भारतीय मानक

Indian Standard

IS 3600 (Part 8) : 2024
ISO 9017 : 2017

स्टील में फ्यूज़न वेल्डेड जोड़ों और धातु — परीक्षण पद्धति

भाग 8 धात्विक सामग्रियों में वेल्ड संबंधी विनाशी परीक्षण — फ्रैक्चर परीक्षण

(तीसरा पुनरीक्षण)

Fusion Welded Joints and Weld Metal in Steel — Method of Test

Part 8 Destructive Tests on Welds in Metallic Materials — Fracture Test

(Third Revision)

ICS 25.160.40

भारतीय मानक ब्यूरो
BUREAU OF INDIAN STANDARDS
मानक भवन, 9 बहादुर शाह ज़फर मार्ग, नई दिल्ली - 110002
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI - 110002
www.bis.gov.in www.standardsbis.in

February 2024 **Price Group 8**

Welding General and its Applications Sectional Committee, MTD 11

NATIONAL FOREWORD

This Indian Standard (Part 8) (Third Revision) which is identical to ISO 9017 : 2017 'Destructive tests on welds in metallic materials — Fracture test' issued by the International Organization for Standardization (ISO) was adopted by the Bureau of Indian Standards on the recommendation of the Welding General and its Applications Sectional Committee and approval of the Metallurgical Engineering Division Council.

This standard was first published in 1966 and subsequently revised in 1973 and 1985. The third revision of this standard has been undertaken to align it with ISO 9017 : 2017 under dual numbering system to harmonize it with the latest developments that have taken place at international level.

This standard is published in various parts. Other parts in this series are:

Part 1 Tensile test on cruciform and lapped joints

Part 2 Impact tests — Test specimen location, notch orientation and examination

Part 3 Transverse tensile test

Part 4 Longitudinal tensile test on weld metal in fusion welded joints

Part 5 Bend tests

Part 9 Macroscopic and microscopic examination of welds

The text of ISO standard has been approved as suitable for publication as an Indian Standard without deviations. Certain terminologies and conventions are, however, not identical with those used in Indian Standard. Attention is especially drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, it should be read as 'Indian Standard'; and

b) Comma (,) has been used as a decimal marker, while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

The Committee responsible for the preparation of this standard has reviewed the provisions of following International Standards referred in these adopted standards and decided their acceptability for use in conjunction with this standard.

International Standard	*Title*
ISO 5817 : 2023	Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections
ISO 10042 : 2018	Welding — Arc-welded joints in aluminium and its alloys — Quality levels for imperfections
ISO 17637 : 2016	Non-destructive testing of welds — Visual testing of fusion-welded joints

In reporting the results of a test or analysis made in accordance with this standard, is to be rounded off, it shall be done in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision*)'.

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FUSION WELDED JOINTS AND WELD METAL IN STEEL — METHOD OF TEST

PART 8 DESTRUCTIVE TESTS ON WELDS IN METALLIC MATERIALS — FRACTURE TEST

(Third Revision)

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.)

