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TC 17

ISO RECOMMENDATION

R 203

INTERRUPTED CREEP TESTING OF STEEL AT ELEVATED TEMPERATURES

(LOAD AND TEMPERATURE INTERRUPTED)

1st EDITION

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BRIEF HISTORY

The ISO Recommendation R 203, *Interrupted Creep Testing of Steel at Elevated Temperatures (Load and Temperature Interrupted)*, was drawn up by Technical Committee ISO/TC 17, *Steel*, the Secretariat of which is held by the British Standards Institution (B.S.I.).

Work on this matter, which was begun by the Technical Committee in 1955 was completed in 1958, with the adoption of a proposal as a Draft ISO Recommendation.

On 4 November 1959, the Draft ISO Recommendation (No. 292) was distributed to all the ISO Member Bodies and was approved, subject to some editorial amendments, by the following Member Bodies:

Australia	France	Poland
Austria	Germany	Portugal
Belgium	Greece	Romania
Brazil	Hungary	Spain
Bulgaria	India	Sweden
Burma	Israel	Turkey
Chile	Italy	United Kingdom
Czechoslovakia	Japan	U.S.S.R.
Denmark	Netherlands	
Finland	Norway	

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 June 1961, to accept it as an ISO RECOMMENDATION.

ISO Recommendation R 203 June 1961

INTERRUPTED CREEP TESTING OF STEEL AT ELEVATED TEMPERATURES

(LOAD AND TEMPERATURE INTERRUPTED)

1. SCOPE

This ISO Recommendation applies to those tests in which the strain is measured under tensile creep stress and lies between 0.1 and 1.0 per cent, and in which the period of testing does not exceed 10 000 hours.*

It applies to tests in single machines and to each test in multiple testing machines.

2. PRINCIPLE OF TEST

The test consists of heating a test piece to a uniform temperature and subjecting it to constant tensile load at that temperature, except that, during any interruptions, the load is removed and the test piece returns to ambient temperature, and determining the strain as a function of time, the measurement of elongation being carried out at ambient temperature after removal of load.

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 applying the load.

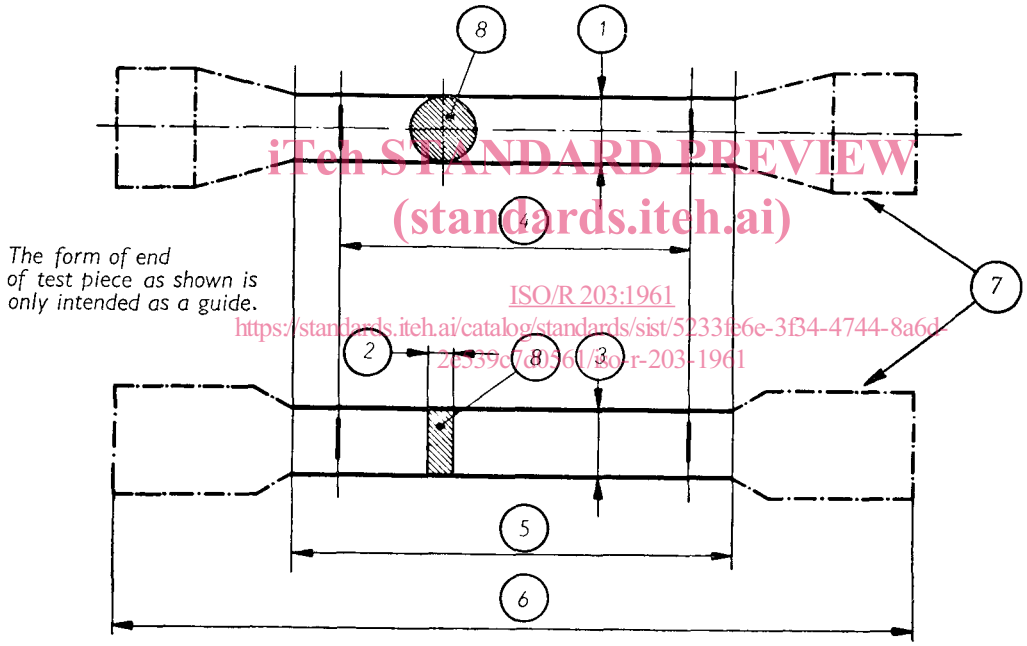
3.2 *Stress* (actually "nominal stress"). At any moment during the test, load divided by the original cross-sectional area of the test piece (at ambient temperature).

3.3 *Percentage permanent elongation.* Variation of the gauge length of a test piece, subjected to a prescribed stress (see clause 3.2) and, after removal of same, expressed as a percentage of the original gauge length.

* This limit of 10 000 hours is fixed as a function of the conditions of test, and in particular of the temperature limits in section 7. For tests of more than 10 000 hours, the tolerances should be agreed between the parties.

