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Profielen van ongeplasticeerd polyvinylchloride (PVC-U) voor de vervaardiging van ramen en deuren -Classificatie, eisen en beproevingsmethoden

Profilés de polychlorure de vinyle non plastifié (PVC-U) pour la fabrication des fenêtres et des portes - Classification, prescriptions et méthodes d'essai

Unplasticized polyvinylchloride (PVC-U) profiles for the fabrication of windows and doors - Classification, requirements and test methods

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English version

Unplasticized polyvinylchloride (PVC-U) profiles for the fabrication of windows and doors - Classification, requirements and test methods

Profilés de polychlorure de vinyle non plastifié (PVC-U)
pour la fabrication des fenêtres et des portes -
Classification, prescriptions et méthodes d'essai

Profile aus weichmacherfreiem Polyvinylchlorid (PVC-U)
zur Herstellung von Fenstern und Türen - Klassifizierung,
Anforderungen und Prüfverfahren

This European Standard was approved by CEN on 27 December 2002.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

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Foreword

This document (EN 12608:2003) has been prepared by Technical Committee CEN/TC 33 "Doors, windows, shutters, building hardware and curtain walling", 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of an identical text or by endorsement, at the latest by October 2003, and conflicting national standards shall be withdrawn at the latest by October 2003.

The standard specifies classification, requirements and test methods.

It is based on standards of the CEN member bodies on PVC-U profiles for the fabrication of windows and the Guide Technique UEAtc "Pour l'agrément des fenêtres en PVC".

No existing European Standard will be superseded by this standard.

This standard is supported by separate standards on test methods to which references are made.

Annexes A and C are normative. Annex B is informative.

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

1 Scope

This European Standard specifies classifications, requirements and test methods for unplasticized polyvinylchloride (PVC-U) profiles for the fabrication of windows and doors.

This standard applies to profiles in the colour range:

$$L^* \geq 82 \text{ (chromaticity co-ordinate } Y \geq 60)$$

$$- 2,5 \leq a^* \leq 5$$

$$- 5 \leq b^* \leq 15$$

when determined according to ISO 7724-3 with the apparatus according to ISO 7724-1 and ISO 7724-2 with the following specifications:

- employing CIE Standard illuminant D65 including specular reflectance;
- measuring condition 8/d or d/8 (without gloss trap for both).

NOTE Profiles in accordance with this standard are capable of making durable windows and doors, taking into account factors such as climatic conditions, design, methods of fabrication and long term performance.

2 Normative references

This European Standard 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 Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 477, *Unplasticized polyvinylchloride (PVC-U) profiles for the fabrication of windows and doors – Determination of the resistance to impact of main profiles by falling mass.*

EN 478, *Unplasticized polyvinylchloride (PVC-U) profiles for the fabrication of windows and doors – Appearance after exposure at 150 °C – Test method.*

EN 479, *Unplasticized polyvinylchloride (PVC-U) profiles for the fabrication of windows and doors – Determination of heat reversion.*

EN 513, *Unplasticized polyvinylchloride (PVC-U) profiles for the fabrication of windows and doors – Determination of the resistance to artificial weathering.*

EN 514, *Unplasticized polyvinylchloride (PVC-U) profiles for the fabrication of windows and doors – Determination of the strength of welded corners and T-joints.*

EN ISO 105-A01:1995, *Textiles – Tests for colour fastness – Part A01: General principles of testing (ISO 105-A01:1994).*

EN ISO 178, *Plastics – Determination of flexural properties (ISO 178:1993).*

EN ISO 179-2, *Plastics – Determination of Charpy impact properties – Part 2: Instrumented impact test (ISO 179-2:1997).*

EN ISO 306, *Plastics – Thermoplastic materials – Determination of Vicat softening temperature (VST) (ISO 306:1994).*

EN ISO 8256, *Plastics – Determination of tensile-impact strength (ISO 8256:1990, including Technical Corrigendum 1:1991)*.

EN ISO 1163-2:1999, *Plastics – Unplasticized poly(vinylchloride) (PVC-U) moulding and extrusion materials – Part 2: Preparation of test specimens and determination of properties (ISO 1163-2:1995)*.

