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Structural timber — Determination of characteristic values of mechanical properties and density

bsi.

National foreword

This British Standard is the UK implementation of EN 384:2016. It supersedes BS EN 384:2010 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee B/518, Structural timber.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Structural timber - Determination of characteristic values of mechanical properties and density

Bois de structure - Détermination des valeurs caractéristiques des propriétés mécaniques et de la masse volumique

Bauholz für tragende Zwecke - Bestimmung charakteristischer Werte für mechanische Eigenschaften und Rohdichte

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

Page

European foreword

This document (EN 384:2016) has been prepared by Technical Committee CEN/TC 124 “Timber structures”, the secretariat of which is held by AFNOR.

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of an identical text or by endorsement, at the latest by February 2017, and conflicting national standards shall be withdrawn at the latest by February 2017.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 384:2010.

Compared to EN 384:2010, the following modifications have been made:

— the definitions have been revised;

— the adjustments of test results to the reference moisture content are presented as equations;

— the equations for determining other properties from properties derived by testing have been changed;

— regarding the determination of 5 %-percentiles the standard has been adopted to the revised EN 14358;

— the procedure for verification of a lot has been transferred to EN 14358.

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

Introduction

Structural design codes can only function effectively if standard methods of determining the mechanical and physical properties exist. The aim of the procedures given in this standard is to derive characteristic values that are comparable in terms of the populations they represent. The standard permits the use of as much existing test data as possible from various sampling and testing techniques.

Where methods are given to permit characteristic values to be determined from a less than ideal amount of structural size test data, reduction factors to reflect a lower degree of confidence are employed.

1 Scope

This European Standard gives a method for determining characteristic values of mechanical properties and density, for defined populations of visual grades and/or strength classes of machine graded structural timber. Additionally it covers the stages of sampling, testing, analysis and presentation of the data.

The standard provides methods to derive strength, stiffness and density properties for structural timber from tests with defect-free specimen.

The values determined in accordance with this standard for mechanical properties and density are suitable for assigning grades and species to the strength classes of EN 338.

NOTE 1 For assigning grades and species to the strength classes in EN 338 only three properties, i.e. bending or tension strength, modulus of elasticity parallel to grain in bending or tension and density need to be determined from test data, other properties can be calculated according to Table 2.

NOTE 2 EN 1912 gives examples of established visual grades assigned to strength classes.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 408, *Timber structures — Structural timber and glued laminated timber — Determination of some physical and mechanical properties*

EN 13183-2, *Moisture content of a piece of sawn timber — Part 2: Estimation by electrical resistance method*

EN 13183-3, *Moisture content of a piece of sawn timber — Part 3: Estimation by capacitance method*

EN 14081-1:2016, *Timber structures — Strength graded structural timber with rectangular cross section — Part 1: General requirements*

EN 14081-2, *Timber structures — Strength graded structural timber with rectangular cross section — Part 2: Machine grading; additional requirements for initial type testing*

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

EN 14358:2016, *Timber structures — Calculation and verification of characteristic values*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
characteristic value
representative value of a material property used for design, which is based either on 5-percentile values (e.g. strength properties and density) or mean values (e.g. modulus of elasticity)

3.2
***p*-percentile**
value for which the probability of getting lower values is p %

3.3
population
timber for which the characteristic values are relevant

3.4
timber source
identifiable geographical origin of a species or species combination from which timber is, or is intended to be, strength graded

3.5
sample
a number of ungraded specimens of one timber species or species combination, one source, with sizes and quality representative of the timber population (see 5.1)

3.6
sub-sample
part of one or more samples consisting of specimens of one grade

3.7
small clear test
test to determine mechanical properties of small defect-free specimens

3.8
specimen
piece of timber from which the test piece is taken

3.9
thickness
lesser dimension perpendicular to the longitudinal axis of a piece of timber

3.10
width
larger dimension perpendicular to the longitudinal axis of a piece of timber

3.11
depth
in the case of bending, cross-sectional dimension parallel to the direction of loading; in the case of tension, the width

