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R 147

LOAD CALIBRATION OF TESTING MACHINES FOR TENSILE TESTING OF STEEL

1st EDITION

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BRIEF HISTORY

The ISO Recommendation R 147, *Load Calibration of Testing Machines for Tensile Testing of Steel*, was drawn up by Technical Committee ISO/TC 17, *Steel*, the Secretariat of which is held by the British Standards Institution (B.S.I.).

During a meeting held by Working Group ISO/TC 17/WG 1, *Methods of Mechanical Testing for Steel*, in Paris, in May 1953, study was begun on the draft proposal concerning this ISO Recommendation.

The draft proposal drawn up by the Working Group was submitted to the Technical Committee for examination during its meeting, held in Stockholm, in June 1955. As a result of the comments put forward at that meeting, the draft proposal was referred back to the Working Group, which modified it accordingly. The Technical Committee re-examined this draft proposal during its plenary meeting, held in London, in March 1957. At that time it was decided that the Technical Committee Secretariat would set up a new draft proposal; this latter was submitted by correspondence to the members of the Technical Committee, which accepted it with slight changes, the draft proposal thus revised being adopted as a Draft ISO Recommendation.

On 11 July 1958, the Draft ISO Recommendation (No. 206) was distributed to all the ISO Member Bodies and was approved, subject to small modifications, by the following (23 out of a total of 40) Member Bodies:

Austria	Hungary	Romania
Belgium	India	Spain
Bulgaria	Israel	Sweden
Burma	Italy	Switzerland
Chile	Japan	United Kingdom
Czechoslovakia	New Zealand	U.S.S.R.
Denmark	Norway	Yugoslavia
Finland	Poland	

Two Member Bodies opposed the approval of the Draft: France, Germany.

The Draft ISO Recommendation was then submitted by correspondence to the ISO Council, which decided, in February 1960, to accept it as an ISO RECOMMENDATION.

ISO Recommendation R 147 February 1960

LOAD CALIBRATION OF TESTING MACHINES FOR TENSILE TESTING OF STEEL

1. SCOPE

1.1 This ISO Recommendation applies to the load calibration of machines used for the tensile testing of steel in accordance with ISO Recommendation R 82, *Tensile Testing of Steel.* The machine is calibrated under conditions of increasing load.

1.1.1 The following methods of load calibration are described:

(a) by means of weights (masses), see section 3, page 4

(b) by means of elastic devices (dynamometers), see section 4, page 5

(c) by means of proving levers, see section 5, page 6.

1.2 Whatever method is used, the calibration should check both the repeatability and the accuracy of the machine.

1.2.1 This check involves the comparison between

the load determined by means of the calibrating device, designated hereinafter by convention as true load (F), and

the load read on the machine being calibrated, designated hereinafter by convention as indicated load (Fi).

2. DEFINITIONS

2.1 Repeatability

2.1.1 Repeatability for a given true load: the greatest difference observed between the indicated loads corresponding to repeated application of the true load.

2.1.2 Repeatability for a given indicated load: The greatest difference observed between the true loads corresponding to repeated values of the indicated load.

NOTE: The larger the difference, the worse the repeatability.

2.2 Error

2.2.1 Error for a given true load: the difference between the true load and the arithmetic mean of readings corresponding to repeated applications of the load. It is expressed as a percentage of the true load.

2.2.2 Error for a given indicated load: the difference between the indicated load and the arithmetic mean of the readings of the true loads corresponding to repeated values of the indicated load. It is expressed as a percentage of the indicated load.

3. DIRECT CALIBRATION BY MEANS OF WEIGHTS (MASSES)

3.1 As a general rule, each scale of the machine to be calibrated should be verified over the upper four fifths of its range. For each scale, it should be verified at not less than 5 points approximately equally spaced over that part of the scale, the lowest of the points corresponding to the minimum load at which it is proposed to use the machine. These operations constitute one series of tests.

3.1.1 If it is intended to use the machine under conditions where readings are taken in the first fifth of the scale, verification of that portion of the scale should be made at not less than 3 points approximately equally spaced over that portion of the scale, the lowest of the points corresponding to the minimum load at which it is proposed to use the machine. These operations over the whole scale then constitute one series of tests.

