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INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO RECOMMENDATION
R 82

TENSILE TESTING OF STEEL

1st EDITION
February 1959

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BRIEF HISTORY

The ISO Recommendation R 82, *Tensile Testing of Steel*, was drawn up by Technical Committee ISO/TC 17, *Steel*, the Secretariat of which is held by the British Standards Institution (B.S.I.).

At the first meeting of ISO/TC 17, held in London, in June 1950, the Secretariat submitted a first draft proposal for the tensile test, based on a document which had been drawn up by the former International Federation of the National Standardizing Associations (ISA).

The Technical Committee discussed this draft proposal in meeting, and instructed its Working Group No. 1, *Methods of Mechanical Testing for Steel*, to prepare a new version of it, taking into account the views expressed at the first meeting.

In August 1953, the Working Group submitted a second draft proposal, which was studied by the Technical Committee during its third plenary meeting, held in London, in December 1953. The ISO/TC 17 Secretariat was then assigned to draw up a third draft proposal, incorporating the changes voted during the meeting, and this was circulated in April 1954.

The comments of the Member Bodies on this third draft proposal were discussed at the fourth plenary meeting, held in Stockholm, in June 1955, and the Technical Committee decided to adopt it, subject to a few amendments, as a Draft ISO Recommendation.

On 31 October 1956, this Draft ISO Recommendation (No. 133) was distributed to all the ISO Member Bodies and was approved, subject to a few modifications of details, by the following Member Bodies:

*Canada	Japan	Sweden
Denmark	Netherlands	Turkey
France	Pakistan	*Union of South Africa
*Greece	Poland	U.S.S.R.
Hungary	Portugal	Yugoslavia
*Ireland	Spain	

One Member Body opposed the approval of the Draft: Germany

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.

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

ISO Recommendation R 82 February 1959

TENSILE TESTING OF STEEL

1. SCOPE

This ISO Recommendation applies to products of diameters equal to or greater than 4 mm (0.157 in) or thicknesses equal to or greater than 3 mm (0.118 in). For the tensile testing of certain products, such as sheets, strips, wires and tubes, particular specifications are applicable.

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 hereafter. 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_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 3.9) 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 occured during the test $S_o - S_u$, to the original cross sectional area S_o, expressed as a percentage.

3.5 *Percentage elongation factor at point of constriction* (Z_u). Ratio of the maximum change in cross-sectional area, which has occurred during the test $S_o - S_u$, to the minimum cross-sectional area after fracture S_u, expressed as a percentage.

3.6 *Maximum load* (F_m). The highest load which the test piece withstands during the test.

3.7 *Final load* (F_u). Load imposed on the test piece at the moment of fracture.

3.8 *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.

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

3.10 *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.

3.11 *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 ".

3.11.1 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.

3.12 *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. 4 (*a*), page 7).

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. 0.5.

3.13 *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. 4 (*b*), page 7).

3.13.1 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 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 fracture
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	Z_u	Percentage elongation factor at point of constriction $\frac{S_o - S_u}{S_u} \times 100$
20	—	Stress at permanent set limit
21	—	Permanent set limit
22	—	Stress at proof limit
23	—	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 and R_m may be replaced by L and R respectively.

