



SLOVENSKI STANDARD
SIST-TS ENV 14272:2004
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Plywood - Calculation method for some mechanical properties

Sperrholz - Rechenverfahren für einige mechanische Eigenschaften

Contreplaqué - Méthode de calcul de certaines propriétés mécaniques

Ta slovenski standard je istoveten z: ENV 14272:2002

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ICS:

79.060.10 Vežan les Plywood

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EUROPEAN PRESTANDARD
PRÉNORME EUROPÉENNE
EUROPÄISCHE VORNORM

ENV 14272

June 2002

ICS 79.060.10

English version

Plywood - Calculation method for some mechanical properties

Contreplaqué - Méthode de calcul pour certaines
caractéristiques

Sperrholz - Rechenverfahren für einige mechanische
Eigenschaften

This European Prestandard (ENV) was approved by CEN on 5 April 2002 as a prospective standard for provisional application.

The period of validity of this ENV is limited initially to three years. After two years the members of CEN will be requested to submit their comments, particularly on the question whether the ENV can be converted into a European Standard.

CEN members are required to announce the existence of this ENV in the same way as for an EN and to make the ENV available promptly at national level in an appropriate form. It is permissible to keep conflicting national standards in force (in parallel to the ENV) until the final decision about the possible conversion of the ENV into an EN is reached.

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

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Foreword

This document ENV 14272:2002 has been prepared by Technical Committee CEN/TC 112 "Wood-based panels", the secretariat of which is held by DIN.

The annexes A and B are informative.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to announce this European Prestandard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

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ENV 14272:2002 (E)

1 Scope

This European Prestandard gives a calculation method for the estimation of some mechanical properties of plywood (strength and stiffness) with a symmetrical composition.

The resulting values are intended as predictive only.

2 Normative references

This European Prestandard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Prestandard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

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

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

EN 636-1, *Plywood — Specifications — Part 1: Requirements for plywood for use in dry conditions.*

EN 636-2, *Plywood — Specifications — Part 2: Requirements for plywood for use in humid conditions.*

EN 636-3, *Plywood — Specifications — Part 3: Requirements for plywood for use in exterior conditions.*

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3 Principle

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To derive by calculation the mechanical properties of a panel, using the corresponding mechanical properties of the wood species compounding the layers. Each pair of layers (or layer) values are weighted by a geometrical factor related to its weight in the panel cross section.

4 Terms and definitions and symbols

4.1 Terms and definitions

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

4.1.1

characteristic strength

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

4.1.2

characteristic stiffness

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

4.1.3

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

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

4.1.4

basic value

characteristic value of properties to be used in the equations of the calculation method for each pair of layers (or layer)

NOTE Characteristic values are mean values for modulus of elasticity and fifth percentile values for strengths and modulus of elasticity.

4.2 Symbols

In the tables the following symbols are used:

4.2.1 Main symbols

A	Area ($b \cdot t_{\text{nom}}$), in square millimetres
f	Strength, in newtons per square millimetre
E	Modulus of elasticity, in newtons per square millimetre
G	Modulus of rigidity, in newtons per square millimetre
b	Unit width of panel, in millimetres
t	Thickness of panel or a pair of layers, in millimetres
W	Section modulus, equal to $\left(\frac{bt_{\text{nom}}^2}{6}\right)$, in cubic millimetres
I	Second moment of area, equal to $\left(\frac{bt_{\text{nom}}^3}{12}\right)$, in millimetres to the fourth power
ρ	Density, in kilograms per cubic metre
k_a	Modification factor, appearance class
a	Thickness of the layer (distance between the outer faces of a pair of layers), in millimetres
$\Delta L / L$	Relative elongation of the face plies (bending, tension and compression)
V	Strength or modulus, in newtons per square millimetre

4.2.2 Subscripts

m	Bending
t	Tension
c	Compression
v	Panel shear
r	Planar shear
w	Applies to the plywood species with the lower ration strength/modulus (f / E) for a given property in a panel with a lay-up mixing several species
nom	Nominal
n	Number of pairs of layers of the panel
j	Pair of layers (or layer) under consideration starting from the face, associated to n , its value is comprised between 1 and n
i	Starting from the face, rank of pair of layers having the shortest relative elongation in failure (bending, tension and compression)

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- ρ Density
0 Length of the plywood (direction of the grain of the outer layers)
90 Perpendicular to the length
05 5 percentile characteristic value

5 Calculation method**5.1 General**

The estimate of the mechanical properties of plywood can be found by calculation.

