INTERNATIONAL STANDARD

ISO 527-5

Second edition
2009-07-01

Plastics — Determination of tensile properties —

Part 5: Test conditions for unidirectional fibre-reinforced plastic composites

Plastiques — Détermination des propriétés en traction —

Partie 5: Conditions d'essai pour les composites plastiques renforcés de fibres unidirectionnelles

Reference number
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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 527-5 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 13, *Composites and reinforcement fibres*.

This second edition cancels and replaces the first edition (ISO 527-5:1997), of which it constitutes a minor revision. The main changes are as follows:

— the normative references have been updated;

— in 6.1.2, a thickness has been specified specifically for specimens from filament-wound test plates.

ISO 527 consists of the following parts, under the general title *Plastics — Determination of tensile properties*:

— *Part 1: General principles*

— *Part 2: Test conditions for moulding and extrusion plastics*

— *Part 3: Test conditions for films and sheets*

— *Part 4: Test conditions for isotropic and orthotropic fibre-reinforced plastic composites*

— *Part 5: Test conditions for unidirectional fibre-reinforced plastic composites*

Plastics — Determination of tensile properties —

Part 5: Test conditions for unidirectional fibre-reinforced plastic composites

1 Scope

1.1 This part of ISO 527 specifies the test conditions for the determination of the tensile properties of unidirectional fibre-reinforced plastic composites, based upon the general principles given in Part 1.

1.2 See ISO 527-1:1993, Subclause 1.2.

1.3 The test method is suitable for all polymer matrix systems reinforced with unidirectional fibres and which meet the requirements, including failure mode, set out in this part of ISO 527.

The method is suitable for composites with either thermoplastic or thermosetting matrices, including preimpregnated materials (prepregs). The reinforcements covered include carbon fibres, glass fibres, aramid fibres and other similar fibres. The reinforcement geometries covered include unidirectional (i.e. completely aligned) fibres and rovings and unidirectional fabrics and tapes.

The method is not normally suitable for multidirectional materials composed of several unidirectional layers at different angles (see ISO 527-4).

1.4 The method is performed using one of two different types of test specimen, depending on the direction of the applied stress relative to the fibre direction (see Clause 6).

1.5 See ISO 527-1:1993, Subclause 1.5.

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 527-1:1993, *Plastics — Determination of tensile properties — Part 1: General principles*

ISO 527-4, *Plastics — Determination of tensile properties — Part 4: Test conditions for isotropic and orthotropic fibre-reinforced plastic composites*

ISO 1268 (all parts), *Fibre-reinforced plastics — Methods of producing test plates*

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

ISO 3534-1, *Statistics — Vocabulary and symbols — Part 1: General statistical terms and terms used in probability*

3 Principle

See ISO 527-1:1993, Clause 3.

4 Terms and definitions

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

4.1
gauge length

See ISO 527-1:1993, Subclause 4.1.

4.2
speed of testing

See ISO 527-1:1993, Subclause 4.2.

4.3
tensile stress
σ (engineering)

See ISO 527-1:1993, Subclause 4.3, except that σ for type A specimens is defined as σ_1 and for type B specimens as σ_2 (see Clause 6 for details of type A and B specimens).

4.3.1
tensile strength
σ_M

See ISO 527-1:1993, Subclause 4.3.3, except that σ_M for type A specimens is defined as σ_{M1} and for type B specimens as σ_{M2}.

4.4
tensile strain
ε
increase in length per unit length of the original gauge length

NOTE 1 For type A specimens, ε is defined as ε_1 and for type B specimens as ε_2.

NOTE 2 It is expressed as a dimensionless ratio or in percent.

4.5
tensile strain at tensile strength
tensile failure strain
ε_M
tensile strain at the point corresponding to the tensile strength of the specimen

NOTE 1 For type A specimens, ε_M is defined as ε_{M1} and for type B specimens as ε_{M2}.

NOTE 2 It is expressed as a dimensionless ratio or in percent.

4.6
modulus of elasticity in tension
Young's modulus
E

See ISO 527-1:1993, Subclause 4.6, except that E for type A specimens is defined as E_1 and for type B specimens as E_2.

