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Wood-based panels - Characteristic values for structural design - Part 2: Plywood

Panneaux à base de bois - Valeurs caractéristiques pour la conception des structures - Partie 2: Contreplaqué

Holzwerkstoffe - Charakteristische Werte für die Berechnung und Bemessung von Holzbauwerken - Teil 2: Sperrholz

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European foreword

This document (EN 12369-2:2025) has been prepared by Technical Committee CEN/TC 112 “Wood-based panels”, the secretariat of which is held by DIN.

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of an identical text or by endorsement, at the latest by March 2026, and conflicting national standards shall be withdrawn at the latest by March 2026.

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

This document supersedes EN 12369-2:2011.

EN 12369-2:2025 includes the following significant technical changes with respect to EN 12369-2:2011:

— where values required by EN 1995-1-1 for plywood panels have been missing, this document provides additional properties in Clause 7 to be used in the structural design according to EN 1995-1-1;

— the symbols used in wood-based panels product standards, test standards and in EN 1995-1-1 do not match exactly to each other. This document gives advice how to use design properties when the structural design is performed according to EN 1995-1-1;

— normative reference to ISO 3131 replaced by reference to ISO 13061-2;

— values for classes F 35 and E 35 mentioned in EN 636 introduced by interpolation.

This document is intended to be used in conjunction with EN 1995-1-1.

The EN 12369 series *Wood-based panels — Characteristic values for structural design* is currently composed of the following parts:

— Part 1: OSB, particleboards and fibreboards;

— Part 2: Plywood;

— Part 3: Solid wood panels.

Annex A and Annex B are informative.

This document has been prepared under a standardization request addressed to CEN by the European Commission. The Standing Committee of the EFTA States subsequently approves these requests for its Member States.

Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

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

1 Scope

This document provides information on the characteristic values for use in designing structures incorporating wood-based panels. The characteristic values given are as defined in EN 1995-1-1.

When utilizing the classification system for derivation of plywood characteristic values, this document can only be applied with reference to EN 636.

This document includes the characteristic values of the mechanical properties for plywood complying with EN 636 in bending, tension, compression, panel shear and planar shear. EN 636 classifies bending properties into two sets of classes, one for stiffness and another for strength. Stiffness and strength in tension and compression are related to the same properties in bending.

For shear properties, fixed values determined by correlation to density are provided.

Where optimized values are needed, the characteristic values are determined directly by testing in accordance with EN 789 and EN 1058 or by combination of testing according to the latter two standards and calculation according to EN 14272.

This document applies to panels complying with the three following conditions:

— 5 layers or more and 6 mm overall thickness and more;

— the ratio of the cumulative thickness of veneers in alternate directions does not exceed 2.5;

— wood species with a mean density greater than 350 kg/m^3 and not exceeding 750 kg/m^3.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 323, *Wood-based panels — Determination of density*

EN 635-2, *Plywood — Classification by surface appearance — Part 2: Hardwood*

EN 635-3, *Plywood — Classification by surface appearance — Part 3: Softwood*

EN 789:2004, *Timber structures — Test methods — Determination of mechanical properties of wood based panels*

EN 1995-1-1:2004,[1] *Eurocode 5: Design of timber structures — Part 1-1: General — Common rules and rules for buildings*

EN 13986:2004+A1:2015, *Wood-based panels for use in construction — Characteristics, evaluation of conformity and marking*

3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

[1] As impacted by EN 1995-1-1:2004/A1:2008, EN 1995-1-1:2004/A2:2014 and EN 1995-1-1:2004/AC:2006.

3.1
characteristic value
value of a material property relating to limit state design, for use in the design of timber structures, elements, assemblies and component

Note 1 to entry: As defined in EN 1995-1-1, this value corresponds to a specified percentile of the assumed distribution of the property under consideration.

Note 2 to entry: For plywood determined as stipulated in this document.

3.2
service class 1
class characterized by a moisture content in the materials corresponding to a temperature of 20 °C and the relative humidity of the surrounding air exceeding 65 % for only a few weeks per year

Note 1 to entry: In these conditions the moisture content of coniferous plywood can be expected not to exceed 12 %.

