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Corrosion of metals and alloys — Stress corrosion testing —

Part 8:
Preparation and use of specimens to evaluate weldments

Corrosion des métaux et alliages — Essais de corrosion sous contrainte —

Partie 8: Préparation et utilisation des éprouvettes pour évaluer les assemblages soudés

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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 3.

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 part of ISO 7539 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 7539-8 was prepared by Technical Committee ISO/TC 156, *Corrosion of metals and alloys*.

ISO 7539 consists of the following parts, under the general title *Corrosion of metals and alloys — Stress corrosion testing*:

— *Part 1: General guidance on testing procedures*

— *Part 2: Preparation and use of bent-beam specimens*

— *Part 3: Preparation and use of U-bend specimens*

— *Part 4: Preparation and use of uniaxially loaded tension specimens*

— *Part 5: Preparation and use of C-ring specimens*

— *Part 6: Preparation and use of pre-cracked specimens*

— *Part 7: Slow strain rate testing*

— *Part 8: Preparation and use of specimens to evaluate weldments*

— *Part 9: Preparation and use of pre-cracked specimens for tests under rising load or rising displacement*

Annex A of this part of ISO 7539 is for information only.

Corrosion of metals and alloys — Stress corrosion testing —

Part 8:
Preparation and use of specimens to evaluate weldments

1 Scope

This part of ISO 7539 covers the procedures available for stress corrosion testing of welded specimens and examines the additional factors which must be taken into account when conducting tests on welded specimens. In particular this part of ISO 7539 gives recommendations for the choice of specimens and test procedures to determine the resistance of a metal to stress corrosion when it is welded.

The term “metal”, as used in this part of ISO 7539, includes alloys.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 7539. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 7539 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 857-1:1998, *Welding and allied processes — Vocabulary — Part 1: Metal welding processes.*

ISO 7539-2:1989, *Corrosion of metals and alloys — Stress corrosion testing — Part 2: Preparation and use of bent-beam specimens.*

ISO 7539-3:1989, *Corrosion of metals and alloys — Stress corrosion testing — Part 3: Preparation and use of U-bend specimens.*

ISO 7539-4:1989, *Corrosion of metals and alloys — Stress corrosion testing — Part 4: Preparation and use of uniaxially loaded tension specimens.*

ISO 7539-5:1989, *Corrosion of metals and alloys — Stress corrosion testing — Part 5: Preparation and use of C-ring specimens.*

ISO 7539-6:—[1)], *Corrosion of metals and alloys — Stress corrosion testing — Part 6: Preparation and use of pre-cracked specimens.*

ISO 7539-7:1989, *Corrosion of metals and alloys — Stress corrosion testing — Part 7: Slow strain rate testing.*

IEC 60050-851 (1991-08), *International Electrotechnical Vocabulary — Chapter 851: Electric Welding.*

1) To be published. (Revision of ISO 7539-6:1989)

3 Terms and definitions

For the purposes of this part of ISO 7539 the following terms and definitions apply.

3.1
welding
operation which unites materials by means of heat or pressure, or both, in such a way that there is continuity in the nature of the materials which have been joined and in which filler metal, the melting temperature of which is of the same order as that of the parent metal(s), may or may not be used

NOTE This definition also includes surfacing.

[ISO 857-1]

3.1.1
fusion welding
welding involving localized melting without the application of force and with or without the addition of filler metal

[ISO 857-1]

3.1.2
arc welding
fusion welding in which heat for welding is obtained from an electric arc or arcs

[ISO 857-1; IEC 60050-851]