4 Symbols and abbreviations

a_f	distance between the inner load points of the bending test (in mm)
E_0	modulus of elasticity parallel to grain (in N/mm^2)
$E_{0,mean}$	mean characteristic value of modulus of elasticity parallel to grain (in N/mm^2)
$E_{0,k}$	5-percentile characteristic value of modulus of elasticity parallel to grain (in N/mm^2)
$E_{90,mean}$	mean characteristic value of modulus of elasticity perpendicular to grain (in N/mm^2)
$\overline{E}_i$	mean modulus of elasticity for one sub-sample (in N/mm^2)

$\overline{E}_{i,min}$	lowest mean modulus of elasticity of all sub-samples (in N/mm²)
$E_{m,global}$	global modulus of elasticity in bending (in N/mm²)
$E_{m,local}$	local modulus of elasticity in bending (in N/mm²)
f	strength property
$f_{c,0,k}$	5- percentile characteristic value of compression strength parallel to grain (in N/mm²)
$f_{c,90,k}$	5- percentile characteristic value of compression strength perpendicular to grain (in N/mm²)
f_k	5- percentile characteristic value of strength (in N/mm²)
$f_{m,k}$	5- percentile characteristic value of bending strength (in N/mm²)
$f_{t,0,k}$	5- percentile characteristic value of tension strength parallel to grain (in N/mm²)
$f_{t,90,k}$	5- percentile characteristic value of tension strength perpendicular to grain (in N/mm²)
$f_{05,i}$	5-percentile value for each sub-sample (in N/mm²)
$f_{05,i,min}$	lowest 5-percentile value of all sub-samples (in N/mm²)
$f_{v,k}$	5- percentile characteristic value of shear strength (in N/mm²)
G_{mean}	mean characteristic value of shear modulus (in N/mm²)
h	depth (in mm)
k_h	factor for adjusting *f* when h is not 150 mm
k_l	factor for adjusting *f* when test span is not 18 h
k_n	factor to adjust for the number of sub-samples
k_v	factor to allow for the lower variability of f_{05} values between sub-samples for machine grades in comparison with visual grades
ℓ	span (in mm)
ℓ_{et}	effective length for the test (in mm)
n	total number of specimens
n_i	number of specimens in a sub-sample
n_s	number of sub-samples
u	moisture content (in %)
u_{ref}	reference moisture content, normally at 12 %
ρ	density (in kg/m³)
ρ_{mean}	mean density (in kg/m³)
ρ_k	characteristic density (5-percentile) (in kg/m³)
$\rho_{05,i}$	5-percentile density for a sub-sample (in kg/m³)
$\rho_{05,i,min}$	lowest 5-percentile density of all sub-samples (in kg/m³)

5 Mechanical properties determined from full-size specimens

5.1 Sampling

The sampling shall be representative of the population.

Any known or suspected difference in the mechanical properties of the population due to e.g. sawmills, tree size, countries or silviculture shall be represented within the sampling by a similar proportion to their frequency in the population. This shall be the major influence in determining the number and size of samples.

Samples shall be selected from one source of timber and shall be graded visually or by machine to sub-samples according to the requirements given in EN 14081-1.

For visual grading, each sub-sample shall consist of at least 40 specimens and be of one source.

For bending and tension parallel to grain tests, specimens shall have a sufficient length so that critical defects can be located in the critical test zone (see 5.2). A length of at least 30 times the depth or 3.6 m whichever is the lesser meets this requirement.

For the determination of strengths perpendicular to the grain and shear strength clear specimens shall be sampled.

5.2 Testing

Testing shall be carried out in accordance with EN 408 for strength, modulus of elasticity, density and moisture content. For bending parallel to grain, tension parallel to grain or modulus of elasticity, a critical section shall be selected in each piece of timber. This section is the position at which failure is expected to occur and therefore determines the grade for that piece. For bending the tension edge shall be selected at random. Whenever possible the critical section shall be placed inside the inner load points in a bending test or between the jaws in a tension test (centrally if possible). If this is not possible, the second most critical section shall be tested and determines the grade for that piece.

Existing historical data (before 1995) from different test methods or moisture conditions are acceptable provided sufficient information exists to adjust the results to the reference conditions given in 5.3.

5.3 Reference conditions

5.3.1 Moisture content

The reference moisture content shall be consistent with a temperature of 20 °C and 65 % relative humidity.

