SLOVENSKI STANDARD
SIST EN 2561:2001

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

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Luft- und Raumfahrt - Kohlenstoffaserverstärkte Kunststoffe - Unidirektionale Laminate - Zugprüfung parallel zur Faserrichtung

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

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English version

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

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

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 successively 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of an identical text or by endorsement, at the latest by March 1996, and conflicting national standards shall be withdrawn at the latest by March 1996.

According to the CEN/CENELEC Internal Regulations, the following countries are bound to implement this European Standard:
Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, 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 strain at failure in tension of carbon fibre reinforced plastics in the form of unidirectional laminates.

This method is only applicable to specimens where the axis is parallel 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 purposes 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_{T11})

Tensile stress at the moment failure occurs.

3.3 Ultimate tensile strength related to the fibre (σ_f)

The ultimate tensile strength calculated as a function of the fibre cross sectional area and based on the hypothesis that all the tensile load is carried by the fibres.

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

3.4 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).

3.5 Percentage strain to failure (A %)

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.

3.6 Secant modulus between $P_R/10$ and $P_R/2$ (E_{T11})

Slope of the straight line passing through :

- the point of the stress/strain diagram parallel to the load axis, corresponding to a stress calculated from $P_R/2$;
- the point on the same diagram corresponding to a stress calculated from $P_R/10$.

P_R is the load at failure of the specimen.

3.7 Secant modulus related to the fibre (E_f)

The secant modulus calculated as a function of the fibre cross sectional area and based on the hypothesis that all the tensile load is carried by the fibres.

3.8 Poisson's ratio (ν_{12})

Absolute value of the ratio of the difference in strain ε_{22} to the difference in strain ε_{11}, measured between $P_R/10$ and $P_R/2$ (see figure 1).

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 rate of displacement until failure occurs.

5 Apparatus

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

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

5.3 A means of recording strains, in relation to the load (extensometer or strain gauges), accurate to within 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, heated cabinet, regulated so as to conform to EN 2744 for tests at temperatures other than ambient

5.5 Thermocouple and recorder for tests at temperatures other than ambient

6 Specimens

Take specimens from panels prepared according to EN 2565.

6.1 Form and dimensions

See annex A.

6.2 Number

Minimum of five

7 Procedure

7.1 Conditioning

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

7.2 Tests

7.2.1 Measure the width to within 0,01 mm in the centre of the specimen and at two opposite points located 30 mm from the centre.

b is the arithmetic mean of these three measurements.

Measure the thickness to within 0,01 mm in the centre of the specimen and at two opposite points on the specimen axis and located 30 mm from the centre.

h is the arithmetic mean of these three measurements.

7.2.2 For 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.

7.2.3 The alignment of the specimen in the test machine jaws shall be sufficient to avoid the introduction of any bending loads.

7.2.4 The jaws shall entrap the tabs of the specimens of types A and B (see figure A.1).

7.2.5 The load shall be applied at a constant rate of jaw separation of 2 mm/min.

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

7.2.7 Record the load at failure P_R and, if necessary, the strain at failure $(\varepsilon_{11})_R$.

8 Expression of results

8.1 Ultimate tensile strength σ_{T11} (MPa)

$$\sigma_{T11} = \frac{P_R}{b\ h}$$

where:

P_R is the load at failure, in newtons ;
b is the width, in millimeters ;
h is the thickness, in millimeters.

8.2 Ultimate tensile strength related to the fibre σ_f (MPa)

$$\sigma_f = \frac{P_R\ \rho_f}{n\ b\ M_{sf}}$$

where:

n is the number of plies ;
M_{sf} is the mass per unit area of fibre, in grams per square meter, per ply ;
ρ_f is the density of fibre, in kilograms per cubic meter ;
P_R is the load at failure, in newtons;
b is the width, in millimeters.

8.3 Secant modulus E_{T11} (MPa) between P_R /10 and P_R /2

Determine the strains from the recorded load/strain diagram (figure 1) :

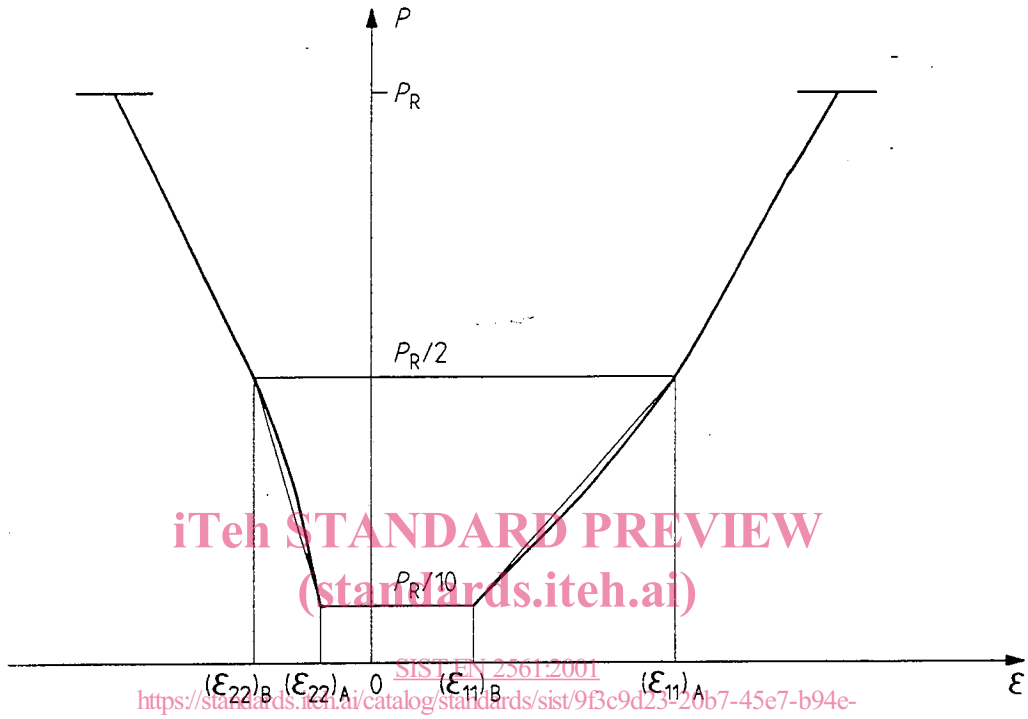

Figure 1

$$E_{T11} = \frac{0{,}4 \quad P_R}{b \quad h\left[(\varepsilon_{11})_B - (\varepsilon_{11})_A\right]}$$

where:

P_R is the load at failure, in newtons ;
b is the width, in millimeters ;
h is the thickness, in millimeters ;
$(\varepsilon_{11})_A$ is the strain parallel to the fibre direction corresponding to P_R /10 ;
$(\varepsilon_{11})_B$ is the strain parallel to the fibre direction corresponding to P_R /2.