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Structural timber — Strength classes

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National foreword

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Content

European foreword

This document (EN 338:2016) 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of an identical text or by endorsement, at the latest by October 2016, and conflicting national standards shall be withdrawn at the latest by October 2016.

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This document supersedes EN 338:2009.

Compared to EN 338:2009, the following modifications have been made:

— new table of strength classes for softwood species based on tension tests;

— extension with new classes in the table of strength classes for hardwood species based on edgewise bending tests;

— modification of some characteristic values for strength, stiffness and density;

— equations to determine the characteristic values of other strength properties from the grade determining properties has been transferred to EN 384.

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Introduction

A strength class system groups together grades, species and sources with similar strength properties thus making them interchangeable. This then permits an engineer to specify a chosen strength class and use the characteristic strength values of that class in design calculations.

1 Scope

This European Standard establishes a system of strength classes for general use in design codes.

It gives characteristic strength and stiffness properties and density values for each class to which EN 14081-1 refers.

This standard is applicable to all softwood and hardwood timber for structural use, within the scope of EN 14081-1.

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

EN 14081 (all parts), *Timber structures — Strength graded structural timber with rectangular cross section*

3 Terms and definitions

For the purposes of this document, the following term and definition apply.

3.1
population
timber of one species or species combination and one source for which the strength, stiffness and density properties apply

4 Symbols and abbreviations

$E_{m,0,mean}$	mean characteristic value of modulus of elasticity in bending parallel to grain (in kN/mm²);
$E_{t,0,mean}$	mean characteristic value of modulus of elasticity in tension parallel to grain (in kN/mm²);
$E_{m,0,k}$	5-percentile characteristic value of modulus of elasticity in bending parallel to grain (in kN/mm²);
$E_{t,0,k}$	5-percentile characteristic value of modulus of elasticity in tension parallel to grain (in kN/mm²);
$E_{m,90,mean}$	mean characteristic value of modulus of elasticity in bending perpendicular to grain (in kN/mm²);
$E_{t,90,mean}$	mean characteristic value of modulus of elasticity in tension perpendicular to grain (in kN/mm²);
$f_{c,0,k}$	5-percentile characteristic value of compressive strength parallel to grain (in N/mm²);
$f_{c,90,k}$	5-percentile characteristic value of compressive strength perpendicular to grain (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 tensile strength parallel to grain (in N/mm²);
$f_{t,90,k}$	5-percentile characteristic value of tensile strength perpendicular to grain (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 kN/mm²);

ρ_k 5-percentile characteristic value of density (in kg/m³);

ρ_{mean} mean characteristic value of density (in kg/m³)

5 Classification of structural timber

This standard provides for a number of strength classes, each designated by a number indicating the value of the edgewise bending or tension strength in N/mm².

For softwood species based on edgewise bending tests, the characteristic values of strength, stiffness and density for the strength classes Cxx, where xx refers to the 5-percentile characteristic bending strength value, are given in Table 1.

For softwood species based on tension tests, the characteristic values of strength, stiffness and density for the strength classes Txx, where xx refers to the 5-percentile characteristic tension strength value, are given in Table 2.

NOTE 1 Timber belonging to T classes is mainly intended for glulam and other cases where tension is the dominating load.

NOTE 2 The T classes correspond to classes L, LS or LD as in EN 14081–4 with some differences in tabulated properties and is also referred to in EN 14080.

For hardwood species based on edgewise bending tests, the characteristic values of strength, stiffness and density for the strength classes Dxx, where xx refers to the 5-percentile characteristic bending strength value, are given in Table 3.

NOTE 3 C and T classes may also be used for hardwoods with similar strength and density profiles such as e.g. poplar or chestnut.

The most common used strength classes in Europe are printed in bold.

Table 1 — Strength classes for softwood based on edgewise bending tests – strength, stiffness and density values

	Class	C14	**C16**	**C18**	C20	C22	**C24**	C27	**C30**	C35	C40	C45	C50
Strength properties in N/mm²													
Bending	$f_{m,,k}$	14	**16**	**18**	20	22	**24**	27	**30**	35	40	45	50
Tension parallel	$f_{t,0,k}$	7,2	**8,5**	**10**	11,5	13	**14,5**	16,5	**19**	22,5	26	30	33,5
Tension perpendicular	$f_{t,90,k}$	0,4	**0,4**	**0,4**	0,4	0,4	**0,4**	0,4	**0,4**	0,4	0,4	0,4	0,4
Compression parallel	$f_{c,0,k}$	16	**17**	**18**	19	20	**21**	22	**24**	25	27	29	30
Compression perpendicular	$f_{c,90,k}$	2,0	**2,2**	**2,2**	2,3	2,4	**2,5**	2,5	**2,7**	2,7	2,8	2,9	3,0
Shear	$f_{v,k}$	3,0	**3,2**	**3,4**	3,6	3,8	**4,0**	4,0	**4,0**	4,0	4,0	4,0	4,0
Stiffness properties in kN/mm²													
Mean modulus of elasticity parallel bending	$E_{m,0,mean}$	7,0	**8,0**	**9,0**	9,5	10,0	**11,0**	11,5	**12,0**	13,0	14,0	15,0	16,0
5 percentile modulus of elasticity parallel bending	$E_{m,0,k}$	4,7	**5,4**	**6,0**	6,4	6,7	**7,4**	7,7	**8,0**	8,7	9,4	10,1	10,7
Mean modulus of elasticity perpendicular	$E_{m,90,mean}$	0,23	**0,27**	**0,30**	0,32	0,33	**0,37**	0,38	**0,40**	0,43	0,47	0,50	0,53
Mean shear modulus	G_{mean}	0,44	**0,50**	**0,56**	0,59	0,63	**0,69**	0,72	**0,75**	0,81	0,88	0,94	1,00
Density in kg/m³													
5 percentile density	ρ_k	290	**310**	**320**	330	340	**350**	360	**380**	390	400	410	430
Mean density	ρ_{mean}	350	**370**	**380**	400	410	**420**	430	**460**	470	480	490	520

