INTERNATIONAL STANDARD

ISO 14590

Third edition
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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 et faible limite d'élasticité, et aptitude au formage accrue

Reference number
ISO 14590:2016(E)

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Foreword

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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).

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For an explanation on 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.

The committee responsible for this document is ISO/TC 17, *Steel*, Subcommittee SC 12, *Continuous mill flat rolled products*.

This third edition cancels and replaces the second edition (ISO 14590:2005), which has been technically revised.

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

1 Scope

This International Standard applies to cold-reduced steel sheet of two types that are commercially available in the world. Type 1 represents steels that are produced to mechanical properties only and Type 2 represents steels that are produced to both chemical and mechanical properties. Bake hardening steels are included in both types.

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 documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

ISO 16162, *Cold-rolled steel sheet products — Dimensional and shape tolerances*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
bake hardenable steel
highly formable steel that, subsequent to cold working, has been subjected to a low-temperature heat treatment, such as that used for paint baking (170 °C to 200 °C), in order to effect a significant increase in its yield strength, primarily due to carbon ageing

3.2
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

3.3
dual-phase steel
steel whose thermal processing has resulted in a multi-phase structure that includes one or more low-temperature transformation products, thus providing for improved formability at higher strength levels

3.4
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 decrease of ductility will result from skin passing.

3.5
ageing
change in steel properties with the passage of time

Note 1 to entry: Ageing may result in a change in yield strength and a corresponding decrease in ductility during storage. Ageing always has a negative effect on formability. The redevelopment of a definite yield point phenomenon as a result of ageing can result in a renewed susceptibility to surface imperfections, such as stretcher strain marks (Lüder's Lines) and fluting when the steel is formed. To avoid these adverse outcomes, it is essential that the period between final processing at the producing mill and fabrication be kept to a minimum. Rotation of stock, by using the oldest material first, is important. Effective roller levelling immediately prior to fabrication can achieve reasonable freedom from stretcher strain marks.

3.6
lot
up to a specified quantity of steel sheet of the same designation rolled to the same thickness and grade

3.7
Type 1
cold-reduced steel sheet (3.2) specified to mechanical properties only

3.8
Type 2
cold-reduced steel sheet (3.2) specified to both mechanical properties and chemical composition

3.9
preliminary strain load
F_{WH}
load (kgf or N) of work hardening reached when the preliminary strain elongation specified in the tensile test is reached

Note 1 to entry: Preliminary strain elongation herein shall be 2 %.

Note 2 to entry: to entry: Refer to Figure A.2.

3.10
strain ageing yield load
F_{SA}
load (kgf or N) at yielding measured during the tensile testing of the specimen after it has been strained and heat-treated at 170 °C for 20 min

Note 1 to entry: Refer to Figure A.1.

3.11
BH amount
O_{BH}
value (kgf/mm^2 or N/mm^2) obtained by dividing the value (kgf or N) derived by subtracting the preliminary strain load, F_{WH}, from the strain ageing yield load, F_{SA}, of the test piece parallel portion original area (mm^2) before the preliminary strain

4 Dimensions

Cold-reduced steel sheet of high tensile strength and low yield point with improved formability is produced in thicknesses from 0,25 mm to 3,2 mm and in widths of 600 mm and over in coils and cut lengths. Product less than 600 mm wide, slit from wide sheet, will be considered as sheet.

5 Conditions of manufacture

5.1 Steelmaking

Unless otherwise agreed upon by the interested parties, 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.

5.2 Chemical composition

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

Table 1 — Chemical composition for Type 2 (heat analysis)

Mass fractions in percent

Grade[a]	C max.	Si max.	Mn max.	P max.	S max.
SS220	0,10	0,50	1,00	0,100	0,030
SS260	0,10	0,50	1,50	0,120	0,030
SS300	0,15	0,50	1,50	0,140	0,030
DP250	0,10	0,70	2,00	0,030	0,030
DP280	0,12	0,70	2,50	0,030	0,030
DP300	0,14	1,40	2,00	0,080	0,030
DP350	0,14	1,40	2,50	0,100	0,030
DP400	0,18	1,40	2,50	0,030	0,030
DP600	0,20	1,40	3,00	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

NOTE Micro-alloying elements can be added.

