INTERNATIONAL STANDARD

ISO 20819-2

First edition
2023-02

Plastics — Wood-plastic recycled composites (WPRC) —

Part 2: Test methods

Plastiques — Composites recyclés bois-plastique (WPRC) —

Partie 2: Méthodes d'essai

Reference number
ISO 20819-2:2023(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC61, *Plastics*, Subcommittee SC11, *Products*.

A list of all parts in the ISO 20819 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Wood-plastic composites (WPC) are composites of natural fibres such as wood and various plastics. ISO 16616 has been established as the ISO for such products. WPC is commonly used for exterior materials such as wood decks and louvers, and interior materials such as doors and flooring.

To protect the global environment, it is required to promote the recycling of plastics. WPCs that use such recycled plastics are called wood-plastic recycled composites (WPRC). The quality of recycled plastics such as WPRC is lower than that of virgin plastics, and there are concerns about the inclusion of harmful substances, which may make consumers hesitant when choosing WPRC using recycled plastics. On the other hand, it is also necessary to provide appropriate information to consumers who want to purchase environmental-friendly products with a higher recycling rate.

ISO 20819-1 is a calculation method of recycling ratio, labelling, and safety test. Safety testing for hazardous substances is necessary to dispel consumer concerns about contamination with hazardous substances when using recycled materials. ISO 20819-2 provides a test method for product durability that is expected when recycled plastic is used. There has never been an ISO standard that specializes in using recycled plastics in this way. It also stipulates test methods for cellular products not mentioned in ISO 16616.

This document has been established so that consumers' anxiety can be reduced by conducting the tests specified in this document, and environmental-friendly and safe products using recycled plastic can be selected.

Plastics — Wood-plastic recycled composites (WPRC) —

Part 2:
Test methods

1 Scope

This document defines the test methods for fundamental physical properties and durability required for wood-plastic recycled composites (hereinafter called WPRC) stipulated in ISO 20819-1.

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.

ISO 75-2, *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 472, *Plastics — Vocabulary*

ISO 4892-2, *Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc lamps*

ISO 16616:2015, *Test methods for natural fibre-reinforced plastic composite (NFC) deck boards*

ISO 20819-1:2020, *Plastics — Wood-plastic recycled composites (WPRC) — Part 1: Specification*

EN 15534-1, *Composites made from cellulose-based materials and thermoplastics(usually called wood-polymer composites(WPC) or natural fibre composites(NFC))-Part1:Test methods for characterisation of compounds and products*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 472 and the following apply.

ISO and IEC maintain terminological 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/

3.1
wood-plastic recycled composites
WPRC
mixture of woody material/natural fibre and thermoplastics, composited by means of plastic moulding and containing recycled material as raw material forming at least 40 % of the total.

[SOURCE: ISO20819-1:2020, 3.1]

3.2
non-foaming material
wood-plastic recycled composites that do not contain internal air voids.

Note 1 to entry: Non-foaming materials include solid products, hollow products, and products with multilayer formation consisting of different constituents inside and outside.

[SOURCE: ISO20819-1:2020, 3.6 — Note 1 to entry has been added.]

3.3
cellular material
wood-plastic recycled composites containing internal air voids scattered primarily for the purpose of weight reduction.

Note 1 to entry: Cellular material can include material integrated with a non-foaming material using methods such as multilayer moulding.

[SOURCE: ISO20819-1:2020, 3.7]

4 Quality

4.1 Appearance

The appearance of WPRC shall conform with the requirements in Table 1.

Table 1 — Appearance

Defect types	Judgment
Dirtiness and flaws [a]	Should be free from remarkably conspicuous defects. [c]
Warps and twists	Should be free from remarkably conspicuous defects. [c]
Mixture of foreign matter [b]	Should be free from remarkably conspicuous defects. [c]
Chipping, cracks, breakage, and through-cracks	Should not be allowed.
[a] Influences of raw materials are not included. [b] Foreign matter shall mean substances other than raw materials. [c] Subject to consultation between the partners.	