3 Terms and definitions

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

3.1

durability

ability of a profile to maintain satisfactory properties in a window and/or door over an estimated working life which is at least the economically reasonable working life of the window and/or door installed in a building (works)

NOTE The indications given on the working life of a product cannot be interpreted as a guarantee given by the producer, but are regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

3.2

profile

product produced by extrusion

3.2.1

main profile

profile, which has a load bearing function within the window

3.2.2

auxiliary profile

glazing bead or profile, which has a reduced load bearing function within the window

3.3

external wall of the main profile

wall as shown in Figure 2 and according to the requirements of Table 3

3.4

sight surface

face surface of a profile, that is exposed to view, when the window is closed

3.5

nominal profile shape

shape and dimensions of the profile, as specified by the manufacturer

3.6

deviation from straightness

deviation of the longitudinal axis of the profile from the straight line

3.7

depth of a profile (D)

dimension which is measured at right angles to the glazing plane, between the front and back face surfaces of a profile (see Figure 1)

3.8

overall width of a profile (W)

greatest dimension, measured in the direction of the glazing plane, and perpendicular to the longitudinal axis of the profile (see Figure 1)

3.9 material

compound of PVC-U in the form of granules or powder for the production of profiles for the fabrication of windows and doors (for the different types of material see 3.9.2 to 3.9.5.2)

3.9.1 defined formulation

formulation, which is a controlled composition of polymer, additives and pigments

3.9.2 virgin material

material of defined formulation in granular or powder form, which has not been used or processed other than required for its manufacture and to which no reprocessible or recyclable material has been added

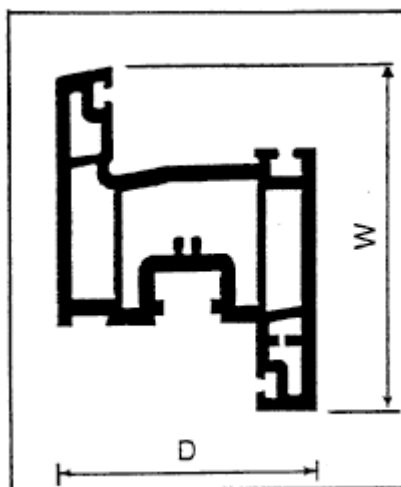


Figure 1 — Example of D and W

3.9.3 own reprocessible material

material of defined formulation free of contamination and degradation, made from unused PVC-U profiles including offcuts, which is reprocessed in the same factory in which it was previously extruded

NOTE This includes unused products, such as mis-measured windows, coming from window manufacturers using profiles from the same material as that to be processed.

3.9.4 external reprocessible material

two types of external reprocessible materials are defined: ERM_a and ERM_b

3.9.4.1 ERM_a

material free of contamination and degradation, made from unused PVC-U window profiles, including off cuts, which has been originally processed by a manufacturer other than that carrying out the reprocessing

3.9.4.2 ERM_b

material made from unused PVC-U products, other than window profiles or a mixture of PVC-U products with PVC-U window profiles, regardless of where they were originally manufactured

3.9.5**recyclable material**

two types of recyclable materials are defined: RM_a and RM_b

3.9.5.1 **RM_a**

material made from used PVC-U window profiles which is free from contamination

3.9.5.2 **RM_b**

material made from used PVC-U products other than window profiles or a mixture of PVC-U products with PVC-U window profiles

4 Classification**4.1 General**

In this European Standard various aspects of performance are classified. The selection of appropriate classes necessary to fulfil national requirements may be incorporated into normative national annexes to this standard.

4.2 Classification by climatic zones

Two different climatic zones M (moderate climate) and S (severe climate) for Europe are given in Table 1.

Table 1 — Classification of climatic zones in Europe

	Moderate climate M	Severe climate S
Annual total solar energy ^a on horizontal surface	< 5 GJ/m ² and < 22 °C	≥ 5 GJ/m ² or ≥ 22 °C
Average of the daily maximum temperature ^a of the warmest month per year		
^a Values measured according the specifications of the World Meteorological Organisation (WMO).		

In order to be classified as a moderate climate, the annual solar energy on a horizontal surface shall be < 5 GJ/m² and the average temperature of the warmest month of the year shall be < 22 °C.

