SLOVENSKI STANDARD
SIST EN 2597:2001

01-junij-2001

Aerospace series - Carbon fibre reinforced plastics - Unidirectional laminates - Tensile test perpendicular to the fibre direction

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Luft- und Raumfahrt - Kohlenstoffaserverstärkte Kunststoffe - Unidirektionale Laminate - Zugversuch senkrecht zur Faserrichtung

Série aérospatiale - Plastiques renforcés de fibres de carbone - Stratifiés unidirectionnels - Essai de traction perpendiculairement a la direction des fibres

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English version

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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 Central Secretariat has the same status as the official versions.

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

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

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Foreword

This European Standard has been prepared by the European Association of Aerospace Manufacturers (AECMA).

After inquiries and votes carried out in accordance with the rules of this Association, this Standard has received the approval of the National Associations and the Official Services of the member countries of AECMA, prior to its presentation to CEN.

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of an identical text or by endorsement, at the latest by January 1999, and conflicting national standards shall be withdrawn at the latest by January 1999.

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, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This standard specifies the method of determination of the ultimate tensile strength, tensile modulus and, if required, the Poisson's ratio and elongation at failure in tension of carbon fibre reinforced plastics in the form of unidirectional laminates.

This method is only applicable to specimens the axis of which is perpendicular to the direction of the fibres.

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.

EN 2489 Aerospace series - Fibre reinforced plastics - Determination of the action of test fluids

EN 2565 Aerospace series - Preparation of carbon fibre reinforced resin panels for test purposes [1)]

EN 2743 Aerospace series - Reinforced plastics - Standard procedures for conditioning prior to testing [1)]

EN 2744 Aerospace series - Non-metallic materials - Preferred test temperatures

EN 2823 Aerospace series - Fibre reinforced plastics - Test method for the determination of the effect of exposure to humid atmosphere on physical and mechanical characteristics [1)]

3 Definitions

For the purpose of this standard, the following definitions apply:

3.1 Tensile stress

Tensile load experienced by the specimen at any moment during the test, per initial unit cross sectional area within the free length.

3.2 Ultimate tensile strength (σ_{T22})

Tensile stress at the moment failure occurs.

1) Published as AECMA Prestandard at the date of publication of this standard

3.3 Strains (ε_{11} and ε_{22})

Change in the distance between reference points in the specimen free length, produced by a tensile load and expressed with respect to the initial distance between these points.

ε_{11} is the strain measured parallel to the fibre direction.

ε_{22} is the strain measured perpendicular to the fibre direction (in the plane of the laminate).

3.4 Percentage strain to failure (a_{22})

Increase in the distance between reference points in the specimen free length, produced by a tensile load and expressed as a percentage of the initial distance between these points and measured at the moment of failure.

3.5 Secant modulus between $F_R/10$ and $F_R/2$ (E_{T22})

On the strain/stress diagram (stress and strain being parallel to the loading axis) the secant modulus is the slope of the straight line passing through:

- the point corresponding to a stress calculated from $F_R/2$;
- the point corresponding to a stress calculated from $F_R/10$.

F_R is the load at failure of the specimen.

3.6 Poisson's ratio (ν_{21})

Absolute value of the ratio of the difference in strain ε_{11} to the difference in strain ε_{22}, measured between $F_R/10$ and $F_R/2$ (see figure 2).

4 Principle

The method consists of the measurement of the longitudinal and, if required, the lateral strains in the material, in relation to the load applied, during a tensile test carried out at a constant speed until failure occurs.

Two types of specimen (A and B) may be used which give significantly different results as far as mean values and scatter are concerned.

It shall be specified on which type of specimen the result was obtained.

5 Apparatus

5.1 Micrometer with 6 mm diameter flat faces and accurate to ± 0,01 mm.

5.2 Testing machine, accurate to ± 1 % in the load range used.

5.3 A means of recording strains, in relation to the load (extensometer or strain gauges), accurate to ± 1 % in the strain range used. The instrument shall not mark the specimen in a way which may cause premature failures.

5.4 If necessary, regulated heated cabinet for tests at temperatures other than ambient, according to EN 2744.

5.5 Thermocouple and recorder for tests at temperatures other than ambient.

6 Specimens

The specimens shall be taken from panels prepared according to EN 2565.

These panels shall have a curvature lower than the following limit:

$$\frac{f}{k} \leq 0{,}002$$

where:

f is the curvature, in millimetres;
k is the reference length, in millimetres.

