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## Resistance welding — Testing of welds — Peel and chisel testing of resistance spot and projection welds

*Soudage par résistance — Essais des soudures — Essais de pelage et de déboutonnage au burin appliqués aux soudures par résistance par points et par bossages*





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# Contents

	Page
<b>Foreword</b> .....	<b>iv</b>
<b>Introduction</b> .....	<b>v</b>
<b>1 Scope</b> .....	<b>1</b>
<b>2 Normative references</b> .....	<b>1</b>
<b>3 Terms and definitions</b> .....	<b>1</b>
<b>4 Test specimens</b> .....	<b>2</b>
<b>5 Test procedure</b> .....	<b>3</b>
5.1 Chisel test.....	3
5.2 Peel test.....	5
5.3 Measurement of weld size.....	5
<b>6 Test report</b> .....	<b>10</b>
<b>Bibliography</b> .....	<b>11</b>

## 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](http://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](http://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.

The committee responsible for this document is IIW, *International Institute of Welding*, Commission III.

This third edition cancels and replaces the second edition (ISO 10447:2006), which has been technically revised.

## Introduction

This edition of ISO 10447 includes figures showing failure types and fracture modes of resistance spot and embossed projection welds in accordance with ISO 14329:2003.

The previous edition of ISO 10447 was revised to align it with ISO 17677-1.



# Resistance welding — Testing of welds — Peel and chisel testing of resistance spot and projection welds

## 1 Scope

This International Standard specifies the procedures and recommended tooling to be used for peel and chisel testing of resistance spot and projection welds. This International Standard applies to welds made in two or more sheets in the thickness range of 0,5 mm to 3,0 mm.

The aim of these tests is to determine

- weld size and failure type when welds are destructively tested, and
- verification of welds by non-destructive chisel tests.

NOTE The preferred method of peel testing seam welds (mechanized peel testing) is covered in ISO 14270.

## 2 Normative references

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

ISO 14270, *Specimen dimensions and procedure for mechanized peel testing resistance spot, seam and embossed projection welds*

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

#### **chisel test**

destructive test with a chisel in which welds are tested by applying a predominantly tensile force that results in stresses primarily normal to the surface of the joint interface

Note 1 to entry: See [Figure 1](#).

### 3.2

#### **peel test**

destructive test in which welds are tested by applying a peel force that results in stresses primarily normal to the surface of the joint interface

Note 1 to entry: See [Figure 2a](#) and [Figure 2b](#).

