SLOVENSKI STANDARD
SIST EN 14081-2:2006

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Nadomeģ a:
SIST EN 518:1996
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Lesene konstrukcije - Razvrģ anje konstrukcijskega lesa s fazonskimi kosi po trdnosti - 2. del: Strojno razvrģ anje; dodatne zahteve za za etni preskus proizvodnje

Timber structures - Strength graded structural timber with rectangular cross section - Part 2: Machine grading; additional requirements for initial type testing

Holzbauwerke - Nach Festigkeit sortiertes Bauholz für tragende Zwecke mit rechteckigem Querschnitt - Teil 2: Maschinelle Sortierung, zusätzliche Anforderungen an die Erstprüfung

Structures en bois - Bois de structure de section rectangulaire classé selon la résistance - Partie 2: Classement mécanique - Exigences supplémentaires concernant les essais de type initiaux

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EUROPEAN STANDARD

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This European Standard was approved by CEN on 26 August 2005.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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Foreword

This European Standard (EN 14081-2:2005) has been prepared by Technical Committee CEN/TC 124 “Timber structures”, the secretariat of which is held by SFS.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2006, and conflicting national standards shall be withdrawn at the latest by August 2007.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

This European Standard supersedes EN 518:1995 and EN 519:1995.

Other parts of this European Standard are:

EN 14081-1 Timber structures – Strength graded structural timber with rectangular cross section – Part 1: General requirements,

EN 14081-3 Timber structures – Strength graded structural timber with rectangular cross section – Part 3: Machine grading; additional requirements for factory production control,

EN 14081-4 Timber structures – Strength graded structural timber with rectangular cross section – Part 4: Machine grading; grading machine settings for machine controlled systems.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

Introduction

Machine grading is in common use in a number of countries. The countries use two basic systems, referred to as ‘output controlled’ and ‘machine controlled’. Both systems require a visual override inspection to cater for strength-reducing characteristics that are not automatically sensed by the machine.

The output-controlled system is suitable for use where the grading machines are situated in sawmills grading limited sizes, species and grades in repeated production runs of around one working shift or more. This enables the system to be controlled by testing timber specimens from the daily output. These tests together with statistical procedures are used to monitor and adjust the machine settings to maintain the required strength properties for each strength class. With this system it is permissible for machine approval requirements to be less demanding and for machines of the same type to have non-identical performance.

The machine controlled system was developed in Europe. Because of the large number of sizes, species and grades used it was not possible to carry out quality-control tests on timber specimens drawn from production. The system relies therefore on the machines being strictly assessed and controlled, and on considerable research effort to derive the machines settings, which remain constant for all machines of the same type.

The acceptability of grading machines and the derivation of settings rely on statistical procedures and the results will therefore depend on the method used. For this reason this document gives appropriate statistical procedures.

The requirements in this European Standard are based on machines in current use and on future types of machines as far as these can be foreseen. It is recognised that additional clauses or standards may be required if unforeseen developments take place.

1 Scope

This European Standard specifies requirements, additional to those in EN 14081-1, for initial type testing of machine graded structural timber with rectangular cross-sections shaped by sawing, planing or other methods, and having deviations from the target sizes corresponding to EN 336. This includes requirements for strength grading machines and test equipment for proof loading graded material, and optional requirements for control planks to test the dynamic performance of grading machines.

2 Normative references

The following referenced documents are indispensable for the application of this European Standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 338, *Structural timber — Strength classes*

EN 384, *Structural timber — Determination of characteristic values of mechanical properties and density*

EN 408:2003, *Timber structures — Structural timber and glued laminated timber — Determination of some physical and mechanical properties*

EN 14081-1:2005, *Timber structures — Strength graded structural timber with rectangular cross section — Part 1: General requirements*

EN 14081-3, *Timber structures — Strength graded structural timber with rectangular cross section — Part 3: Machine grading; additional requirements for factory production control*

3 Terms and definitions

For the purpose of this European Standard, the terms and definitions given in EN 14081-1:2005, and the following apply.

