
**Steel strip, cold-reduced with a mass
fraction of carbon over 0,25 %**

*Feuillards en acier au carbone laminés à froid à teneur en carbone
supérieure à 0,25 %*

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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.

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 documents 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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 12, *Continuous mill flat rolled products*.

This fourth edition cancels and replaces the third edition (ISO 4960:2007), which has been technically revised. The main changes compared to the previous edition are as follows:

- added definitions for surface finishes and "lot";
- revised scope;
- added Clause 4 for "Dimensions";
- "Specified qualities appropriate to the particular grade" changed to "Ordering conditions", renumbered as 5.3;
- 5.5.1 changed from HRB to HRBW;
- previous 5.5 changed to 5.8 using revised surface finish terminology, addition of surface roughness requirements;
- revised Table 5.

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.

Steel strip, cold-reduced with a mass fraction of carbon over 0,25 %

1 Scope

This document specifies the minimum requirements for steel strip of carbon over 0,25 %, in coils and cut lengths.

The product is applicable to highly stressed parts of many different types and is characterized by close dimensional tolerances and controlled surface finishes.

The steel strip is produced in a number of types and surface finishes to be compatible with differing applications requirements.

This document does not apply to alloy steels or stainless steels.

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 6507-1, *Metallic materials — Vickers hardness test — Part 1: Test method*

ISO 6508-1, *Metallic materials — Rockwell hardness test — Part 1: Test method*

ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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 <http://www.electropedia.org/>

3.1

cold-reduced carbon steel strip

product produced from a hot-rolled pickled coil which has been given substantial cold reduction

Note 1 to entry: The product is characterized by an improved surface, greater uniformity in thickness and improved mechanical properties compared to hot-rolled strip. A cold-reduced strip is also characterized by tighter thickness tolerances than a cold-reduced sheet, as well as by specified edges.

3.2

skin pass

light cold rolling of the product

Note 1 to entry: The purpose of the skin passing is one or more of the following: to minimize the appearance of coil breaks, stretcher strains and fluting; to control the shape; and to obtain the required surface finish.

Note 2 to entry: Some increase in hardness and some loss in ductility will result from skin passing.

3.3

mill edge

normal side edge without any definite contour produced in hot rolling

Note 1 to entry: Mill edges may contain some irregularities, such as cracked or torn edges or thin (feathered) edges.

3.4

sheared edge

material with a burr developed where the material was cut

3.5

matte finish

dull finish

rougher finish obtained by temper passing cold-reduced strip using rolls roughened by mechanical or chemical means

Note 1 to entry: Surface roughness of the strip is typically Ra 0,5 μm to 2,0 μm , which is beneficial in obtaining better paint adhesion, and in aiding drawing by reducing surface friction due to better oil adhesion.

3.6

regular bright finish

moderately bright reflective lustre finish obtained by temper passing cold-reduced strip using rolls with a ground finish

Note 1 to entry: Surface roughness of the strip is typically Ra 0,5 μm , which is suitable for many applications but not necessarily for bright plating applications.

3.7

plating bright finish

smooth bright finish where a high lustre is not necessarily obtained by temper passing cold-reduced strip using rolls with a fine ground finish

Note 1 to entry: Surface roughness of the strip is typically Ra 0,25 μm max.

3.8

best bright finish

mirror bright finish obtained by temper passing cold-reduced strip using rolls with a polished finish

Note 1 to entry: Surface roughness of the strip is typically Ra 0,10 μm max., which is suitable for bright plating.

3.9

lot

up to a specified quantity of material of the same designation rolled to the same thickness and surface condition

4 Dimensions

Cold-reduced steel strip is commonly produced in thicknesses of 6 mm and under, and in widths up to 600 mm, in coils and cut lengths. Strip products may be available in widths greater than 600 mm by agreement between producer and purchaser; however, such products are typically classified as cold-rolled sheet.

5 Conditions of manufacture

5.1 Steelmaking

Unless otherwise agreed by the interested parties, the processes used in making the steel and in manufacturing steel strips are left to the discretion of the manufacturer. On request, the purchaser shall be informed of the steelmaking process being used.

5.2 Chemical composition

The chemical composition (heat analysis) shall conform to the requirements given in [Tables 1](#) and [2](#).

5.3 Chemical analysis

5.3.1 Heat analysis

An analysis of each heat shall be made by the manufacturer in order to determine conformity with the requirements given in [Tables 1](#) and [2](#). On request, a report of the heat analysis shall be made available to the purchaser or the purchaser's representative. Each of the elements listed in [Tables 1](#) and [2](#) shall be included in the report of the heat analysis. When the amount of copper, nickel, chromium or molybdenum present is less than 0,02 %, the analysis may be reported as "<0,02 %".

