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Destructive tests on welds in metallic materials — Fracture test

Essais destructifs des soudures sur matériaux métalliques — Essai de texture

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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).

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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 5, *Testing and inspection of welds*.

This second edition cancels and replaces the first edition (ISO 9017:2001), which has been revised to update the normative references.

Request for official interpretations of any aspect of this document 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.

Destructive tests on welds in metallic materials — Fracture test

1 Scope

This document specifies the sizes of test specimen and the procedures for carrying out fracture tests in order to obtain information about types, sizes and distribution of internal imperfections such as porosities, cracks, lack of fusion, lack of penetration and solid inclusions on the fracture surface.

This document applies to metallic materials in all forms of product with joints made by any fusion welding process with a thickness greater or equal to 2 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 5817, *Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections*

ISO 10042, *Welding — Arc-welded joints in aluminium and its alloys — Quality levels for imperfections*

ISO 17637, *Non-destructive testing of welds — Visual testing of fusion-welded joints*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

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

3.1
examination length
L_f
length of the test specimen measured along the weld axis between any side notches

Note 1 to entry: See Figure 6.

3.2
total examination length
ΣL_f
sum of the lengths of all the test specimens comprising the test piece, measured along the weld axis, of the fracture faces between the side notches of the test specimens

Note 1 to entry: See Figure 6.

3.3
examination thickness
a_f
thickness of the fracture area for each test specimen

Note 1 to entry: See Figures 7 and 8.

3.4
examination area
A_f
product of the examination length and the examination thickness for each test specimen

3.5
total examination area
ΣA_f
sum of all examination areas

4 Principle

Fracture the joint through the weld metal in order to examine the fracture surface. The fracture can be induced by bending or tension, static or dynamic loading. Furthermore, notch dimensions and temperature can be varied to induce the fracture.

Unless otherwise specified, the test shall be carried out at ambient temperature (23 ± 5) °C.

5 Symbols and abbreviated terms

The symbols and abbreviated terms to be used for fracture tests are specified in Table 1 and represented in Figures 5 to 8.

Normally, it is sufficient to give the basic denomination, but for special applications, additional denominations about the notching and test method can be requested.

EXAMPLE 1 Test specimen taken from a fillet weld with an examination length of 40 mm and examination thickness of 10 mm.

Without any requirement about notching and test method:

Basic denomination: FW / ($L_f a_f$)

i.e. for this example: FW / (40 × 10)

With additional requirement (square face notching and test method):

Comprehensive denomination: FW / ($L_f a_f$) / Fq (See Figure 8.)

i.e. for this example: FW / (40 × 10) / Fq (See Figure 8)

EXAMPLE 2 Test specimen taken from a butt weld with an examination length of 40 mm and examination thickness of 10 mm.

Without any requirement about notching and test method:

Basic denomination: BW / ($L_f a_f$)

i.e. for this example: BW / (40 × 10)

With additional requirement (round side notching and test method):

Comprehensive denomination: BW / ($L_f a_f$) / Sr (See Figure 6.)

i.e. for this example: BW / (40 × 10) / Sr (See Figure 6.)