If the annual total solar energy on a horizontal surface is ≥ 5 GJ/m² or the average daily maximum temperature of the warmest month of the year is ≥ 22 °C, the climate is classified as severe.

NOTE 1 Profiles which are designed to be used in a severe climate (S), can also be used in a moderate climate (M).

NOTE 2 In those countries where the two climatic zones exist care should be taken that profiles designed for a moderate climate (M) are not used in the severe climate (S).

4.3 Classification of resistance to impact by falling mass of main profiles

For the resistance to impact by falling mass at - 10 °C two classes are given in Table 2.

Table 2 — Classification of main profiles to impact by falling mass at - 10 °C

	Class I	Class II
Falling mass (g)	1 000	1 000
Falling height (mm)	1 000	1 500

NOTE In certain climatic regions a greater resistance to brittle failure is considered and therefore two classes for the impact resistance of main profiles by falling mass are established.

4.4 Classification of wall thickness of main profiles

For the external wall of the main profile three classes of wall thickness are given in Table 3 (see also Figure 2).

Table 3 — Classification of wall thickness

Dimensions in millimetres

	Class A	Class B	Class C
sight surface	≥ 2,8	≥ 2,5	no requirements
non-sight surface	≥ 2,5	≥ 2,0	no requirements

In order to be classified for either class A or B both minimum requirements for wall thickness shall be fulfilled. Sight surfaces and non-sight surfaces are shown in Figure 2.

NOTE 1 Class A, B or C is used for the declaration of the wall thickness of the main profile.

NOTE 2 The classification of profiles by wall thickness is intended to represent the wide variations in profile and window design for the various applications which are in use in Europe. It is not intended to imply differences in profile quality or in the performance of windows provided that the relevant performance requirements for both profiles and windows are met.

5 Requirements

5.1 Material

5.1.1 Virgin material

Profiles shall be manufactured from a virgin material of unplasticized polyvinylchloride (PVC-U), complying with the requirements in 5.1.3. Only those additives and pigments may be used, that are necessary for the manufacturing of durable profiles with appropriate surface finish, mechanical strength and physical properties as required by this European Standard.

5.1.2 Reprocessable and recyclable material

When the material used is not 100 % virgin material then all the requirements of this standard apply together with the further requirements of this clause.

5.1.2.1 Own reprocessable material

The use of own reprocessable material for the production of PVC-U profiles is permitted without limitations and provided that the defined formulation is the same as for the virgin material.

5.1.2.2 External reprocessable material

External reprocessable material type ERM_a may be used after any necessary restabilization and/or addition of additives (e.g. modifiers, pigments, lubricants etc.) as a core of a profile where any surfaces or parts of surfaces which may be visible after installation of the window fabricated from the profiles are completely covered by coextrusion with a virgin material or an own reprocessable material.

The thickness of the coextruded outer surface layer shall be a minimum of 0,5 mm.

External reprocessable material type ERM_b shall not be used.

5.1.2.3 Recyclable material

Recyclable material type RM_a may be used after any necessary restabilization and/or remodification as a core of a profile where any surfaces or parts of surfaces which may be visible after installation of windows fabricated from the profiles are completely covered by coextrusion with a virgin material or an own reprocessable material.

The thickness of the outer surface coextruded layer shall be a minimum of 0,5 mm.

Recyclable material type RM_b shall not be used.

5.1.3 Material characteristics

The materials which are used for the extrusion of profiles shall meet the requirements of annex A.

5.2 Appearance

The colour of the profile shall be the same and uniform on any surfaces or parts of surfaces which may be visible after installation of the window fabricated from the profile, when viewed in accordance with 6.1.

The surfaces of the profiles shall be smooth, flat and free from pitting, impurities, cavities and other surface defects when viewed in accordance with 6.1. The edges of the profiles shall be clean and burr-free.

NOTE 1 Further arrangements with respect to appearance (see annex B), such as tolerances on the standard colour, should be made between the customer and the manufacturer, and are not part of the requirements of this standard.

NOTE 2 Extrusion lines, caused by the process are admissible, so long as they are not visually intrusive.

