BS EN ISO 11833-1:2012

BSI Standards Publication

Plastics — Unplasticized poly(vinyl chloride) sheets — Types, dimensions and characteristics

Part 1: Sheets of thickness not less than 1 mm (ISO 11833-1:2012)

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National foreword

This British Standard is the UK implementation of EN ISO 11833-1:2012. It supersedes BS EN ISO 11833-1:2007 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PRI/75, Plastics and rubber film and sheets.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Compliance with a British Standard cannot confer immunity from legal obligations.

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Plastics - Unplasticized poly(vinyl chloride) sheets - Types, dimensions and characteristics - Part 1: Sheets of thickness not less than 1 mm (ISO 11833-1:2012)

Plastiques - Feuilles en poly(chlorure de vinyle) non plastifié - Types, dimensions et caractéristiques - Partie 1: Plaques d'épaisseur non inférieure à 1 mm (ISO 11833-1:2012)

Kunststoffe - Weichmacherfreie Polyvinylchloridtafeln - Typen, Maße und Eigenschaften - Teil 1: Tafeln mit einer Dicke von mindestens 1 mm (ISO 11833-1:2012)

This European Standard was approved by CEN on 23 June 2012.

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Foreword

This document (EN ISO 11833-1:2012) has been prepared by Technical Committee ISO/TC 61 "Plastics" in collaboration with Technical Committee CEN/TC 249 “Plastics” the secretariat of which is held by NBN.

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of an identical text or by endorsement, at the latest by January 2013, and conflicting national standards shall be withdrawn at the latest by January 2013.

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.

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Endorsement notice

The text of ISO 11833-1:2012 has been approved by CEN as a EN ISO 11833-1:2012 without any modification.

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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ISO 11833-1 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 11, *Products*.

This third edition cancels and replaces the second edition (ISO 11833-1:2007), of which Table 5 (concerning the basic properties of the sheets) and Clause 7 (concerning marking) have been technically revised.

ISO 11833 consists of the following parts, under the general title *Plastics — Unplasticized poly(vinyl chloride) sheets — Types, dimensions and characteristics*:

— *Part 1: Sheets of thickness not less than 1 mm*

— *Part 2: Sheets of thickness less than 1 mm*

Plastics — Unplasticized poly(vinyl chloride) sheets — Types, dimensions and characteristics —

Part 1:
Sheets of thickness not less than 1 mm

1 Scope

This part of ISO 11833 specifies the requirements for flat extruded sheets and pressed sheets of unplasticized poly(vinyl chloride) (PVC-U) and the test methods to be used to measure the required values.

It applies only to sheets of thickness not less than 1,0 mm.

It does not cover biaxially stretched PVC-U sheets.

2 Normative references

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.

ISO 75-2:2004, *Plastics — Determination of temperature of deflection under load — Part 2: Plastics and ebonite*

ISO 178, *Plastics — Determination of flexural properties*

ISO 179-1, *Plastics — Determination of Charpy impact properties — Part 1: Non-instrumented impact test*

ISO 291, *Plastics — Standard atmospheres for conditioning and testing*

ISO 306:2004, *Plastics — Thermoplastic materials — Determination of Vicat softening temperature (VST)*

ISO 527-2, *Plastics — Determination of tensile properties — Part 2: Test conditions for moulding and extrusion plastics*

ISO 899-2, *Plastics — Determination of creep behaviour — Part 2: Flexural creep by three-point loading*

ISO 1163-1:1995, *Plastics — Unplasticized poly(vinyl chloride) (PVC-U) moulding and extrusion materials — Part 1: Designation system and basis for specifications*

ISO 1183-1, *Plastics — Methods for determining the density of non-cellular plastics — Part 1: Immersion method, liquid pyknometer method and titration method*

ISO 1183-2, *Plastics — Methods for determining the density of non-cellular plastics — Part 2: Density gradient column method*

ISO 2039-1, *Plastics — Determination of hardness — Part 1: Ball indentation method*

ISO 2818, *Plastics — Preparation of test specimens by machining*

ISO 13468-1, *Plastics — Determination of the total luminous transmittance of transparent materials — Part 1: Single-beam instrument*

IEC 60093, *Methods of test for volume resistivity and surface resistivity of solid electrical insulating materials*

3 Material

Sheets shall be fabricated from PVC-U compounds as defined in ISO 1163-1:1995, Subclause 1.3. Compounds may contain additives such as stabilizers, lubricants, processing aids, impact modifiers, fillers, flame retardants and colourants. Compounds and additives of unknown identity and composition shall not be used for the processing of sheets.