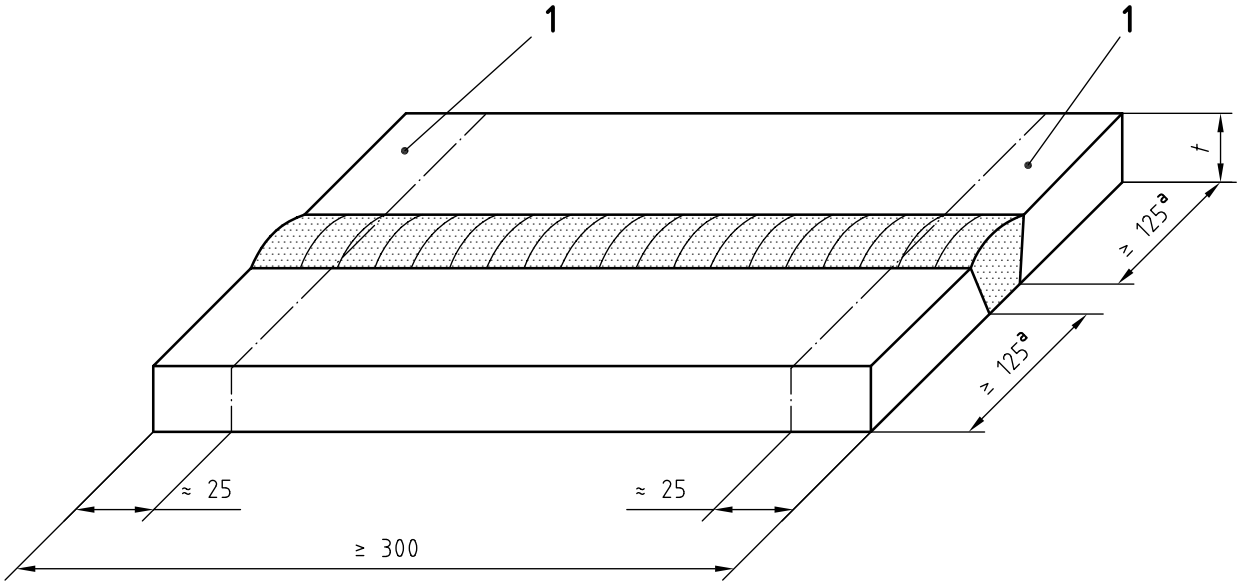
Table 1 — Symbols and abbreviated terms

Denomination	Symbol or abbreviated term	Unit
Butt weld	BW	–
Fillet weld	FW	–
Thickness of test piece	t, t_1, t_2	mm
Length of test piece	l_1, l_2	mm
Outside diameter of tube	D	mm
Test specimen and test piece		
— examination length	L_f	mm
— examination thickness	a_f	mm
— examination area	A_f	mm^2
— area of imperfections	A_i	mm^2
Side notch	S	–
— square (q)	Sq	–
— round (r)	Sr	–
— sharp (s)	Ss	–
Longitudinal notch		
Face notch	F	–
— square (q)	Fq	–
— round (r)	Fr	–
— sharp (s)	Fs	–
Root notch	R	–
— square (q)	Rq	–
— round (r)	Rr	–
— sharp (s)	Rs	–

6 Dimensions of test pieces

Unless otherwise specified by the application standard or by agreement between the contracting parties, test piece dimensions shall be in accordance with Figures 1 to 4. The test piece shall provide sufficient test specimens for the required total examination length (ΣL_f) and area (ΣA_f).

Dimensions in millimetres



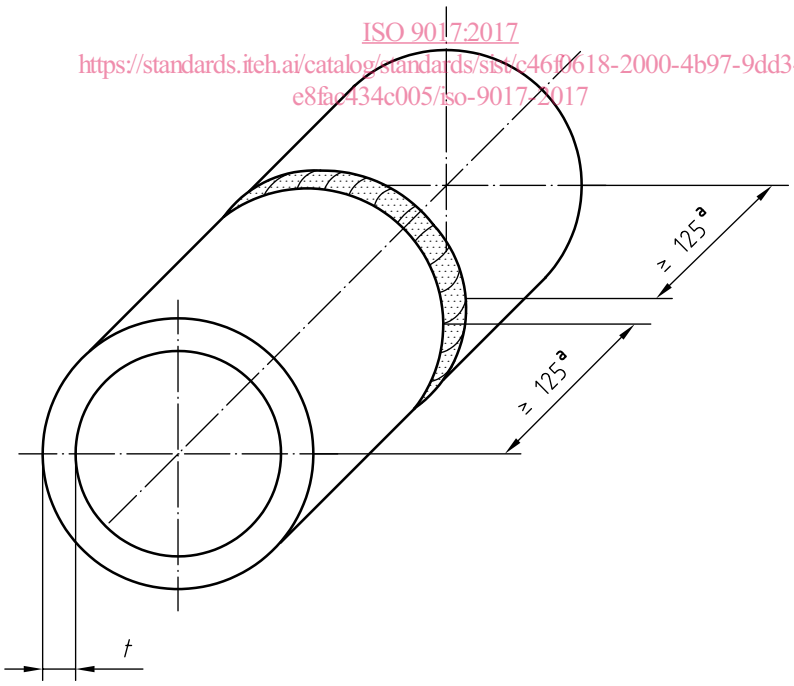
Key

1 discard

a ≥150 mm for materials of high thermal conductivity (e.g. aluminium and copper).

