suppliers who will be able to relate their stocks more easily to specifications received from customers. Of course on occasions it may be necessary for the designer to specify a species: for example where durability is important.

The rest of this section describes the changeover from BS 5268 to European Standards and the effect this has on the strength class descriptions used. (See feature box, *British and European Standards for strength classes*, on the opposite page.)

In the UK, strength classes were first introduced in BS 5268-2:1984. They were designated SC9 (the strongest) through to SC1 (the weakest). Table 1 above shows how the softwood species and grade combinations were attributed at the time.

British and European Standards for strength classes

1984	BS 5268-2	Introduced UK strength classes. Designated SC1, SC2 through to SC9 with associated permissible strength values. 1988 and 1991 revisions did not affect SC designations
1995	BS EN 338	Introduced CEN strength classes. Designated C14, C16, C18 through to C40. Class numbers refer to characteristic strength values.
1996	BS 5268-2	CEN strength classes specified in BS 5268 but CEN classes are allocated permissible strength values (Table7 of BS 5268-2:1996), not characteristic values. SC designation superseded. Also 'species/visual grade' equivalents were listed in Table 2 of BS 5268-2:1996.
2002	BS 5268-2	Latest and final revision.References to CEN strength classes are unaffected.

As shown in Table 1, timber can be either visually or machine graded to strength classes; for example, GS British grown Sitka spruce is classified as SC1 whereas M75 European redwood or whitewood is classified as SC5. The system was created with SS/MSS and GS/MGS grade strength values for the major imported softwood species becoming directly equivalent to SC4 and SC3 strength values (eg MSS European redwood or whitewood is SC4).

However, not all species and grade combination permissible stresses coincide exactly with the strength class boundaries. This is especially true for some species of British grown timber. Taking British grown Douglas fir as an example, it can be seen from Table 2 that MSS graded Douglas fir has an intermediate stress value but can only qualify for SC3. The same goes for any of those listed with a bending strength greater than 5.3 N/mm^2 and less than 7.5 N/mm^2.

To overcome this disadvantage, it makes sense to grade each species **direct to a strength class** (ie using the threshold value of the strength class) so that a proportion of Douglas fir that was graded MSS (ie assigned SC3) can now be graded direct to SC4; those specimens not classed as good enough for SC4 will be graded direct to SC3 or reject assuming that the selected class combination in this case is SC4/SC3/reject.

In 1994, Eurocode 5 was produced and issued by CEN (European Committee for Standardisation). At the same time the strength class system that supports the Eurocode was introduced. These strength classes and their associated properties are specified in BS EN 338 and range from C14 (the weakest) to C40 (the strongest) for coniferous species; intermediate values are C16, C18, C20, C22, C24, C27, C30, and C35.

Referring back to visual grading, it should be noted that the current version of BS 5268-2, Table 2, shows that the softwood species and UK grade combinations are attributed to the CEN strength classes. For example, SS grade British grown Sitka spruce is equivalent to C18, and GS grade imported redwood or whitewood is equivalent to C16.

Trial grading machine settings for some classes were established for certain species where, for example, the number 24 for C24 is equivalent to the characteristic strength value † for the class. However for various technical reasons, the trial settings and their respective commercial yields were not as expected when based on their supposed equivalence to the commonly specified BS strength classes (ie SC5, SC4 etc).

As an intermediate measure (since 1996) the CEN strength classes are specified in BS 5268-2:2002 with permissible stress values (not characteristic values) associated with each class. (With BS 5268-2:1991, the British Standard strength classes were listed with the appropriate permissible stress values.) For example, Table 8 in BS 5268-2:2002 lists C16 with a permissible stress in bending of 5.3 N/mm^2 which is the same stress as for SC3 in Table 9 of BS 5268:1991.

Since 1997, therefore, a parcel of timber (of a given species) graded to C16 (BS 5268:2002 specification) should have the same yield as that parcel would have had if graded to SC3.

When the BS EN 338 specification for strength classes becomes mandatory and BS 5268 specifications are replaced, some changes in settings, and therefore yields, will occur. At C16 and C27 levels this might be small, but will be more noticeable at C24 level.

† Characteristic strength value is directly derived from the 5th percentile value of the strength distribution.