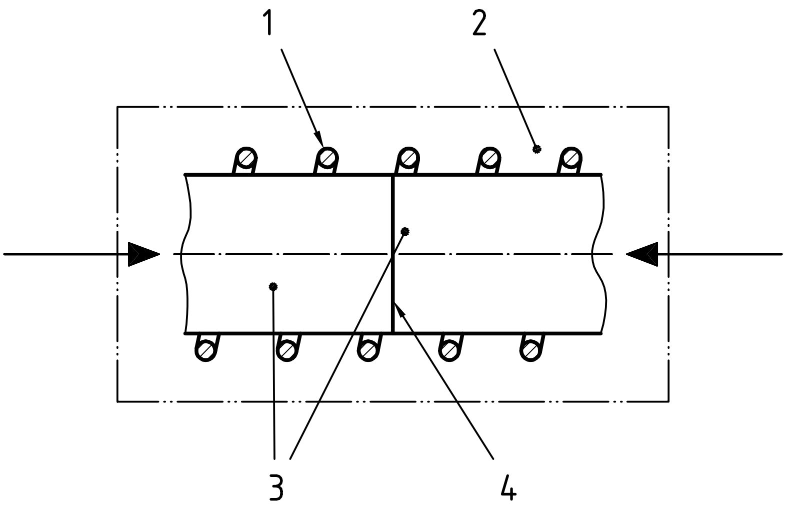
3.1.3
diffusion welding
pressure welding in which the workpieces are kept in contact under a specified continual pressure and are heated, either on their faying surfaces or in their entirety, at a defined temperature for a controlled time

NOTE 1 This process results in local plastic deformation and also, owing to the very close contact between the surfaces, the diffusion of the atoms through the interface. The end result is thus complete continuity of the material.

NOTE 2 The operation may take place in a vacuum, under a gas shield or in a fluid, preferably without the addition of a filler metal.

See Figure 1.

[ISO 857-1]



Key

1 Induction heating element

2 Work chamber

3 Workpiece

4 Weld

Figure 1 — Diffusion welding

3.2
arc voltage
voltage across the arc, including the anode and cathode voltage drop, measured as near as possible to the arc

[IEC 60050-851]

See annex A.

4 Special considerations for weldments

4.1 General

The factors given in this clause may all influence the corrosion and/or mechanical properties of a weldment relative to that of the parent metal and their effects may require consideration in stress corrosion test procedures. Whilst the considerations listed below are relevant to the more common fusion welding processes, similar consideration shall also be given to solid phase (non-fusion) welding processes and diffusion welding.

Weld regions are more likely than the parent metal to contain defects which may influence corrosion and stress corrosion behaviour, e.g. microcracking, lack of fusion and porosity. For this reason, examination of the weld shall be undertaken to assess whether the failure of any specimen is the result of pre-existing defects rather than stress corrosion.

It is recommended that the weldment be characterized with regard to residual welding stresses, surface condition and weld defects prior to testing. See clause 7.

4.2 Changes in microstructure

In fusion welding, the application of heat to a parent metal produces microstructural changes in the heat affected zone (HAZ) of the parent metal adjacent to the weld junction. A rapidly-cooled weld metal differs microstructurally and chemically from the parent metal and is more typical of a cast structure. These differences may influence both weldment corrosion and mechanical properties, as well as susceptibility to stress corrosion cracking.

Some alloys such as C-Mn steels display a visible HAZ. However, in some alloys, welding may also produce precipitation and segregation effects within the parent metal remote from the visible HAZ.

4.3 Non-metallic inclusions

In addition to changes in chemical composition, the welding procedure and conditions used may result in a weld metal with a non-metallic inclusion content and distribution different from that of the parent metal. This may influence weldment corrosion and stress corrosion cracking behaviour.

4.4 Stress concentration effects

Shrinkage stresses following welding will introduce residual welding stresses which will be both transverse and longitudinal with respect to the welding direction (and through thickness in thick-walled samples). Tensile stresses are usually generated at the weld, with balancing compressive stresses in the parent metal. In addition, weld geometry may cause further stress concentration effects.

5 Specimen types

5.1 General

The design and type of specimen used depend on the form of the metal from which the specimen is to be made and on the objective of the test.

The test specimens described in ISO 7539 parts 2-7 are suitable for tests on weldments, subject to the additional considerations presented in this part of ISO 7539. In addition, a number of other types of specimens, as described in 5.2.1 to 5.2.8 below, can be used.

Specimens can be prepared from weldments in the as-welded or post-weld heat-treated conditions. It is recommended that specimens be tested in the same condition of heat treatment as that of the intended application.

