

# ISO

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

## ISO RECOMMENDATION R 190

TENSILE TESTING OF LIGHT METALS  
AND THEIR ALLOYS

1st EDITION  
March 1961

*To become  
ISO 6892-1984*

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## BRIEF HISTORY

The ISO Recommendation R 190, *Tensile Testing of Light Metals and their Alloys*, was drawn up by Technical Committee ISO/TC 79, *Light Metals and their Alloys*, the Secretariat of which is held by the Association Française de Normalisation (AFNOR).

Work on this question by the Technical Committee began in 1955 and led in 1956 to the adoption of a Draft ISO Recommendation.

This first Draft ISO Recommendation (No. 263) was circulated to all the ISO Member Bodies for enquiry. 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 Member Bodies in December 1958, and which was approved by the following Member Bodies:

Austria	India	Portugal
Brazil	Ireland	Spain
Burma	Israel	Sweden
Canada	Italy	Switzerland
Finland	Japan	United Kingdom
France	Netherlands	U.S.S.R.
Germany	New Zealand	Yugoslavia
Hungary	Poland	

Two Member Bodies opposed the approval of the Draft:

Belgium                      Romania

The Draft ISO Recommendation was then submitted by correspondence to the ISO Council, which decided, in March 1961, to accept it as an ISO RECOMMENDATION.

## TENSILE TESTING OF LIGHT METALS AND THEIR ALLOYS

### 1. SCOPE

This ISO Recommendation applies to wrought products of diameter or thickness equal to or greater than 0.2 mm, and to castings. For the tensile testing of certain products, such as foils or wires of small diameter, special methods are required, and for tubes special test pieces.

Methods of selection and preparation of test samples are to be the subject of a separate Recommendation.

### 2. PRINCIPLE OF TEST

The test consists in subjecting a test piece to tensile stress, generally to fracture, with a view to determining one or more of the mechanical properties enumerated below. The test is carried out at ambient temperature, unless otherwise specified.

### 3. DEFINITIONS

**3.1 Gauge length.** At any moment during the test, the prescribed part of the cylindrical or prismatic portion of the test piece on which elongation is measured. In particular, a distinction should be made between the following:

- (a) *the original gauge length ( $L_0$ ).* Gauge length before the test piece is strained, and
- (b) *the final gauge length ( $L_u$ ).* Gauge length after the test piece has been fractured and the fractured parts have been carefully fitted together so that they lie in a straight line.

- 3.2** *Percentage permanent elongation.* Variation of the gauge length of a test piece subjected to a prescribed stress (see clause 3.7) and, after removal of the stress, expressed as a percentage of the original gauge length. The symbol of this elongation is supplemented by an index indicating the prescribed stress.
- 3.3** *Percentage elongation after fracture (A).* Permanent elongation of the gauge length after fracture  $L_u - L_o$ , expressed as a percentage of the original gauge length  $L_o$ .
- 3.4** *Percentage reduction of area (Z).* Ratio of the maximum change in cross-sectional area which has occurred during the test,  $S_o - S_u$ , to the original cross-sectional area  $S_o$ , expressed as a percentage.
- 3.5** *Maximum load ( $F_m$ ).* The highest load which the test piece withstands during the test.
- 3.6** *Final load ( $F_u$ ).* Load imposed on the test piece at the moment of fracture.
- 3.7** *Stress* (actually "nominal stress"). At any moment during the test, load divided by the original cross-sectional area of the test piece.
- 3.8** *Tensile strength ( $R_m$ ).* Maximum load divided by the original cross-sectional area of the test piece, i.e. stress corresponding to the maximum load.
- 3.9** *Stress at specified permanent set ( $R_r$ ).* Stress at which, after removal of load, a specified permanent elongation, expressed as a percentage of the original gauge length, occurs (see Fig. 4 (a), page 7).
- 3.9.1** The symbol used for this stress is followed by a suffix giving the specified percentage of the original gauge length (frequently 0.2).
- 3.10** *Proof stress or Yield strength (offset)\* ( $R_p$ ).* Stress at which a non-proportional elongation, equal to a specified percentage of the original gauge length, occurs (see Fig. 4 (b), page 7).
- 3.10.1** The symbol used for this stress is followed by a suffix giving the specified percentage of the original gauge length (e.g. 0.1 or 0.2).

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\* This last term is used in the U.S.A. and Canada.