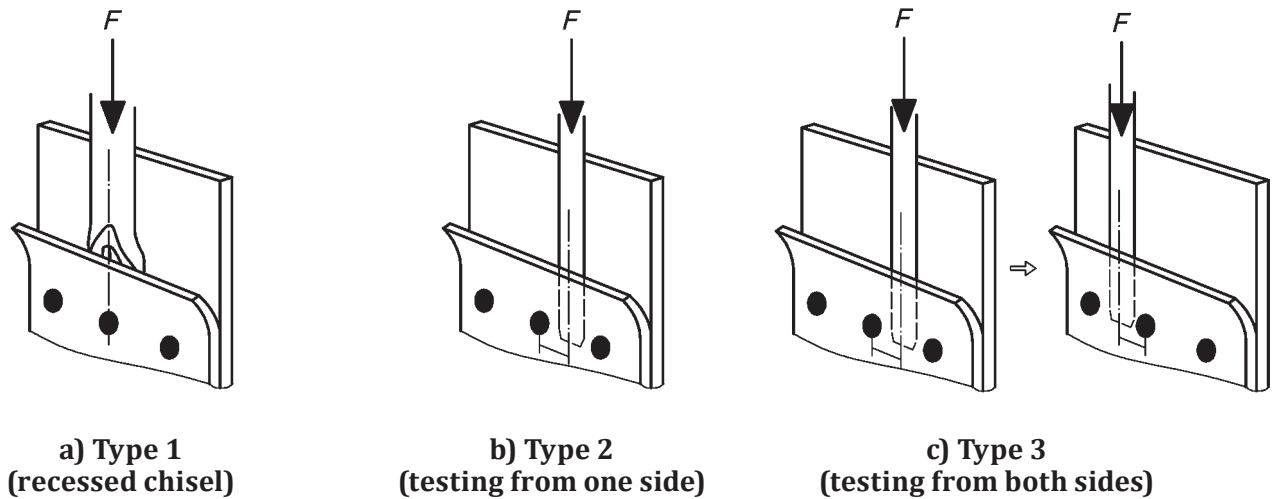


Figure 1 — Chisel testing of resistance spot and protection welded joints

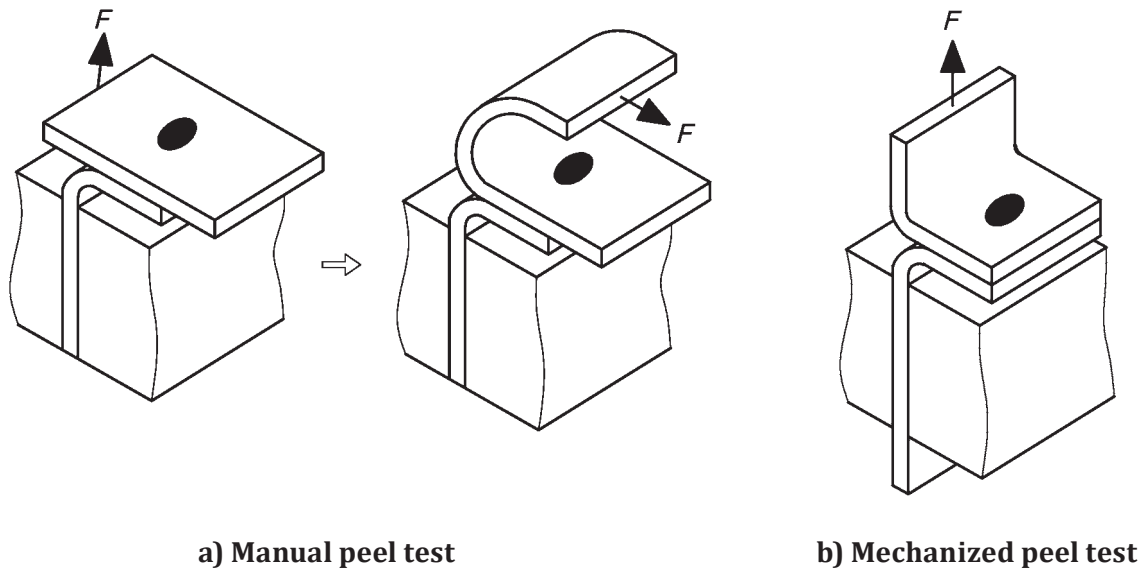


Figure 2 — Peel testing of resistance spot and projection welded joints

#### 4 Test specimens

When used for quality control in production, tests shall be conducted on actual components or specimens taken from actual components.

When used for setting welding parameters, where it is not practical to use actual components, separate welded test pieces may be used. The test pieces shall be produced from the same material used for the component, and welded under conditions adapted to simulate and produce the same required weld quality. The effects of different shunt or impedance conditions should be taken into account when producing the test pieces by inserting sufficient material in the throat of the machine to approximate the magnetic effect of the workpiece under production conditions.