3.1
characteristic strength
population 5-percentile value obtained from the results of tests with a duration of 300 s ± 120 s using test pieces at an equilibrium moisture content resulting from a temperature of 20 °C and a relative humidity of 65 %

3.2
characteristic stiffness
population mean value obtained under the same test conditions as defined in 3.1

3.3
critical feed speed
speed within the intended usable range at which the grading machine is least accurate in measuring its indicating property

3.4
depth
dimension perpendicular to the longitudinal axis of a timber beam, in the plane of the bending forces

3.5
grade determining property
mechanical or physical property for which a particular value of that property has to be achieved for the material to be assigned to that grade, e.g. bending strength, mean modulus of elasticity and density for the strength classes of EN 338

3.6
indicating property
measurement or combination of measurements made by the grading machine, which are closely related to one or more of the grade determining properties. For grading machines which compute and predict values of the grade determining properties directly from numerous measuring devices, the indicating property may be a predicted value of a grade determining property

3.7
optimum grade
highest grade, of those for which settings are required, to which a piece of timber can be assigned, such that the grade determining properties of the graded sample will meet the values required for the grade

3.8
settings
values of the parameters used to set the machine to grade timber, which are mathematically related to the indicating property

3.9
sub-sample
number of specimens of timber of one species or species combination, from one growth area or source of production

3.10
thickness
lesser dimension perpendicular to the longitudinal axis of a piece of timber

4 Symbols

b	width of cross section (in mm)
E	theoretical modulus of elasticity (in N/mm^2)
E_p	actual modulus of elasticity measured in a proof load test (in N/mm^2)
$E_{assigned}$	mean modulus of elasticity for assigned grade (in N/mm^2)
$E_{optimum}$	mean modulus of elasticity for optimum grade (in N/mm^2)
$E_{0,mean}$	characteristic mean modulus of elasticity parallel to grain (in N/mm^2)
F	applied force (in N)
F_p	proof load (in N)
$f_{m,k}$	characteristic bending strength (in N/mm^2)
f_p	proof stress (in N/mm^2)
h	depth of cross section (in mm)
k_h	size factor

ℓ span (in mm)

t thickness (in mm)

w deflection or deformation (in mm)

β_{ach} achieved safety index

β_{tar} target safety index

δ deflection (in mm)

μ mean value of bending strength for the optimum or assigned strength classes (in N/mm^2)

5 Requirements for strength grading machines

5.1 The machine shall be of a type that meets the requirements given in Clauses 5 and 6 if it is part of a machine controlled system, or Clauses 5 and 7 if it is part of an output controlled system. It shall be installed and set up according to the manufacturer's specification and to any additional requirements resulting from the tests given here. In addition, the installation and calibration may be checked by the use of control planks meeting the requirements given in Annex C of this document, using the procedures given in EN 14081-3.

5.2 The following information shall be provided in the manufacturer's specification for the machine:

a) specification and description of the mechanical and electrical operation of the machine, and the software (this includes information on data processing such as smoothing of the output signals) used by the machine to grade timber;

b) range of environmental conditions under which the machine will operate;

c) installation, maintenance and operating instructions;

d) method, extent and frequency of calibration procedures, including the use of control planks if applicable;

e) species populations, sizes, tolerances, surface finish, moisture content, grades, environmental operating temperature range, throughput speed, and limits of warp of the timber to be graded;

f) manufacturing tolerances of the machine;

g) checking and adjustment procedures for all components that may affect the machine's grading accuracy.

5.3 Manufacturing tolerances and transducer accuracy tolerances shall ensure that production machines meet the requirements of this European Standard, and are compatible with grade settings derived for the machine type.

5.4 The grading machine shall not damage the timber during the grading operation to an extent that it affects the intended use of the timber.

