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INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO RECOMMENDATION
R 89

TENSILE TESTING OF STEEL WIRE

1st EDITION
February 1959

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 89, *Tensile Testing of Steel Wire*, was drawn up by Technical Committee ISO/TC 17, *Steel*, the Secretariat of which is held by the British Standards Institution (B.S.I.).

The drawing up of an ISO Recommendation concerning this test was decided on at the third meeting of ISO/TC 17, held in London, in December 1953. The Technical Committee instructed its Working Group No. 1, *Methods of Mechanical Testing for Steel*, to prepare a draft proposal which was circulated to the members of the Technical Committee in August 1954.

The draft proposal was considered with the comments received from the Member Bodies at the fourth meeting of the full Committee, held in Stockholm, in June 1955, and was adopted, with a number of small amendments, as a Draft ISO Recommendation.

On 31 January 1957, the Draft ISO Recommendation (No. 160) was submitted to all the ISO Member Bodies and, subject to a few modifications, was approved by the following Member Bodies:

*Australia	*Greece	Pakistan
Belgium	Hungary	Portugal
*Canada	*Ireland	Spain
Czechoslovakia	Italy	Sweden
Denmark	Japan	Union of South Africa
Finland	Mexico	
Germany	*New Zealand	

One Member Body opposed the approval of the Draft: France.

The Draft ISO Recommendation was then submitted by correspondence to the ISO Council, which decided, in February 1959, to accept it as an ISO RECOMMENDATION.

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* These Member Bodies stated that they had no objection to the Draft being approved.

ISO Recommendation R 89 February 1959

TENSILE TESTING OF STEEL WIRE

1. SCOPE

This ISO Recommendation applies to products of constant cross-section and mainly characterized by this section, in particular its form and dimensions. The dimensions of the cross-section are always very small compared with the usual lengths produced and the ratio of the dimension defining the width to that defining the thickness is generally less than 4.

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 hereafter.

3. DEFINITIONS

3.1 *Gauge length.* At any moment during the test, the prescribed part 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_o). 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 3.8) and after removal of same, 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 *Load at yield point* (F_e). Load at which the elongation of the test piece first increases without increase of load or with decrease of load.

3.8 *Stress* (actually "nominal stress"). At any moment during the test, load divided by the original cross-sectional area of the test piece.

3.9 *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.

3.10 *Yield stress* (R_e). Stress at yield point. If, in testing, a drop in the load is observed, the stress corresponding to the highest load is known as the "upper yield point" and the stress corresponding to the lowest load subsequently observed is known as the "lower yield point".

3.10.1 In assessing the values of the upper and lower yield points, the characteristics of the testing machine should be taken into consideration; for example, the inertia of the dynamometer of the testing machine may result in the load dropping below the true lower yield point.

3.11 *Stress at permanent set limit.* Stress at which, after removal of load, a prescribed permanent elongation, expressed as a percentage of the original gauge length, occurs; the prescribed value may frequently be 0.2 per cent (see Fig. 3 (*a*), page 6).

3.11.1 The symbol used for this stress is supplemented by an index giving the prescribed percentage of the original gauge length, e.g. 0.5.

3.12 *Stress at proof limit.* Stress at which a non-proportional elongation, equal to a specified percentage of the original gauge length, occurs. When a stress at proof limit is specified, the non-proportional elongation should be stated, e.g. proof limit 0.1 per cent or 0.2 per cent (see Fig. 3 (*b*), page 6).

3.12.1 The symbol used for this stress is supplemented by an index giving the prescribed percentage of the original gauge length, e.g. 0.1.

4. SYMBOLS AND DESIGNATION

Number	Symbol	Designation
1	d*	Diameter of a round wire, or, with other sections, diameter of the minimum circumscribing circle
2	a	Thickness of a flat wire
3	b	Width of a flat wire
4	L_o**	Original gauge length
5	L_t	Total length
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	—	Permanent elongation after yield limit
11	F_e	Load at yield point
12	R_e	Yield stress
13	F_m	Maximum load
14	R_m**	Tensile strength
15	F_u	Final load, i.e. load at moment of fracture
16	$L_u - L_o$	Permanent elongation after fracture
17	A	Percentage elongation after fracture $\frac{L_u - L_o}{L_o} \times 100$
18	Z	Percentage reduction of area $\frac{S_o - S_u}{S_o} \times 100$
19	—	Stress at permanent set limit
20	—	Permanent set limit
21	—	Stress at proof limit
22	—	Proof limit

* 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 et R_m may be replaced by L anb R respectively.

