INTERNATIONAL STANDARD

ISO 14271

Second edition
2011-09-01

Resistance welding — Vickers hardness testing (low-force and microhardness) of resistance spot, projection, and seam welds

Soudage par résistance — Essais de dureté Vickers (force réduite et microdureté) sur soudures par résistance par points, par bossages et à la molette

Reference number
ISO 14271:2011(E)

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Published in Switzerland

Foreword

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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 14271 was prepared by the *International Institute of Welding*, Commission III, *Resistance welding, solid state welding, and allied processes*, which has been approved as an international standardizing body in the field of welding by the ISO Council.

This second edition cancels and replaces the first edition (ISO 14271:2000), which has been technically revised.

Requests for official interpretations of any aspect of this International Standard should be directed to the ISO Central Secretariat, who will forward them to the IIW Secretariat for an official response.

Resistance welding — Vickers hardness testing (low-force and microhardness) of resistance spot, projection, and seam welds

1 Scope

This International Standard specifies the procedures for the hardness testing of etched cross-sections of resistance spot, projection, and seam welds.

The aim of the hardness tests is to determine the Vickers hardness, in the low-force or microhardness range, of the weld nugget, the heat affected zone, and parent material in ferrous or non-ferrous metals for welds made in sheets of thickness 0,5 mm to 6 mm.

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

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

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

ISO 6507-4, *Metallic materials — Vickers hardness test — Part 4: Tables of hardness values*

ISO 17677-1, *Resistance welding — Vocabulary — Part 1: Spot, projection and seam welding*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 17677-1 and the following apply.

3.1
low-force hardness test
Vickers hardness test using an applied force greater than or equal to 1,961 N, but less than or equal to 9,807 N

3.2
microhardness test
Vickers hardness test using an applied force less than 1,961 N

NOTE Vickers hardness tests in the low-force range and Vickers microhardness tests give different results that are not easily correlated.

3.3
Vickers hardness value
HV
expression of hardness obtained by dividing the force applied to a Vickers indenter by the surface area of the permanent impression made by the indenter

NOTE This definition is technically in accordance with ISO 23718:2007[1], 1.4.26.

4 Recommended forces for testing resistance welds

When the low-force Vickers hardness test is used, an applied force of either 1,961 N or 9,807 N shall be used. In the case of the Vickers microhardness test, an applied force of 0,980 7 N shall be used.

NOTE The test forces stipulated in ISO 6507-1 can be used when specified.

5 Test pieces and testing locations

5.1 Test pieces

The test piece shall be in accordance with ISO 6507-1.

5.2 Testing locations

Hardness tests shall be performed on a test piece containing a cross-section taken through the weld. The thickness of the test piece shall be at least 1,5 times the diagonal length of the hardness indentation. In principle the cross-section shall lie on a plane passing through the nugget.

When the electrode indentation is essentially circular in a planar view, i.e. the ratio between the maximum and minimum diameter of the electrode indentation is less than 1,3, the section can be taken in any direction as shown in Figure 1.

When the electrode indentation is elongated as indicated, in a planar view (e.g. some projection welds and seam welds), the section shall be taken perpendicular to the sheet surfaces, along the longitudinal axis of the welds, as in Figures 2 and 3. With seam welds, sections can be taken transverse to, or along, the direction of welding.

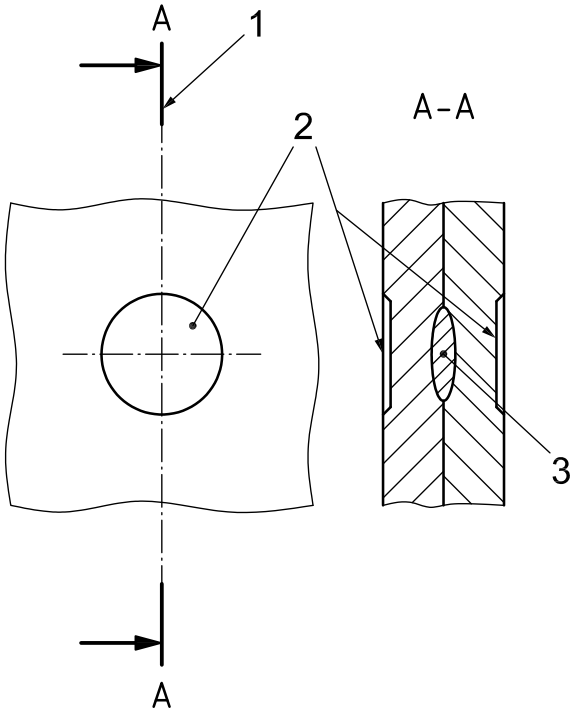
If specified in the application standard, supplementary cross-sections at right angles can be made.

In the case of projection welds that are non-circular or non-elongated, special direction of the cross-section can be taken when specified.

Etched test pieces shall be used in both cases. When determining microhardness, the weld structure shall be revealed.