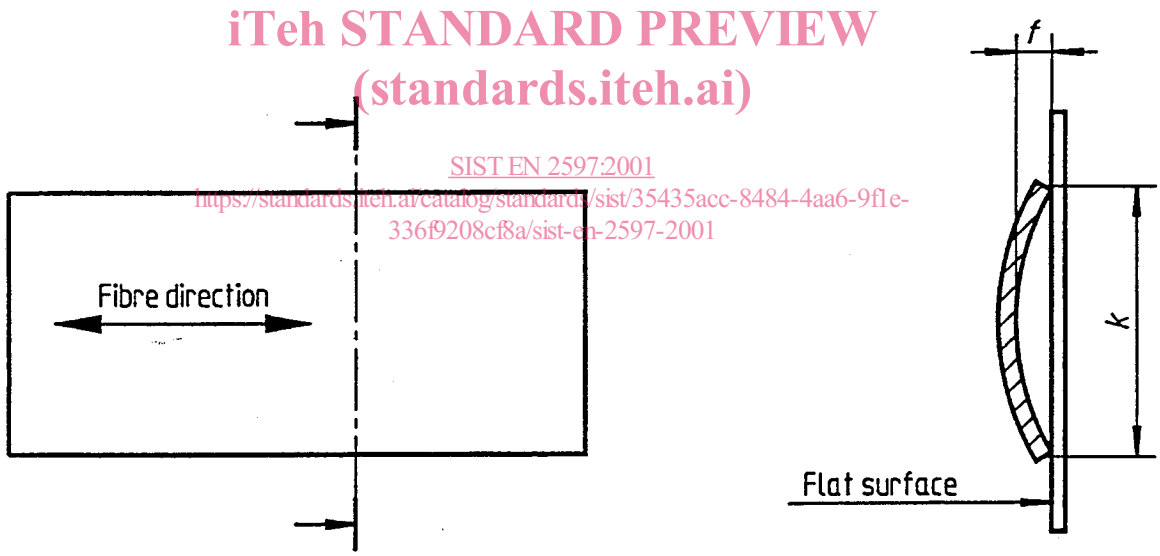

Figure 1: Curvature

6.1 Form and dimensions

See annex A.

6.2 Number

Minimum of ten

NOTE: This number is necessary due to the high scatter in test results specific to this test.

7 Procedure

7.1 Conditioning

- EN 2743 for tests in the initial state;
- EN 2489 for tests after immersion;
- EN 2823 for tests after exposure to humid atmosphere.

7.2 Specimen measurement

7.2.1 Type A specimens

Measure the width b to ± 0,01 mm at the free length (see annex A).

Make three measurements of the thickness to ± 0,01 mm across the width of the free length.

h is the arithmetic mean of these three measurements.

7.2.2 Type B specimens

Measure the width to ± 0,01 mm in the centre of the specimen and at two opposite points located 50 mm from the centre.

b is the arithmetic mean of these three measurements.

Measure the thickness to ± 0,01 mm in the centre of the specimen and at two opposite points on the specimen axis and located 50 mm from the centre.

h is the arithmetic mean of these three measurements.

7.3 Tests

7.3.1 Tests at temperatures other than ambient

The period separating the conditioning and start of the test shall conform to the following conditions:

- for specimens which have not been aged or subjected to immersion, the exposure time at the test temperature shall be established by preliminary tests;
- for specimens subjected to immersion, see EN 2489;
- for humidity aged specimens, see EN 2823.

7.3.2 General requirements

7.3.2.1 The specimen shall be aligned in the test machine jaws so as to avoid the introduction of any bending loads.

7.3.2.2 The specimens shall be positioned in the jaws according to figure A.3.

7.3.2.3 The load shall be applied at a constant rate of jaw separation of 0,5 mm/min.

7.3.2.4 Record the strain ε_{22} and, if necessary, the strain ε_{11} using the extensometer or strain gauges as a function of load.

7.3.2.5 Record the load at failure F_R and, if necessary, the strain at failure $(\varepsilon_{22})_R$.

8 Expression of results

8.1 Ultimate tensile strength σ_{T22} (MPa)

$$\sigma_{T22} = \frac{F_R}{b \cdot h}$$

where:

F_R is the load at failure, in Newtons;
b is the width, in millimetres;
h is the thickness, in millimetres.

8.2 Secant modulus E_{T22} (MPa) between $F_R/10$ and $F_R/2$

Determine the strains from the load/strain recording (figure 2).

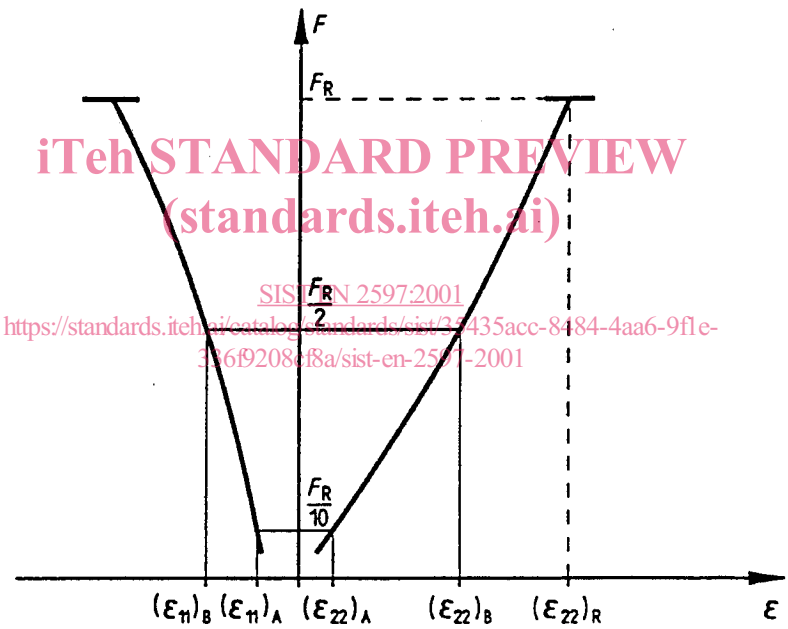

Figure 2: Load/strain recording

$$E_{T22} = \frac{0{,}4\, F_R}{b \cdot h \left[(\varepsilon_{22})_B - (\varepsilon_{22})_A\right]}$$

where:

F_R is the load at failure, in Newtons;
b is the width, in millimetres;
h is the thickness, in millimetres;
$(\varepsilon_{22})_A$ is the strain perpendicular to the fibre direction corresponding to $F_R/10$;
$(\varepsilon_{22})_B$ is the strain perpendicular to the fibre direction corresponding to $F_R/2$.