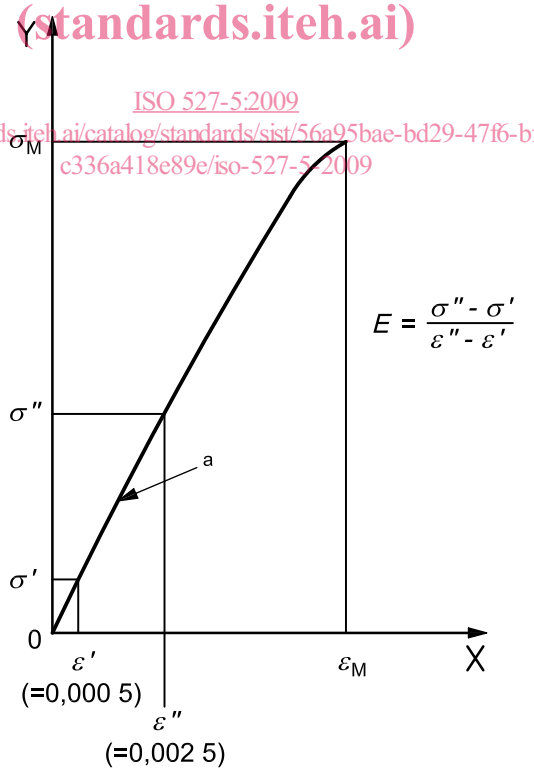
NOTE The strain values used are as given in ISO 527-1:1993, Subclause 4.6, i.e. $\varepsilon' = 0{,}000\ 5$ and $\varepsilon'' = 0{,}002\ 5$ (see Figure 1), unless alternative values are given in the material or technical specifications.

4.7
Poisson's ratio
μ

See ISO 527-1:1993, Subclause 4.7, except that for type A specimens μ_b is defined as μ_{12} and μ_h as μ_{13}, using the coordinates shown in Figure 2, and for type B specimens μ_b is defined as μ_{21} and μ_h as μ_{23}.

4.8
specimen coordinate axes
coordinate axes for the material under test, as shown in Figure 2, the direction parallel to the fibres being defined as the "1"-direction and the direction perpendicular to them (in the plane of the fibres) as the "2"-direction

NOTE The "1"-direction is also referred to as the 0° or longitudinal direction and the "2"-direction as the 90° or transverse direction.



Key
X strain, ε
Y stress, σ

[a] Slope E.

Figure 1 — Stress-strain curve

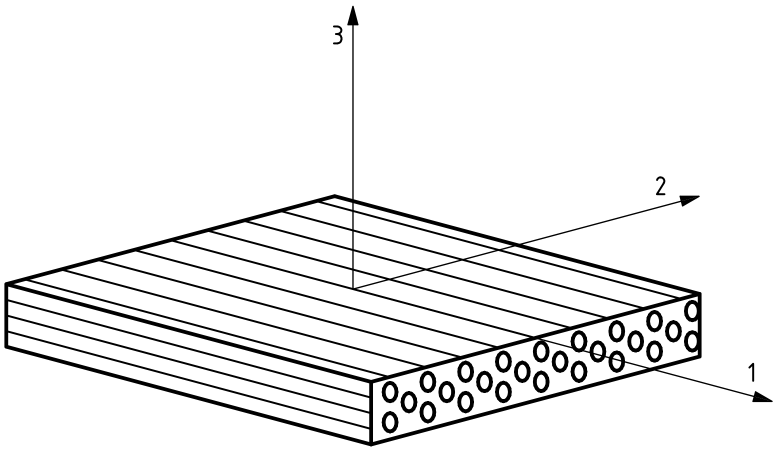


Figure 2 — Unidirectionally reinforced plastic composite showing axes of symmetry

5 Apparatus

See ISO 527-1:1993, Clause 5, except for the following:

The micrometer or its equivalent (see 5.2.1) shall read to 0,01 mm or better. It shall have a suitable-size ball-ended anvil if used on irregular surfaces and a flat anvil if used on flat, smooth (e.g. machined) surfaces.

Subclause 5.2.2 does not apply.

Care shall be exercised to ensure that the pressure exerted by the grips (see 5.1.3) is only sufficient to prevent the specimen slipping in the grip when loaded to failure. Excessive grip pressure may cause crushing of the specimen due to the low transverse strength of these materials. Hydraulic grips which can be set at a constant grip pressure are preferred.