NOTE 1 Values given above for tension strength, compression strength, shear strength, char. modulus of elasticity in bending, mean modulus of elasticity perpendicular to grain and mean shear modulus have been calculated using the equations given in EN 384.

NOTE 2 The tension strength values are conservatively estimated since grading is done for bending strength.

NOTE 3 The tabulated properties are compatible with timber at moisture content consistent with a temperature of 20 °C and a relative humidity of 65 %, which corresponds to a moisture content of 12 % for most species.

NOTE 4 Characteristic values for shear strength are given for timber without fissures, according to EN 408.

NOTE 5 These classes may also be used for hardwoods with similar strength and density profiles such as e.g. poplar or chestnut.

NOTE 6 The edgewise bending strength may also be used in the case of flatwise bending.

Table 2 — Strength classes for softwood based on tension tests – strength, stiffness and density values

	Class	T 8	T 9	T 10	**T 11**	T 12	T 13	**T 14**	T 14,5	T 15	T 16	**T 18**	**T 21**	**T 22**	T 24	T 26	T 27	T 28	T 30
Strength properties in N/mm²																			
Bending	$f_{m,,k}$	13,5	14,5	16	**17**	18	19,5	**20,5**	21	22	23	**25,5**	**29**	**30,5**	33	35	36,5	37,5	40
Tension parallel	$f_{t,0,k}$	8	9	10	**11**	12	13	**14**	14,5	15	16	**18**	**21**	**22**	24	26	27	28	30
Tension perpendicular	$f_{t,90,k}$	0,4	0,4	0,4	**0,4**	0,4	0,4	**0,4**	0,4	0,4	0,4	**0,4**	**0,4**	**0,4**	0,4	0,4	0,4	0,4	0,4
Compression parallel	$f_{c,0,k}$	16	17	17	**18**	19	20	**21**	21	21	22	**23**	**25**	**26**	27	28	29	29	30
Compression perpendicular	$f_{c,90,k}$	2,0	2,1	2,2	**2,2**	2,3	2,4	**2,5**	2,5	2,5	2,6	**2,7**	**2,7**	**2,7**	2,8	2,9	2,9	2,9	3,0
Shear	$f_{v,k}$	2,8	3,0	3,2	**3,4**	3,6	3,8	**4,0**	4,0	4,0	4,0	**4,0**	**4,0**	**4,0**	4,0	4,0	4,0	4,0	4,0
Stiffness properties in kN/mm²																			
Mean modulus of elasticity parallel tension	$E_{t,0,mean}$	7,0	7,5	8,0	**9,0**	9,5	10,0	**11,0**	11,0	11,5	11,5	**12,0**	**13,0**	**13,0**	13,5	14,0	15,0	15,0	15,5
5 percentile modulus of elasticity parallel tension	$E_{t,0,k}$	4,7	5,0	5,4	**6,0**	6,4	6,7	**7,4**	7,4	7,7	7,7	**8,0**	**8,7**	**8,7**	9,0	9,4	10,1	10,1	10,4
Mean modulus of elasticity perpendicular	$E_{t,90,mean}$	0,23	0,25	0,27	**0,30**	0,32	0,33	**0,37**	0,37	0,38	0,38	**0,40**	**0,43**	**0,43**	0,45	0,47	0,50	0,50	0,52
Mean shear modulus	G_{mean}	0,44	0,47	0,50	**0,56**	0,59	0,63	**0,69**	0,69	0,72	0,72	**0,75**	**0,81**	**0,81**	0,84	0,88	0,94	0,94	0,97
Density in kg/m³																			
5 percentile density	ρ_k	290	300	310	**320**	330	340	**350**	350	360	370	**380**	**390**	**390**	400	410	410	420	430
Mean density	ρ_{mean}	350	360	370	**380**	400	410	**420**	420	430	440	**460**	**470**	**470**	480	490	490	500	520

NOTE 1 Values given above for bending strength, compression strength, shear strength, char. modulus of elasticity in tension, mean modulus of elasticity perpendicular to grain and mean shear modulus have been calculated using the equations given in EN 384.

NOTE 2 The bending strength values are conservatively estimated since grading is done for tension strength.