4 Classification

Extruded and pressed sheets are each classified into the following five groups, characterized by type of sheet as well as by the numerical values of the three most important properties, i.e. tensile stress at yield, Charpy impact strength and Vicat softening temperature (see Table 5):

Group 1: General-purpose grade;

Group 2: Transparent grade;

Group 3: High-modulus grade;

Group 4: High-impact grade;

Group 5: Heat-resistant grade.

5 Requirements

5.1 Masking

Protection of the sheet surface with a suitable material (for example polyethylene or paper) shall be agreed between the interested parties as required.

5.2 Appearance

The surface shall be free of noticeable flaws, cracks, mottling, voids, bubbles, impurities and other defects which are not acceptable for the application envisaged. The sheet shall have a smooth surface, except for embossed sheets which shall have a uniform pattern.

5.3 Colour

Colourants and pigments shall be distributed uniformly throughout the material. Admissible differences in colour within a sheet and amongst sheets shall be agreed between the interested parties as required.

5.4 Dimensions

5.4.1 Length and width

The nominal length and width of sheets shall be agreed between the interested parties. For any individual sheet selected at random from any delivery, the tolerances shall be as specified in Table 1.

Table 1 — Tolerances on length and width

All values in millimetres

Nominal dimension D_n	Tolerance on length and width	
	Extruded sheet	Pressed sheet
$D_n \leq 500$	$^{+3}_{0}$	$^{+4}_{0}$
$500 < D_n \leq 1\,000$	$^{+4}_{0}$	
$1\,000 < D_n \leq 1\,500$	$^{+5}_{0}$	
$1\,500 < D_n \leq 2\,000$	$^{+6}_{0}$	
$2\,000 < D_n \leq 4\,000$	$^{+7}_{0}$	

5.4.2 Rectangularity

For any individual sheet selected at random from any delivery, the tolerance on rectangularity, expressed as the difference in length of the diagonals, shall be as specified in Table 2.

Table 2 — Tolerances on rectangularity

All values in millimetres

Nominal dimensions (length × width)	Tolerance (difference between diagonals)	
	Extruded sheet	Pressed sheet
1 800 × 910	7	5
2 000 × 1 000	7	5
2 440 × 1 220	9	7
3 000 × 1 500	11	8
4 000 × 2 500	17	13

The tolerances specified in Table 2 assume that the length and width of the sheet comply with Table 1.

Tolerances on sheets of other nominal dimensions shall be calculated, in millimetres, using the following equations and rounded to the nearest integer:

Extruded sheet:

$$\left|\overline{AC}-\overline{BD}\right| = \sqrt{(\overline{AB}+4\overline{BC}/1\,000)^2+\overline{BC}^2} - \sqrt{(\overline{AB}-4\overline{BC}/1\,000)^2+\overline{BC}^2}$$

Pressed sheet:

$$\left|\overline{AC}-\overline{BD}\right| = \sqrt{(\overline{AB}+3\overline{BC}/1\,000)^2+\overline{BC}^2} - \sqrt{(\overline{AB}-3\overline{BC}/1\,000)^2+\overline{BC}^2}$$

where $\left|\overline{AC}-\overline{BD}\right|$ is the deviation from rectangularity (see Figure 1).

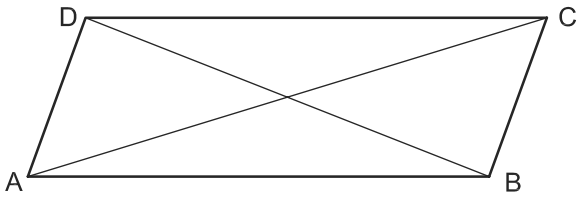


Figure 1 — Deviation from rectangularity

5.4.3 Thickness

The thickness shall be determined in accordance with 6.3. The tolerance on the thickness shall be as specified in Table 3 for non-critical applications (T_1) or as specified in Table 4 for critical applications (T_2), as agreed between the interested parties.

Table 3 — Tolerances on thickness for non-critical applications (T_1)

Nominal thickness, d mm	**Tolerance** %	
	Extruded sheet	Pressed sheet
$1 \leq d \leq 5$	±13	±15
$5 < d \leq 20$	±10	±10
$d > 20$	±7	±7
NOTE Tolerances for embossed sheets shall be agreed between interested parties as required.		

