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ISO RECOMMENDATION
R 956

TENSILE TEST
FOR LIGHT METAL AND LIGHT METAL ALLOY WIRES

1st EDITION

January 1969

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TENSILE TEST

FOR LIGHT METAL AND LIGHT METAL ALLOY WIRES

1. SCOPE

This ISO Recommendation relates to the tensile testing of light metal and light metal alloy wires.

2. PRINCIPLE OF TEST

The test consists in subjecting a length of wire to tensile stress, generally to fracture, with a view to determining one or more of the mechanical properties enumerated in clauses 7.1, 7.4, 7.5 and 7.6.

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 length of the test piece on which elongation is measured. In particular a distinction should be made between the two following lengths :

3.1.1 *Original gauge length* (L_o). Gauge length before the test piece is strained.

3.1.2 *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 same, expressed as a percentage of the original gauge length. If a symbol is used for this elongation, it should be 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 the 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 greatest 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 complete 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. the stress corresponding to the maximum load.

3.9 *Permanent set stress* (R_r). Stress at which, after removal of load, a prescribed permanent elongation, expressed as a percentage of the original gauge length, occurs (see clause 3.2 and Fig. 3*a*).

3.10 *Proof stress (non-proportional elongation) or yield strength (offset)** (R_p). Stress which produces, while the load is still applied, a non-proportional extension equal to the specified percentage of the original gauge length L_o.

When a proof stress or yield strength is specified, the non-proportional elongation should be stated, e.g. 0.2 % (see Fig. 3*b*).

The symbol used for this stress should be supplemented by an index giving the prescribed percentage of the original gauge length, e.g. 0.2 %.

* This last term is used in the United States of America and in Canada.

4. SYMBOLS AND DESIGNATIONS

Reference number*	Symbol	Designation
1	d	Diameter or equivalent diameter (i.e. diameter of a round wire having the same cross-sectional area)
2	a	Thickness of a flat test piece
3	b	Width of a flat test piece
4	L_o	Original gauge length**
5	L_t	Total length of the tensile test piece
6	–	Gripped ends
7	S_o	Original cross-sectional area of the gauge length
8	L_u	Final gauge length
9	S_u	Minimum cross-sectional area after fracture
10	F_m	Maximum load
11	R_m	Tensile strength**
12	F_u	Final load, i.e. load at moment of complete fracture
13	$L_u - L_o$	Permanent elongation after fracture
14	A	Percentage elongation after fracture $A = \frac{L_u - L_o}{L_o} \times 100$
15	Z	Percentage reduction of area $Z = \frac{S_o - S_u}{S_o} \times 100$
16	R_r	Permanent set stress
17	–	Specified permanent set
18	R_p	Proof stress (non-proportional elongation) or yield strength (offset)
19	–	Specified non-proportional elongation

* See Figures 1 to 3.

