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Destructive tests on welds in metallic materials — Bend tests

Essais destructifs des soudures sur matériaux métalliques — Essais de pliage

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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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The committee responsible for this document is ISO/TC 44, *Welding and allied processes*, Subcommittee SC 5, *Testing and inspection of welds*.

This edition cancels and replaces the third edition (ISO 5173:2009+Amd 1:2011) which has been technically revised.

Destructive tests on welds in metallic materials — Bend tests

1 Scope

This International Standard specifies a method for making transverse root, face and side bend tests on test specimens taken from butt welds, butt welds with cladding (subdivided into welds in clad plates and clad welds) and cladding without butt welds, in order to assess ductility and/or absence of imperfections on or near the surface of the test specimen. It also gives the dimensions of the test specimen.

In addition, this International Standard specifies a method for making longitudinal root and face bend tests to be used instead of transverse bend tests for heterogeneous assemblies when base materials and/or filler metal have a significant difference in their physical and mechanical properties in relation to bending.

This International Standard applies to metallic materials in all forms of product with welded joints made by any welding process.

2 Terms and definitions

For the purposes of this document, the following apply

2.1

transverse face bend test specimen for a butt weld

TFBB

specimen for which the surface in tension is the side that contains the greater width of the weld or the side from which the welding arc was first applied, applicable to transverse butt weld specimens

See Figure 1.

2.2

transverse root bend test specimen for a butt weld

TRBB

specimen for which the surface in tension is the side opposite to that of the face butt weld bend test specimen, applicable to transverse butt weld specimens

See Figure 2.

2.3

transverse side bend test specimen for a butt weld

SBB

specimen for which the surface in tension is a cross-section of the weld

See Figure 3.

2.4

longitudinal face test specimen for a butt weld root bend test specimen for a butt weld

LFBB

LRBB

specimen whose direction is parallel to butt weld direction, applicable to face and root bend specimens

See Figure 4.

2.5

face bend test specimen for cladding without a butt weld

FBC

specimen for which the cladding is in tension, applicable to both transverse and longitudinal specimens

See Figure 5.

2.6

side bend test specimen for cladding without a butt weld

SBC

specimen for which the cross-section of the cladding overlay is in tension, applicable to both transverse and longitudinal specimens

See Figure 6.

2.7

face bend test specimen for cladding with a butt weld side bend test specimen for cladding with a butt weld

FBCB

SBCB

specimen for which the cladding is in tension and for which the cross-section of the cladding overlay is in tension and which contains a butt weld

See Figures 7 and 8.

3 Principle

Submitting a test specimen, taken transversely or longitudinally from a welded joint, to plastic deformation by bending it, without reversing the bending direction, in such a way that one of the surfaces or cross-sections of the welded joint is in tension.

Unless otherwise specified, the test shall be carried out at an ambient temperature of between 10 °C and 35 °C. Tests carried out under controlled conditions, where required, shall be made at temperature of $(23 \pm 5) ^\circ\text{C}$.

The test shall be made in accordance with one of the methods described in Clause 6.

4 Symbols and abbreviated terms

4.1 Symbols

See Table 1 and Figures 1 to 15.

4.2 Abbreviated terms

TFBB	Transverse face bend test specimen for a butt weld
TRBB	Transverse root bend test specimen for a butt weld
SBB	Transverse side bend test specimen for a butt weld
LFBB	Longitudinal face bend test specimen for a butt weld
LRBB	Longitudinal root bend test specimen for a butt weld
FBC	Face bend test specimen for cladding without a butt weld
SBC	Side bend test specimen for cladding without a butt weld
FBCB	Face bend test specimen for cladding with a butt weld
SBCB	Side bend test specimen for cladding with a butt weld

Table 1 — Symbols and designations

Symbol	Designation	Unit
A	minimum percentage elongation after fracture required by the material specification	%
b	width of the test specimen	mm
b_1	width of outside fusion line	mm
d	diameter of the former or the inner roller ^a	mm
D	outside diameter of the pipe ^a	mm
l	distance between the rollers	mm
L_f	initial distance between contact of the roller and the centre line of the weld	mm
L_o	original gauge length	mm
L_s	maximum width of the weld after machining	mm
L_t	total length of the test specimen	mm
r	radius of the test specimen edges	mm
R	radius of the rollers	mm
t	thickness of the test piece	mm
t_c	thickness of the cladding	mm
t_s	thickness of the test specimen	mm
t_w	thickness of base material under cladding	mm
α	bending angle	°
^a The term “pipe”, alone or in combination, is used to mean “pipe”, “tube” or “hollow section (without rectangular cross section)”.		

