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Welding — Welding of reinforcing steel —

Part 1: Load-bearing welded joints

Soudage — Soudage des aciers d'armatures —

Partie 1: Assemblages transmettant des efforts

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 17660-1 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 121, *Welding*, in collaboration with Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 10, *Unification of requirements in the field of metal welding*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

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

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— *Part 1: Load-bearing welded joints*

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

Requests for official interpretations of any aspect of this part of ISO 17660 should be directed to the Secretariat of ISO/TC 44/SC 10 via your national standards body. A complete listing of these bodies can be found at www.iso.org.

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Introduction

Reinforcing steel bars are produced by a number of process routes and usually have a ribbed profile. Taking these issues into account, it is apparent that both the welder and the welding coordinator require a specific level of skill and job knowledge and that special procedures for quality assurance need to be adopted.

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Welding — 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, examination and testing.

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

This part of ISO 17660 is not applicable to factory production of welding fabric and lattice girders using multiple spot welding machines or multiple projection welding machines.

The requirements of this part of ISO 17660 are only applicable to static loaded structures.

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NOTE For fatigue-loaded structures, depending on type of joint and welding process, it is recommended that an appropriate reduction be taken into account on the fatigue strength of the reinforcing steel.

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2 Normative references

The following referenced documents are indispensable for the application 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 5817, *Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections*

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

ISO 14731:—[1], *Welding coordination — Tasks and responsibilities*

ISO 14732[2], *Welding personnel — Approval testing of welding operators for fusion welding and of resistance weld setters for fully 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*

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1) To be published (revision of ISO 14731:1997, EN 719:1994).

2) Equivalent to EN 1418.

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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: 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, wire rod and wire*

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

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

EN 10079, *Definition of steel products*

EN 10080, *Steel for the reinforcement of concrete — Weldable reinforcing steel — General*

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

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3 Terms and definitions

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For the purposes of this document, the terms and definitions given in EN 10079, EN 10080 and ISO 16020 and the following apply.

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 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
manufacturer
enterprise carrying out the welding works within workshops or on site

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4 Symbols and abbreviated terms

a	throat thickness
A_{gt}	percentage total elongation at maximum force
A_n	nominal cross-sectional area of the bar
A_s	nominal cross-sectional area of the bar to be anchored
b	excess of the bar
d	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
S_f	shear factor
t	thickness of the web of a section or of a plate to be welded
t_{min}	minimum thickness of the web of a section or of a plate to be welded
w	weld width
x	root gap
y	depth of root face
α	included angle
BW	butt weld
CEV	carbon equivalent value
FW	fillet weld
SF	Shear factor class
WPQR	welding procedure qualification record
WPS	welding procedure specification

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5 Welding processes

The following welding processes in accordance with ISO 4063 may be used (see Table 1):

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

Welding process	English term	American term
111	manual metal arc welding (metal arc welding with covered electrode)	shielded metal arc welding
114	self-shielded tubular cored arc welding	
135	metal active gas welding (MAG-welding)	gas metal arc welding
136	tubular cored metal arc welding with active gas shield	flux cored arc welding
21	resistance spot welding	
23	projection welding	
24	flash welding	
25	resistance butt welding	
42	friction welding	
47	oxy-fuel gas pressure welding	pressure gas welding

The principles of this part of ISO 17660 may be applied to other welding processes.

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6 Load-bearing welded joints

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6.1 General

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

Table 2 — Common ranges of bar diameters for welded joints

Welding processes	Type of welded joint	Range of bar diameters for load-bearing welded joint mm
21 23	cross joint [a]	4 to 20
24	butt joint	5 to 50
25		5 to 25
42	butt joint	6 to 50
	joint to other steel component	6 to 50
47	butt joint	6 to 50
111 114 135 136	butt joint without backing	$\geqslant$ 16
	butt joint with permanent backing	$\geqslant$ 12
	lap joint	6 to 32
	strap joint	6 to 50
	cross joint [a]	6 to 50
	joint to other steel components	6 to 50

[a] d_{min}/d_{max} should be $\geqslant$ 0,4.

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The joints specified in 6.2, 6.3, 6.4 and 6.6 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, and shall be specified. For cross joints, the shear strength shall be specified in the design (see also Annex G).

The welded joint shall meet the strength and ductility requirements of the specific reinforcing steel, unless such requirements are deemed to be irrelevant for the functions of the welded product.

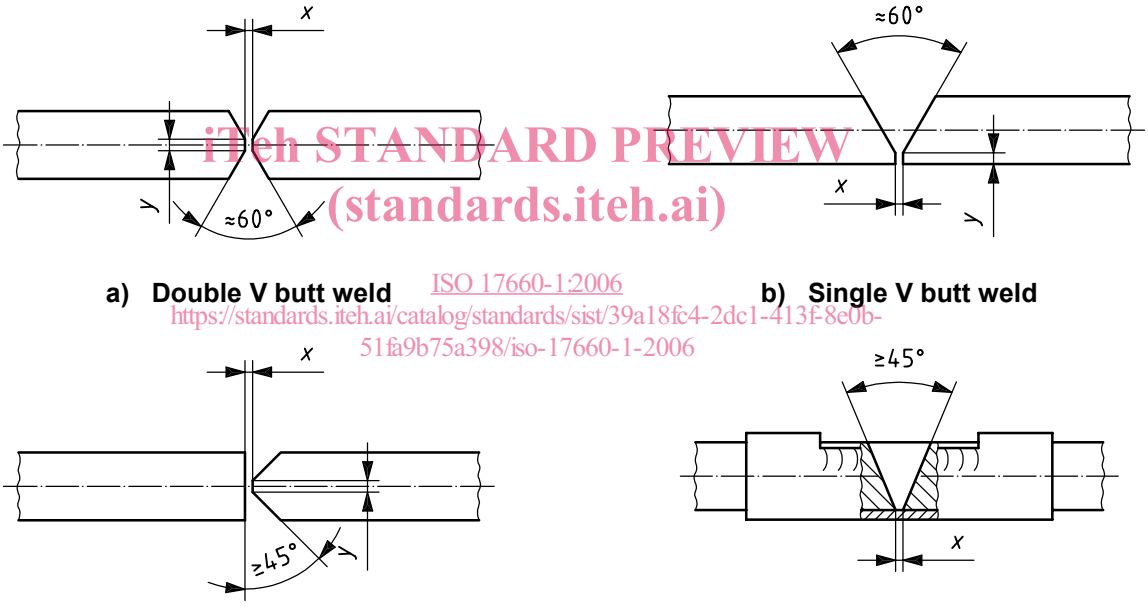
The joints specified below are examples of good practice. Other joint configurations may be used if they can be shown to meet the requirements of Clause 11.