[SOURCE: EN 1995-1-1:2004, 2.3.1.3, modified – Moisture content for plywood has been added in Note 1 to entry.]

3.3
service class 2
class characterized by a moisture content in the materials corresponding to a temperature of 20 °C and the relative humidity of the surrounding air exceeding 85 % for only a few weeks per year

Note 1 to entry: In these conditions the moisture content of coniferous plywood can be expected not to exceed 18 %.

[SOURCE: EN 1995-1-1:2004, 2.3.1.3, modified – Moisture content for plywood has been added in Note 1 to entry.]

3.4
service class 3
climatic conditions leading to higher moisture content in the materials than in service class 2

Note 1 to entry: In these conditions the moisture content of coniferous plywood can be expected to exceed 18 %.

[SOURCE: EN 1995-1-1:2004, 2.3.1.3, modified – Moisture content for plywood has been added in Note 1 to entry.]

3.5
load duration class
class characterized by the effect of a constant load acting for a certain period of time in the life of the structure

Note 1 to entry: For a variable action, the appropriate class is determined on the basis of an estimate of the interaction between the typical variation of the load with time and the rheological properties of the materials.

Note 2 to entry: For strength and stiffness calculations, actions are assigned to one of the load-duration classes given in Table 1, derived from EN 1995-1-1.

Table 1 — Load duration classes

Load duration class	Order of accumulated duration of characteristic load	Examples of loading
Permanent	More than 10 years	Self weight
Long-term	6 months to 10 years	Storage
Medium-term	1 week to 6 months	Imposed load
Short-term	Less than 1 week	Snow[a] and wind
Instantaneous	—	Accidental load

[a] In areas which have a heavy snow load for a prolonged period of time, part of the load should be regarded as medium-term.

3.6
lay-up
thickness and arrangement of the plies

3.7
composition
factors compounding the lay-up plus the combination of wood species

4 Symbols

4.1 Main symbols

E	Modulus of elasticity (defined as stiffness in EN 1995-1-1:2004), (N/mm^2)
f	Strength (N/mm^2)
G	Shear modulus (N/mm^2)
k	Factorfor modification instrength (k_{mod}) or stiffness (k_{def}) after a periodof time relative toinitial values. Values are included in EN 1995-1-1
ρ	Density of a wood species or of plywood (kg/m^3)
0	In the direction of the grain of the outer layer of plywood
90	Perpendicular to the grain of the outer layer of plywood

4.2 Subscripts

c	Compression
k	Characteristic (5th percentile)
m	Bending
r	Planar shear
t	Tension
v	Panel shear w
	Wood species
p	Panel
Mean	Mean (50th percentile)
mod	related to modification factor for strength
def	related to modification factor for deflection

5 General

In this document the 5th percentile defines the characteristic value for:

— strength;

— density;

— modulus of elasticity where buckling, as an example, may be expected in service.

Otherwise the population 50th percentile defines the characteristic mean value of the modulus of elasticity and shear modulus.

The strength properties are log-normally distributed. Stiffness properties and density are normally distributed.

The characteristic value is derived in panels with moisture content as determined by a temperature of 20 °C and a relative humidity of 65 %.

All structural calculations shall be done in accordance with EN 1995-1-1.

Where panels are structurally used underservice class 1,2 and 3conditions, performance values inferred by the classification and listed in Table 2 and Table 3 shall be modified according to the service class and the duration of load (k_{mod}, k_{def}).

Manufacturers utilizing the EN 636 classification system for determination of characteristic values may present these values in a format similar to that in Annex A.

The characteristic values shall be supported by the following information:

— product description;

— product specifications;

— service class or classes in which the panel can be used;

— details of the veneer species and grade, and of the composition;

— density of the panel.

6 Characteristic values for plywood

6.1 Introduction

Characteristic values for plywood can be determined by one of two distinct methods as described in Clause 1. The following tables in this clause provide the characteristic values for plywood based on the EN 636 Classification System.