4.2 Basic physical properties and durability

When the basic physical properties and durability tests of WPRC are conducted according to 5.3, the performance of the basic physical properties for non-foaming material and cellular material shall be in accordance with Table 2 and Table 3. Durability performance should be in accordance with the consultation between partners.

Note Guide for standard of performance value is described in Annex A.

Table 2 — Material performance of basic properties

Performance item		Test methods				Unit	Performance value
		Test clause	Non-foaming materials	Cellular materials	Measurement		
Density		5.3 a)	Method A	—	—	g/cm^3	[a]
			Method B		—		[a]
Water absorption properties	Water absorption	5.3 b)	Method A		—	%	[a]
	Length change rate	5.3 b)	Method A		—	%	[a]
Strength	Flexural properties	5.3 c)	Method A	—	Flexural stress with cut-out test specimens	MPa	[a]
			Method B		Flexural stress with actual size test specimens	MPa	[a]
	Impact resistance	5.3 d)	Method A	—	Impact strength with cut-out test specimens	kJ/m^2	[a]
			Method B		Impact resistance with actual size test specimens	—	[a]
			Method C		Impact resistance with actual size test specimens	—	[a]
Thermal properties		5.3 e)	Method A	—	Temperature of deflection under load	°C	[a]
			Method B[b]		Residual ratio of thermal flexural stress	%	[a]

[a] Subject to the standard of each country.

[b] Excluding non-foaming hollow products.

Table 3 — Material performance of durability

Performance item		Test methods				Unit	Performance value
		Test clause	Non-foaming materials	Cellular materials	Measurement		
Weather-ability	Flexural properties after weathering test	5.3 f)	Method A	—	Change rate of flexural stress after weathering test	%	[a]
			Method B [c]		Change rate of flexural stress after weathering test	%	[a]
Heat aging resistance	Flexural properties after heat aging tests	5.3 g)	Method A	—	Change rate of flexural stress after heat aging test	%	[a]
			Method B		Change rate of flexural stress after heat aging test	%	[a]
	Impact resistance after heat aging test	5.3 h)	Method A	—	Change rate of impact strength after heat aging test	%	[a]
			Method B		Impact resistance with actual size test specimens after heat aging test	—	[a]
			Method C		Impact resistance with actual size test specimens after heat aging test	—	[a]
Thermal shock resistance	Flexural properties after thermal cycling test	5.3 i)	Method A	—	Change rate of flexural stress after thermal cycling test	%	[a]
			Method B		Change rate of flexural stress after thermal cycling test	%	[a]
	Impact resistance after thermal cycling test	5.3 j)	Method A	—	Change rate of impact strength after thermal cycling test	%	[a]
			Method B		Impact resistance with actual size test specimens after thermal cycling test	—	[a]
			Method C		Impact resistance with actual size test specimens after thermal cycling test	—	[a]

[a] Subject to consultation between partners.

5 Test method

5.1 Sampling of test specimens

The collection method, dimensions, and number of test specimens for non-foaming material and cellular material are shown in Table 4 and Table 5.

Test specimens for hollow products with non-foaming material shall be collected from the surface of hollow products, except for test items of the water absorption property and actual size test specimens. Test specimens for cellular material shall not be collected from the vicinity of both ends of the product in the width direction.

Table 4 — Collection method, dimensions, and number of test specimens of basic physical properties

Performance item		Test methods			Test specimens collection method	Dimensions of test specimens	Number of test specimens
		Test clause	Non-foaming materials	Cellular materials			
Density		5.3 a)	Method A	—	s	*l* : 20 mm *w* : 20 mm *t* : 5 mm or more	3
			Method B		p	*l* : 20 mm *w*: Product width or 150 mm *t* : Product thickness	3
Water absorption properties	Water absorption	5.3 b)	Method A		p	*l* : 100 mm *w* : Product width *t* : Product thickness	3
	Length change rate	5.3 b)	Method A		p	*l* : 100 mm *w* : Product width *t* : Product thickness	3
Strength	Flexural properties	5.3 c)	Method A	—	s-1	*l* : 80 mm *w* : 10 mm *t* : 4 mm	3
			Method B		p	*l* : Twenty times the thickness *w* : Product width *t* : Product thickness	3
	Impact resistance	5.3 d)	Method A	—	s-1	*l* : 80 mm *w* : 10 mm *t* : 4 mm	5
			Method B		p	*l* : The length of the support span in a real structure plus 100 mm *w* : Product width *t* : Product thickness	3
			Method C		p	*l* : More than the support span for the construction procedure specified by the manufacturer *w* : Product width *t* : Product thickness	3

