



Steel — Tensile testing of tubes

Acier — Essai de traction des tubes

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up has the right to be represented on that Committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 375 was drawn up by Technical Committee ISO/TC 17, *Steel*, and circulated to the Member Bodies in March 1972.

It has been approved by the Member Bodies of the following countries :

Australia	France	Romania
Austria	Germany	South Africa, Rep. of
Belgium	Hungary	Spain
Canada	India	Sweden
Chile	Ireland	Switzerland
Czechoslovakia	Italy	Thailand
Denmark	Netherlands	Turkey
Egypt, Arab Rep. of	New Zealand	United Kingdom
Finland	Poland	U.S.A.

The Member Bodies of the following countries expressed disapproval of the document on technical grounds :

Japan
Norway

This International Standard cancels and replaces ISO Recommendation R 375-1964.

Steel – Tensile testing of tubes

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies requirements for the tensile testing of complete steel tubes or longitudinal strips of full thickness cut from steel tubes having a cross-sectional area generally not less than 40 mm² (0.06 in²). The longitudinal strip test is not, however, usually carried out on tubes less than 0,5 mm (0.02 in) thick.

Test pieces which are machined all over are to be of the form described in ISO 82 and are to be tested in accordance with its requirements.

NOTE – Test pieces, consisting of strips cut transversely from tubes, are to be prepared and treated in accordance with the material specification and then tested in accordance with the requirements of ISO 82 or ISO 86 according to whether the thickness is equal to or greater than 3 mm (0.12 in), or less than this value.

For welded tubes, the position of the weld in relation to the test pieces is to be in accordance with the material specification.

For the tensile testing of other steel products, ISO 82, ISO 86 and ISO 89 are applicable.

2 REFERENCES

ISO 82, *Steel – Tensile testing*.

ISO 86, *Steel – Tensile testing of sheet and strip less than 3 mm and not less than 0,5 mm thick*.

ISO 89, *Steel – Tensile testing of wire*.

ISO/R 147, *Load calibration of testing machines for tensile testing of steel*.

ISO/R 205, *Determination of proof stress and proving test for steel at elevated temperatures*.

ISO/R 336, *Plain end steel tubes, welded or seamless – General table of dimensions and masses per unit length*.

ISO/R 783, *Mechanical testing of steel at elevated temperatures – Determination of lower yield stress and proof stress and proving test*.

ISO 2566/1, *Steel – Conversion of elongation values – Part 1 : Carbon and low alloy steels*.

ISO 2573, *Determination of K-values of a tensile testing system*.¹⁾

3 PRINCIPLE

The test consists in straining a test piece by 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. For tests at elevated temperatures, ISO/R 205 and ISO/R 783 are applicable.

1) At present at the stage of draft.

4 DEFINITIONS

4.1 gauge length : The prescribed part of the cylindrical or prismatic portion of the test piece on which elongation is measured at any moment during the test. In particular, a distinction is to be made between the following :

4.1.1 original gauge length (L_o) : Gauge length before the test piece is strained;

4.1.2 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.

4.2 extensometer gauge length (L_e) : The length of the parallel portion of the test piece used for the measurement of extension by means of an extensometer. (The length may differ from L_o and may be any value greater than b (see clause 5) but less than the parallel length L_c .)

4.3 percentage permanent elongation : Increase in the gauge length of a test piece subjected to a prescribed stress (see 4.1.2) and after removal of the stress, expressed as a percentage of the original gauge length. If a symbol for this elongation is used it is to be supplemented by an index indicating the prescribed stress.

4.4 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 .

NOTE — If the gauge length is other than $5,65 \sqrt{S_o}$, where S_o is the original cross-sectional area, A is to be supplemented by a suffix indicating the gauge length used, for example :

A_{10} = percentage elongation on gauge length of $10 \sqrt{4 S_o / \pi}$.

4.5 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. (S_u = minimum cross-sectional area after fracture.) (See also clause 19.)

4.6 maximum load (F_m) : The highest load which the test piece withstands during the test.

4.7 stress (actually “nominal stress”) : At any moment during the test, load divided by the original cross-sectional area of the test piece.

4.8 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.

