
**Structural steels with improved
atmospheric corrosion resistance**

*Aciers de construction à résistance améliorée à la corrosion
atmosphérique*

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 4952 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 3, *Steels for structural purposes*.

This third edition cancels and replaces the second edition (ISO 4952:2003), which has been technically revised.

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Structural steels with improved atmospheric corrosion resistance

1 Scope

1.1 This International Standard specifies the chemical and mechanical characteristics, the methods of manufacture, the acceptance conditions and the marking of structural steel products with improved atmospheric corrosion resistance.

This International Standard applies to plates hot-rolled on reversing mills, having a thickness of 4 mm and over, wide flats, bars, and hot-rolled sections, generally used in the delivery condition and which, as a rule, form part of the bolted, riveted or welded structures in metal constructions¹⁾ and which have an improved atmospheric corrosion resistance.

1.2 This International Standard does not include the following steels, certain of which are covered by other International Standards:

- general-purpose structural steels (ISO 630);
- steels for boilers and pressure purposes (ISO 9328-2);
- steels for heat treatment;
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- continuously hot-rolled steel sheet of structural quality with improved atmospheric corrosion resistance (ISO 5952);
- steel plates for forming and deep drawing.

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 148-1, *Metallic materials — Charpy pendulum impact test — Part 1: Test method*

ISO 377, *Steel and steel products — Location and preparation of samples and test pieces for mechanical testing*

ISO 404:1992, *Steel and steel products — General technical delivery requirements*

ISO 2566-1, *Steel — Conversion of elongation values — Part 1: Carbon and low alloy steels*

1) For precautions to be taken when welding, the guide for the welding and weldability of C-Mn and C-Mn micro-alloy steels published by Sub-commission IX-G of the International Welding Institute may be helpful (document IIS/IIW 843-87), as well as the notes given in Annex C of this International Standard.

ISO 4952:2006(E)

ISO 4948-1, *Steels — Classification — Part 1: Classification of steels into unalloyed and alloy steels based on chemical composition*

ISO 6892, *Metallic materials — Tensile testing at ambient temperature*

ISO/TR 9769, *Steel and iron — Review of available methods of analysis*

ISO 10474, *Steel and steel products — Inspection documents*

ISO 14284, *Steel and iron — Sampling and preparation of samples for the determination of chemical composition*

3 Terms and definitions

For the purposes of this document, the following term and definition apply.

3.1 steel with improved atmospheric corrosion resistance
steel in which a certain number of alloying elements, such as P, Cu, Cr, Ni, etc., have intentionally been added in order to increase its resistance to atmospheric corrosion, by forming an auto-protective oxide layer of the base metal

4 General requirements

4.1 Steelmaking process

Unless otherwise agreed at the time of order, the steelmaking method is left to the discretion of the manufacturer; however, it shall be stated to the purchaser if so requested at the time of delivery.

4.2 Method of deoxidation

With the exception of qualities A and B, the steels shall be from casts with the addition of elements capable of producing a fine grain.

Steel of qualities A and B shall be supplied as non-rimming steel.

4.3 Delivery condition

4.3.1 The products are usually delivered as-rolled, except for S415W and S460W, which are delivered in the thermomechanically rolled or quenched and tempered conditions. Other delivery conditions may be agreed at the time of the order.

4.3.2 Flat products of quality D are delivered as-rolled, normalized (normalizing rolling), in the thermomechanically rolled, quenched and tempered condition, or in an equivalent condition.

4.4 Surface condition

The products shall have a smooth surface corresponding to the rolling process used; they shall not have any defects that are prejudicial to their subsequent processing or appropriate use.

By agreement, alternative requirements may be specified such as ISO 7788 for plates and wide flats, ISO 20723 for sections and ISO 9443 for bars. Other and/or more requirements than those reported in International Standards may be specified as well.

5 Technical requirements

5.1 Chemical composition

5.1.1 General

The steels specified in this International Standard are alloyed steels in accordance with ISO 4948-1.

5.1.2 Cast (heat) analysis

The composition limits for the cast (heat) analysis are given in Table 1.

If agreed at the time of enquiry and order, rare earth elements may be added, with a maximum of 0,15 %.