[a] SS = structural steel;
DP = dual phase;
BH = bake hardening.

Table 2 — Limits on additional chemical elements for Type 2

Mass fractions in percent

Element	Cu[a] max.	Ni[a] max.	Cr[a,b] max.	Mo[a,b] max.	Nb[c] max.	V[c] max.	Ti[c] max.
Heat analysis	0,20	0,20	0,15	0,06	0,008	0,008	0,008
Product analysis	0,23	0,23	0,19	0,07	0,018	0,018	0,018

NOTE Each of the elements listed in this table 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 %.

[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 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 apply.

[c] Heat analysis greater than 0,008 % may be supplied after agreement between the producer and purchaser.

5.3 Chemical analysis

5.3.1 Heat analysis

An analysis of each heat of steel shall be made by the manufacturer to determine compliance with the requirements of 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 tolerances shall be in accordance with Tables 2 and 3.

Table 3 — Product analysis tolerances

Mass fractions in percent

Element	Range/maximum of specified element	Tolerance
C	≤0,15 >0,15 to ≤0,40	0,03 0,04
Si	>0,30 to ≤0,60 >0,60	0,05 0,06
Mn	>0,60 to ≤1,15 >1,15 to ≤1,70 >1,70	0,04 0,05 Subject to negotiation
P	≤0,04 >0,04	0,01 Not applicable
S	≤0,06	0,01

NOTE 1 This table applies to Type 2 Grades SS, DP and BH.

NOTE 2 The above maximum tolerance is the allowable excess over the specified requirement and not the heat analysis. For example, for Grade DP350, the following product analysis values are within these tolerances: C 0,17; Mn 1,04; P not applicable; S 0,04 and Si 0,55.

5.4 Mechanical properties

Type 1 and Type 2 steels shall satisfy the mechanical properties shown, respectively, in Tables 4 and 5 when they are determined in accordance with the requirements of Clauses 6 and 7. On request, a report of the mechanical properties shall be made to the purchaser.

NOTE Prolonged storage of the sheet can result in ageing, leading to an adverse effect on formability.

Table 4 — Mechanical properties for Type 1

Grade[a]	R_{eL}[b] N/mm², min.	O_{BH}[c] N/mm², min.	R_m[d] N/mm², min.	A min, %[e]	
				L_o = 50 mm	L_o = 80 mm
175YL	175	—	340	31	29
205YL	205	—	370	29	27
235YL	235	—	390	27	25
265YL	265	—	440	23	21
295YL	295	—	490	21	19
325YL	325	—	540	18	17
355YL	355	—	590	15	14
225YY	225	—	490	22	20
245YY	245	—	540	19	18
265YY	265	—	590	16	15
365YY	365	—	780	12	11
490YY	490	—	980	5	4
185YH	185	30	340	31	29

NOTE 1 MPa = 1 N/mm².

[a] YL = forming/drawing use;
YY = dual phase;
YH = bake hardening.

[b] R_{eL} = lower yield strength.

[c] O_{BH} = see 3.11.

[d] R_m = tensile strength.

[e] A = percentage elongation after fracture.

Table 5 — Mechanical properties for Type 2

Grade[a]	R_{eL}[b] MPa, min.	O_{BH}[c] MPa, min.	R_m[d] MPa, min.	A min, %[e,f] L_o = 80 mm
SS220	220	—	320	30
SS260	260	—	360	28
SS300	300	—	400	26
DP250	250	—	400	26
DP280	280	—	600	20
DP300	300	—	400	26
DP350	350	—	600	16
DP400	400	—	800	8
DP600	600	—	1 000	5
BH180	180	—	300	32
BH220	220	30	320	30
BH260	260	30	360	28
BH300	300	30	400	26

NOTE 1 1 MPa = 1 N/mm^2.

NOTE 2 Micro-alloying elements can be added.

NOTE 3 For DP and BH steels, less than 0,7 mm thickness, reduce minimum R_{eL} by 2 %.

