SLOVENSKI STANDARD
oSIST prEN ISO 4545-1:2015

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Kovinski materiali - Preskus trdote po Knoopu - 1. del: Preskusna metoda (ISO/DIS 4545-1:2015)

Metallic materials - Knoop hardness test - Part 1: Test method (ISO/DIS 4545-1:2015)

Metallische Werkstoffe - Härteprüfung nach Knoop - Teil 1: Prüfverfahren (ISO/DIS 4545 -1:2015)

Matériaux métalliques - Essai de dureté Knoop - Partie 1 : Méthode d'essai (ISO/DIS 4545-1:2015)

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ICS:

77.040.10 Mehansko preskušanje kovin Mechanical testing of metals

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Metallic materials — Knoop hardness test —

Part 1: Test method

Matériaux métalliques — Essai de dureté Knoop —

Partie 1: Méthode d'essai

ICS: 77.040.10

ISO/CEN PARALLEL PROCESSING

This draft has been developed within the International Organization for Standardization (ISO), and processed under the **ISO lead** mode of collaboration as defined in the Vienna Agreement.

This draft is hereby submitted to the ISO member bodies and to the CEN member bodies for a parallel five month enquiry.

Should this draft be accepted, a final draft, established on the basis of comments received, will be submitted to a parallel two-month approval vote in ISO and formal vote in CEN.

To expedite distribution, this document is circulated as received from the committee secretariat. ISO Central Secretariat work of editing and text composition will be undertaken at publication stage.

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

ISO 4545-1 was prepared by Technical Committee ISO/TC 164, *Mechanical testing of metals*, Subcommittee SC 3, *Hardness testing*.

This second edition cancels and replaces the first (ISO 4545-1:2005), which has been technically revised.

ISO 4545 consists of the following parts, under the general title *Metallic materials — Knoop hardness test*:

— *Part 1: Test method;*

— *Part 2: Verification and calibration of testing machines;*

— *Part 3: Calibration of reference blocks;*

— *Part 4: Table of hardness values.*

Metallic materials — Knoop hardness test —

Part 1: Test method

1 Scope

This part of ISO 4545 specifies the Knoop hardness test method for metallic materials, for test forces from 0,0098 07 N to 19,614 N. The method is recommended only for indentations with diagonals ≥ 0,020 mm.

NOTE Special considerations for Knoop testing of metallic coatings can be found in ISO 4516 (see [7] in Bibliography).

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4545-2, *Metallic materials — Knoop hardness test — Part 2: Verification and calibration of testing machines*

ISO 4545-3, *Metallic materials — Knoop hardness test — Part 3: Calibration of reference blocks*

ISO 4545-4, *Metallic materials — Knoop hardness test — Part 4: Table of hardness values*

3 Principle

A diamond indenter, in the form of a rhombic-based pyramid with angles α and β between opposite edges respectively equal to 172,5° and 130° at the vertex, is forced into the surface of a test piece followed by measurement of the long diagonal, d, of the indentation remaining in the surface after removal of the test force, F (see Figures 1 and 2).

