SLOVENSKI STANDARD
SIST EN 14272:2012

01-april-2012

Nadomešča:
SIST-TS ENV 14272:2004

Vezan les - Računske metode za nekatere mehanske lastnosti

Plywood - Calculation method for some mechanical properties

Sperrholz - Rechenverfahren für einige mechanische Eigenschaften

Contreplaqué - Méthode de calcul pour certaines caractéristiques mécaniques

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Ta slovenski standard je istoveten z: **EN 14272:2011**

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ICS:

79.060.10	Vezan les	Plywood

SIST EN 14272:2012 **en,fr,de**

2003-01.Slovenski inštitut za standardizacijo. Razmnoževanje celote ali delov tega standarda ni dovoljeno.

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 14272

December 2011

ICS 79.060.10

Supersedes ENV 14272:2002

English Version

Plywood - Calculation method for some mechanical properties

Contreplaqué - Méthode de calcul pour certaines caractéristiques mécaniques

Sperrholz - Rechenverfahren für einige mechanische Eigenschaften

This European Standard was approved by CEN on 1 October 2011.

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COMITÉ EUROPÉEN DE NORMALISATION
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Foreword

This document (EN 14272:2011) 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of an identical text or by endorsement, at the latest by June 2012, and conflicting national standards shall be withdrawn at the latest by June 2012.

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 ENV 14272:2002.

Annex A and Annex B are normative.

Compared to ENV 14272:2002, the following modifications have been made:

a) calculation applies to panels of any composition, symmetrical or not;

b) values resulting for the panels can be used for calculation as characteristics values as required by EN 1995-1-1;

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c) new Annex A (normative) provides the derivation for the veneer values (basic values);

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d) new Annex B (normative) provides practical spreadsheets to derive the properties;

e) new Annex C (informative) gives an example of bending strength.

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, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

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1 Scope

This European Standard specifies, for plywood panels of any composition, symmetrical or not, a calculation method to derive some mechanical properties (strength and stiffness in bending, tension, compression, panel and planar shear) as well as density from the wood compounding the layers.

NOTE Usually, the lay-up of the panels is symmetrical but, very often, the surface appearance of the face and the surface appearance of the back face differ, hence a difference between the mechanical properties of the respective veneers. Therefore, in this case, the composition is not mechanically symmetrical and a symmetry independent calculation method is needed.

Provided that structural characteristic values are taken for the layers, the resulting values for the panels can be used as characteristic values as required by EN 1995-1-1.

Conversely, Annex A defines the procedures to derive the veneer properties, in bending, tension and compression, either from testing panels according to EN 789 and EN 1058 or from timber testing according to EN 408 or from imposed values defined in EN 338.

Annex B provides practical spreadsheets, which are applications of the equations in the main part of this standard.

Annex C provide an example for the calculation of bending strength, in accordance with Annex B.

2 Normative references

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The following referenced documents are indispensable for the application 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.

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EN 325, *Wood-based panels — Determination of dimensions of test pieces*

EN 338:2009, *Structural timber — Strength classes*

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

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

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

EN 1058, *Wood-based panels — Determination of characteristic 5-percentile values and characteristic mean values*

EN 12369-2, *Wood-based panels — Characteristic values for structural design — Part 2 Plywood*

EN 14358, *Timber structures — Calculation of characteristic 5-percentile values and acceptance criteria for a sample*

3 Principle

Using the mechanical properties of the wood species, which compound the layers (in this standard referred to as veneer or basic values), it consists in deriving, by calculation, the mechanical properties of a panel.

For bending, tension and compression, each layer property value, along and across the length of the panel, is weighted by a geometrical factor related to its weight in the panel cross section.

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In this standard, where a value for a given property of the veneers is derived with a specified test method (including exploitation of the results), the models in this standard will provide a panel value for that property as if derived with the specified test method.