NOTE 3 The tabulated properties are compatible with timber at moisture content consistent with a temperature of 20 °C and a relative humidity of 65 %, which corresponds to a moisture content of 12 % for most species.

NOTE 4 Characteristic values for shear strength are given for timber without fissures, according to EN 408.

NOTE 5 These classes may also be used for hardwoods with similar strength and density profiles such as e.g. poplar or chestnut.

NOTE 6 The bending strength may be used in the case of edgewise or flatwise bending.

Table 3 — Strength classes for hardwoods based on edgewise bending tests – strength, stiffness and density values

	Class	D18	**D24**	D27	**D30**	D35	**D40**	D45	**D50**	D55	**D60**	D65	**D70**	D75	D80
Strength properties in N/mm²															
Bending	$f_{m,k}$	18	**24**	27	**30**	35	**40**	45	**50**	55	**60**	65	**70**	75	80
Tension parallel	$f_{t,0,k}$	11	**14**	16	**18**	21	**24**	27	**30**	33	**36**	39	**42**	45	48
Tension perpendicular	$f_{t,90,k}$	0,6	**0,6**	0,6	**0,6**	0,6	**0,6**	0,6	**0,6**	0,6	**0,6**	0,6	**0,6**	0,6	0,6
Compression parallel	$f_{c,0,k}$	18	**21**	22	**24**	25	**27**	29	**30**	32	**33**	35	**36**	37	38
Compression perpendicular	$f_{c,90,k}$	4,8	**4,9**	5,1	**5,3**	5,4	**5,5**	5,8	**6,2**	6,6	**10,5**	11,3	**12,0**	12,8	13,5
Shear	$f_{v,k}$	3,5	**3,7**	3,8	**3,9**	4,1	**4,2**	4,4	**4,5**	4,7	**4,8**	5,0	**5,0**	5,0	5,0
Stiffness properties in kN/mm²															
Mean modulus of elasticity parallel bending	$E_{m,0,mean}$	9,5	**10,0**	10,5	**11,0**	12,0	**13,0**	13,5	**14,0**	15,5	**17,0**	18,5	**20,0**	22,0	24,0
5 percentile modulus of elasticity parallel bending	$E_{m,0,k}$	8,0	**8,4**	8,8	**9,2**	10,1	**10,9**	11,3	**11,8**	13,0	**14,3**	15,5	**16,8**	18,5	20,2
Mean modulus of elasticity perpendicular	$E_{m,90,mean}$	0,63	**0,67**	0,70	**0,73**	0,80	**0,87**	0,90	**0,93**	1,03	**1,13**	1,23	**1,33**	1,47	1,60
Mean shear modulus	G_{mean}	0,59	**0,63**	0,66	**0,69**	0,75	**0,81**	0,84	**0,88**	0,97	**1,06**	1,16	**1,25**	1,38	1,50
Density in kg/m³															
5 percentile density	ρ_k	475	**485**	510	**530**	540	**550**	580	**620**	660	**700**	750	**800**	850	900
Mean density	ρ_{mean}	570	**580**	610	**640**	650	**660**	700	**740**	790	**840**	900	**960**	1020	1080

NOTE 1 Values given above for tension strength, compression strength, shear strength, char. modulus of elasticity in bending, mean modulus of elasticity perpendicular to grain and mean shear modulus, have been calculated using the equations given in EN 384.

NOTE 2 The tabulated properties are compatible with timber at moisture content consistent with a temperature of 20 °C and a relative humidity of 65 %, which corresponds to a moisture content of 12 % for most species.

NOTE 3 Characteristic values for shear strength are given for timber without fissures, according to EN 408.

NOTE 4 The edgewise bending strength may also be used in the case of flatwise bending.

6 Allocation of a population to a strength class

6.1 Grading

6.1.1 Visual graded timber

Visual graded timber shall be graded according to a grading standard that meets the requirements of EN 14081-1.

NOTE EN 1912 lists a number of visual grades and species that are allocated to the strength classes of this standard.

6.1.2 Machine graded timber

Machine graded timber shall meet the requirements of EN 14081 (all parts).

6.2 Classification

6.2.1 Characteristic values

The characteristic values of bending or tension strength, mean modulus of elasticity in bending or tension and density for the population concerned shall be determined in accordance with EN 384. Other strength and stiffness properties, as well as mean density values, are determined according to EN 384.

6.2.2 Allocation to a strength class

A population may be assigned to a strength class if its characteristic values of strength, mean modulus of elasticity and density equal or exceed the values for that strength class given in Table 1, 2 or 3.

Provided the settings are available in Approved Grading Reports, a grading machine may be set to grade directly to the strength class strength, stiffness and density values. Timber graded in this way should be referred to by the strength class number and marked according to EN 14081-1, EN 14081-2 and EN 14081-3.

Bibliography

[1] EN 408, *Timber structures — Structural timber and glued laminated timber — Determination of some physical and mechanical properties*

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

[3] EN 14080, *Timber structures — Glued laminated timber and glued solid timber — Requirements*

[4] EN 14358, *Timber structures — Calculation and verification of characteristic values*

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