5.1.3 Product analysis

Table 2 gives the limits of permissible deviations in the product analysis relative to the limits for the cast (heat) analysis given in Table 1.

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Table 1 — Chemical composition of improved atmospheric corrosion resistance steels [cast (heat) analysis]

Grade	Quality ^a	C % max	Mn %	Si %	P %	S % max	Cr %	Cu %	Ni % max	Mo % max	Zr % max
S235W	A to D	0,13 ^b	0,20 – 0,60 ^b	0,10 – 0,40	≤ 0,040	0,035	0,40 – 0,80	0,25 – 0,55	0,65	—	—
S355WP	A to D	0,12	≤ 1,00	0,20 – 0,75	0,06 – 0,15	0,035	0,30 – 1,25	0,25 – 0,55	0,65	—	—
S355W	A to D	0,19	0,50 – 1,50	≤ 0,50	≤ 0,040	0,035	0,40 – 0,80	0,25 – 0,55	0,65	0,30	0,15
S390WP	A to D	0,12	≤ 1,40	0,15 – 0,65	0,07 – 0,12	0,035	0,30 – 1,25	0,25 – 0,55	0,65		
S415W	A to D	0,20	0,50 – 1,35	0,15 – 0,65	0,040	0,035	0,40 – 0,80	0,25 – 0,55	0,65		
S460W	A to D	0,20	≤ 1,40	0,15 – 0,65	0,040	0,035	0,40 – 0,80	0,25 – 0,55	0,65		

Any element other than those listed in this table, which is added intentionally, shall be indicated to the purchaser.

^a These steels shall contain at least one of the following grain-refining elements in the proportions indicated below:

- Al_{total} ≥ 0,020 %;
- Nb = 0,015 % to 0,060 %;
- V = 0,02 % to 0,15 %;
- Ti = 0,02 % to 0,10 %.

If these elements are used in combination, at least one of them shall be present in the steel in the minimum specified quantity.

^b If a minimum tensile strength requirement of 400 N/mm² is agreed, the limits for C and Mn can be increased to 0,15 and 1,00 respectively.

Table 2 — Permissible deviations for the product analysis relative to the specified cast (heat) analysis

Element	Specified limits %	Permissible deviation ^a
C	≤ 0,20	+ 0,03
Mn	≥ 0,20, ≤ 1,50	+ 0,10 – 0,05
Si	≥ 0,10, ≤ 0,75	+ 0,10 – 0,05
P	≤ 0,040 ≥ 0,06, ≤ 0,15	+ 0,005 ± 0,01
S	≤ 0,035	+ 0,005
Cr	≥ 0,30, ≤ 0,80 > 0,80, ≤ 1,25	± 0,05 ± 0,10
Ni	≤ 0,65	+ 0,05
Cu	≥ 0,20, ≤ 0,55	± 0,05
Nb	≥ 0,015, ≤ 0,060	± 0,005
V	≥ 0,02, ≤ 0,15	– 0,01 + 0,02
Ti	≥ 0,02, ≤ 0,10	– 0,01 + 0,02
Al	≥ 0,020	– 0,005
Mo	ISO 4952:2006 ≤ 0,30	+ 0,05
Zr	≤ 0,15	+ 0,02

^a The deviations apply either above or below the specified limits of the range, but not simultaneously for one element from different samples taken from different products originating from the same cast.

When maxima only are specified, the deviations are positive only.

The values only apply to samples prepared under the conditions laid down in 7.3.1.

5.2 Mechanical properties

Steels in the delivery conditions defined in 4.3 shall comply with the mechanical characteristics specified in Table 3, when these are determined on test pieces selected in accordance with the specifications of Clause 7.

For products more than 63 mm thick, the mechanical properties shall be subject to an agreement between the parties involved.