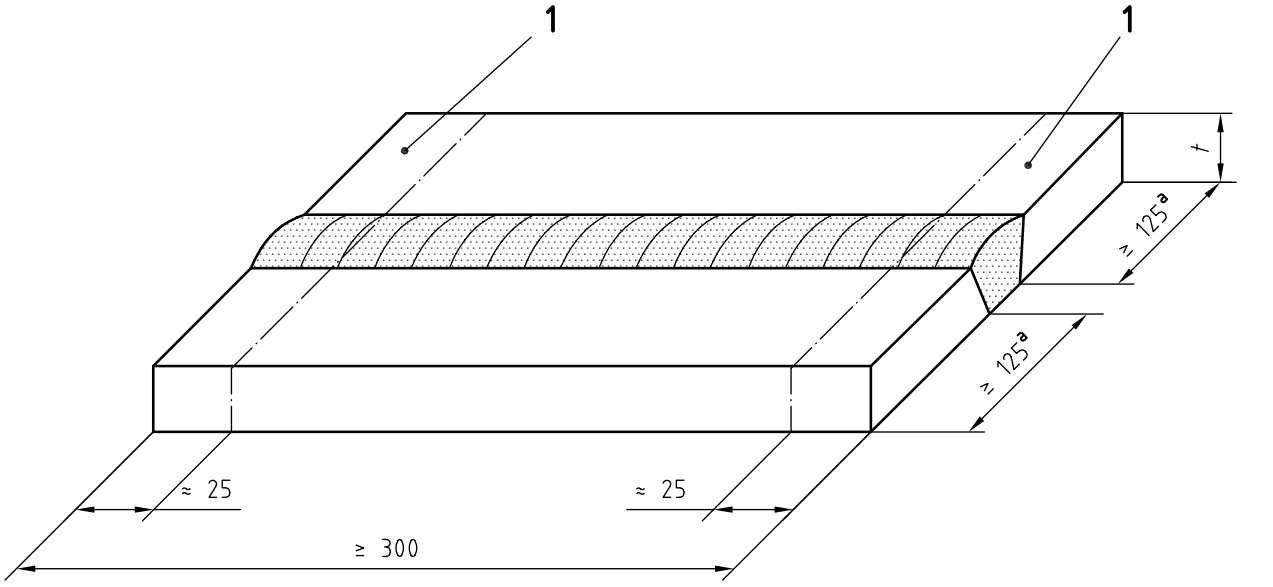
Table 1 — Symbols and abbreviated terms

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



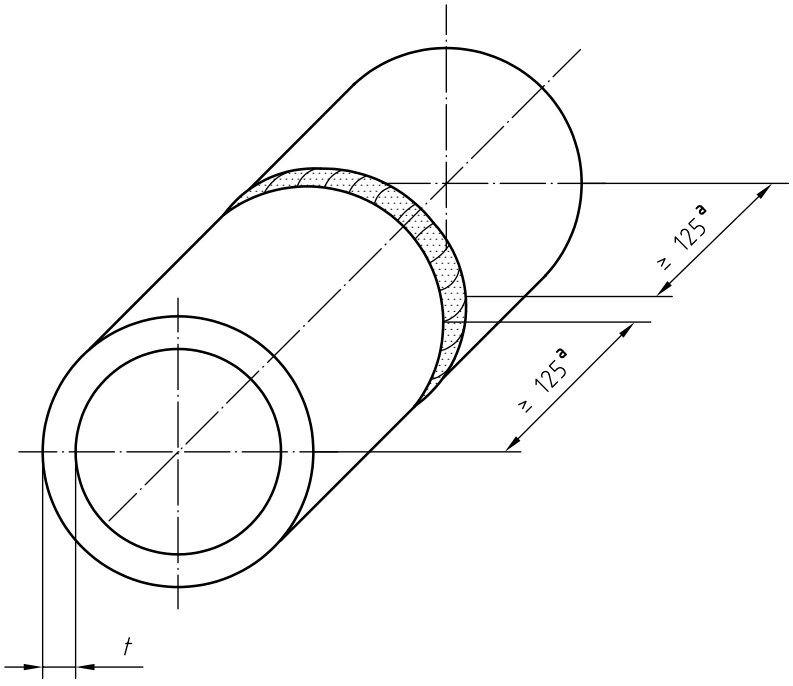
Key

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

