ISO

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO RECOMMENDATION
R 527

PLASTICS
DETERMINATION OF TENSILE PROPERTIES

1st EDITION
November 1966

For each individual country the only valid standard is the national standard of that country.

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BRIEF HISTORY

The ISO Recommendation R 527, *Determination of Tensile Properties*, was drawn up by Technical Committee ISO/TC 61, *Plastics*, the Secretariat of which was held by the American Standards Association, Inc. (ASA).

Work on this question by the Technical Committee began in 1953 and led, in 1960, to the adoption of a Draft ISO Recommendation.

This first Draft ISO Recommendation (No. 468) was circulated to all the ISO Member Bodies for enquiry, in April 1960. As the results of this consultation were not considered satisfactory, the Technical Committee presented a second Draft ISO Recommendation, which was circulated to all the ISO Member Bodies in April 1964, and which was approved, subject to a few modifications of an editorial nature, by the following Member Bodies:

Australia	Hungary	Spain
Austria	India	Sweden
Brazil	Israel	Switzerland
Bulgaria	Japan	Turkey
Canada	Korea, Rep. of	United Kingdom
Chile	Netherlands	U.S.A.
Colombia	New Zealand	U.S.S.R.
Czechoslovakia	Poland	Yugoslavia
Denmark	Portugal	
Finland	Republic of South Africa	
Germany	Romania	
Greece		

Three Member Bodies opposed the approval of the Draft:

Belgium
France
Italy

The second Draft ISO Recommendation was then submitted by correspondence to the ISO Council, which decided, in November 1966, to accept it as an ISO RECOMMENDATION.

PLASTICS

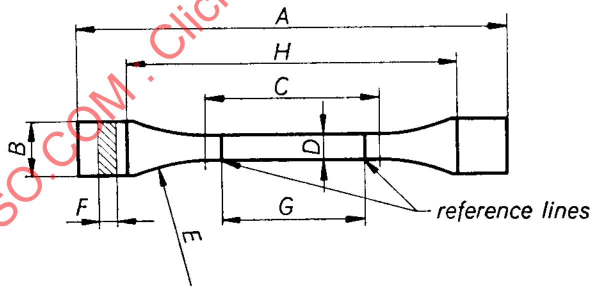
DETERMINATION OF TENSILE PROPERTIES

1. SCOPE

1.1 This ISO Recommendation describes a method for determining the tensile properties of plastics in the form of standard test specimens tested under defined conditions of pretreatment, temperature, humidity and rate of separation of grips.

1.2 Three different test specimens are specified. The test specimen to be used for testing a given material is as specified in the specification for the material. The first test specimen (Type 1, Fig. 1) will normally be found suitable for materials, e.g. laminates based on thermosetting resins and many rigid thermoplastic moulding materials, having moderate elongations at break; the second (Type 2, Fig. 2) for materials, e.g. polyethylene and plasticized polyvinyl chloride, having relatively high elongations at break and the third (Type 3, Fig. 3) for thermosetting moulding materials.

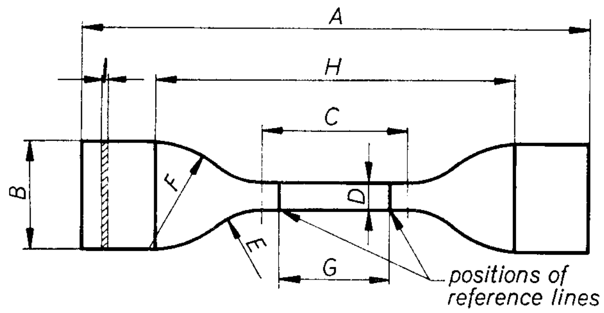
Different rates of separation of grips are specified to suit the different materials to which the method can be applied. It is not possible to make a valid comparison between the results of tensile tests on different materials if the test specimens or the rates of straining or both are different.



