

Methods of testing

Plastics —

Part 3: Mechanical properties —

**Methods 320A to 320F: Tensile strength,
elongation and elastic modulus**

IMPORTANT NOTE Before reading this method it is essential to read the foreword, general introduction and instructions to BS 2782, issued separately.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 12 and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

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0 Introduction

This group of methods describes tests for determining the short-term tensile properties of the range of materials detailed in clause 1, this does not include films, thin sheet, PTFE and cellular materials. Methods applicable to thin sheet and film are described in Methods 326A to 326C¹⁾.

Methods 320C to 320F are revisions and extensions of, and replace, methods 301A to 301L “Mechanical properties. Tensile strength and elongation at break” of BS 2782:1970, with the exception of method 301K dealing with PTFE (excluding rod). Methods 301A to 301L (excluding 301K) BS 2782:1970 are therefore withdrawn. It is intended to revise method 301K of BS 2782:1970 and publish it separately as Method 327A¹⁾.

The materials have been divided into four categories according to type of test piece. The range of testing speeds specified is such that, for most materials, conditions can be selected so that they reach their yield point or point of rupture in 20 s or 100 s.

The methods are intended to be used for material characterization purposes and for routine quality control work. The methods given combine the determination of stress and strain data. However, the information that is noted or recorded during the test may be confined to the measurement of one particular feature, depending on the scope and purpose of the evaluation.

The methods of test outlined here incorporate a wider range of test pieces than ISO/R 527 but there is general agreement with regard to technical content.

NOTE Methods 320A and 320B have been withdrawn and are superseded by BS 2782-3:Method 321:1993 and BS 2782-3: Method 322:1993.

WARNING NOTE. Due attention should be paid to any necessary safety precautions and these methods should only be operated by trained personnel.

1 Scope and field of application

These methods describe four procedures for the determination of the tensile properties of plastics materials, each applicable to a specific type of material.

Method 320C is applicable to rigid thermoplastic and thermosetting sheet, including certain types of industrial laminates, extrusion and moulding compounds.

Method 320D is applicable only to the determination of the strength properties of rigid thermosetting moulding materials including filled and reinforced compounds.

Method 320E is applicable to fibre reinforced materials (composites) incorporating mats, cloth woven rovings, including pre-pregs.

Method 320F is applicable to the determination of the strength properties of unidirectional reinforced materials (composites) including pre-pregs.

2 References

The following standards publications are referred to in these methods.

BS 2782, *Methods of testing plastics — Foreword, general introduction and instructions: 1975*¹⁾ —

¹⁾Methods 326A to 326C, *Tensile properties of film* — ¹⁾Method 327A, *Tensile strength and elongation at break of PTFE (excluding rod)*.

Method 327A *Tensile strength and elongation at break of PTFE (excluding rod)*.

BS 4994, *Vessels and tanks in reinforced plastics*.

BS 6214, *Testing machines for rubbers and plastics — Part 1: Tensile, flexural and compression machines*.

ISO/R 527, *Determination of tensile properties*.

3 Definitions

For the purposes of this British Standard the following definitions apply.

3.1 tensile stress

the tensile force carried by the test piece per unit area of the original cross-sectional area between the reference lines

3.2 strain

the ratio of the change in the distance between the reference lines to the original distance

3.3 tensile strength

the maximum tensile stress which the test piece is capable of supporting (see A.6 and A.8)

3.4 yield stress

the tensile stress at which occurs the first marked inflection of the stress-strain curve. Where any increase in strain occurs without any increase in stress, this point is taken as the yield stress (see Figure 7)

¹⁾ In course of preparation.

3.5**off-set yield stress**

the stress on the stress-strain curve where the curve departs from initial linearity by a specified strain (see Figure 7)

3.6**percentage elongation**

the elongation produced in the gauge length of the test piece by a tensile stress and expressed as a percentage of the original gauge length (distance between the reference lines)

3.7**percentage elongation at yield**

the elongation produced in the gauge length of the test piece at the yield stress, expressed as a percentage of the original gauge length (distance between the reference lines)

3.8**percentage elongation at break**

the elongation at break produced in the gauge length of the test piece expressed as a percentage of the original gauge length (distance between the reference lines) (see A.9)

3.9**elastic modulus**

the ratio of stress to corresponding strain below the proportional limit, where the proportional limit is the greatest stress which a material is capable of supporting without any deviation from proportionality of stress to strain (Hooke's Law). The stress-strain relationship of many plastics does not conform to Hooke's Law throughout the elastic range but deviates therefrom even at stresses well below the yield stress. For such materials, the slope of the tangent to the stress-strain curve at a low strain is usually taken as the elastic modulus

3.10**secant modulus**

in general, the ratio of stress to corresponding strain at any given point on the stress-strain curve. However, for rigid materials (e.g. for Method 320E), it is usual to define secant modulus as the ratio of stress to corresponding strain measured relative to a level of pre-stress applied to straighten the test piece. In such instances, the secant modulus shall be based on the stress required to extend the gauge length of the test piece by 0.2 % from a pre-stress of approximately 10 % of the expected force at 0.002 strain (see A.8)

4 Principle

The principle of the test is the subsection of test pieces of defined groups of plastics materials to a tensile force and the calculation of any of the properties defined in clause 3, as required.

5 Apparatus

The following apparatus is required.

5.1 Tensile testing machine. The tensile testing machine shall be power driven and capable of maintaining the appropriate rate of grip separation as specified for the appropriate test procedure. In all cases, a continuous indication of the force applied to the test piece, preferably recorded autographically with a permanent indication of the maximum force, shall be provided. The force scale shall be calibrated by a suitable method to ensure that the error does not exceed the requirements for grade A of BS 5214-1:1975 (see A.1).

Unless otherwise specified, the machine shall be provided with a type of grip which maintains or increases grip pressure as the force applied to the test piece increases. The test piece shall be held in such a manner that slip relative to the grips is prevented as far as possible, and the clamping system should not produce premature failure at the grips.

5.2 Extensometer. When an extensometer is used, a continuous indication of the elongation of the gauge length, and, if appropriate, a permanent indication of the maximum elongation shall be given. Preferably the elongation should be recorded autographically in the form of a force elongation curve. When an extensometer is attached to the test piece, care should be taken to ensure that any distortion of, or damage to, the test piece is minimal, and it is essential that no slippage occurs between the extensometer grips and the test piece. The instrument shall be essentially free from inertia lag at the specified speed of testing and shall be calibrated by a suitable method to ensure that the error does not exceed 2 % of the actual strain.

5.3 Micrometers. For measuring the thickness and width of rigid materials, a screw micrometer reading to 0.01 mm or less shall be used.

For measuring the thickness of flexible materials, a dial gauge micrometer (or comparator) reading to 0.01 mm or less and provided with a flat circular foot that will apply a pressure of 20 ± 3 kPa shall be used.

6 Test pieces

The test pieces for each test procedure are listed in Table 1 and are shown with detailed dimensions and tolerances in Figure 3 to Figure 6.