3.2 For each scale, at least two separate series of tests in ascending order of load should be carried out.

3.2.1 For hydraulic machines, the positions of the ram should, if practicable, be changed for each series.

3.3 To verify what indicated load Fi corresponds to a true load F, a scale-pan attached to the loading shackle of the machine is so loaded that the total weight is equal to F. The weight should be accurate to $\pm$ 0.1 per cent. This tolerance may require the difference between gravity in different places to be taken into account. The indicated load Fi, shown on the graduated scale, is read. The operation is repeated five times, the whole or part of the load being removed between each reading.

3.3.1 Thus, at each point, for each series of tests, the following readings are obtained:

$$Fi_1, Fi_2, Fi_3, Fi_4 \text{ and } Fi_5$$

Error is expressed as a percentage by the quantity:

$$\frac{Fi - F}{F} \times 100$$

where $$Fi = \overline{Fi} = \frac{Fi_1 + Fi_2 + Fi_3 + Fi_4 + Fi_5}{5}.$$

Repeatability is determined by the difference between the highest and the lowest of the ten values of Fi obtained in the two series of tests.

3.4 For verification described in clause 3.3, the number of tests at each point may, by agreement between the parties concerned, be reduced, but there should be not less than three tests.

NOTE:

The following points should be noted with this method:

(a) The range of load which can be covered is limited (generally to 5 000 kg).
(b) The transportation of large numbers of standardized weights is difficult.
(c) In some cases the application of standardized weights is difficult.

4. CALIBRATION BY MEANS OF ELASTIC DEVICES (DYNAMOMETERS)

4.1 This method of calibration consists in measuring the deformation due to the load on an elastic device (dynamometer) which has been previously calibrated, and deducing the magnitude of the true load F from the measured deformation of the device.

4.1.1 According to the type of elastic device available, the verification may be made

either
under constant indicated load, see clause 4.5,
or
under constant true load, see clause 4.6.

4.2 The elastic device should be rigid and free from hysteresis so that its calibration at any part of its working range is known to:

$\pm$ 0.5 per cent of its indicated load for machines to be calibrated to $\pm$ 1 per cent, and
$\pm$ 0.2 per cent of its indicated load for machines to be calibrated to $\pm$ 0.5 per cent.

4.2.1 If the elastic device has a temperature coefficient, suitable corrections should be made for the temperature at which the testing machine is calibrated.

4.3 As a general rule, each scale of the machine to be calibrated should be verified over the upper four fifths of its range. For each scale, it should be verified at not less than 5 points approximately equally spaced over that part of the scale, the lowest of the points corresponding to the minimum load at which it is proposed to use the machine. These operations constitute one series of tests.

4.3.1 If it is intended to use the machine under conditions where readings are taken in the first fifth of the scale, verification of that portion of the scale should be made at not less than 3 points approximately equally spaced over that portion of the scale, the lowest of the points corresponding to the minimum load at which it is proposed to use the machine. These operations over the whole scale then constitute one series of tests.

4.4 For each scale, at least two separate series of tests in ascending order of load should be carried out.

4.5 Constant indicated load

To verify that graduation of machine corresponding to an indicated load *Fi*, five successive tests should be carried out under conditions of increasing load. For each test, when balance at the reading *Fi* has been reached (or at least the rate of increase of load has become very small), the true load F, shown by the elastic device, is read.

4.5.1 Thus, at each point, for each series of tests, the following readings are obtained:

$$F_1,\ F_2,\ F_3,\ F_4 \text{ and } F_5.$$

Error is expressed as a percentage by the quantity:

$$\frac{Fi - F}{Fi} \times 100$$

where $$F = \bar{F} = \frac{F_1 + F_2 + F_3 + F_4 + F_5}{5}.$$

Repeatability is determined by the difference between the highest and the lowest of the ten values of F obtained in the two series of tests.

4.6 Constant true load *

To verify the machine at a point corresponding to a true load F, a load F is applied to the elastic device and the corresponding indicated load Fi, shown by the machine, is read. The operation is repeated five times, the whole or part of the load being removed between each reading.