s : Collection from the product surface

s-1 : Collection from the product surface, and surface shall be smoothed. If the product is a two-layer moulding and the test specimen is thicker than the thickness required for the test, it shall be shaved to the same thickness as its layer thickness ratio.

p : Collection from the product

l : Length

w : Width

t : Thickness

Table 4 *(continued)*

Performance item	Test methods			Test specimens collection method	Dimensions of test specimens	Number of test specimens
	Test clause	Non-foaming materials	Cellular materials			
Thermal properties	5.3 e)	Method A	—	s-1	*l* : 80 mm *w* : 10 mm *t* : 4 mm	3
		Method B		s-1	*l* : 200 mm *w* : 15 mm *t* : 10 mm	3 for each temperature

s : Collection from the product surface

s-1 : Collection from the product surface, and surface shall be smoothed. If the product is a two-layer moulding and the test specimen is thicker than the thickness required for the test, it shall be shaved to the same thickness as its layer thickness ratio.

p : Collection from the product

l : Length

w : Width

t : Thickness

Table 5 — Collection method, dimensions and number of test specimens of durability

Performance item		Test methods			Test specimens collection method	Dimensions of test specimens	Number of test specimens
		Test clause	Non-foaming materials	Cellular materials			
Weather-ability	Flexural properties after weathering test	5.3 f)	Method A	—	s-1	*l* : 80 mm *w* : 10 mm *t* : 4 mm	E3
			Method B		s-1	*l* : 200 mm *w* : 15 mm *t* : 10 mm	E3

s : Collection from product surface

s-1 : Collection from product surface, and surface shall be smoothed. If the product is a two-layer moulding and the test specimen is thicker than the thickness required for the test, it shall be shaved to the same thickness as its layer thickness ratio.

p : Collection from product

l : Length

w : Width

t : Thickness

E3 : Each 3 test specimens with, without durability test

E5 : Each 5 test specimens with, without durability test

Table 5 *(continued)*

Performance item		Test methods			Test specimens collection method	Dimensions of test specimens	Number of test specimens
		Test clause	Non-foaming materials	Cellular materials			
Heat aging resistance	Flexural properties after heat aging test	5.3 g)	Method A	—	s-1	*l* : 80 mm *w* : 10 mm *t* : 4 mm	E3
			Method B		p	*l* : Twenty times the thickness *w* : Product width *t* : Product thickness	E3
	Impact resistance after heat aging	5.3 h)	Method A	—	s-1	*l* : 80 mm *w* : 10 mm *t* : 4 mm	E5
			Method B		p	*l* : The length of the support span in a real structure plus 100 mm *w* : Product width *t* : Product thickness	E3
			Method C		p	*l* : More than the support span for the construction procedure specified by the manufacturer *w* : Product width *t* : Product thickness	E3

s : Collection from product surface

s-1 : Collection from product surface, and surface shall be smoothed. If the product is a two-layer moulding and the test specimen is thicker than the thickness required for the test, it shall be shaved to the same thickness as its layer thickness ratio.