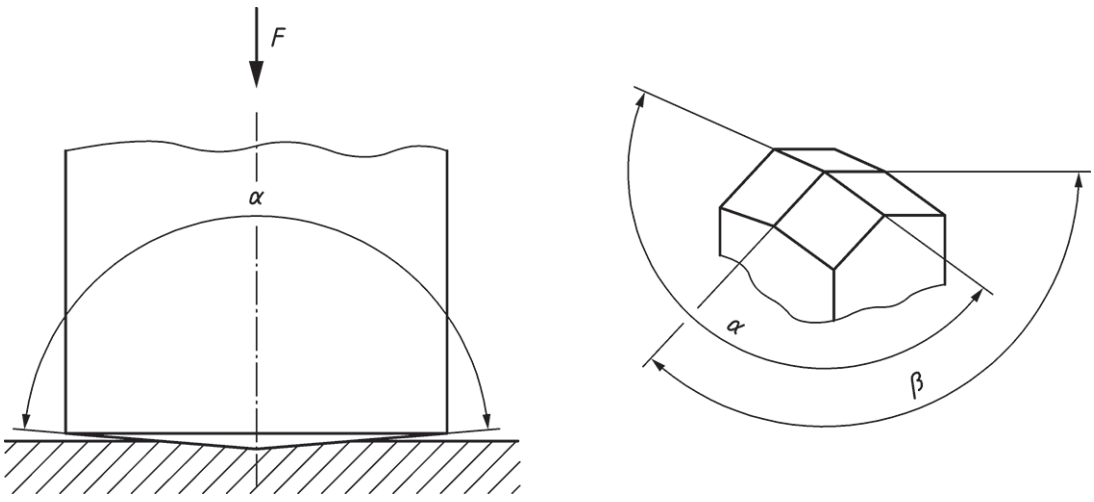

Figure 1 — Principle of the test and indenter geometry

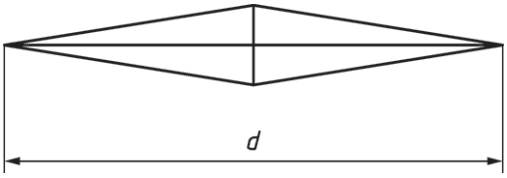

Figure 2 — Knoop indentation

The Knoop hardness is proportional to the quotient obtained by dividing the test force by the projected area of the indentation, which is assumed to be a rhombic-based pyramid, and having at the vertex the same angles as the indenter.

4 Symbols and abbreviated terms

4.1 See Table 1 and Figures 1 and 2.

4.2 The following is an example of the designation of Knoop hardness.

EXAMPLE

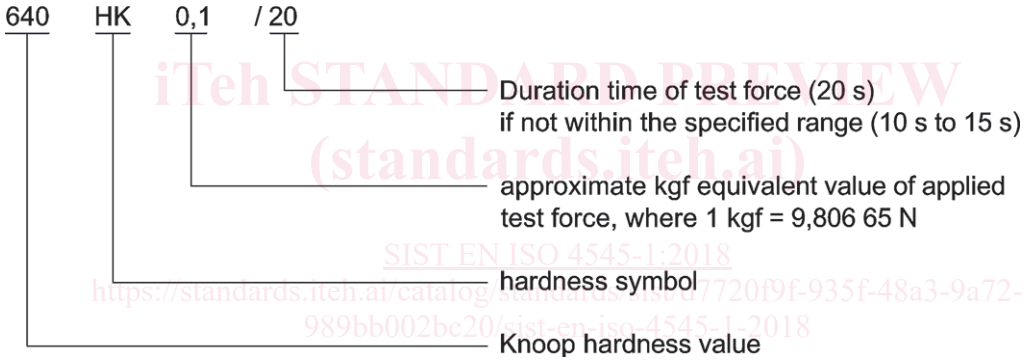

Table 1 — Symbols and abbreviated terms

Symbol/ abbreviated term	Designation
F	Test force, in newtons (N)
d	Length of the long diagonal, in millimetres
c	Indenter constant, relating projected area of the indentation to the square of the length of the long diagonal Indenter constant, $c = \frac{\tan\frac{\beta}{2}}{2\tan\frac{\alpha}{2}}$, c = 0,070 28 where α and β are the angles between the opposite edges at the vertex of the diamond pyramid (see Figure 1)
HK	Knoop hardness = Constant $\times \frac{\text{Test force}}{\text{Projected area of indentation}}$ $= 0{,}102 \times \frac{F}{cd^2} = 1{,}451\,\frac{F}{d^2}$
NOTE Constant = $0{,}102 = \frac{1}{9{,}806\,65}$, where 9,806 65 is the conversion factor from kgf to N.	

5 Testing Machine

5.1 Testing machine, shall be capable of applying a predetermined force or forces within the desired range of test forces, in accordance with ISO 4545-2.

5.2 Indenter, shall be a diamond in the shape of a rhombic-based pyramid, as specified in ISO 4545-2.

5.3 Diagonal measuring system, shall satisfy the specifications in ISO 4545-2.

The optical portion of the diagonal measuring system should have Köhler illumination. See Annex A of ISO 4545-3.

Many older objectives lenses are nonlinear towards the edge of the field of view. Therefore, magnifications should be provided so that the diagonal can be enlarged to greater than 25 % but less than 75 % of the maximum possible optical field of view.

NOTE Systems using a camera for measurement may use 100 % of the camera's field of view provided they are designed to consider the 75 % and any other field of view limitations of the optical system.

The resolution required of the diagonal measuring system depends on the size of the smallest indentation to be measured.

The scale of the measuring system shall be graduated to permit estimation of the diagonals of the indentation in accordance with Table 2.

