

Revised

**ISO**

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO RECOMMENDATION

**R 375**

TENSILE TESTING OF STEEL TUBES

1st EDITION

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## BRIEF HISTORY

The ISO Recommendation R 375, *Tensile Testing of Steel Tubes*, was drawn up by Technical Committee ISO/TC 17, *Steel*, the Secretariat of which is held by the British Standards Institution (BSI).

Work on this question by the Technical Committee began in 1954 and led, in 1962, to the adoption of a Draft ISO Recommendation.

In November 1962, this Draft ISO Recommendation (No. 519) 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:

Australia	France	Romania
Austria	Hungary	Spain
Belgium	India	Sweden
Brazil	Ireland	Switzerland
Burma	Italy	Turkey
Canada	Japan	United Kingdom
Chile	Netherlands	U.S.A.
Czechoslovakia	New Zealand	U.S.S.R.
Denmark	Norway	Yugoslavia
Finland	Poland	

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 August 1964, to accept it as an ISO RECOMMENDATION.

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## TENSILE TESTING OF STEEL TUBES

### 1. SCOPE

This ISO Recommendation applies to tensile testing of complete steel tubes or longitudinal strips of full thickness cut from steel tubes. 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 should be of the form described in the ISO Recommendation R 82, *Tensile testing of steel*, and should be tested in accordance with its requirements, except that the rate of testing should be in accordance with clauses 7.1 and 7.2 of this ISO Recommendation.

NOTE. — Test pieces, consisting of strips cut transversely from tubes, should be prepared and treated in accordance with the material specification and then tested in accordance with the requirements of ISO Recommendations R 82 or R 86\* according to whether the thickness is equal to or less than 3 mm, except that the rate of testing should be in accordance with clauses 7.1 and 7.2 of this ISO Recommendation.

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

### 2. PRINCIPLE OF TEST

The test consists in subjecting a length of tube tested in full section, or a longitudinal strip of full thickness cut from a tube, to an increasing tensile stress, generally to fracture, with a view to determining one or more of the mechanical properties enumerated hereafter. The specification for the product concerned should state which form of test piece is to be used.

The test is carried out at ambient temperature, unless otherwise specified.

### 3. DEFINITIONS

3.1 *Gauge length*. At any moment during the test, length 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 fractures parts have been carefully fitted together so that they lie in a straight line.

\* ISO Recommendation R 82, *Tensile testing of steel*, and  
ISO Recommendation R 86, *Tensile testing of steel sheet and strip less than 3 mm and not less than 0.5 mm thick*.

- 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  $L_o - L_u$ , 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 ( $R_a$ ).* 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), p. 8).
- 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. 0.2.
- 3.12 *Proof strength ( $R_e$ ).* 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), p. 8).
- 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 DESIGNATIONS

No. *	Symbol	Designation
1	$D$	External diameter of round tube, or, with tubes of other sections, diameter of the minimum circumscribing circle**
2	$a$	Thickness of tube
3	$b$	Mean width of longitudinal strip
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 of the gauge length after fracture
11	—	Permanent elongation after yield limit
12	$F_e$	Load at yield point
13	$R_e$	Yield stress
14	$F_m$	Maximum load
15	$R_m$	Tensile strength
16	$F_u$	Final load, i.e. load at moment of fracture
17	$L_u - L_o$	Permanent elongation after fracture
18	$A$	Percentage elongation after fracture
		$\frac{L_u - L_o}{L_o} \times 100$
19	$Z$	Percentage reduction of area after fracture
		$\frac{S_o - S_u}{S} \times 100$
20	$R_a$	Stress at permanent set limit
21	—	Permanent set limit
22	$R_c$	Proof strength
23	—	Proof limit

\* See Figures 1 to 5.

\*\* 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 symbol  $L_o$  may be replaced by  $L$ .