## 4. SYMBOLS AND DESIGNATIONS

Number	Symbol	Designation
1	$d$	Diameter of the round part of a round bar, or, with other sections, diameter of the minimum circumscribing circle *
2	$a$	Thickness of a flat bar
3	$b$	Width of a flat bar
4	$L_o^{**}$	Original gauge length
5	$L_c$	Parallel length
6	$L_t$	Total length
7	—	Gripped ends
8	$S_o$	Original cross-sectional area of the gauge length
9	$L_u$	Final gauge length
10	$S_u$	Minimum cross-sectional area after testing
11	$F_m$	Maximum load
12	$R_m^{**}$	Tensile strength
13	$F_u$	Final load, i.e. load at moment of fracture
14	$L_u - L_o$	Permanent elongation after fracture
15	$A$	Percentage elongation after fracture $\frac{L_u - L_o}{L_o} \times 100$
16	$Z$	Percentage reduction of area $\frac{S_o - S_u}{S_o} \times 100$
17	$R_t$	Stress at specified permanent set
18	—	Specified permanent set
19	$R_p$	Proof stress
20	—	Specified non-proportional elongation

\* The minimum circumscribing circle is the smallest circle which completely circumscribes the whole periphery of the cross-section, but it need not pass through more than two points.

\*\* In correspondence and where no misunderstanding is possible, the symbols  $L_o$  and  $R_m$  may be replaced by  $L$  and  $R$  respectively.

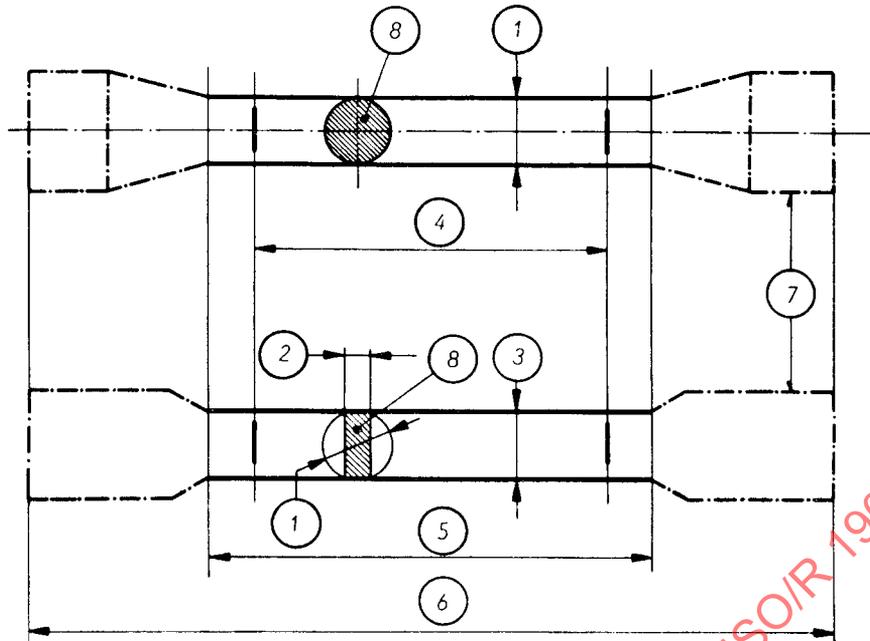


Fig. 1

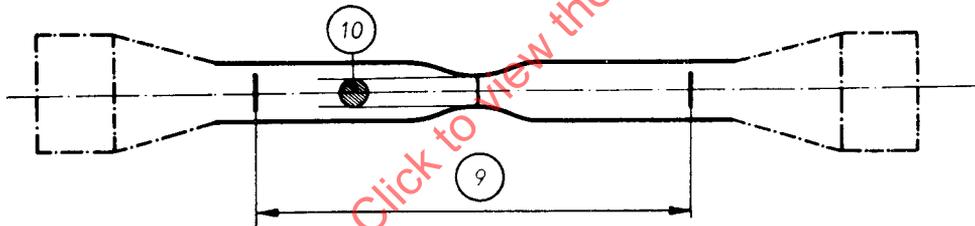


Fig. 2

Note: The form of end of test piece as shown is intended only as a guide.

