
Destructive tests on welds in metallic materials — Hardness testing of narrow joints welded by laser and electron beam (Vickers and Knoop hardness tests)

Essais destructifs des soudures sur matériaux métalliques — Essais de dureté sur joints étroits soudés par faisceau d'électrons et faisceau laser (Essais de dureté Vickers et Knoop)

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Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

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.

ISO 22826 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 5, *Testing and inspection of welds*.

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Introduction

Requests for official interpretation of any aspect of this International Standard should be directed to the Secretariat of ISO/TC 44/SC 5 via your national standards body. A complete listing of these bodies can be found at www.iso.org

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Destructive tests on welds in metallic materials — Hardness testing of narrow joints welded by laser and electron beam (Vickers and Knoop hardness tests)

1 Scope

This International Standard specifies the requirements for hardness testing of transverse sections of narrow laser and electron beam welded joints in metallic materials. It covers Vickers and Knoop hardness tests in accordance with ISO 6507-1 and ISO 4545, respectively, with test forces of 0,098 N to just under 98 N (HV 0,01 to just under HV 10) for the Vickers hardness test and test forces up to and including 9,8 N (just under HK 1) for the Knoop hardness test.

This International Standard is applicable to welds made with or without filler wire. It may not be applicable to the testing of wider hybrid laser/arc welds.

International Standards for hardness testing of welds without a narrow profile are ISO 9015-1 and ISO 9015-2.

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, *Metallic materials — Hardness test — Knoop test*

ISO 4546, *Metallic materials — Hardness test — Verification of Knoop hardness testing machines*

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

ISO 6507-1, *Metallic materials — Vickers hardness test — Part 1: Test method*

ISO 6507-2:—¹⁾, *Metallic materials — Vickers hardness test — Part 2: Verification and calibration of testing machines*

ISO 6507-3:—²⁾, *Metallic materials — Vickers hardness test — Part 3: Calibration of reference blocks*

ISO 10250, *Metallic materials — Hardness testing — Tables of Knoop hardness values for use in tests made on flat surfaces*

ISO/TR 16060, *Destructive tests on welds in metallic materials — Etchants for macroscopic and microscopic examination*

1) To be published. (Revision of ISO 6507-2:1997)

2) To be published. (Revision of ISO 6507-3:1997)

3 General

Hardness testing shall be carried out in accordance with ISO 6507-1, ISO 6507-2 and ISO 6507-3 for the Vickers hardness test, and ISO 4545, ISO 4546 and ISO 4547 for the Knoop hardness test.

Testing is carried out to determine the range of hardness values in the parent metal (both parent metals for dissimilar-metal joints), the heat-affected zone and the weld metal. This can be achieved by carrying out hardness tests as either individual indentations or groups of indentations (type E test) or as rows of indentations (type R test).

Testing should preferably be carried out at a temperature of $(23 \pm 5)^\circ\text{C}$. If the test is carried out at a temperature outside this range, it shall be noted in the test report.

Microhardness testing results are affected by vibrations, therefore testing shall be carried out in a vibration-free location.

4 Symbols and abbreviated terms

For the purposes of this International Standard, the abbreviations given in Table 1 apply.

Table 1 — Symbols and abbreviated terms

Symbol	Meaning	Unit
HAZ	Heat-affected zone	—
E	Individual indentation	—
R	Row of indentations	—
HV	Vickers hardness	^a
HK	Knoop hardness	^b
<i>L</i>	Distance between the centre points of the indentations	mm
<i>M</i>	Recommended distance between the centre points of the indentations in R	mm
<i>W</i>	Distance between the centre points of the indentations in heat-affected zone and fusion line	mm
<i>d_V</i>	Diagonal length of the indentation in a Vickers hardness test	mm
<i>d_{KL}</i>	Long diagonal length of the indentation in a Knoop hardness test	mm
<i>d_{KS}</i>	Short diagonal length of the indentation in a Knoop hardness test	mm
<i>h</i>	Weld penetration depth	mm
<i>t</i>	Thickness of test specimen	mm
^a See ISO 6507-1. ^b See ISO 4545 and ISO 10250.		