History of visual and machine grades

The publication of BS 4978:1973 introduced the two, still current, visual grades, SS (Special Structural) and GS (General Structural), which are based on the 'knot area ratio' visual grading system. The permissible strength values associated with these grades are derived by laboratory testing in-grade (ie already graded SS or GS) structural sizes. The SS and GS grades are roughly equivalent to 55% and 35% strength ratios which means, for example, that a specimen of timber graded SS might contain a defect that will, at worst, reduce the strength by 45% relative to the strength of an equivalent clear (ie defect-free) specimen. At the same time the machine equivalents of SS and GS, namely, MSS and MGS were referenced in BS 4978:1973

As well as MSS and MGS, two other machine grades had been introduced earlier in 1971, namely M75 and M50. **All four machine grades were superseded in 1996**.

The number of specified stress grades and species that were available in the late 1970s, both imported and British grown, meant that the task of specifying timber for structural use was becoming more complicated. To ease the situation the relevant code committee decided to incorporate a strength class system into the revision of CP 112-2 under its proposed new British Standard, BS 5268-2.

Derivation of settings

The basic bending type machines require the determination of a value of Eplank, E_p, corresponding to a desired bending stress level, as a joist, for the grade or strength class. E_p is a modulus of elasticity measured as a plank over a span of 900 mm with a centre point load.

The first stage requires the statistical relationship between the bending strength as a joist and the modulus of elasticity as a plank (ie E_p). This can only be achieved by carrying out destructive testing to determine bending strength and is consequently time consuming work carried out in a test laboratory.

Figure 3 illustrates a plot of bending strength (modulus of rupture) against flatwise modulus of elasticity. Each point on the plot represents the result of two values. The first value is the result of a strength test of a joist with a weak point from which a failure stress is calculated; this is plotted on the vertical axis. The second value is the reading from the grading machine (load or deflection type) and this reading will correspond to the location (along the length) of the failure point in the strength test; this is plotted on the horizontal axis.

The line drawn through the middle of the points is called the mean regression line. From this is constructed a line below which only a percentage level of the results should fall. The level is normally 5% and is called the 5th percentile exclusion line.

A factor is then applied to this line to allow for duration of load (all test values of strength are short term test values) which includes a factor of safety. The overall value for this factor is 2.45. The line is called the **grade stress line** (Figure 9).

From the grade stress line, values of E_p on the horizontal axis are determined for the required bending stress level, on the vertical axis, which is traditionally the permissible stress for the grade. Similar procedures apply for the CEN strength class required-stress levels, whether they are to the British Standard specification (which is based on permissible stress) or to the European specification (which is based on characteristic stress).

Having determined the limiting value of E_p for each grade or strength class for each species, which is also dependent on the combination being graded, the value of the particular **indicating parameter** for each type of machine is calculated. For bending machines this is a value of load or deflection and the value that the operator inputs to the control terminal of the grading machine.

On a more general point, the better the correlation between bending strength and E_p, the closer all the points will be to the mean line; hence the strength prediction is improved. This means that the 5th percentile line moves closer to the mean line and can become slightly steeper, and E_p values become less for each strength class. It also allows more pieces into the strength class, therefore improving yields in the upper strength class and reducing the reject rate.

In order to build up sufficient data for carrying out regression analysis (Figure 3), the European Standard covering machine grading requires a minimum number of test specimens. For a new species using an existing type of machine, 450 specimens in 3 sizes are required. The results from the different sizes are pooled together, and strength values are adjusted to a standard datum width (ie in the case of a joist, depth) and to a moisture content of 15% for analysis purposes. E_p values are adjusted to a standard thickness for pooling and regression analysis purposes, and are adjusted to 18% moisture content. This is the moisture at which dry grading should be carried out. The establishment of a settings model for a new machine would require a minimum of 900 specimens.

Because current methods of determining settings are required to cope with the various combinations of strength class that are likely to be graded in commerce (eg C27/C18/reject, C27/C16/reject, C24/C16/reject and C16/reject), the resulting E_p value for the same strength class can be different depending on the combination being graded. The subject is covered in the next section.