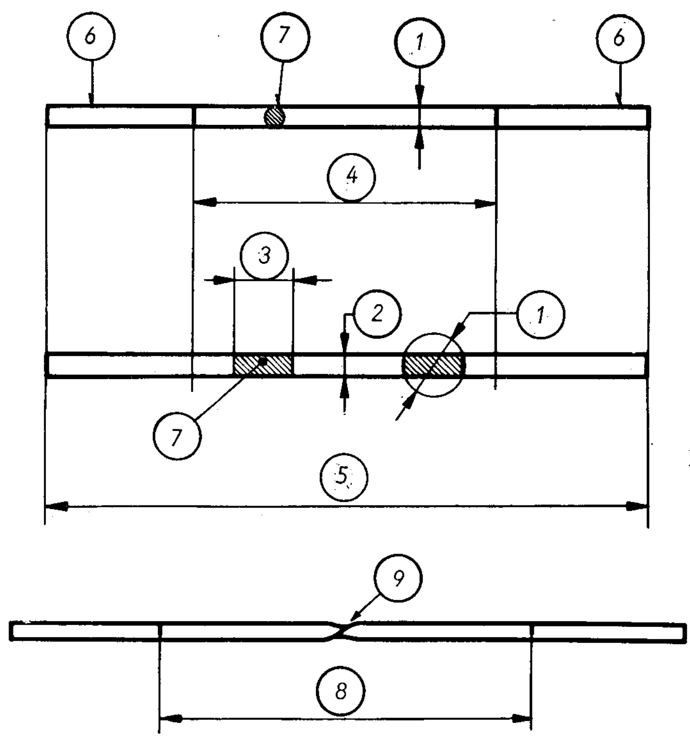
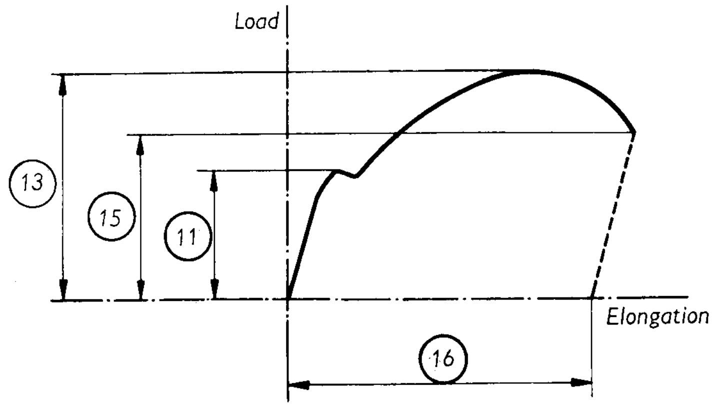


FIG. 1



F G. 2

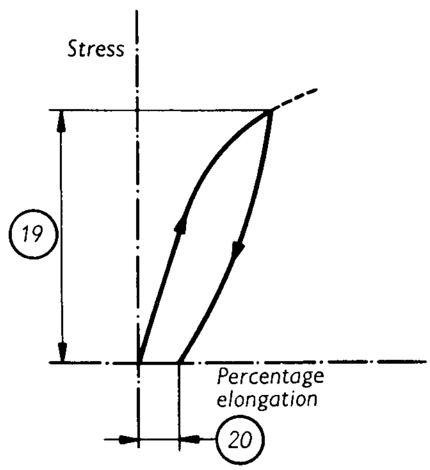


FIG. 3(*a*)

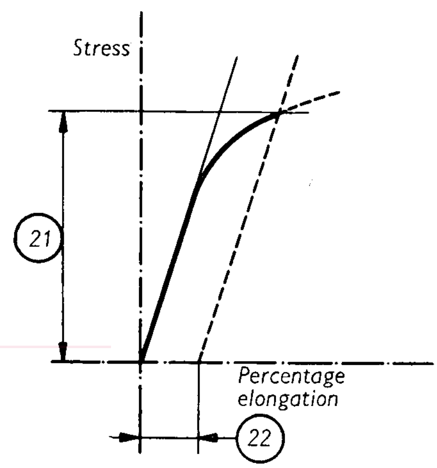


FIG. 3(*b*)

5. TEST PIECES

5.1 The test piece consists of a straight piece of wire of such a length that the distance between the grips of the machine is not less than 150 mm.

5.2 If a test piece having a gauge length $L_o = 11.3\sqrt{S_o}$ is used, such test pieces are known as proportional test pieces.

5.2.1 When test pieces other than proportional test pieces are used, the gauge length should, in principle, be equal to 100 mm (4 in); however, for steels having small elongations, e.g. less than 5 per cent, the specification for the product may fix a gauge length of 200 mm (8 in).

5.2.2 The gauge length used should be stated in the test report.

6. DETERMINATION OF CROSS-SECTIONAL AREA OF TEST PIECE

6.1 The cross-sectional area of the test piece is measured to an accuracy of 1 per cent, unless otherwise specified in the specification for the material.

6.1.1 The cross-sectional area of the test pieces of circular cross-section is determined from the arithmetic mean of two measurements at right angles to each other.

6.1.2 The cross-sectional area of test pieces of non-circular cross-section may be determined by weighing a known length of the material and determining the density of the steel. By agreement between the parties concerned, the latter determination may be omitted and the density of the steel taken as 7.85 g/cm^3.

6.1.3 In all cases, the method of determining the cross-sectional area of test pieces of non-circular cross-sections should be agreed between the parties concerned.

7. PROCEDURE

If possible, the test piece should not be straightened before testing. If straightening is necessary, it is done by hand, but if this is not possible, a hammer of wood or similar material is used, the wire being placed on a flat surface of wood or similar material.

8. DETERMINATION OF ELONGATION

8.1 When the elongation is to be determined, the test piece should be marked throughout the length between grips, except for a distance of at least $2d$, with gauge marks spaced at intervals equal to half the gauge length to an accuracy of 1 per cent of the gauge length.

NOTE: The test piece must be straight before it is marked, and marking must be in such a manner as not to cause liability to fracture at the gauge marks.

8.1.1 After testing, 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 between the two marks on either side of the mark nearest to the fracture.

8.1.2 In principle, this type of determination is valid only if the distance between the fracture and the nearest grip is not less than $5d$.

8.1.3 The measurement is valid in any case if the elongation reaches the specified value, whatever the position of the fracture.

9. RATE OF TESTING

9.1 The rate of application of the load should be as follows:

(*a*) at no time should it exceed 10 kgf/mm^2 per second,

(*b*) when determining tensile strength, elongation and reduction of area, if should not exceed 3 kgf/mm^2 per second in the neighbourhood of the maximum load.

9.1.1 When determining yield stress, proof stress or permanent set stress, the rate of application of the load should not involve an increase in stress exceeding 1 kgf/mm^2 per second from the beginning of the test until the required load is reached.