## 5 Test procedure

### 5.1 Chisel test

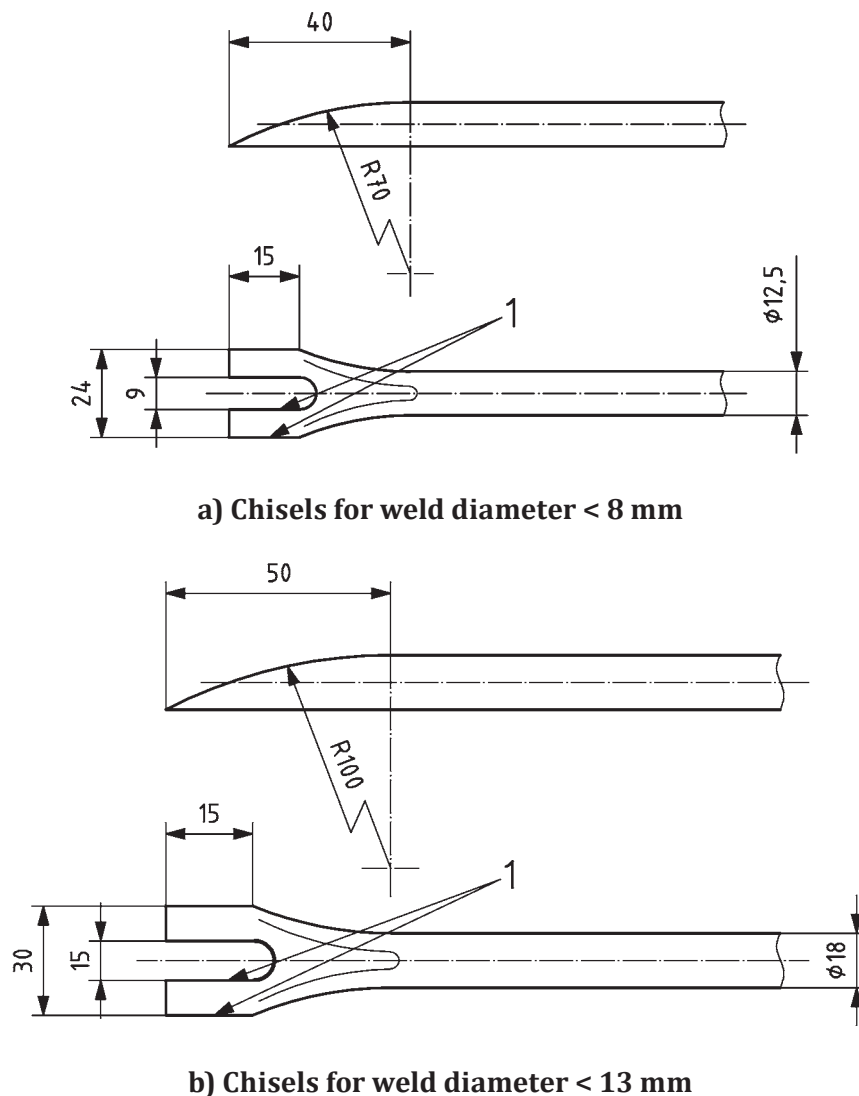
A chisel shall be used to separate the sheets adjacent to the weld under test.

Typical chisel designs are shown in [Figure 3](#) and [Figure 4](#). The chisel geometry should be chosen based on the workpiece thickness and geometry, weld diameter, distance between welds, and whether the weld is to be destructively or non-destructively tested (see [Table 1](#)).

The slot in the chisel shown in [Figure 3](#) is only necessary if the axis of the chisel is placed at the centre of the weld.

The chisel should be driven between the sheets manually by a hammer or tool with e.g. pneumatic, electric or hydraulic drive.

Dimensions in millimetres



#### Key

1 burr to be removed from all corners

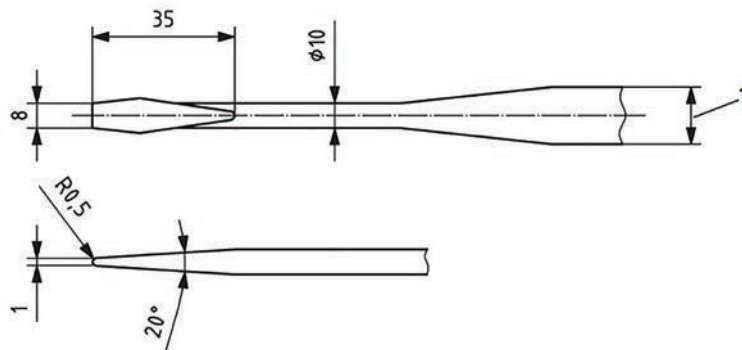
Figure 3 — Typical dimensions of chisels