5.3 Dimensions and tolerances

5.3.1 Nominal shape

The cross-section of the profiles shall conform to the nominal profile shape.

The tolerances of the external dimensions of the profile (see Figure 1) with respect to the nominal profile shape shall be in accordance with Table 4.

Table 4 — Tolerances on external dimensions

Dimensions in millimetres

External dimension	Tolerance
Depth (D) \leq 80	$\pm 0,3$
> 80	$\pm 0,5$
Overall width (W)	$\pm 0,5$

The determination of the external dimensions is in accordance with 6.2.

5.3.2 Thickness of walls of main profile

The thickness of the walls of the main profile according to Figure 2 shall be declared by the manufacturer.

For class A the minimum value for the sight surface shall be $\geq 2,8$ mm and for the non-sight surface $\geq 2,5$ mm.

For class B the minimum value for the sight surface shall be $\geq 2,5$ mm and for the non-sight surface $\geq 2,0$ mm.

For class C the manufacturer shall specify the minimum value for sight surface and the minimum value for the non-sight surface.

The determination of the thickness is in accordance with 6.2.

NOTE It is recognized that in practice the values specified in Figure 2 for the wall-thickness in the grooves and for certain small parts of the non-sight surfaces are not always met. It is not the intention to force the manufacturers to change their tools directly after publication of this standard, so that their profiles meet the wall-thickness requirements. Therefore, a transition period of 10 years to ensure that after this period all the profiles meet the intended requirements (see indexes^a and^b in the legend of Figure 2).

5.3.3 Tolerances on other dimensions

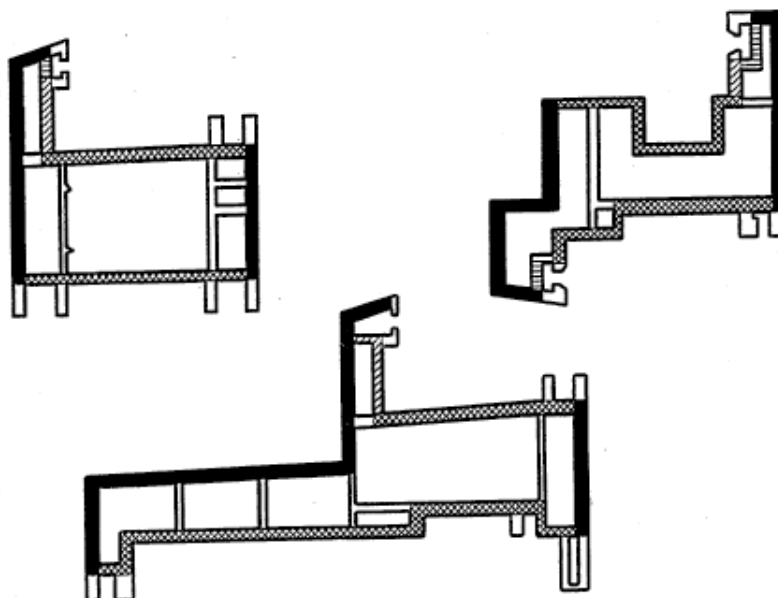
The critical dimensions of main profiles other than the thickness of external walls and of auxiliary profiles as well as their tolerances shall be specified by the manufacturer.

5.3.4 Deviation from straightness of main profiles

When measured in accordance with 6.2 the deviation from the straightness shall not be > 1 mm for a length of 1 m.

5.4 Mass of main profiles

When measured in accordance with 6.3 the mass per m length of main profiles shall not be < 95 % of the nominal mass per m length.



Key

Type of wall	designation	Class A	Class B	Class C
	sight surface	≥ 2,8 mm	≥ 2,5 mm	no requirement
	non sight-surface (structural integrity of the profile)	≥ 2,5 mm	≥ 2,0 mm	no requirement
		≥ 2,3 mm ^a	≥ 2,0 mm	no requirement
		≥ 1,2 mm ^b	≥ 2,0 mm	no requirement
		no requirement	no requirement	no requirement

^a This value is valid until 31 December 2009, after that date it will be ≥ 2,5 mm.
^b This value is valid until 31 December 2009, after that date it will be ≥ 2,0 mm.

