INTERNATIONAL STANDARD

ISO 630-4

First edition
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Structural steels —

Part 4: Technical delivery conditions for high-yield-strength quenched and tempered structural steel plates

Aciers de construction —

Partie 4: Conditions techniques de livraison pour tôles en acier de construction trempé et revenu à haute limite d'élasticité

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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 630-4 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 3, *Steels for structural purposes*.

This first edition cancels and replaces ISO 630:1995, which has been technically revised. It incorpoates ISO 630:1995/Amd 1:2003.

ISO 630 consists of the following parts, under the general title *Structural steels*:

— *Part 1: General technical delivery conditions for hot-rolled products*

— *Part 2: Technical delivery conditions for structural steels for general purposes*

— *Part 3: Technical delivery conditions for fine-grain structural steels*

— *Part 4: Technical delivery conditions for high-yield-strength quenched and tempered structural steel plates*

The following parts are under preparation:

— *Part 5: Technical delivery conditions for structural steels with improved atmospheric corrosion resistance*

— *Part 6: Technical delivery conditions for seismic improved structural steels for building*

Structural steels —

Part 4:
Technical delivery conditions for high-yield-strength quenched and tempered structural steel plates

1 Scope

This part of ISO 630 specifies qualities for high-yield-strength quenched and tempered structural steels. This part of ISO 630 applies to steel plates rolled on a reversing mill which are used in the quenched and tempered condition and normally intended for welded or bolted structures.

This part of ISO 630 does not include the following structural steels, some of which are covered by other International Standards:

— Sheet and strip — refer to ISO TC 17/SC 12, *Continuous mill flat rolled products*;

— Tubular products — refer to ISO TC 5/SC 1, *Steel tubes*.

NOTE Lists of standards covered by ISO/TC 17/SC 12 and ISO/TC 5/SC 1 are available on the ISO Web site.

This part of ISO 630 covers 10 grades. Grades S460Q, S500Q, S550Q, S620Q, S690Q, S890Q and S960Q are covered in Annex A. Grades SG460Q, SG500Q, and SG700Q are covered in Annex B.

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 630–1, *Structural steels — Part 1: General technical delivery conditions for hot-rolled products*

ISO 643, *Steels — Micrographic determination of the apparent grain size*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 630-1 and the following apply.

3.1
quenching
operation which consists of cooling a ferrous product more rapidly than in still air from a high temperature above Ac_1

NOTE Ac_1 is the temperature at which austenite begins to form during heating.

3.2
tempering
heat treatment applying to a ferrous product, generally after quench hardening, or another heat treatment to bring the properties to the required level, and consisting of heating to specific temperatures ($< Ac_1$) and soaking for an appropriate duration, followed by cooling at an appropriate rate

NOTE Additionally, the following may apply: processes of direct quenching plus tempering.

3.3
fine-grain steel
steel with fine-grain structure with an equivalent index of ferritic grain size □6 determined in accordance with ISO 643

See 6.1.

4 Classification and designation

4.1 Classification

The steel grades specified in this part of ISO 630 shall be classified as non-alloy quality or alloy special steels.

4.2 Grades and qualities

This document specifies 10 grades. Grades S460Q, S500Q, S550Q, S620Q, S690Q, S890Q and S960Q are covered in Annex A. Grades SG460Q, SG500Q, and SG700Q are covered in Annex B.

Each grade is available in up to five qualities. These grades and qualities differ in their specified mechanical properties and impact energy requirements.

Quality A: no impact test

Quality C: impact testing at 0 °C

Quality D: impact testing at −20 °C

Quality E: impact testing at −40°C

Quality F: impact testing at −60°C

4.3 Normative annexes

The requirements of Annex A or Annex B are to be regarded separately. Each annex is independent of the other without combining in any way.

5 Information to be supplied by purchaser

5.1 Mandatory information

The information that shall be supplied by the purchaser at the time of the order is specified in ISO 630-1.