If strain gauges bonded to the specimen are used, the errors produced by the transverse effect on the transverse gauge will generally be much larger for anisotropic composites than for metals, which are isotropic. Accurate measurement of Poisson's ratio requires correction for this effect.

NOTE It is recommended that alignment of the specimen and loading train be checked as described in Annex B.

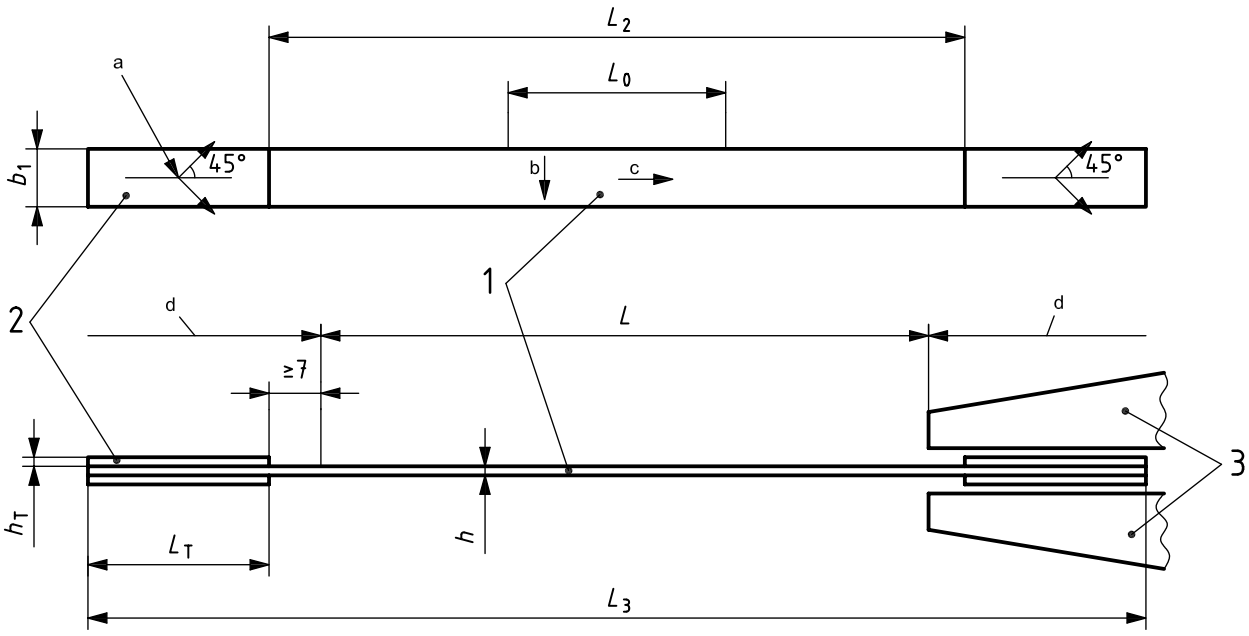
6 Test specimens

6.1 Shape and dimensions

6.1.1 General

Two types of test specimen are specified for use with this part of ISO 527, depending on the direction of test relative to the fibre direction, as detailed and illustrated in Figure 3.

Dimensions in millimetres



Key

1 specimen
2 tab
3 jaws

a Tab-fibre orientation.
b Fibre direction in type B specimen.
c Fibre direction in type A specimen.
d Zone covered by jaws.

Dimensions in millimetres

		Type A	Type B
L_3	Overall length	250	250 (see Note 2)
L_2	Distance between end tabs	150 ± 1	150 ± 1
b_1	Width	15 ± 0,5	25 ± 0,5
h	Thickness	1 ± 0,2	2 ± 0,2
L_0	Gauge length (recommended for extensometers)	50 ± 1	50 ± 1
L	Initial distance between grips (nominal)	136	136
L_T	Length of end tabs	> 50	> 50 (see Note 2)
h_T	Thickness of end tabs	0,5 to 2	0,5 to 2

NOTE 1 Requirements on specimen quality and parallelism are given in Clause 6.

NOTE 2 For specimens taken from filament-wound plates prepared using ISO 1268-5, an overall specimen length of 200 mm is acceptable, with an end-tab length of 25 mm.

Figure 3 — Type A and type B specimens