4.3 Figures corresponding to the abbreviations

Figures 1 to 8 represent bend test specimens for butt welds and cladding.

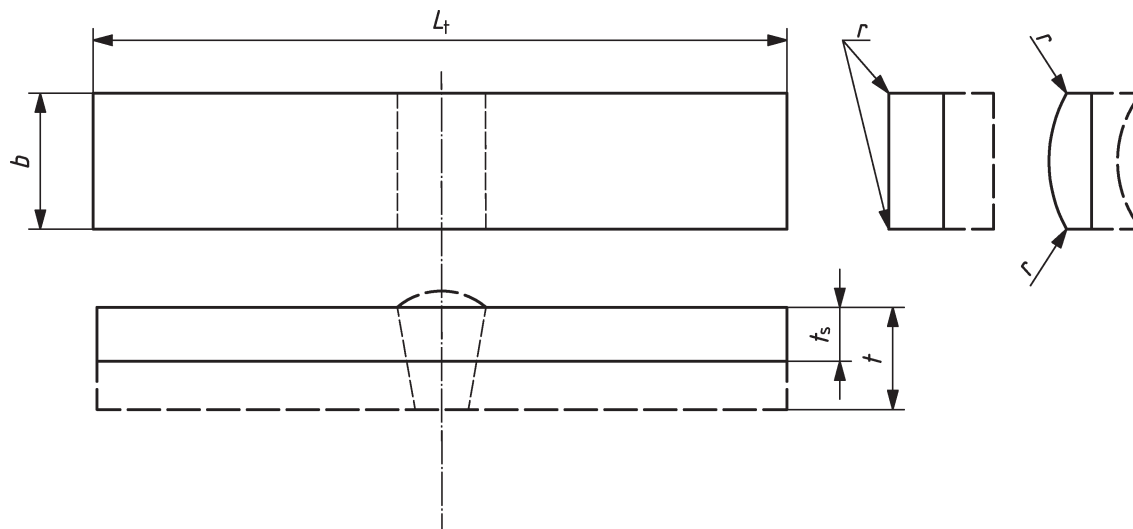


Figure 1 — Transverse face bend test specimen for a butt weld (TFBB)

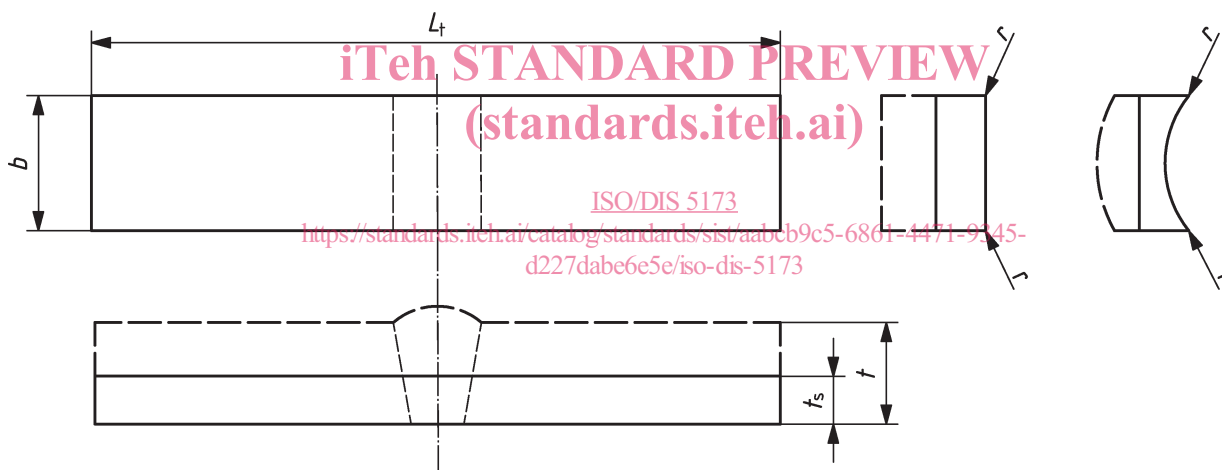


Figure 2 — Transverse root bend test specimen for a butt weld (TRBB)