5.3.2 Product analysis

A product analysis may be made by the purchaser in order to verify the specified analysis of the product and shall take into consideration any normal heterogeneity. The product analysis shall be in accordance with [Tables 2](#) and [3](#).

Table 1 — Chemical composition (heat analysis)

Mass fractions in percent

Grade	C	Mn ^a	P ^b max.	S ^b max.	Si ^c max.
CS30	0,28 to 0,34	0,60 to 0,90	0,035	0,03	0,35
CS35	0,32 to 0,38	0,60 to 0,90	0,035	0,03	0,35
CS40	0,37 to 0,44	0,60 to 0,90	0,035	0,03	0,35
CS45	0,43 to 0,50	0,60 to 0,90	0,035	0,03	0,35
CS50	0,48 to 0,55	0,60 to 0,90	0,035	0,03	0,35
CS55	0,50 to 0,60	0,60 to 0,90	0,035	0,03	0,35
CS60	0,55 to 0,65	0,60 to 0,90	0,035	0,03	0,35
CS65	0,60 to 0,70	0,60 to 0,90	0,035	0,03	0,35
CS70	0,65 to 0,75	0,60 to 0,90	0,035	0,03	0,35
CS75	0,70 to 0,80	0,40 to 0,70	0,035	0,03	0,35
CS85	0,80 to 0,93	0,70 to 1,00	0,035	0,03	0,35
CS95	0,90 to 1,03	0,30 to 0,50	0,035	0,03	0,35

^a Other manganese values can be specified upon agreement at the time of ordering, provided a range of 0,30 % is maintained.

^b When specified, phosphorus and sulfur may be ordered to 0,020 % maximum by heat analysis.

^c Silicon can be specified as a restricted range upon agreement at the time of ordering.

Table 2 — Limits on additional chemical elements

Mass fractions in percent

Element	Grade	Heat analysis	Product analysis
		max.	max.
Cu ^a	(CS30–CS75)	0,30	0,33
	(CS85–CS95)	0,25	0,28
Ni ^a	(CS30–CS75)	0,20	0,23
	(CS85–CS95)	0,25	0,28
Cr ^{abc}	(CS30–CS75)	0,20	0,24
	(CS85–CS95)	0,30	0,34
Mo ^{ab}	(CS30–CS95)	0,06	0,07
Nb ^d	(CS30–CS95)	0,008	0,018
V ^d	(CS30–CS95)	0,008	0,018
Ti ^d	(CS30–CS95)	0,008	0,018

^a The sum of copper, nickel, chromium and molybdenum shall not exceed 0,50 % on heat analysis. When one or more of these elements are specified, the sum does not apply. In which case, only the individual limits on the remaining elements will apply.

^b The sum of chromium and molybdenum shall not exceed 0,16 % on heat analysis. When one or more of these elements are specified, the sum does not apply. In which case, only the individual limits on the remaining elements will apply.

^c A higher value of Cr may be supplied after agreement between the producer and consumer.

^d An analysis greater than 0,008 % may be supplied after agreement between the manufacturer and the purchaser.

Table 3 — Product analysis tolerances for Table 1

Mass fractions in percent

Element	Range/Maximum of specified element	Tolerance over maximum specified
C	$0,15 < C \leq 0,40$	0,04
	$0,40 < C \leq 0,80$	0,05
	$>0,80$	0,06
Mn	$\leq 0,60$	0,03
	$0,60 < Mn \leq 1,15$	0,04
Si	$0,30 < Si \leq 0,60$	0,05
P	$\leq 0,04$	0,01
S	$\leq 0,04$	0,01

NOTE The above maximum tolerance is the allowable excess over the requirement of the heat analysis shown in Table 1.

5.4 Ordering conditions

5.4.1 Cold-reduced steel strip is supplied one of the following ordering conditions:

- full-hard quality: material rolled to the final thickness with a minimum hardness;
- spheroidized annealed quality: annealed to a hardness or tensile strength, or both;
- quenched and tempered quality: quenched and tempered steel strip for steel designations of CS55 and over, tempered to properties;
- intermediate quality: temper rolled to a hardness range by a controlled amount of cold-reduced after annealing.

5.4.2 The material shall be ordered in accordance with either hardness or tensile strength requirements, but not with both, unless agreed to by both parties.