Table 2 — Resolution of the measuring system

Diagonal length d mm	Resolution of the measuring system
$d < 0{,}040$	0,000 2 mm
$0{,}040 \leq d$	0,5 % of d
NOTE The diagonal length of the indentation determines the necessary magnification V of the measuring system according to the following condition: $V \times d \geq 14$ mm For indentation diagonals $d < 0{,}035$ mm this condition may not be fulfilled, but the magnification should be at least 400x.	

6 Test piece

6.1 The test shall be carried out on a polished surface, which is smooth and even, free from oxide scale and foreign matter and, in particular, free from lubricants, unless otherwise specified in product standards. The finish of the surface shall permit accurate determination of the diagonal length of the indentation.

6.2 Preparation shall be carried out in such a way that any pull out of materials or alteration of the surface hardness, due to excessive heating or cold work, for example, is minimized.

6.3 Due to the small depth of Knoop hardness indentations, it is essential that special precautions be taken during preparation. It is recommended to use a polishing/electropolishing technique that is adapted to the material to be measured.

6.4 The thickness of the test piece or of the layer under test shall be at least 1/3 times the length of the diagonal length of the indentation. No deformation shall be visible at the back of the test piece after the test.

6.5 For test pieces of small cross-section or of irregular shape, it may be necessary to provide some form of additional support, for example, mounting in plastic material. The test piece shall be adequately supported by the mounting medium so that the test piece does not move during the force application.

7 Procedure

7.1 The test is normally carried out at ambient temperature within the limits of 10 °C to 35 °C. . If the test is carried out at a temperature outside this range, it shall be noted in the test report. Tests carried out under controlled conditions shall be made at a temperature of (23 ± 5) °C.

7.2 The test forces given in Table 3 are typical. Other test forces may be used. Test forces should be chosen that result in indentations with a long diagonal greater than 0,020 mm.

7.3 The daily verification defined in Annex A shall be performed before the first test of each week for each test force used but is recommended daily. The daily verification is recommended whenever the test force is changed. The daily verification shall be done whenever the indenter is changed. The daily verification should be done within 200 HK of the expected hardness level to be tested.

7.4 The test piece shall be placed on a rigid support. The support surfaces shall be clean and free from foreign matter (scales, oil, dirt, etc.). It is important that the test piece lies firmly on the support so that displacement cannot occur during the test.

7.5 Focus the diagonal measuring system microscope so that the specimen surface can be observed.

NOTE Some testers do not require that the microscope be focused on the specimen surface.

7.6 Bring the indenter into contact with the test surface and apply the test force in a direction perpendicular to the surface, without shock, vibration or overload, until the applied force attains the specified value. The time from the initial application of the force until the full test force is reached shall be 7^{+1}_{-5} s .The indenter shall contact the test piece at a velocity between 0.015 and 0.070 mm/s.

The duration of the test force shall be 14^{+1}_{-4} s, except for tests on materials whose time-dependent properties would make this an unsuitable range. For these tests, this duration shall be specified as part of the hardness designation (see EXAMPLE in 4.2).

NOTE The requirements for the time durations are given with asymmetric limits. For example, 7^{+1}_{-5} s indicates that 7 s is the nominal time duration, with an acceptable range of not less than 2 s (7 s – 5 s) to not more than 8 s (7 s + 1 s).

Table 3 — Typical test forces

Hardness scale	Test force value, *F*	
	N	approximate kgf [a] equivalent
HK 0,001	0,0098 07	0,001
HK 0,002	0,0196 1	0,002
HK 0,005	0,0490 3	0,005
HK 0,01	0,098 07	0,010
HK 0,02	0,196 1	0,020
HK 0,025	0,245 2	0,025
HK 0,05	0,490 3	0,050
HK 0,1	0,980 7	0,100
HK 0,2	1,961	0,200
HK 0,3	2,942	0,300
HK 0,5	4,903	0,500
HK 1	9,807	1,000
HK 2	19,614	2,000

[a] Not an SI unit.

7.7 Throughout the test, the apparatus shall be protected from shock or vibration. (See [6] in Bibliography)

7.8 The minimum distance between the limit of any indentation and the edge of the test piece shall be at least 3 times the short diagonal of the indentation.

7.9 The minimum distance between the limits of two adjacent indentations, oriented side-by-side, shall be at least 2,5 times the length of the short diagonal. For indentations oriented end-to-end, the minimum distance between the limits of two adjacent indents shall be at least one time the length of the long diagonal. If two indentations differ in size, the minimum spacing shall be based on the short diagonal of the larger indentation.