The class values given in these tables shall be modified appropriately for service class and load duration in accordance with the requirements of EN 1995-1-1.

NOTE A data analysis has provided a conservative property relationship:

— to bending for tension and compression values and;

— to density for shear values.

See Annex B for more information on this relationship.

6.2 Bending, tension and compression

6.2.1 General

Testing according to EN 310 and application of the procedure in EN 326-2 for internal control enables the classification of the panels according to their composition and performances.

Characteristic values are provided for bending strength (see Table 2) and bending stiffness (see Table 3) for the classes as specified by the EN 636 Classification System. Table 1 and Table 2 in EN 636:2012+A1:2015 give the current threshold performance levels required to be achieved for the purpose of classification.

Although classification for strength and stiffness are independent of each other, the characteristic values for tension and compression in both cases are derived from bending strength.

The surface appearance class, as specified in EN 635-2 and EN 635-3, shall be taken into account both for modulus and strength. Declared characteristic values shall also make reference to these surface appearance classes.

6.2.2 Strength

Class characteristic values for strength in bending, tension and compression, based on class limits as specified in EN 636 are listed in Table 2.

Table 2 — Class characteristic values for strength in bending, tension and compression

Class	Characteristic strength values N/mm²		
	Surface grain direction[a]		
	0 and 90[a]	0[b]	90[c]
	Bending f_m	Tension and compression f_{t-c}	
F3	3	1,2	1,5
F5	5	2	2,5
F10	10	4	5
F15	15	6	7,5
F20	20	8	10
F25	25	10	12,5
F30	30	12	15
F35	35	14	17,5
F40	40	16	20
F50	50	20	25
F60	60	24	30
F70	70	28	35
F80	80	32	40

[a] The class is specified for both parallel to grain (0) and perpendicular to grain (90) directions (for example class F25/15 has bending $f_{m,0}$ = 25 N/mm² and $f_{m,90}$ = 15 N/mm², $f_{t-c,0}$ = 10 N/mm² and $f_{t-c,90}$ = 7,5 N/mm²). The F classes for strength are specified in EN 636.

[b] The value of tensile and compressive strength $f_{t-c,0}$ is based on the F class as specified for parallel to the face veneer grain direction (0).

[c] The value of tensile and compressive strength $f_{t-c,90}$ is based on the F class as specified for perpendicular to the face veneer grain direction (90).

6.2.3 Modulus of elasticity

Class limits for modulus of elasticity in bending and tension-compression are listed in Table 3.

Table 3 — Classification for modulus of elasticity in bending, tension and compression

Class	Mean modulus N/mm²		
	Surface grain direction[a]		
	0 and 90[a]	0[b]	90[c]
	Bending E_m	Tension and compression E_{t-c}	
E5	500	250	400
E10	1 000	500	800
E15	1 500	750	1 200
E20	2 000	1 000	1 600
E25	2 500	1 250	2 000
E30	3 000	1 500	2 400
E35	3 500	1 750	2 800
E40	4 000	2 000	3 200
E50	5 000	2 500	4 000
E60	6 000	3 000	4 800
E70	7 000	3 500	5 600
E80	8 000	4 000	6 400
E90	9 000	4 500	7 200
E100	10 000	5 000	8 000
E120	12 000	6 000	9 600
E140	14 000	7 000	11 200

The 5th percentile values for stiffness shall be taken as X times the mean values above:

X = 0,67 for panels containing wood species with a mean density less than 640 kg/m³

X = 0,84 for panels wholly made of hardwood with a mean density at least equal to 640 kg/m³

NOTE Factors are derived from EN 338:2016, Annex A.

[a] The class is specified for both parallel to grain (0) and perpendicular to grain (90) directions (for example class E60/30 in bending $E_{m,0}$ = 6 000 N/mm² and $E_{m,90}$ = 3 000 N/mm². $E_{t-c,0}$ = 3 000 N/mm² and $E_{t-c,90}$ = 2 400 N/mm². The E classes for modulus of elasticity are specified in EN 636.