5.5 Mechanical properties

5.5.1 Hardness

When required [see [5.4.2](#) and [Clause 15 h](#)], the hardness shall conform to [Tables 4, 5, 7](#) or [8](#). In case of the intermediate quality, hardness shall conform to [Table 8](#), or shall be as agreed upon between the manufacturer and the purchaser.

HV is the Vickers hardness.

HR is the Rockwell hardness. HRBW is the Rockwell hardness (type B) using tungsten carbide indenter ball.

5.5.2 Tensile properties

When required [see [5.4.2](#) and [Clause 15 h](#)] the tensile properties shall be as stated in [Tables 5](#) and [6](#), at the time the steel is made available for shipment if the mechanical property designation is specified.

5.6 Application

It is desirable to identify the specified product for fabrication by the name of the part or by the intended application. Proper identification of the part may include visual examination, prints or description, or a combination of these.

5.7 Weldability

This product is suitable for welding if appropriate welding conditions are selected.

5.8 Surface finish condition

5.8.1 Cold-reduced steel strip is produced in a regular bright finish by rolling on rolls having a moderately smooth finish (it is not generally applicable to bright plating); or in a dull finish by rolling on rolls roughened by mechanical or chemical means. The dull finish is suitable for lacquer or paint adhesion.

5.8.2 Quenched and tempered strip (see [5.4.1](#)) may be supplied with the following surface finishes:

- a) matte (dull);
- b) regular bright;
- c) plating bright;
- d) best bright.

5.9 Oiling

As a deterrent to rusting, a coating of oil is usually applied to cold-reduced steel strip. The oil is not intended as a drawing or forming lubricant and should be easily removable with degreasing chemicals. On request, the manufacturer shall advise the purchaser which type of oil has been used. Cold-reduced steel strip may be ordered not oiled, if required, in which case the supplier has limited responsibility if oxidation occurs.

Table 4 — Hardness requirements for full-hard quality defined in 5.4.1 a)

Specified thickness mm	Hardness min.			
	HV	HV	HV	HR
	CS30 to CS45	CS50 to CS70	CS75 to CS95	CS30 to CS95
$e < 0,36$	240	250	260	15T92
$0,36 \leq e < 1$	230	240	250	30T83
$1 \leq e$	220	230	240	B98

Table 5 — Hardness, tensile strength and elongation requirements for spheroidized quality defined in 5.4.1 b)

Grade	Hardness max. ^{ab}				R_m max. ^b MPa	A% min. ^{bc}	
	HR15T	HR30T	HRBW	HV		$L_o = 50$ mm	$L_o = 80$ mm
CS30	85	67	76	160	585	18	16
CS35	86	68	78	170	590	17	15
CS40	87	70	80	170	595	16	14
CS45	88	72	83	175	600	16	14
CS50	88	72	84	180	605	15	13
CS55	88	73	85	180	610	15	13
CS60	89	74	87	185	620	14	12
CS65	89	75	88	185	630	13	11
CS70	90	76	89	190	640	12	10
CS75	90	76	90	190	640	12	10
CS85	91	78	93	205	670	12	10
CS95	92	80	94	210	680	12	10

NOTE Material may be ordered in terms of hardness; or tensile strength, and elongation requirements, but not of both (see 5.4.2).

R_m = tensile strength

A = percentage elongation after fracture

L_o = gauge length on test piece

1 MPa = 1 N/mm²

^a The HRBW values shown are applicable to thicknesses over 1 mm. HR30T should be used for thickness >0,36 mm to ≤1 mm. HR15T should be used for thicknesses ≤0,36 mm.

^b Lower maximum values of hardness or lower maximum levels of tensile strength and higher elongation values may be specified when ordering.

^c Elongation values apply only to thicknesses >0,5 mm to ≤3 mm: for greater thicknesses, elongation values shall be as agreed upon.

Table 6 — Tensile strength requirements for quenched and tempered quality defined in 5.4.1 c)

Grade	Tensile strength, R_m	Maximum thickness up to which the tensile values apply ^b
	range ^a MPa	
CS55	1 150 to 1 650	2
CS60	1 180 to 1 680	2
CS65	1 230 to 1 770	2,5
CS70	1 275 to 1 810	2,5
CS75	1 320 to 1 870	2,5
CS85	1 400 to 1 950	2,5
CS95	1 465 to 2 050	2

^a For a given tensile strength, the steel grade should be chosen with particular regard to thickness and the application of the materials. The purchaser should normally specify a tensile strength range equal to or greater than 200 N/mm² when ordering material.

1 MPa = 1 N/mm²

^b With greater thicknesses, the tensile strength values shall be as agreed upon at the time of ordering.