The calculation method described can only be applied to plywood panels with a symmetrical composition.

For the classification of plywood see:

- EN 636-1 for use in dry conditions
- EN 636-2 for use in humid conditions
- EN 636-3 for use in exterior conditions

5.2 Basic values for the calculation method

For calculation of an estimate of characteristic values of mechanical properties for different plywood compositions, the basic values of the layers are derived from the characteristic values of the properties of single species plywood panels.

NOTE Annex B gives a method for deriving basic values.

Depending on the purpose, the basic values for layers are derived from testing small or semi-size test pieces.

The needed basic values are as given in Table 1.

Table 1 — Basic 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 stiffness values, N/mm ²
E_m : Bending
E_t : Tension
E_c : Compression
G_v : Panel shear
Characteristic stiffness values, 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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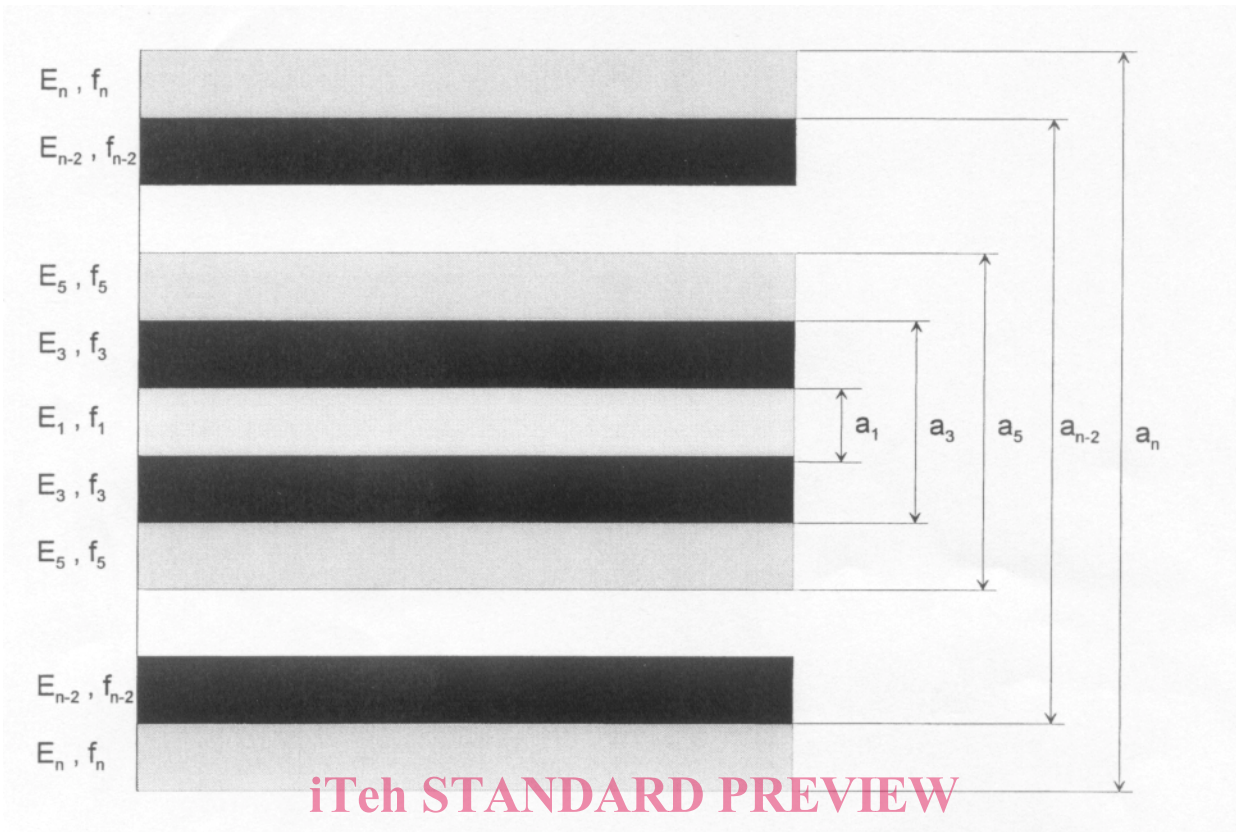
5.3 Wood species

For calculating an estimate of the characteristic values of mechanical properties basic values for each wood species concerned in the plywood composition shall be used.