p : Collection from product

l : Length

w : Width

t : Thickness

E3 : Each 3 test specimens with, without durability test

E5 : Each 5 test specimens with, without durability test

Table 5 *(continued)*

Performance item		Test methods			Test specimens collection method	Dimensions of test specimens	Number of test specimens
		Test clause	Non-foaming materials	Cellular materials			
Thermal shock resistance	Flexural properties after thermal cycling test	5.3 i)	Method A	—	s-1	*l* : 80 mm *w* : 10 mm *t* : 4 mm	E3
			Method B		p	*l* : Twenty times the thickness *w* : Product width *t* : Product thickness	E3
	Impact resistance after thermal cycling test	5.3 j)	Method A	—	s-1	*l* : 80 mm *w* : 10 mm *t* : 4 mm	E5
			Method B		p	*l* : The length of the support span in a real structure plus 100 mm *w* : Product width *t* : Product thickness	E3
			Method C		p	*l* : More than the support span for the construction procedure specified by the manufacturer *w* : Product width *t* : Product thickness	E3

s : Collection from product surface

s-1 : Collection from product surface, and surface shall be smoothed. If the product is a two-layer moulding and the test specimen is thicker than the thickness required for the test, it shall be shaved to the same thickness as its layer thickness ratio.

p : Collection from product

l : Length

w : Width

t : Thickness

E3 : Each 3 test specimens with, without durability test

E5 : Each 5 test specimens with, without durability test

5.2 Appearance tests

Appearance tests shall be conducted visually using normal or corrected vision.

5.3 Basic physical property tests and Durability tests

Tests of the basic physical properties and tests of durability for WPRC shall be as follows.

Unless otherwise specified in the relevant test method, the test specimens shall be conditioned during at least 72 h in the standard atmosphere 23/50 according to ISO 291 [(23 ± 2) °C, (50 ± 10) % RH].

If there is more than one test method, the actual test method used shall be recorded in the report.

a) Density

For products with non-foaming material, density tests shall be in accordance with either Method A or Method B. For products with cellular material, tests shall be in accordance with **Method B**.

Method A: In accordance with ISO 16616:2015, 6.1. Distilled water shall be used as an immersion fluid. The density of water shall be 0,997 5 g/cm^3 at 23 °C.

Method B: The scale having a structure in which a test specimen suspended from the centre of the plate with metallic wire at 0,5 mm diameter or less can be immersed in water shall be used. The mass of a test specimen shall be measured on the order of 0,02 % of the mass. (It shall be confirmed that the scale can measure on the order of 0,01 g.) A sinker made of a high density material shall be used, the test specimen shall be immersed in water, and the total mass of the test specimen and of the sinker shall be measured. The mass of only the sinker shall be measured, and then the density shall be calculated using Formula (1).

$$\rho_s = \frac{m_{S,A} \times \rho_w}{(m_{S,A} - m_{S+K,W} + m_{K,W})} \quad (1)$$

where

ρ_s is the density of the test specimens, in grams per cubic centimetre;

$m_{S,A}$ is the mass of the test specimens, in grams;

$m_{S+K,W}$ is the apparent mass of the test specimens and the sinker in water, in grams;

$m_{K,W}$ is the apparent mass of the sinker in water, in grams;

ρ_w is the density of water at test temperature, in grams per cubic centimetre.

The density of water shall be 0,997 5 g/cm^3 at 23 °C.

The density shall be measured to one decimal place, and the average value of three test specimens shall be rounded off to one decimal place.

b) Water absorption

Method A: In accordance with EN 15534-1:2014, 8.3 for measuring the water absorption properties in weight, width, and length of test specimens. The test shall be conducted at (23 ± 2) °C . The immersion time shall be 24 hours, and the number of test specimens shall be three. The results shall be measured as an integer, and the average value of three test specimens shall be rounded to an integer.

c) Flexural properties

For products with non-foaming material, tests shall be in accordance with either Method A or Method B. For products with cellular material, tests shall be in accordance with Method B.

Method A: This shall be applied to the cut-out test specimens and shall be in accordance with ISO 178. Flexural stress shall be calculated to the three decimal places, and the average value of three test specimens shall be rounded to an integer.

Method B: This shall be applied to the actual size test specimens and shall be as follows. The test shall be conducted at (23 ± 2) °C and (50 ± 10) % relative humidity.