EXAMPLE For instance, if, in a panel composition, a specified percentile of a bending property of veneers is determined with EN 789 and EN 1058, the calculated value of the bending property of the panel will be its specified percentile as if determined by using EN 789 and EN 1058.

4 Terms and definitions

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

4.1
characteristic strength
population fifth percentile value relating to a temperature of 20 °C and a relative humidity of 65 %

4.2
characteristic stiffness
either the population fifth percentile or the mean value relating to a temperature of 20 °C and a relative humidity of 65 %

4.3
characteristic density
population fifth percentile value with mass and volume corresponding to equilibrium at a temperature of 20 °C and a relative humidity of 65 % either of the wood species or of the panels, single species or mixed species

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NOTE The density values found from calculation refer to the minimum acceptable density of veneers used in the lay-up of plywood. In the case of single species plywood these values are taken as the characteristic values for the plywood. In the case of mixed species plywood the characteristic value of density of the panel is calculated from the characteristic densities of the individual veneers according to the proportion of each species

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4.4
veneer value or basic value
characteristic value of a property to be used for each layer in the equations of the calculation method

NOTE Characteristic values of the wood species, along and across the grain, are fifth percentile values for strength but either mean values or fifth percentile values for stiffness (modulus of elasticity).

4.5
reference panel value
value of a given mechanical property of a panel composition

NOTE It is to be used to derive the veneer value (or basic value) of the property.

5 Symbols

5.1 Main symbols

A area ($b \cdot t_{nom}$), in square millimetres

f strength, in Newtons per square millimetre

E modulus of elasticity, in Newton per square millimetre

Fs shear forces in a bending panel, in Newtons

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G modulus of rigidity, in Newtons per square millimetre

b width of panel (equal to 1 in the equations), in millimetres

t, thickness of layers, in millimetres

T thickness of panels, in millimetres

W section modulus, equal to $\left(b.t_{nom}^2 / 6\right)$, in cubic millimetres

I second moment of area, equal to $\left(b.t_{nom}^3 / 12\right)$, in millimetres to the fourth power

ρ density, in kilograms per cubic metre

k_a modification factor, appearance class grade

z distance of the axis of a layer to the neutral axis of the panel, in millimetres

Z distance of the neutral axis from either face of the panel, in millimetres

Ecc eccentricity factor, no dimension

$\Delta L/L$ relative elongation of the layers (bending, tension and compression)

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P property

V strength or modulus, in Newton per square millimetre

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Rw in the set of layers, the weaker ratio of strength upon modulus for the properties of the wood species involved in the composition of a panel

Up stiffness of the panel

s standard deviation

5.2 Subscripts

m bending

t tension

c compression

v panel shear

r planar shear

w applies to the lower ratio strength/modulus (*f*/*E*) of a property of a layer in a multi-species panel

nom, mean nominal value and mean value respectively

n number of layers of the panel (from top face to bottom face)

i rank of layers from top face

ax stands for neutral axis in bending

ρ density

0 parallel to length of the plywood (direction of the grain of the face layers)

90 perpendicular to the length

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05 5 percentile characteristic value

6 Calculation method

6.1 General

The mechanical properties of plywood, in bending, tension, compression panel shear and planar shear can be derived by calculation.

The calculation method described in this standard can be applied to plywood panels of any composition, symmetrical or not.

For the classification according to appearance classes of plywood, see EN 635-2 and EN 635-3.

6.2 Properties relevant to the calculation methods

For calculation of characteristic values of mechanical properties for different plywood compositions, the values of the properties of the veneers compounding the layers shall be derived in accordance with Annex A.

The relevant properties are as listed in Table 1.

6.3 Wood species

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For calculating the characteristic values of panel mechanical properties, test values shall be used where available for each wood species in the plywood panel composition; where not, imposed values from EN 338 shall be used.

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NOTE EN 338 values, related to the density of the wood species, are quite conservative and therefore should be used as a last resort option.