5.2 Types of specimen

5.2.1 Flat weldment

See Figure 2.

This type of weldment is applicable for all tension and bend specimens and for any welding procedure whether involving single- or multi-pass welds. The weldment may also be used to evaluate the effect of residual welding stresses.

5.2.2 Circular bead weldment

See Figure 3.

The welding procedure involves one circular bead deposit of weld metal. The circular weld develops residual welding stresses. It is applicable to any material form that can be machined to the recommended size as specified in Figure 3.

5.2.3 Bead-on-bar weldment

See Figure 4.

The longitudinal fusion welds at diametrically opposite positions on the bar develop residual welding stresses in the bar. Hence, this weldment can be used to evaluate the tendency for stress corrosion cracking of the parent metal. It is applicable to materials that can be machined to approximately 25 mm diameter.

5.2.4 Direct tension specimen

See Figure 5.

This specimen type is stressed in uniaxially loaded tension (see ISO 7539-4 and ISO 7539-7). Notches, with or without pre-cracks, may be introduced into the weld metal, parent metal or heat affected zone (see ISO 7539-6). These specimens also may be made exclusively from weld metal.

5.2.5 U-bend specimen

See Figure 6.

The U-bend specimen is applicable to any weldment that can be formed into a U-shape without mechanical cracking or localized bending in the heat affected zone (see ISO 7539-3). The bending operation after welding creates high levels of elastic and plastic strain resulting in a wide range of stresses in a single specimen. The presence of residual welding stresses makes this a particularly severe test procedure.

5.2.6 Bent-beam specimens

See Figure 7.

These specimens are machined from welded plate into rectangular bar with the welding direction normal to or parallel to the axis of the specimen (see ISO 7539-2). They can be loaded in 3-point or 4-point bending to measure the stress corrosion tendencies in the weld region.

5.2.7 Pre-cracked specimens

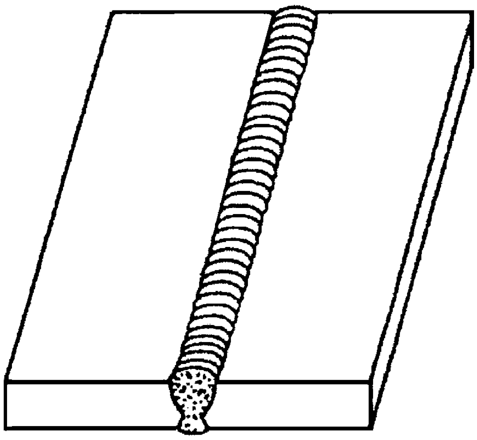
See Figure 8.

Pre-cracked specimens can be used to measure the tendency for stress corrosion cracking (see ISO 7539-6) in various parts of the weldment. Caution should be exercised in the interpretation and application of results for specimens where the stress corrosion cracks deviate from their expected path and the presence of residual welding stresses may affect the local stress intensity factor at the crack tip.

5.2.8 C-ring and slit-tube specimens

See Figure 9.

In the C-ring test (see ISO 7539-5), the stress is applied externally. In the slit-tubing test, the stress is applied by a wedge that is forced into the slit section. While any material form can be machined into a ring section, this test is specifically designed for tubing.

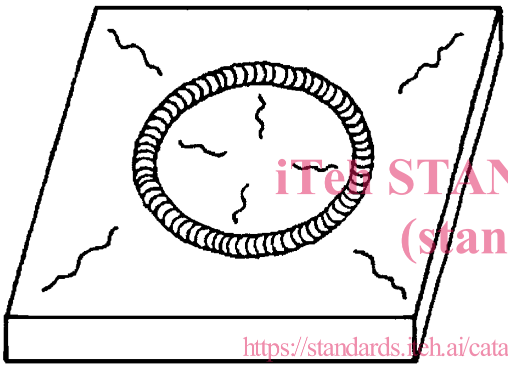


Procedure:

a) Discard weld ends.

b) Remove test sections as required. Sections may be taken across the weld or longitudinally with the weld.

