SLOVENSKI STANDARD
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Aerospace series - Glass fibre reinforced plastics - Flexural test - Three point bend method

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Luft- und Raumfahrt - Glasfaserverstärkte Kunststoffe - Biegeversuch - Dreipunktverfahren

Série aérospatiale - Plastiques renforcés au verre textile - Essai de flexion - Méthode des trois pannes

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49.025.40 Guma in polimerni materiali Rubber and plastics

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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

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of an identical text or by endorsement, at the latest by February 1999, and conflicting national standards shall be withdrawn at the latest by February 1999.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 three point bend method for the determination of the flexural properties of glass fibre reinforced plastics for aerospace applications.

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 2374 Aerospace series - Glass fibre reinforced mouldings and sandwich composites - Production of test panels

EN 2489 Aerospace series - Fibre reinforced plastics - Determination of the action of liquid chemicals

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

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 Deflection

The distance travelled during the test by a point on the upper or lower face of the specimen at the centre of its span measured from its initial position.

3.2 Conventional deflection

Unless otherwise specified, a deflection equal to 1,5 times the specimen thickness.

3.3 Flexural stress

The stress at the surface of the material in the middle of the span of the specimen between the supports at any time during the test.

3.4 Flexural strength

Flexural stress at the moment when the applied force reaches the maximum value.

3.5 Flexural stress at failure

Flexural stress at the moment of failure of the specimen.

3.6 Flexural modulus

Slope of the tangent at the origin of the stress/strain curve calculated from the force/deflection recording.

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

4 Principle

The method consists of the measurement of the deflection at the central loading nose as a function of the applied force during a flexural test carried out at constant speed until failure occurs. The strain parallel to the specimen length is calculated as a function of the applied flexural stress.

The following properties may be determined:

- flexural stress and deflection at failure of specimens which break before or on reaching conventional deflection;
- flexural stress at conventional deflection of specimens which break beyond conventional deflection;
- flexural strength of specimens which reach maximum load before or at conventional deflection;
- flexural strength or flexural stress at failure if this is required by the material standard;
- flexural modulus.

NOTE: The flexural modulus is only an approximate value of YOUNG's modulus of elasticity.

5 Apparatus

A test machine, allowing relative displacement of the loading nose with respect to the supports at a constant speed, and indicating forces to ± 1 % and deflections to ± 2 %.

The supports and the loading nose shall be at least as wide as the specimen and shall be parallel to one another.

The radius, r_1, of the loading nose and the radius, r_2, of the supports shall be as follows:

$r_1 = (5 \pm 0{,}1)$ mm;

$r_2 = (2 \pm 0{,}2)$ mm.

It shall be possible to adjust the span (see figure 1).

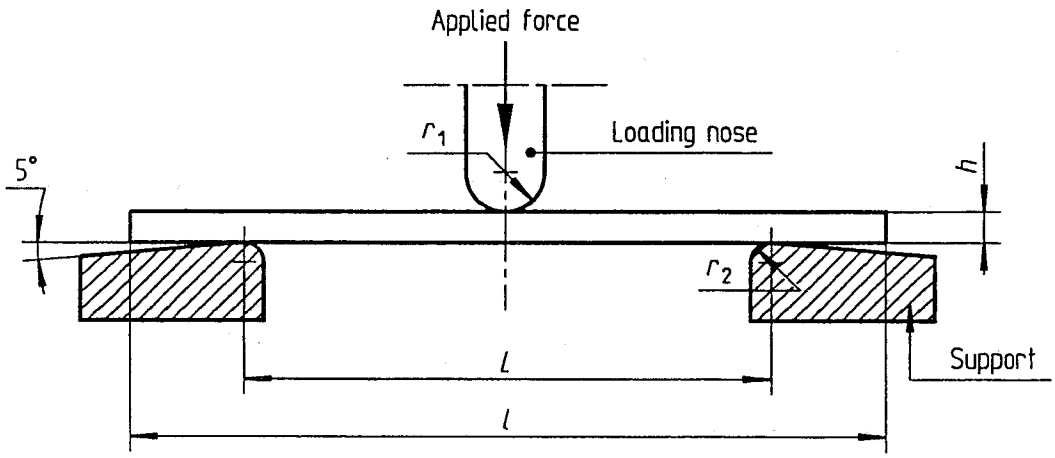

Figure 1: Detail of test apparatus

6 Specimens

6.1 Dimensions

- Thickness "h": (3 ± 0,2) mm
- Width "b": (15 ± 0,5) mm
- Length "l": [(20 × h) ± 1] mm

NOTE: If it is impossible to obtain specimens from the finished component, prepare test panels according to EN 2374 or to a suitable method by agreement between the parties concerned.

