UDC 669.14 : 620.172 : 536.4

Ref. No. : ISO/R 783-1968 (E)

ISO

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO RECOMMENDATION

R 783

MECHANICAL TESTING OF STEEL AT ELEVATED TEMPERATURES
DETERMINATION OF LOWER YIELD STRESS AND PROOF STRESS
AND PROVING TEST

1st EDITION
July 1968

Printed in Switzerland

Also issued in French and Russian. Copies to be obtained through the national standards organizations.

BRIEF HISTORY

The ISO Recommendation R 783, *Mechanical testing of steel at elevated temperatures – Determination of lower yield stress and proof stress and proving test,* 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 1961 and led, in 1965, to the adoption of a Draft ISO Recommendation.

In December 1966, this Draft ISO Recommendation (No. 930) 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	Hungary	South Africa, Rep. of
Austria	India	Spain
Brazil	Israel	Sweden
Canada	Netherlands	Switzerland
Chile	New Zealand	Thailand
Czechoslovakia	Norway	Turkey
Denmark	Poland	U.A.R.
Finland	Portugal	United Kingdom
France	Romania	

Five Member Bodies opposed the approval of the Draft :

Belgium
Germany
Italy
Japan
U.S.A.

The Draft ISO Recommendation was then submitted by correspondence to the ISO Council, which, decided, in July 1968, to accept it as an ISO RECOMMENDATION.

ISO Recommendation | R 783 | July 1968

MECHANICAL TESTING OF STEEL AT ELEVATED TEMPERATURES

DETERMINATION OF LOWER YIELD STRESS AND PROOF STRESS AND PROVING TEST

1. SCOPE

This ISO Recommendation describes the determination of lower yield stress and proof stress of steel in which the test temperature does not exceed 1000 °C.*

2. PRINCIPLE OF TEST

The test consists of heating uniformly a test piece to a prescribed temperature and then subjecting it to tensile stress at that temperature with a view to

(*a*) determining the lower yield stress (R_{eL}) or proof stress (R_p),

(*b*) proving that the proof stress is above a specified minimum value.

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,

Original gauge length (L_o). Gauge length measured at ambient temperature before the test piece is strained.

3.2 *Extensometer gauge length* (L_e^v). The length of the parallel portion of the test piece used for the measurement of extension by means of an extensometer. This length may differ from L_o.

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

3.4 *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.

For the purpose of this ISO Recommendation the following definitions apply :

3.5 *Yield stress* (R_e) :

3.5.1 *Upper yield stress* (R_{eH}). The value of stress measured at the commencement of plastic deformation at yield (see clause 12.3 and Fig. 2(b), 2(c), 2(d) and 2(e)).

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.

* This limit of 1000 °C is fixed as a function of the condition of test, particularly for the tolerances on temperature in section 7. In particular, it does not imply that the conception of the proof stress from room temperature up to 1000 °C is equally significant for all steels.

3.5.2 *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 clause 12.3 and Fig. 2(b), 2(c), 2(d) and 2(e)).

3.6 *Proof stress* (non-proportional elongation) (R_p). Stress at which a non-proportional elongation, equal to a specified percentage of the original gauge length, occurs. When a proof stress (R_p) is specified, the non-proportional elongation should be specified (e.g. 0.2 %) and the symbol used for the stress should be supplemented by an index giving the prescribed percentage of the original gauge length (e.g. $R_{p0,2}$).

4. SYMBOLS AND DESIGNATIONS

Number	Symbol	Designation
1	d	Diameter of parallel length of test section of test piece of circular cross-section
2	D	External diameter of tube
3	a	Thickness of a flat bar or thickness of tube
4	b	Width of a flat bar or of specimen cut from tube
5	L_o	Original gauge length measured at ambient temperature before application of load
6	L_c	Parallel length of test piece
7	L_t	Total length of test piece
8	L_e	Extensometer gauge length
9		Gripped ends of test piece
10	S_o	Original cross-sectional area of gauge length
11	R_p * (e.g. $R_{p0,2}$)	Proof stress (non-proportional elongation) (0.2 % proof stress)
12	R_{eH}	Upper yield stress
13	R_{eL}	Lower yield stress

* Any symbol used should be followed by the temperature at which the test is made.

NOTE. – See Figure 1.

5. TEST PIECE

5.1 The cross-section of the test piece may be circular, square, rectangular, or, in special cases, of some other shape.

5.2 There should be transition curves (fillets) between the gripped ends and the parallel length; the gripped ends may be of any shape to suit the holders of the testing machine.

5.3 The tolerances on the preparation of the test pieces should be in accordance with those given in the Table, Page 8.

5.4 As a general rule, the diameter of the parallel length of machined cylindrical test pieces should be not less than 4.0 mm (0.16 in).