[b] The value of tensile and compressive modulus of elasticity $E_{t-c,0}$, is based on the E class specified for parallel to the face veneer grain direction (0).

[c] The value of tensile and compressive strength $E_{t-c,90}$, is based on the E class specified perpendicular to the face veneer grain direction (90).

6.3 Shear properties

The properties of plywood such as panel shear modulus (G_v), panel shear strength (f_v), planar shear modulus ($G_{r)}$ and planar shear strength (f_r), are related to the density of the wood species used.

In case of single species panel, density shall be determined according to EN 323 and expressed as $\rho_{p,mean}$.

For panels combining more than one wood species, the density shall be determined by the species with the lowest density in the composition. The property values to be taken shall be those of the bottom of the range of density the wood species belongs to and expressed as $\rho_{w,mean}$.

The mean density of the species can be determined according to ISO 13061-2 or according to EN 384.

When the 5th percentile characteristic density of the species is known the mean value can be derived using the following equation:

$$\rho_{w,mean} = \rho_{w,05} / 0{,}823$$

NOTE 5th percentile ratio derived from EN 338:2016, Table 1.

The values of the properties are listed in Table 4.

If combinations of wood species groups are used the value from the lowest wood species group shall be used.

For densities in-between the tabled ones, the value of the nearer lower limit shall be taken to determine the relevant property.

Table 4 — Characteristic and mean values for panel shear (v) and planar shear (r) properties

$\rho_{w,mean}$	G_v	f_v	$G_{r,0}$ *and* $G_{r,0}$	$F_{r,0}$ *and* $F_{r,90}$
kg/m^3	N/mm^2			
350	220	1,8	7,3	0,4
400	270	2,7	11	0,5
450	310	3,5	16	0,6
500	360	4,3	22	0,7
550	400	5,0	32	0,8
600	440	5,7	44	0,9
650	480	6,3	60	1,0
700	520	6,9	82	1,1
750	550	7,5	110	1,2

6.4 Characteristic density and mean density

The determination of the characteristic density and the mean density of the panels is described in EN 636 and in EN 323.

NOTE Density values are supplementary properties in EN 13986 but will be included in the revision of EN 1995-1-1.

7 Material property values to be used for the structural design according to EN 1995-1-1

7.1 General

For plywood panels used as structural components, the relevant characteristics are indicated in EN 13986:2004+A1:2015 Annex ZA.1.

Those essential characteristics include strength and stiffness: in tension, compression, panel shear and planar shear in two directions of plane (0 and 90). Values shall be tested or determined according to EN 13986:2004+A1:2015, 5.13. The characteristics values can be determined according to test standard EN 789 or can be taken from this document, if included.

The use of EN 1995-1-1 for the structural design requires the complete set of panel density, strength, and stiffness parameters to be given before the product can be designed and used according to EN 1995-1-1.

The strength and stiffness properties required by EN 1995-1-1 and included in EN 789 or 6.2 of this document are presented in Table 5.

Table 5 — List of strength and stiffness properties in two directions of plane (0 and 90)

Properties	Strength/MOE				EN 789:2004 Clause	EN 12369-2
Out-of-plane						
Bending	$f_{m,0,k}$	$f_{m,90,k}$	$E_{m,0,mean}$	$E_{m,90,mean}$	7.5	Table 2 and 3
Planar shear	$f_{r,0,k}$	$f_{r,90,k}$	$G_{r,0,mean}$	$G_{r,90,mean}$	11.5	Table 4
In-plane						
Compression	$f_{c,0,k}$	$f_{c,90,k}$	$E_{c,0,mean}$	$E_{c,90,mean}$	8.5	Table 2 and 3
Tensile	$f_{t,0,k}$	$f_{t,90,k}$	$E_{t,0,mean}$	$E_{t,90,mean}$	9.5	Table 2 and 3
Panel shear	$f_{v,0,k}$	$f_{v,90,k}$	$G_{v,0,mean}$	$G_{v,90,mean}$	10.6	Table 4

The additional properties not included in the EN 13986:2004+A1:2015 Annex ZA (essential characteristics) and in EN 789 or Clause 6 of this document, but required by EN 1995-1-1 are presented in Table 6.

