INTERNATIONAL STANDARD

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Metallic materials — Hardness test — Verification of Knoop hardness testing machines

Matériaux métalliques — Essai de dureté — Contrôle des machines d'essai de dureté Knoop

Reference number
ISO 4546:1993(E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established 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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 4546 was prepared by Technical Committee ISO/TC 164, *Mechanical testing of metals*, Sub-Committee SC 3, *Hardness testing*.

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Metallic materials — Hardness test — Verification of Knoop hardness testing machines

1 Scope

This International Standard specifies a method of verification of testing machines for determining Knoop hardness for metallic materials in accordance with ISO 4545. It covers test forces up to and including 9,807 N. The method is applicable only for indentations with diagonals ⩾ 20 µm.

This International Standard describes a direct verification method for checking the main functions of the machine, and an indirect verification method suitable for the overall checking of the machine. The indirect verification method may be used on its own for periodic routine checking of the machine in service.

If a testing machine is also to be used for other methods of hardness testing, it should be verified independently for each method.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 4545:1993, *Metallic materials — Hardness test — Knoop test.*

ISO 4547:1993, *Metallic materials — Hardness test — Calibration of standardized blocks to be used for Knoop hardness testing machines.*

ISO 10250:—[1], *Metallic materials — Hardness test — Tables of Knoop hardness values for use in tests made on flat surfaces.*

1) To be published.

3 General conditions

Before a Knoop hardness testing machine is verified, it shall be checked to ensure that

— the machine is properly set up;

— the plunger holding the indenter is capable of sliding in its guide without any appreciable clearance;

— the indenter holder is firmly mounted in the plunger;

— the test force can be applied and removed without shock or vibration and in such a manner that the readings are not influenced;

— the change in mode from removal of the test force to measuring mode does not influence the readings;

— the lighting system does not affect the readings;

— the centre of the indentation is in the centre of the field of view.

The illumination device of the measuring microscope shall provide uniform lighting of the entire observed field and maximum contrast between the indentation and the surrounding surface.

4 Direct verification

Direct verification involves

— verification of the test force;

— verification of the indenter;

— verification of the measuring device.

4.1 Verification of the test force

4.1.1 Each test force used (chosen from table 1), within the working range of the testing machine, shall be measured at not less than two positions of the plunger approximating the limits of travel during testing. The movement of the plunger shall be unrestricted by friction.

4.1.2 The test force shall be measured by one of the following two methods:

a) by means of an elastic proving device previously calibrated to an accuracy of ± 0,2 %;

b) by balancing against a force, accurate to ± 0,2 %, applied by means of standardized masses.

4.1.3 Three readings shall be taken for each test force at each position of the plunger. Immediately before each reading is taken, the plunger shall be moved in the same direction as during the test.

4.1.4 Each test force shall not deviate from the nominal value by more than 1,0 % for test forces from HK 0,2 to HK 1, by more than ± 1,5 % of the nominal value for test forces over HK 0,01 but less than HK 0,2, or by more than ± 2 % of the value for test forces less than or equal to HK 0,01.

4.2 Verification of the indenter

4.2.1 The four faces of the diamond pyramid shall be polished and free from surface defects.

4.2.2 Verification of the shape of the indenter can be made by direct measurement. The accuracy of the device used for verification shall be ± 0,07°.

Table 1

Hardness symbol	Test force N	Maximum permissible error (expressed as a percentage of the specified hardness HK of the standardized block used)								
		Hardness								
		50	100	150	200	250	300	350	400	450
HK 0,01	$98,07 \times 10^{-3}$	5	6	7	9	9	10	11	—	—
HK 0,02	0,196 1	5	5	6	6	7	7	8	9	9
HK 0,025	0,245 2	5	5	5	6	6	7	7	8	8
HK 0,05	0,490 3	5	5	5	5	5	5	5	6	6
HK 0,1	0,980 7	5	5	5	5	5	5	5	5	5
HK 0,2	1,961	5	5	5	5	5	5	5	5	5
HK 0,3	2,942	5	5	5	5	5	5	5	5	5
HK 0,5	4,903	5	5	5	5	5	5	5	5	5
HK 1	9,807	5	5	5	5	5	5	5	5	5

