INTERNATIONAL STANDARD

ISO 18278-3

First edition
2017-08

Resistance welding — Weldability —

Part 3: Evaluation procedures for weldability in spot weld bonding

Soudage par résistance — Soudabilité —

Partie 3: Méthodes d'évaluation de l'aptitude au soudocollage par points

Reference number
ISO 18278-3:2017(E)

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Contents

Page

Foreword

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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 voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 6, *Resistance welding and allied mechanical joining*.

A list of all parts in the ISO 18278 series can be found on the ISO website.

Requests for official interpretations of any aspect of this document should be directed to the Secretariat of ISO/TC 44/SC 6 via your national standards body. A complete listing of these bodies can be found at www.iso.org.

Introduction

This document describes procedures for evaluating the weldability of weld bonding using the resistance spot welding process by determining the welding current range and electrode life.

These procedures can be used to evaluate the following:

a) the effect of electrode material, shape, dimensions and electrode cooling;

b) the effect of material types and thicknesses and coatings being welded;

c) the effect of welding conditions;

d) the effect of welding equipment;

e) the effect of adhesive on welding.

Resistance welding — Weldability —

Part 3:
Evaluation procedures for weldability in spot weld bonding

1 Scope

This document specifies procedures for the determination of the acceptable welding current range and the electrode life for spot weld bonding using resistance spot welding with adhesive bonding.

This document is applicable for the evaluation of the weldability of prepared assemblies of uncoated and coated metal sheets with individual thicknesses from 0,4 mm to 6,0 mm.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 669, *Resistance welding — Resistance welding equipment — Mechanical and electrical requirements*

ISO 5182, *Resistance welding — Materials for electrodes and ancillary equipment*

ISO 5821, *Resistance welding — Spot welding electrode caps*

ISO 14373, *Resistance welding — Procedure for spot welding of uncoated and coated low carbon steels*

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

ISO 18278-1:2015, *Resistance welding — Weldability — Part 1: General requirements for the evaluation of weldability for resistance spot, seam and projection welding of metallic materials*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 669, ISO 14373, ISO 17677-1 and ISO 18278-1 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at http://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
spot weld bonding
resistance spot welding through an adhesive or sealant

3.2
substrate
material upon the surface of which an adhesive is spread for weld bonding

3.3
prepared assembly
set of components (substrates and adhesives) positioned prior to welding

3.4
wearing sheet
sheet which is used to produce electrode wear through continuous spot welding

4 Weld bonding equipment

4.1 General

Methods to characterize resistance welding equipment can be found in ISO 669.

The mass and friction of the movable electrode assembly can be determined in accordance with ISO 18278-1.

4.2 Adhesive dispensing equipment

The adhesive dispensing equipment shall be defined by agreement between the contracting parties.

4.3 Storage chamber

The storage chamber shall have a temperature regulation system that is sufficient to maintain the properties of the adhesive or sealant, as required by the manufacturer of the adhesive or sealant.

4.4 Electrodes

The electrode materials shall be as defined in ISO 5182. Their geometry shall be defined according to ISO 5821.

4.5 Welding current

The type of welding current used (alternating current or direct current) shall be specified before testing and recorded. Constant current control settings shall be used.

When using AC resistance welding equipment, it shall be set so that welding current is not less than 30 % of R.M.S. value at full conduction angle.

4.6 Mechanical settings

The mechanical settings shall be chosen to limit the impact of the electrode meeting the sheet.

To limit the impact of the electrode an electrode approach speed of 0,15 m/s is recommended and/or the peak force should be less than 150 % of the nominal electrode force.

The machine squeeze time should be of sufficient duration to overcome electrode bounce effects and machine inertia so as to allow the electrode force to build up to the required value before the welding current is initiated.

4.7 Measurement of parameters

4.7.1 Temperature

The ambient temperature shall be measured.

4.7.2 Amount of adhesive applied

Measurement of the amount of adhesive applied shall be carried out as defined by the contracting parties.

For example, measurements can be performed using a calliper gauge, scale magnifier or by relative weighing.

4.7.3 Welding current and electrode force

Measurement of welding current and electrode force shall be in accordance with ISO 18278-1:2015, 5.3.

4.7.4 Electrode cooling water flow rate

Since water cooling significantly influences electrode life, the inlet water temperature should be maintained at 20 °C and shall not exceed 30 °C. A separate water supply should be used for each electrode, and the water flow rate for each electrode shall be a minimum of 4 l/min. The water cooling tube should be arranged to ensure that the water directly cools the electrode.

Dimensions of the water cooling holes and pipes shall comply with the relevant requirements of the appropriate ISO Standard for various electrode types. The distance between the back and working face of the electrode should not exceed the values given in ISO 5821 which specifies electrode dimensions.

Any deviations shall be recorded.