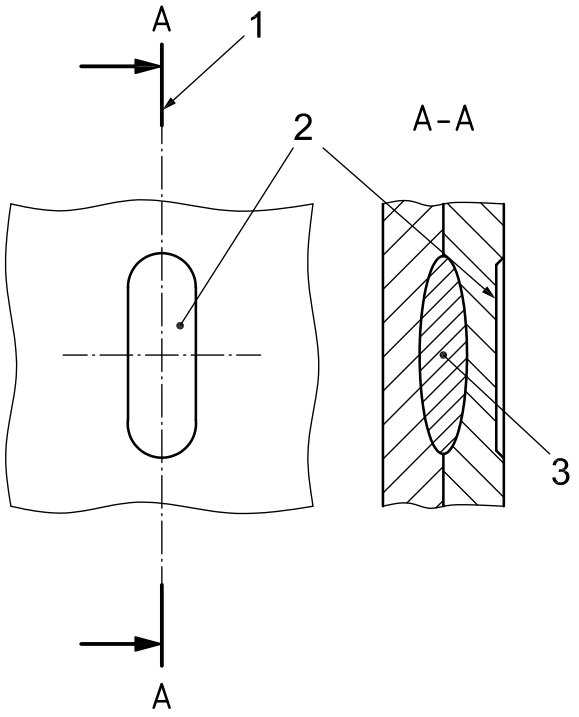
6 Test equipment

The testing procedure shall comply with ISO 6507-1. The testing machine shall be verified and calibrated in accordance with ISO 6507-2 and ISO 6507-3, respectively.



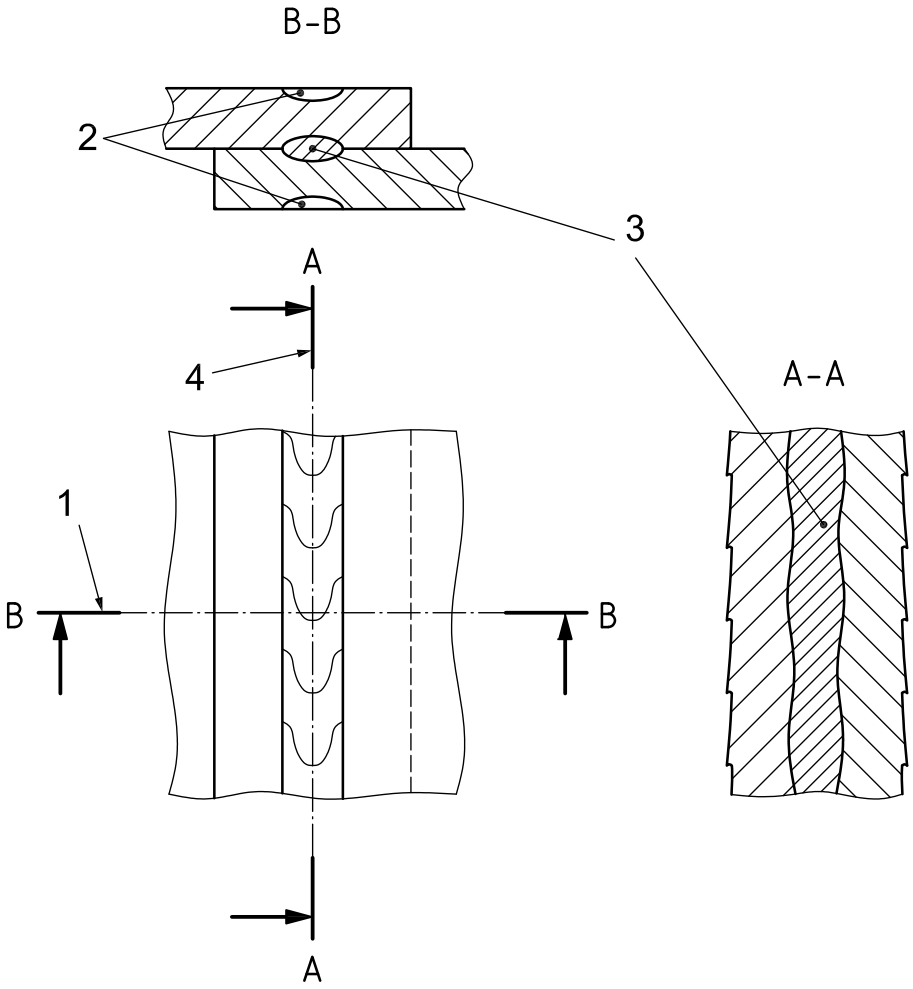
Key
1 location of cross-section
2 electrode indentation
3 weld nugget

Figure 1 — Recommended locations for taking sections through welds: circular weld



Key
1 location of cross-section
2 electrode indentation
3 weld nugget

Figure 2 — Recommended locations for taking sections through welds: elongated projection weld



Key

1 location of cross-section
2 electrode indentation
3 weld nugget
4 location of longitudinal section

Figure 3 — Recommended locations for taking sections through welds: seam weld

7 Testing positions and procedure

7.1 Choice of test

Low-force Vickers hardness testing range, as the test force, is recommended for the hardness test of parent material, the heat affected zone, and the weld nugget. The Vickers microhardness test range (3.2) should be used for the detection of hardness variations within these regions.