Figure 1 — Test piece for butt welds in plate

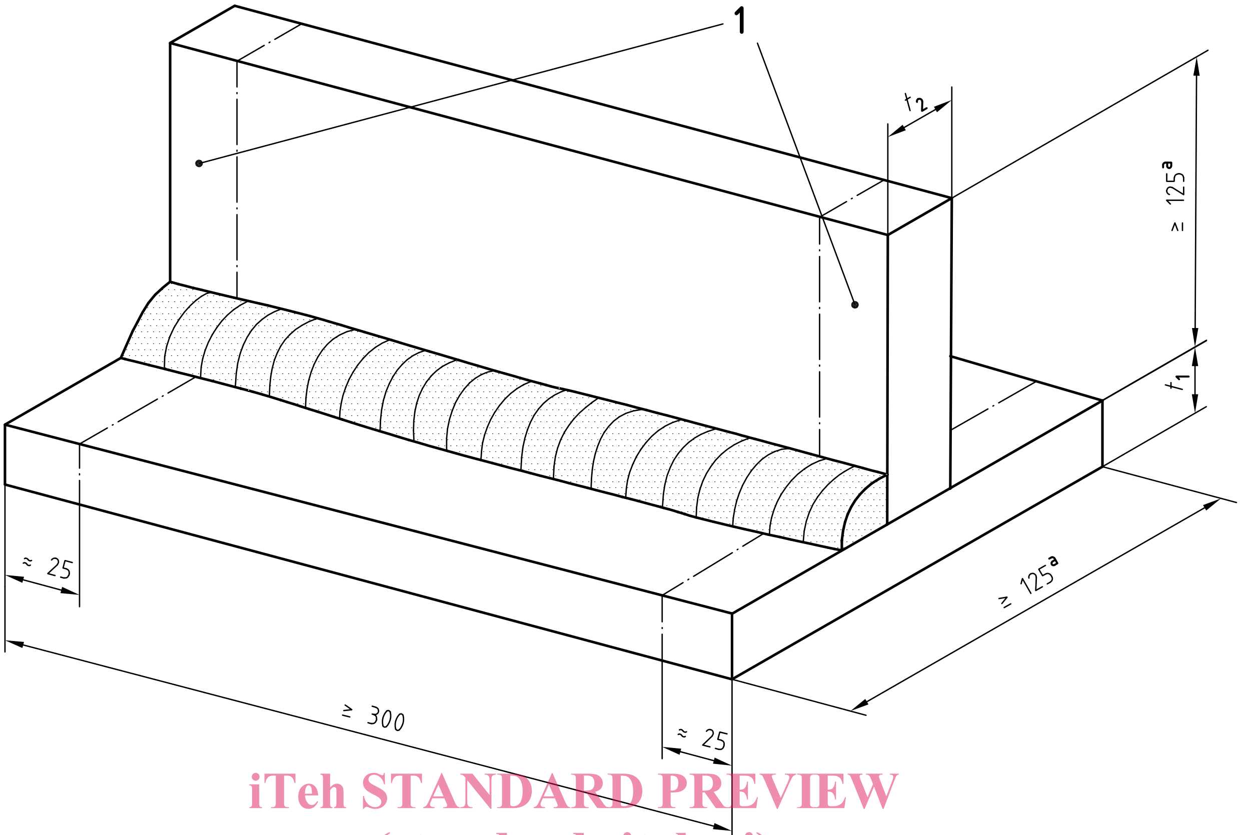
Dimensions in millimetres



Key

a ≥150 mm for materials of high thermal conductivity (e.g. aluminium and copper).