5.2 Options

The options of ISO 630-1 apply (see ISO 630-1). In addition, the following options apply to products according to this part of ISO 630. If the purchaser does not indicate a wish to implement any of these options at the time of the order, the products shall be supplied in accordance with the basic specification (see 5.1).

a) Testing of impact properties in the transverse direction using Charpy V-notch test pieces in accordance with ISO 630-1.

b) Testing of tensile and impact properties at a frequency per each plate as heat-treated.

c) On special request of the purchaser, the manufacturer shall inform the purchaser at the time of the order which of the alloying elements appropriate to the steel grade required will be deliberately added to the material to be delivered and reported in the heat analysis.

d) On special request of the purchaser, the manufacturer shall inform the purchaser at the time of the order which of the alloying elements appropriate to the steel grade required will be deliberately added to the

material to be delivered and reported in the product analysis. The product analysis shall be carried out at an agreed frequency when specified at the time of the order.

6 Requirements

See ISO 630-1.

6.1 Steelmaking process

See ISO 630-1.

If a special steelmaking process has been specified, this shall be reported in the inspection document.

The steels shall have a fine-grain practice containing sufficient amounts of nitrogen-binding elements.

6.2 Deoxidation

The steels specified in this specification shall be fully killed.

6.3 Delivery condition

The products covered by this part of ISO 630 are delivered in the quenched and tempered condition. The delivery condition is indicated in the inspection document.

6.4 Chemical composition

6.4.1 Heat analysis

The chemical composition determined by heat analysis shall comply with the specified values in Table A.1 or Table B.1.

6.4.2 Product analysis

The product analysis of grades S460Q, S500Q, S550Q, S620Q, S690Q, S890Q and S960Q shall comply with the values given in Table A.2.

The permitted deviations on analysis of grades SG460Q, SG500Q, and SG700Q, relative to the values for heat analysis, are given in Table B.2.

6.4.3 Carbon equivalent values

The carbon equivalent value (CEV) requirements for Annex A grades are given in Table A.3 and for Annex B grades in Table B.3.

For determining the CEV, the following International Institute for Welding (IIW) formula shall be used:

$$CEV = C + Mn/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15$$

6.5 Mechanical properties

6.5.1 Tensile properties

The tensile properties at ambient temperature shall comply with the values specified in Table A.4 or Table B.4.

6.5.2 Charpy V-notch impact tests

The impact properties of Charpy V-notch test pieces shall comply with the values specified in Table A.5 or Table B.5. The orientation of the specimens shall be longitudinal, unless a transverse orientation is agreed between the purchaser and manufacturer (see 5.2, ISO 630-1, and the values in Table A.6).

6.6 Surface conditions

See ISO 630-1.

6.7 Internal soundness

See ISO 630-1.

6.8 Dimensions and tolerances on dimensions, shape and mass

See ISO 630-1.

7 Inspection

Specific inspection shall be required for all grades.

8 Sampling — Frequency of testing

8.1 Verification

The verification of mechanical properties shall be by heat.

8.2 Test units

8.2.1 Annex A

The test unit shall contain products of the same form, grade, quality, and delivery condition, and of the same thickness range as specified in Table A.4 for the yield strength and shall be taken by heat:

— 40 tons or part thereof.

8.2.2 Annex B

The test unit shall be taken on each plate as heat treated.

9 Test methods

See ISO 630-1.

10 Marking

See ISO 630-1.

Annex A
(normative)

Steel grades S460Q, S500Q, S550Q, S620Q, S690Q, S890Q and S960Q: Chemical composition and mechanical properties

Table A.1 — Chemical composition (heat analysis) [a]

Grade	Quality	C % max.	Si % max.	Mn % max.	P % max.	S % max.	N % max.	B % max.	Cr % max.	Cu % max.	Mo % max.	Nb % max.[b]	Ni % max.	Ti % max.[b]	V % max.[b]	Zr % max.[b]
All grades	D	0,20	0,80	1,70	0,025	0,015	0,015	0,005 0	1,50	0,50	0,70	0,06	2,0	0,05	0,12	0,15
	E, F				0,020	0,010										

[a] Depending on the thickness of the product and the manufacturing conditions, the manufacturer may add to the steel one or several alloying elements up to the maximum values given in order to obtain the specified properties (see 6.4.1).

[b] There shall be at least 0,015 % of a grain-refining element present. Aluminium is also one of these elements. The minimum content of 0,015 % applies to soluble aluminium, this value is regarded as attained if the total aluminium content is at least 0,018 %; in case of dispute, the soluble aluminium content shall be determined.