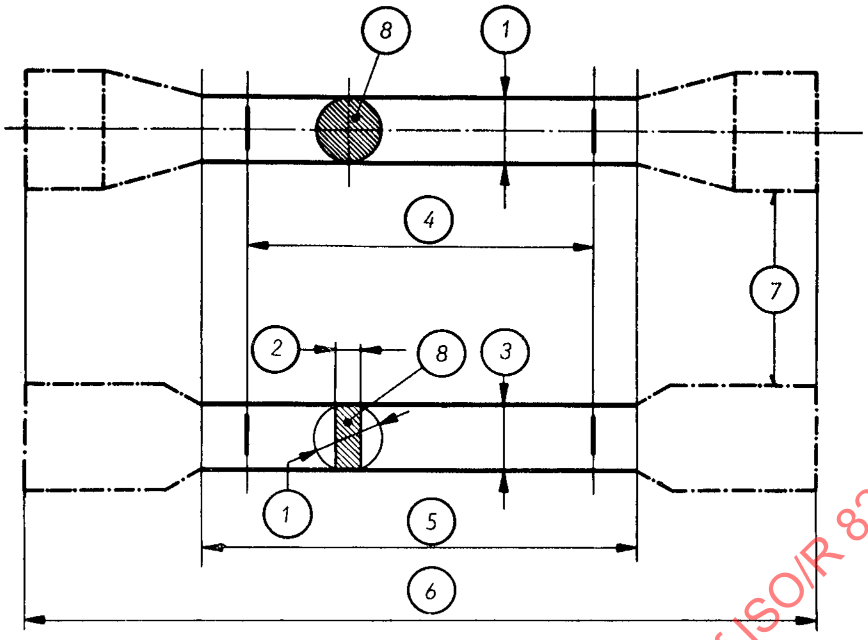

FIG. 1

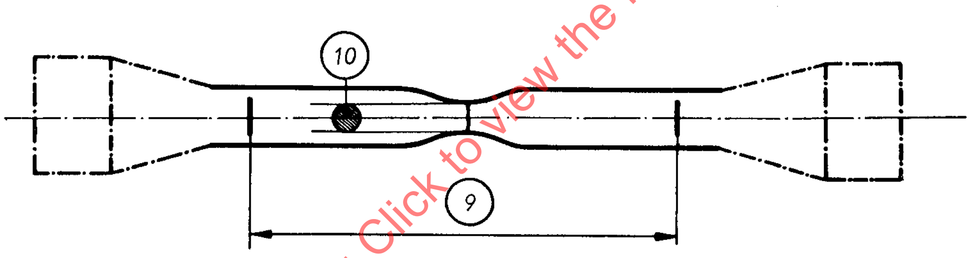

FIG. 2

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

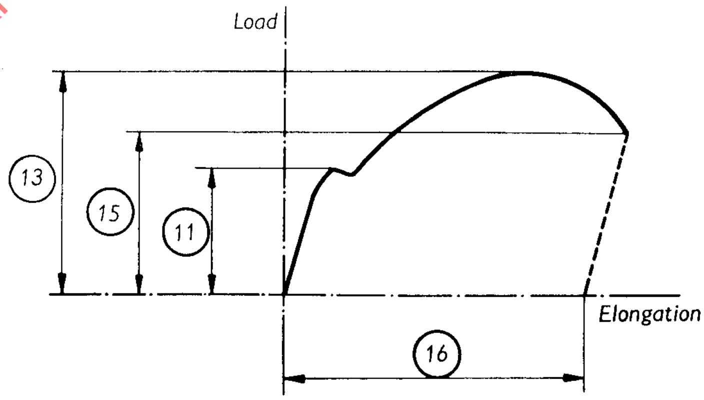

FIG. 3

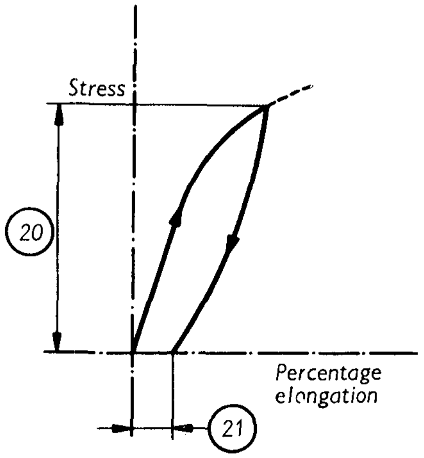

FIG. 4 (*a*)

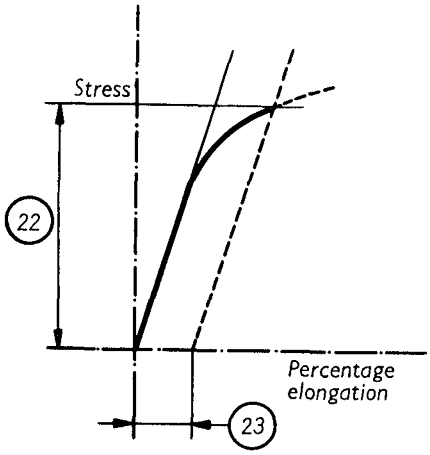

FIG. 4 (*b*)

5. TEST PIECES

5.1 The cross-section of the test piece may be circular, square, rectangular or, in special cases, of other form. For test pieces of rectangular section, it is recommended that a ratio of 4:1 for sides should not be exceeded.