If it is necessary to use a thickness of specimen greater than 3 mm or if a failure in compression is expected, the radius of the supports may be increased on condition that:

$$r_2 \leq 1{,}5\ h$$

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 exposure to humid atmosphere.

7.2 Specimen measurement

In the central section of the specimen, measure the width b to ± 0,1 mm, then make three measurements of the thickness h to ± 0,02 mm and calculate their arithmetic mean.

7.3 Support span

Adjust the span, L, to comply with the following equation:

$$L = (16 \times h) \pm 1$$

where:

L is the span, in millimetres;

h is the thickness of the specimen, in millimetres.

Measure the span to ± 0,5 %.

7.4 Test speed

Set the test machine to the speed V, according to one of the following:

- V is specified;
- the rate of strain is specified;
- calculate V:

$$V = \frac{Sr \cdot L^2}{6\,h}$$

where:

V is the test speed, in millimetres per minute;
Sr is the rate of strain, in units per minute;
L is the span, in millimetres;
h is the thickness of the specimen, in millimetres.

If there is no requirement, calculate V:

$$V = K \cdot h$$

where:

V is the test speed, in millimetres per minute;
h is the thickness of the specimen, in millimetres;
K = 0,5 min^{-1}.

7.5 Test atmosphere

Carry out the tests at (23 ± 2) °C and (50 ± 5) % relative humidity.

7.6 Tests

Position the specimen symmetrically with respect to the supports, ensuring that its length is perpendicular to these supports. Ensure that the loading nose is placed exactly in the middle of the span and apply force at a constant speed, avoiding shock loading.

The force and deflection shall be simultaneously recorded.

Note the values of the required characteristics:

- at conventional deflection;
- at maximum force;
- at failure.

8 Expression of results

8.1 Flexural stress

$$\sigma_f = \frac{3\,F\,L}{2\,b\,h^2}$$

where:

σ_f is the flexural stress, in megapascals;
F is the force applied, in newtons;
L is the span, in millimetres;
b is the width of the specimen, in millimetres;
h is the thickness of the specimen, in millimetres.

NOTE: A more precise calculation of the flexural stress takes into account the horizontal component of the flexural moment:

$$\sigma_f \qquad \frac{3\,F\,L}{2\,b\,h^2}\left(1+\frac{4\,d^2}{L^2}\right)$$

where:

d is the deflection, in millimetres.

8.2 Flexural modulus

Examine the force/deflection curve and determine the modulus from the initial rectilinear part, using at least five points.

If the initial part of the curve is not linear, then a straight line shall be drawn between 10 % and 25 % of the maximum force, see figure 2.

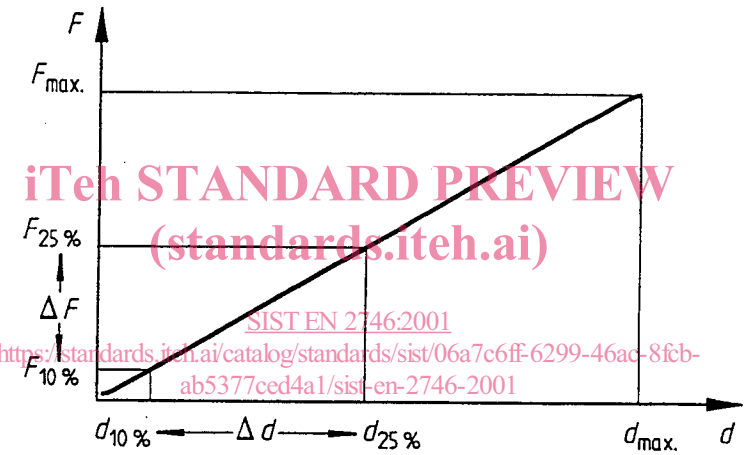

Figure 2: Force/deflection curve

$$E_f \qquad \frac{L^3}{4\,b\,h^3}\quad\frac{\Delta F}{\Delta d}$$

where:

E_f is the modulus, in megapascals;

L is the span, in millimetres;

b is the width of the specimen, in millimetres;

h is the thickness of the specimen, in millimetres;

ΔF is a chosen difference in force, in newtons;

Δd is the difference in deflection corresponding to the difference in force ΔF, in millimetres.