Table 4 — Tolerances on thickness for critical applications (T_2)

	Tolerance mm
Extruded sheet	±(0,1 + 0,03 × nominal thickness)
Pressed sheet	±(0,1 + 0,05 × nominal thickness)
NOTE Tolerances for embossed sheets shall be agreed between interested parties as required.	

5.5 Basic properties

The basic mechanical, thermal and optical properties of sheets of each group shall be as specified in Table 5.

Table 5 — Basic properties of sheets

Properties	Test method	Unit	Requirements by manufacturing methods and types (average values)									
			Extruded sheets					Pressed sheets				
			Group 1 General purpose	Group 2 Trans-parent	Group 3 High modulus	Group 4 High impact	Group 5 Heat resistant	Group 1 General purpose	Group 2 Trans-parent	Group 3 High modulus	Group 4 High impact	Group 5 Heat resistant
Tensile stress at yield	ISO 527-2 Type 1B	MPa	≥ 50	≥ 45	≥ 60	≥ 45	≥ 50	≥ 50	≥ 45	≥ 60	≥ 45	≥ 50
Nominal strain at break	ISO 527-2 Type 1B	%	≥ 8	≥ 5	≥ 3	≥ 8	≥ 10	≥ 5	≥ 5	≥ 8	≥ 10	≥ 8
Modulus of elasticity in tension	ISO 527-2 Type 1B	MPa	≥ 2 500	≥ 2 000	≥ 3 200	≥ 2 300	≥ 2 500	≥ 2 500	≥ 2 500	≥ 3 000	≥ 2 000	≥ 2 500
Charpy impact strength of notched specimens	ISO 179-1 Type 1epA	kJ/m^2	≥ 2	≥ 1	≥ 2	≥ 5	≥ 2	≥ 2	≥ 1	≥ 2	≥ 10	≥ 2
Vicat softening temperature	ISO 306:2004 Method B50	°C	≥ 70	≥ 60	≥ 70	≥ 70	≥ 85	≥ 75	≥ 65	≥ 78	≥ 70	≥ 90
Dimensional change on heating	Subclause 6.5.2	%	Nominal thickness 1,0 mm to 2,0 mm: from −10 to +10 Nominal thickness over 2,0 mm to 5,0 mm: from −5 to +5 Nominal thickness over 5,0 mm to 10,0 mm: from −4 to +4 Nominal thickness over 10,0 mm: from −4 to +4					From −3 to +3				
Delamination	Subclause 6.5.2		Not applicable					No blisters, cracks or flaking (delamination)				
Total luminous transmittance (Applicable to group 2 only)	ISO 13468-1	%			Class A: General purpose					Class B: High transparency		
			Nominal thickness 2,0 mm or less:		≥ 80					≥ 82		
			Nominal thickness over 2,0 mm to 6,0 mm:		≥ 71					≥ 78		
			Nominal thickness over 6,0 mm to 10,0 mm:		≥ 61					≥ 75		
			Nominal thickness over 10,0 mm:		—					—		

NOTE Requirements for embossed sheets shall be agreed between interested parties as required.

5.6 Other mechanical and physical properties

Requirements for the properties in Table 6 shall be agreed between the interested parties as required.

Table 6 — Other mechanical and physical properties

Property	Test method	Unit
Charpy impact strength of unnotched specimens at 0 °C and −20 °C	ISO 179-1 Type 1eU/pendulum energy 4 J	kJ/m^2
Temperature of deflection under load	ISO 75-2:2004 Method A	°C
Creep modulus in flexure under stress of 5 MPa	ISO 899-2 40 °C	MPa
Density	ISO 1183-1 or ISO 1183-2	g/cm^3
Flexural strength	ISO 178 b [a] = 35 mm	MPa
Ball indentation hardness	ISO 2039-1	N/mm^2
Volume resistivity	IEC 60093	Ω·cm

[a] b = width of test specimen.

5.7 Chemical and physiological properties

5.7.1 Flammability

Requirements for flammability shall be agreed between the interested parties as required. Relevant national and international standards shall be considered in the agreement.

5.7.2 Chemical resistance

Requirements for chemical resistance for critical applications shall be agreed between the interested parties as required.