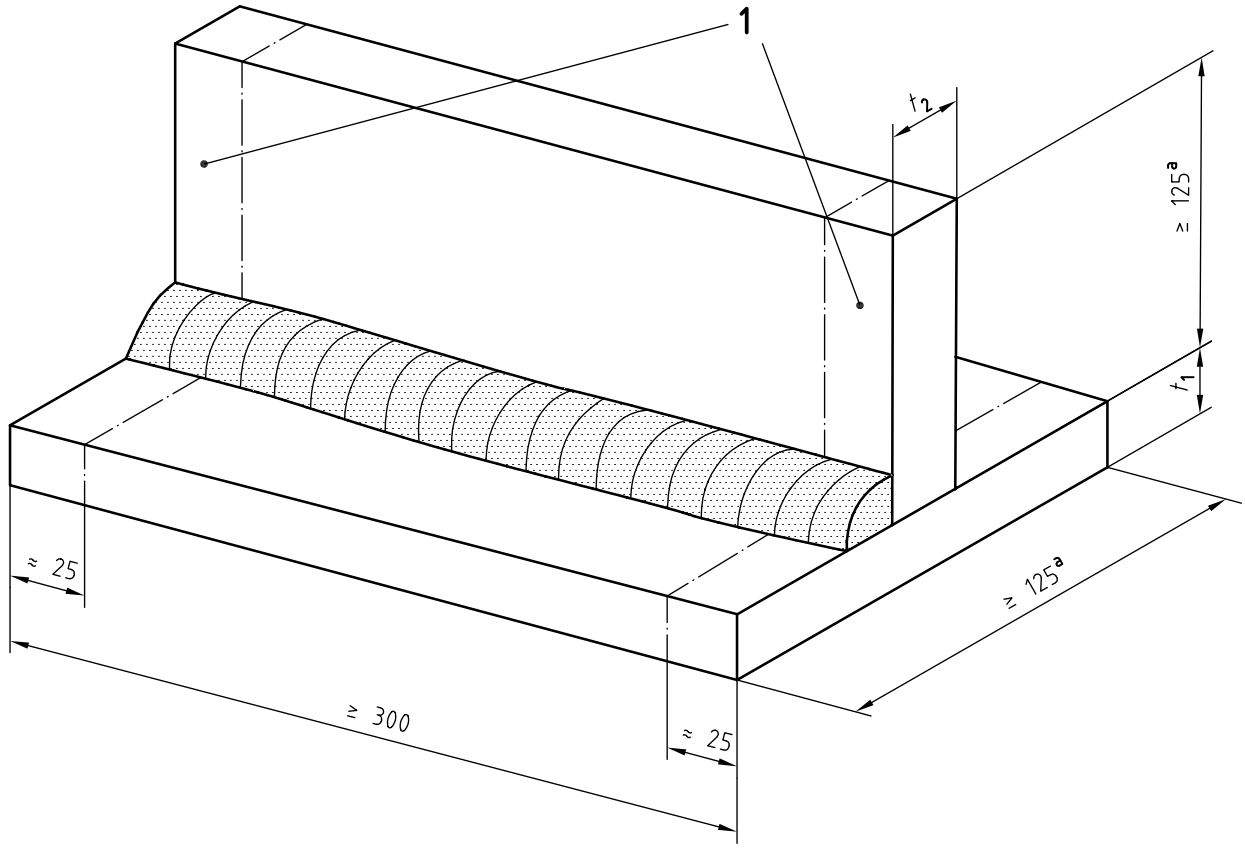
Dimensions in millimetres



Key

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

Figure 2 — Test piece for butt welds in pipe



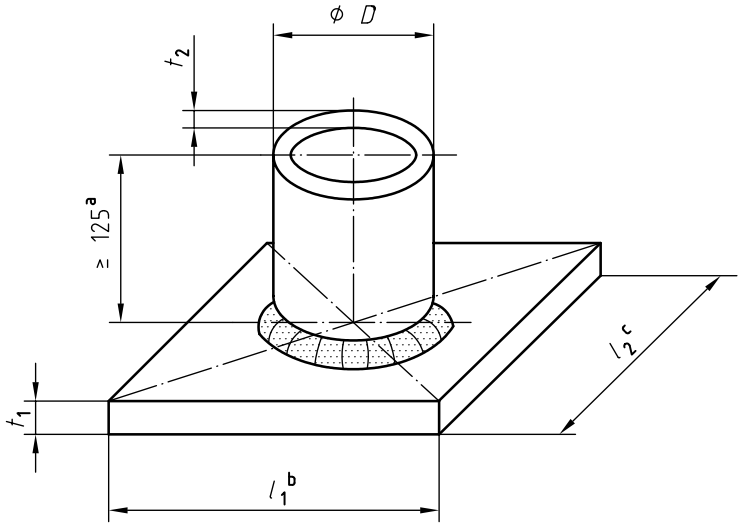
Key

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).