5.4 Factors for plywood composition

The characterization of plywood composition is shown in Figure 1.

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NOTE If two or more plies are glued together in the same grain direction, they are considered as one single layer for the purposes of calculation.

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Figure 1 — Plywood composition

The calculations are based on the following equations:

$$V_{n-j} = E_{n-j} \quad (\text{stiffness}) \quad (1)$$

or

$$V_{n-j} = f_{n-j} \quad (\text{strength})$$

where E_n is the modulus and f_n is the strength of the n 'th pair of layers in Figure 1.

5.5 Calculation of characteristic values for strength and stiffness

5.5.1 Bending

5.5.1.1 General

$$V_{n-j} = V \cdot (I_{n-j}) / I \quad (2)$$

where V is defined in equation (1) and I is the moment of inertia of the full cross section of the panel per unit of width.

I_j is the moment of inertia, per unit of width, of the pair of layer under consideration along (0) or across (90) the grain.

Property $V_{0,n}$ along the grain (0) of the face layer per unit width:

When the grain direction of the central layer is at right angles to the grain direction of the face layer, equation (3.1) shall be used:

$$V_{0,n} = \frac{a_n^3 - a_{n-2}^3}{a_n^3} \times V_n + \frac{a_{n-4}^3 - a_{n-6}^3}{a_n^3} \times V_{n-4} + \dots + \frac{a_3^3 - a_1^3}{a_n^3} \times V_3 \quad (3.1)$$

When the grain direction of the central layer is parallel to the grain direction of the face layer, equation (3.2) shall be used:

$$V_{0,n} = \frac{a_n^3 - a_{n-2}^3}{a_n^3} \times V_n + \frac{a_{n-4}^3 - a_{n-6}^3}{a_n^3} \times V_{n-4} + \dots + \frac{a_5^3 - a_3^3}{a_n^3} \times V_5 + \frac{a_1^3}{a_n^3} \times V_1 \quad (3.2)$$

Property $V_{90,n}$ across the grain (90) of the face layer per unit width:

When the grain direction of the central layer is at right angles to the grain direction of the face layer, equation (3.3) shall be used:

$$V_{90,n} = \left[\frac{a_{n-2}^3 - a_{n-4}^3}{a_n^3} \times V_{n-2} + \frac{a_{n-6}^3 - a_{n-8}^3}{a_n^3} \times V_{n-6} + \dots + \frac{a_1^3}{a_n^3} \times V_1 \right] \times \mu \quad (3.3)$$

When the grain direction of the central layer is parallel to the grain direction of the face layer, equation (3.4) shall be used:

$$V_{90,n} = \left[\frac{a_{n-2}^3 - a_{n-4}^3}{a_n^3} \times V_{n-2} + \frac{a_{n-6}^3 - a_{n-8}^3}{a_n^3} \times V_{n-6} + \frac{a_7^3 - a_5^3}{a_n^3} \times V_7 + \frac{a_3^3 - a_1^3}{a_n^3} \times V_3 \right] \times \mu \quad (3.4)$$

where

$$\mu = \frac{a_n}{a_{n-2}} \text{ in case of strength calculation} \quad (3.5)$$

$\mu = 1$ in case of stiffness (modulus of elasticity) calculation

5.5.1.2 Strength (f_m)

The bending strength along the grain (0) of the face layer shall be calculated from the equations (3.1) or (3.2) by substituting V_{n-j} defined in equation (3.6.1):

$$V_{n-j} = k_a \cdot E_{n-j} \cdot (a_{n-j} / a_n) \cdot [f_i / E_i \cdot (a_n / a_i)]_w \quad (3.6.1)$$

The bending strength across the grain (90) of the face layer shall be calculated from the equations (3.3) or (3.4) using equation (3.6.2). See notation in 5.5.1.4.

$$V_{n-j} = k_a \cdot E_{n-j} \cdot (a_{n-j} / a_n) \cdot [f_i / E_i \cdot (a_{n-2} / a_i)]_w \quad (3.6.2)$$

Where

f , E respectively are the strength and modulus of the layers

k_a is a modification factor related to plywood grades ; it is a factor depending on the appearance class in accordance with EN 635-2 for hardwood and EN 635-3 for softwood (see Table 2). The k_a factor for the minimum appearance class in the composition shall be used.

a_n is the distance between the outer faces of the surface layers (thickness of the panel)

a_i is the distance between the outer faces of the pair of layers having the lowest $\Delta L / L$ factor