5.1.1 There is a transition curve 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. Sections, bars, etc., may be tested without being machined.

5.1.2 The tolerances on the preparation of the test pieces are in accordance with those given in the table, page 8.

5.2 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).

5.3 As a rule, only test pieces complying with the requirement that $L_o = k\sqrt{S_o}$, where k may be equal to 4, 5.65, 8.16 or 11.3, are used for the tensile test; these test pieces are known as proportional test pieces.

5.3.1 The international use of proportional test pieces with $k = 4$, 8.16 and 11.3 should be regarded as an interim measure and these should only be used in connection with the existing specifications. These values of k may be cancelled after a period to be determined later.

5.4 Test pieces other than proportional test pieces as defined in clause 5.3 may, for technical reasons, be used for products of very small cross-sections and, for economical reasons, for certain other products.

5.5 The parallel length is between $L_o + \frac{d}{2}$ and $L_o + 2d$.

5.5.1 Provided there is sufficient material, the length $L_o + 2d$ is always used for arbitration purposes.

5.6 If prismatic test pieces with rectangular cross-sections are to be cut from a parcel of rolled sections, a uniform parallel length is adopted which may be obtained from the formula $L_o + 2d$, where L_o and d refer to the test piece with the largest cross-section.

TABLE

Tolerances on dimensions of test pieces

Designation	Nominal dimensions	Machining tolerance * on nominal dimensions (ISA j 12)	Tolerance on form: Values	Tolerance on form: ISA Symbols
Diameter of machined circular-section test piece (metric units)	over 3 mm to 6 mm	± 0.06 mm	0.03 mm	IT 9
	over 6 mm to 10 mm	± 0.075 mm	0.04 mm	
	over 10 mm to 18 mm	± 0.09 mm	0.04 mm	
	over 18 mm to 30 mm	± 0.105 mm	0.05 mm	
Diameter of machined circular-section test piece (inch units)	over 0.119 in to 0.237 in	± 0.002 5 in	0.001 in **	
	over 0.237 in to 0.394 in	± 0.003 in	0.001 in **	
	over 0.394 in to 0.709 in	± 0.003 5 in	0.002 in **	
	over 0.709 in to 1.182 in	± 0.004 in	0.002 in **	
Dimensions of cross-section of rectangular-section test piece, machined on the four faces		Same tolerances as for diameter of circular-section test pieces		
Dimensions of cross-section of rectangular-section test piece, unmachined on two opposite faces (metric units)	over 6 mm to 10 mm	—	0.22 mm	IT 13
	over 10 mm to 18 mm	—	0.27 mm	
	over 18 mm to 30 mm	—	0.33 mm	
	over 30 mm to 50 mm	—	0.39 mm	
Dimensions of cross-section of rectangular-section test piece, unmachined on two opposite faces (inch units)	over 0.237 in to 0.394 in	—	0.009 in	
	over 0.394 in to 0.709 in	—	0.010 in	
	over 0.709 in to 1.182 in	—	0.012 in	
	over 1.182 in to 1.969 in	—	0.016 in	

* The machining tolerance applies when it is desired to use the nominal cross-section without measurement or calculation.

** Rounded off to 0.001 in.

Examples of the use of tolerances are given in the Appendix.

6. DETERMINATION OF ELONGATION

6.1 As a rule, elongation is determined on the $k\sqrt{S_o}$ gauge length which, before the test, is marked to within 1 per cent of that gauge length.

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	$L_o = 5.65\sqrt{S_o}$
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 rejection of test pieces due to the fracture being outside the limits specified in the table, page 8, 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

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

then calculate the elongation after fracture from the formula:

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

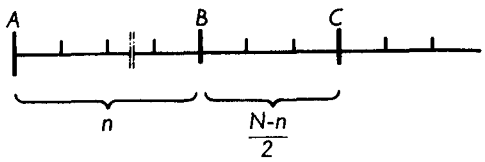

FIG. 5 *a*)