4.6.1 Thus, at each point, for each series of tests, the following readings are obtained:

$$Fi_1,\ Fi_2,\ Fi_3,\ Fi_4 \text{ and } Fi_5.$$

Error is expressed as a percentage by the quantity:

$$\frac{Fi - F}{F} \times 100$$

where $$Fi = \bar{Fi} = \frac{Fi_1 + Fi_2 + Fi_3 + Fi_4 + Fi_5}{5}.$$

Repeatability is determined by the difference between the highest and the lowest of the ten values of Fi obtained in the two series of tests.

4.7 For the verifications described in clauses 4.5 and 4.6, the number of tests at each point may, by agreement between the parties concerned, be reduced, but there should be not less than three tests.

5. CALIBRATION BY MEANS OF PROVING LEVERS

5.1 In this method, the application of the load to the testing machines is by means of proving levers. Proving levers are devices for applying to the testing machine defined loads by means of standardized weights (masses) with mechanical advantage.

5.2 The weights (masses) and proving levers should be such that the applied load is accurate to $\pm$ 0.2 per cent.

5.3 As a general rule, each scale of the machine to be calibrated should be verified over the upper four fifths of its range. For each scale, it should be verified at not less than 5 points approximately equally spaced over that part of the scale, the lowest of the points corresponding to the minimum load at which it is proposed to use the machine. These operations constitute one series of tests.

5.3.1 If it is intended to use the machine under conditions where readings are taken in the first fifth of the scale, verification of that portion of the scale should be made at not less than 3 points approximately equally spaced over that portion of the scale, the lowest of the points corresponding to the minimum load at which it is proposed to use the machine. These operations over the whole scale then constitute one series of tests.

5.4 For each scale, at least two separate series of tests in ascending order of load should be carried out.

5.5 To verify the machine at a point corresponding to a true load F, the proving lever is so loaded that the load applied to the machine is equal to F. The indicated load Fi, shown by the machine, is read. The operation is repeated five times, the whole or part of the load being removed between each reading.

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* This verification corresponds to that described in clause 3.3 for the direct calibration by means of weights.

5.5.1 Thus, at each point, for each series of tests, the following readings are obtained:

$$Fi_1, Fi_2, Fi_3, Fi_4 \text{ and } Fi_5.$$

Error is expressed as a percentage by the quantity:

$$\frac{Fi - F}{F} \times 100$$

where

$$Fi = \bar{Fi} = \frac{Fi_1 + Fi_2 + Fi_3 + Fi_4 + Fi_5}{5}.$$

Repeatability is determined by the difference between the highest and the lowest of the ten values of *Fi* obtained in the two series of tests.

NOTE:

Direct calibration up to 50 000 kg is possible by means of proving levers used to apply vertical loads. With proving levers designed to apply horizontal loads, only indirect calibration is possible.

6. ASSESSMENT OF CALIBRATION

6.1 The assessment of the calibration of the machine depends on whether the machine is:

Grade 0.5, intended for precision tests where a very high degree of accuracy is essential;

Grade 1.0, intended for routine purposes, in particular for tests usually made for the purpose of commercial acceptance.

6.2 For each class of machine, the specified conditions should be complied with at all verified points. These conditions are set out in the following table:

Grade	Conditions to be fulfilled	
	Repeatability	Error
0.5	either not greater than 0.5 per cent of the applied load, or not greater than 0.1 per cent of the maximum of the calibrated portion of the scale, whichever is the greater.	not greater than 0.5 per cent. The use of a correction curve is not permitted.
1.0	either not greater than 1 per cent of the applied load, or not greater than 0.2 per cent of the maximum of the calibrated portion of the scale, whichever is the greater.	not greater than 1 per cent. However, in the case of a machine in service, provided that the conditions of repeatability are satisfied and that for any of the test loads the error does not exceed 2 per cent, the machine can be used with a correction curve until such time as it is overhauled. It is recommended that in this case more frequent tests should be made to ensure that the correction curve remains true.

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