5 Preparation of test specimens

Test specimens shall be prepared in accordance with ISO 6507-1 or ISO 4545.

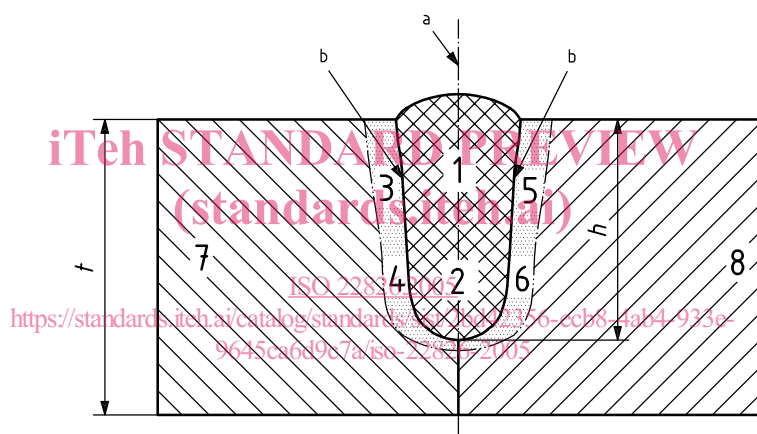
A cross-section of the test piece shall be taken by mechanical cutting, usually transverse to the welded joint. This operation and the subsequent preparation of the surface shall be carried out without heating to a temperature high enough to cause softening or hardening of the surface.

The surface to be tested shall be properly prepared and preferably etched in accordance with ISO/TR 16060, so that accurate measurements of the diagonal length of indentations can be obtained in the different zones of the welded joint.

6 Test procedure

6.1 General

Figure 1 shows typical areas for the location of groups of indentations. Numbers 1 and 2 refer to the weld metal, numbers 3 to 6 refer to the heat-affected zone (HAZ), and numbers 7 and 8 refer to the parent metal.



Key

- 1, 2 weld metal
- 3, 4, 5, 6 heat-affected zone (HAZ)
- 7, 8 parent metal

a Centre of the weld metal.

b Fusion line.

Figure 1 — Location of group indentations for Vickers and Knoop hardness testing

When the type of welded joint is different from those shown in the examples, a test procedure appropriate to the type of joint shall be carried out.

6.2 Type of test

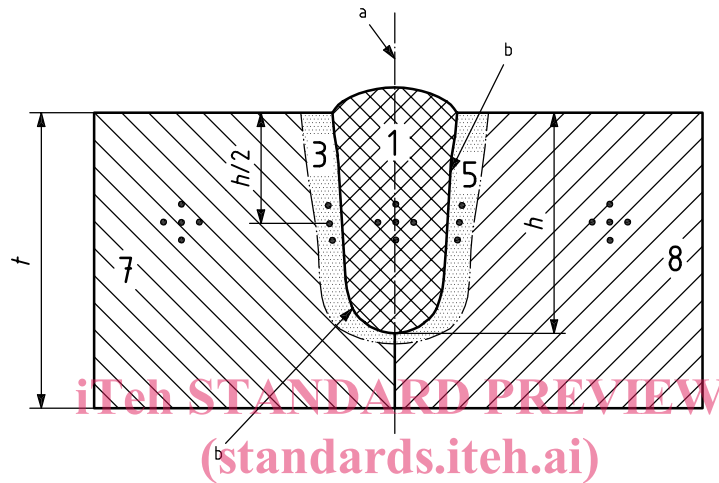
Type E or type R tests shall be carried out with the indentations located in accordance with Figures 2 and 3 for type E tests and Figures 4 and 5 for type R tests. The type of test shall be at the discretion of the test operator unless otherwise specified. The type of test used shall be recorded.