Detail measuring instrument

Detail measuring length

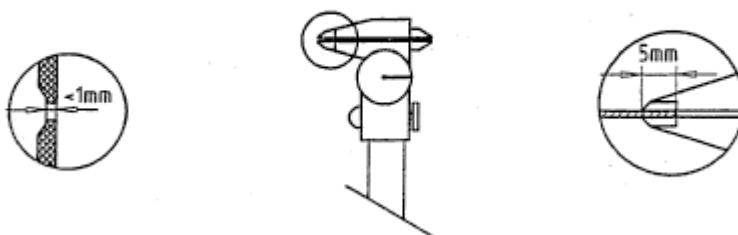


Figure 2 — Cross section of three typical main profiles and the minimum thickness of the walls in the classes A, B and C

5.5 Heat reversion

5.5.1 Main profile

When tested in accordance with EN 479 for each test specimen the heat reversion (R) of the two largest opposing sight surfaces shall not be > 2,0 %.

The difference in heat reversion for each test specimen between these sight surfaces shall not be > 0,4 %.

5.5.2 Auxiliary profiles

When tested in accordance with EN 479 the heat reversion for each test specimen shall not be > 3,0 %.

NOTE For glazing beads which are to be used externally a limit of 2 % of the heat reversion is recommended.

5.6 Resistance to impact of main profiles by falling mass

When tested in accordance with EN 477 for the appropriate classification no more than one test specimen shall show rupture in the wall.

For coextruded profiles the delamination of the coextruded layer is also considered as failure.

5.7 Behaviour after heating at 150 °C

When tested in accordance with EN 478 the profiles shall show no defects. For coextruded profiles the delamination of the coextruded layer is also considered as failure.

5.8 Resistance to weathering

5.8.1 Exposure procedure

Test specimens taken from sight surfaces of main profiles shall be exposed in the climatic zone M or S in accordance with EN 513 for a time period representing five years outdoor weathering in terms of the calculation method given in annex B.

In annex C a calculation method is given for the determination of the radiation dose or exposure time to be used for artificial weathering.

NOTE For quality control purposes the time period can be decreased to representing two years outdoor exposure.

5.8.2 Impact strength after artificial weathering

After exposure in accordance with 5.8.1 the reduction in impact strength expressed as a percentage of the impact strength of the unexposed test specimens and the exposed test specimens shall not be > 40 %.

The determination of the impact strength is in accordance with EN 513.

NOTE The value of 40 % is tentative and subject to the results of current research.

5.8.3 Colour fastness

After exposure in accordance with 5.8.1 the change in colour between the unexposed and exposed test specimens expressed in ΔE^* shall not be > 5 and Δb^* not > 3. The determination of the change in colour is in accordance with EN 513.

NOTE The visual change in colour can be determined using the methods specified in EN 20105-A02 and EN 20105-A03.

5.9 Weldability

For the determination of the weldability of profiles, welded corners are tested in accordance with EN 514. The calculated mean stress at maximum load of each corner, σ_t or σ_c , shall not be $< 25 \text{ N/mm}^2$ for the tensile bending test or 35 N/mm^2 for the compression bending test. Each individual value shall not be $< 20 \text{ N/mm}^2$ for the tensile bending test and not be $< 30 \text{ N/mm}^2$ for the compression bending strength.

The weld shall not be finished by grooving, knifing etc. except for the outside edge of the 90° angle, which shall be cleaned to permit the sample to sit fully onto the support.

6 Test methods

6.1 Determination of the appearance

The appearance is determined by viewing by normal or corrected vision at a range of 1 m, in 45° north sky light perpendicular to the surface as specified in clause 14 of EN ISO 105-A01:1995 or with an equivalent artificial source of light.

6.2 Determination of dimensions

6.2.1 Measuring devices

The measuring devices for the determination of the external dimensions and the wall thicknesses shall have an accuracy of 0,05 mm and for the deviation from straightness shall have an accuracy of 0,1 mm.

6.2.2 Test specimen

For the determination of the deviation from straightness the length of the profile to be tested shall be (1 000) mm.

6.2.3 Conditioning

Condition the test specimen at $(23 \pm 5)^\circ\text{C}$ for at least 1 hour prior to testing.

