
Cold-reduced steel sheet of high tensile strength and low yield point with improved formability

Tôles en acier laminées à froid à haute résistance à la traction, basse limite inférieure d'écoulement et aptitude au formage accrue

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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 3.

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.

International Standard ISO 14590 was prepared by Technical Committee TC 17, *Steels*, Subcommittee SC 12, *Continuous mill flat rolled products*.

Annex A forms an integral part of this International Standard.

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1 Scope

1.1 This International Standard applies to killed, cold-reduced steel sheet of two types that are commercially available in the world. The first type (see Table 1) represents steels that are produced to mechanical properties only and the second type (see Table 2) are produced to both mechanical and chemical properties. Bake hardening steels are included in both types.

1.2 Cold-reduced sheet less than 600 mm wide may be slit from wide sheet and will be considered as sheet.

1.3 This International Standard does not cover steels designated as commercial quality or drawing qualities (covered in ISO 3574), steels of structural quality (covered in ISO 4997) or steels of higher strength with improved formability (covered in ISO 13887).

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 6892:1998, *Metallic materials – Tensile testing at ambient temperature*.

ISO 7438:1985, *Metallic materials – Bend test*.

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1

cold-reduced steel sheet

product obtained from hot-rolled descaled steel sheet by cold reducing to the required sheet thickness followed by annealing to recrystallize the grain structure

3.2

skin pass

light cold rolling of the material (covered by this International Standard) the purpose being one or more of the following:

- a) minimize the appearance of coil breaks, stretcher strains and fluting;
- b) control the shape;
- c) obtain required surface finish suitable for ordering decorative painting.

NOTE Some increase in hardness and some loss of ductility will result from skin passing.

4 Conditions of manufacture

4.1 Steelmaking

Unless otherwise agreed upon, the processes used in making the steel and in manufacturing cold-reduced steel sheet are left to the discretion of the manufacturer. On request, the purchaser shall be informed of the steelmaking process being used.

4.2 Chemical composition

The chemical composition (heat analysis) shall conform to the requirements given in Table 2. No chemical composition is applicable to Table 1

4.3 Chemical analysis

4.3.1 Heat analysis

A heat analysis of each heat of steel shall be made by the manufacturer to determine compliance with the requirements of Table 2. When requested, at the time of ordering, this analysis shall be reported to the purchaser or his representative.

4.3.2 Product analysis

A product analysis may be made by the purchaser to verify the specified analysis of the product and shall take into consideration any normal heterogeneity. The sampling method and deviation limits shall be agreed upon between the interested parties at the time of ordering.

4.4 Weldability

The product is normally suitable for welding if appropriate welding conditions are selected.

4.5 Application

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

4.6 Mechanical properties

At the time that the steel is made available for shipment, the mechanical properties shall be as stated in Table 1 or Table 2 when they are determined on test pieces obtained in accordance with the requirements of clause 7.

NOTE Prolonged storage of the sheet may cause a change in the mechanical properties (increase in hardness and a decrease in elongation) leading to an adverse effect on formability.

4.7 Surface condition

The condition of the surface of cold-reduced steel sheet is not required to be the same for unexposed parts as it is for exposed parts.

Surface condition of sheet for unexposed parts may contain pores, some slight pitting, small markings, light scratches and a light discoloration. The surface of sheet for exposed parts shall be reasonably free of these conditions. Unless otherwise agreed, only one side is inspected.

4.8 Surface finish

Cold-reduced steel sheet is normally produced in a matt finish, dull in appearance, which is suitable for ordinary decorative painting but is not recommended for electroplating.

When cold-reduced steel sheet is deformed during fabrication, localized areas may roughen to some degree and such affected portions of the part may require hand finishing to prepare the surface for the intended application.

4.9 Oiling

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

5 Dimensional tolerances

5.1 Dimensional tolerances

See Tables 3 to 10, inclusive.

5.2 Restricted thickness tolerances

See Table 4.