6.2 Butt joints

6.2.1 Butt joints welded by welding processes 111, 114, 135 and 136

Examples of butt joint preparation for load-bearing welded joints are given in Figures 1a) to 1d). 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.



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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 and y depend on the welding process.

Figure 1 — Examples for preparation of butt joints

6.2.2 Butt joints welded by welding processes 24, 25, 42 and 47

For welding processes 24, 25 and 47, the misalignment of the bars shall not exceed 1 mm for the nominal bar diameters $\leqslant$ 10 mm, and 10 % of the nominal bar diameter for the other values.

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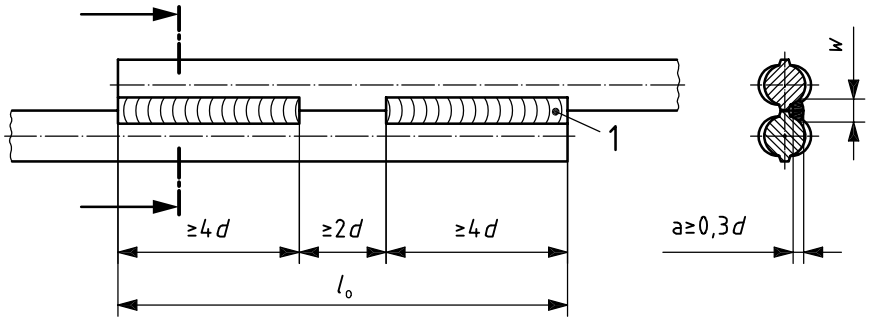
For welding processes 24, 25 and 47, only bars with the same diameter shall be welded together.

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

6.3 Lap joints

Lap joints using single-sided intermittent lap welds (asymmetric force flow) shall be welded in accordance with Figure 2.



Key

1 weld
a throat thickness
d nominal diameter of the thinner of the two welded bars
l_o overall lap length
w weld width

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NOTE Welding is also possible on both sides with minimum weld length of 2,5 d. A conservative estimate of the effective throat thickness can be taken as $a \approx 0{,}5\ w$.

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Figure 2 — Lap joint

6.4 Strap joints

Strap joints with single-sided lap welds shall be welded in accordance with Figure 3.

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.

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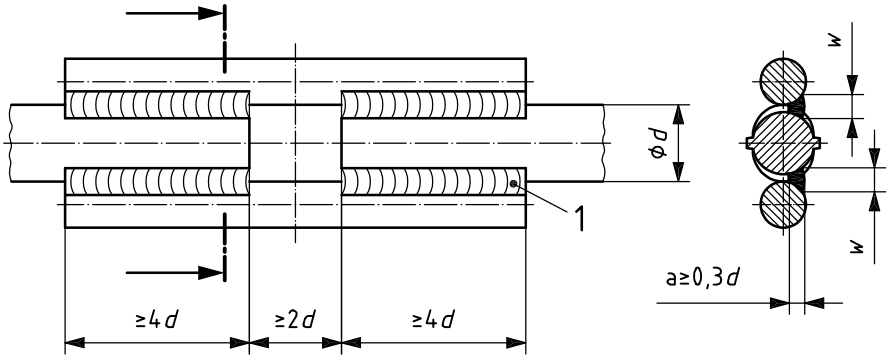

Key

1 weld

a throat thickness

d nominal diameter of the thinner of the two welded bars

w weld width

NOTE Welding is also possible on both sides with minimum weld length of 2,5 d. A conservative estimate of the effective throat thickness can be taken as $a \approx 0{,}4\ w$.

Figure 3 — Strap joint

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6.5 Cross joints

6.5.1 General

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The required shear factor (S_f) of the cross joint should be specified on the drawings (for shear factor classification, see Annex G) and shall be verified by testing in accordance with Clause 14.

6.5.2 Cross joints for welding processes 111, 114, 135 and 136

Cross joints shall be welded in accordance with Figure 4. The joint shall be welded, whenever possible, from at least two sides with two equal welds (see Figure 4a).

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 4b.

To avoid cracks in the weld, the following conditions shall be fulfilled:

— a minimum throat thickness $a \geqslant 0{,}3\ d_{min}$;

— a minimum length of the weld $l \geqslant 0{,}5\ d_{min}$.

If more than one transverse bar is used on the same side of the longitudinal bar, the spacing of the transverse bars shall be at least three times the nominal diameter of the transverse bar.

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