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INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO RECOMMENDATION
R 86

TENSILE TESTING OF STEEL SHEET AND STRIP
LESS THAN 3 mm AND NOT LESS THAN 0.5 mm THICK

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 86, *Tensile Testing of Steel Sheet and Strip Less than 3 mm and Not Less than 0.5 mm Thick*, 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 second meeting of ISO/TC 17, held in New York, in June 1952. 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 March 1954.

The comments of the Member Bodies were considered by the Working Group which submitted, in August 1954, a revised draft proposal to the members of ISO/TC 17. The revised draft proposal was discussed at the fourth plenary meeting of the Technical Committee, held in Stockholm, in June 1955, along with the comments of the Member Bodies, and was adopted, with a number of small amendments, as a Draft ISO Recommendation.

On 31 January 1957, the Draft ISO Recommendation (No. 151) was submitted to all the ISO Member Bodies and, subject to a few modifications, was approved by the following Member Bodies:

*Bulgaria	*Ireland	Romania
*Canada	Italy	Spain
Denmark	Mexico	Sweden
Finland	*New Zealand	Union of South Africa
France	Norway	United Kingdom
Germany	Pakistan	U.S.S.R.
*Greece	Poland	
Hungary	Portugal	

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 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 86 | February 1959

TENSILE TESTING OF STEEL SHEET AND STRIP

LESS THAN 3 mm AND NOT LESS THAN 0.5 mm THICK

1. 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.

2. DEFINITIONS

2.1 *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.

2.2 *Percentage permanent elongation.* Variation of the gauge length of a test piece subjected to a prescribed stress (see Clause 2.7) 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.

2.3 *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.

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

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

2.6 *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.

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

2.8 *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.

2.9 *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".

2.9.1 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.

2.10 *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 5).

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

2.11 *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 5).

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

3. SYMBOLS AND DESIGNATIONS

Number	Symbol	Designation
1	a	Thickness of test piece
2	b	Width of test piece
3	L_o*	Original gauge length
4	L_c	Parallel length
5	L	Total length
6	—	Gripped ends
7	S_o	Original cross-sectional area of the gauge length
8	L_u	Final gauge length
9	—	Percentage permanent elongation after yield limit
10	F_e	Load at yield point
11	R_e	Yield stress
12	F_m	Maximum load
13	R_m*	Tensile strength
14	F_u	Final load, i.e. load at moment of fracture
15	$L_u - L_o$	Permanent elongation after fracture
16	A	Percentage elongation after fracture $\frac{L_u - L_o}{L_o} \times 100$
17	—	Stress at permanent set limit
18	—	Permanent set limit
19	—	Stress at proof limit
20	—	Proof limit

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

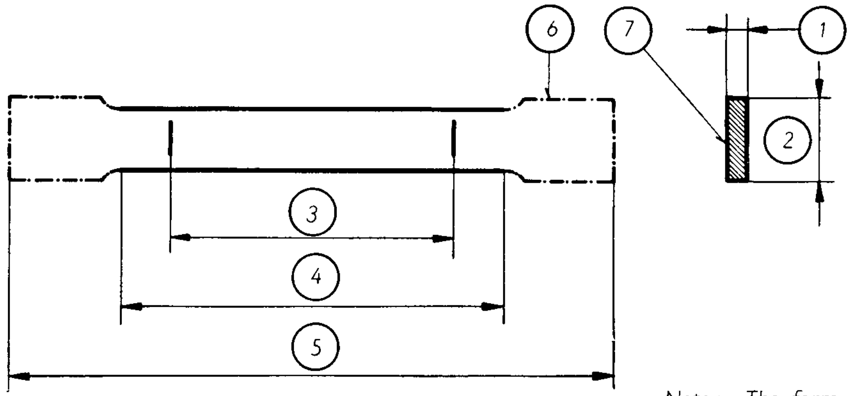

FIG. 1

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

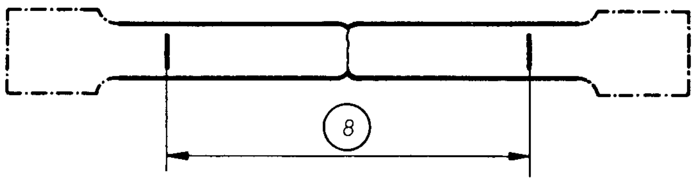

FIG. 2

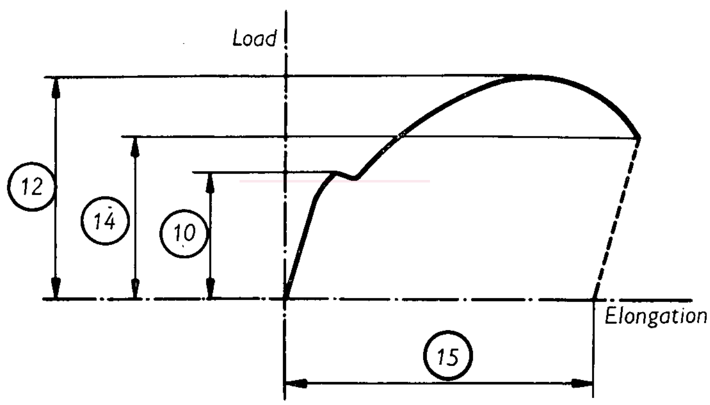

FIG. 3

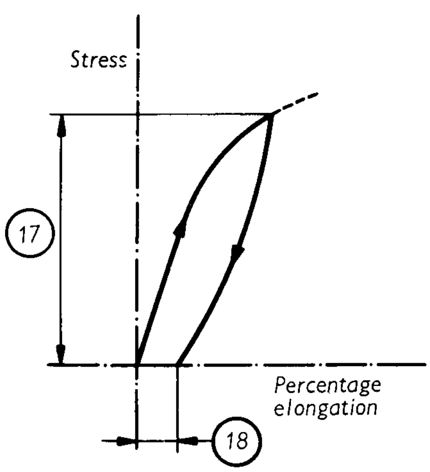

FIG. 4 (*a*)