6 Sampling

6.1 Tensile test

One representative sample for the tensile test required in Table 1 or Table 2 shall be taken from each lot of sheet for shipment. A lot consists of 50 t or less of sheet of the same grade rolled to the same thickness and condition.

6.2 Bend test (when specified)

One representative sample for the bend test shall be taken from each lot of sheet for shipment. A lot consists of all sheet of the same grade rolled to the same thickness and condition.

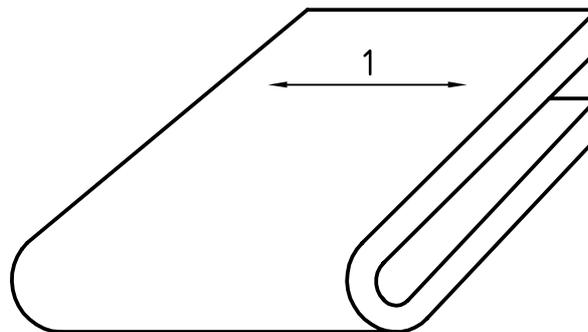
7 Mechanical property tests

7.1 Tensile test

The tensile test shall be carried out in accordance with the requirements of ISO 6892. Transverse test pieces shall be taken midway between the centre and edge of the sheet as rolled.

7.2 Bend test (when specified)

The bend test piece shall withstand being bent as described in Table 1 or Table 2 and Figure 1, without cracking on the outside of the bent portion. The bend test shall be carried out at ambient temperature in accordance with ISO 7438.



Key

1 Rolling direction

Figure 1 — Transverse bend test piece (after bending)

8 Retests

8.1 General

If a test does not give the specified results, two or more pieces shall be taken at random from the same lot. Both retests shall conform to the requirements of this International Standard; otherwise the lot may be rejected.

8.2 Machining and flaws

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

8.3 Additional tests

If a test does not give the specified results, two additional tests shall be carried out at random on the same lot. Both retests shall conform to the requirements of this International Standard; otherwise, the lot may be rejected.

9 Resubmission

The manufacturer may resubmit for acceptance the products that have been rejected during earlier inspection because of unsatisfactory properties, after he has subjected them to suitable treatment (selection, heat treatment) which, on request, will be indicated to the purchaser. In this case, the tests shall be carried out as if they applied to a new batch.

The manufacturer has the right to present the rejected products to a new examination for compliance with the requirements for another grade.

10 Workmanship

The surface condition shall be that normally obtained on this product. The material in cut lengths shall be free from amounts of lamination, surface flaws and other imperfections that are detrimental to the final product or to subsequent appropriate processing. Processing for shipment in coils does not afford the manufacturer the opportunity to observe readily or to remove imperfect portions as can be carried out on the cut length product.

11 Inspection and acceptance

While not usually required for products covered by this International Standard, when the purchaser specifies that inspection and test for acceptance be observed prior to shipment from the manufacturer's works, the manufacturer shall afford the purchaser's inspector all reasonable facilities to determine that the steel is being furnished in accordance with this International Standard.

Steel that is reported to be defective after arrival at the user's works, shall be set aside, properly and correctly identified and adequately protected. The supplier shall be notified in order that he be able to properly investigate.

12 Coil size

When the product is ordered in coils, a minimum or range of acceptable inside diameter (I.D.) shall be specified. In addition, the maximum outside diameter (O.D.) and the maximum acceptable coil mass shall be specified.

13 Marking

Unless otherwise stated, the following minimum requirements for identifying the steel shall be legibly stencilled on the top of each lift or shown on a tag attached to each coil or shipping unit.

- a) manufacturer's name or identifying brand;
- b) reference to this International Standard, i.e., ISO 14590;
- c) the quality designation number and grade;
- d) the order number;
- e) the product dimensions;
- f) the lot number;
- g) the mass.

14 Information to be supplied by the purchaser

To specify adequately the requirements of this International Standard, inquiries and orders shall include the following information.