NOTE For most timber species this corresponds to a moisture content of about 12 %.

For specimens not tested to failure, the moisture content of each specimen is permitted to be determined from EN 13183-2 or EN 13183-3.

5.3.2 Bending strength

The reference condition corresponds to bending to a depth of 150 mm and to the standard test set-up proportions of third point loading with an overall span of 18 times the specimen depth.

5.3.3 Tension strength

The reference condition corresponds to a depth of 150 mm.

5.3.4 Density

Density is determined on small defect-free prisms according EN 408.

For specimens not tested to failure, the density of each specimen is permitted to be determined from the mass and volume of the test piece and adjusted to the density of the small defect-free prisms, by dividing by 1,05 in case of softwood. For hardwood no adjustment is necessary.

Adjustment for moisture content may also be necessary.

5.4 Adjustment factors

5.4.1 General

Test results shall be adjusted, piece by piece, to the standard reference conditions as given in 5.3.

If historical data (before 1995) is being used and records for individual specimen are incomplete, sub-sample 5-percentile or mean value shall be adjusted.

5.4.2 Moisture content

Test values for compression parallel to the grain, modulus of elasticity parallel to the grain and density of specimens not tested at the reference moisture content shall be adjusted either:

— by adjustment factors derived from tests;

— or by Formulae (1), (2) or (3).

$$f_{c,0}=f_{c,0}\ (u)(1+0{,}03(u-u_{ref})) \tag{1}$$

$$E_0 = E_0(u)\ (1+0{,}01\ (u-u_{ref})) \tag{2}$$

$$\rho = \rho\ (u)(1-0{,}005(u-u_{ref})) \tag{3}$$

where

$f_{c,0}$ is the compression strength parallel to the grain;

E_0 is the modulus of elasticity parallel to the grain;

ρ is the density;

u is the moisture content at testing (8 % ≤ u ≤ 18 %)

u_{ref} is the reference moisture content, normally u_{ref} = 12 % (see 5.3.1).

For the adjustment of compression strength parallel to the grain and the modulus of elasticity u shall be taken as 18 % for moisture contents higher than 18 %.

If the moisture content u is lower than 8 %, special consideration is required for the adjustment of strength properties, modulus of elasticity and density.

For the adjustment of density special consideration is required for moisture contents above fibre saturation.

If other more relevant factors are available from test data, then they shall be used instead.

5.4.3 Timber size and test length

For depth less than 150 mm, and characteristic density less than or equal to 700 kg/m^3, bending and tension strength shall be adjusted to 150 mm depth by dividing by the factor k_h from Formula (4):

$$k_h = Min\begin{cases}\left(\dfrac{150}{h}\right)^{0,2}\\ 1{,}3\end{cases} \tag{4}$$

where

h is the depth in mm.

Where the bending test arrangement is within the boundaries in EN 408, but with (span ℓ different of 18 h and/or distance between inner load points, a_f different of 6 h), then the bending strength shall be adjusted by dividing by the factor k_l from Formula (5):

$$k_l = \left(\frac{48h}{\ell_{et}}\right)^{0,2} \quad (5)$$

$$\ell_{et} = \ell + 5a_f \quad (6)$$

where

l_{et} effective test length in mm;

l span within the test arrangement;

a_f distance between the two inner loading points;

a_f and ℓ are the values taken from the test.

5.4.4 Modulus of elasticity

If the global modulus of elasticity $E_{m,global}$ for bending parallel to grain is measured for each specimen it shall be adjusted to the modulus of elasticity parallel to grain E_0.

NOTE According to EN 408, for the determination of the global modulus of elasticity, the shear modulus is taken as infinity.

For softwoods, the following Formula (7) should be used:

$$E_0 = E_{m,global\ (uref)} * 1,3 - 2690 \quad (7)$$

If another relevant equation is available from test data, it shall be used instead. This also applies to hardwoods for which a specific equation shall be provided. This alternative equation shall be established on at least 450 pieces, covering the full range of sizes, sources and quality corresponding to the intended use.