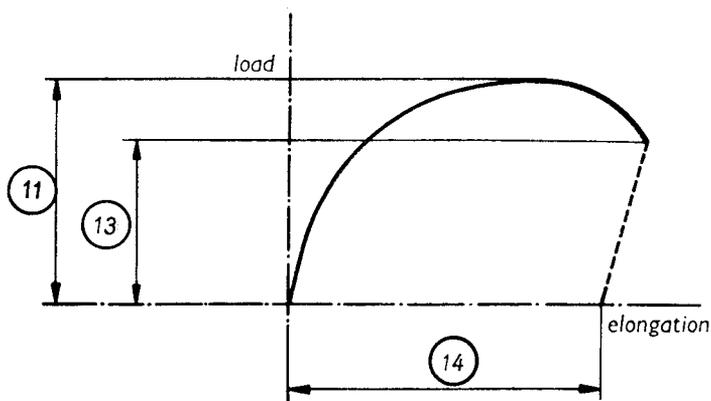


Fig. 3

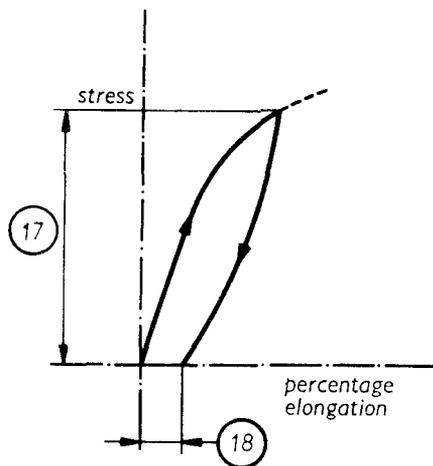


Fig. 4 (a)

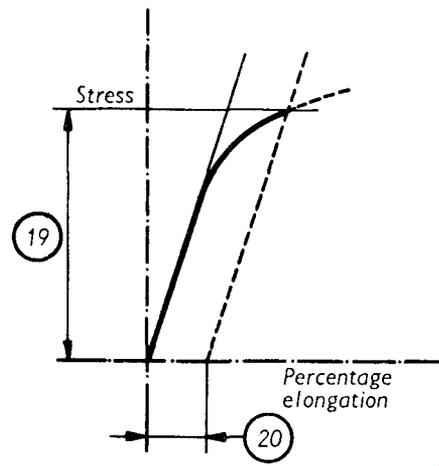


Fig. 4 (b)

## 5. TEST PIECES

**5.1 Machined test pieces.** The cross-section of the test piece may be circular, square, rectangular or, in special cases, of other form.

**5.1.1** There is a transition curve of radius sufficient to avoid stress concentration between the gripped heads and the parallel length, and the gripped heads may be of any shape to suit the holders of the testing machine.

**5.1.2** Machined dimensions to be a standard  $\pm 0.2$  mm (0.01 in) for test pieces of 10 mm (0.5 in) or greater diameter or width and  $\pm 0.1$  mm (0.005 in) for test pieces less than 10 mm diameter or width. The machined portion should be parallel within 0.1 mm (0.005 in) but may be tapered from the ends to the centre within this same tolerance. The ends of a sample should be concentric with the centre line of the reduced portion within 0.25 mm (0.010 in).

**5.1.3** As a rule, the diameter of the calibrated portion of the machined cylindrical test pieces is not less than 4.0 mm (0.16 in).

**5.2 Unmachined test pieces.**

(a) *Wrought.* For unmachined test pieces of uniform section, e.g. bars, sections, etc., it is recommended that the elongation should be measured on a gauge length of:

$$L_0 = 4 - 4.5 - 5.65 - 8.16 \text{ or } 11.3 \sqrt{S_0}$$

(b) *Cast.* Separate cast-to-size pieces which are to be submitted to testing in the "as cast" condition should have a parallel portion of circular cross-section and should have a transition curve of radius sufficient to avoid stress concentration between the gripped heads and the parallel length. The cross-sectional diameter of the parallel length must not differ by more than 10 per cent from the nominal value.

**5.3 Measurements.** In general, the cross-sectional area should be calculated from measurements of the necessary dimensions, with an error of not more than:

- $\pm 3$  per cent for dimensions from 0.2 mm to 0.5 mm;
- $\pm 1$  per cent for dimensions greater than 0.5 mm up to 3 mm;
- $\pm \frac{1}{2}$  per cent for dimensions greater than 3 mm.

Where this accuracy cannot readily be obtained, the method of measurement should be specified in the standard for this material.

On unmachined cast test pieces of circular cross-section the measured dimensions should be the average of four measurements taken at 45 degrees from each other.