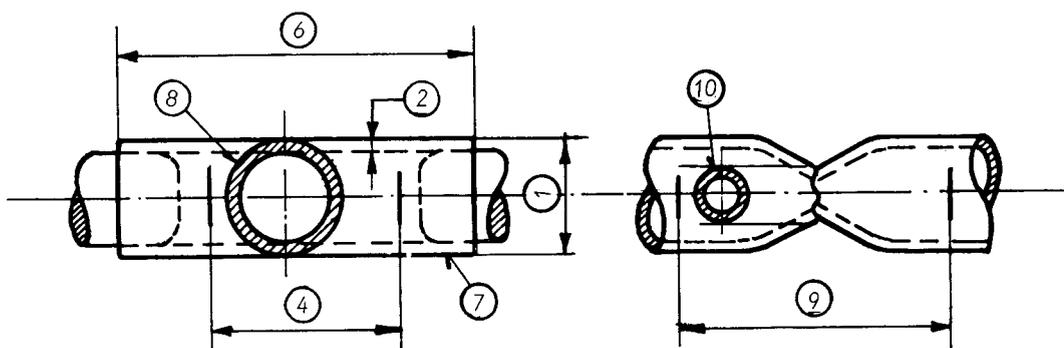


FIG. 1. — Test on full section

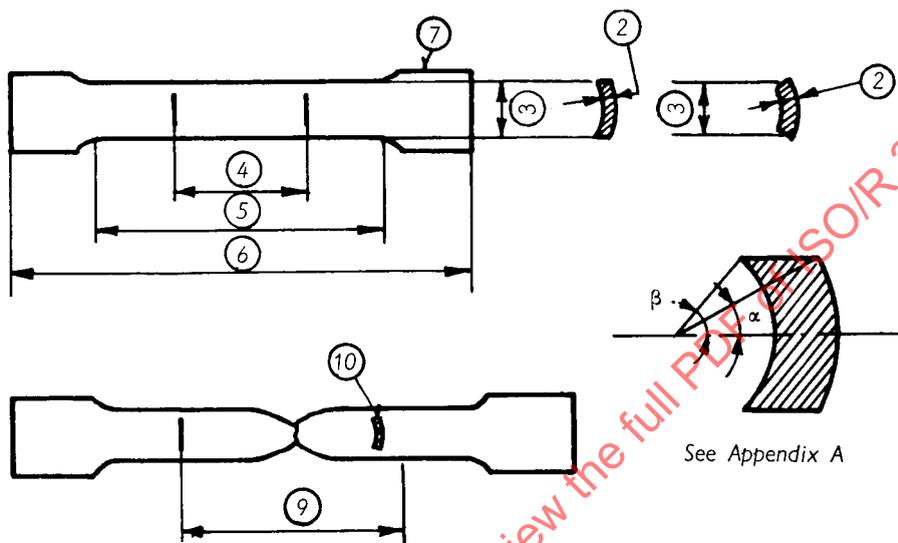


FIG. 2. — Test on longitudinal strip

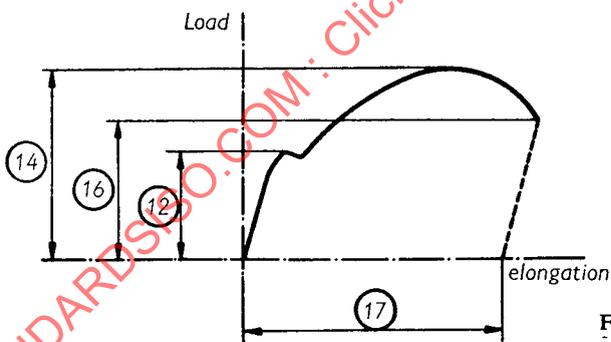


FIG. 3

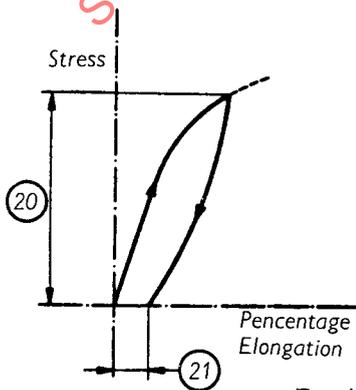


FIG. 4 a)

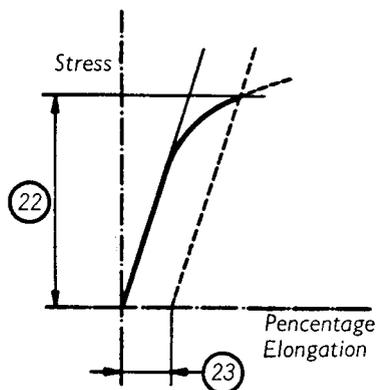


FIG. 4 b)

## 5. TEST PIECES

5.1 The test piece may consist of a piece of the tube tested in full section or a longitudinal strip of full thickness cut from the tube.

Preferably the tube should be tested in full section.

5.1.1 The tolerance on form for test pieces cut from tubes should be 0.33 mm (0.013 in).

5.1.2 The form of the test piece should be reported.

### 5.2 Test on piece of tube in full section

5.2.1 Tubes to be tested may be plugged at each end. The length of the plug projecting beyond the grip in the direction of the gauge length should not exceed the external diameter of the tube, and the shape should be such that it does not interfere with the free elongation of the gauge length.

5.2.2 The free length between the end of each plug and the nearest gauge mark should be between  $\frac{D}{4}$  and  $D$ , except that, provided there is sufficient material,  $D$  should always be approached for arbitration purposes.

### 5.3 Test on longitudinal strip

5.3.1 The test piece should have a parallel length, and may have enlarged ends, in which case there should be a transition curve between the gripped ends and the parallel length. The parallel length should not be flattened, but the gripped ends may be flattened for gripping in the testing machine.

5.3.2 The parallel length  $L_c$  should be between  $L_o + \frac{b}{2}$  and  $L_o + 2b$ , except that, provided there is sufficient material,  $L_o + 2b$  should always be used for arbitration purposes.

5.4 As a rule, only proportional test pieces should be used for tensile tests carried out either on a piece of tube in full section or on a longitudinal strip cut from the tube, i.e. they should conform to:  $L_o = k \sqrt{S_o}$ , where  $k$  may be 4-5.65-8.16 or 11.3.

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

5.5 **Determination of the original cross-sectional area of the test piece.** The cross-sectional area of the test piece should be determined to an accuracy of 1 per cent, unless otherwise specified in the specification for the material.

5.5.1 The cross-sectional area of a test piece consisting of a piece of tube in full section or of a longitudinal strip cut from the tube may be calculated from the weight of the measured length of the test piece. The weight per unit volume of material should be taken as 7.85 kg/dm<sup>3</sup> (489.6 lb/ft<sup>3</sup>).

5.5.2 Alternatively, for tubes of regular cross-section, the cross-sectional area may be determined by linear measurement and calculation.

5.5.3 The cross-sectional area of a test piece consisting of a longitudinal strip cut from a tube should be determined by linear measurement and calculation (see Appendix for the method of calculation).

## 6. DETERMINATION OF ELONGATION

6.1 As a rule, elongation is determined on the gauge length, which before the test, should be marked to  $\pm 1$  per cent of the 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 0.25 mm (0.01 in). For full section test pieces, the increase in gauge length after test is measured to the nearest 0.5 mm (0.02 in).