NOTE 4 When yield phenomenon in not obvious, use Rp 0,2 % in place of R_{eL}.

a SS = structural steel;
DP = dual phase;
BH = bake hardening.

b R_{eL} = lower yield strength.

c O_{BH} = see 3.11.

d R_m = tensile strength.

e A = percentage elongation after fracture.

f L_o = original gauge length of test piece.

5.5 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.

5.6 Weldability

This product is normally suitable for welding when appropriate welding conditions are selected.

NOTE 1 As the carbon content increases above 0,15 %, spot welding becomes increasingly difficult.

NOTE 2 Because the heat of welding might significantly lower the strength of Grade 490 YY, this grade is not recommended for welding.

5.7 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 marks, 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.

5.8 Surface finish

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

5.8.2 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.

5.9 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 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 sheet may be ordered not oiled, if required; in which case, the supplier has limited responsibility if oxidation occurs.

5.10 Dimensional and shape tolerances

Dimensional and shape tolerances applicable to cold-reduced steel sheet of high tensile strength and low yield point with improved formability shall be as given in ISO 16162.

6 Sampling — Tensile test

One representative transverse sample from each lot of 50 t or less for shipment shall be taken for the tensile test to verify conformance to the requirements of Tables 4 and 5.

7 Test methods — Tensile test

The tensile tests shall be carried out in accordance with ISO 6892-1. Transverse test pieces shall be taken midway between the centre and the edge of the as rolled sheet.

8 Retests

8.1 Machining and flaws

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

8.2 Elongation

On any tensile test, if any part of the fracture is outside the middle half of the gauge length as scribed before the test, the test shall be discarded and a retest shall be carried out.

8.3 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 International Standard; otherwise, the lot shall be rejected.

9 Resubmission

9.1 The manufacturer has the right to resubmit, for acceptance, the products that have been rejected during earlier inspection because of unsatisfactory properties, after the rejected products have been subjected to a suitable treatment (e.g. selection, heat treatment, etc.) 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 lot.

9.2 The manufacturer has the right to present the rejected products for re-examination for compliance with the requirements of another quality or grade.

10 Workmanship

10.1 The surface condition shall be that normally obtained in a cold-rolled product.

10.2 The steel sheet in cut lengths shall be free from quantities of laminations, surface flaws, and other imperfections that are detrimental to the final product or to subsequent appropriate processing.

10.3 Processing for shipment in coils does not afford the manufacturer the opportunity to observe readily or to remove non-conforming portions as can be carried out on the cut length product. However, this does not relieve the manufacturer of the responsibility to provide a product that meets the requirements for surface condition that is normally obtained in a cold rolled product.

11 Inspection and acceptance

11.1 Although not usually required for products covered by this International Standard, when the purchaser specifies that inspection and tests for acceptance shall 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.

11.2 Steel that is reported to be non-conforming after arrival at the user's works shall be set aside, properly and correctly identified and adequately protected. The manufacturer shall be notified in order that the reported non-conforming material may be properly investigated.

12 Coil size

When ISO 14590 steel sheet is ordered in coils, a minimum or range of acceptable inside diameter(s) (ID) shall be specified. In addition, the maximum outside diameter (OD) and the maximum acceptable coil mass shall be specified.

13 Marking

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

a) the manufacturer's name or identifying brand;

b) a reference to this International Standard, i.e. ISO 14590;

c) the grade and type designations;

d) the order number;

e) the product dimensions;

f) the mass;

g) the bundle or coil number.

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) the number of this International Standard, i.e. ISO 14590;

b) the grade and type designations;

c) the dimensions of the product and the quantity required;

d) whether skin passing is required (see 3.4);

e) whether sheet is to be furnished oiled or not oiled (see 5.9);

f) the report of the heat analysis, if required for Table 2 (see 5.3.1);

g) the application (name of part), if possible (see 5.5);

h) the report of the mechanical properties, if required (see 5.4);

i) the type of surface finish (see 5.8);

j) inspection and tests for acceptance prior to shipment from the manufacturer's works, if required (see 11.1);

k) limitations on masses and dimensions of individual coils and bundles, if applicable (see Clause 12);

l) restricted thickness tolerances, if required (see 5.10).

EXAMPLE A typical ordering description is as follows.