- 5.4 As a rule, only test pieces complying with the requirement that  $L_o = k \sqrt{S_o}$ , where  $k$  may be equal to 4, 4.5, 5.65, 8.16 or 11.3, are used for the tensile test; these test pieces are known as proportional test pieces.
- 5.4.1 The international use of proportional test pieces with  $k = 4, 4.5, 8.16$  and  $11.3$  should be regarded as an interim measure and these should be used only in connection with the existing specifications. These values of  $k$  may be cancelled after a period to be determined later.
- 5.5 Test pieces other than proportional test pieces as defined in clause 5.4 may, for technical reasons, be used for products of very small cross-sections, and for economical reasons with other products.
- 5.6 The parallel length should be not less than  $L_o + \frac{d}{2}$ . Provided there is sufficient material, the length  $L_o + 2d$  is always used for arbitration purposes.
- 5.7 For plates, either a proportional test piece or a test piece with a fixed gauge length may be used. For sheets and strips, particularly below 3 mm in thickness, a test piece with a fixed gauge length is desirable. In such cases, the elongation value to be specified will vary with the thickness, and particular care is necessary when testing metal less than 0.5 mm in thickness.

Suggested forms of test pieces are:

Form	Width	Gauge length
A	12 mm	100 mm
B	0.5 in	2 in

## 6. DETERMINATION OF ELONGATION

- 6.1 As a rule, elongation is determined on the gauge length which, before the test, is marked to 0.25 mm (0.01 in).
- 6.1.1 The fractured parts of the test piece are carefully fitted together so that they lie in a straight line. The increase in gauge length after test is measured to approximately 0.25 mm (0.01 in).
- 6.1.2 In principle, this type of determination is valid only if the distance between the fracture and the nearest gauge mark is not less than:

1/3 of the gauge length after fracture for test pieces with	$L_o = 4 \sqrt{S_o}$
1/3 of the gauge length after fracture for test pieces with	$L_o = 4.5 \sqrt{S_o}$
1/3 of the gauge length after fracture for test pieces with	$L_o = 5.65 \sqrt{S_o}$
1/4 of the gauge length after fracture for test pieces with	$L_o = 8.16 \sqrt{S_o}$
1/5 of the gauge length after fracture for test pieces with	$L_o = 11.3 \sqrt{S_o}$

- 6.1.3 The measurement is valid in any case if the elongation reaches the specified value, whatever the position of the fracture.
- 6.2 To avoid the possibility of test pieces being rejected because the fracture has occurred outside the limits specified in the clause 6.1.2, the following method may be employed:
- 6.2.1 Before testing, subdivide the gauge length  $L_o$  into  $N$  equal parts.
- 6.2.2 After testing, designate by  $A$  the end mark on the shorter piece. On the larger piece, designate by  $B$  the graduation mark, the distance from which to the fracture is most nearly equal to the distance from the fracture to the end mark  $A$ .
- 6.2.3 If  $n$  be the number of intervals between  $A$  and  $B$ , the elongation after fracture is determined as follows:

(a) If  $N - n$  is an even number (see Fig. 5 (a), below),

measure the distance between  $A$  and  $B$  and the distance from  $B$  to a graduation mark  $C$

at  $\frac{N-n}{2}$  intervals from  $B$ ;

then calculate the elongation after fracture from the formula:

$$A = \frac{AB + 2BC - L_o}{L_o} \times 100 \text{ per cent.}$$

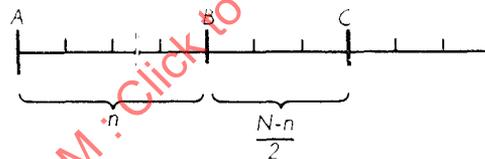


Fig. 5 (a)

(b) If  $N - n$  is an uneven number (see Fig. 5 (b), below),

measure the distance between  $A$  and  $B$  and the distance from  $B$  to the graduation marks  $C'$  and  $C''$

at  $\frac{N-n-1}{2}$  and  $\frac{N-n+1}{2}$  intervals from  $B$ ;

then calculate the elongation after fracture from the formula:

$$A = \frac{AB + BC' + BC'' - L_o}{L_o} \times 100 \text{ per cent.}$$

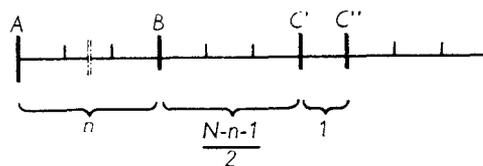


Fig. 5 (b)