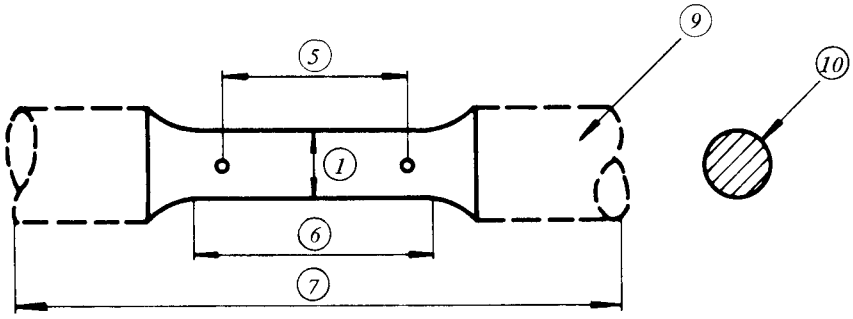

FIG. 1(a) – **Test piece of circular cross-section**

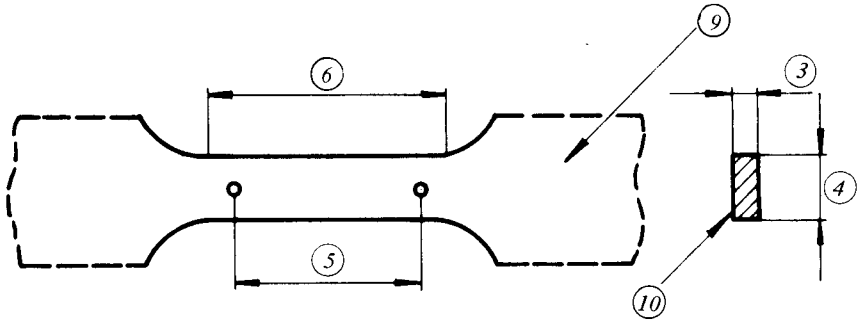

FIG. 1(b) – **Test piece of rectangular cross-section**

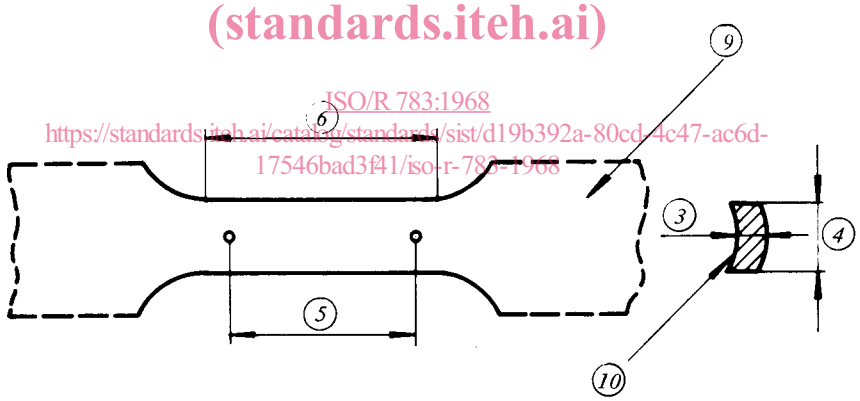

FIG. 1(c) – **Strip test piece cut from tube**

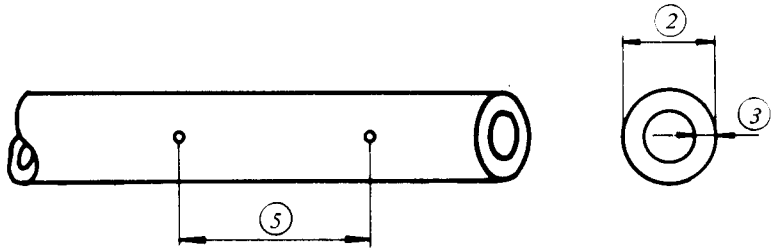

FIG. 1(d) – **Tubular test piece**

NOTE. – The numerical symbols in Figures 1(a), 1(b), 1(c) and 1(d) are explained in section 4.

TABLE – Tolerances on dimensions of test pieces

Designation	Nominal dimensions	Machining tolerance* on nominal dimensions (ISO j_s 12)	Tolerance on form	
			Values	ISO 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.

6. MEASUREMENT OF EXTENSION

The extension should be measured by means of an extensometer. The extensometer should be such that any measurement of extension does not differ from the true value of that extension by more than 0.01 % of the extensometer gauge length, and should be of a type that will take account of the extensions on both sides of the test piece. The parallel length should be not less than 25 mm (1 in) and should preferably be not less than 50 mm (2 in). The extensometer gauge length should be not less than 10 mm and at the centre of the parallel length. Departures from the specified length should not exceed 2 %. The extensometer may be attached to the parallel portion or to the enlarged ends of the test piece; in the latter case, the extension is calculated on the assumption that the observed extension has occurred wholly within the parallel length. When determining lower yield stress, it may not be necessary to measure extension in certain circumstances (see clause 10.4) and an extensometer can be dispensed with.

NOTE. – The additional deformation which occurs between the points of attachment of the extensometer and the ends of the parallel length will lower the proof stress value. This effect is usually so small that it can be ignored.

7. HEATING APPARATUS

7.1 The heating apparatus for the test piece should be such that the test piece can be heated to a temperature which, at any time throughout the duration of the test and at any point within the gauge length, does not deviate from the specified temperature by more than ± 5 °C for temperatures up to and including 800 °C or ± 6 °C for temperatures over 800 °C up to and including 1000 °C.

7.2 The temperature-measuring equipment should be frequently calibrated.

8. MEASUREMENT OF TEMPERATURE

8.1 Temperature-measuring equipment with a sensitivity of 1 °C should be provided to indicate the temperature of the test piece.

8.2 In general, not less than three thermocouples,* one at each end and one in the middle of the parallel length, should be used. This number may be reduced if the general arrangement of the furnace and the test piece is such that, from experience, it is known that the variation in temperature of the test piece does not exceed the maximum specified in clause 7.1.

9. HEATING OF TEST PIECE AND CONTROL OF TEMPERATURE

The test piece should be heated to the required test temperature and maintained at that temperature, within the tolerances specified in clause 7.1, for the duration of the test. The load should only be applied after the temperature-measuring apparatus and the extensometer, if any, have attained a steady value for at least 10 minutes.

* Attention is drawn to the necessity of frequently verifying the calibration of the thermocouples.