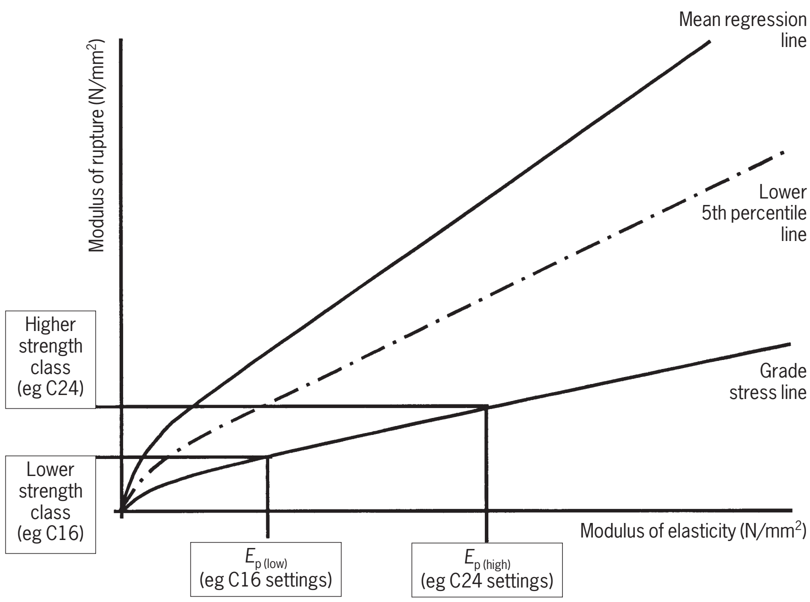

Figure 9 Modulus of rupture against modulus of elasticity, E_p, showing the construction of the grade stress line

Strength class combinations

Figure 3 shows the less than perfect degree of correlation between modulus of rupture (MoR) and E_p. This shows itself in Figures 11 and 12 as an overlap in strength distribution between pieces graded into the higher strength class and those graded into the lower strength class. The amount of overlap depends on the degree of separation between the two E_p limits on the horizontal scale.

In the early days of machine stress grading, the method used by the computer model to generate machine settings only had to deal with either M75/M50 or MSS/MGS and no other combinations. With the introduction of the strength class system, the method had to be adapted and refined to cope with the various combinations that were likely to be graded (eg SC5/SC4, SC5/SC3 and SC4/SC3). This was later adapted for the CEN strength classes (eg C27/C18 and C24/C16).

There is, however, a small penalty to be paid by having this flexibility. The closer the strength class boundaries, the greater the interaction between the MoR distributions and the greater the effect on the 5th percentile strength value of the graded sample.

To allow for this, the E_p values, and therefore the setting values, are not calculated directly from the line linking bending strength to E_p, but they have to be modified to allow for the degree of separation between two adjacent strength classes (usually called the bandwidth).

This bandwidth effect can be illustrated by the example which follows and by Figures 10, 11 and 12 on Page 10.

Figure 10 shows the distribution of bending strength for ungraded timber of one cross-sectional size for a particular species – say 520 pieces in number. Referring now to Figure 11, if this material is graded to a single low value strength class, say C16 using an E_p value of E_1, the result might be 500 pieces; the characteristic strength will be the strength of the 25th weakest piece of what is a relatively large distribution containing the strongest pieces. (Characteristic strength is equivalent to the ranked 5th percentile; ie the 25th ranked strength value of the 500 pieces.)

Referring to Figure 12, if the same specimens are graded to C24 and C16 in the same pass, then some of the pieces previously graded to C16 will be graded into C24. This impoverishes the C16 distribution and the 5th percentile strength value of those remaining in C16 will fall.

If, for instance, 360 specimens are graded into C24, leaving 140 remaining in the C16 distribution then, using E_1 as the limit for C16, the 5th percentile value becomes the 7th weakest piece of 140 generally inferior pieces – certainly devoid of the strongest specimens.

To maintain the C16 strength level means that the settings for C16 have to be increased from E_1 to, say, E_2. The consequence of raising the E_p value from E_1 to E_2, and also the setting values, means the yield of C16 will now drop from 140, the weakest pieces having been removed and now classed as reject. The reject rate obviously increases.

Variations of this principle apply to comparisons between, for instance, C27/C16 and C24/C16 again where C16 settings are different for the same species and cross-sectional size. The same applies to C24/C16 and C24/C14 where C24 settings can be surprisingly different for the same species and size.