The local bending modulus of elasticity $E_{m.local}$ can also be measured directly and used as modulus of elasticity parallel to grain E_0:

$$E_0 = E_{m,local\ (uref)} \quad (8)$$

If a tension modulus of elasticity is measured it can be used as modulus of elasticity parallel to grain E_0 without any adjustment except for moisture content (see Formula 2).

5.4.5 Other adjustments

If the test methods and/or conditions differ from the reference conditions in any way other than described in 5.3.2 and 5.3.3, then adjustment factors shall be derived from similar methods and/or conditions and used to adjust the 5-percentile or mean value to the reference conditions.

5.5 Analysis of data

5.5.1 Sub-sample analysis

For each sub-sample i:

— a 5-percentile strength value $f_{05,i}$ and a 5-percentile density value $\rho_{05,i}$ shall be determined using EN 14358. When using non parametric calculation, for type testing of machine controlled systems, the factor $k_{0.5,0.75}$ (as defined in EN 14358) may be taken as 1;

— a mean stiffness value $\overline{E}_i$ shall be determined using EN 14358.

5.5.2 Characteristic values

5.5.2.1 Machine grading

5th percentile and mean values of strength and stiffness properties shall be calculated according to EN 14081-2 and EN 14081-3.

The characteristic value of bending strength f_k shall be calculated from the Formula (9):

$$f_k = f_{05} k_v \tag{9}$$

where

f_{05} 5-th percentile strength calculated according to EN 14081-2 and EN 14081-3

k_v is a factor to allow for the lower variability of f_{05} values between sub-samples for machine grades in comparison with visual grades;

- for machine grades based on bending tests with $f_{m,k}$ greater than 30 N/mm², k_v = 1,0
- for machine grades based on bending tests with $f_{m,k}$ equal or less than 30 N/mm², k_v = 1,12.

NOTE The influence of the grading method on the lower tail distribution of strength could have been reflected in different γ_M values in Eurocode 5. But since it is not possible for design to distinguish visually and machine graded timber, it has been decided to consider this effect through k_v in the present standard.

The characteristic mean value of modulus of elasticity $E_{0,\text{mean}}$ shall be calculated from the Formula (10):

$$E_{0,mean} = \overline{E_0} / 0,95 \tag{10}$$

where

$\overline{E_0}$ mean modulus of elasticity calculated according to EN 14081-2 and EN 14081-3

5.5.2.2 Visual grading

5.5.2.2.1 Strength property

The characteristic strength values f_k for each grade shall be calculated from the Formula (11):

$$f_k = min\left(1{,}2 f_{05,i,min}, \frac{\sum_{i=1}^{ns} n_i f_{05,i}}{n}\right) * k_n \tag{11}$$

where

$f_{05,i}$ 5- percentile strength of sub-sample *i*

$f_{05,i,\min}$ lowest 5- percentile strength of *i* – sub-samples

n_s the number of sub-samples

n_i the number of specimens in sub-sample i

n the total number of specimens

k_n factor to adjust for the number of sub-samples.

k_n = 1 for strengths perpendicular to the grain and shear and k_n shall be taken from Table 1 for other strengths parallel to grain.

Table 1 — Factor to adjust test results to the number of sub-samples

Number of sub-samples	1	2	3	4	5 or more
k_n for modulus of elasticity and density	0,88	0,91	0,94	0,97	1,00
k_n for strengths parallel to the grain	0,70	0,80	0,90	0,95	1,00

5.5.2.2.2 Modulus of elasticity

The characteristic modulus of elasticity $E_{0,\text{mean}}$ for each grade shall be calculated from the Formula (12):

$$E_{0,mean} = \min\left(1{,}1\overline{E}_{i,\min},\ \frac{\sum_{i=1}^{ns} n_i \overline{E}_i}{n}\right) * k_n / 0{,}95 \quad (12)$$

Where

$\overline{E}_i$ mean value of modulus of elasticity of sub-sample i

$\overline{E}_{i,\min}$ lowest mean value of modulus of elasticity of i – sub-samples

n_s the number of sub-samples

n_i the number of specimens in sub-sample i

n the total number of specimens

k_n factor to adjust for the number of sub-samples - shall be obtained from Table 1.