NOTES

1 Values are based on a maximum error of 1,0 µm or 2 % of the diagonal of indentation, whichever is greater.

2 Values are not given when the indentation diagonal is less than 0,020 mm.

3 For intermediate values, the maximum permissible error may be obtained by interpolation.

4.2.3 The angles α and β between the opposite edges at the vertex of the diamond pyramid shall be 172,5° ± 0,1° and 130° ± 0,1° (see figure 1).

4.2.4 The angle between the axis of the diamond pyramid and the axis of the indenter holder (normal to the seating surface) shall not exceed 0,5°. The four faces shall meet in a point, the length of any common junction between opposite faces being less than 1,0 µm (see figure 2).

4.3 Verification of the measuring device

4.3.1 The measuring device shall permit estimation of the diagonal of the indentation to within ± 0,2 µm.

4.3.2 The device for measuring the diagonal of the indentation shall be calibrated against an accurately ruled line scale (stage micrometer) or device of equivalent accuracy. The errors of the line scale shall be known within an uncertainty of 0,2 µm.

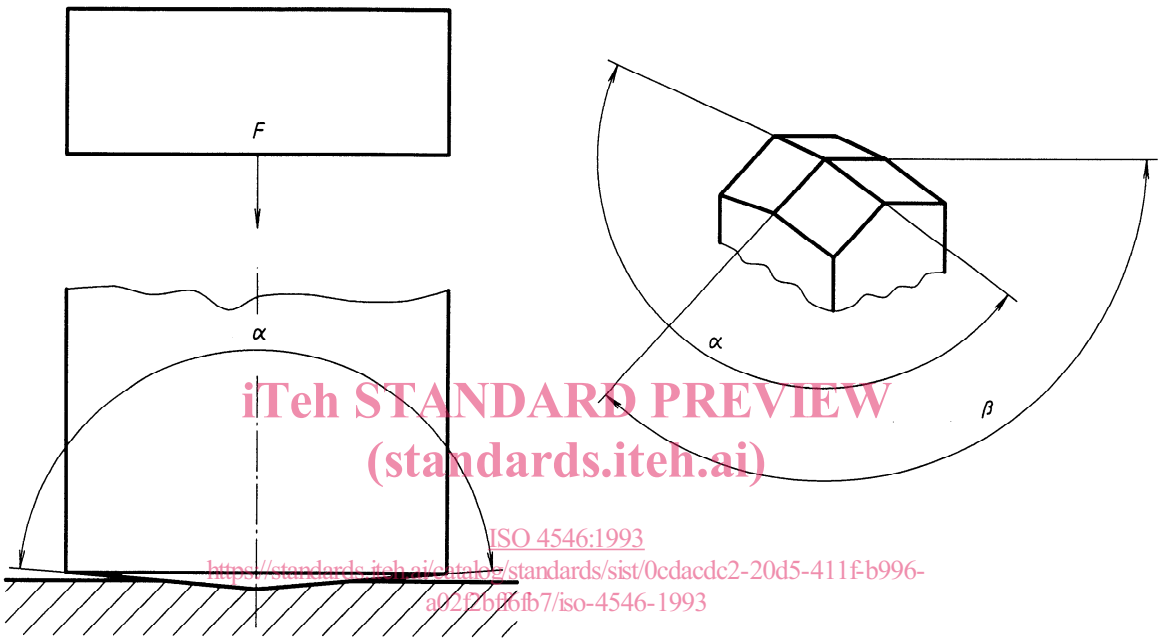

Figure 1

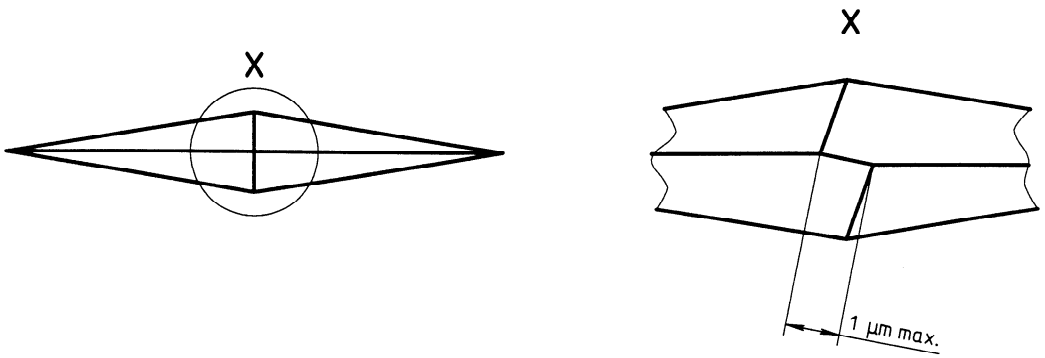

Figure 2

4.3.3 The maximum permissible error of the measuring device shall be ± 1,0 % or 0,4 µm, whichever is greater.

Alternatively, any calibration factor or curve used shall be chosen such that the error scatter does not exceed 0,4 µm.

5 Indirect verification

Indirect verification may be carried out by means of standardized blocks when available[2], calibrated in accordance with ISO 4547.

5.1 Procedure

For the indirect verification of a testing machine, the following procedures shall be applied.

5.1.1 When verifying testing machines used for several test forces, at least two different forces shall be chosen. One of the forces shall be the lowest force in the range of the machine and the other force shall be chosen within the upper half of the range. For each test force chosen, two different standardized blocks shall be chosen within the range for which the machine is used. The ratio of the hardness values for the two blocks shall be equal to or greater than 2.