Table A.2 — Chemical composition (product analysis) based on Table A.1 [a]

Grade	Quality	C % max.	Si % max.	Mn % max.	P % max.	S % max.	N % max.	B % max.	Cr % max.	Cu % max.	Mo % max.	Nb % max.[b]	Ni % max.	Ti % max.[b]	V % max.[b]	Zr % max.[b]
All grades	D	0,22	0,86	1,80	0,030	0,017	0,016	0,006 0	1,60	0,55	0,74	0,07	2,1	0,07	0,14	0,17
	E, F				0,025	0,012										

[a] Depending on the thickness of the product and the manufacturing conditions, the manufacturer may add to the steel one or several alloying elements up to the maximum values given in order to obtain the specified properties (see 6.4.2).

[b] There shall be at least 0,010 % of a grain-refining element present. Aluminium is also one of these elements. The minimum content of 0,010 % applies to soluble aluminium, this value is regarded as attained if the total aluminium content is at least 0,013 %; in case of dispute, the soluble aluminium content shall be determined.

Table A.3 — Maximum CEV based on the heat analysis

Designation		Maximum CEV in % for nominal product thickness in mm		
Grade	Quality	≤50	>50 ≤100	>100 ≤150
S460Q	D, E, F	0,47	0,48	0,50
S500Q	D, E, F	0,47	0,70	0,70
S550Q	D, E, F	0,65	0,77	0,83
S620Q	D, E, F	0,65	0,77	0,83
S690Q	D, E, F	0,65	0,77	0,83
S890Q	D, E, F	0,72	0,82	—
S960Q	D, E	0,82	—	—

Table A.4 — Tensile properties at room temperature

Designation		Minimum yield strength R_{eH} [ac] MPa [b] Nominal thickness mm			Tensile strength R_m [a] MPa [b] Nominal thickness mm			Minimum elongation after fracture % $L_0 = 5{,}65\sqrt{S_0}$
Grade	Quality	≥3 ≤50	>50 ≤100	>100 ≤150	≥3 ≤50	>50 ≤100	>100 ≤150	
S460Q	D, E, F	460	440	400	550 to 720		500 to 670	17
S500Q	D, E, F	500	480	440	590 to 770		540 to 720	17
S550Q	D, E, F	550	530	490	640 to 820		590 to 770	16
S620Q	D, E, F	620	580	560	700 to 890		650 to 830	15
S690Q	D, E, F	690	650	630	770 to 940	760 to 930	710 to 900	14
S890Q	D, E, F	890	830	—	940 to 1 100	880 to 1 100	—	11
S960Q	D, E	960	—	—	980 to 1 150	—	—	10

[a] For plate and wide flats with widths ≥600 mm, the direction transverse to the rolling direction applies. For all other products, the values apply for the direction parallel to the rolling direction.

[b] 1 MPa = 1 N/mm^2.

[c] If R_{eH} is not pronounced, refer to ISO 630-1:2011, 9.2.

Table A.5 — Minimum values of impact energy for impact tests on longitudinal V-notch test pieces

Designation		Minimum values [a] of impact energy in J at test temperatures [b], in °C			
Grade	Quality	0	−20	−40	−60
S460Q S500Q S550Q S620Q S690Q S890Q S960Q	D	40	30	—	—
S460Q S500Q S550Q S620Q S690Q S890Q S960Q	E	50	40	30	—
S460Q S500Q S550Q S620Q S690Q S890Q	F	60	50	40	30

[a] Unless otherwise specified, the testing temperature for each quality is the lowest available with a specified energy value.

[b] For nominal thicknesses ≤12 mm, see ISO 630-1.

Table A.6 — Minimum values of impact energy for impact tests on transverse V-notch test pieces, when the impact test on transverse test pieces is agreed at the time of the order

Designation		Minimum values [a] of impact energy in J at test temperatures [b], in °C			
Grade	Quality	0	−20	−40	−60
S460Q S500Q S550Q S620Q S690Q S890Q S960Q	D	30	27	—	—
S460Q S500Q S550Q S620Q S690Q S890Q S960Q	E	35	30	27	—
S460Q S500Q S550Q S620Q S690Q S890Q	F	40	35	30	27

[a] Unless otherwise specified, the testing temperature for each quality is the lowest available with a specified energy value.

[b] For nominal thicknesses ≤12 mm, see ISO 630-1.