The results of chisel testing can be influenced by the following factors:

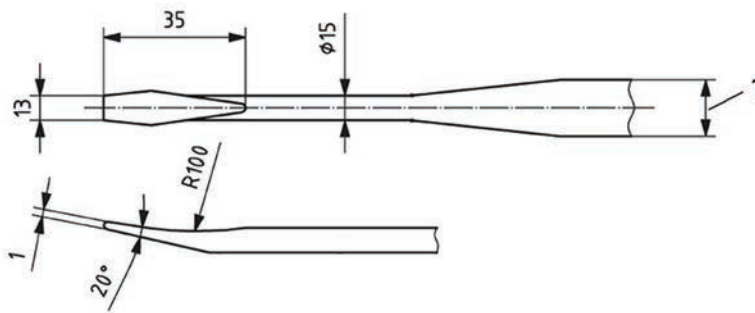
- a) chisel shape – dimensions and condition;
- b) hammer type – mass and type of blow;
- c) test specimen – sheet thickness;
- d) position of the weld in relation to the sheet and its edge;
- e) position of the chisel relative to the weld;
- f) insertion depth of chisel.

Before non-destructive chisel testing is implemented in production, the effectiveness of the test shall be verified by destructive tests. Non-destructive chisel testing should be used with considerable caution, especially when used with high strength steels. Joint design and material thickness can also influence the results.

Dimensions in millimetres



a) Type 2-1 chisel (for thickness ≤ 2 mm)



b) Type 2-2 chisel (for thickness > 2 mm)

**Key**

1 arbitrary value

**Figure 4 — Examples of dimensions of chisels for non-destructive chisel test**

**Table 1 — Selection of recommended chisels for chisel testing**

Chisel design	Test type (Destructive or non-destructive)	For testing	
		Weld diameter, $d_w$ (mm)	Plate thickness, $t$ (mm)
<a href="#">Figure 3a</a>	Both	< 8	–
<a href="#">Figure 3b</a>	Both	< 13	–
<a href="#">Figure 4a</a>	Non destructive	–	≤ 2,0
<a href="#">Figure 4b</a>	Non destructive	–	> 2,0

For destructive chisel testing, a chisel shall be driven between the sheets and adjacent to the weld until fracture occurs in or adjacent to the weld, or until severe deformation occurs. The aim of this test is to separate the sheets so that a weld plug or interfacial fracture occurs to allow weld size to be determined. In the case of a weld between three or more sheets, the test shall be made between each adjacent pair of sheets.

For non-destructive chisel testing, a chisel shall be driven between the sheets and adjacent to the weld until the material yields or bends near the weld. The aim of this test is to obtain an indication that a weld has been made without causing fracture to occur in or adjacent to the weld. In the case of a weld between three or more sheets, the test shall be made between each adjacent pair of sheets. If fracture has not occurred after testing, the components shall be restored to their original shape.

## 5.2 Peel test

The peel test is a destructive test for determining weld size and fracture mode of a welded lap joint.

The sheets near the weld are slowly peeled apart until all welds under test are completely fractured. A roller tool, pincers, pliers, vise, or mechanized equipment (see [Figure 2](#) and [Figure 5](#)) are typically used. If a roller tool is used, a diameter of 30 mm is recommended for sheet thicknesses up to 1 mm in accordance with [Figure 5a](#). Testing using a vise and pliers shall be in accordance with [Figure 5b](#).

For materials that are too thick or too strong to be tested manually, mechanized testing in accordance with ISO 14270 is recommended. The applied force may be generated by means of a normal tensile testing machine or other suitable mechanized equipment.