- a) reference to this International Standard, i.e., ISO 14590;
- b) the grade;
- c) the dimensions of the product and the quantity required;
- d) whether skin passing is required (see 3.2);
- e) whether strip is to be furnished oiled or not oiled (see 4.9);
- f) the report of the heat analysis, if required (see 4.3.1);
- g) the application (name of part), if possible (see 4.5);
- h) the report of the mechanical properties, if required (see 4.6);
- i) the type of finish (see 4.8);
- j) inspection and tests for acceptance prior to shipment from the manufacturer's works, if required (see clause 11);
- k) limitations on mass and dimensions of individual coils and bundles, if applicable (see clause 12);
- l) restricted thickness tolerances, if required (see 5.2).

NOTE A typical ordering description is as follows:

International Standard ISO 14590 cold reduced steel sheet grade 325YL, normal thickness tolerances, 1 mm × 800 mm × 1800 mm, 40 000 kg for part No. 7654. Automobile seat rail, oiled, furnish report of heat analysis and tensile test, maximum lift mass 40 000 kg.

Table 1 — Mechanical properties

Grade	R_{eL} N/mm ² min.	BH Amt. N/mm ² min.	R_m N/mm ² min.	A_{50} % min.	180° bend mandrel diameter ^a
175YL	175	—	340	31	Flat
205YL	205	—	370	29	Flat
235YL	235	—	390	27	Flat
265YL	265	—	440	23	Flat
295YL	295	—	490	21	Flat
325YL	325	—	540	18	1,0 <i>t</i>
355YY	355	—	590	15	2,0 <i>t</i>
225YY	225	—	490	22	Flat
245YY	245	—	540	19	1,0 <i>t</i>
265YY	265	—	590	16	2,0 <i>t</i>
365YY	365	—	780	12	6,0 <i>t</i>
490YY	490	—	980	5	8,0 <i>t</i>
185YH	185	30	340	31	Flat
<p>YH = Bake hardening R_{eL} = Lower yield strength BH Amount = see A 2.3 R_m = tensile strength A = percentage elongation after fracture <i>t</i> = thickness of bend test piece, in millimeters 1 N/mm² = 1 MPa</p>					
<p>^a The bend test is performed only when specified (see 7.2). The bend test diameters in this table are for test pieces prepared for laboratory testing. Conditions during fabrication may be more severe and not simulate those during laboratory testing.</p>					

Table 2 — Mechanical properties and chemical composition

Grade	R_{eL} N/mm ² min.	BH Amt. N/mm ² min.	R_m N/mm ² min.	A_{50} % min.	180° bend mandrel diameter ^a
RP220	220	—	340	30	Flat
RP260	260	—	380	28	Flat
RP300	300	—	420	26	Flat
DP250	250	—	400	26	Flat
DP300	300	—	500	22	Flat
DP350	350	—	600	16	2,0 <i>t</i>
DP280	280	—	600	20	2,0 <i>t</i>
DP400	400	—	800	8	4,0 <i>t</i>
DP600	600	—	1000	5	8,0 <i>t</i>
BH180	180	40	300	32	Flat
BH220	220	30	340	30	Flat
BH260	260	30	380	28	Flat
BH300	300	30	420	26	Flat
Grade	C %	Si %	Mn %	P %	S %
RP220	0,08 max.	0,50 max.	0,70 max.	0,080 max.	0,030 max.
RP260	0,08	0,50	0,70	0,100	0,030
RP300	0,10	0,50	0,70	0,120	0,030
DP250	0,10	0,50	0,70	0,030	0,030
DP300	0,12	0,50	0,80	0,080	0,030
DP350	0,14	0,50	1,00	0,100	0,030
DP280	0,14	0,70	1,80	0,030	0,030
DP400	0,18	0,70	1,80	0,030	0,030
DP600	0,20	0,70	1,80	0,030	0,030
BH180	0,04	0,50	0,70	0,060	0,030
BH220	0,08	0,50	0,70	0,080	0,030
BH260	0,08	0,50	0,70	0,100	0,030
BH300	0,10	0,50	0,70	0,120	0,030
RP = Rephosphorized; DP = Dual Phase; BH = Bake Hardening R_{eL} = Lower yield strength R_m = tensile strength A = percentage elongation after fracture <i>t</i> = thickness of bend test piece, in millimeters 1 N/mm ² = 1 MPa BH Amount = see A 2.3 Grades DP400 and DP600 may contain microalloying elements like Nb, Ti and/or V.					
^a The bend test is performed only when specified (see 7.2). The bend test diameters in this table are for test pieces prepared for laboratory testing. Conditions during fabrication may be more severe and not simulate those during laboratory testing.					