5.7.3 Physiological behaviour

Requirements for physiological behaviour shall be agreed between the interested parties as required. The relevant legislation shall be taken into consideration if the sheet is likely to come into contact with food.

6 Test methods

6.1 General

6.1.1 Sampling

Take a sample sufficient to investigate the compliance of the material with this specification. The sampling procedure given in ISO 2859-1 is recommended.

6.1.2 Preparation of specimens

Prepare all specimens in accordance with ISO 2818. The surface of the specimens shall be free of any damage or faults in order to avoid notch effects. Should any burrs be present on a specimen, remove them without damaging the surface. If necessary, finish the edges of the machined surfaces with sandpaper. When it is necessary to machine the sheet to reduce the thickness for a particular test, leave one original surface intact.

6.1.3 Conditioning and testing of specimens

Unless otherwise specified in Clause 5 or hereafter, carry out testing in one of the standard atmospheres specified in ISO 291, after conditioning the specimens for at least 16 h in the same atmosphere.

6.2 Appearance examination

Examine the original and cut surfaces with the naked eye, from a distance of 60 cm, for noticeable flaws, cracks, mottling, voids, bubbles, impurities and other defects, inspecting the sheet in the direction opposite to that of the incident light. Ultrasonic or X-ray examination may also be used to detect voids.

6.3 Dimensions

6.3.1 Measure the length, width and diagonals of the sheet to the nearest 1 mm, using a calibrated ruler or tape measure.

6.3.2 Measure the thickness to the nearest 0,01 mm, using a calibrated thickness gauge.

6.4 Mechanical properties

6.4.1 Tensile stress at yield and nominal strain at break

Determine the tensile stress at yield and the nominal strain at break in accordance with ISO 527-2, using at least five type 1B specimens for each direction and a test speed of 50 mm/min.

6.4.2 Modulus of elasticity in tension

Determine the modulus of elasticity in tension in accordance with ISO 527-2, using at least three type 1B specimens for each direction and a test speed of 1 mm/min.

6.4.3 Charpy impact strength of notched specimens

For nominal thicknesses $\geq$ 4 mm, determine the Charpy impact strength of notched specimens in accordance with ISO 179-1, using at least ten type 1epA specimens cut out in the extrusion direction and at least ten cut out in the transverse direction.

6.5 Thermal properties

6.5.1 Vicat softening temperature

Determine the Vicat softening temperature in accordance with ISO 306:2004, method B50.

6.5.2 Dimensional change on heating and resistance to delamination

6.5.2.1 Specimens

Cut out at least three specimens measuring 120 mm $\times$ 120 mm at the locations in the sample sheet shown in Figure 2.

a) **Extruded sheet** b) **Pressed sheet**

Key

1 specimens
2 direction of extrusion
3 direction of calendering of sublayers

Figure 2 — Locations of specimens

Mark straight lines of length 100 mm ± 2 mm on the specimens in the longitudinal (extrusion or calendering) and transverse directions at a minimum of two places as shown in Figure 3.