4. SYMBOLS AND DESIGNATIONS

Number	Symbol	Designation
1	d	Diameter of a circular section test piece
2	a	Thickness of a flat bar
3	b	Width of a flat bar
4	L_o	Original gauge length measured at ambient temperature, before application of the load
5	L_c	Parallel length
6	L_t	Total length
7	—	Gripped ends
8	S_o	Original cross-sectional area of the gauge length



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

5. TEST PIECES

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

5.2 There should be transition curves 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 5.

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

TABLE

Tolerances on dimensions of test pieces

Designation	Nominal dimensions	Machining tolerance* on nominal dimensions (ISA j 12)	Tolerance on form	
			Values	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 measurement or calculation.

** Rounded off to 0.001 in.

6. DETERMINATION OF ELONGATION

6.1 The measurement represents the strain on the axis of the test piece. It should be measured with an accuracy equal to 1 per cent of the total creep to be measured.

The deformation is measured during the interruptions after the test piece has returned to ambient temperature and the load has been removed, i.e. the permanent elongation.

6.2 If an extensometer apparatus is used, the measurements can be taken on load and at temperature. In this case, any portions of the apparatus extending beyond the furnace should be so designed or protected that short-period changes of air temperature do not affect the readings. It is advisable to maintain a reasonable stability of the temperature of the air surrounding the testing machine.

6.3 The gauge length should be at least equal to 25 mm (1 inch) and specified to an accuracy of ± 1 per cent. The actual gauge length used will depend on the sensitivity of the measuring apparatus and the value of the strain to be measured.

7. HEATING APPARATUS

The heating apparatus for the test piece should be such that the test piece can be raised to a temperature which—at any time with the test piece at temperature and under load, throughout the duration of the test and at any point within the gauge length—does not deviate from the specified temperature by more than the following:

± 3 °C for temperatures not greater than 600 °C,

± 4 °C for temperatures greater than 600 °C, but not greater than 800 °C,

± 6 °C for temperatures greater than 800 °C, but not greater than 1 000 °C.

For temperatures greater than 1 000 °C, the permissible variation should be specified by agreement.

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 * evenly spaced along the gauge 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 variation permitted by section 7.

In the case of single machines, for a vertical furnace the number should be not less than two; for a horizontal furnace the number may be reduced to one.

In the case of multiple machines, a sufficient number of thermocouples should be disposed about the test pieces on the periphery and centre of the furnace to ensure that all the test pieces satisfy the requirements of section 7.

* Attention is drawn to the necessity to ensure that the calibration of the thermocouples remains accurate during the total time of the test.

9. HEATING OF TEST PIECE AND CONTROL OF TEMPERATURE

9.1 The heating-up period should be between one and four hours, to bring the temperature approximately to the required test temperature. Care should be taken to avoid heating beyond the desired temperature. The first heating-up, and only the first, should be followed by a soaking period, to reach thermal equilibrium, the time of which should be stated in the material specification. If not stated, the time should be 16 to 24 hours, during which the final adjustment of temperature is made before the load is applied to the test piece.

9.2 The heating-up time and the time to reach thermal equilibrium should be recorded.

10. TESTING MACHINE

The testing machine should be capable of applying the load to the specimen without shock and, unless otherwise stated in the material specification, to an accuracy within $\pm$ 1.0 per cent of the load indicated by the machine.

11. LOADING *

Before applying the full load, a pilot load of not more than 10 per cent of the full load should be applied for several minutes and wholly or partly removed, to check the performance of the machine. The full load is then applied.

12. TEMPERATURE AND CREEP READINGS

12.1 Either a continuous record should be made or sufficient readings of the temperature of the test piece should be taken throughout the test to indicate that the temperature conditions have been satisfactory, and the average of the test piece temperature readings should be taken as the test temperature.

12.2 A sufficient number of strain readings should be taken to plot the creep curve clearly over the whole period of the test. The number of times the test piece returns to ambient temperature should also be recorded.

13. PRESENTATION OF RESULTS

13.1 The report on each test should contain either the plotted curve of the total plastic strain (excluding elastic strain) against time, or sufficient data to enable this curve to be plotted accurately, together with the test temperature, the stress, the dimensions of the test piece, as well as the heating-up time, the time to reach thermal equilibrium (see clause 9.1) and, for each interruption, the duration and the time when it took place. The duration of test is the total time at test temperature and under load.

13.2 In extrapolating the results, the report should indicate in detail the method used.

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* With some types of creep testing machines, the load cannot be applied in increments, and therefore the total elastic and plastic strain on loading is obtained. When tests are carried out with this type of machine, the plastic strain on loading may be obtained by deducting the elastic strain from the total strain. The elastic strain is calculated from the value of Young's modulus corresponding to the type of steel and the test temperature.

ANNEX

Extrapolation

It is well known that creep data are often required for periods of time well beyond those generally used for creep testing. There are various theories for extrapolating creep test results, and where such extrapolation is carried out, the precise method followed should be indicated in full detail. In any case, it is inadvisable to extrapolate beyond ten times the duration of the test, nor should creep data be extrapolated unless some of the group of tests have lasted at least 500 hours.

In considering extrapolation, full consideration should be given to the change of structure of the material under the influence of time, temperature and strain.

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