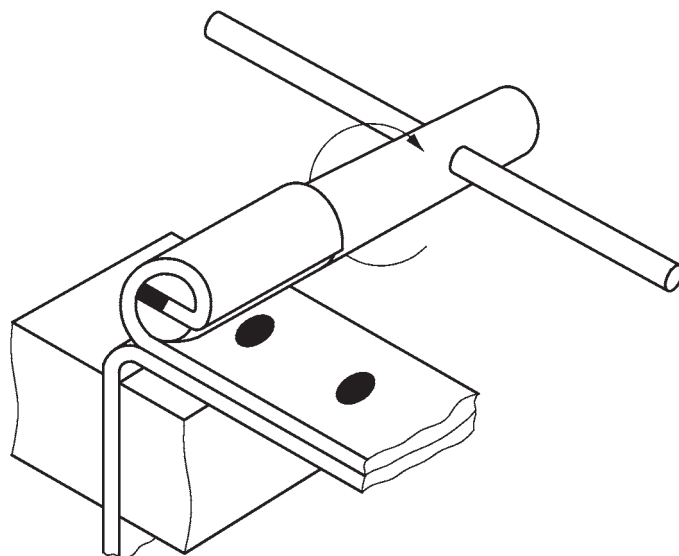
Fracture mode and plug size can vary depending on the direction of the applied force.

Peel testing can be applied to test specimens cut from production components or welded test pieces.

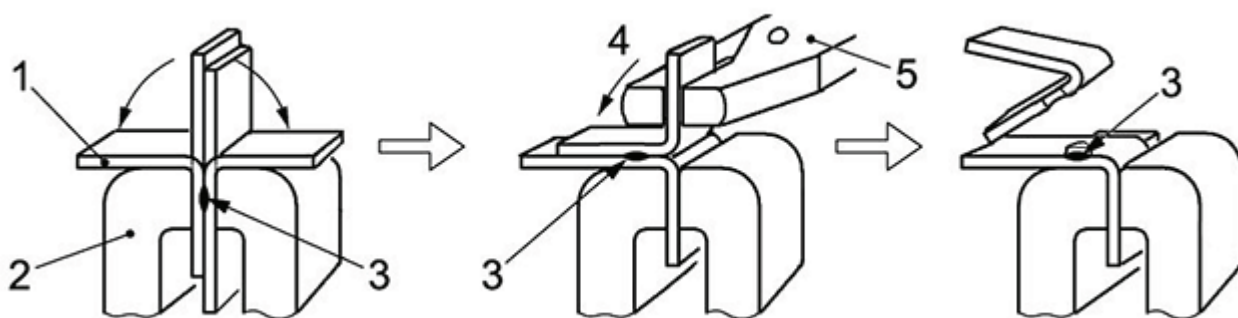
## 5.3 Measurement of weld size

A destructive chisel test or peel test allows the measurement of the weld size and assessment of the failure type in accordance with ISO 17677-1. In the case of mechanized testing in accordance with ISO 14270, it can also be possible to measure the force at failure.

The maximum and minimum diameters of the weld ( $d_1$  and  $d_2$ ) shall be measured to determine the weld size ( $d_w$ ) in accordance with [Figure 6](#) and [Figure 7b](#).



a) Peel testing using a vise and a roller

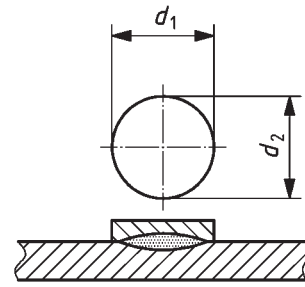
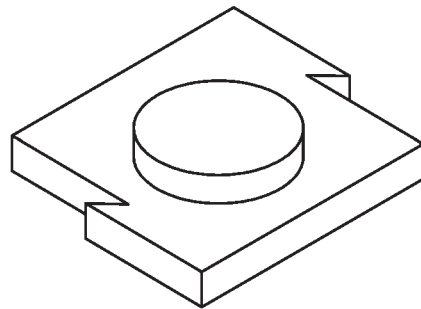


b) Peel testing using vice and plier

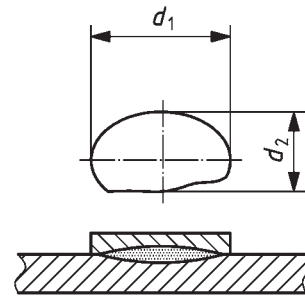
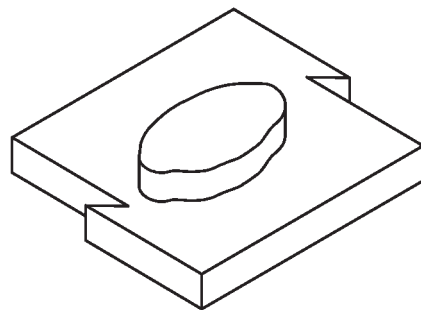
**Key**