NOTE For example, in bending type machines, damage should not be caused by large compression perpendicular to grain stresses and/or large bending stresses.

5.5 Grading machines whose indicating property does not take account of the material properties along the whole length of each piece of timber, but whose indicating property measurements are influenced by strength reducing characteristics away from the measuring position (as in bending type machines), shall measure the indicating property to within 800 mm of each end of the piece of timber. Where the indicating property is influenced only by strength reducing characteristics at the measuring position (as in radiation type machines), the measurements shall be made to within 150 mm of each end.

5.6 The grading machine shall be capable of comparing each indicating property measurement with pre-set boundary settings, which correspond to individual grades, and of marking each piece of timber according to the lowest grade sensed within the length of that piece.

5.7 The infeed and outfeed equipment shall provide the correct height and angle of entry/exit for the timber to/from the grading machine and shall not interfere significantly with the sensing of the indicating property, even when the timber is distorted within the limits given in item e) of 5.2. If the infeed and outfeed equipment is not part of the grading machine then this requirement shall appear in the manual for the machine.

5.8 The grading machine shall be fitted with the means to enable the accuracy of each measuring device to be checked individually, to ensure correct operation of the machine.

6 Additional initial type testing for machine controlled systems

6.1 General

For machine controlled systems the acceptance of machine graded timber to meet the requirements of this European Standard predominantly depends on the grading machine and the settings used.

6.2 Requirements for the derivation and verification of machine settings

6.2.1 When a new species is required to be graded by a machine that has already been shown to meet the requirements of this European Standard, those requirements that are not likely to be affected by species differences may be disregarded for the new species.

NOTE Annex B gives background information and guidance on the procedure required here to derive grading machine settings.

6.2.2 The total test sample shall be selected as a minimum number of four sub-samples (see 3.9), to represent the range of timber for which the settings will be applicable (see 5.3.2 in EN 14081-1:2005). The minimum number of pieces in a sub-sample shall be 100. The minimum number of pieces in the total test sample shall be 900 for the derivation of settings for a grading machine and the full range of sizes and grades. To derive settings for new species for a machine that has previously met the requirements of this European Standard with different species, a minimum of 450 pieces are required.

The number of pieces in the total sample shall ensure that there are a minimum number of 20 pieces in each assigned and optimum grade for which settings are required.

NOTE 1 If more than two grades are to be graded in one pass then it may be necessary to increase the number of pieces up to 400 pieces per grade.

The timber shall represent the timber source (see 5.3.2 and 5.3.3 in EN 14081-1:2005), range of sizes, and quality that will be graded in production (with the exception of 6.2.2 c) below), with the most demanding surface finish, and grading shall be carried out at the critical feed speed. It is acceptable for machines not to measure density, but density as a grade determining property shall be checked in accordance with 6.2.5. The grade determining properties shall be measured in accordance with EN 384.

NOTE 2 The grade determining properties for meeting the requirements of EN 338 are bending strength, MOE and density. For other grades the grade determining properties may be different.

If a grading machine does not detect certain strength reducing characteristics in timber, and those characteristics are not detected by visual override inspection or other procedures, care shall be taken to ensure that those characteristics are present in the test sample in the same proportions as will exist in production. Mention of such characteristics shall also be made in the report on the approval tests to ensure that they are taken into account when settings are required for other species.

The number of pieces shall be influenced by the following:

a) number of grades and sizes to be graded. At least three sizes shall be tested.

b) level of the grades.

NOTE 3 Grades with very high critical properties, e.g. above strength class C30, should require more test data because errors in the model will be more significant.

c) strength and/or stiffness requirement for the strength class to be graded compared to the grade determining property range within the sample. Where the characteristic properties of almost all the timber sample meet the requirements for the grade being tested, the grades assigned by the grading machine have little chance of being in error. Where possible, a greater quantity of weaker material of the same species shall be included in the sample to ensure that the grading machine is making valid decisions when assigning timber to grades (see 6.2.5).

d) number of sensing devices used by the machine and the complexity of the model.