6.2.4 Procedure

6.2.4.1 External dimensions and wall thicknesses.

Measure the external dimensions and wall thicknesses at $(23 \pm 5)^\circ\text{C}$.

6.2.4.2 Deviation from straightness.

Put the test specimen with the concave side at $(23 \pm 5)^\circ\text{C}$ on a flat base. Measure the gap(s) between the profile and the base with an appropriate measuring device (e.g. distance gauges). Repeat the test with the side perpendicular to that tested first.

6.3 Determination of the profile mass

6.3.1 Apparatus

6.3.1.1 Balance, with an accuracy of 1 g.

6.3.1.2 Measuring device with an accuracy of 0,5 mm for the determination of the length of the profile.

6.3.2 Test specimen

The length of the profile to be tested shall be 200 mm to 300 mm.

6.3.3 Conditioning

Condition before measuring the profiles at (23 ± 2) °C for at least 1 hour.

6.3.4 Procedure

Measure the length of the test specimen to 1 mm, weigh the test specimen to 1 g. Determine the mass per m length expressed in g/m to the nearest 10 g/m.

7 Marking

7.1 Main profiles

7.1.1 Main profiles shall be legibly and visibly marked in an unobtrusive position not visible when the window is closed at least once every 1 m along the length of the profile.

7.1.2 The marking of the main profiles shall contain the following minimum information:

- the name or trade mark of the manufacturer;
- reference to this European Standard;
- climatic zone classification;
- resistance to impact by falling mass classification;
- wall thickness classification;
- in case of recycled material RM_a ;
- production code sufficient to enable traceability (e.g. date, machine and/or shift number).

EXAMPLE ABC LTD - EN 12608 - M - II - C - 93.04.17,38,2.

Optional additional information contained within the mark may include:

- profile type/code;
- level of third party involvement (attestation).

7.2 Auxiliary profiles

7.2.1 Auxiliary profiles shall be similarly marked either on the profile itself or its packaging.

7.2.2 The marking of auxiliary profiles shall contain the following minimum information:

- the name or trade mark of the manufacturer;
- reference to this European Standard;
- climatic zone classification;
- production code sufficient to enable traceability.

EXAMPLE XYZ LTD - EN 12608 - S - 93,368

Annex A (normative)

Material characteristics, preparation of samples and requirements

A.1 Scope

Annex A describes a procedure to prepare samples from PVC-U profiles or from granules or powder from virgin, reprocessable or recyclable material for the determination of the characteristics and the requirements for those characteristics.

A.2 Test specimens

The test specimens for the determination of the material characteristics according A.4 shall be taken either from profiles or from pressed plaques.

A.3 Preparation of pressed plaques

The preparation of the pressed plaques shall be in accordance with the procedure given in clause 3 of EN ISO 1163-2:1999 and with the following:

- the material used shall be shredded extruded PVC-U profiles, granules or powder from virgin, reprocessable or recyclable materials;
- the differential speed between the two rolls of the mixing mill shall be within the range 1 : 1,4 to 1 : 1,1;
- the pressed plaque shall have a thickness of $(4 \pm 0,2)$ mm;
- the cooling of the plaque given in 3.3.3 of EN ISO 1163-2:1999 shall be at the nominal rate of 15 K/min.

A.4 Material characteristics

A.4.1 Vicat softening temperature

When tested in accordance with EN ISO 306 using method B with a temperature rate of (50 ± 5) °C/h the Vicat Softening Temperature (VST) shall not be < 75 °C.

For non-coextruded profiles the test specimens shall be taken directly from the profiles or from pressed plaques.

For coextruded profiles the test specimens shall be taken from pressed plaques made from materials separately.

In case of dispute the test on pressed plaques is the reference method.

A.4.2 Charpy impact strength

When tested in accordance with EN ISO 179-2 at (23 ± 2) °C with method designation 1eA the Charpy impact strength shall either not be < 10 kJ/m² or < 20 kJ/m². The level chosen shall be specified by the manufacturer.

For non-coextruded profiles the test specimens shall be taken from pressed plaques.

For coextruded profiles the test specimens shall be taken from pressed plaques made from both materials separately.