Dimensions in millimetres

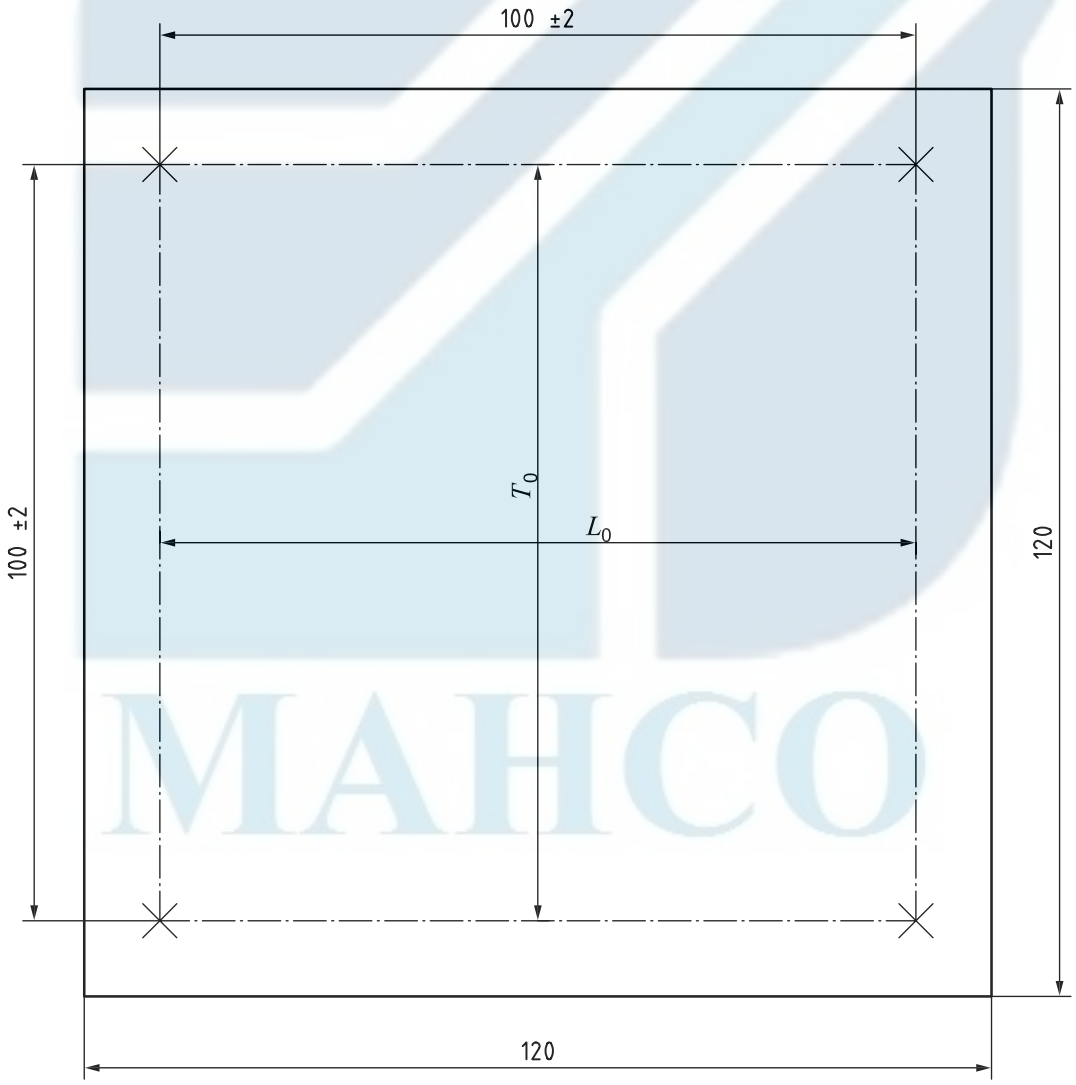


Figure 3 — Marking of specimens

6.5.2.2 Procedure

Heat the specimens in an oven at the temperature and for the time specified in Table 7.

Table 7 — Temperature and duration of heating

Nominal sheet thickness, d_n mm	Temperature °C	Heating time min
$1 \leq d_n \leq 2$	140 ± 2	30 ± 1
$2 < d_n \leq 4$		45 ± 1
$4 < d_n \leq 6$		55 ± 1
$6 < d_n \leq 10$		75 ± 1
$10 < d_n \leq 30$		90 ± 2
$d_n > 30$		120 ± 5
NOTE Heating time means the residence time at the test temperature used.		

Remove the specimens from the oven and allow them to cool to room temperature. Measure the lengths L and T of the marked lines and calculate the change ΔL and ΔT in each, in percent, as follows:

$$\Delta L = \frac{L - L_0}{L_0} \times 100 \quad (1)$$

$$\Delta T = \frac{T - T_0}{T_0} \times 100 \quad (2)$$

where

L_0 is the length of the line in the longitudinal direction prior to heating, expressed in millimetres (100 mm ± 2 mm);

L is the length of the line in the longitudinal direction after heating, expressed in millimetres;

T_0 is the length of the line in the transverse direction prior to heating, expressed in millimetres (100 mm ± 2 mm);

T is the length of the line in the transverse direction after heating, expressed in millimetres.

Calculate the arithmetic average of ΔL and ΔT and report.

Examine the original and cut surfaces of pressed sheets with the naked eye for delamination.

6.5.2.3 Resistance to delamination of pressed sheets

The resistance to delamination of pressed sheets may be determined using a wedge (see Annex A) and the resistance of sheets thicker than 20 mm may also be determined using thermal bending, as required (see Annex B).

6.6 Total luminous transmittance

Determine the total luminous transmittance of colourless transparent sheets in accordance with ISO 13468-1.

