INTERNATIONAL STANDARD

ISO 14329

First edition
2003-07-01

Resistance welding — Destructive tests of welds — Failure types and geometric measurements for resistance spot, seam and projection welds

Soudage par résistance — Essais destructifs des soudures — Types de rupture et dimensions géométriques pour les assemblages soudés par résistance par points, à la molette et par bossages

Reference number
ISO 14329:2003(E)

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Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
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Foreword

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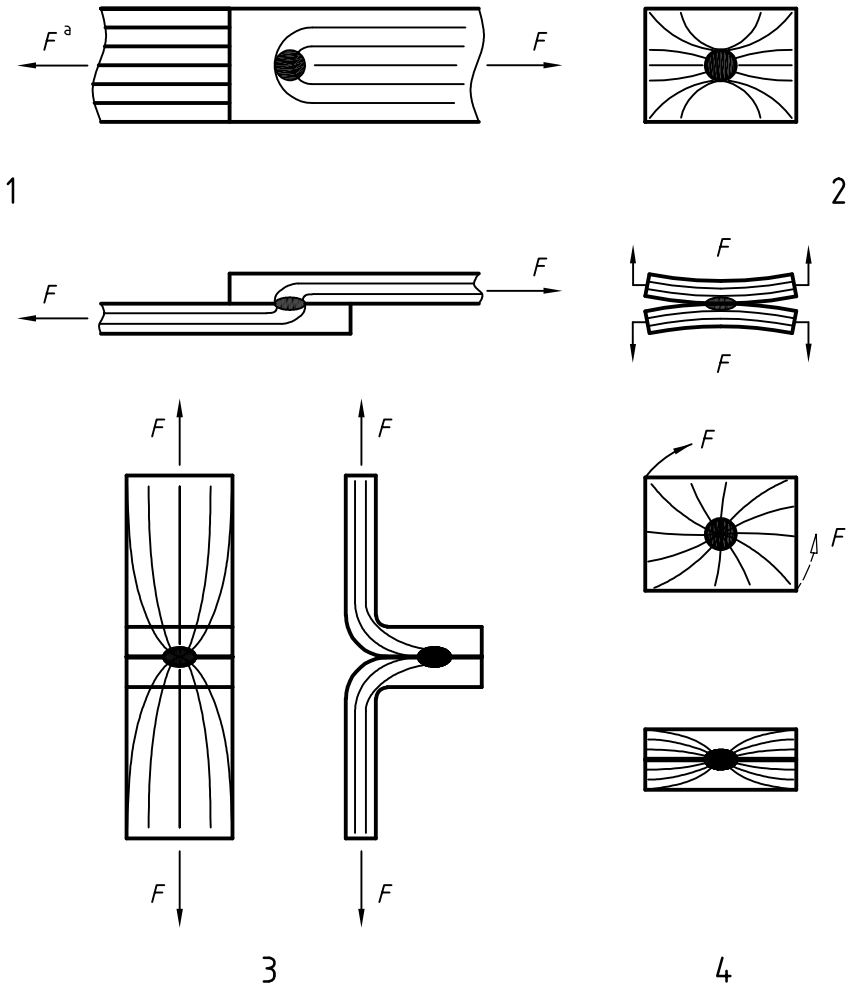
ISO 14329 was prepared in collaboration with the International Institute of Welding which has been approved by the ISO Council as an international standardizing body in the field of welding.

Resistance welding — Destructive tests of welds — Failure types and geometric measurements for resistance spot, seam and projection welds

1 Scope

This International Standard specifies the definitions of the geometric measurements and fracture types to be used in relation to the testing of resistance spot, projection and seam welds in which different loading configurations cause different stress distributions in the weld (see Figure 1). The aim of these definitions is to give a base for all other related standards.



Key

1 shear testing
2 cross tension testing
3 peel testing
4 torsion testing

a Testing load

Figure 1 — Schematic illustrations showing stress distribution depending on direction of the testing load

2 Terms and definitions

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

2.1 Failure modes of specimens and components

2.1.1
interface failure
fracture through the weld nugget between the sheets at the place of the interface

See Figure 2.

2.1.2
partial plug failure
fracture in which a combination of plug and interface failures are present

See Figure 3.

2.1.3
plug
metal pulled from one sheet remaining attached to the surface of the other after testing

See Figure 3.

2.1.4
plug failure
fracture in the base metal, the heat affected zone (HAZ) or in the nugget leaving a lug

See Figure 3.

2.1.5
solid phase weld
pressure weld without a fused zone

See Figure 5 d).

2.2 Measurements made on broken test specimens (Figures 2, 3 and 4)

2.2.1
asymmetrical welds
elongated or oval welds

NOTE Diameters "d_1" and "d_2" should be measured along the two main axes and reported separately (see Figure 3).

2.2.2
weld diameter
d
⟨interface failure⟩ mean of the minimum and the maximum diameters of the fused zone measured at the interface omitting the corona bond area

See Figure 2.

2.2.3
weld diameter
d
⟨partial plug failure⟩ mean of the diameter of the fused zone measured at the interface, omitting the corona bond area, and the maximum diameter of the plug segment

See Figure 3.

2.2.4
weld diameter
d
⟨plug failure⟩ mean of the minimum and maximum diameters of the plug measured at the base of the plug

See Figure 3.

2.2.5
minimum width of resistance seam weld
w
⟨plug failure⟩ width of the weld plugs measured at the base of the plug

See Figure 4.

2.2.6
minimum width of resistance seam weld
w
⟨interface failure⟩ width of the nugget in the plane of the interface at right angles to the longitudinal axis of the seam

2.3 Measurements made on sections taken from the weld

2.3.1
brazed zone
⟨welding of metallic coated sheets⟩ area over which the bond is formed between the coatings only

See Figure 5c).

2.3.2
brazed zone diameter
d_{sb}
diameter of the brazed zone measured in the plane of the interface between the joined pieces

NOTE The mean value should be used [see Figure 5c)].

2.3.3
corona bond diameter
d_c
diameter of the area surrounding the nugget of a spot or projection weld at the faying surfaces in which solid phase bonding only has occurred

See Figure 2.

NOTE The mean value should be used, if possible [see Figures 5a) and 5b)].

2.3.4
distance between nugget centres of seam welds
a
distance between the centres of two adjacent nuggets

See Figure 6.

NOTE The position of the nugget centre normally corresponds with the position of maximum nugget penetration.

2.3.5
distance of the minimum nugget penetration of seam welds
b
distance between two minimum nugget penetrations

See Figure 6.

NOTE The distance cannot be observed in every seam weld.

2.3.6
electrode indentation depth
e_u, e_l
maximum depth of the indentation of the electrode measured in the direction of the electrode force

See Figure 5a).

2.3.7
electrode indentation diameter
d_{eu}, d_{el}
diameters of the depression on the exterior surfaces of the work pieces

See Figure 5a).

NOTE The mean value should be used.

2.3.8
elongated welds
same as asymmetrical welds

See 2.2.1 and Figure 3.

NOTE Two sections in the major axis should be used to determine nugget width and length, nugget penetration, electrode indentation, and sheet separation as individual figures referred to the axis.

2.3.9
heat affected zone diameter
d_{HAZ}
diameter of the heat affected structure measured on a macro- or microsection

See Figures 5a) and b).

2.3.10
heat affected zone penetration
$p_{HAZ\ u}$, $p_{HAZ\ l}$
penetration of the heat affected zone in the thickness direction in each sheet

See Figure 5a).

2.3.11
maximum nugget penetration of seam welds
p_{max}
maximum penetration in the thickness direction expressed as a percentage of the combined thickness

See Figure 6.

2.3.12
minimum nugget penetration of seam welds
p_{min}
minimum penetration of the nugget in the thickness direction expressed as a percentage of the combined thickness

See Figure 6.

NOTE The penetration can be measured in discontinuous seam and roll spot welds but the ability to do so in continuous seam and roll spot welds depends on the weld condition and material.

2.3.13
nugget diameter
d_n
mean of the maximum and the minimum diameters of the nugget measured in the plane of the interface between the pieces joined

See Figures 5a) to c).

2.3.14
nugget penetration
p_u, p_l
penetration of the nugget in the thickness direction in one sheet

See Figure 5a).

2.3.15
overlap of nuggets
o
length of common area between two adjacent and overlapping seam weld nuggets

See Figure 6.

NOTE The area contains the portion of the preceding weld nugget remelted by the succeeding weld.

2.3.16
sheet separation
x
mean gap surrounding the weld between the faying surfaces measured at a distance of $0{,}5d_n$ from the edge of the weld nugget

See Figure 5a).

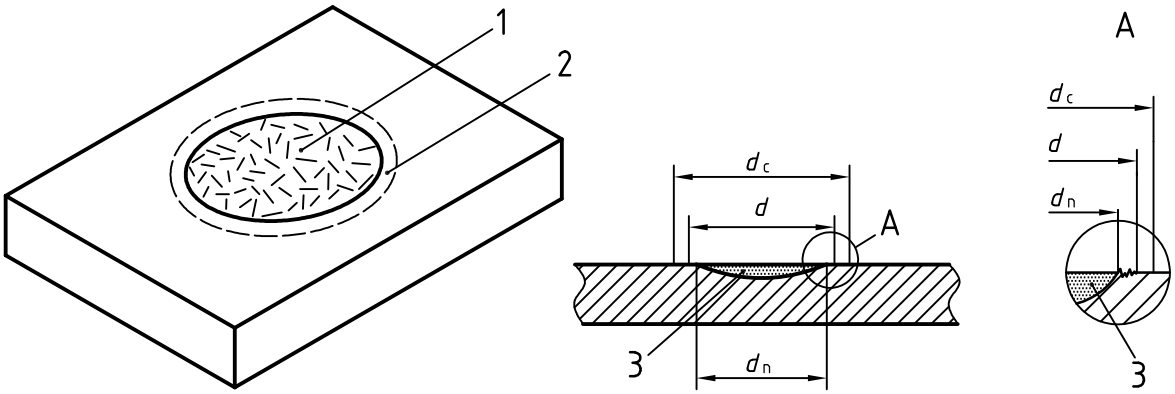
2.3.17
solid phase weld diameter
d_s
diameter of the solid phase weld measured in the lane of the interface between the pieces joined

NOTE The mean value should be used [see Figure 5d)].

3 Symbols, abbreviated terms and units

For the purposes of this document the following symbols and abbreviations apply. All units are millimetres.

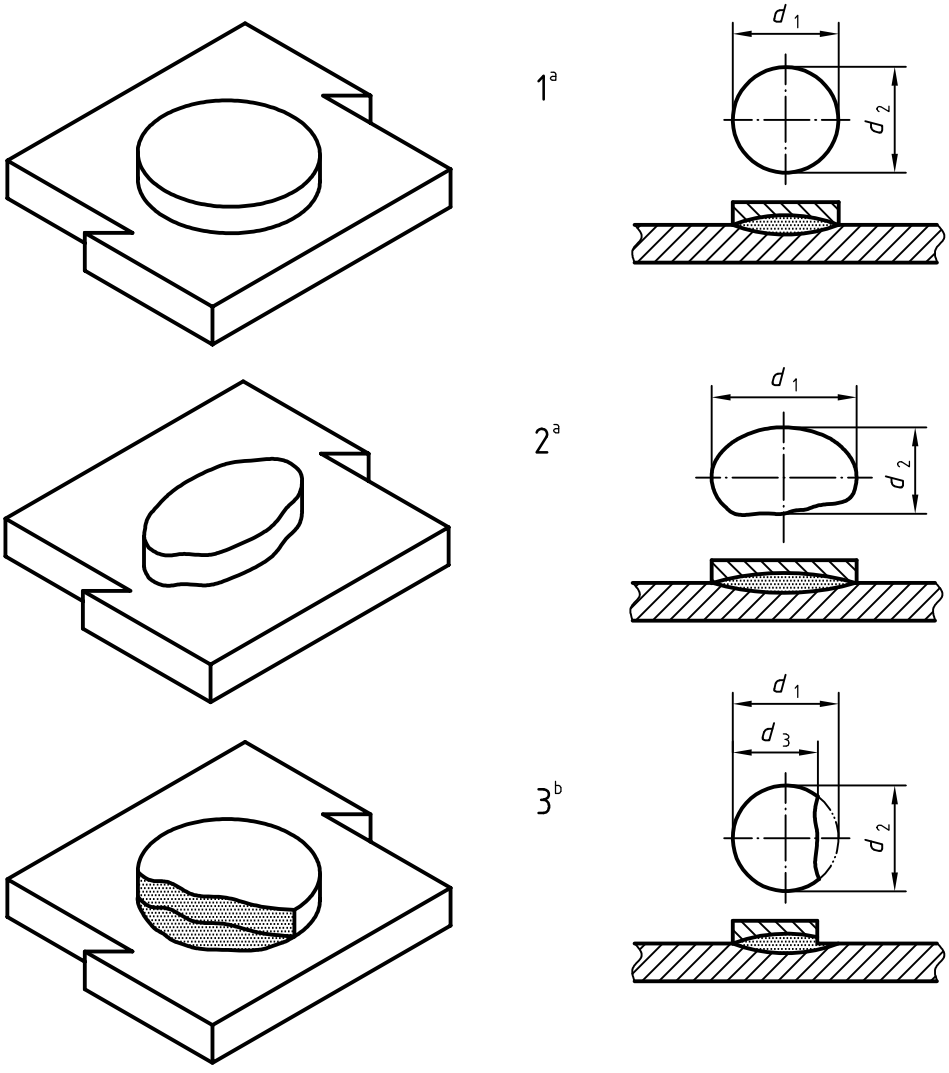
Symbol	Definition
a	distance between nugget centres, seam weld
b	distance of minimum nugget penetration, seam weld
d	weld diameter
d_c	corona bond diameter
d_{el}	electrode indentation diameter, lower sheet
d_{eu}	electrode indentation diameter, upper sheet
d_{HAZ}	diameter of heat affected zone
d_n	nugget diameter
d_p	mean plug diameter
d_s	diameter of solid phase weld
d_{sb}	diameter of brazed zone
d_1	maximum weld diameter
d_2	minimum weld diameter
d_3	minimum width of plug at partial plug failure
e_l	electrode indentation depth, lower sheet
e_u	electrode indentation depth, upper sheet
o	overlap of nuggets, seam weld
p_{HAZl}	heat affected zone penetration, lower sheet
p_{HAZu}	heat affected zone penetration, upper sheet
p_l	nugget penetration, lower sheet
p_{max}	maximum nugget penetration, seam weld
p_{min}	minimum nugget penetration, seam weld
p_u	nugget penetration, upper sheet
t	sheet thickness
w	minimum width, seam weld
x	sheet separation depth



Key

1 sheared nugget
2 corona bond zone
3 nugget

Figure 2 — Measurement of weld size for interface failure



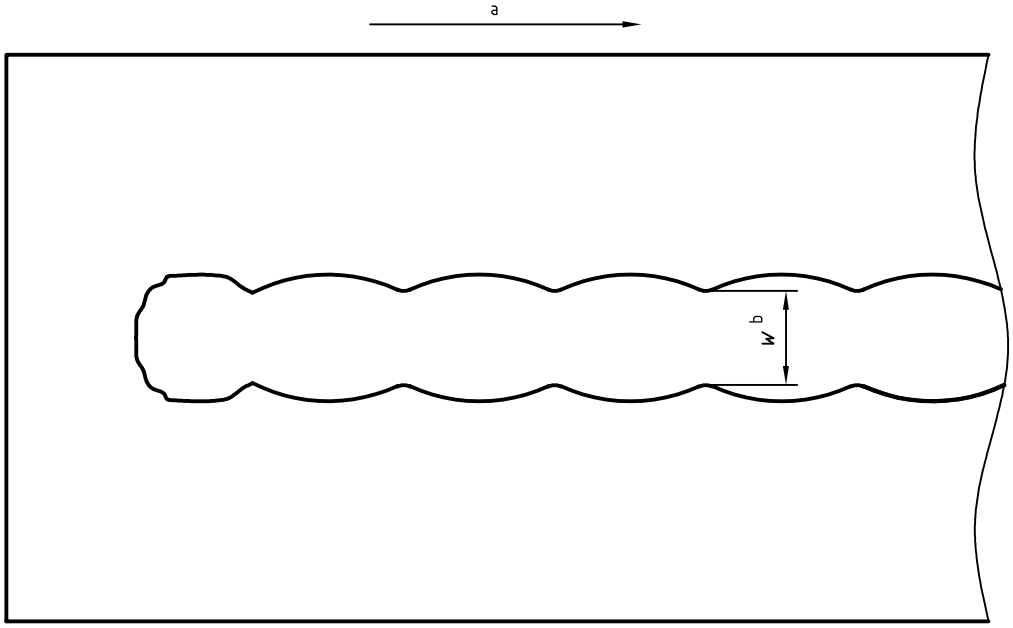
Key

1 symmetrical
2 asymmetrical
3 partial

[a] $d = d_p = (d_1 + d_2)/2$

[b] $d = (d_1 + d_2)/2$ and $d_p = (d_2 + d_3)/2$

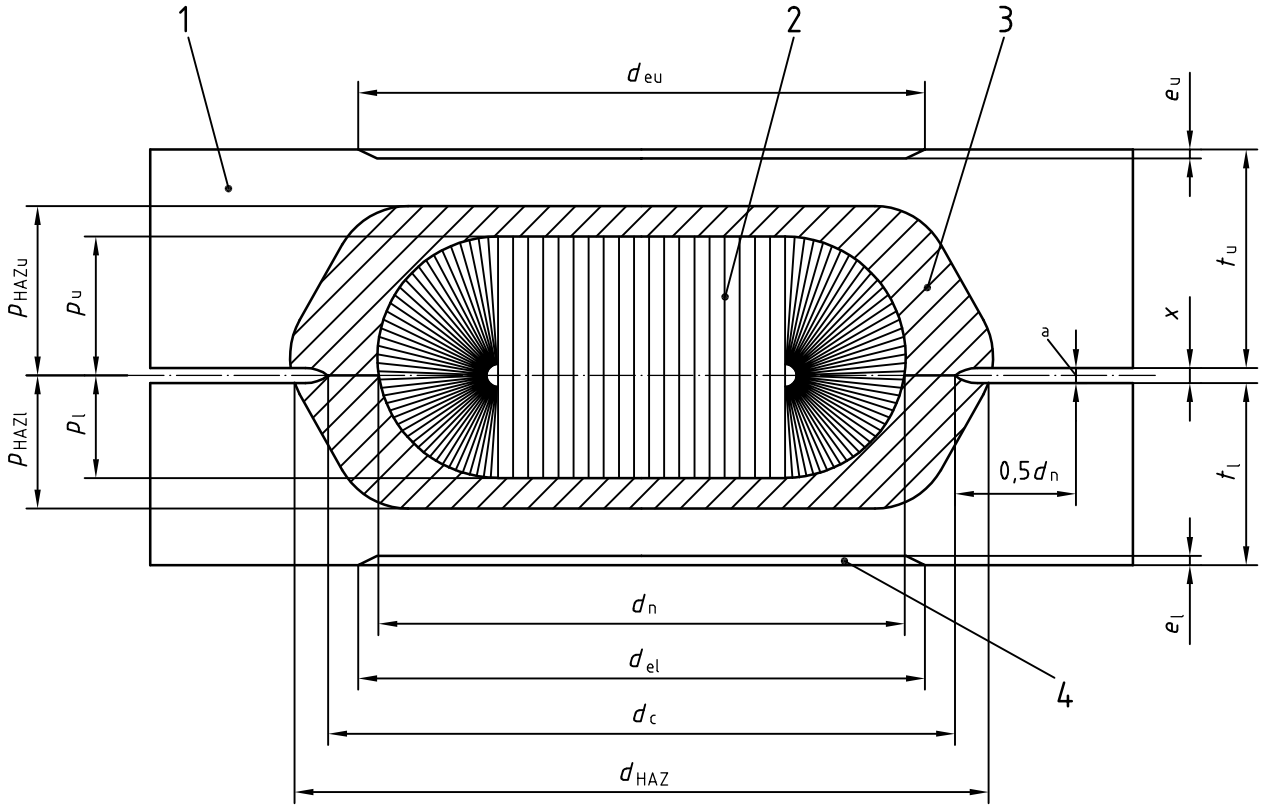
Figure 3 — Measurement of weld and plug diameter with plug failure



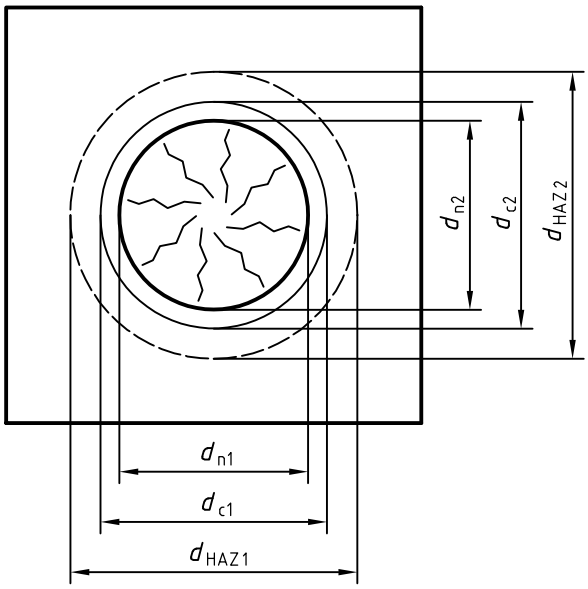
a Direction of welding

b Measured at base of plug

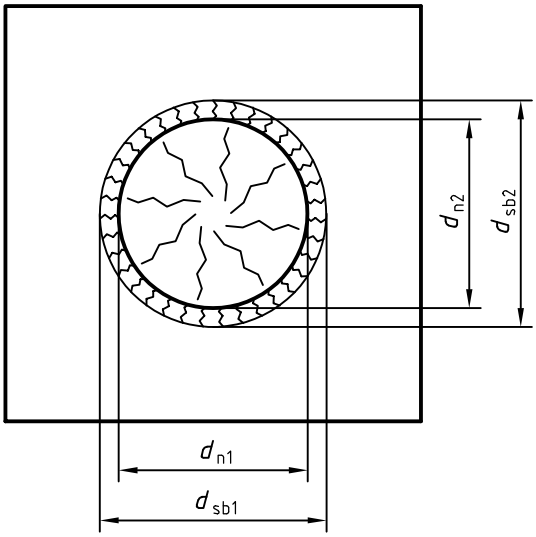
Figure 4 — Measurement of the minimum width of a seam weld, after peel testing — Plane view



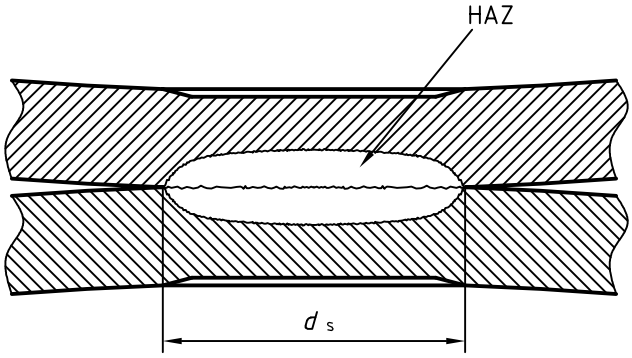
a) Measurements taken at weld cross-section



b) Diameter measurements for coated materials



c) Diameter measurements for coated materials with brazed zone



d) Measurements at sections taken transverse to the welding direction in the case of welds without nugget

Key

1 base material
2 nugget
3 heat affected zone (HAZ)
4 electrode indentation

[a] Measuring location for x

Figure 5 — Weld measurements

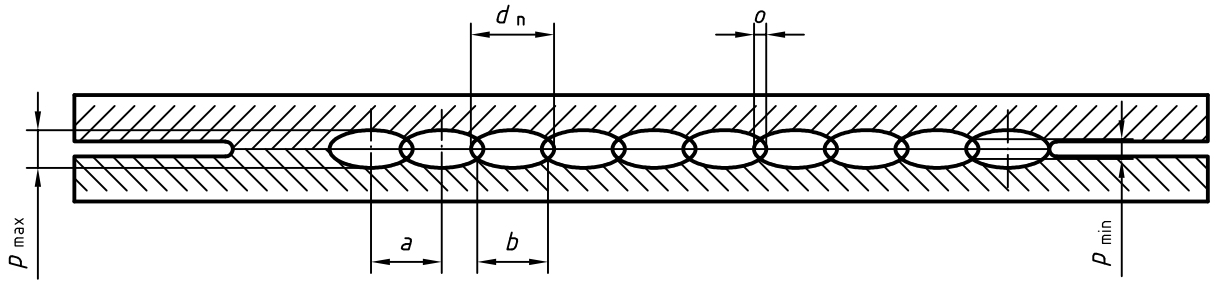


Figure 6 — Longitudinal cross-section of a seam weld taken parallel to the welding direction

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