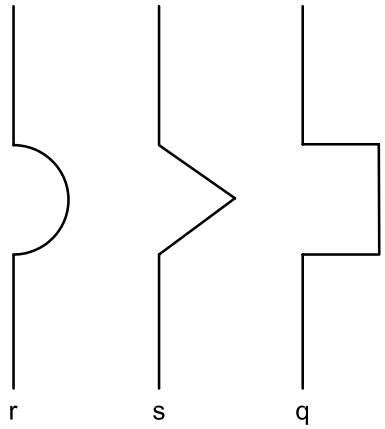
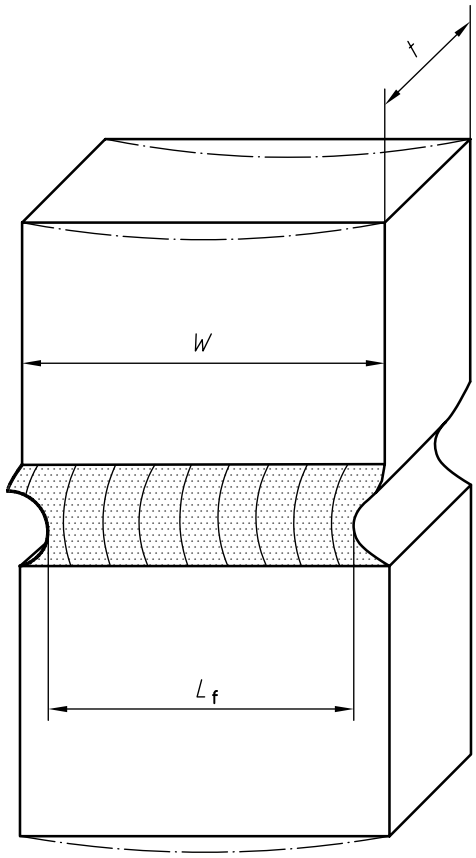
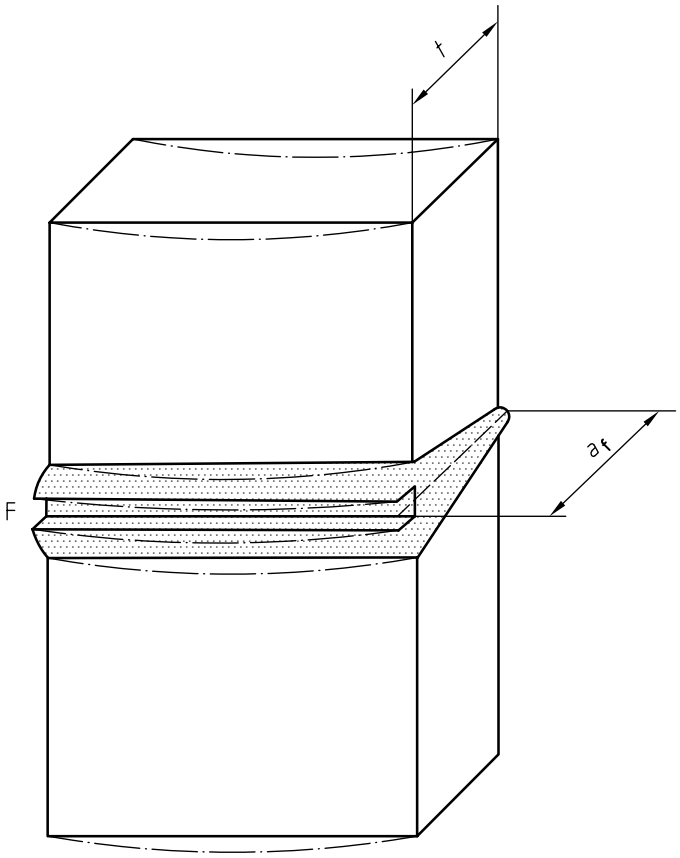