1) Test apparatus

The test apparatus shall consist of the flexural tester, supports, and loading edge. The flexural tester shall employ the midpoint one line load method and shall be capable of applying load at

a loading speed that reaches the maximum load in one to three minutes and shall be equipped with the supports and loading edge. The supports and loading edge shall be a steel as shown in Figure 1, and the tip that contacts the test specimen shall be semi-circular in shape with a radius of 10 to 15 mm. However, the radius of the supports and the radius of the loading edge shall be the same, and the length shall be larger than the width of the test specimen.

2) Test method

i) Dimension measurement

Before the test, the width, thickness, and length of the test specimen shall be measured using a measurement device, such as callipers and a steel measuring tape. The width and thickness shall be measured at the loading part at the centre of the test specimen.

ii) Installation of test specimen

The method for supporting and loading the test specimen shall be in accordance with Figure 2. In addition, the support span of the test specimen shall be sixteen times larger than the product thickness.

iii) Loading

One line load shall be applied to the surface of the test specimen at the centre of the span, and the maximum load shall be reached at the speed of the load in one to three minutes. Regarding the force measurement, the force shall be measured when the test specimen fractures.

3) Calculation of flexural stress

Flexural stress shall be calculated using Formula (2) to the three decimal places, and the average value of three test specimens shall be rounded to an integer.

$$\Sigma_f=(FL/4Z) \times 100 \quad (2)$$

where

σ_f is the flexural stress, in megapascals;

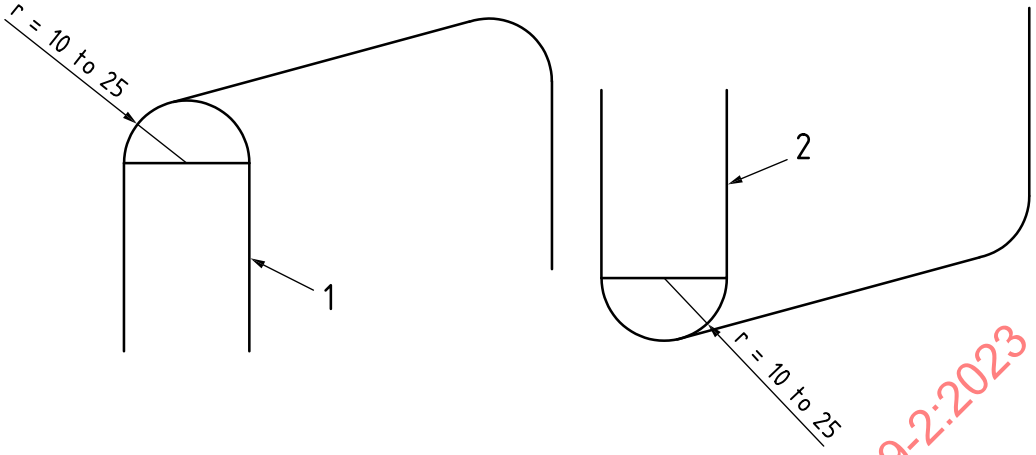
F is the applied force, in newtons;

L is the span, in millimetres;

Z is the section modulus, in cubic millimetres.

Regarding the section modulus submitted by the manufacture, the value appropriately calculated from the definition of structural theory shall be used.