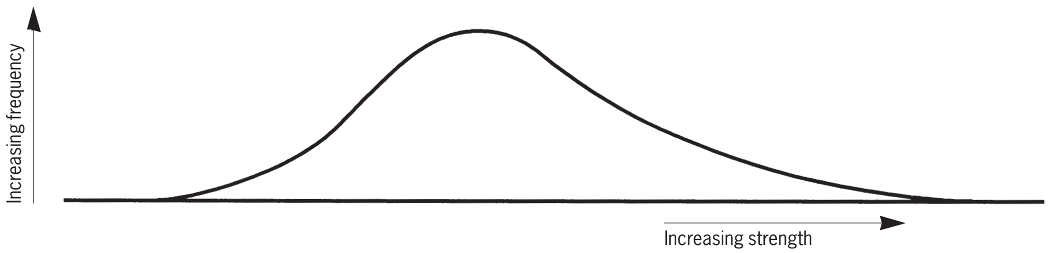

Figure 10 Distribution of bending strength for ungraded timber representing one species

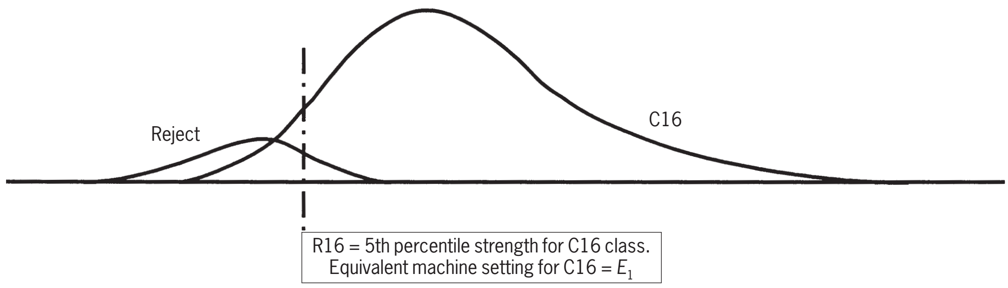

Figure 11 Distribution of bending strength for a single grade or strength class and rejected material

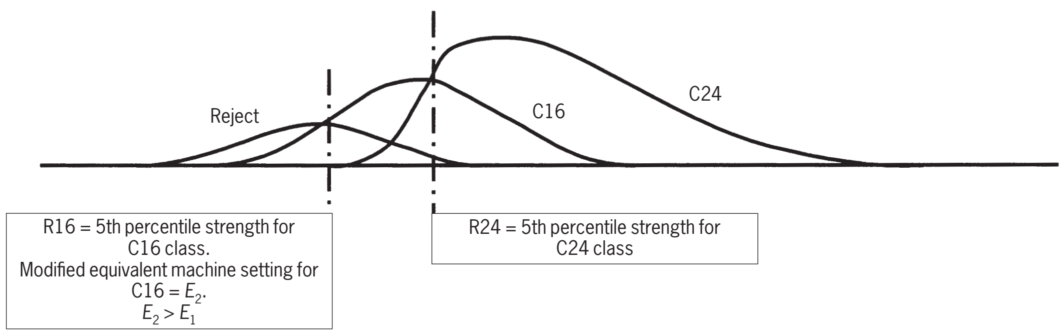

Figure 12 Distribution of bending strength for a graded combination and rejected material

Machine regrading

As stated in the feature box aside, timber must be regraded if the size reductions through timber processing exceed certain limits. The timber should be regraded to the original strength class combination.

As can be seen from Figures 11 and 12, there is a degree of overlap between strength class distributions which obviously depends on the interaction between species and strength class boundaries, and also on individual samples within the species.

Knowing, for example, that some C14 specimens are strong enough for C16, there can be the temptation to regrade C14 material (which has been produced from grading C24/C14) to C16 in order to increase the quantity of a more marketable strength class (ie C16).

However the settings for C16/reject were developed knowing that the C16 distribution contained a sufficient number of strong pieces to balance out the weaker specimens therefore maintaining the 5th percentile level of the distribution.

Although the specimens regraded to C16 might appear to be strong enough as indicated by the grading machine, the preselection process (eg grading to C24/C14/reject) has removed many if not all the stronger specimens. This will leave the C16 distribution impoverished at the top end and means that the resulting 5th percentile of the distribution will be too low.

Other aspects also to be considered are that edgewise modulus of elasticity (of the joist, not the plank) and density have to meet the strength class specification.