Table 7 — Hardness requirements for quenched and tempered quality defined in 5.4.1 c)

Grade	Vickers hardness	Maximum thickness up to which the hardness values apply ^b
	range ^a HV	
CS55	300 to 490	2
CS60	350 to 500	2
CS65	365 to 525	2,5
CS70	375 to 535	2,5
CS75	390 to 555	2,5
CS85	415 to 580	2,5
CS95	335 to 610	2

^a The purchaser should normally specify a hardness range equal to or greater than 66 HV when ordering material.

^b With greater thicknesses, the hardness values shall be as agreed upon at the time of ordering.

Table 8 — Hardness requirements for intermediate quality defined in 5.4.1 d)

Specified thickness mm	Rockwell hardness	HR max.	HV max.		
	Scale	CS30 to CS95	CS30 to CS45	CS50 to CS70	CS75 to CS95
$e < 0,36$	HR15T	89	240	250	260
$0,36 \leq e < 1$	HR30T	81	230	240	250
$1 \leq e$	HRBW	97	220	230	240

5.10 Dimensional tolerances

Dimensional tolerances shall be in accordance with [Tables 9 to 13](#) inclusive. When required, specified tolerances shall be as agreed between the manufacturer and purchaser. It has not been practicable to formulate flatness tolerances for material covered by this document.

6 Sampling

One representative sample for the hardness or tensile test required in [Tables 4 to 8](#), as applicable, shall be taken from each lot of 25 t or less for shipment. The sample shall be taken midway between the edges.

7 Test methods

7.1 Hardness test

The hardness test shall be carried out in accordance with ISO 6507-1 or ISO 6508-1.

7.2 Tensile test

The tensile test shall be conducted in accordance with the methods specified in ISO 6892-1. Longitudinal test pieces shall be taken midway between the centre and the edge of the as-rolled strip.

8 Decarburization

When specified, the steel strip shall have a maximum permissible depth of complete plus partial decarburization of 0,025 mm or 1,5 % of the thickness of the strip, whichever is greater, except that strip less than 0,03 mm thick shall show no complete decarburization.

9 Retests

9.1 Machining and flaws

If any test piece shows defective machining or develops flaws, it shall be discarded and another test piece substituted.

9.2 Additional tests

If any test does not give the specified results, two additional tests shall be conducted on samples selected at random from the same lot. Both retests shall conform to the requirements of this document; otherwise the lot shall be rejected.

Table 9 — Thickness tolerances for cold-reduced carbon steel strip, for coils and cut lengths

Values in millimetres

Specified thickness	Tolerance ^a for specified width					
	≤125		> 125 ≤ 250		> 250 ≤ 600	
	N	F	N	F	N	F
$e < 0,15$	±0,01	±0,01	±0,02	±0,015	—	—
$0,15 \leq e < 0,25$	±0,02	±0,015	±0,02	±0,015	—	—
$0,25 \leq e < 0,4$	±0,02	±0,015	±0,03	±0,02	±0,03	±0,02
$0,4 \leq e < 0,6$	±0,03	±0,02	±0,03	±0,02	±0,04	±0,03
$0,6 \leq e < 0,8$	±0,04	±0,03	±0,04	±0,03	±0,05	±0,035
$0,8 \leq e < 1$	±0,04	±0,03	±0,05	±0,035	±0,05	±0,035
$1 \leq e < 1,5$	±0,05	±0,035	±0,06	±0,045	±0,07	±0,055

NOTE Thickness is measured at any point on the strip not less than 20 mm from a side edge for mill edge strip, and not less than 10 mm from a side edge for sheared edge strip. For widths of mill edge strip 40 mm or less and sheared edge strip 20 mm wide or less, measurements are made on the centre-line of the strip. Measurements are not made on top of the shear burr.

^a N indicates normal tolerances; F indicates fine tolerances.

Table 9 (continued)

Specified thickness	Tolerance ^a for specified width					
	≤125		> 125 ≤ 250		> 250 ≤ 600	
	N	F	N	F	N	F
1,5 ≤ e < 2,5	±0,06	±0,04	±0,07	±0,055	±0,08	±0,06
2,5 ≤ e < 4	±0,07	±0,05	±0,08	±0,06	±0,10	±0,08
4 ≤ e ≤ 6	±0,09	±0,06	±0,10	±0,08	±0,12	±0,09

NOTE Thickness is measured at any point on the strip not less than 20 mm from a side edge for mill edge strip, and not less than 10 mm from a side edge for sheared edge strip. For widths of mill edge strip 40 mm or less and sheared edge strip 20 mm wide or less, measurements are made on the centre-line of the strip. Measurements are not made on top of the shear burr.