Figure 2 — Flat weldment



Procedure:

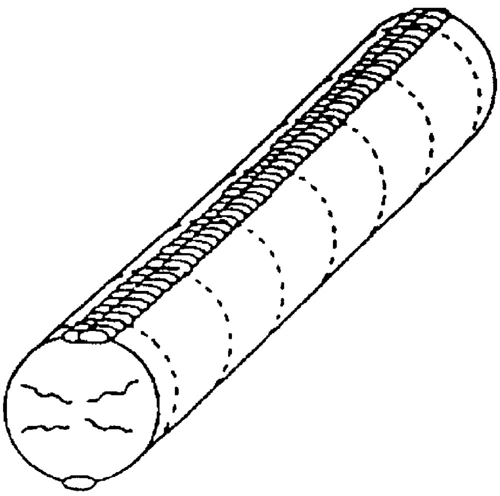
a) Specimen size: 100 × 100 × 3 mm.

b) Clamp or tack weld the edges of the test specimen to a base plate to obtain restraint.

c) Weld a 50 mm diameter circular bead using the selected weld procedure.

d) Examine both sides of specimen after exposure.

Figure 3 — Circular bead weldment



Procedure:

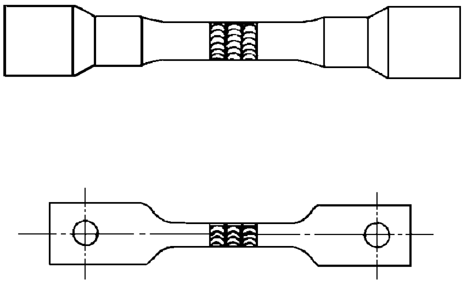
a) Specimen size: 25 mm diameter × 150 mm long.

b) Fusion weld entire length on opposite sides.

c) Discard 6 mm from ends and remove 20-mm test specimens.

d) Examine cross section for radial cracking.

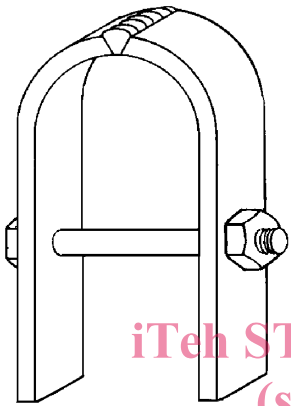
Figure 4 — Bead-on-bar weldment



Procedure:

a) Direct tension specimens to be machined directly from flat plate weldment (see Figure 2).

Figure 5 — Direct tension weldments

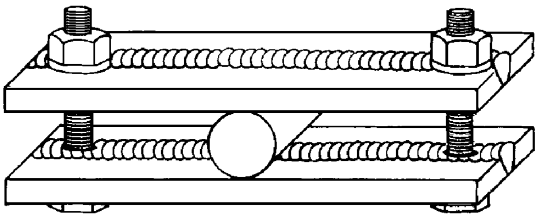


Procedure:

a) U-bend specimens to be machined directly from flat plate weldment (see Figure 2).

NOTE The welds may be oriented 90° to the direction shown.

Figure 6 — U-bend weldment



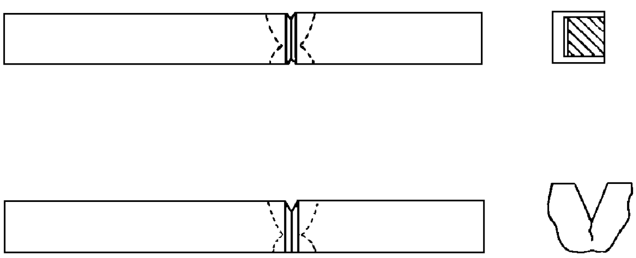
Procedure:

a) Bent-beam specimens to be machined directly from flat plate weldment (see Figure 2). Fulcrum should be notched so as not to contact weld bead.

b) Dimensions: as required.

NOTE The welds may be oriented at 90° to the direction shown.

Figure 7 — Bent-beam weldment



Procedure:

a) Specimens may be machined from flat plate weldment (see Figure 2) or K-weld (see Figure 10) or half K-weld preparations.

Figure 8 — Precracked cantilever beam weldment