Unit: mm



Key

1 support

2 loading edge

Figure 1 — Example of support and loading edge

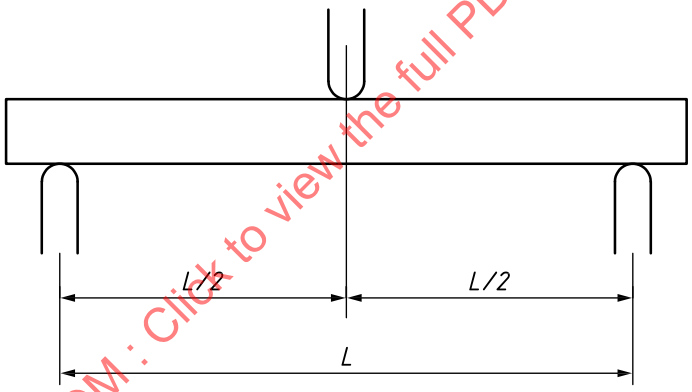


Figure 2 — Method for supporting and loading test specimen

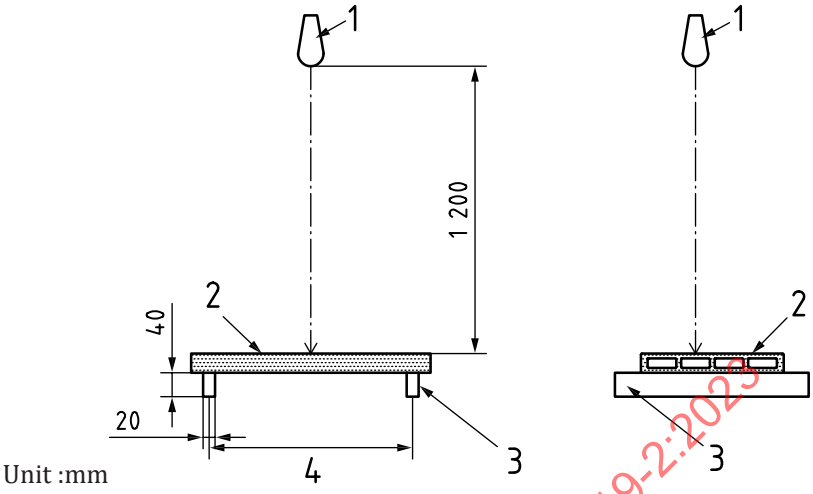
d) Impact resistance

Impact properties tests for products with non-foaming material shall be in accordance with Method A, Method B, or Method C. Tests for products with cellular material shall be accordance with either Method B or Method C.

Method A (Impact strength with cut-out test specimens). In accordance with ISO179-1. Method designation shall be ISO 179-1/1fU, in principle. Impact strength shall be calculated to one decimal place, and the average for the five test specimens shall be rounded to one decimal place.

Method B (Impact resistance with actual size test specimens). In accordance with ISO 16616:2015, 6.4. The test temperature shall be (23 ± 2) °C, and the evaluation items shall be the presence or absence of cracks.

Method C (Impact resistance with actual size test specimens). A test specimen shall be supported at the span indicated by Figure 3, the tester shall have a steel-made weight of (1 ± 0,05) kg mass freely fall from a height of 1,200 mm to a position as indicated by Figure 3 that has no reinforcement at its back face, and the presence of any cracks and breakage shall be checked. The test shall be conducted on three test specimens. The distance between supports shall be in accordance with the work procedures specified by the manufacturer. The test shall be conducted at (23 ± 2) °C.



Unit :mm

Key

1 weight
2 test specimen
3 steel pipe
4 prescribed span

Note The dimensions of the weight for impact resistance are shown in Figure 4.

Figure 3 — Example of impact resistance test

Unit: mm

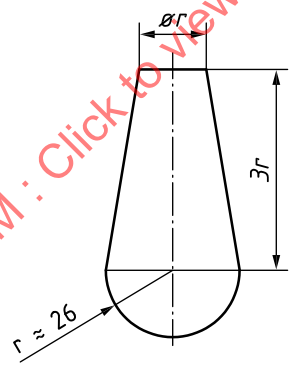


Figure 4 — Weight for impact resistance test

e) Thermal properties

For solid products with non-foaming material, tests of the thermal properties shall be in accordance with either Method A or Method B. For hollow products with non-foaming material, tests of the thermal properties shall be in accordance with Method A. For other products with cellular material, tests shall be in accordance with Method B.

Method A (Temperature of deflection under load): In accordance with ISO 75-2.

Method B (Residual ratio of thermal flexural stress): Test specimens shall be kept at a test temperature for two hours or more. The test shall be conducted at temperatures of (23 ± 2) °C and (50 ± 2) °C in accordance with ISO 178, and the residual ratio of thermal flexural stress shall be calculated using Formula (3). The testing speed shall be 5 mm/min, and the span length shall be 160 mm. The loading surface shall be the product surface. The flexural stress shall be measured to three significant figures, and the average value of the three test specimens shall be rounded to an integer. The residual ratio of the thermal flexural stress shall be calculated as an integer.

$$R_t = 100 \times \sigma_{f50}/\sigma_{f23} \quad (3)$$

where

R_t is residual ratio of thermal flexural stress, in percentage;

σ_{f23} is average value of flexural stress at 23 °C, in megapascals;

σ_{f50} is average value of flexural stress at 50 °C, in megapascals.

f) Flexural properties after weathering test

For solid products with non-foaming material, tests shall be in accordance with either Method A or Method B. For hollow products with non-foaming material, they shall be in accordance with Method A. For products with cellular material, they shall be in accordance with Method B.