5.1.2 When verifying testing machines used for only one test force, three standardized blocks shall be used, uniformly distributed over the range of the machine.

5.1.3 For special purposes, a hardness testing machine may be verified at one hardness value only, corresponding approximately to that of the tests to be made.

5.1.4 On each standardized block, five indentations shall be made and measured. The test shall be made in accordance with ISO 4545.

Attention is drawn to ISO 10250, which contains tables of values for use in tests made on flat surfaces.

5.1.5 For each standardized block, let d_1, d_2, ..., d_5, be the values of the measured diagonals of the indentations, arranged in increasing order of magnitude.

5.2 Repeatability

5.2.1 The repeatability of the testing machine under the particular verification conditions is determined by the difference

$$d_5 - d_1$$

5.2.2 The repeatability of the testing machine verified is not considered satisfactory unless it is less than or equal to 0,05 $\bar{d}$

where

$$\bar{d} = \frac{d_1 + d_2 + \ldots + d_5}{5}$$

5.3 Error

5.3.1 The error of the testing machine under the particular verification conditions is characterized by the difference:

$$\bar{H} - H$$

where

$$\bar{H} = \frac{H_1 + H_2 + \ldots + H_5}{5}$$

H_1, H_2, ..., H_5 are the hardness values corresponding to d_1, d_2, ..., d_5;

H is the specified hardness of the standardized block used.

5.3.2 The maximum error of the testing machine, expressed as a percentage of the specified hardness of the standardized block, shall not exceed the values given in table 1.

6 Verification test report

The verification test report shall contain the following information:

a) reference to this International Standard;

b) method of verification (direct or indirect);

c) identification of the hardness testing machine;

d) test force(s) used;

e) hardness values of standardized blocks used;

f) the result obtained;

g) date of verification test and reference to the testing institution.

2) When this International Standard was published, blocks were available for verification of forces and hardnesses equal to or greater than 100 HK 0,1.

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