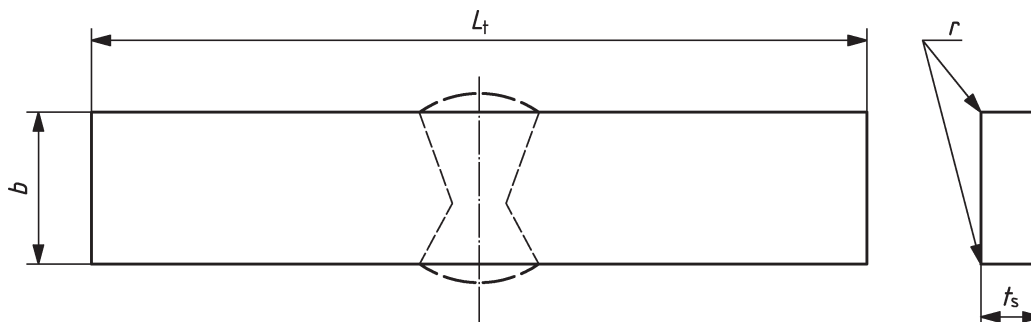


Figure 3 — Transverse side bend test specimen for a butt weld (SBB)

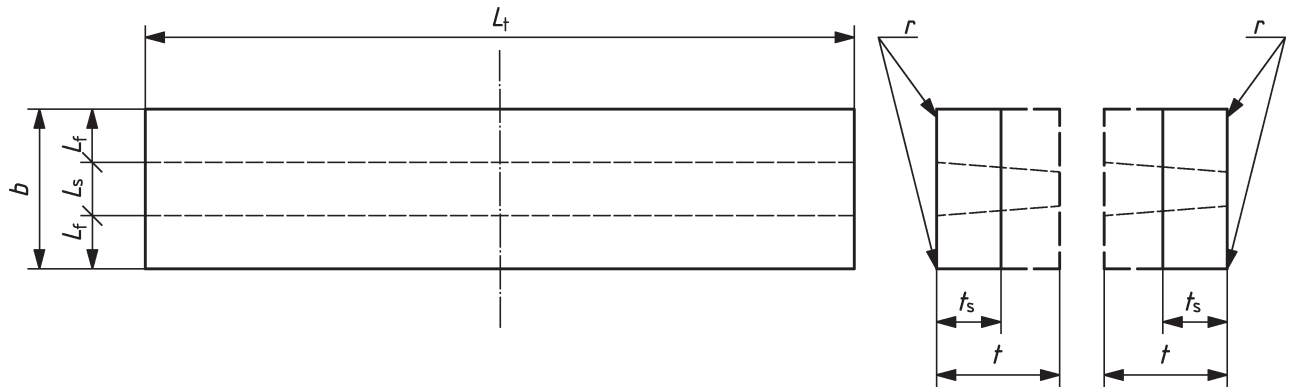


Figure 4 — Longitudinal bend test specimen for a butt weld (LFBB and LRBB)