5.5.2.2.3 Density

The characteristic density values ρ_k for each grade shall be calculated from the Formula (13):

$$\rho_k = min\left(1{,}1\rho_{05,i,\min},\ \frac{\sum_{i=1}^{ns} n_i \rho_{05,i}}{n}\right) * k_n \quad (13)$$

where

$\rho_{05,i}$ 5- percentile density of a subsample i

$\rho_{05,i,\min}$ lowest 5-percentile density of all subsamples

n_s the number of sub-samples

n_i the number of specimens in sub-sample i

n the total number of specimens

k_n factor to adjust for the number of sub-samples - shall be obtained from Table 1

6 Bending strength and modulus of elasticity determined from small, clear hardwood specimens

The following procedure is only permitted for tropical hardwood species.

Factors to determine characteristic values of bending strength and modulus of elasticity may be derived where both small clear and structural size data are available for at least three other species. (It is essential that these species are similar in the range of sizes of strength reducing characteristics and density). These factors shall then be derived from ratios of the grade characteristic values from the structural size data to the mean values of the small clear data. These factors are then permitted to be applied to species where only small, clear data exist.

For the small clear data, the number of specimens in a sample shall be at least 40 taken from at least five trees, and the test method shall be the same in all cases.

Characteristic values determined in this way shall be reduced by multiplying by 0,8.

7 Other mechanical properties for hardwoods and softwoods

If no structural size test data are available for the relevant properties, then the characteristic values shall be determined in accordance with Table 2 from the characteristic values for bending strength (C or D classes) or tensile strength (T classes), mean modulus of elasticity and density, provided that those values have been determined in accordance with Clauses 5, 6 and 8.

Table 2 — Equations for calculating of other properties

Equation valid for		C classes	T classes	D classes
Species		softwood	softwood	hardwood
Based on		edgewise bending	tension	edgewise bending
Strength properties in N/mm²				
Bending	$f_{m,k}$	given	3,66 +1,213 * $f_{t,0,k}$	given
Tension parallel to grain	$f_{t,0,k}$	−3,07 + 0,73 * $f_{m,k}$	given	0,60 * $f_{m,k}$
Tension perpendicular to grain	$f_{t,90,k}$	0,4	0,4	0,6
Compression parallel to grain	$f_{c,0,k}$	4,3*($f_{m,k}$)^{0,5}	5,5*($f_{t,0,k}$)^{0,5}	4,3*($f_{m,k}$)^{0,5}
Compression perpendicular to grain	$f_{c,90,k}$	0,007 * ρ_k	0,007 * ρ_k	0,010 * ρ_k *or* *0,015 * ρ_k if $\rho_k \geq 700$ kg/m³*
Shear	$f_{v,k}$	$f_{m,k} \leq 24$ MPa: 1,6 + 0,1*$f_{m,k}$ $f_{m,k} > 24$ MPa: 4,0	$f_{t,0,k} \leq 14$ MPa: 1,2 + 0,2*$f_{t,0,k}$ $f_{t,0,k} > 14$ MPa: 4,0	$f_{m,k} \leq 60$ MPa: 3,0 + 0,03*$f_{m,k}$ $f_{m,k} > 60$ MPa: 5,0
Stiffness properties in kN/mm²				
Mean modulus of elasticity parallel to grain	$E_{0,mean}$	given	given	given
Char. modulus of elasticity parallel to grain	$E_{,0,k}$	0,67 * $E_{0,mean}$	0,67 * $E_{0,mean}$	0,84 * $E_{0,mean}$
Mean modulus of elasticity perpendicular to grain	$E_{90,mean}$	$E_{0,mean}/30$	$E_{0,mean}/30$	$E_{0,mean}/15$
Mean shear modulus	G_{mean}	$E_{0,mean}/16$	$E_{0,mean}/16$	$E_{0,mean}/16$
Density in kg/m³				
Char. density	ρ_k	given	given	given
Mean density	ρ_{mean}	1,2 * ρ_k	1,2 * ρ_k	1,2 * ρ_k
		These equations may also be used for hardwoods with similar strength profiles such as e.g. poplar or chestnut.		

8 Report

A written report giving details of the population, sampling, testing, analytical procedure and calculations shall be prepared (see Annex A).

Where a visual grade is assigned to a strength class, the sample distribution of knot size (at the critical section), rate of growth and density is required.