2) Weathering test

Weathering test shall be in accordance with cycle No. 1, cycle No.4 or cycle No.B4 of ISO 4892-2 and the irradiation time shall be 500 h.

3) Measurement of flexural stress

The flexural stress of the test specimens after weathering test and the test specimens without weathering test shall be measured by the following test methods.

Methods A: In accordance with ISO 178.

Methods B: Flexural stress tests shall be conducted according to ISO 178. The testing speed shall be 5 mm/min, and the span shall be 160 mm. The loading surface shall be the product surface. The flexural stress shall be measured to three significant figures, and the average value of the three test specimens shall be rounded to three significant figures.

4) Change rate of flexural stress after weathering test

Change rate of flexural stress after weathering test shall be calculated using Formula (4) to an integer by rounding off.

$$C_w = 100 \times (\sigma_{fw} - \sigma_f)/\sigma_f \quad (4)$$

where

C_w is change rate of flexural stress after weathering test, in percentage;

σ_{fw} is flexural stress after weathering test, in megapascals;

σ_f is flexural stress without weathering test, in megapascals.

Instead of change rate of flexural stress, residual ratio of flexural stress after weathering test may be calculated using Formula (5) to an integer by rounding off, depending on the client's request.

$$R_w = 100 \times (\sigma_{fw}/\sigma_f) \quad (5)$$

where

R_w is residual ratio of flexural stress after weathering test, in percentage;

σ_{fw} is flexural stress after weathering test, in megapascals;

σ_f is flexural stress without weathering test, in megapascals.

g) Flexural properties after heat aging test

For products with non-foaming material, tests shall be in accordance with either Method A or Method B. For products with cellular material, tests shall be in accordance with Method B.

1) Heat aging test

For heat aging test, test specimens shall be exposed to 150 °C for seven days. If the heat aging test temperature is too high and deformation of the test specimen occurs, the test shall be conducted by decreasing the heat aging test temperature in 10 °C increments until the test specimen does not deform. The heat aging test temperature shall be noted in the test report.

2) Measurement of flexural stress

The flexural stress of the test specimens after heat aging test and the test specimens without heat aging test shall be measured by the following test methods.

Method A: This shall be applied to the cut-out test specimens and shall be in accordance with 5.3 c) Method A.

Method B: This shall be applied to the actual size test specimens and shall be in accordance with 5.3 c) Method B.

3) Change rate of flexural stress after heat aging test

Change rate of flexural stress after heat aging test shall be calculated using Formula (6) to an integer by rounding off.

$$C_h = 100 \times (\sigma_{fh}-\sigma_f)/\sigma_f \quad (6)$$

where

C_h is change rate of flexural stress after heat aging test, in percentage;

σ_{fh} is flexural stress after heat aging, in megapascals;

σ_f is flexural stress without heat aging, in megapascals.

Instead of change rate of flexural stress, residual ratio of flexural stress after heat aging test may be calculated using Formula (7) to an integer by rounding off, depending on the client's request.

$$R_h = 100 \times (\sigma_{fh}/\sigma_f) \quad (7)$$

where

R_h is residual ratio of flexural stress after heat aging, in percentage;

σ_{fh} is flexural stress after heat aging, in megapascals;

σ_f is flexural stress without heat aging, in megapascals.

h) Impact resistance after heat aging test

For products with non-foaming material, tests shall be in accordance with either Method A, Method B or Method C. For products with cellular material, tests shall be in accordance with either Method B or Method C.

1) Heat aging test

Heat aging test shall be same as g).