- 1 test piece
- 2 vice
- 3 weld
- 4 peeling direction
- 5 pliers

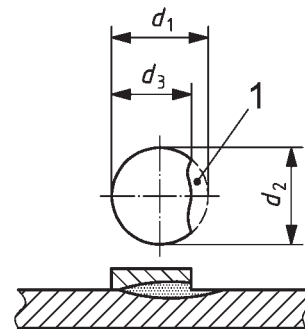
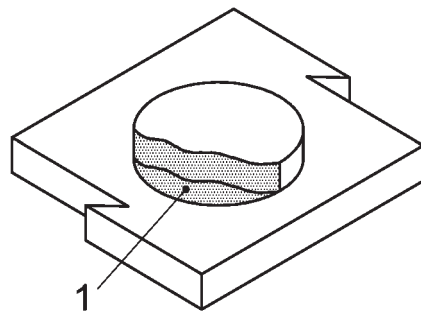
**Figure 5 — Manual peel test configurations**



a) Symmetrical plug <sup>a</sup>



b) Asymmetrical plug <sup>a</sup>



c) Partial plug <sup>b</sup>

**Key**

1 interfacial fracture

<sup>a</sup>  $d_w = d_p = (d_1 + d_2) / 2$

<sup>b</sup>  $d_w = (d_1 + d_2) / 2$  and

$d_p = (d_2 + d_3) / 2$

**Figure 6 — Examples of weld diameter measurements when plug failures are observed**

Precautions should be taken when measuring weld size, particularly for asymmetrical welds.

In the case of plug failure, fracture can occur in the parent metal away from the weld. If possible, this excess metal should be folded back or removed. If this is not possible, then only one dimension can be measured. A knife-edged gauge or measuring device as shown in [Figure 7a](#) is used for the measurement of weld diameters with plug failure. The average diameter of the weld,  $d_w$ , is calculated from  $d_1$  and  $d_2$  using the following Formula (1):

$$d_w = (d_1 + d_2) / 2 \tag{1}$$

When only one dimension is measured, it is considered to be the weld diameter,  $d_w$ .

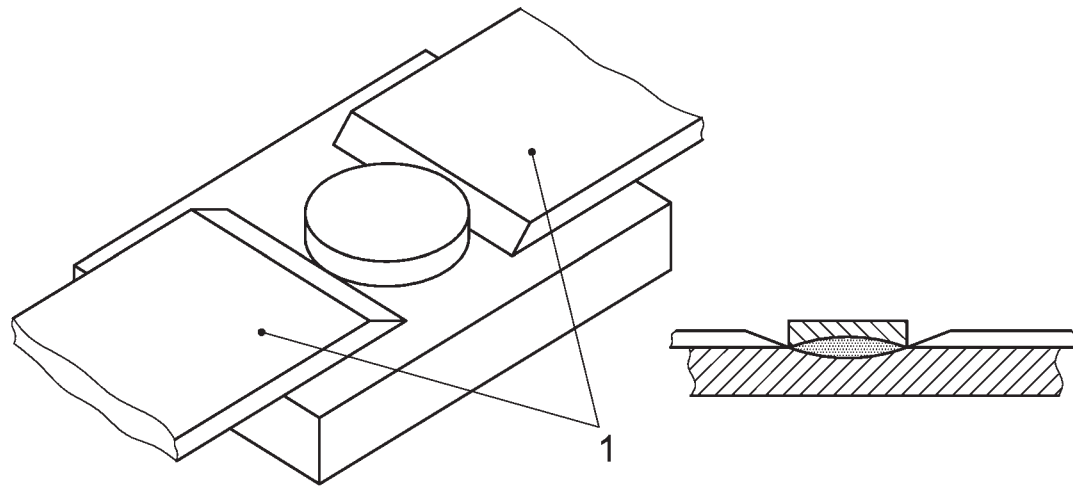
In the case of partial plug failure, the maximum and minimum plug diameters ( $d_2$  and  $d_3$ ) should also be measured and recorded. The average diameter of the plug,  $d_p$ , is calculated using the following Formula (2):

