British Standard

BRITISH STANDARD

BS EN
910 : 1996

Destructive tests on welds in metallic materials — Bend tests

The European Standard EN 910 : 1996 has the status of a British Standard

ICS 25.160.40

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee WEE/2, Welding tests, upon which the following bodies were represented:

Aluminium Federation
Association of Consulting Scientists
British Constructional Steelwork Association Ltd.
British Iron and Steel Producers' Association
Electricity Association
Health and Safety Executive
Institution of Structural Engineers
Lloyd's Register of Shipping
Ministry of Defence
Power Generation Contractors' Association (PGCA (BEAMA Ltd.))
Welding Institute
Welding Manufacturers' Association (BEAMA Ltd.)

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Contents

National foreword

This British Standard has been prepared by Technical Committee WEE/2 and is the English language version of EN 910 : 1996 *Destructive tests on welds in metallic materials — Bend tests* published by the European Committee for standardization (CEN).

EN 910 was produced as a result of international discussions in which the United Kingdom took an active part.

BS EN 910 : 1996 supersedes tests detailed in BS 709 : 1983, BS 4206 : 1967 and BS 3451 : 1973 which have been deleted by amendment.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 910

March 1996

ICS 25.160.40

Descriptors: Welding, welded joints, butt joints, metals, bend tests, testing conditions, test specimen, dimensions, designation

English version

Destructive tests on welds in metallic materials — Bend tests

Essais destructifs des soudures sur matériaux métalliques — Essais de pliage

Zerstörende Prüfungen von Schweißnähten an metallischen Werkstoffen — Biegeprüfungen

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Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

Ref. No. EN 910 : 1996 E

Foreword

This European Standard has been prepared by the Technical Committee CEN/TC 121, Welding, of which the secretariat is held by DS.

This European Standard shall be given the status of a national standard, either by publication of an identical test or by endorsement, at the latest by September 1996, and conflicting national standards shall be withdrawn at the latest by September 1996.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Contents

1 Scope

This 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 to the surface of the joint. It also gives the dimensions of the test specimen.

In addition this 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 standard applies to metallic materials in all forms of product with welded joints made by any fusion arc welding process. Side bend tests may be carried out when the wall thickness is greater than 12 mm.

2 Definitions

For the purpose of this European Standard, the following definitions apply:

2.1 face bend test specimen of butt weld (FBB)

A specimen for which the surface in tension is the side which contains the larger width of the weld or the side from which the welding arc was first applied.

This applies to both transverse (see figure 1a) or longitudinal (see figure 1c) butt welds specimens.

2.2 root bend test specimen of butt weld (RBB)

A specimen for which the surface in tension is the side opposite to the face butt weld bend test specimen.

This also applies to both transverse (see figure 1a) or longitudinal (see figure 1c) butt welds specimens.

2.3 transverse side bend test specimen of butt weld (SBB)

A specimen for which the surface in tension is a cross-section of the weld (see figure 1b).

2.4 face bend test specimen of cladding without a butt weld (FBC)

A specimen for which the cladding is in tension (see figure 1d).

This applies to both transverse or longitudinal specimens.

2.5 side bend test specimen of cladding without a butt weld (SBC)

A specimen for which the cross-section of the cladding overlay is in tension (see figure 1e).

This applies to both transverse or longitudinal specimens.

2.6 face or side bend test specimen of cladding with a butt weld (FBCB or SBCB)

A specimen for which the cladding is in tension or for which the cross-section of the cladding overlay is in tension and which contains a butt weld (see figure 1f and figure 1g).

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 ambient temperature (23 ± 5) °C.

The test shall be made according to one of the methods described in clause **6**.

4 Denominations and symbols

The denominations and symbols to be used for the bending tests are specified in table 1 and represented in figures 1 to 3.

5 Removal of test specimens

5.1 Removal

For transverse bend test of butt welds the test specimen shall be removed 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 test of butt welds the test specimen shall be removed longitudinally from the welded joint of the manufactured product or from the welded test piece.

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

5.2 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.

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

5.3 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 allowed 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.

Table 1. Denominations and symbols

Symbol	Denomination	Unit
a	Thickness of the test specimen	mm
b	Width of the test specimen	mm
b_1	Width of outside fusion line	mm
c	Thickness of the cladding	mm
D	Outside diameter of the pipe[1)]	mm
d	Diameter of the former	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 rollers	mm
r	Radius of the test specimen edges	mm
t	Thickness of the welded joint or base material under cladding	mm
α	Bending angle	° (degrees)
FBB	Face bend test specimen of butt weld	not applicable
RBB	Root bend test specimen of butt weld	not applicable
SBB	Transverse side bend test specimen of butt weld	not applicable
FBC	Face bend test specimen of cladding without a butt weld	not applicable
SBC	Side bend test specimen of cladding without a butt weld	not applicable
FBCB	Face bend test specimen of cladding with a butt weld	not applicable
SBCB	Side bend test specimen of cladding with a butt weld	not applicable

[1)] The term 'pipe', alone or in combination, is used to mean 'pipe', 'tube' or 'hollow section (without rectangular cross-section)'.

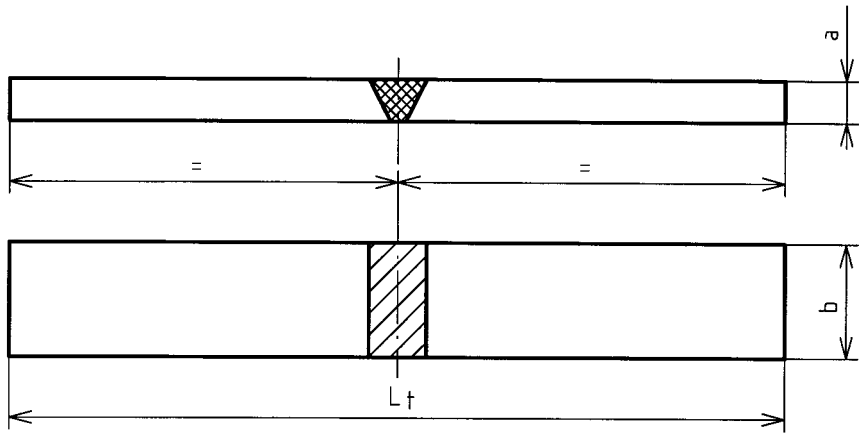


Figure 1a. Transverse root and face bend test specimen of a butt weld (RBB and FBB)

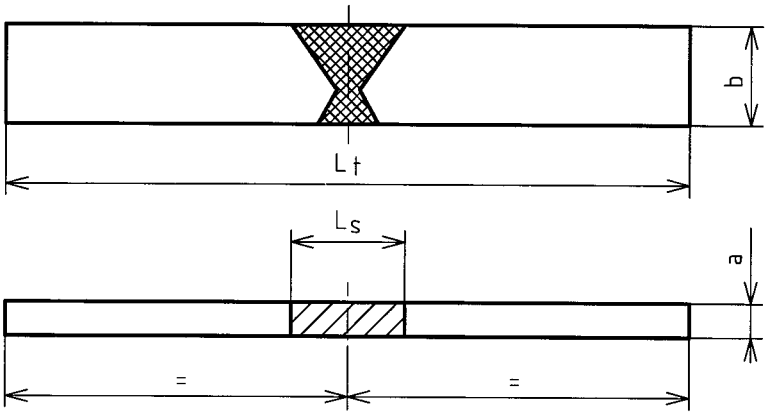


Figure 1b. Transverse side bend test specimen of a butt weld (SBB)

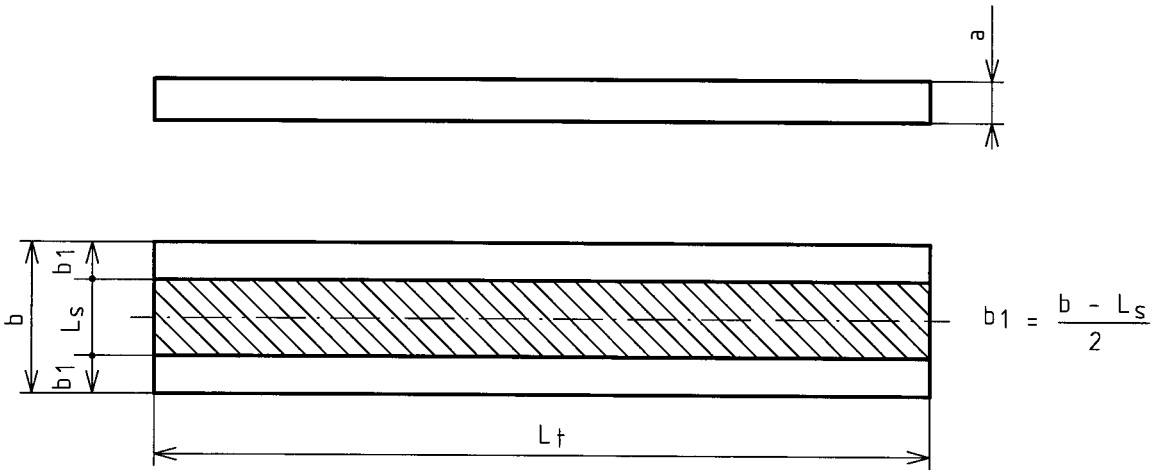


Figure 1c. Longitudinal bend test specimen of a butt weld (RBB and FBB)

NOTE. The radius 'r' shall be made on the side where the surface is in tension.

Figure 1. Bend test specimens on butt weld and cladding

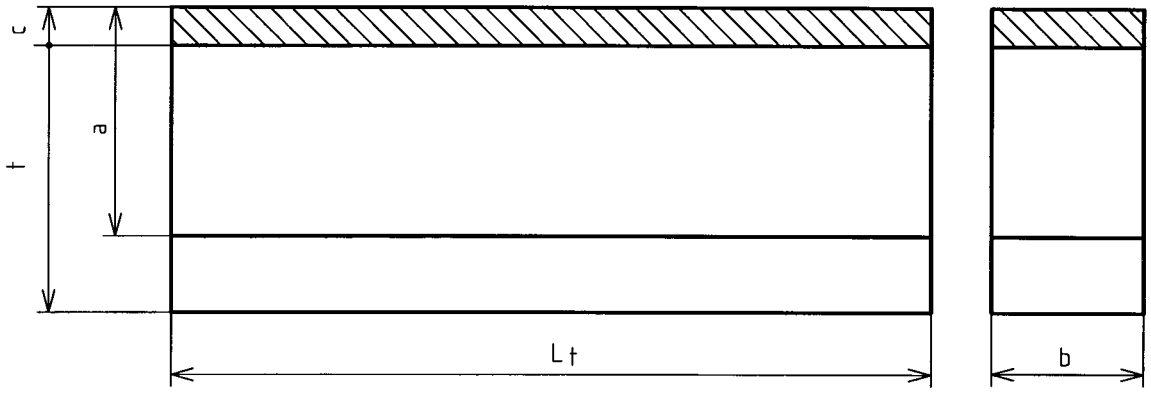


Figure 1d. Face bend test specimen of cladding without a butt weld (FBC)

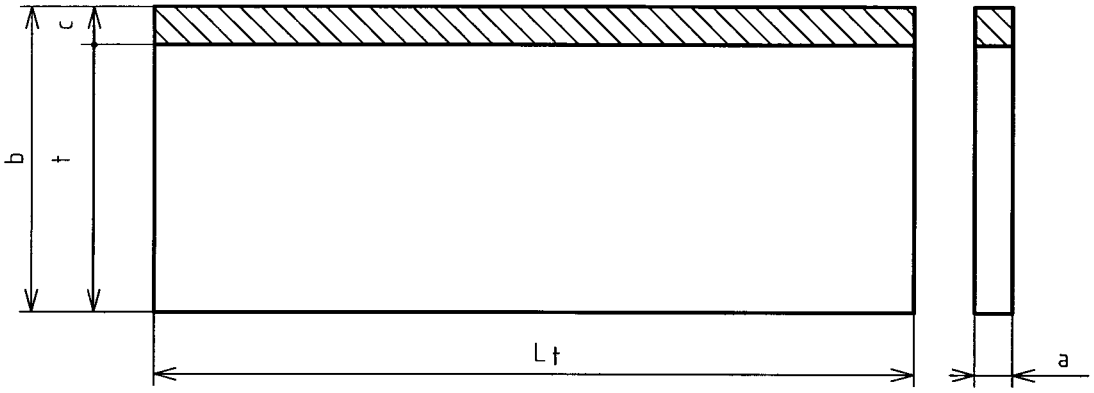


Figure 1e. Side bend test specimen of cladding without a butt weld (SBC)

NOTE. The radius 'r' shall be made on the side where the surface is in tension.

Figure 1. Bend test specimens on butt weld and cladding *(continued)*

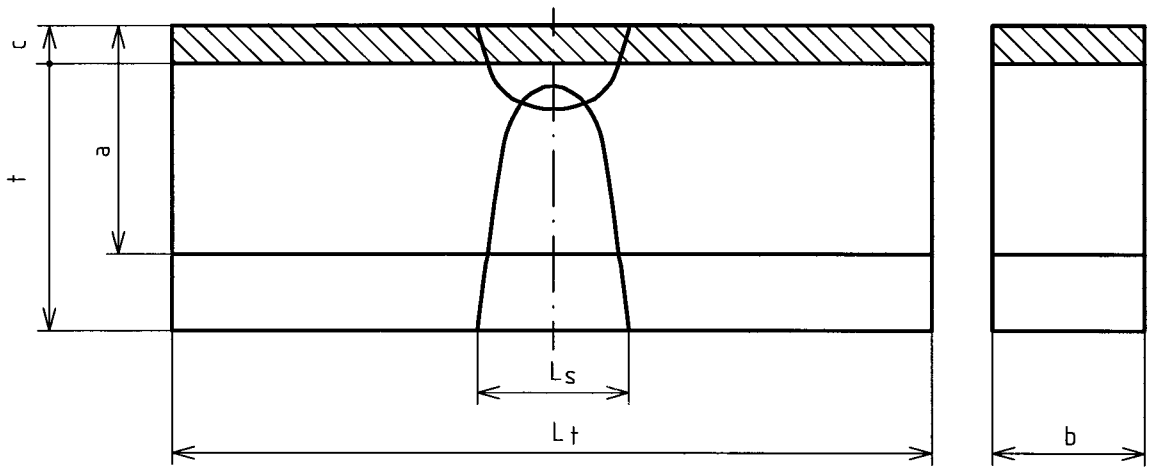


Figure 1f. Face bend test specimen of cladding with a butt weld (FBCB)

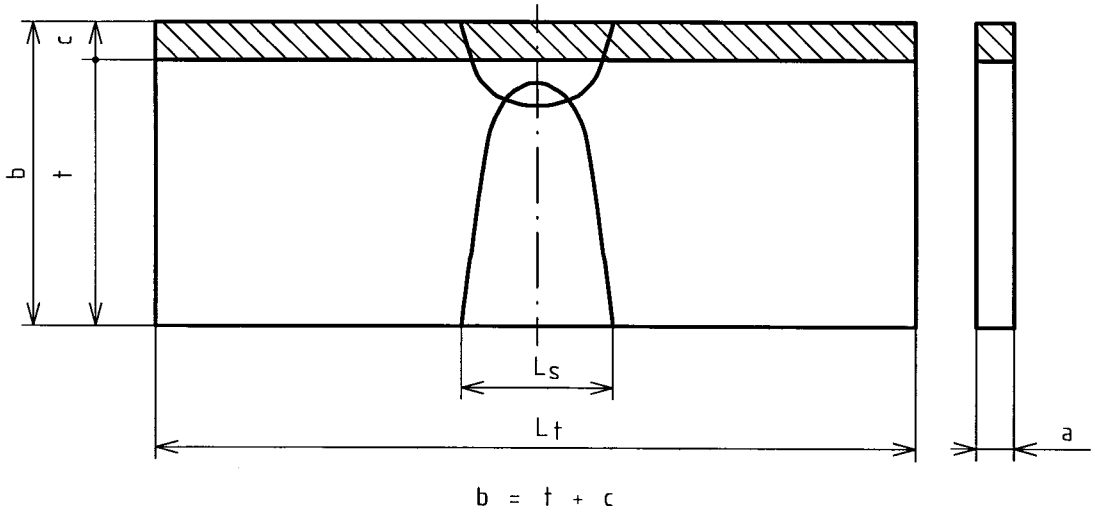


Figure 1g. Side bend test specimen of cladding with a butt weld (SBCB)

NOTE. The radius 'r' shall be made on the side where the surface is in tension.

Figure 1. Bend test specimens on butt weld and cladding *(concluded)*

5.4 Extraction

5.4.1 *General*

The mechanical or thermal processes used to extract the test specimen shall not change the properties of the test specimen in any way.

5.4.2 *Steel*

Shearing is excluded for thicknesses greater than 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 greater than or equal to 8 mm from the test specimen but in any case sufficient (according to the process used) not to introduce metallurgical effects which could affect the test results.

5.4.3 *Other metallic materials*

Shearing and thermal cutting are excluded, only machining (e.g. sawing or milling) shall be used.

5.5 Preparation of specimens

5.5.1 *General*

Specimens should be prepared in such a manner that the preparation shall not affect both the base material and weld metal.

5.5.2 *Location*

5.5.2.1 *Transverse root and face bend tests of a butt weld (RBB and FBB) (see figure 2a)*

For transverse root and face bend tests the test specimen thickness, *a*, shall be equal to the thickness of the base material adjacent to welded joint.

When a relevant application standard requires testing of the full thickness greater than 30 mm, several test specimens may be taken to cover the full thickness of the joint.

In these cases, the location of the test specimen in the welded joint thickness shall be identified.

5.5.2.2 *Transverse side bend tests of a butt weld (SBB) (see figure 2b)*

For side bend tests the test specimen width, b, shall be equal to the thickness of the base material of the welded joint. The specimen shall have at least a thickness, a, of $(10 \pm 0{,}5)$ mm and have a ratio $b \geq 1{,}5a$.

The ratio between the thickness, a, and the diameter of the former, d, shall conform to the requirements of the relevant application standard.

When the joint thickness exceeds 40 mm, it is permissible to take several specimens from the welded joint, instead of one, provided the width, b, of each test specimen is in the range from 20 mm to 40 mm. In these cases the location of the test specimen in the welded joint thickness shall be identified.

5.5.2.3 *Longitudinal bend tests of a butt weld (RBB and FBB) (see figure 2c)*

For longitudinal bend tests the test specimen thickness, a, shall be equal to the thickness of the base material near the welded joint. If the test piece thickness, t, is greater than 12 mm, the test specimen thickness, a, shall be equal to $(12 \pm 0{,}5)$ mm and the face or root of the weld shall be in tension.

5.5.2.4 *Face bend tests of cladding without a butt weld (FBC) (see figure 2d)*

For face bend tests the test specimen thickness, a, shall be equal to the thickness of the base material plus the thickness of the cladding up to a maximum of 30 mm.

When the thickness of the base material plus cladding exceeds 30 mm, it is permissible to remove material from the base material to produce a test specimen thickness, a, that is in accordance with the application standard or as agreed between the contracting parties.

5.5.2.5 *Side bend tests of cladding without a butt weld (SBC) (see figure 2e)*

For side bend tests the test specimen width, b, shall be equal to the thickness of the base material plus the thickness of the cladding up to a maximum of 30 mm. The specimen shall have at least a thickness, a, of $(10 \pm 0{,}5)$ mm and have a ratio of $b \geq 1{,}5a$.

When the thickness of the base material plus cladding exceeds 30 mm, it is permissible to remove material from the base material to produce a test specimen width, b, that is in accordance with the application standard or as agreed between the contracting parties.

5.5.2.6 *Transverse face bend tests of cladding with a butt weld (FBCB) (see figure 2f)*

For transverse face bend tests of cladding with a butt weld the test specimen thickness, a, shall be equal to the thickness of the base material plus the thickness of the cladding.

In this case, the location of the weld shall remain in the middle of the test specimen or at a suitable position for testing.

When the purpose of the test is the complete joint incorporating both the butt joint and the cladding and when the thickness of the joint exceeds 30 mm, several specimens may be taken as described in **5.5.2.1** and figure 1a.

When the purpose of the test is the cladding only and when the thickness of the specimen, a, exceeds 30 mm, no further tests on the base material are required.

5.5.3 ***Dimensions***

5.5.3.1 *Length*

The length L_t of test specimens shall be $L_t \geq l + 2R$ and at least be such that the requirements of the appropriate application standards are fulfilled.

5.5.3.2 *Thickness*

For the thickness, a, see **5.5.2**.

5.5.3.3 *Width*

a) Transverse root or face bend tests:

1) For plates

– for steel, the width b of the test specimen shall not be less than 1,5 times a, with a minimum of 20 mm;

– for aluminium, copper and their alloys, the width b of the test specimen should be not less than $2a$, with a minimum of 20 mm.

2) For pipes, the width b of the test specimen shall be at minimum:

– for pipe diameters $\leq$ 50 mm: $t + 0{,}1D$ (with a minimum of 8 mm);

– for pipe diameters > 50 mm: $t + 0{,}05D$ (with a minimum of 8 mm and a maximum of 40 mm).

NOTE. For outside diameter, D, greater than 25 times the wall thickness of the pipe, the specimen may be taken as required for the flat plates.

b) Transverse side bend tests:

The width b of the test specimen shall generally be equal to the thickness of the base material near the welded joint.

c) Longitudinal bend tests:

The width b of the test specimen shall be:

$b = L_s + 2b_1$ (see table 2)

Table 2. Width of longitudinal bend specimen

Dimensions in mm

Material	a	b (see figure 1c)
Steel	≤ 20	$L_s + 2 \times 10$
	> 20	$L_s + 2 \times 15$
Aluminium, copper and their alloys	≤ 20	$L_s + 2 \times 15$
	> 20	$L_s + 2 \times 20$
The width of the specimen for other metallic materials is by agreement between the contracting parties.		

5.5.3.4 *Edges*

The edges of the test specimen on the face in tension shall be rounded by mechanical means to a radius r not exceeding $0{,}2a$ to a maximum of 3 mm (see figure 3a).

5.5.3.5 *Surface preparation*

The final stages of preparation shall be obtained by machining or grinding, suitable precautions being taken to avoid superficial strain hardening or excessive heating of the material. Within the length l (see figure 3) the surface shall be free from scratches or notches transverse to the test specimen direction except for undercut which shall not be removed unless required by the relevant application standard and/or by agreement between the contracting parties.

The surfaces of the test specimen shall be machined in such a way that, unless otherwise specified in the relevant application standard and/or by agreement between the contracting parties, all excess weld metal is removed. Unless otherwise specified the penetration bead may be left intact inside pipes of small diameter on the opposite side of the former.

6 Conditions of testing

6.1 Etching

Before starting the bend test, the shape and the position of the fusion zone or fusion line may be established by lightly macroetching the surface of the test specimen to be tested in tension.

6.2 Testing

6.2.1 *Testing with a former (see figure 3)*

The test shall be carried out by placing the test specimen on two supports consisting of parallel rollers, the weld shall be in the centre of the roller distance, except for longitudinal bend tests. The test specimen shall be bent by loading gradually and continuously in the middle of the span, on the axis of the weld, with a load applied by a former (three point bending) perpendicularly to the test specimen surface.

6.2.2 *Testing with a roller (see figure 4)*

The guided bend test with a roller is an alternative method of testing that may be used for aluminium alloys and for joints in other materials where the weld metal, or one of the materials being joined, has a lower yield or proof strength than the (other) base material.

The test shall be carried out by firmly clamping one end of the test specimen in a testing device having a roller parallel to a former. The test specimen shall be bent by loading, gradually and continuously by means of the rotation of the outer roller through an arc centred on the axis of the former.

6.3 Diameter of former and roller

The diameter d of the former shall conform to the requirements of the relevant application standard.

The diameter of the roller shall be at least 20 mm unless otherwise specified in the relevant application standard.

6.4 Distance between rollers

The distance l (see figure 3) between rollers shall be between $d + 2a$ and $d + 3a$.

6.5 Bending angle

The test is completed when the bending angle α (see figures 3 and 4) reaches the value given in the relevant application standard.

6.6 Bending elongation

When required for measuring elongation, the root or face bend test specimens in steels shall have a gauge length of:

– for fusion welds: $L_o = L_s$ or $2L_s$ or $L_s + a$;

– for pressure welds, electron beam welds and laser welds: $L_o = a$ or $2a$.

For other metallic materials, the gauge length, if required, should be agreed between the contracting parties.

7 Test results

After bending, both the external surface and the sides of the test specimen shall be examined.

The evaluation of the bend test specimen shall be made and reported in accordance with the relevant application standard. Unless otherwise specified, imperfections less than 3 mm long on the specimen edges shall not be a cause for failure of the test.

8 Test report

The test report shall include as a minimum the following information:

a) reference to this standard;

b) identification of the test specimen (marking, type of base material, heat treatment, etc.);

c) shape and dimensions of the test specimen;

d) type and symbol of bend test (root and face, transverse or longitudinal, side transverse bend test);

e) conditions of testing (see clause 6):

– test methods (former or roller);

– diameter of the former;

– distance between rollers;

f) testing temperature if not at ambient temperature range;

g) type and dimensions of imperfections observed;

h) bending angle.

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

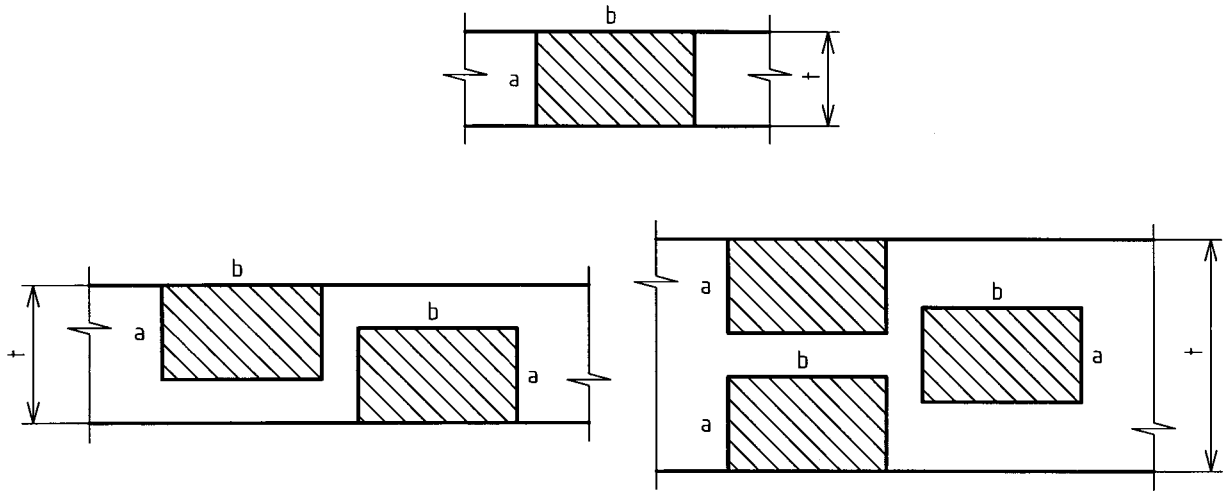


Figure 2a. Root and face bend test specimens of a butt weld (RBB and FBB)

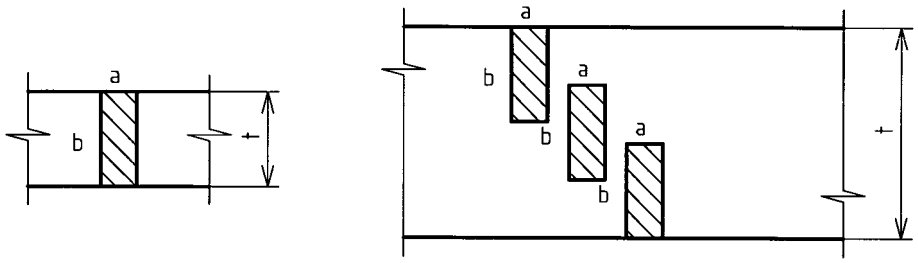
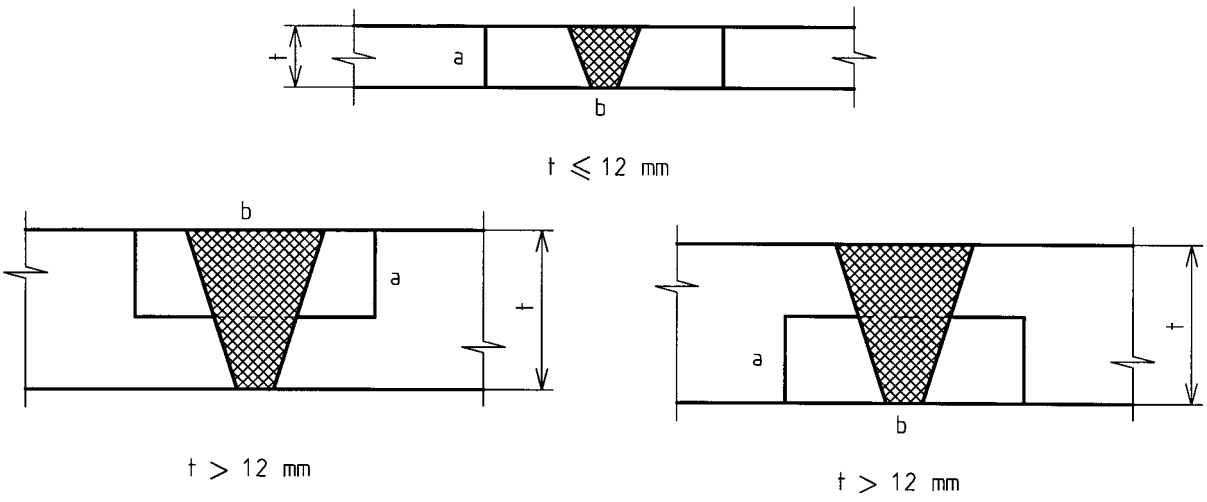


Figure 2b. Side bend test specimens of a butt weld (SBB)



Position of the test specimen if the face is in tension

Position of the test specimen if the root is in tension

Figure 2c. Longitudinal bend test specimens of a butt weld (RBB and FBB)

Figure 2. Removal of bend test specimens of butt welds and cladding

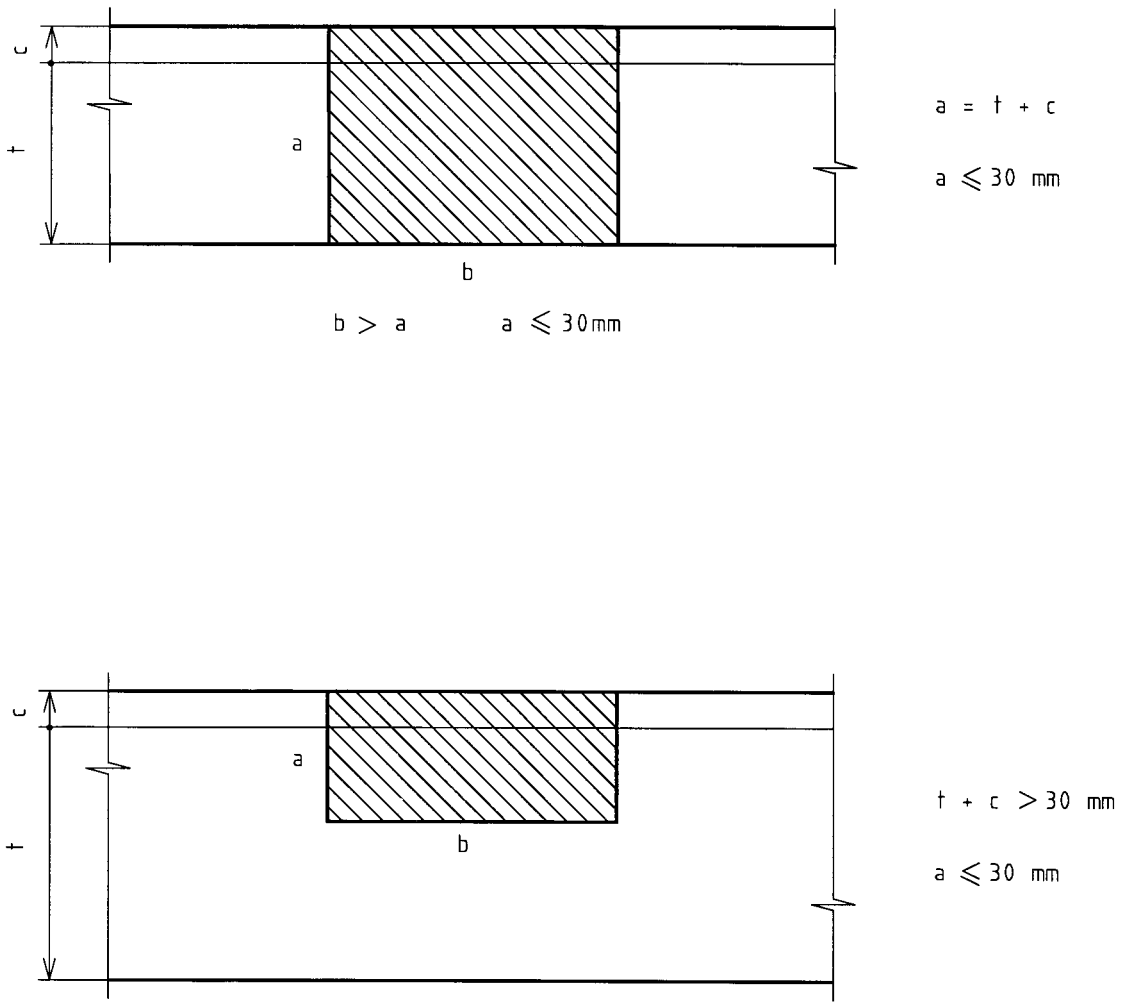


Figure 2d. Face bend test specimens of cladding without a butt weld (FBC)
Figure 2. Removal of bend test specimens of butt welds and cladding *(continued)*

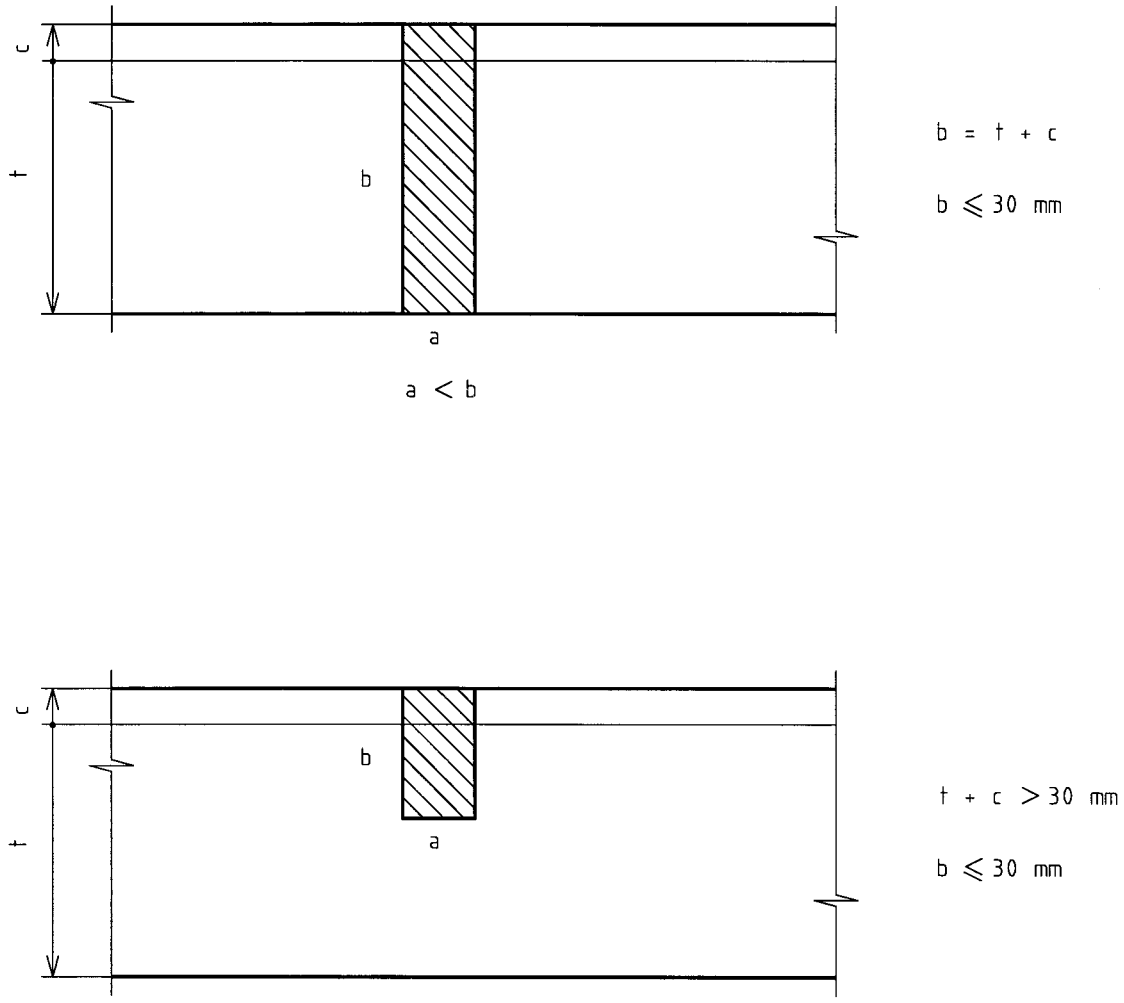
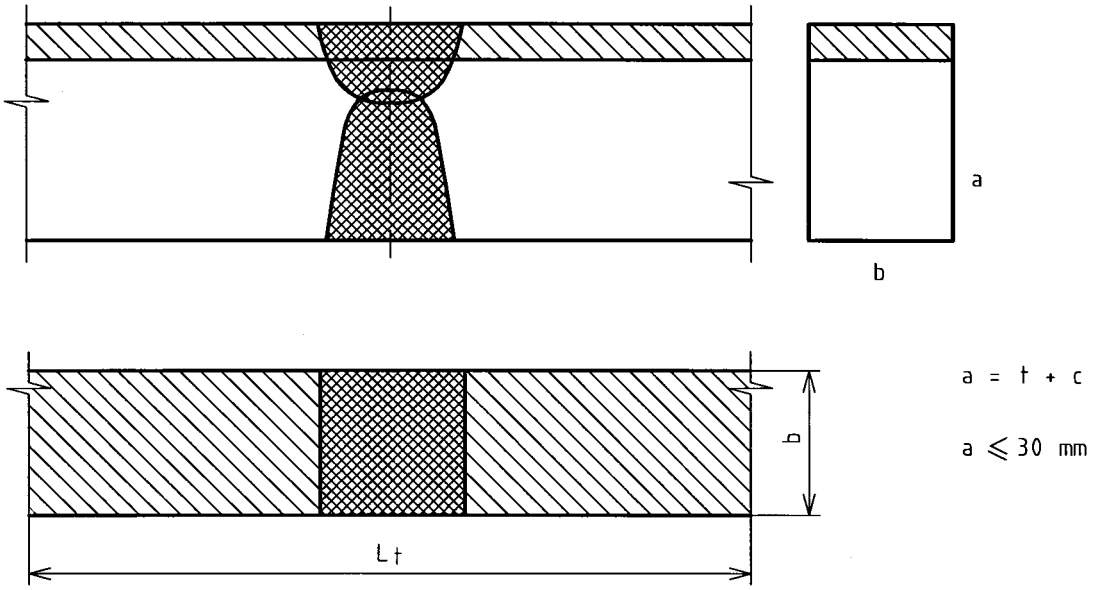


Figure 2e. Side bend test specimens of cladding without a butt weld (SBC)

Figure 2. Removal of bend test specimens of butt welds and cladding (*continued*)



NOTE. If t + c > 30 mm, see figure 2a.

Figure 2f. Transverse bend test specimens of cladding with a butt weld (FBCB)

Figure 2. Removal of bend test specimens of butt welds and cladding (*concluded*)

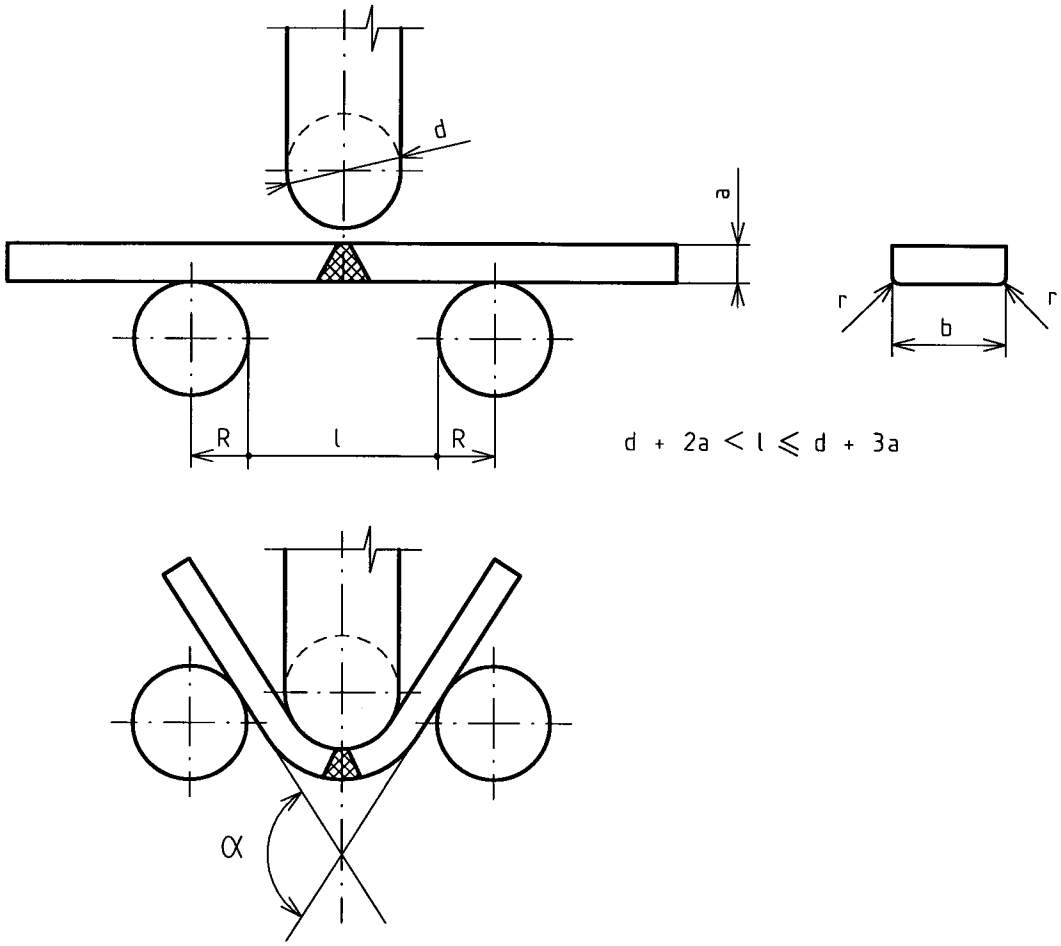


Figure 3a. Transverse face or root bend test

Figure 3. Method of bend testing with a former

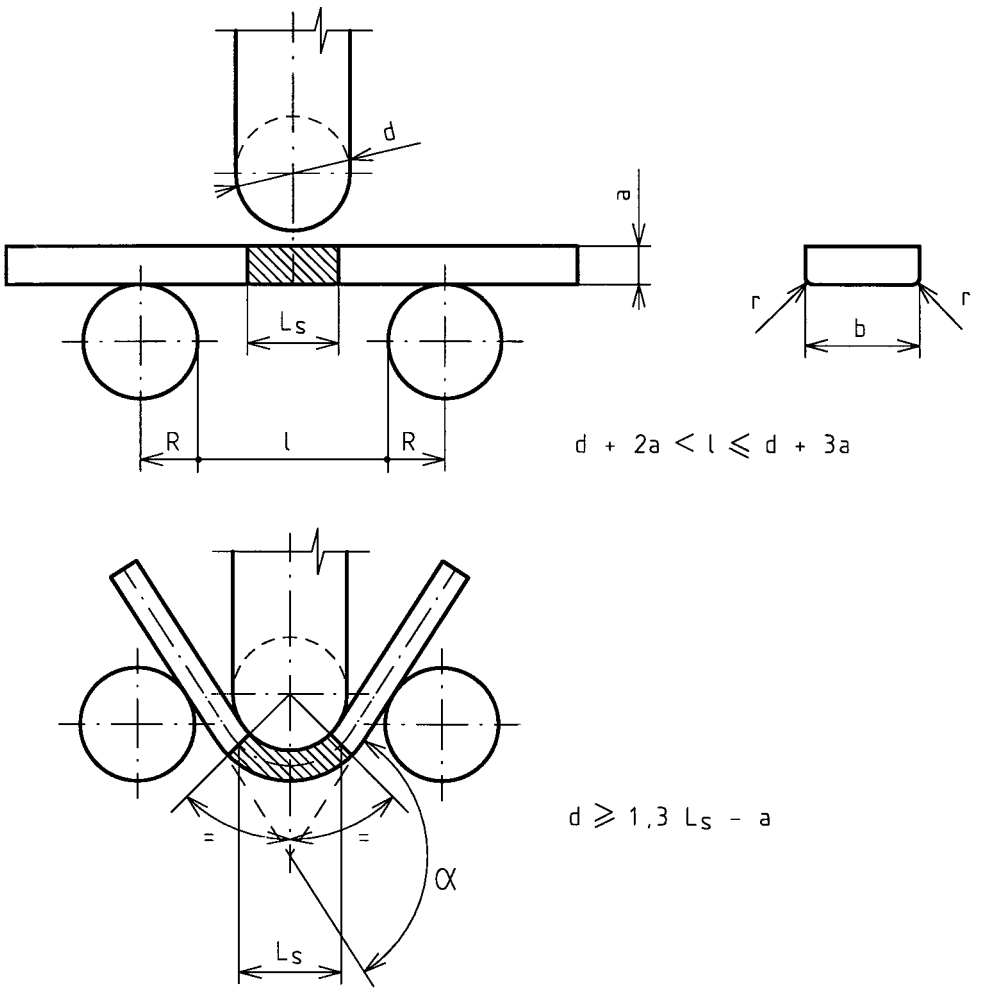


Figure 3b. Transverse side bend test

Figure 3. Method of bend testing with a former *(continued)*

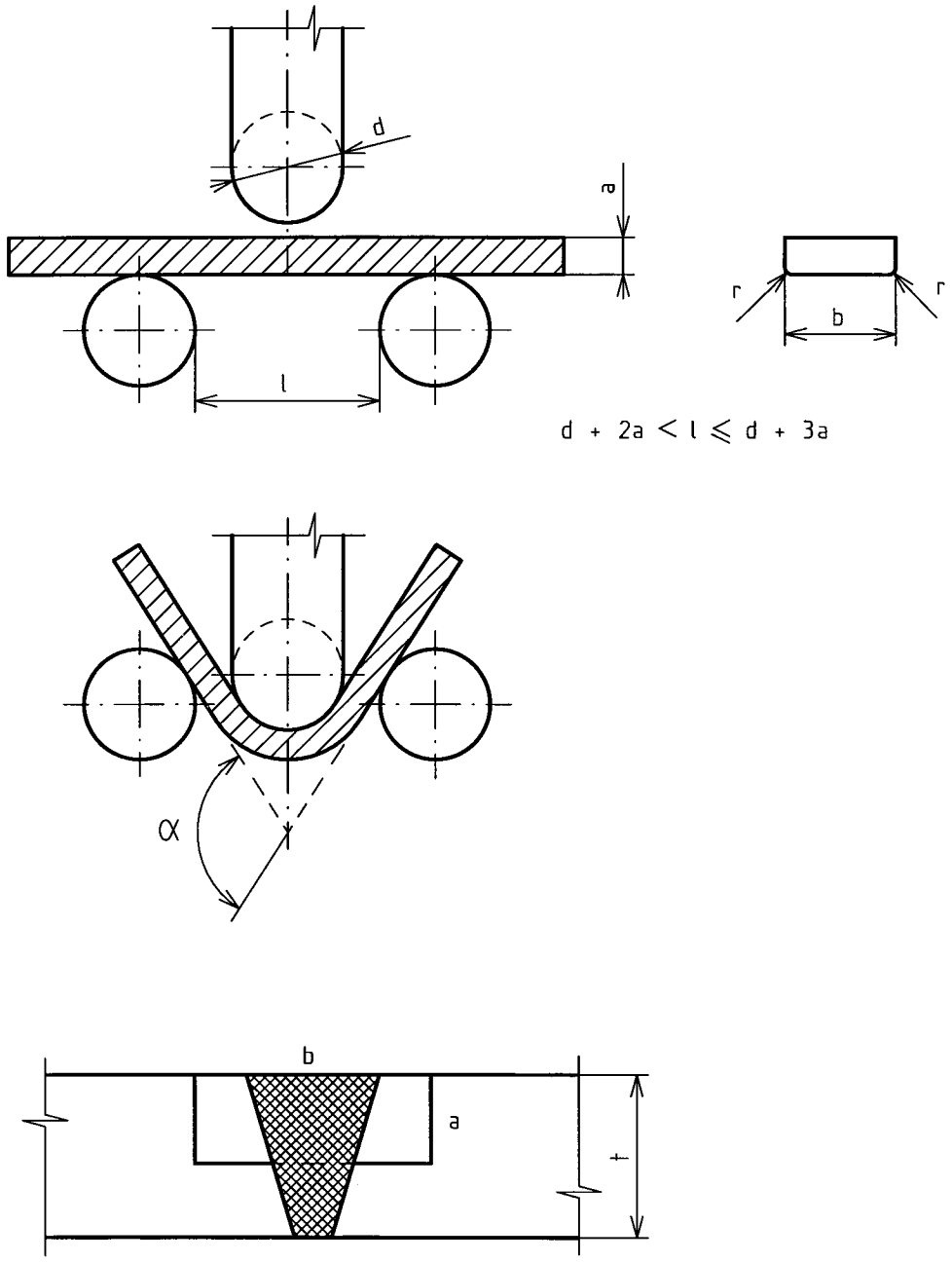


Figure 3c. Longitudinal bend test

Figure 3. Method of bend testing with a former *(concluded)*

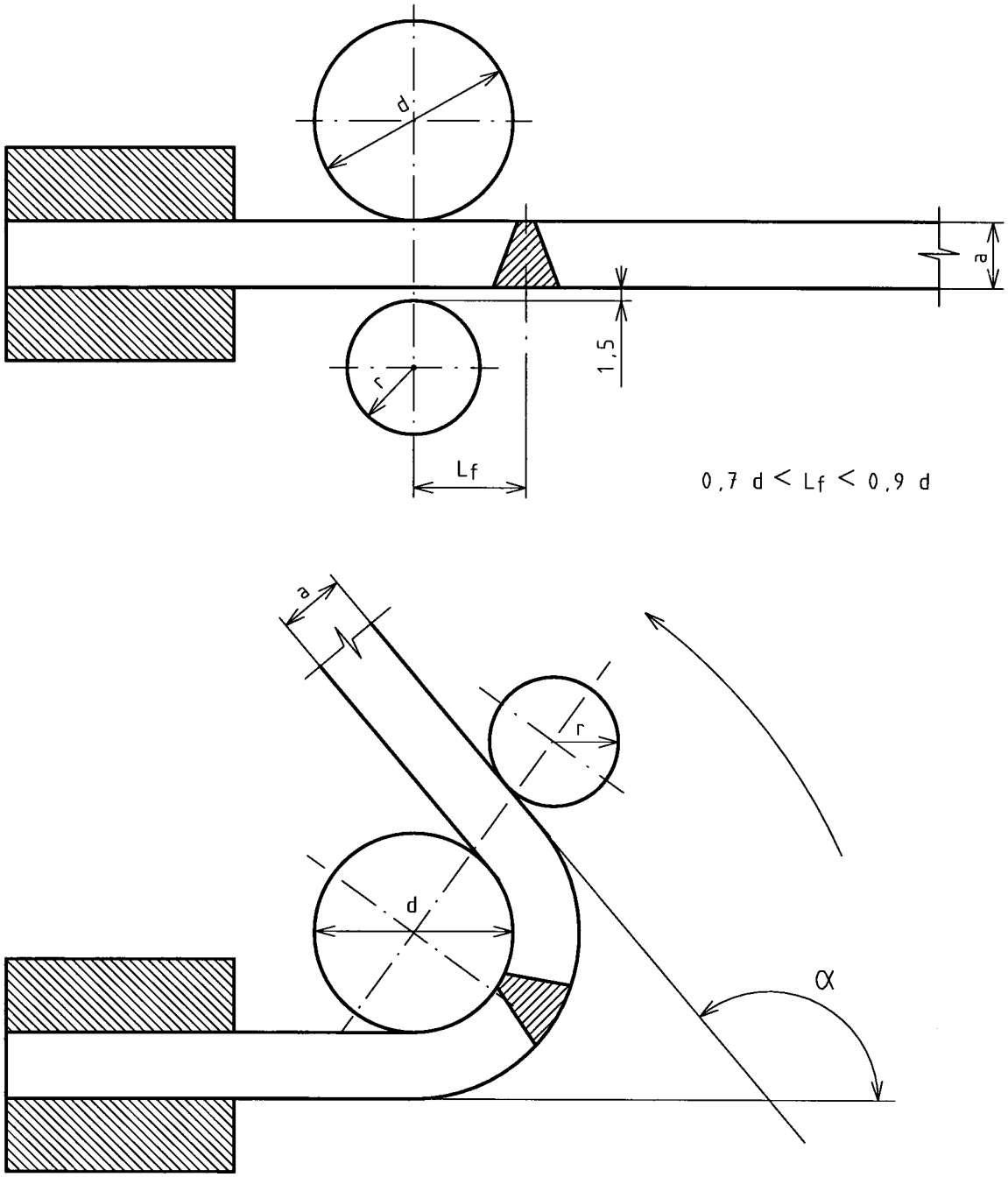


Figure 4. Method of bend testing using a roller

Annex A (informative)
Test report

N° .....

According to pWPS .....

According to test result 'bend test'

test result ' .....'

Manufacturer: .....

Purpose of the examination: .....

Form of product: .....

Base material: .....

Consumable: .....

Test temperature: .....

Table A.1 Bend test in accordance with EN 910

Specimen N°/position	**Type of test**	**Dimensions** mm	**Former diameter** mm	**Distance between rollers** mm	**Bend angle** °	**Original gauge lenth** mm	**Elongation** %	**Remarks e.g. fracture appearance**

Examiner or examining body:

Certified by:

....

(Name, date and signature) (Name, date and signature)

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