6.7 Other mechanical and physical properties

6.7.1 Charpy impact strength of unnotched specimens

Determine the Charpy impact strength of unnotched specimens in accordance with ISO 179-1 at 0 °C or −20 °C with a pendulum impact testing machine, using a pendulum of energy 4 J and at least ten ISO 179-1/1eU (edgewise, unnotched) specimens cut out in each direction.

6.7.2 Temperature of deflection under load

Determine the temperature of deflection under load in accordance with ISO 75-2:2004, method A.

6.7.3 Creep modulus

Determine the flexural creep modulus in accordance with ISO 899-2 under a stress of 5 MPa, at 40 °C and after 10 h, 100 h and 1 000 h.

6.7.4 Density

Determine the density of the sheet in accordance with ISO 1183-1 or ISO 1183-2.

6.7.5 Flexural strength

Determine the flexural strength in accordance with ISO 178.

6.7.6 Ball indentation hardness

Determine the ball indentation hardness in accordance with ISO 2039-1.

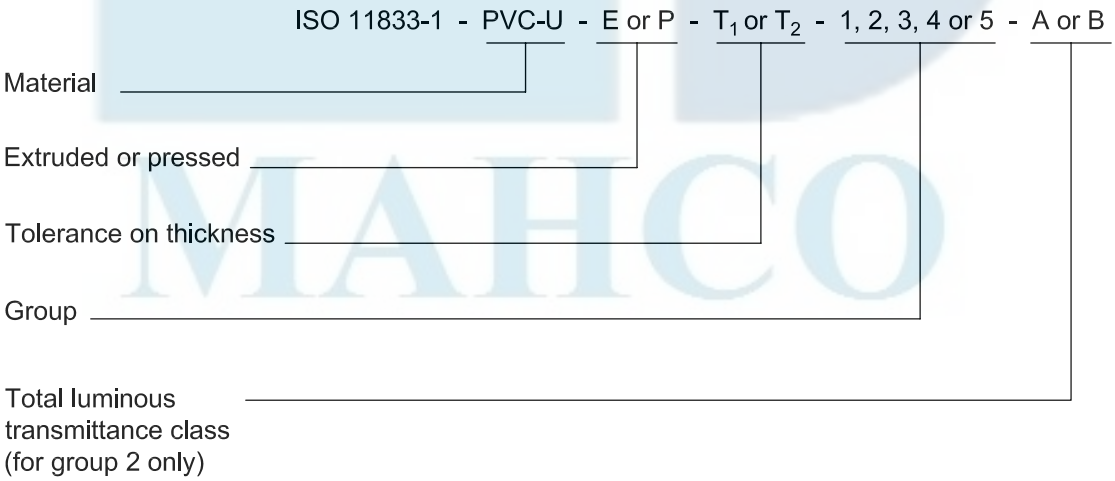
6.7.7 Volume resistivity

Determine the volume resistivity in accordance with IEC 60093.

7 Marking

The following information shall be marked on each package of sheets:

a) the number of this part of ISO 11833, the material and the product designation, as shown below:



b) the dimensions;

c) the manufacturer's name and country, and the year and month of manufacture or lot number.

Annex A
(informative)

Determination of resistance to delamination of thick pressed sheets using a wedge

A.1 Specimen

Use a rectangular specimen 150 mm long by 25 mm wide and of the thickness of the sheet under test. Cut it from the edge of the sheet with its length parallel to the edge of the sheet.

A.2 Number of specimens

Use one specimen.

A.3 Apparatus

A.3.1 **Vice**, mounted on a rigid base, for holding the specimen.

A.3.2 **Light hammer** or **mallet**.

A.3.3 **Wedge**, having the dimensions shown in Figure A.1 and made of tempered steel, e.g. a machined hacksaw blade.