Figure 5 — Notch profiles

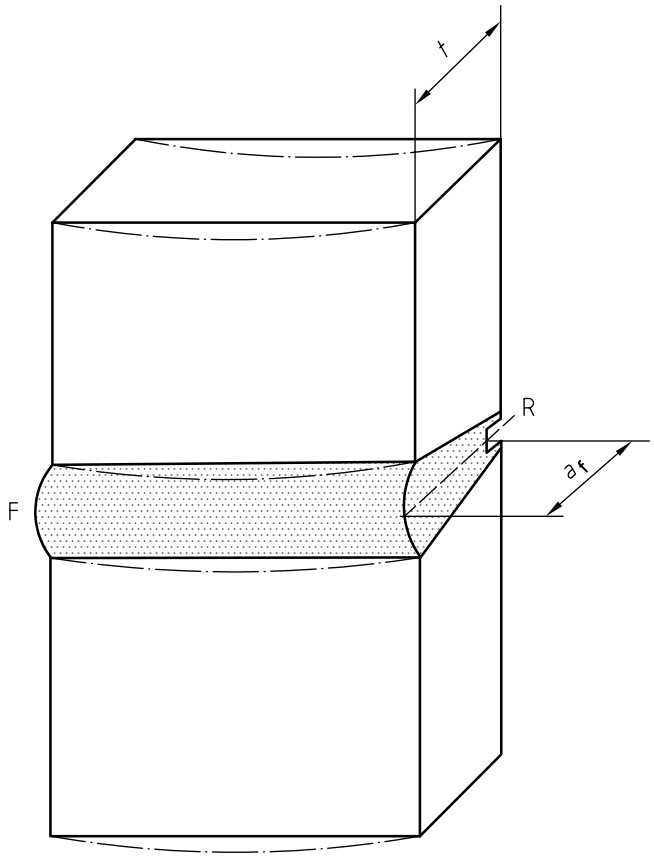


NOTE Full line for plates; chain dotted line for pipes.

Figure 6 — Side notches



a) Face notch



b) Root notch

NOTE Full line for plates; chain dotted line for pipes

Figure 7 — Longitudinal notches in butt welds

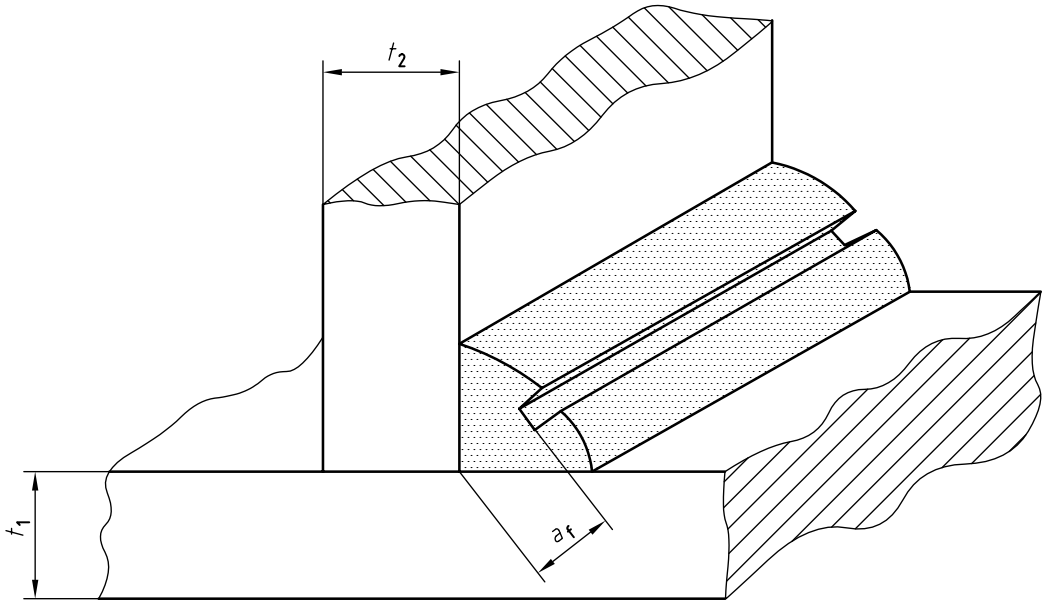


Figure 8 — Longitudinal notch in fillet welds

8 Test procedure

8.1 Butt welds

8.1.1 General

Fracture tests may be carried out by:

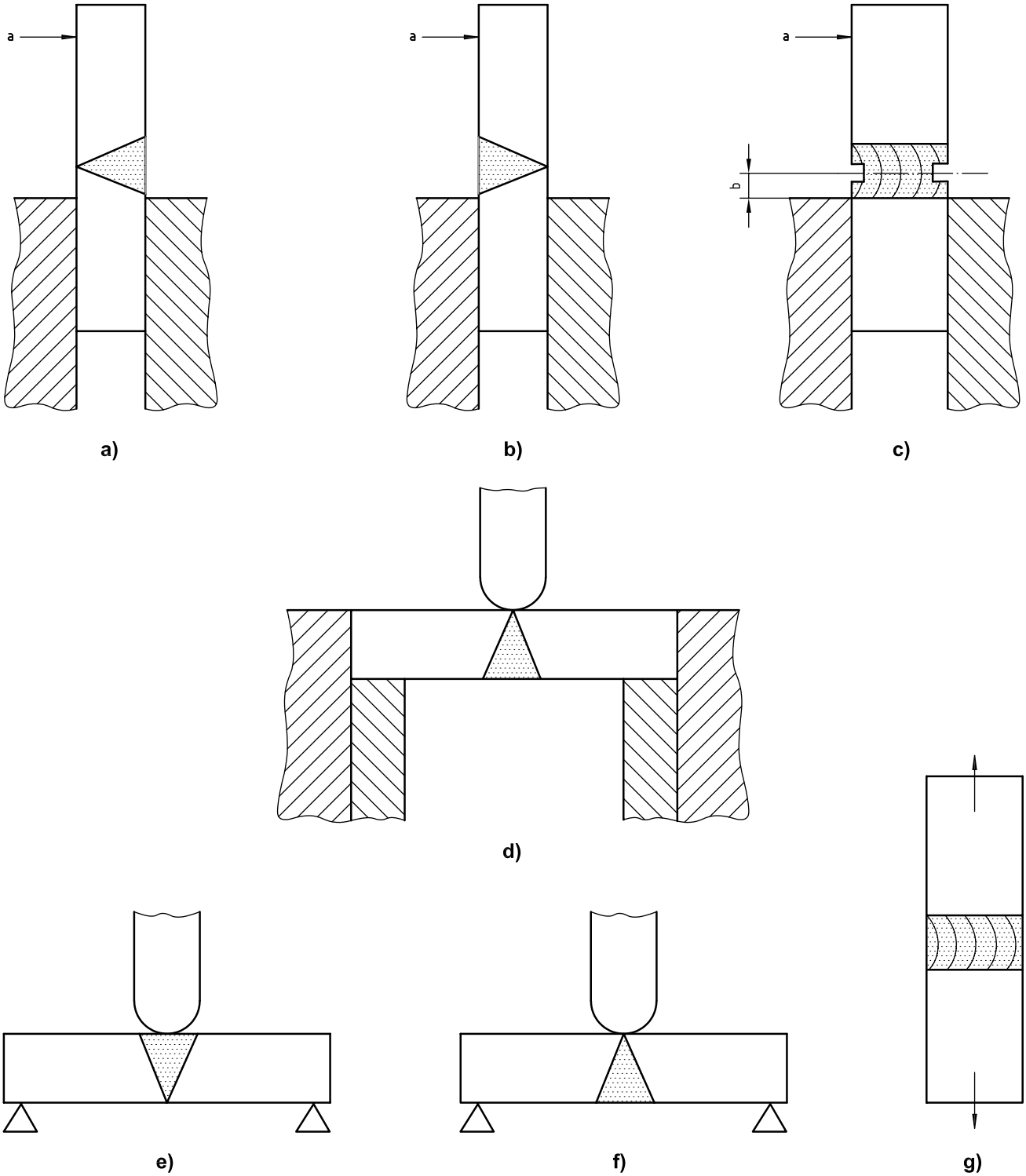
— dynamic strokes e.g. with a hammer, [see Figures 9 a) ,b) ,c)];

— applying a load by pressing in a vice, bending machine or workshop press [see Figures 9 d), e), f)];

— applying a load by tension [see Figure 9 g)].

For ductile materials, it can be useful to have a minimum distance between the notch and the jaws of the clamping device [see Figure 9 c)].

For some materials, it can be useful to test at a low temperature in order to initiate fracture.



Key

a Impact.

b See 8.1.1.

Figure 9 — Examples of test methods for butt welds (BW) (Notches according to **Figures 5** to 7)

8.1.2 Thin material

For fracturing thin welded joints alternate bending can be necessary. The limit depends on the ductility of the material. It shall be carried out by pressing the test specimen, close to the notch, in the jaws. If no fracture occurs, straightening and repeated bending shall follow.

Tension testing [see Figure 9 g)] may be also used instead of bending. Striking with a hammer is not recommended for fracture tests on thin materials.

8.1.3 Thick material

Thicker materials may be fractured by hammer strokes.

When a bending machine is used, the diameter of the former shall be chosen in such a way that the fracture occurs without the need for alternate bending.