Dimensions in millimetres

A	Overall length, minimum	150
B	Width at ends	20 ± 0.5
C	Length of narrow parallel portion	60 ± 0.5
D	Width of narrow parallel portion	10 ± 0.5
E	Radius, minimum	60
F	Thickness	see text
G	Distance between reference lines	50 ± 0.5
H	Initial distance between grips	115 ± 5

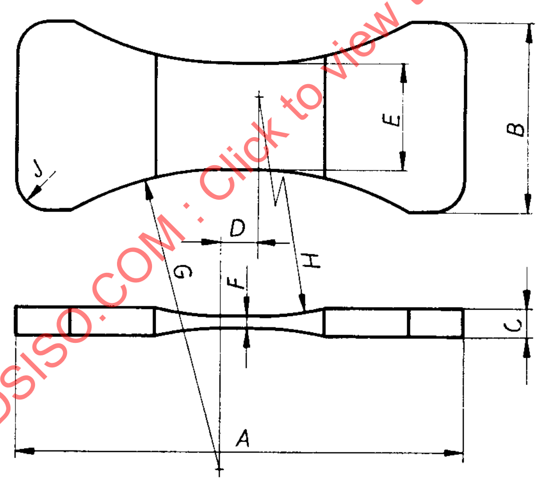
FIG. 1. — Type 1 test specimen showing positions of reference lines (if used)



Dimensions in millimetres

A	Overall length, minimum	115
B	Width at ends	25 ± 1
C	Length of narrow parallel portion	33 ± 2
D	Width of narrow parallel portion	$6 {}^{+0.4}_{0}$
E	Small radius	14 ± 1
F	Large radius	25 ± 2
G	Distance between reference lines	25 ± 1
H	Initial distance between grips	80 ± 5
I	Thickness	see text

FIG. 2. — **Cutting edges of die for Type 2 test specimen showing positions of reference lines (if used).**



Dimensions in millimetres

Tolerance on dimensions ± 5 per cent

A	Overall length	110
B	Width at ends	45
C	Thickness at ends	6.5
D	Length of narrow parallel portion	9.5
E	Width of narrow parallel portion	25
F	Thickness of narrow parallel portion	3.2
G	Side radius	75
H	Face radius	75
J	End radius	6.5

FIG. 3. — **Type 3 test specimen**

2. DEFINITIONS

2.1 **Tensile stress.** Tensile load per unit area of minimum original cross section within the narrow parallel portion, carried by the test specimen at any moment. It is expressed in kilogrammes-force per square centimetre.

2.2 **Percentage elongation.** Increase in the distance between reference lines on the narrow parallel portion of the test specimen, due to a tensile load, and expressed as a percentage of the initial distance between the reference lines.

2.3 **Yield point.** First point on the load/extension curve at which an increase in extension occurs without an increase in load.

NOTE. — In cases where the yield point is not well defined by the load/extension curve, it is frequently necessary to define an offset yield point. This is done by specifying a point on the load/extension curve where the curve departs from linearity by a specified percentage elongation or extension (see Fig. 5).

2.4 **Elastic modulus.** Ratio of stress to corresponding strain within the range of the greatest stress that the material is capable of sustaining without any deviation of proportionality of stress to strain.

It is expressed in kilogrammes-force per square centimetre.

3. SIGNIFICANCE

3.1 The tensile properties that can be measured by some or all of the procedures described in this method include tensile stress and elongation at the yield point, tensile stress and elongation at break, maximum tensile stress and modulus of elasticity.

Materials of low ductility may not exhibit a well-defined yield point. Stress-strain curves at several different values of temperature, humidity and straining rate usually give reasonably reliable indications of the behaviour of materials under tensile stress.

3.2 Tensile tests may provide data for quality control, acceptance or rejection in accordance with the terms of specifications, research and development, engineering design and other purposes. Test results cannot be considered significant for applications in which the rate of application of stress differs considerably from those specified for this method of test. Such applications should be considered in terms of tests such as impact, creep and fatigue.