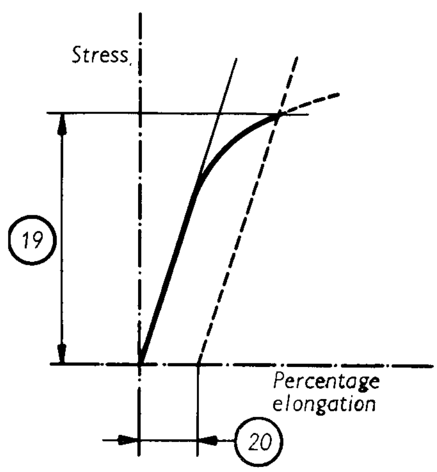

FIG. 4 (*b*)

4. TEST PIECES

4.1 The test piece has a width b of 20 mm (3/4 in) and a gauge length L_o of 80 mm (3 in). However, if the nominal thickness is not greater than 2 mm (0.08 in), the test piece may have a width b of 12.5 mm (½ in) and a gauge length L_o of 50 mm (2 in).

4.1.1 The test piece generally has enlarged ends, in which case there should be a transition radius of not less than 20 mm (3/4 in) between the gripped ends and the parallel length. The width of the enlarged ends should be not less than 20 mm (3/4 in) and not more than 40 mm (1½ in). Alternatively, the test piece may consist of a strip with parallel sides.

4.1.2 The ends of the test pieces are held in suitable grips in the testing machine in such a way that the centre line of the pull coincides with the longitudinal axis of the test piece and tension is uniformly distributed throughout the whole width of the enlarged end.

4.1.3 The preparation of the test pieces is carried out in a manner not likely to impair the properties of the material. In the case of test pieces being stamped out by dies, it is necessary for the effect of cold working of the edges to be completely removed before the test piece is tested.

4.1.4 The tolerances on the preparation of the test pieces are in accordance with the following table:

Symbol	Designation	Nominal dimension		Machining tolerance on nominal dimension*		Tolerance on form	
		mm	in	mm	in	mm	in
b	Width of parallel length	12.5 20.0	1/2 3/4	±0.09** ±0.10**	±0.004** ±0.004**	0.04*** 0.05***	0.002*** 0.002***
L_o	Gauge length	50 or 80	2 or 3	±0.5	±0.02	0.04*** 0.05***	—

4.2 The parallel length is between $L_o + \frac{b}{2}$ and $L_o + 2b$.

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

5. DETERMINATION OF ELONGATION

5.1 As a rule, the elongation is determined on the gauge length which, before the test, is marked to ± 1 per cent of the gauge length.

5.1.1 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 the nearest 0.25 mm (0.01 in).

5.1.2 In principle, this type of determination is valid only if the distance between the fracture and the nearest gauge mark is not less than one quarter of the original gauge length L_o.

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

** Tolerances ISA *j* 12.

*** Tolerances ISA *IT* 9.

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

5.2 To avoid the possibility of rejection of test pieces due to the fracture being outside the limits specified in clause 5.1, the following method may be employed:

5.2.1 Before testing, subdivide the gauge length L_o into N equal parts.

5.2.2 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.

5.2.3 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:

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

(*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″

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

then calculate the elongation after fracture from the formula:

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

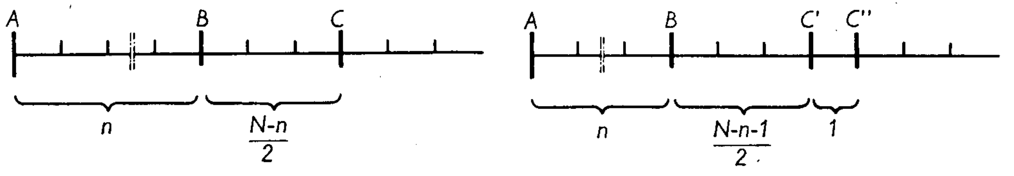

FIG. 5 (*a*) FIG. 5 (*b*)

FIG. 5. **Measurement of elongation**

6. RATE OF TESTING

6.1 If the yield stress is to be determined, the speed of the machine is regulated so that the rate of increase of stress on the test piece is not more than 1 kgf/mm² (0.6 tonf/in²) per second from a specific stress of approximately 5 kgf/mm² (3 tonf /in²) until the yield point is reached.

6.2 In the plastic range, the rate should at any moment be not higher than 25 mm/min (1 in/min). No value is fixed for the lower limit of this rate. If the yield stress is not to be determined, the rate in the elastic range may be as high as that permitted for the plastic range.