Regrading in an attempt to improve the classification of timber specimens is therefore not permitted.

In a similar vein it can be tempting to try to regrade reject material from, say, the C24/C16/reject combination to C16 knowing that the C16 settings in the C16/reject combination are less onerous than the C16 settings in the C24/C16/reject combination.

However the less onerous settings for C16 in the C16/reject, as already stated, were developed knowing that the C16 distribution contained numerous strong pieces to balance out the weaker ones, so maintaining the 5th percentile.

This clearly is not the case for the reject distribution from C24/C16/reject. Any reject material from this combination that could qualify for C16 on the basis of exceeding the C16 setting in the C16/reject combination – and there would be a reasonable percentage – would represent only the bottom end of the C16 distribution in Figure 11 and will therefore reduce the 5th percentile to an unacceptably low level.

Again, regrading to improve the classification of timber by trying to take advantage of less onerous settings for the same strength class is not permitted.

General requirements and limitations for machine strength grading of timber

- Machine stress grading only applies to approved softwood species. Information concerning approved species, both British grown and imported, and the appropriate machine settings produced by BRE, are held by the UKTGC Technical Secretariat.
- Machine stress grading operations should be only carried out by personnel and grading companies under the supervision of a certification body.
- The current British Standard covering the machine stress grading of timber in the UK, and for grading machine operations abroad but running under the control of UK certification bodies, is BS EN 519: 1995. The latest draft European Standards are prEN 14081-1:2000, prEN 14081-2 and prEN 14081-3 and by prEN 14081-4 now being prepared.
- For dry grading, the mean moisture content of a batch of timber should be 20% with no pieces exceeding 24%.
- The requirements in BS EN 519 for fissures and distortion of a batch of timber being stress graded apply only to dry-graded timber.
- The timber sizes shall meet the requirements of BS EN 336 including one of the two tolerance classes, and for machine grading shall have a minimum finished size of 35 mm thick and 60 mm wide.
- If the machine grading has been carried out before planing, provided that the processing reduction is not greater than 3 mm from the target size, nor greater than 5 mm from the target size for dimensions over 100 mm, the grade shall not be considered to have changed. If the reduction is greater, the timber shall be regraded.
- If the marking or stamping is removed by planing, the timber shall be re-marked or restamped with its original mark or stamp.
- Visual override limits for non-fully machine graded portions of timber only apply where the size of knots or degree of slope of grain exceeds the extent of similar characteristics in the fully graded portion of the same piece. Non fully-machine-graded portions extend to 460 mm from each end in the case of the Cook-Bolinder machine and 470 mm for the Computermatic machine.
- Machine grading of green timber is permitted. However this will result nearly always in a loss of yield, for a given strength class, compared with dry grading the same material.
- Regrading to improve the classification of timber specimens (eg reject to C14 or C16) is not allowed.

Acknowledgements

BRE thank the following for commenting on the contents of this Digest at its draft stage:

Gordon Callendar of James Callendar & Son Ltd;

David Mills of BSW Sawmills Ltd;

Francis Wilbur of James Jones & Co Ltd;

David Wood of A W Jenkinson & Co Ltd; and Gordon Waugh of Charles Ransford & Son Ltd.

The project was funded by the Forestry Commission.

References

British Standards

BS 4978:1996 Specification for visual strength grading of softwood

BS 5268-2:1996 Structural use of timber. Code of practice for permissible stress design, materials and workmanship

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

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

BS EN 338:1995 Structural timber. Strength classes

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

European Standards (draft)

prEN 14081-1 Timber structures. Strength graded structural timber with rectangular cross section. General requirements

prEN 14081-2 Timber structures. Strength graded structural timber with rectangular cross section. Machine grading. Additional requirements for initial type testing

prEN 14081-3 Timber structures. Strength graded structural timber with rectangular cross section. Machine grading. Additional requirements for factory production control

prEN 1995-1-1 Eurocode 5. Design of timber structures. General rules. General rules and rules for buildings

prEN 1995-1-2 Eurocode 5. Design of timber structures. General rules. Structural fire design

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Published by BRE Bookshop,
151 Rosebery Avenue,
London EC1R 4GB
Tel: 020 7505 6622
Fax: 020 7505 6606
email: brebookshop@emap.com

April 2003
ISBN 1 86081 620 7

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www.bre.co.uk