Table 6 — List of additional physical, strength and stiffness properties (including third direction, face loading)

Physical properties	**Density**				**Reference**	**EN 12369-2 Clause**
Mean density	ρ_{mean}					7.2.1
Characteristic density	ρ_{05}				EN 636	6.4 and 7.2.1
Properties	**Strength/MOE**				**EN 789:2004 Clause**	**EN 12369-2 Clause**
Out-of-plane						
Bending MOE	—	—	$E_{m,0,k}$	$E_{m,90,k}$	7.5	7.2.2
Planar shear	—	—	$G_{r,0,k}$	$G_{r,90,k}$	11.5	7.2.2
Bearing[a]	$f_{c,face,k}$	—	$E_{ct,face,mean}$	$E_{ct,face,k}$	—	7.2.3 and 7.2.2
Tensile	$f_{t,face,k}$	—	—	—	—	7.2.4
In-plane						
Compression	—	—	$E_{ct,0,k}$	$E_{ct,90,k}$	8.5 or 9.5	7.2.2
Tensile	—	—	$E_{ct,0,k}$	$E_{ct,90,k}$	8.5 or 9.5	7.2.2
Panel shear	—	—	$G_{v,0,k}$	$G_{v,90,k}$	10.6	7.2.2
Bending/MOE	$f_{m,0,edge,k}$[b]	$f_{m,90,edge,k}$[b]	$E_{ct,0,mean}$	$E_{ct,90,mean}$	—	7.2.5
Bending MOE	—	—	$E_{ct,0,k}$	$E_{ct,90,k}$	—	7.2.5 and 7.2.2

[a] In EN 789 compressive strength $f_{c,90}$ perpendicular to the plane of the panel.

[b] Plywood shall not be used as an edgewise bent beam itself. In EN 789 there is no test method for that loading case, the size effect should also be taken into account properly. See 7.2.5 for the other design cases.

7.2 Additional supplementary material properties for Eurocode 5 (EN 1995-1-1, EN 1995-1-2, EN 1995-2)

7.2.1 Mean density (ρ_{mean}) and characteristic density (ρ_k)

EN 1995-1-1 includes both ρ_{mean}, and ρ_k as required parameter. If only one of the density parameters is given, for softwood plywood having density 400 kg/m^3 or more, the other parameter can be calculated based on the formula:

$$\rho_k = 0{,}87 \times \rho_{mean}$$

For hardwood plywood having density 350 kg/m^3 or more, the formula

$$\rho_k = 0{,}93 \times \rho_{mean}$$

can be used.

For plywood having mixed wood species, the equation for softwood applies.

NOTE Density properties (ρ_{mean}, ρ_k) belong to the supplementary properties in the wood-based panels harmonized standard EN 13986 and in plywood's specification standard EN 636:2012+A1:2015 and are not included in EN 13986:2004+A1:2015 Tables 1, 2 and 3. Thus, those values might be missing from the product's declaration of performance (DoP). The characteristic density or the mean density might be given in manufacturer's additional technical documents referring to structural panel's DoP.

7.2.2 Characteristic modulus of elasticity and rigidity values

Unless other value is given for hardwood plywood having a characteristic density of 600 kg/m^3 or more, the characteristic 5-percentile value should be 0,84 times the mean value of stiffness parameter.

Unless other value is given for hardwood plywood having a characteristic density of less than 600 kg/m^3, the characteristic 5-percentile value should be 0,67 times the mean value of stiffness parameter.

Unless other value is given for softwood plywood and mixed wood species plywood having a characteristic density of 400 kg/m^3 or more, the characteristic 5-percentile value should be 0,67 times the mean value of stiffness parameter.