4.9 yield stresses : In a steel which exhibits a yield phenomenon, a point is reached during the test at which plastic deformation, soon after it has been initiated, continues to occur at nearly constant stress.

4.9.1 upper yield stress (R_{eH}) : The value of stress measured at the commencement of plastic deformation at yield (see figure 3);

or

the value of stress measured at the first peak obtained during yielding even when that peak is equal to or less than any subsequent peaks observed during plastic deformation at yield (see figure 4).

4.9.2 lower yield stress (R_{eL}) : The lowest value of stress measured during plastic deformation at yield, ignoring any initial transient effects which might occur. (See figures 3 and 4.)

NOTE — If a steel which usually exhibits a yield phenomenon is in a cold-worked or heat-treated condition, the yield phenomenon may not exist. In such cases a proof stress must be specified. (See 4.10 and 4.11.)

4.10 proof stress (non-proportional elongation) (R_p) : The stress at which a non-proportional elongation, equal to a specified percentage of the original gauge length, occurs. (See figure 7.)

When a proof stress (R_p) is specified, the non-proportional elongation is to be stated (for example 0,2 %) and the symbol used for the stress is to be supplemented by an index giving this prescribed percentage of the original gauge length, $R_{p0,2}$.

4.11 proof stress (total elongation) or proof stress under load (R_t) : The stress at which a non-proportional elongation plus elastic elongation, equal to a specified percentage of the original gauge length, occurs. (See figure 8.)

When a proof stress (R_t) is specified, or agreed between the interested parties, the total elongation is to be stated and the symbol used for the stress is to be supplemented by an appropriate index, for example $R_{t0,5}$. (See also 15.3.2.)

NOTE — The value obtained by this total elongation method will only be equivalent to R_p if suitable allowance is made for the measurement of elastic extension.

4.12 permanent set stress (R_r); (stress at permanent set limit) : The stress at which, after removal of load, a prescribed permanent elongation, expressed as a percentage of the original gauge length, occurs. The symbol used for this stress is to be supplemented by an index giving the prescribed percentage of the original gauge length, for example $R_{r0,2}$. (See figure 9.)

5 SYMBOLS AND DESIGNATIONS

Symbols and designations are given in the table below.

Number	Preferred symbol	Designation
1	D	External diameter of round tube, or, with tubes of other sections, diameter of the minimum circumscribing circle ¹⁾
2	a	Thickness of tube (Figures 1 and 2)
3	b	Mean width of longitudinal strip (Figure 2)
4	L_o ²⁾	Original gauge length (Figures 1 and 2)
5	L_c	Parallel length (Figure 2)
—	L_e	Extensometer gauge length
6	L_t	Total length (Figures 1 and 2)
7	—	Gripped ends (Figures 1 and 2)
8	L_u	Final gauge length after fracture (Figures 1 and 2)
9	$L_u - L_o$	Permanent elongation after fracture (Figure 10)
10	A	Percentage elongation after fracture $\left(\frac{L_u - L_o}{L_o} \right) 100$
11	S_o	Original cross-sectional area of the gauge length (Figure 1)
12	S_u	Minimum cross-sectional area after fracture (Figures 1 and 2)
13	R_{eH}	Upper yield stress or upper yield point ³⁾ (Figures 3, 4 and 5)
14	R_{eL}	Lower yield stress or lower yield point ³⁾ (Figures 3, 4 and 5)
15	R_p	Proof stress (non-proportional elongation) or yield strength (offset) ³⁾ (Figure 7)
	(e.g. $R_{p0,2}$)	(0,2 % non-proportional elongation)
16	R_t	Proof stress (total elongation) or yield strength (total elongation) ³⁾ (Figure 8)
	(e.g. $R_{t0,5}$)	(0,5 % total elongation)
17	R_r	Permanent set stress (Figure 9)
	(e.g. $R_{r0,2}$)	(0,2 % permanent set stress)
18	F_m	Maximum load
19	Z	Percentage reduction of area $\left(\frac{S_o - S_u}{S_o} \right) 100$
20	R_m ²⁾	Tensile strength $\frac{F_m}{S_o}$ (Figure 10)

1) 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.

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

3) The latter term is used in the U.S.A. and in Canada.