$$d_p = (d_2 + d_3) / 2, \text{ for partial plug failure.} \tag{2}$$

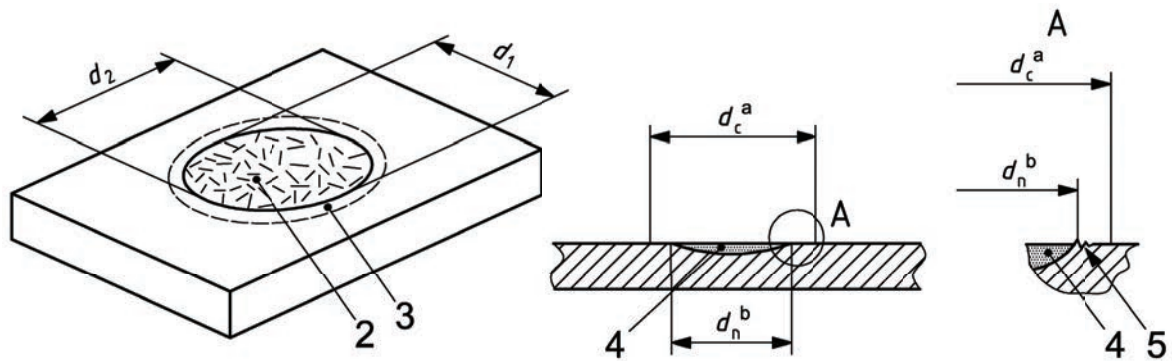
Depending upon the application, for asymmetric welds, the ratio between  $d_1$  and  $d_2$ , shall be specified and included in the test report.

The strength of the weld might vary depending on the direction of the applied force when the weld shape is asymmetric.

Weld diameter dimensions should be rounded down to the nearest 0,1 mm. In the case of an interface failure (see [Figure 7b](#)), the weld diameters ( $d_1$  and  $d_2$ ) should be measured using a pocket lens or magnifier with an incorporated scale to determine the edge of the interfacial fracture accurately. If a smooth pressure welded bond zone (corona bond) is present, only the rough fracture zone shall be measured.



a) Plug failure

b) Interface failure <sup>c</sup>**Key**

- 1 jaws of knife-edged measuring tool
- 2 sheared or fractured faying surface
- 3 corona bond zone
- 4 nugget
- 5 rough fracture zone
- a Diameter of the corona bond.
- b Diameter of estimated nugget zone (i.e. weld diameter).

$$c \quad d_w = (d_1 + d_2) / 2$$

NOTE The cross sections shown in [Figure 7](#) are used only for explanation. Nugget diameter can be measured on an etched cross section of the weld. This measurement does not need any etched cross sections of welds.

**Figure 7 — Measuring weld diameter**

## 6 Test report

A test report shall include at least the following:

- a) a reference to this International Standard (i.e. ISO 10447);
- b) type of test (chisel or peel);
- c) description of test equipment;
- d) welding process (resistance spot or projection);
- e) welding equipment;
- f) welding parameters;
- g) material information;
- h) weld size ( $d_1$ ,  $d_2$ ,  $d_3$ ,  $d_w$ ,  $d_p$ , as appropriate);
- i) ratio of maximum to minimum value (of  $d_1$  and  $d_2$ ) for each weld, if required;
- j) failure description (symmetrical plug failure, asymmetrical plug failure, partial plug failure, interfacial failure, etc.);
- k) other data specified.



## Bibliography

- [1] ISO 14329:2003, *Resistance welding — Destructive tests of welds — Failure types and geometric measurements for resistance spot, seam and projection welds*