6.3 Test location requirements

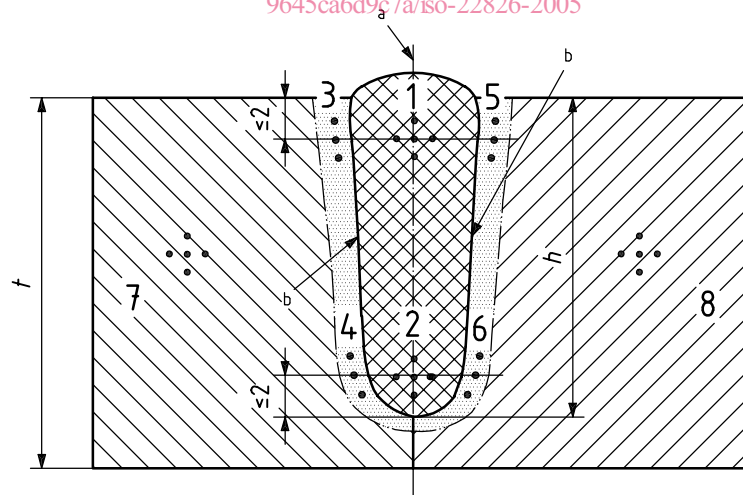
When the parent metal thickness, t , or the penetration depth, h , is 4 mm or less, the indentations in the weld metal and HAZ shall be located in a line at the centre of the plate thickness, i.e. at $t/2$, or at the mid-point of the penetration depth, i.e. at $h/2$, as shown in Figures 2a) and 2c).

When t or h is greater than 4 mm, the indentations shall be located in a line at a distance within 2 mm of the top surface and back surface (or the bottom part of the penetration) as shown in Figures 2b) and 2d). In the case of double fillet welds with full joint penetration, the indentation shall also be located at the centre part of overlapped fusion zone as shown in Figure 2d).

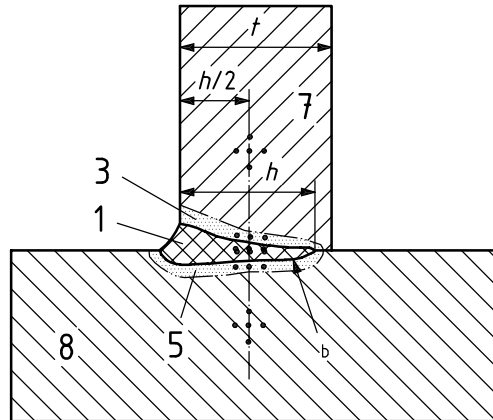
Dimensions in millimetres



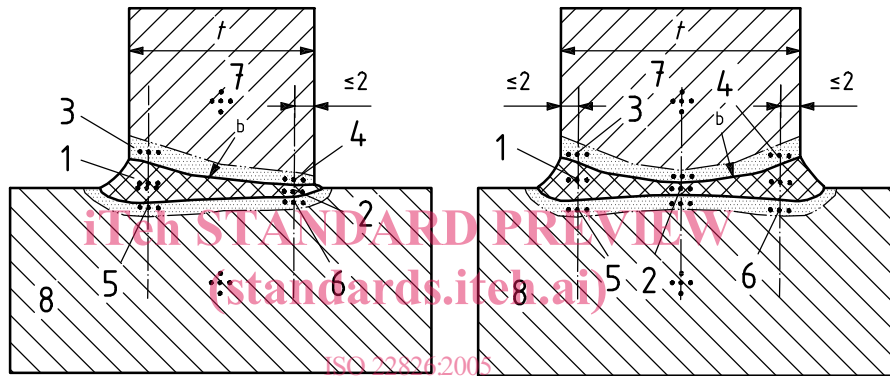
a) Location of indentations — Penetration depth $h \leq 4$ mm
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b) Location of indentations — Penetration depth $h > 4$ mm



c) Location of indentations — Penetration depth h or $t \leq 4$ mm



d) Location of indentations — Penetration depth h or $t > 4$ mm

Key

- 1, 2 weld metal
- 3, 4, 5, 6 heat-affected zone (HAZ)
- 7, 8 parent metal

- a Centre of the weld metal.
- b Fusion line.

Figure 2 — Location of indentations for thin and thick plates — Type E test

For hardenable ferrous metals, the distance between the centre of any indentation and the edge of the test piece shall be:

- at least 2,5 times the mean diagonal length of the indentation for Vickers hardness testing;
- the short diagonal length of the indentation for Knoop hardness testing.