NOTE A sample form to be filled in giving details of the characteristics values is shown in Annex A.

Annex A
(normative)

Requirements for reports for visual grading assignment

The following information shall be included in a report for assessment of approved grading according to EN 14081-1.

a) confirmation that the requirements in Annex A of EN 14081-1:2016 are met;

b) the reference and date of the grading standard used;

c) a note of any strength reducing characteristics that are known and not considered by the visual grading and their frequency in the test sample;

d) details of the timber species, growth area and the grades to be graded. The growth area shall be defined and a map of it shall be included;

e) the method and justification of sampling;

f) details of the grading conditions;

g) the moisture condition (e.g. green or kiln dried) and length of the specimens at the time of grading shall be included in the report unless data are historical and this information is not available;

h) table showing the different cross sections, length spans, number of specimens and growth area, an example is given in Table A1;

i) details of the testing which shall be carried out to EN 408, for MOE the clause number in EN 408 shall be given in the report and details of conversion to shear free MOE should be given, including reference to any supporting documents;

j) table with means and coefficients of variation of the grade determining properties and the moisture content at time of testing for all sub-samples individually and combined, an example is given in Table A2;

k) where a visual grade is assigned to a strength class, histograms showing the sample distribution(s) of knot size measure(s) (relevant to the grading standard) at the critical section, rate of growth and density;

l) table giving the required characteristic values for the strength classes and the characteristic values calculated for the grades based on the test data., an example is given in Table A3.

Table A.1 — Example of reporting of sample description

		Number of specimens per dimension					
Dimensions at grading [mm]		20 × 100	30 × 100	50 × 150	30 × 200	70 × 220	
Length span (min – max) [m]		3,0 – 4,2	3,0 – 4,5	5,2 – 5,5	5,2 – 6,0	4,0 – 4,5	
Sample ID	Origin						Total
1	“Area A”	20		20		20	60
2	“Area B”	20		20			40
3	“Area C”			30	27		57
4	“Area D”		30			20	50
5	“Area E”	20	20	20			60
Total		60	50	90	27	40	267

Table A.2 — Example of reporting of the derivation of characteristic values of sub-samples (one grade and source combination)

Characteristic of sub-sample for the grade under review:	“Grade A”	Moisture content at testing [%]		Adjusted strength[a] [MPa]				Adjusted modulus of elasticity[a] [GPa]		Adjusted density[a] [kg/m³]		
Source	No of pieces ($N \geq 40$)	Mean	COV	Mean	COV	P/NP[b]	$f_{05,i}$	$\overline{E}_i$	COV	Mean	COV	$\rho_{05,i}$
				See EN 14358:2016, 4.2				*See EN 14358:2016, 4.3*		*See EN 14358:2016, 4.2*		
Mean and COV for the grade												

NOTE Standard references are for guidance only.

[a] Adjusted values refer to results after applying adjustments in 5.4 to test values.

[b] Parametric or non-parametric evaluation used.

Table A.3 — Example of reporting of derivation of characteristic values of grades and comparison with the requirement

Grade	Strength class	Characteristic strength					Characteristic modulus of elasticity					Characteristic density				
		$1,2\, f_{05,\mathrm{i,min}}$	$\frac{\sum_{i=1}^{ns} n_i f_{05}}{n}$	k_n	f_k	Strength class requirement	$1,1\, \overline{E}_{i,\mathrm{min}}$	$\frac{\sum_{i=1}^{ns} n_i \overline{E}_i}{n}$	k_n	$E_{0,mean,k}$	0,95 strength class requirement	$1,1\, \rho_{05,i,\mathrm{min}}$	$\frac{\sum_{i=1}^{ns} n_i \rho_{05,\mathrm{i}}}{n}$	k_n	ρ_k	Strength class requirement
"Grade A"	C30	*See EN 384:2016, 5.5.2.2.1*				*See EN 338*	*See EN 384:2016, 5.5.2.2.2*				*See EN 338*	See *EN 384:2016, 5.5.2.2.3*				*See EN 338*
"Grade B"	C18															

Bibliography

[1] EN 1912, *Structural Timber — Strength classes — Assignment of visual grades and species*

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