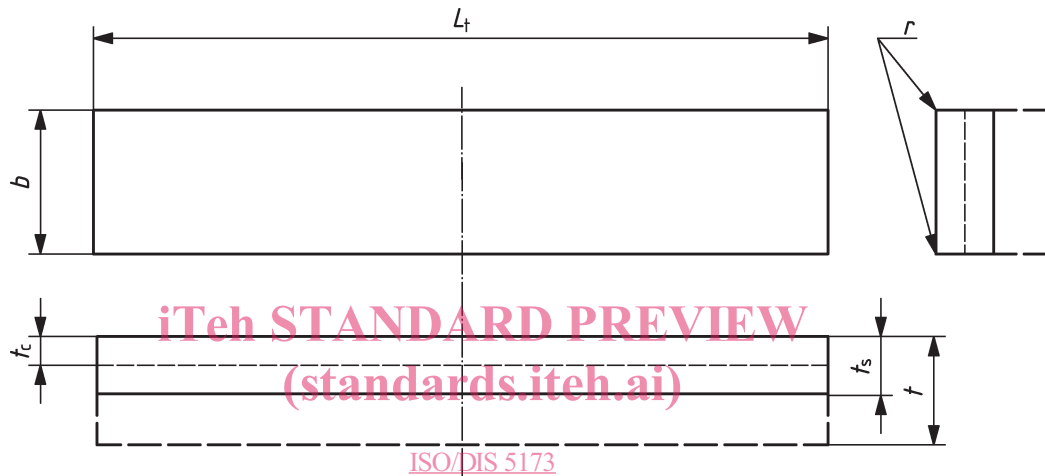


Figure 5 — Face bend test specimen for cladding without a butt weld (FBC)

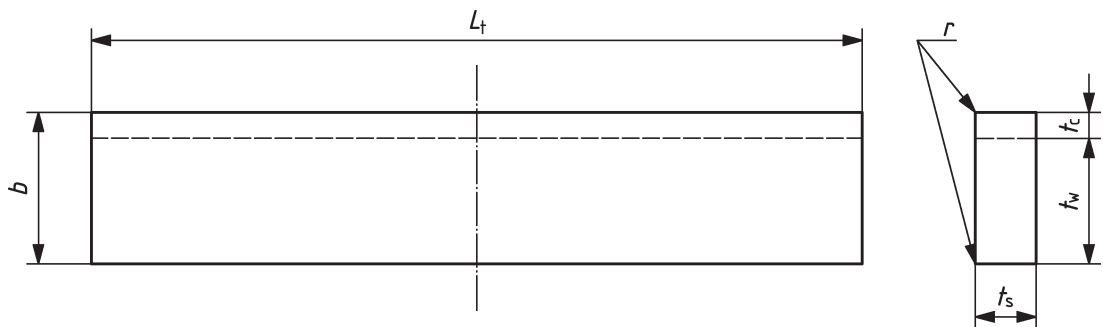


Figure 6 — Side bend test specimen for cladding without a butt weld (SBC)

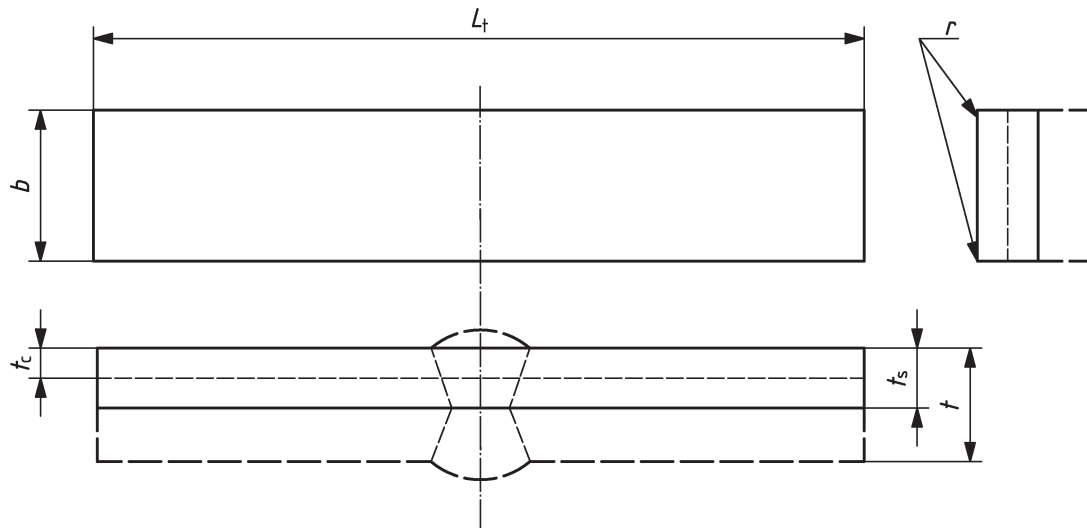


Figure 7 — Face bend test specimen for cladding with a butt weld (FBCB)