Dimensions in millimetres

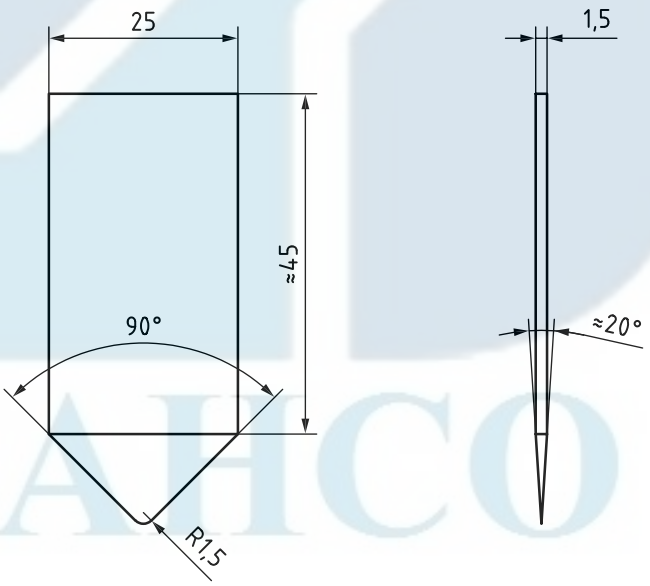


Figure A.1 — Dimensions of wedge

A.4 Procedure

Clamp the specimen in the vice so that one 150 mm edge is horizontal and 15 mm above the jaws of the vice. Place the sharp point of the wedge on the horizontal edge of the specimen, the width of the wedge being

parallel to the plane of lamination of the specimen. Strike the wedge a sharp blow with the hammer or mallet and repeat this action at five approximately equidistant points across the thickness of the specimen, these points also being approximately equidistant along the length of the specimen. If delamination occurs at any one impact, record the specimen as a failure.

Annex B
(informative)

Determination of resistance to delamination of thick pressed sheets by thermal bending

B.1 Specimen (thickness ≥ 20 mm)

Cut at least three specimens 50 mm long by 10 mm wide from the sheet under test at the locations shown in Figure 2.

B.2 Procedure

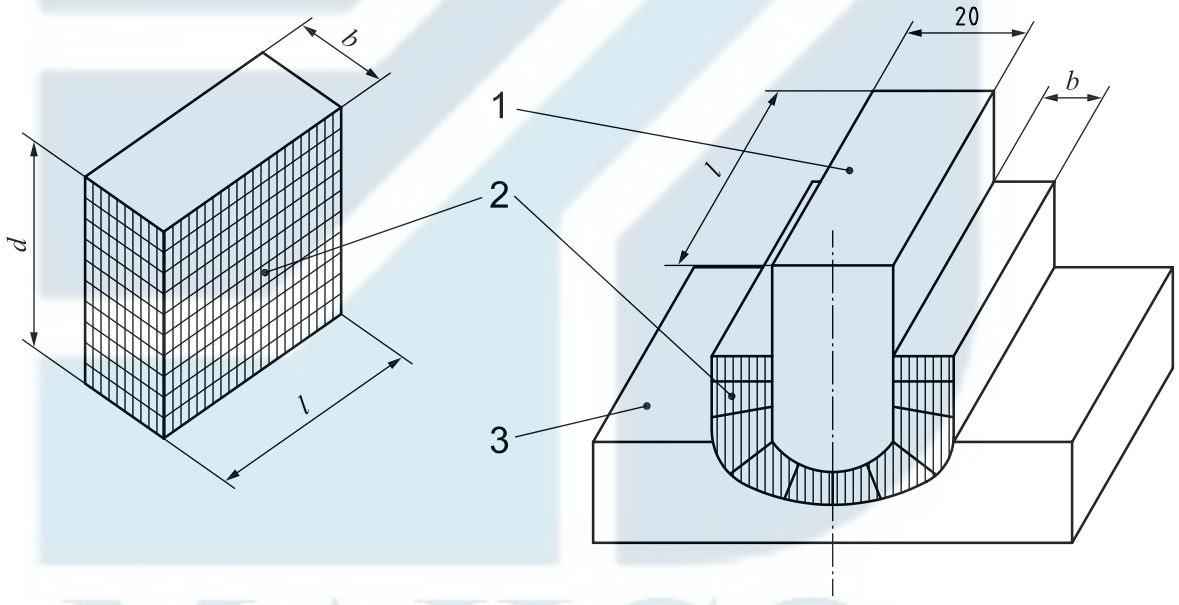
Place the specimens horizontally in an oven with air circulation, and heat under the following conditions:

Temperature 140 °C ± 2 °C

Heating time 20 min ± 1 min

Remove the specimens from the oven and bend them with a mandrel as shown in Figure B.1.

Dimensions in millimetres



Key

1	mandrel	b	= width (10 mm)
2	specimen	d	= thickness
3	plate with cavity	l	= length (50 mm)

Figure B.1 — Bending a specimen

If delamination occurs, record the specimen as a failure.

Bibliography

[1] ISO 2859-1, *Sampling procedures for inspection by attributes — Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

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