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

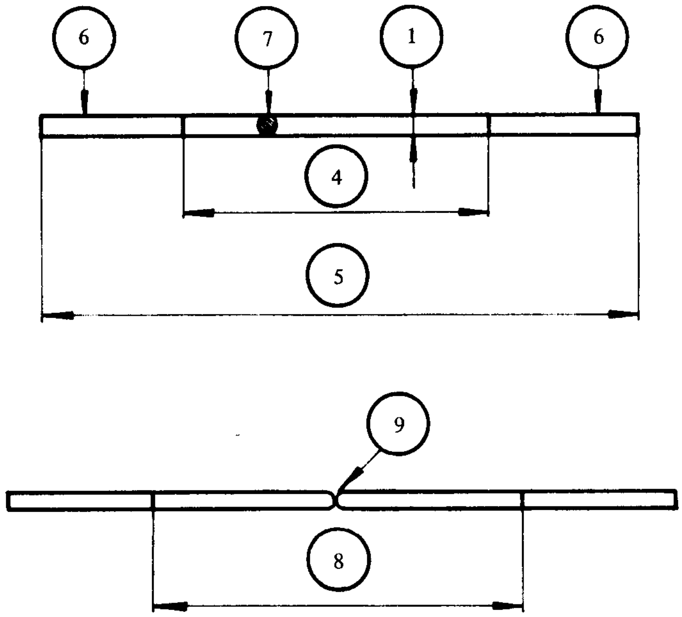

FIG. 1

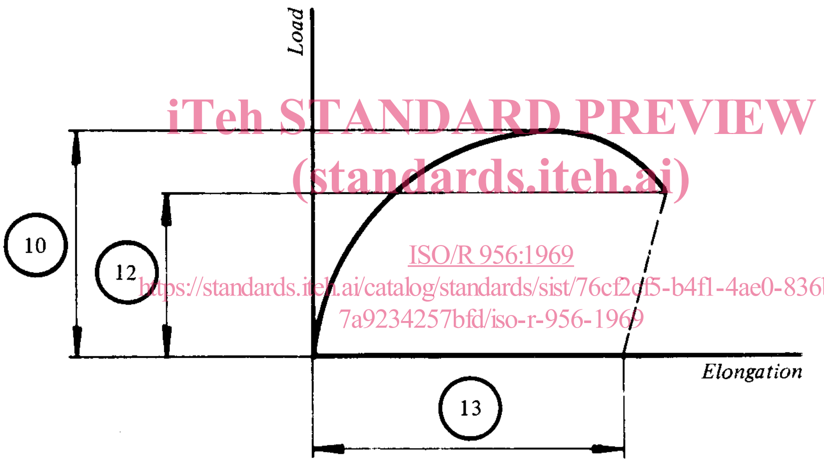

FIG. 2

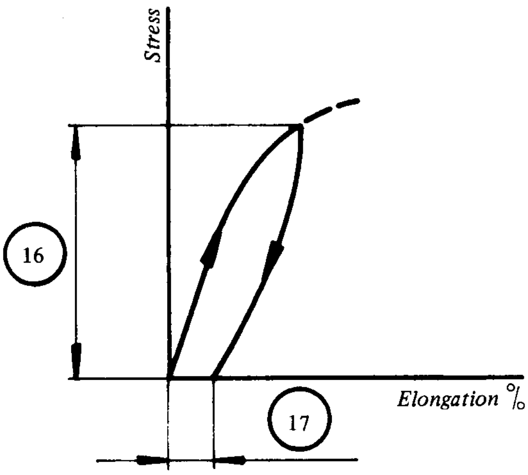

FIG. 3*a*

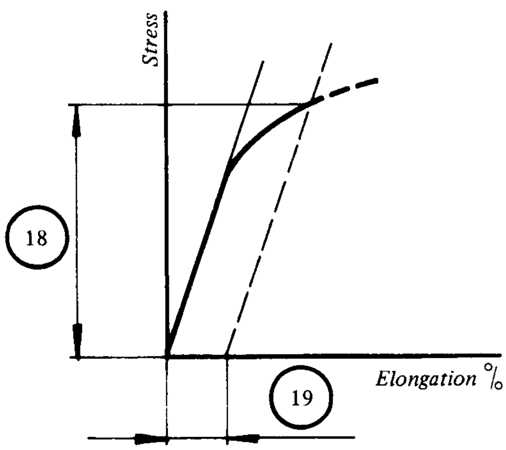

FIG. 3*b*

5. TEST PIECES

5.1 The test piece should be a piece of wire of such a length that the distance between the grips of the machine is not less than L_o + 50 mm (L_o + 2 in).

When it is not required to measure the elongation, the length between the grips should be within the range 100 to 250 mm (4 to 10 in).

5.2 The proportional test piece should have a gauge length of $L_o = 4\sqrt{S_o}$, or $4.5\sqrt{S_o}$, or $5.65\sqrt{S_o}$, or $11.3\sqrt{S_o}$, rounded off to the nearest 1 mm (0.05 in).

5.3 By agreement a non-proportional test piece may be used. The gauge length L_o of non-proportional test pieces is normally 200 mm (8 in) but other gauge lengths, e.g. 100 mm (4 in) or 250 mm (10 in), may be used by agreement.

5.4 The gauge length L_o actually used in the test should be stated in the test report.

5.5 Where only tensile strength is required to be determined, the test piece need not be straightened before testing. If straightening is necessary, care should be taken that only the minimum amount of cold work is introduced.