^a N indicates normal tolerances; F indicates fine tolerances.

Table 10 — Width tolerances for cold-reduced carbon steel strip, for coils and cut lengths, mill edge

Values in millimetres

Specified width	Tolerance ^a
w ≤ 100	±1,5
100 > w ≤ 200	±2
200 > w ≤ 400	±2,5
400 > w ≤ 500	±3
500 > w ≤ 600	±4

^a The values specified do not apply to the uncropped ends of a mill-edge coil within 7 m inclusive of both ends. By agreement between the manufacturer and purchaser, material can be ordered with all plus tolerances, in which case the value is doubled.

Table 11 — Width tolerances for cold-reduced carbon steel strip, for coils and cut lengths sheared edge, not re-squared

Values in millimetres

Specified width	Width tolerance ^a for specified thickness			
	≤1,5	> 1,5 ≤ 2,5	> 2,5 ≤ 4,5	> 4,5 ≤ 6
w ≤ 100	±0,2	±0,25	±0,35	±0,4
100 > w ≤ 200	±0,25	±0,3	±0,45	±0,5
200 > w ≤ 300	±0,3	±0,35	±0,5	±0,5
300 > w ≤ 450	±0,4	±0,45	±0,6	±0,7
450 > w ≤ 600	±0,5	±0,5	±0,6	±0,7

^a By agreement between the manufacturer and the purchaser, material can be ordered to all plus tolerances or to all minus tolerances, in which case the value is doubled.

Table 12 — Length tolerances for cold-reduced carbon steel strip, for coils and cut lengths

Values in millimetres

Specified length	Tolerance ^a for specified widths up to 600 mm
l ≤ 1 500	+15
1 500 < l ≤ 3 000	+20
3 000 < l ≤ 6 000	+25

^a Closer tolerances are subject to agreement between the manufacturer and purchaser.

Table 12 (continued)

Specified length	Tolerance ^a for specified widths up to 600 mm
$6\ 000 < l$	+0,5 % of specified length

^a Closer tolerances are subject to agreement between the manufacturer and purchaser.

Table 13 — Camber tolerances for cold-reduced carbon steel strip, for coils and cut lengths

Values in millimetres

Specified width	Camber tolerance ^a
$> 10 \leq 40$	25 max. in any 2 000 length
$> 40 \leq 600$	10 max. in any 2 000 length

NOTE 1 Camber is the greatest deviation of a side edge from a straight line (see Figure 1), the measurement being taken on the concave side with a straightedge.

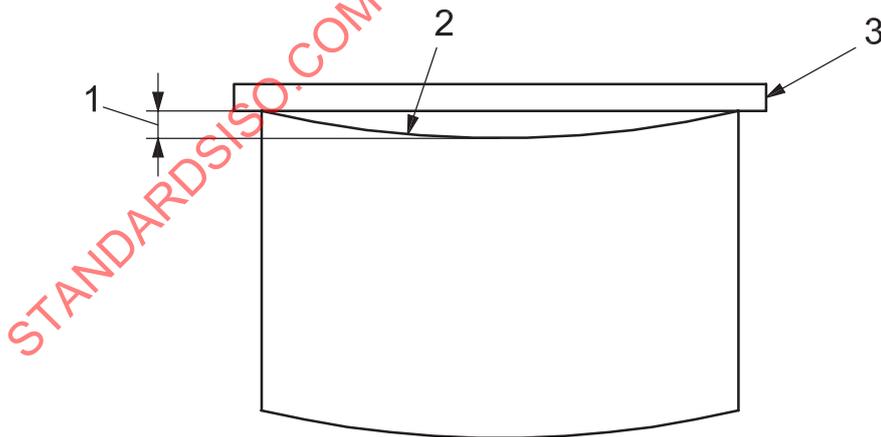
NOTE 2 In those cases where it is not practical to measure the tolerance as given in this table, the camber tolerance, t_2 , may be calculated from the formula:

$$t_2 = \frac{(2 \times l_2 \times t_1)}{l_1}$$

where

- l_1 is the standard length in this table (2 000 mm);
- l_2 is the non-standard length;
- t_1 is the camber tolerance in this table.

^a The values do not apply to the uncropped ends of a mill-edge coil, within 7 m inclusive of both ends.



Key

- 1 edge camber
- 2 side edge
- 3 straight edge

Figure 1 — Measurement of camber