Annex B
(normative)

Steel grades SG460Q, SG500Q, and SG700Q: Chemical composition and mechanical properties

Table B.1 — Chemical composition (heat analysis)

Grade	Quality	C % max.	Si % max.	Mn % max.	P % max.	S % max.	Cu % max.	Ni % max.	Cr % max.	Mo % max.	V % max.	Nb % max.	Ti % max.	B % max.	Zr % max.
SG460Q	A, C, D	0,18	0,55	1,60	0,035	0,035	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[b]
SG500Q	A, C, D	0,22	0,55	2,00	0,035	0,04	[a]	[a]	[a]	0,05	0,11	0,05	[a]	[a]	[b]
SG700Q	A, D, E	0,21	0,80	2,00	0,035	0,035	0,50	1,50	2,00	0,60	0,10	0,06	0,10	0,006	0,15

[a] There is no requirement, but the amount of these elements shall be determined for each heat and shall be reported in the inspection document.

[b] There is no requirement.

Table B.2 — Permitted deviation of product analysis vs. heat analysis [a]

Element	Range of specified element %	Permissible deviation over maximum specified %
Carbon	≤0,15	0,03
	>0,15 ≤0,22	0,04
Silicon	≤0,80	0,06
Manganese	≤2,00	0,10
Phosphorus	≤0,035	0,01
Sulfur	≤0,04	0,01
Vanadium	≤0,10	0,01
	>0,10 ≤0,25	0,02
Niobium	≤0,06	0,01
Boron	≤0,006	[b]
Titanium	≤0,10	0,01
Copper	≤0,50	0,03
Nickel	≤1,00	0,03
	>1,00 ≤1,50	0,05
Chromium	≤0,90	0,04
	>0,90 ≤2,00	0,06
Molybdenum	≤0,20	0,01
	>0,20 ≤0,40	0,03
	>0,40 ≤0,60	0,04
Zirconium	≤0,15	0,03

[a] Applicable to all qualities A, C, D, and E.

[b] Not applicable.

Table B.3 — Maximum CEV [a] based on the heat analysis

Designation		Maximum CEV in % for nominal product thickness in mm	
Grade	Quality	≤50	>50 ≤100
SG460Q	A, C, D	0,44	0,47
SG500Q	A, C, D	0,47	0,50
SG700Q	A, D, E	0,60	0,63

[a] By agreement for SG700Q.

Table B.4 — Tensile properties at room temperature

Grade	Quality	Yield strength MPa [a] min. Thickness [c] mm				Tensile strength MPa	Minimum elongation after fracture [b] % min.		
		≤16	>16 to ≤40	>40 to ≤100	>100 to ≤150		$L_0 = 5{,}65\sqrt{S_0}$	Gauge length = 50 mm [d]	Gauge length = 200 mm
SG460Q	A, C, D	460	450	420	[e]	570 to 720	15	20	15
SG500Q	A, C, D	500	500	500	[e]	600 to 760	17	19	17
SG700Q	A, D, E	690	690	620	620	760 to 930	14	16	14

[a] 1 MPa = 1 N/mm^2.

[b] Only one of the three requirements is required. Unless specified in the order, the manufacturer may use either a proportional or fixed gauge length specimen. When the test value is reported, the specimen used shall be reported.

[c] The producer should be contacted for possible thickness limits.

[d] If measured using a 40 mm wide tension test specimen, the elongation is determined in a 50 mm gauge length that includes the fracture and shows the greatest elongation.

[e] Not available.

Table B.5 — Longitudinal Charpy V-notch properties

Grade	Quality	Impact energy J			Maximum thickness mm
		0 °C	−20 °C	−40 °C	
SG460Q	A				100
	C	27			100
	D		27		100
SG500Q	A				100
	C	27			100
	D		27		100
SG700Q	A				150
	D		27		150
	E			27	150

Bibliography

[1] EN 10025-6, *Hot rolled products of structural steels — Part 6: Technical delivery conditions for flat products of high yield strength structural steels in the quenched and tempered condition*

[2] ASTM A514M, *Standard Specification for High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding*

[3] JIS G3106, *Rolled steels for welded structure*

[4] JIS G3128, *High yield strength steel plates for welded structure*

[5] JIS G3140, *Higher yield strength steel plates for bridges*

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