NOTE 4 A simple regression model based on one independent variable is likely to require less data than a complex neural network model involving a number of sensing devices.

e) Similarity of the species being considered to other species already graded by that type of grading machine.

6.2.3 For each species, the effect of the variables given in 6.2.2 (where relevant) on the indicating property shall be established (interpolation is permitted), and used to develop the mathematical model relating the machine's indicating property to the grade determining properties. For this purpose sub-samples may be taken from the sample required for 6.2.2. The effect of variables which are not dependent on the particular population of timber may, after establishing the effect on one species, be used for other species. The model may include variables such as size and moisture content, or the model may be determined from the data after adjusting the properties for such variables.

6.2.4 Settings may be derived to grade one or more grades in one pass.

6.2.5.1 The parameters of the model and resulting settings shall be verified for all species and grade combinations, using the procedure below. Having verified the settings for particular sizes, species (or species combinations) and grade combinations, settings for other sizes may be derived directly from the model, where the model contains such adjustments.

6.2.5.2 All sub-samples of timber referred to in 6.2.2 shall be passed through the machine to record the indicating property values for each piece, and then tested to obtain values of the grade determining properties in accordance with EN 384.

6.2.5.3 The indicating property values and grade determining property values shall be adjusted to the same timber size unless size is included in the mathematical model.

6.2.5.4 All the pieces shall be sorted on the basis of the grade determining properties into the highest possible grades for which settings are required, such that they meet the required values for the grade (including use of the factor k_v in EN 384), using the following procedure. The grade so determined for each piece is its optimum grade.

a) required characteristic values shall be determined. These shall be taken from EN 338 or may be as required for special grades.

b) modified required characteristic values shall be determined by applying the k_v factor from EN 384 and the 95 % factor on $E_{0,mean}$ from EN 338 where applicable.

c) test data shall be adjusted to a common moisture content.

d) For each grade to be graded together, beginning with the highest grade, the following procedure shall be repeated:

1) adjusted bending strength values (or other major grade determining property) shall be ranked and the maximum number of pieces that meet the modified required characteristic value assigned to the grade;

2) for modulus of elasticity and density (or other grade determining properties) such that each piece is assigned to a grade, not necessarily the same one, for each of the grade determining properties;

3) grade assignments for the grade determining property that resulted in fewest pieces being assigned to the grade shall be selected;

4) those pieces shall be checked to ensure that all other required characteristic properties are met. If they do, then those pieces shall be assigned to that grade as their optimum grade, and the procedure repeated from d.1) for the next highest grade using the remaining pieces;

5) if not, the procedure shall be repeated from d.1) using just the pieces selected previously under d.3).

6.2.5.5 Settings for each sub-sample shall be determined from model parameters derived from all other sub-samples.

NOTE For example, if there are 8 sub-samples then the settings for sub-sample 1 are determined from sub-samples 2 to 7.

The production settings shall be calculated as the mean value of the settings for all sub-samples. If this is more than 15 % different from the most conservative sub-sample setting, then the production setting shall be that sub-sample setting adjusted by 15 % towards the mean value.

The production settings shall then be used to grade each piece according to its indicating property value. These grades are known as assigned grades.

6.2.5.6 A size matrix giving the numbers of pieces in each of the optimum and assigned grades shall be determined for the total sample.

NOTE Table 1 is an example of where a machine is required to grade C35, C27 and C22 in one pass.

Table 1 – Example: Size matrix

Optimum grade	**Assigned grade**			
	C35	C27	C22	Reject
C35	207	32	16	2
C27	10	168	12	1
C22	4	13	84	2
Reject	0	2	2	24

6.2.5.7 A global cost matrix shall be determined with the value in each cell equal to the number of pieces in each cell in the size matrix multiplied by the value in the equivalent cell of Table 2 divided by the total number of pieces in the assigned grade.