All machine and water cooling details shall be recorded in the format presented in Clause 9.

4.8 Measurement of results

4.8.1 Weld diameter

After destructive testing, the weld diameter shall be measured according to ISO 17677-1.

4.8.2 Detection of expulsion

Occurrence of expulsion shall be determined by

— the electrode displacement curve,

— the welding voltage signal,

— the welding force signal, or

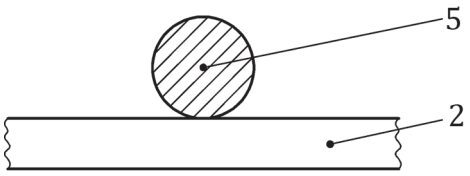
— visually.

In the latter case, expulsion shall be confirmed by visual examination after destructive testing. For steel sheets, an expulsion is characterized by a very sharp deviation in the trace of an electrode displacement or welding voltage signal.

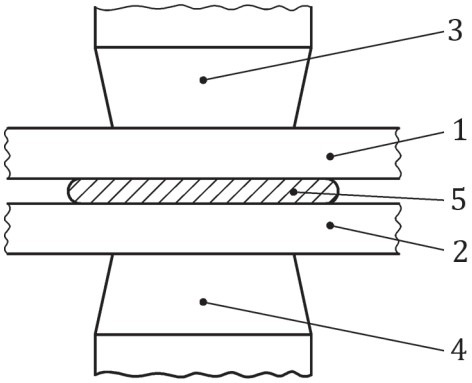
5 Assembly preparation

The weld bonding shall be set up according to the indications given in Figure 1. The amount and pattern of adhesive applied shall be agreed between the contracting parties.

a) Just after adhesive application



b) Prepared assembly under application of electrode force, just before



c) After welding

Key

1 upper sheet
2 lower sheet
3 upper electrode
4 lower electrode
5 adhesive
6 nugget

Figure 1 — Stages during spot weld bonding

To ensure reproducible test conditions, it is necessary to define the adhesive characteristics and dispensing conditions; see 9.1 a) to f).

6 Preliminary adjustments

6.1 Electrode alignment

Electrode alignment shall be checked. This may be accomplished by the methods suggested in Annex A.

Eccentricity (see ISO 669) should be less than 0,5 mm. This may be checked using the carbon imprint method where a sheet of paper is sandwiched between two carbon papers inserted between the two caps after which the electrode force is applied. Examples of carbon imprints obtained on the paper sheet after application of pressure are shown in Figure A.1.

Angular deflection (see ISO 669) should not exceed 5°. A method using a tube is described in Figure A.2.

6.2 Electrode conditioning

Electrodes shall not be conditioned.

7 Determination of the welding current range

7.1 Test specimens

The geometry of test specimens shall be defined for a given welding current range test. Recommended geometries are those for single spot specimens defined in relevant International Standards, especially cross-tension specimens (ISO 14272), tensile-shear specimens (ISO 14273), torsion specimens (ISO 17653), mechanized peel specimens (ISO 14270) or chisel/peel test specimens (ISO 10447). In the case of the chisel test, the specimens shall have a minimum size of 40 mm × 40 mm with at least 35 mm overlap.

The spot weld shall be aligned with the median line of the adhesive bead.

For non-conductive adhesives, shunting may be necessary to initiate current flow through the adhesive. Tensile-shear and cross-tension specimens welding procedures with shunt are shown in Annex B.

Cross-tension, peel and chisel specimens are recommended to obtain accurate weld diameter measurements.

7.2 Welding parameters

Appropriate welding parameters shall be specified in the instructions or in the test order form. Proposed sets of welding parameters for steel assemblies are given in Annex C.

7.3 Test procedure

Starting with a level sufficiently low to be under any welding condition, the welding current is increased in 200 A steps and never decreased. Three test specimens shall be prepared and welded for each current setting, two will be used for destructive testing and the third will be kept in reserve, for example, for metallographic analysis.

When splashing occurs, the test shall be continued until the welding current reaches 10 % above the current after splashing first occurred.

Destructive testing and measurement of the weld diameter shall be performed according to 4.8.1 and the information supplied in 7.1.

For the purpose of the welding current range determination, only the weld diameter is needed, therefore, adhesive curing is not required before destructive testing.

7.4 Current range criteria

The minimum weld diameter shall be specified in the instructions.

NOTE This minimum weld diameter can be equal to $3{,}5\sqrt{t}$, t being the thickness of the thinnest sheet of the assembly.

The upper end of the welding current range, I_{max}, is defined as the maximum current setting for which at least two out of three spot welds show no splash and all current settings below satisfy the same condition.

The lower end of the welding current range, I_{min}, is defined as the minimum current setting for which both spot weld specimens which are destructively tested will have a diameter equal or greater than the defined minimum, and all current settings above until I_{max} satisfy the same condition.