7.2 Position of the indentations for the hardness test

The position of the hardness indentations in the parent material, the heat affected zone, and the weld nugget are shown in Figure 4. Two types of hardness traverses are recommended for hardness testing.

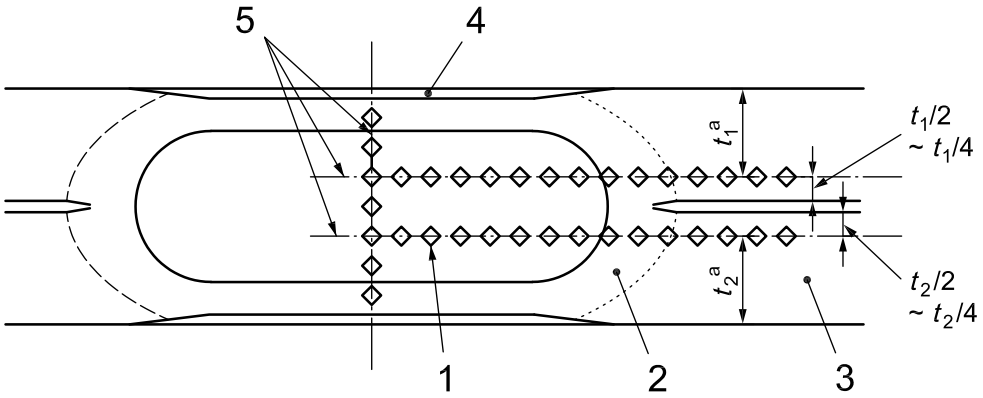
The first type includes the vertical traverse and horizontal traverse(s), as shown in Figure 4 a). When the type or kind of parent materials of both sheets are not the same, or when both plate thicknesses are not the same, the second horizontal traverse is required.

The second type of hardness traverse is the oblique, as shown in Figure 4 b). The first type is recommended for the hardness traverse to keep the consistency of the legacy hardness data. The second type can be used when specified as an alternative.

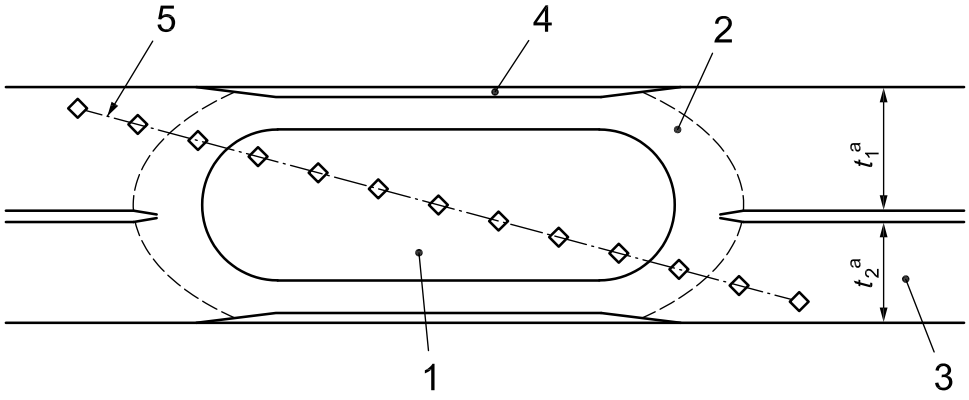
For the vertical and horizontal traverse type, the position of the horizontal hardness traverse shall be located within the region of $t/4$ to $t/2$, where t is the plate thickness, from the faying surface as shown in Figure 4 a) to avoid any measurements in a shrinkage cavity and/or any imperfection part of the weld nugget at the faying surface. The vertical hardness traverse shall be located at or near the centre of the weld nugget.

Additional measurements to those indicated can be made in particular locations, when specified.

NOTE When the traverse line meets discontinuities in the nugget, the line of indentations can be displaced from the original setting position.



a) Hardness measurement traverse on vertical and horizontal lines



b) Hardness measurement traverse on an oblique line

Key

1 weld nugget
2 heat affected zone (HAZ)
3 parent material
4 electrode indentation
5 hardness traverse
t_1 upper plate thickness
t_2 lower plate thickness

[a] $t_1 \geq t_2$.

Figure 4 — Guidelines for positioning the indentations in parent material, heat affected zone, and nugget

7.3 Testing procedure

The procedure shall be carried out in accordance with ISO 6507-1. The low-force hardness range (see Clause 4) is recommended as the test force value for the hardness traverse tests. The microhardness test can also be carried out when the measuring positions are specified.

7.4 Determination of hardness values

The hardness values shall be determined in accordance with ISO 6507-1. ISO 6507-4 contains calculation tables that shall be used to determine the Vickers hardness for testing on a flat surface.

8 Test report

The test report shall contain at least the following information:

a) the test method used, including reference to this International Standard (ISO 14271:2011);

b) hardness test type (low-force hardness test or microhardness test) and test force value;

c) position of indentations (sketch or photograph);

d) single values of hardness;

e) mean value of hardness;

f) resistance welding process;

g) welding conditions;

h) welding equipment;

i) material specification.

Bibliography

[1] ISO 23718:2007, *Metallic materials — Mechanical testing — Vocabulary*

ICS 25.160.40

Price based on 7 pages