Figure 2 — Test piece for butt welds in pipe



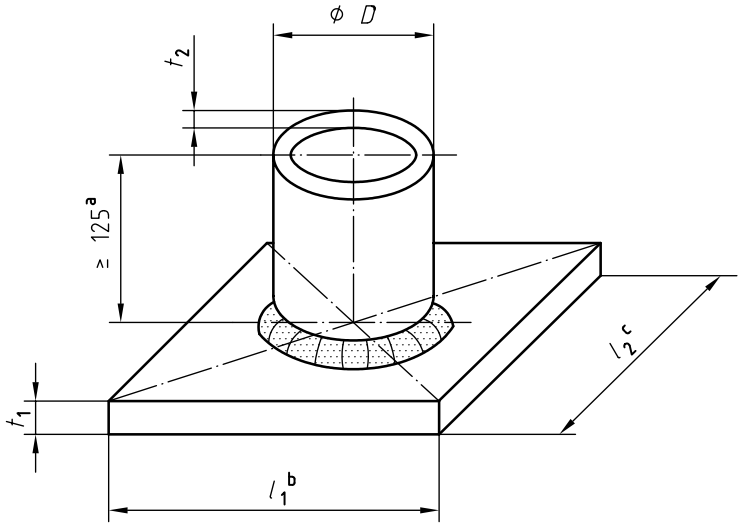
Key

1 discard

a ≥150 mm for materials of high thermal conductivity (e.g. aluminium and copper).

Figure 3 — Test piece for fillet welds on plate

Dimensions in millimetres



Key

a ≥150 mm for materials of high thermal conductivity (e.g. aluminium and copper).

b $l_1 \approx l_2$; $l_1 \geq (D + 100)$.

c $l_2 \geq (D + 100)$.

Figure 4 — Test piece for fillet welds on pipe

7 Removal of test specimens

7.1 General

The examination length, L_f, and area, A_f, and the number of test specimens shall be specified by the application standard or by agreement between the contracting parties. Welded joints in plates shall be cut transversely to the welded joint in test specimens of approximately equal weld length. The weld axis shall remain in the middle of the test specimen for butt welds.

For welded joints in pipe, unless otherwise specified in the application standard or by agreement between the contracting parties, the test piece shall provide at least two test specimens.

When carrying outbend tests, equal numbers of specimens shall be tested with the root in tension and the face in tension. If the pipe diameter is too small for removing the required number of test specimens, additional test pieces shall be welded.

7.2 Marking

Each test piece shall be marked to identify its exact location in the manufactured product or in the joints from which it has been removed.

When removed from the test piece, each test specimen shall be marked.

7.3 Extraction

7.3.1 General

The extraction method shall avoid the introduction of detrimental thermal or mechanical effects.

In general, a portion 25 mm from both ends of the test welds shall be discarded, unless information about the ends of the welds is required (e.g. start/stop imperfections).

7.3.2 Steels

The test specimens shall be cut by thermal cutting or by mechanical means.

7.3.3 Other metallic materials

Other metallic materials shall only be cut mechanically.

7.4 Preparation

Fracture of welds in plates or pipes may be assisted by one or more of the following:

— removing the weld reinforcement;

— notching both edges of the weld (side notching);

— notching into the reinforcement (longitudinal notching).

Depending on the ductility of the weld metal, square, round or sharp notches may be used, (see Figures 5, 6, 7 and 8). For materials of high ductility (e.g. aluminium and copper), sharp notches can be recommended.

The depth of the notches shall be sufficient to induce fracture in the weld.

Unless otherwise specified by the application standard or by agreement between the contracting parties, the notch depth should be such that:

— for the side notch, examination length, L_f, shall be greater than or equal to 70 % of the original width of the test specimen, w (see Figure 6), or the total examination length, ΣL_f, shall be greater than or equal to 60 % of the length of the test specimen;

— for the longitudinal notch, examination thickness, a_f, shall be greater than or equal to 80 % of the original thickness of the test specimen, t (see Figure 7).

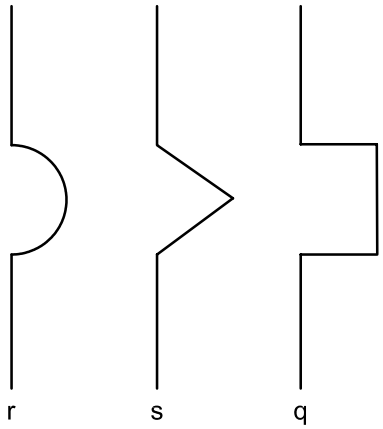


Figure 5 — Notch profiles