7.2.3 Compressive strength ($f_{c,flat,k}$) bearing and compressive and tensile stiffness ($E_{ct,flat,mean}$ and $E_{ct,flat,k}$), out of plane

Unless other value is given (according to EN 789) for structural hardwood plywood having a characteristic density of 600 kg/m^3 or more:

$f_{c,flat,k}$ = 9 N/mm^2,

$E_{ct,flat,mean}$ = 1 000 N/mm^2,

$E_{ct,flat,k}$ = 840 N/mm^2

Unless other value is given (according toEN 789) forstructuralsoftwood plywood having a characteristic density of 400 kg/m^3 or more and for hardwood plywood having a characteristic density of at least 350 kg/m^3 but less than 600 kg/m^3:

$f_{c,flat,k}$ = 2,8 N/mm^2,

$E_{ct,flat,mean}$ = 400 N/mm^2,

$E_{ct,flat,k}$ = 270 N/mm^2

NOTE In EN 789 the symbols for parameters are $f_{c,90}$ and $E_{c,90}$ (also $E_{c,perp}$ used).

7.2.4 Tensile strength ($f_{t,flat,k}$) perpendicular to the face of the panel, out of plane

The tensile strength perpendicular to the plane of the hardwood panel having a characteristic density of 600 kg/m^3 or more shall be taken as:

$f_{t,flat,k}$ = 0,7 N/mm^2

For hardwood plywood having a characteristic density of at least 350 kg/m^3 but less than 600 kg/m^3:

$f_{t,flat,k}$ = 0,4 N/mm^2

For softwood plywood having a characteristic density of 400 kg/m^3 or more:

$f_{t,flat,k}$ = 0,4 N/mm^2

NOTE Above values correspond to the values given for structural timber (EN 384 and EN 338).

7.2.5 Bending strength ($f_{m,0,edge,k}$ and $f_{m,90,edge,k}$) in edgewise loading in plane

Plywood should not be designed as an edgewise bending beam in in-plane loading case. Plywood panels can be a webin glued thinwebbed beams (see EN 1995-1-1:2004, 9.1.1) and have some bending stresses. Plywood can also be used as a shear member in roof, floor and wall diaphragms (see EN 1995-1-1:2004, 9.2.3 and 9.2.4), where bending moment is mainly taken by nailed flange members (e.g. structural timber members in wall diaphragms). EN 1995-1-1:2004, Figure 9.1 and Formulae (9.6) and (9.7) defines the method how compressive and tensile strength should be taken in the in-plane bending unless other values are given. Note that for structural wood-based panels, there is no valid EN 789 test method for in-plane bending.

Unless other values are given, values in Table 5 given for in plane loading shall be used.

Annex A
(informative)

Format for the presentation of characteristic values

Plywood according to EN 13986

Complying with EN 636

For use un service class N according to EN 1995-1-1

Manufactured by:

The characteristic values given below are determined according to:

EN 789 and EN 1058

EN 14272

or

EN 12369-2

(Delete options above not applied)

Table A.1 — Format for characteristic strength and density

Thickness mm	Number of layers	Characteristic strength (N/mm²) and density (kg/m³)										
		Density	Bending		Tension		Compression		Shear			
									Panel		Planar	
			$f_{m,0,k}$	$f_{m,90,k}$	$f_{t,0,k}$	$f_{t,90,k}$	$f_{c,0,k}$	$f_{c,90,k}$	$f_{v,0,k/fv,90,k}$		$f_{r,0.k}$	$f_{r,90.k}$
—	—	—	—	—	—	—	—	—	—		—	—

Table A.2 — Format for mean modulus of elasticity

Thickness m	Number of layers	Mean modulus of elasticity N/mm²								
		Bending		Tension		Compression		Shear		
								Panel	Planar	
		$E_{m,0,mean}$	$E_{m,90,mean}$	$E_{t,0,mean}$	$E_{t,90,mean}$	$E_{c,0,mean}$	$E_{c,90,mean}$	$G_{v,0,mean}$ / $G_{v,90,mean}$	$G_{r,0,mean}$	$G_{r,90,mean}$
—	—	—	—	—	—	—	—	—	—	—

The 5th percentile values for stiffness are taken as:

0,67 times the mean values above for panels made of, fully or partly, softwood species.