Table 3 — Mechanical characteristics

Grade	Quality	Yield strength			Tensile strength R_m N/mm ² *	Percentage elongation at fracture $A^{a,b}$ % min $L_0 = 5,65 \sqrt{S_0}$			Impact energy KV^c J min		
		R_{eH} N/mm ² *	min			$t \leq 16$	$16 < t \leq 40$	$40 < t \leq 63$	+ 20 °C	0 °C	- 20 °C
S235W	A	235	225	215	360 - 520 ^d	26	26	25	27	27	27
	B	235	225	215	360 - 520 ^d	26	26	25			
	C	235	225	215	360 - 520 ^d	26	26	25			
	D	235	225	215	360 - 520 ^d	26	26	25			
S355WP	A	355 ^e			470 - 630	21 ^e					
	D	355 ^e			470 - 630	21 ^e					27
S355W	A	355	345	335	470 - 630	22	22	21	27	27	27
	B	355	345	335	470 - 630	22	22	21			
	C	355	345	335	470 - 630	22	22	21			
	D	355	345	335	470 - 630	22	22	21			
S390WP	A	390 ^e			490 - 650	20 ^e			27	27	27
	B	390 ^e			490 - 650	20 ^e					
	C	390 ^e			490 - 650	20 ^e					
	D	390 ^e			490 - 650	20 ^e					
S415W	A	415	405	395	520 - 680	18	18	17	27	27	27
	B	415	405	395	520 - 680	18	18	17			
	C	415	405	395	520 - 680	18	18	17			
	D	415	405	395	520 - 680	18	18	17			
S460W	A	460	450	440	570 - 730	17	17	16	27	27	27
	B	460	450	440	570 - 730	17	17	16			
	C	460	450	440	570 - 730	17	17	16			
	D	460	450	440	570 - 730	17	17	16			

* 1 N/mm² = 1 MPa
a For transverse test pieces (plate and wide flats not less than 600 mm wide), these values are reduced by 2 points.
b Non-proportional test pieces may be used (see 7.1).
c Average of three tests; no individual result shall be less than 70 % of the specified minimum average value.
d If agreed at the time of enquiry and order, 400 - 560 N/mm² can be applied as the tensile strength requirement.
e This quality is only delivered for a product not more than 12 mm thick.

6 Inspection and testing

6.1 General

The product covered by this International Standard may be the subject of inspection and testing, in accordance with the conditions specified in Clause 8 of ISO 404:1992 relating to the chemical composition and mechanical properties of the product. Verification of the chemical composition of the product is also carried out if this is agreed and stated in the order.

If an inspection and testing is specified in the order, it shall be carried out in accordance with 6.2 to Clause 8, unless otherwise agreed at the time of order.

6.2 Test unit

6.2.1 General

The verification of product analysis and mechanical properties shall be per cast (heat).

6.2.2 Tensile tests

A test unit shall contain products of the same form, grade and delivery condition and be taken from the same thickness range, in accordance with Table 3, for the specified yield strength.

For a test unit not exceeding 50 t, one tensile test shall be carried out.

For a test unit exceeding 50 t, two tensile tests shall be carried out.

6.2.3 Impact tests

A test unit shall contain products of the same form, grade and delivery condition.

For a test unit not exceeding 50 t, one set of three impact tests shall be carried out at 0 °C for quality C or at – 20 °C for quality D or, if specified in the order, at + 20 °C for quality B.

For a test unit exceeding 50 t, two sets of three impact tests shall be carried out at 0 °C for quality C or at – 20 °C for quality D or, if specified in the order, at + 20 °C for quality B.

6.2.4 Product analysis

If specified in the order, one product analysis shall be carried out per cast.

6.2.5 Testing procedures

6.2.5.1 General

Unless otherwise stated by the purchaser, the procedure shall be as specified in 6.2.5.2 and 6.2.5.3.

6.2.5.2 Tensile test

A sample shall be taken for each specified thickness range specified in Table 3, with the additional requirement that, for $t \leq 16$ mm, the maximum thickness of the products of the batch shall be not greater than twice the minimum thickness.

6.2.5.3 Impact test

A sample shall be taken from the thickest product in each thickness range given in Table 3.

For flat products of quality D, if agreed at the time of enquiry and order, a test sample shall be taken from each rolled product (parent plate).

6.3 Position and orientation of sample (see ISO 377)

6.3.1 General

For product thicknesses between 6 mm and 40 mm, sub-surface specimens shall be used.

For product thicknesses exceeding 40 mm, samples shall be taken from the 1/4 thickness position.