6. DETERMINATION OF CROSS-SECTIONAL AREA OF TEST PIECE

6.1 The cross-sectional area of the test piece should be determined to an accuracy of ± 1 % unless otherwise agreed.

6.2 For wires of circular cross-section, the cross-sectional area should be determined from the arithmetic mean of two measurements of the diameter at right angles to each other.

6.3 The cross-sectional area of wires may be determined by weighing, using a pre-determined value for the density.

7. METHOD OF TEST

7.1 Determination of elongation

When the elongation is to be determined, two or more overlapping gauge lengths, L_o, should be marked on the test piece before the test with an accuracy of ± 0.25 mm (0.01 in). In practice this will normally be done by marking at least three half gauge lengths with suitable accuracy.

No gauge mark should be closer to the grips than 2 d.

The test piece should be straight before it is marked and marking should be done in such a way as not to initiate fracture at the gauge marks.

After testing, the fractured parts of the test piece should be carefully fitted together so that they lie in a straight line. The increase in the length of the gauge length L_o should be measured between the two marks on either side of the mark nearest to the fracture.

In principle, the determination is only valid if the fracture occurs at least two diameters away from each end of the gauge length. The measurement is valid in any case if the elongation reaches the specified value, whatever the position of the fracture.

7.2 Rate of testing

If the rate of loading is considered to be of importance, it should be the subject of special agreement. For the determination of the proof stress or yield strength the rate of loading should in no case exceed 1 kgf/mm^2 (0.6 $tonf/in^2$ or 1420 lbf/in^2) per second.

In all cases, the rate of increase of load in the plastic and elastic ranges should be as uniform as possible and the change of rate from one range to the other should be made gradually and without shock.

7.3 Measurement of load

Loads corresponding to specified stresses should be determined on a testing machine compatible in accuracy with Grade 1.0 of ISO Recommendation R 147, *Load calibration of testing machines for tensile testing of steel.*

7.4 Determination of permanent set stress

For the accurate determination of the permanent set stress (0.2 % or any other specified value), the method of measurement of the permanent elongation for successively applied increasing loads (unloading method) should be used as follows :

Increasing loads are successively applied to the test piece and maintained in each case for about 10 seconds. After removal of each load, the permanent elongation which the test piece has taken is measured. The test is stopped when the elongation exceeds 0.2 % or whatever the prescribed percentage may be. The stress corresponding to the specified value of percentage permanent elongation is then obtained by interpolation.

7.5 Determination of proof stress or yield strength

The proof stress or yield strength should be determined as follows :

An accurate curve is plotted or drawn autographically, taking the loads as ordinates and the corresponding elongations as abscissae. A straight line is drawn on the graph parallel to the straight part of the curve, at a distance from the straight part, measured along the axis of the abscissae, equal to the prescribed percentage of the initial gauge length. The desired stress corresponds to the point of intersection of the straight line and the curve.

Alternatively, by agreement, proof stress or yield strength may be determined by suitable automatic equipment.

7.6 Proving test

Where it is desired merely to verify that the material possesses the specified minimum proof stress or yield strength, the following method may be used :

The test piece is placed for between 10 and 12 seconds under the load corresponding to the specified proof stress or yield strength and it is verified, after release of the load, that the permanent elongation remains equal to or less than the prescribed value of the initial length L_o.

NOTE. – The methods described in clauses 7.4 and 7.6 above should not be used for magnesium and its alloys.

BRIEF HISTORY

The ISO Recommendation R 956, *Tensile test for light metal and light metal alloy wires*, 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 led, in 1966, to the adoption of a Draft ISO Recommendation.

In March 1967, this Draft ISO Recommendation (No. 1136) was circulated to all the ISO Member Bodies for enquiry. It was approved, subject to a few modifications of an editorial nature, by the following Member Bodies :

Belgium	Israel	Switzerland
Canada	Italy	Thailand
Chile	Japan	Turkey
Czechoslovakia	Netherlands	U.A.R.
France	New Zealand	United Kingdom
Germany	Norway	U.S.A.
Greece	Poland	U.S.S.R.
Hungary	South Africa, Rep. of	Yugoslavia
India	Sweden	

No Member Body opposed the approval of the Draft.

The Draft ISO Recommendation was then submitted by correspondence to the ISO Council, which decided, in January 1969, to accept it as an ISO RECOMMENDATION.

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