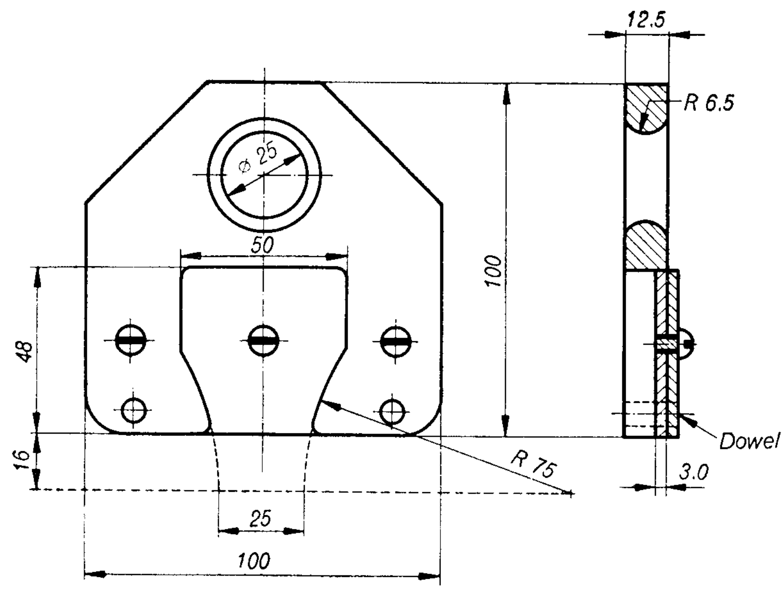
4. APPARATUS

4.1 **Testing machine.** Testing machine with grips that can be separated at one or more (as required) of the rates given in section 8.

4.1.1 *Grips.* Grips for holding the test specimen, one being attached to a fixed or essentially stationary member of the machine and the other to a movable member. The grips are self-aligning; that is, they are attached to the fixed and movable member respectively in such a manner that they will move freely into alignment as soon as any load is applied, so that the long axis of the test specimen will coincide with the direction of the applied pull through the centre line of the grip assembly. The test specimen is held in such a way that slip relative to the grips is prevented as far as possible.

For the Type 1 and Type 2 test specimens, the grips may conveniently be of the kind that tighten automatically under load. The grip shown in Figure 4 is suitable for the Type 3 test specimen.

4.1.2 *Load indicator.* Suitable load-indicating mechanism capable of showing the total tensile load carried by the test specimen when held by the grips. This mechanism is essentially free from inertia lag at the specified rate of testing and indicates the load with an accuracy of $\pm$ 1 per cent of the indicated value, or better.