Table 3 — Normal thickness tolerances for coils and cut lengths

Values in millimetres

Specified width	Thickness tolerances for specified thicknesses ^a									
	≤0,4	> 0,4 ≤0,6	> 0,6 ≤0,8	> 0,8 ≤1,0	> 1,0 ≤1,2	> 1,2 ≤1,6	> 1,6 ≤2,0	> 2,0 ≤2,5	> 2,5 ≤3,0	> 3,0 ≤4,0
600 ≤ 1 200	± 0,04	± 0,05	± 0,07	± 0,08	± 0,09	± 0,11	± 0,13	± 0,15	± 0,18	± 0,20
> 1 200 ≤ 1 500	± 0,05	± 0,06	± 0,08	± 0,09	± 0,10	± 0,12	± 0,14	± 0,16	± 0,19	± 0,21
> 1 500 ≤ 1 800	—	± 0,08	± 0,09	± 0,10	± 0,12	± 0,14	± 0,16	± 0,18	± 0,21	± 0,23

^a The thickness tolerances for sheet in coil form are the same as for sheet supplied in cut lengths but in cases where welds are present, the tolerances shall be double those given over a length of 15 m in the vicinity of the weld.

Thickness is measured at any point on the sheet not less than 25 mm from a side edge.

For specified strength levels of R_{eL} 350 N/mm² and greater increase the thickness tolerances by 10 %, applying normal rounding off procedures.

Table 4 — Restricted thickness tolerances for coils and cut lengths

Values in millimetres

Specified width	Thickness tolerances for specified thicknesses ^a									
	≤0,4	> 0,4 ≤0,6	> 0,6 ≤0,8	> 0,8 ≤1,0	> 1,0 ≤1,2	> 1,2 ≤1,6	> 1,6 ≤2,0	> 2,0 ≤2,5	> 2,5 ≤3,0	> 3,0 ≤4,0
600 ≤ 1 200	± 0,025	± 0,035	± 0,04	± 0,045	± 0,055	± 0,07	± 0,08	± 0,10	± 0,11	± 0,12
> 1 200 ≤ 1 500	± 0,035	± 0,045	± 0,05	± 0,06	± 0,07	± 0,08	± 0,09	± 0,11	± 0,12	± 0,13
> 1 500 ≤ 1 800	—	± 0,05	± 0,06	± 0,06	± 0,07	± 0,08	± 0,09	± 0,11	± 0,12	± 0,13

^a The thickness tolerances for sheet in coil form are the same as for sheet supplied in cut lengths but in cases where welds are present, the tolerances shall be double those given over a length of 15 m in the vicinity of the weld.

Thickness is measured at any point on the sheet not less than 25 mm from a side edge.

For specified strength levels of R_{eL} 350 N/mm² and greater increase the thickness tolerances by 10 %, applying normal rounding off procedures.