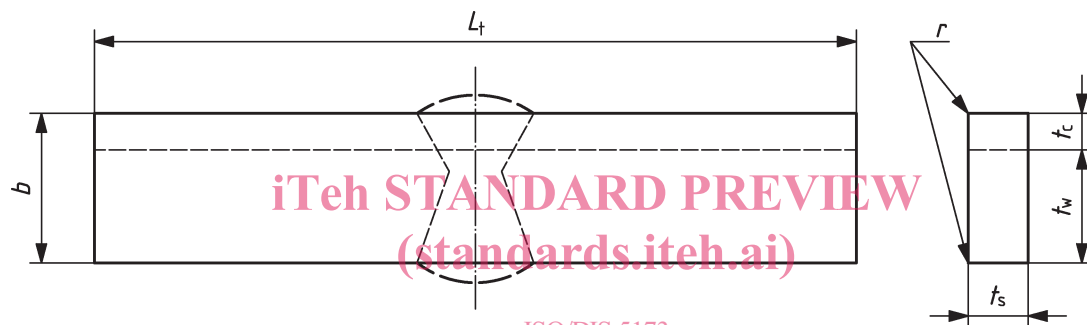


Figure 8 — Side bend test specimen for cladding with a butt weld (SBCB)

5 Preparation of test specimens

5.1 General

Specimens shall be prepared in such a manner that the preparation does not affect either the base material or the weld metal.

5.2 Location

For transverse bend testing of butt welds, the test specimen shall be taken transversely from the welded joint of the manufactured product or from the welded test piece in such a way that after machining the weld axis will remain in the centre of the test specimen or at a suitable position for testing.

For longitudinal bend testing of butt welds, the test specimen shall be taken longitudinally from the welded joint of the manufactured product or from the welded test piece.

The location and orientation of bend test specimens of cladding material shall be specified by the application standard or by agreement between the contracting parties.

5.3 Marking

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

If required by the relevant application standard, the direction of working (e.g. rolling or extrusion) shall be marked.

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

5.4 Heat treatment and/or ageing

No heat treatment shall be applied to the welded joint or to the test specimen unless it is specified or permitted by the relevant application standard dealing with the welded joint to be tested. Details of any heat treatment shall be recorded in the test report. If natural ageing of aluminium alloys takes place, the time between welding and testing shall be recorded.

5.5 Extraction

5.5.1 General

The mechanical or thermal processes used to extract the test specimen shall not change the properties of the test specimen in any way. It is permissible to mechanically remove any material that is affected by thermal cutting provided the finished dimensions of the specimens required by this International Standard are met.

5.5.2 Steel

Shearing shall not be used for thicknesses > 8 mm. If thermal cutting or other cutting methods which could affect the cut surfaces are used to extract the test specimen from the welded plate, or from the test piece, the cuts shall be made at a distance ≥ 3 mm from the test specimen but in any case sufficient (depending on the process used) not to introduce metallurgical effects which could affect the test results.

5.5.3 Other metallic materials

Sheared or thermal cut surfaces are not permitted on bend specimens; only machining (e.g. sawing, grinding or milling) shall be used.

5.6 Specimen size

5.6.1 Transverse root and face bend tests of a butt weld (TFBB and TRBB)

See Figures 1, 2 and 9.

For transverse root and face bend tests, the test specimen thickness, t_s , shall be equal to the thickness of the base material adjacent to the welded joint up to a maximum thickness of 30 mm. If the test piece thickness, t , is greater than 10 mm, the test specimen thickness, t_s , may be machined or otherwise mechanically finished from one side to a thickness equal to $(10 \pm 0,5)$ mm as indicated in Figures 1 and 2. The face or root of the weld shall be in tension when the specimen is bent.

When a relevant application standard requires testing of a full thickness > 10 mm, several test specimens may be taken in order to cover the full thickness of the joint as indicated in Figure 9.