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6.4 Factors for plywood composition

The characterization of plywood composition is shown in Table 2.

For the purposes of calculation, if two or more plies are glued together in the same grain direction, they can be considered as one single layer provided that they belong to the same wood species; otherwise they shall be considered as independent layers.

The calculations are based on the following equations:

$V_i = E_i$ (Modulus of elasticity of the i^{th} layer in Table 2) (1)

or

$V_i = f_i$ (Strength of the i^{th} layer in Table 2) (2)

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Table 1 — Property values for the calculation method

Property
Characteristic strength values, N/mm^2
$f_{m,\,05}$: Bending
$f_{t,\,05}$: Tension
$f_{c,\,05}$: Compression
$f_{v,\,05}$: Panel shear
$f_{r,\,05}$: Planar shear
Mean values for stiffness properties, N/mm^2
E_m: Bending
E_t: Tension
E_c: Compression
G_v: Panel shear
Characteristic values for stiffness properties, N/mm^2
$E_{m,\,05}$: Bending
$E_{t,\,05}$: Tension
$E_{c,\,05}$: Compression
$G_{v,\,05}$: Panel shear
$\rho_{,\,05}$: Density values, kg/m^3

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Table 2 — Plywood composition factors

Layer rank	Wood Species	t_i (mm)	V_i (N/mm²)	k_{ai}	**Grain direction**
1					==========
2					IIIIIIIIIIIIIIIIIIII
3					==========
----------	----------	----------	----------	----------	----------
i -1					==========
i					IIIIIIIIIIIIIIIIIIII
i+1					==========
----------	----------	----------	----------	----------	----------
n -2					==========
n -1					IIIIIIIIIIIIIIIIIIII
n					==========

t_i : layer thickness

V_i : mechanical property of the i^{th} layer

k_a : appearance factor

====== : grain along the length

IIIIIIIIIIIIIII : grain across the length

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7 Characteristic values for strength and stiffness in bending, tension and compression

7.1 General

The properties of the panels are derived from those of their layers as if the panels were homogenous. The equations are based on strength of materials.

7.2 Bending

7.2.1 General

The general equation to be used for the derivation of the second moment of area of a cross section is based on the area A_i of the elementary rectangles compounding the cross section of the panel:

$$I = \sum_{i=1}^{i=n} A_i \times z_i^2 + \sum_{i=1}^{i=n} \frac{A_i \times t_i^2}{12} \tag{3}$$

NOTE This equation can be applied to any composition, symmetrical or not.

If calculation is based on a unit of width, Equation (3) becomes:

$$I = \sum_{i=1}^{i=n} t_i \times z_i^2 + \sum_{i=1}^{i=n} \frac{t_i^3}{12} \tag{4}$$

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7.2.2 Modulus of elasticity

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The stiffness of the panel (as if homogenised) is equal to the sum of the stiffness of the compounding layers as defined by the following equation:

$$Ep_m \times I = Ep_m \times \frac{T^3}{12} = \sum_{i=1}^{i=n} V_{mi} \times t_i \times z_i^2 + \sum_{i=1}^{i=n} \frac{V_{mi} \times t_i^3}{12} \tag{5}$$

$$Ep_m = \frac{12 \times \sum_{i=1}^{i=n} V_{mi} \times t_i \times z_i^2 + \sum_{i=1}^{i=n} V_{mi} \times t_i^3}{\left(\sum_{i=1}^{i=n} t_i \right)^3} \tag{6}$$

Width is assumed to be equal to 1 unit.

Cross layers properties can be taken into account where the values are derived from timber.

E_{mi} shall be input as 0 wherever the cross layers are not taken into account in the determination of the basic values as defined in Annex A.

Annex B provide practical spreadsheets to carry out this calculation (see Tables B.1 and B.2).

7.2.3 Strength

The capacity of the panel (as if homogenised) is equal to the sum of the capacities of the compounding layers as defined by the following equations: