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Welding and allied processes - Welding of reinforcing steel - Part 1: Load-bearing welded joints (ISO/DIS 17660-1:2026)

Schweißen und verwandte Verfahren - Schweißen von Betonstahl - Teil 1: Tragende Schweißverbindungen (ISO/DIS 17660-1:2026)

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Part 1: Load-bearing welded joints

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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 document 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 of 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 10, *Quality management in the field of welding*.

ISO 17660 consists of the following parts, under the general title Welding — *Welding of reinforcing steel:*

— *Part 1: Load-bearing welded joints*

— *Part 2: Non-load-bearing welded joints*

This second edition cancels and replaces the first edition (ISO 17660-2:2006). The main changes in this edition are as follows:

— Figures 2, 3, 4, 9 ,10 and tables from 3 to 10 have been technically revised

— Tables from 3 to 10 have been added

— 9.2.1 Expiring conditions of basic welder qualification have been added

— 12.2 Production weld test requalification interval for high performance have been provided with:

  Example for dealing with multiple procedures
  Risk analysis by the manufacturer

— Annex H “Welder certificate”, Annex I “Operator certificate” and Annex J “Production book” have been added

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Welding and allied processes – Welding of reinforcing steel —

Part 1:
Load-bearing welded joints

1 Scope

This part of ISO 17660 is applicable to the welding of weldable reinforcing steel and stainless reinforcing steel of load-bearing joints, in workshops or on site. It specifies requirements for materials, design and execution of welded joints, welding personnel, quality requirements, mechanical testing.

This document also covers welded joints between reinforcing steel bars and other steel components, such as connection devices and insertion anchors, including prefabricated assemblies. Non-load-bearing joints are covered by ISO 17660-2.

This document is not applicable to factory production of welding fabric and lattice girders using multiple spot-welding machines or multiple projection welding machines.

This document is applicable to static loaded structures. For fatigue-loaded structures, an appropriate reduction in fatigue strength should be taken into account.

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 3834-3, *Quality requirements for fusion welding of metallic materials — Part 3: Standard quality requirements*

ISO 4063, *Welding, brazing, soldering and cutting — Nomenclature of processes and reference numbers*

ISO 5817, *Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections*

ISO 9606-1, *Qualification testing of welders — Fusion welding — Part 1: Steels*

ISO 14554-2, *Quality requirements for welding — Resistance welding of metallic materials — Part 2: Elementary quality requirements*

ISO 14731, *Welding coordination — Tasks and responsibilities*

ISO 14732, *Welding personnel — Qualification testing of welding operators and weld setters for mechanized and automatic welding of metallic materials*

ISO 15609-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 1: Arc welding*

ISO 15609-2, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 2: Gas welding*

ISO 15609-5, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 5: Resistance welding*

ISO 15614-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys*

ISO 15614-12, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 12: Spot, seam and projection welding*

ISO 15614-13, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 13: Upset (resistance butt) and flash welding*

ISO 15620, *Welding — Friction welding of metallic materials*

ISO 15630-1, *Steel for the reinforcement and prestressing of concrete — Test methods — Part 1: Reinforcing bars, rods and wire*

ISO 15630-2, *Steel for the reinforcement and prestressing of concrete — Test methods — Part 2: Welded fabric and lattice girders*

ISO 16020, *Steel for the reinforcement and prestressing of concrete — Vocabulary*

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

ISO 17639, *Destructive tests on welds in metallic materials — Macroscopic and microscopic examination of welds*

EN 10164, *Steel products with improved deformation properties perpendicular to the surface of the product — Technical delivery conditions*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 16020 and the following 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 https://www.electropedia.org/

3.1
load-bearing welded joint
welded joint used for transmission of specified loads between reinforcing steel bars or between reinforcing steel bars and other steel products

3.2
non-load-bearing welded joint
welded joint whose strength is not taken into account in the design of the reinforced concrete structure

Note 1 to entry: The purpose of a non-load-bearing welded joint is usually only to keep the reinforcing components in their correct places during fabrication, transport and concreting. The weld is often called tack weld.

3.3
shear factor
S_f
relation between the shear force of a cross joint and the nominal yield strength R_e, multiplied by the nominal cross section area A_s, of the loaded bar

3.4
welder
person who holds and manipulates the electrode holder, welding torch or blowpipe by hand

3.5
manufacturer
person or organization responsible for the welding production

3.6
examiner
person appointed to verify compliance with the applicable standard

Note 1 to entry: In certain cases, an external independent examiner can be required

3.7
examining body
organization appointed to verify compliance with the applicable standard

Note 1 to entry: In certain cases, an external independent examining body can be required

4 Symbols and abbreviated terms

a	throat thickness
A_{gt}	percentage total extension at maximum force
b	excess of the bar
d, d_1, d_2	nominal diameter of the welded bar
d_{max}	maximum nominal diameter of the welded bar
d_{min}	minimum nominal diameter of the welded bar
e	distance between the bars
F	force to be anchored by transverse bar
F_{max}	maximum tensile force
F_s	shear force
l	length of the weld (cross joint)
l_o	overall lap length
L_{min}	minimum length of the test specimen
r	radius of bent reinforcing steel bar
R_e	specified characteristic yield strength of the reinforcing steel
R_m	nominal tensile strength of the reinforcing steel

5 Welding processes

The common welding processes are listed in Table 1 in accordance with ISO 4063.

Table 1 — List of welding processes and reference numbers in accordance with ISO 4063

Welding process	Term	US synonym
111	Manual metal arc welding (Metal arc welding with covered electrode)	Shielded metal arc welding
114	Self-shielded tubular cored arc welding	
135	MAG welding with solid wire electrode	Gas metal arc welding using active gas with solid-wire electrode
136	MAG welding with flux cored electrode	Gas metal arc welding using active gas and flux-cored electrode
138	MAG welding with metal cored electrode	Gas metal arc welding using active gas and metal cored electrode
141	TIG welding with solid filler material (wire/rod)	Gas tungsten arc welding using inert gas and solid filler material (wire/rod)
21	Resistance spot welding	Spot welding
23	Projection welding	
24	Flash welding	
25	Resistance butt welding	Upset welding
42	Friction welding	
47	Oxyfuel gas pressure welding	Pressure gas welding

The principles of this document may be applied to other welding processes.

NOTE The welding process 47 with high heat input may be critical for cold worked and heat-treated reinforcing steels.

6 Preparations and specifications for welded joints

6.1 General

A summary of recommended ranges of bar diameters for load-bearing welded joints, depending on the welding process, is given in Table 2.

The welds shall not affect the full load-carrying capacity and ductility of the bars. The measures to achieve this should be specified in the design.

Table 2 — Recommended ranges of bar diameters for load-bearing welded joints

Type of welded joint	Welding process	Range of bar diameters for load-bearing welded joints mm
butt joint	111, 114, 135, 136, 138, 141	16 to 50, for without bucking
		12 to 50, for with permanent bucking
	24	5 to 50
	25	5 to 25
	42, 47	16 to 50
lap joint	111, 114, 135, 136, 138, 141	6 to 40
strap joint	111, 114, 135, 136, 138, 141	16 to 50
joint to other steel component	111, 114, 135, 136, 138, 141 42	8 to 50
cross joint [a]	111, 114, 135, 136, 138, 141	10 to 50
	21, 23	5 to 32

[a] d_{min} / d_{max} should be ≥ 0,4.

The joints specified in 6.2, 6.3, 6.4 and 6.6 except joints on bent bar specified in 6.6.2.1 are designed to give full load-bearing capacity of the bar. Exceptions are possible for butt welds and joints between reinforcing steel bars and other steel components, but the specifications shall be specified.

For cross joints, specified in 6.5, the shear strength shall be specified in the design (see also Annex F).

For joints specified in 6.6.2.1 with bent bar under an angle the load is ruled by transverse shearing off the weld. The shear strength should be designed as necessary.

The joints specified in 6.2 to 6.6 are examples of good practice. Other joint configurations and bar diameters may be used if they can be shown to meet the requirements of Clause 11.

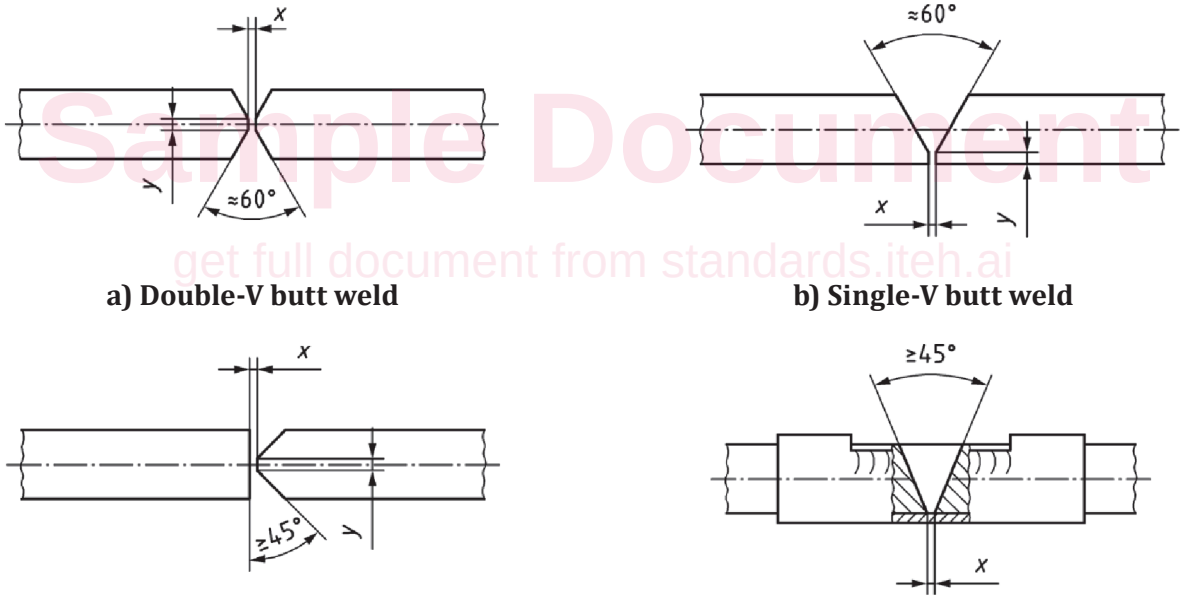
NOTE Excessive heat input may affect strength and ductility of the bar depending on steel grade process route, joint configuration and bar diameter.

6.2 Butt joints

6.2.1 Butt joints welded by welding process 111, 114, 135, 136, 138 or 141

Examples of butt-joint preparation are given in Figure 1 a) to d). Other joint preparations or types of permanent backing may also be used.

The prepared joint shall be bevelled. The joint preparation should be carried out by grinding or flame cutting.



a) Double-V butt weld

b) Single-V butt weld

c) Double-bevel butt weld

d) Single-V butt weld with backing

Key

x	root gap
y	depth of root face

NOTE *x* or *y* depends on the welding process.

Figure 1 — Examples for the preparation of butt joints

6.2.2 Butt joints welded by welding process 24, 25, 42 or 47

For welding process 24 or 25, the misalignment of the bars shall not exceed 1 mm for nominal bar diameters less than or equal to 10 mm, and 10 % of the nominal bar diameter for the other values.

For welding process 24 or 25, only bars with the same diameter shall be welded together.

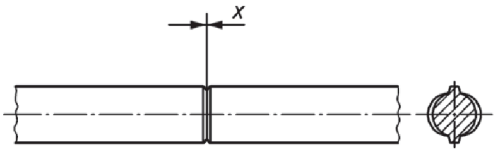
For welding process 42, the maximum misalignment of the bars shall be specified.

For welding process 47, the bars with different diameters shall not be welded in case that the difference of their nominal diameters exceeds 7 mm.

For welding process 47, the misalignment of the bars shall not exceed 20 % of the smaller nominal bar diameter of the two welded bars.

NOTE Excessive heat input may loss of strength and ductility.

An example of the joint preparation for these welding processes is given in Figure 2.



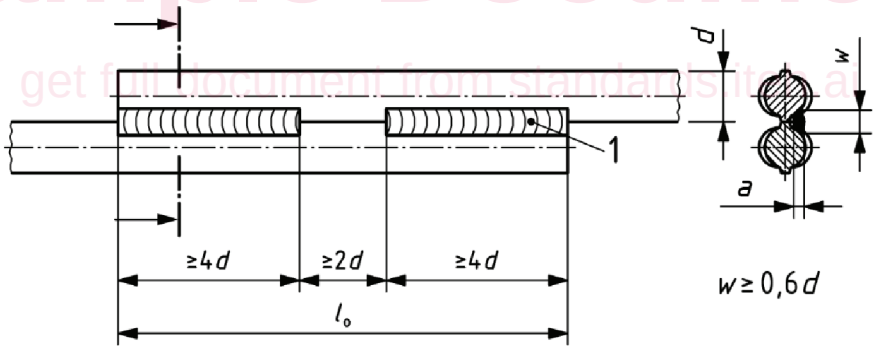
Key

X root gap = 0 mm

Figure 2 — Example for the preparation of butt joints

6.3 Lap joints

Lap joints using intermittent single-flare V-groove welds (asymmetric force flow) shall be welded in accordance with Figure 3.



Key

1 weld

a throat thickness

d nominal diameter of the smaller of the two welded bars

l_o overall lap length

w weld width

NOTE 1 A conservative estimate of the effective throat thickness can be taken as $a \approx 0{,}5\ w$.

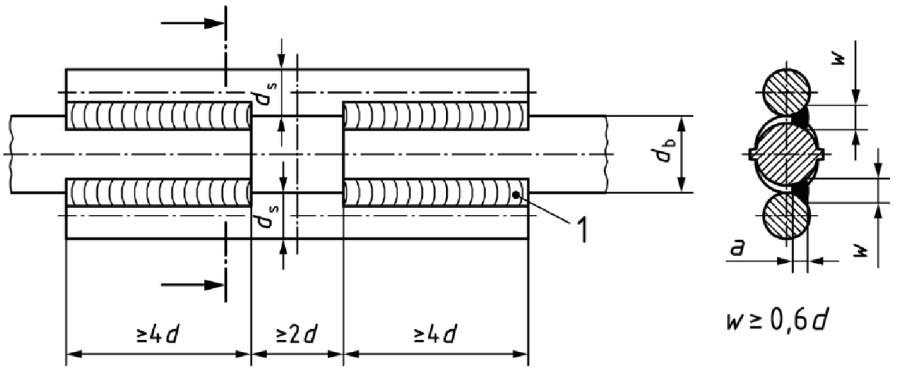
NOTE 2 Welding is also possible on both sides with minimum weld length of 2,5 *d*.

Figure 3 — Lap joint

6.4 Strap joints

Load-bearing strap joints with single-flare V-groove welds shall be welded in accordance with Figure 4.

Where the straps and the bars have the same mechanical properties, the combined cross-sectional area of the two straps shall be equal to or greater than the cross-sectional area of the bars to be joined. Where the straps and the bars do not have the same mechanical properties, the cross-sectional area of the straps shall be adapted on the basis of the ratio of their individual nominal yield stresses.



Key

1	weld
a	throat thickness
d	nominal diameter of the smaller of the welded bars with d_b and the strap bars with d_s
w	weld width

NOTE 1 A conservative estimate of the effective throat thickness can be taken as $a \approx 0{,}5\ w$.

NOTE 2 Welding is also possible on both sides with minimum weld length of 2,5 *d*.

Figure 4 — Strap joint

6.5 Cross joints

6.5.1 General

Unless otherwise specified, cross joints are intended to function in only one direction and are consequently tested in longitudinal bar direction with the transverse bar supported.

The required shear factor, S_f, of the joint shall be specified on the drawings and shall be verified by testing in accordance with Clause 14.3. For shear factor classification see Annex F.

6.5.2 Cross joints by welding process 111, 114, 135, 136, 138 or 141

Cross joints shall be welded in accordance with Figure 5. The joint shall be welded, whenever possible, as double-sided weld (see Figure 5a)). In this case, welds at two sides are preferable in equal welds with adequate cooling between those two welds.

The minimum bar diameter, d_{min} = 10 mm is recommended and the relation, d_{min}/d_{max} shall be ≥ 0,4 (recommended ≥ 0,6).

If only one single-sided weld is used, the shear strength of the welded joint shall be verified with the force applied as shown in Figure 5 b).

Whether welding on double sides or on single side, the following conditions shall be fulfilled to avoid cracks in the weld:

a) a minimum throat thickness $a \geq 0{,}3\ d_{min}$;

b) a minimum length of the weld $l \geq 0{,}5\ d_{min}$.