Table 5 — Width tolerances for coils and cut lengths, not resquared

Values in millimetres

Specified widths	Tolerance ^a
≤ 1 200	+5 0
> 1 200 ≤ 1 500	+7 0
Over 1 500	+9 0

^a Tolerances for sheet over 4 mm thick shall be the subject of agreement

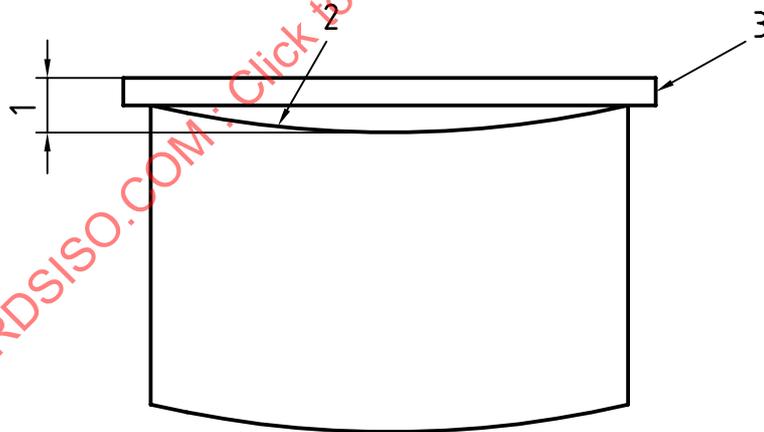
Table 6 — Length tolerances for cut lengths, not resquared

Values in millimetres

Specified lengths	Tolerance
$\leq 3\ 000$	+20 0
$> 3\ 000 \leq 6\ 000$	+30 0
Over 6 000	+ 0,5 % \times length 0

Table 7 — Camber tolerances for coils and cut lengths, not resquared (see figure 2)

Form	Camber tolerance
Coils	20 mm in any 5 000 mm length
Cut lengths	0,4 % \times length



Key

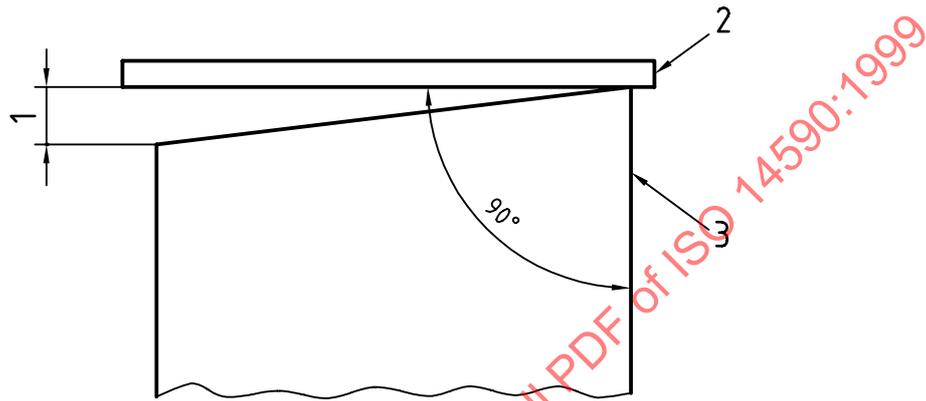
- 1 Edge camber
- 2 Side edge (concave side)
- 3 Straightedge

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

Figure 2 — Measurement of camber

Table 8 — Out-of-square tolerance for cut lengths, not resquared (see figure 3)

Dimensions	Out-of-square tolerance
All thicknesses and all sizes	1 % × width



Key

- 1 Out-of-square
- 2 Straightedge
- 3 Side edge

NOTE Out-of-square is the greatest deviation of an edge from a straight line at right angles to a side and touching one corner, the measurement being taken as shown in this figure. It can also be measured as one half the difference between the diagonals of the cut-length sheet.

Figure 3 — Measurement of out-of-square

Table 9 — Out-of square tolerances for resquared sheet

Values in millimetres

Specified lengths	Specified widths	Out-of-square tolerance
≤ 3 000	≤ 1 200	+ 2 0
	> 1 200	+ 3 0
> 3 000	All widths	+ 3 0

NOTE When measuring material to resquared tolerances, consideration may have to be given to extreme variations in temperature.