In case of dispute the test on pressed plaques is the reference method.

A.4.3 Flexural modulus of elasticity

When tested at (23 ± 2) °C in accordance with EN ISO 178 the flexural modulus of elasticity (E_b) shall not be $< 2\,200\text{ N/mm}^2$.

For non-coextruded profiles the test specimens shall be taken directly from the profiles or from pressed plaques.

For coextruded profiles the test specimens shall be taken from pressed plaques made from both materials separately.

In case of dispute the test on pressed plaques is the reference method.

A.4.4 Tensile impact strength

When tested at (23 ± 2) °C in accordance with EN ISO 8256, using type 5 test specimens, the mean tensile impact strength shall be not $< 600\text{ kJ/m}^2$.

For non-coextruded as well as coextruded profiles the test specimens shall be taken directly from the profiles.

A.5 Test report

The test report shall include the following information:

- reference to this annex;
- details of the test specimens;
- declared level for the Charpy impact strength;
- values obtained.

Annex B (informative)

Permissible tolerances on standard colour

B.1 Scope

Annex B gives an advice on permissible tolerances on standard colour.

B.2 Permissible tolerances on standard colour

When determined in accordance with ISO 7724-3 with the apparatus in accordance with ISO 7724-1 and ISO 7724-2 with the following specifications:

- employing CIE Standard illuminant D65 including specular reflectance;
- measuring condition 8/d or d/8 (without gloss trap for both);

it is advisable that no profile should have a difference in colour to the standard colour by more than the following limits:

$$|\Delta L^*| \leq 1,0$$

$$|\Delta a^*| \leq 0,5$$

$$|\Delta b^*| \leq 0,8$$

$$|\Delta E^*| \leq 1,0$$

Annex C (normative)

Calculation method for the determination of the radiation dose and exposure time to be used for artificial weathering

C.1 Scope

Annex C describes a procedure to calculate the duration of the exposure needed to assess resistance to moderate (M) and severe (S) climates to be used for artificial weathering.

A justification for the chosen method is included in this annex.

C.2 Calculation

C.2.1 In 4.1 the climatic zones are classified in terms of the annual solar energy falling on a horizontal surface and the average temperature of the warmest month per year (see Table 1).

C.2.2 For the purpose of this calculation the following assumption is made on the annual solar energy:

- for moderate climate the amount of solar energy is estimated at 4 GJ/m²/year;
- for severe climate the amount of solar energy is estimated at 6 GJ/m²/year.

C.2.3 In order to compare these figures with the usual practice in artificial weathering, it is necessary to consider not the total solar radiation energy as in C.2.2, but that part falling in the ultraviolet and visible regions between 300 nm to 800 nm. This is about 60 % of the total solar radiation energy. A further correction factor of 67 % is applied to allow for the fact, that not all this radiation is acting at higher summer temperatures and so will be less damaging to the effected surfaces.

The recommended radiation doses for the wavelength range between 300 nm to 800 nm are given in Table C.1.

Table C.1 — Recommended radiation doses for the wavelength range 300 nm to 800 nm

Type of climate	Moderate (M) GJ/m ²	Severe (S) GJ/m ²
1 year's equivalent	1,6	2,4
5 years' equivalent	8,0	12,0

C.2.4 For an artificial weathering device having a time-averaged irradiance of 1 W/m² in the range 300 nm to 800 nm the exposure times are given in Table C.2.

Table C.2 — Recommended exposure times for the wavelength range 300 nm to 800 nm

Climate type	Moderate (M) h	Severe (S) h
1 year's equivalent	$4,4 \times 10^5/I$	$6,6 \times 10^5/I$
5 years' equivalent	$2,2 \times 10^6/I$	$3,3 \times 10^6/I$

Where $I = 550 \text{ W/m}^2$, this means for 5 years' equivalent radiation, then the following exposure time is needed:

- for a moderate climate (M): an exposure time of ca. 4 000 h;
- for a severe climate (S): an exposure time of ca. 6 000 h.

NOTE This calculation method represents only approximate means of estimation. However, it does put the requirements on some sort of logical basis bearing in mind that natural weathering itself is a variable phenomenon depending on location, aspect, shading etc.

Bibliography

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