0,84 times the mean values above for panel made of hardwood species with a mean density at least equal to 640 kg/m³.

NOTE Factors are derived from EN 338:2016, Annex A.

Relevant information for the application of this document:

— classification of the panel in accordance with EN 636;

— composition of the panel claiming to belong to a given class;

— mean density of the panel.

Annex B
(informative)

Information about the conversion factors

NOTE The conversion factors were derived from data published before as material for previous versions of EN 12369-2.

B.1 Tension – Compression

B.1.1 General

For each panel type, the average of the property (strength and modulus of elasticity in bending, tension and compression) was calculated for all the Tabled thickness along the face grain and across.

Then in each direction, the ratio of the mean for tension upon bending was calculated (for modulus and strength) and the same was made for compression.

Then, for all the panel types, for the ratios thus obtained, the 5th percentile value was calculated using normal and log-normal distributions.

B.1.2 Strength

The analysis of the results leads to the following conversion factors, given in Table B.1.

Table B.1 — Conversion factors for the derivation of characteristic values for tension and compression strengths based on bending strength

Properties	f_t/f_m		f_c/f_m	
Grain direction	0	90	0	90
Normal distribution	0,51	0,56	0,48	0,63
Log-normal distribution	0,49	0,54	0,46	0,62
Rounded values	0,40	0,50	0,40	0,50

The rounded values were taken to derive Table 2 class values for tension and compression strength.

B.1.3 Modulus of elasticity

For tension and compression the Tables of performances provided the same values in both grain directions. The analysis of the results leads to the following conversion factors, given in Table B.2.

Table B.2 — Conversion factors for the derivation of characteristic values for modulus of elasticity in tension and compression based on bending strength

Properties	$E_{t,c}/E_m$	
Grain direction	0°	90°
Normal distribution	0,64	0,93
Log-normal distribution	0,63	0,86
Rounded values	0,40	0,80

The rounded values were taken to derive Table 3 class values for tension and compression modulus.

B.2 Shear properties

The documented properties were:

— strength in panel shear (f_v);

— planar shear (f_r);

— modulus of elasticity for panel shear (G_v) only.

For each panel type, a single value was provided foreach these properties together with the mean density.

For each of these properties a linear correlation was established with density, the standard deviation corresponding to the ordinate and its lower estimate were calculated in order to have a 5th percentile value for the ordinate. The following relation was used:

$$V_{pk0} = a + b \times \rho_{0,mean} \; \square \; \square_0 \tag{B.1}$$

where

V_{pk0} is the 5th percentile value for the property p;

a, b respectively are ordinate and slope of the regression line;

$\square_0$ is derived from Formula (B.2).

Using (B.1) lead to the following equations.

Panel shear modulus	**Planar shear modulus**
$G_{v0} = 0,83 \times \rho_{0,mean} + 54 \; \square \; \square_0$	$G_{r0} = \exp\left(\frac{6,7}{1000} \times \rho_{0,mean} + 0,47 \; \square \; \square_0\right)$
Panel shear strength	**Planar shear strength**
$f_{v0} = \frac{14}{1000} \times \rho_{0,mean} \; \square \; 0,5 \; \square \; \square_0$	$f_{r0} = \exp\left(\frac{2,4}{1000} \times \rho_{0,mean} \; \square \; 0,70 \; \square \; \square_0\right)$
$\square_0 = t_{05} \times \left(1 \; \square \; r^2\right) \times \left(\frac{n \; \square \; 1}{n \; \square \; 2}\right) \times S_p \times \left(1 + \frac{1}{n} + \frac{\left(\rho_0 \; \square \; \rho\right)^2}{\sum_{i=1}^{i=n} \left(\rho_i \; \square \; \bar{\rho}^2\right)}\right)^{\frac{1}{2}}$ (B.2)	

where

r is the coefficient of correlation between property p and density;

t_{05} is the Student coefficient so as to have a 5th percentile value (single sided distribution);

S_p is the standard deviation of the property p.

These equations were used to derive Table 4 values for shear properties.

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