Dimensions in millimetres

Tolerance on dimensions ± 5 per cent

FIG. 4. — **Grip for Type 3 test specimen**

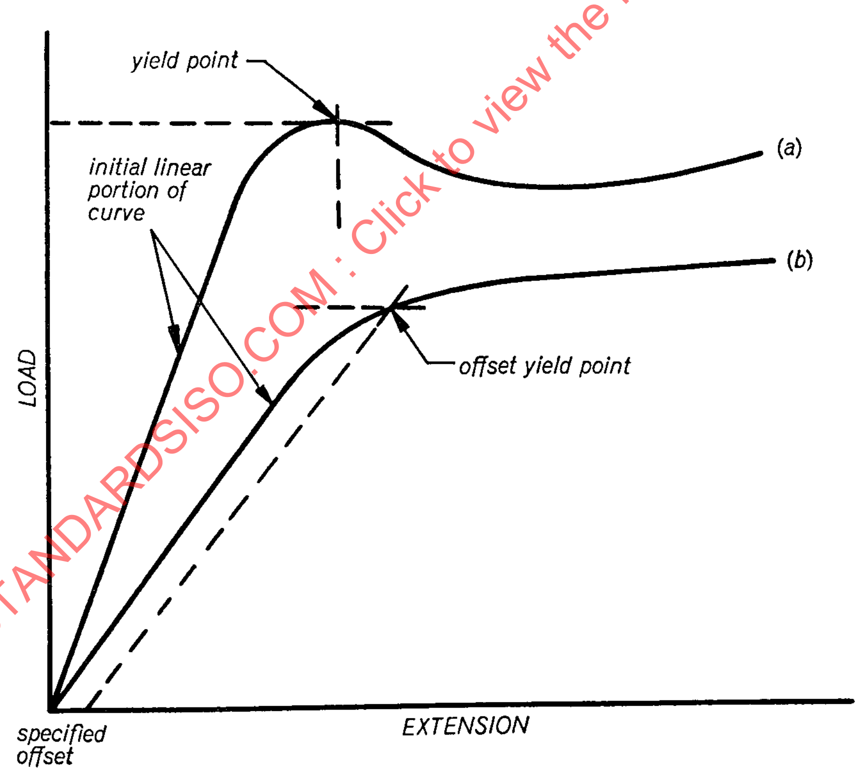


FIG. 5. — **Load/extension diagram**

(*a*) for a material for which a yield point can be determined, and

(*b*) for a material for which an offset yield point has to be determined.

4.2 **Extension indicator** (when required). Suitable instrument for determining, at any time during the test, the distance between two fixed points or reference lines located within the middle parallel-sided part of the test specimen. It is desirable, but not essential, that this instrument should automatically record this distance (or any change in it) as a function of the load on the test specimen or of the elapsed time from the start of the test, or both. If only distance as a function of elapsed time is recorded, load-time data are also taken. The instrument is essentially free of inertia lag at the specified speed of testing and is accurate to $\pm$ 1 per cent of strain or better. For the measurement of modulus of elasticity the instrument is capable of measuring the distance between the reference lines to an accuracy of $\pm$ 0.1 mm.

4.2.1 When the Type 2 test specimen is used for specification or for quality control purposes, the elongations between the reference lines at yield and at break of flexible plastics are measured to the nearest 1 mm by any convenient means.

4.3 **Micrometers.** Screw micrometer reading to at least 0.02 mm for measuring the width and thickness of the Type 1 and Type 3 test specimens.

Dial-gauge micrometer, reading to at least 0.02 mm and provided with a flat circular foot that will apply a pressure of 0.1 to 0.3 kgf/cm² to the test specimen, for measuring the thickness of test specimens of non-rigid materials.

5. TEST SPECIMENS

5.1 For materials of relatively high elongation at break, the Type 2 test specimen is normally suitable.

For testing moulding and extrusion compounds the test specimen may be moulded to shape, in which case the thickness is normally 1 to 2 mm, or it may be cut with a knife-edged die, with cutting edges having the form and dimensions shown in Figure 2, from sheet moulded from the compound to a thickness of 1 to 2 mm.

For testing sheet materials the test specimen is cut from the sheet with the knife-edged die. The thickness of the test specimen is the thickness of the sheet but is not less than 1 mm.

Reference lines, if used, are 25 $\pm$ 1 mm apart and are equidistant from the ends of the middle parallel-sided part of the test specimen as shown in Figure 1.

5.2 For materials of lower elongation at break than those for which the Type 2 test specimen is suitable (excepting those covered by clause 5.3), the Type 1 test specimen is normally suitable. Its form and dimensions are shown in Figure 1.

For testing moulding and extrusion compounds the test specimen may be moulded to shape, in which case the thickness is normally 3 to 4 mm, or it may be machined from sheet moulded from the compound to a thickness of 3 to 4 mm.

For testing sheet materials the test specimen is machined to shape, in which case the thickness of the test specimen is the thickness of the sheet, except that where this exceeds 10 mm the thickness is reduced to 10 mm by machining equal amounts from each face.

For certain materials, e.g. polyamides and cellulose acetate, for which the tensile properties are considerably affected by moisture content and hence by time of conditioning, the thickness of the test specimen may be between 1 and 4 mm as given in the relevant specification for the material.

Reference lines, if used, are 50 $\pm$ 0.5 mm apart and equidistant from the ends of the middle parallel-sided part of the test specimen as shown in Figure 1.

5.2.1 If, for any reason, it is not possible to use the standard test specimen shown in Figure 1, a test specimen of similar form and with dimensions having a constant ratio to those of Figure 1 may be used, in which case the rate of separation of grips should be adjusted so that the middle parallel part of the test specimen is strained at the rate that is appropriate to the standard test specimen.