International Standard ISO 14590, cold-reduced steel sheet grade 325YL, normal thickness tolerances, 1 mm × 800 mm by coil, 100,000 kg for part No. 7654. Automobile seat rail, oiled, furnish report of heat analysis and tensile test, maximum lift mass 40,000 kg.

Annex A
(normative)

Bake hardening test method

A.1 General

This annex specifies the test method for determining the amount of bake hardening, hereinafter referred to as the "BH amount" of cold-reduced high strength steel sheets with improved formability (bake-hardening type).

A.2 Test piece

The class of test piece shall be the same as that used to determine compliance to the mechanical properties of Tables 4 and 5.

A.3 Heat treatment equipment

The heat treatment equipment to be used shall be capable of keeping the established temperature (170 °C) at a precision of ±5 °C.

A.4 Test

A.4.1 Preliminary strain

When a test piece is elongated by 2 % during the process of tensile testing, the load is removed and the preliminary strain load, F_{WH} (N), at that time shall be read out (see Figure A.2).

The permissible range of elongation in this case shall be ±0,2 %. The strain rate shall be controlled as follows: a load shall be applied at a suitable speed up to one-half of the estimated preliminary strain load; after the applied load exceeds the one-half of the estimated preliminary strain load, the average stress increase rate shall be 1 kgf/mm^{2}s to 3 kgf/mm^{2}s (9,8 N/mm^{2}s to 29 N/mm^{2}s).

A.4.2 Heat treatment

The test piece to which a preliminary strain has been given is charged into the heat treatment equipment and heat-treated at 170 °C for 20 min. Thereafter, it is taken out and air-cooled.

A.4.3 Strain ageing tension

The test piece, which is heat-treated after preliminary strain, is subject to tensile testing and the strain ageing yield load, F_{SA}, shall be obtained.

A.4.4 BH amount

The BH amount, O_{BH}, shall be obtained from Formula (A.1):

$$O_{BH} = \frac{F_{SA} - F_{WH}}{A_0} \quad \text{(A.1)}$$

where

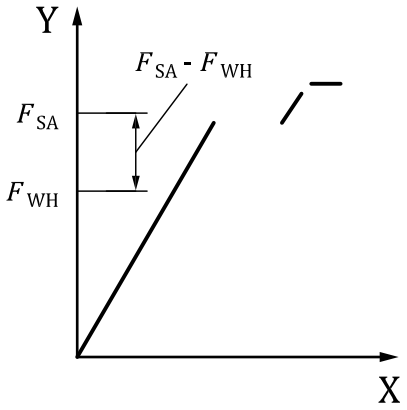
F_{SA} is the strain ageing yield load, in newtons;

F_{WH} is the preliminary strain load, in newtons;

A_0 is the original cross-sectional area of the parallel portion of the test piece before preliminary strain, in square millimetres.

A.4.5 Rounding off to numerical values

The numerical value of the BH amount shall be calculated to one decimal place and rounded off to the nearest integer in the case where the unit is newtons per square millimetres (or megapascals).

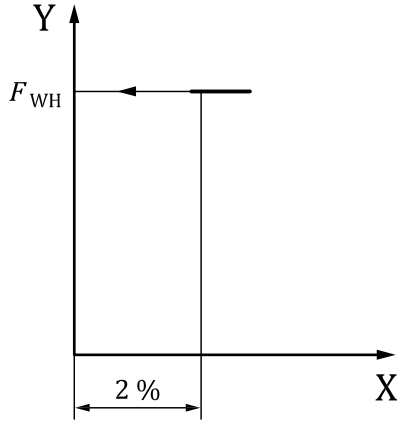


Key

X elongation

Y load

Figure A.1 — Stain aging yield load



Key

X elongation

Y load

Figure A.2 — Preliminary strain load

Bibliography

[1] JIS G 3135,[1)] *Cold Rolled High Strength Steel Sheets with Improved Formability for Automobile Structural Uses*

1) This document is recognized by ISO/TC 17/SC 12 to cover a subject similar to that of this International Standard. This information is given for the convenience of users of this International Standard and constitutes neither an endorsement of the document by TC 17/SC 12 or ISO, nor a statement regarding its degree of equivalence with this International Standard.

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