Bending may be carried out either with the weld perpendicular or transverse to the direction of the applied force according to Figures 9 c), d), e), f). The lowest limit for the test for aluminium is approximately 8 mm thickness.

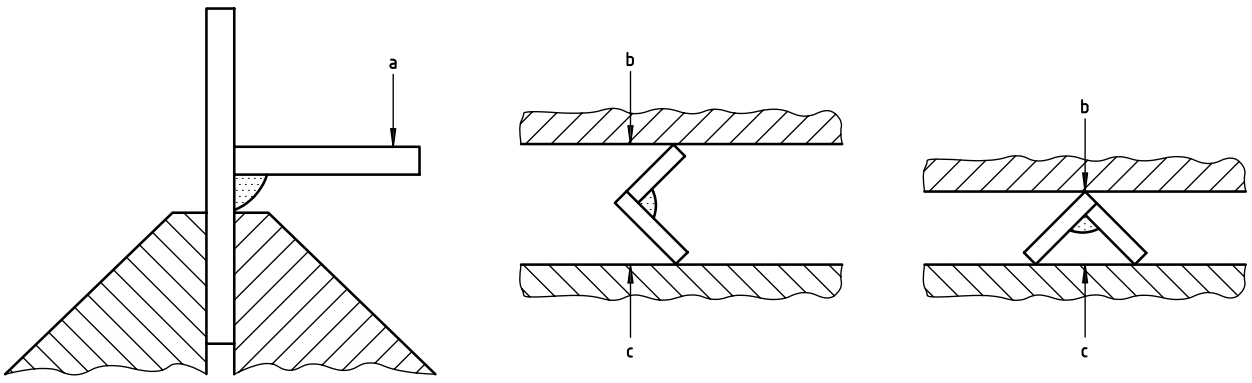
8.2 Fillet welds

Test methods are similar to those for butt welds (see 8.1) except that tension testing is not possible. Examples are given in Figure 10.

8.3 Special recommendations for ductile weld metals

For ductile weld metals such as austenitic steels, aluminium, copper, nickel and their alloys, it can be necessary to restrict the thickness of the test specimen and the throat thickness, increase the width of the notch, decrease the radius of the notch and increase the severity (stroke loading, hammer loading) of the test, if fracture is required in the weld metal.

For ductile weld metals such as ferritic steel, it can be necessary to cool the test specimen.



Key

a Stroke.

b Direction of movement.

c Movement, if applicable.

Figure 10 — Examples of test methods for fillet welds (FW) (Notches according to **Figures 5** and **8**)

9 Test result

The fracture surface shall be examined visually in accordance with ISO 17637. For clear detection and identification of imperfections a low magnifying glass (up to five times) may be used.

A full description of the appearance of the fracture surface and the type and location of any imperfection present shall be reported. It shall be stated that the quality has been evaluated in accordance with ISO 5817 or ISO 10042. The quality level is specified by the application standard or by agreement between the contracting parties.

10 Test report

The test report shall contain the following information:

a) a reference to this document, i.e. ISO 9017;

b) the identification of the test specimen;

c) the specimen denomination in accordance with Table 1;

d) records of types, locations and sizes of all unacceptable imperfections in accordance with the relevant quality level.

An example of a typical test report is given in Annex A.

Annex A
(informative)

Example of a test report

No. .....

According to pWPS .....

According to test result "fracture test"

test result "....."

Manufacturer: .....

Purpose of the examination: .....

Form of product: .....

Parent metal: .....

Consumable: .....

Denomination of test piece: .....

Table A.1 — Fracture test in accordance with ISO 9017

Test specimen	Denomination	Results	
		Type and size of imperfections	Quality level

Examiner or examining body: Certified by:

....

(name, date and signature) (name, date and signature)

Bureau of Indian Standards

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Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the website-www.bis.gov.in or www.standardsbis.in

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Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones: 2323 0131, 2323 3375, 2323 9402 *Website*: www.bis.gov.in

Regional Offices:		*Telephones*
Central	: 601/A, Konnectus Tower -1, 6th Floor, DMRC Building, Bhavbhuti Marg, New Delhi 110002	2323 7617
Eastern	: 8th Floor, Plot No 7/7 & 7/8, CP Block, Sector V, Salt Lake, Kolkata, West Bengal 700091	2367 0012 2320 9474
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