INTERNATIONAL STANDARD

ISO 14590

Second edition
2005-02-01

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 14590:2005(E)

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

Published in Switzerland

Contents

Page

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

This second edition cancels and replaces the first edition (ISO 14590:1999), which has been technically revised.

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

1 Scope

1.1 This International Standard applies to killed cold-reduced steel sheet of two types that are commercially available in the world. Type 1 (Table 1) represents steels that are produced to mechanical properties only and Type 2 (Table 2) are produced to both mechanical and chemical properties. Bake hardening steels are included in both types. All these steels are commonly produced by continuous annealing.

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 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 6892:1998, *Metallic materials — Tensile testing at ambient temperature*

ISO 16162:2000, *Continuously 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 hardening
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
resquared
steel sheet that may have received an additional shearing operation after being cut to length in an attempt to approach a true 90° angle at the shear cut

NOTE "Resquared" is referred to as "restricted" in some areas of the world.

3.5
skin pass
a light cold-rolling of the material covered by this International Standard

NOTE The purpose of the skin passing is one or more of the following:

a) minimize the appearance of coil breaks, stretcher strains and fluting;

b) control the shape;

c) obtain the required surface finish suitable for ordering decorative painting.

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

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

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

When grade SS, DP or BH (Table 2) is specified, 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 shall be agreed upon between the interested parties at the time of ordering. The product analysis tolerances shall be in accordance with Table 4.

4.4 Weldability

This 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 6.

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 should 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

Dimensional tolerances shall be in accordance with ISO 16162.

6 Sampling for tensile test

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

7 Tensile test

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

8 Retests

8.1 Machining and flaws

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

8.2 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 a 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 may properly investigate.

12 Coil size

When the product is ordered in coils, a minimum inside diameter or range of acceptable inside diameters (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) the number of this International Standard;

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) the number of this International Standard;

b) the type and grade;

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

d) whether skin passing is required (see 3.5);

e) whether strip is to be furnished oiled or not oiled (see 4.9);

f) the report of the heat analysis, if required for Table 2 (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 Clause 5).

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 × 1 800 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 for Type 1

Grade [1]	R_{eL} [2] N/mm², min.	O_{BH} [3] N/mm², min.	R_m [4] N/mm², min.	A 50 [5] %, min.	A 80 [5] %, min.
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

1) YL = forming/drawing use
YY = dual phase
YH = bake hardening

2) R_{eL} = lower yield strength

3) O_{BH} = see A.2.3

4) R_m = tensile strength

5) A = percentage elongation after fracture

NOTE N/mm² = 1 MPa

Table 2 — Mechanical properties and chemical composition for Type 2

Grade [1]	R_{eL} [2] N/mm², min.	O_{BH} [3] N/mm², min.	R_m [4] N/mm², min.	A 80 [5] %, min.
SS220	220	—	340	30
SS260	260	—	380	28
SS300	300	—	420	26
DP250	250	—	400	26
DP300	300	—	500	22
DP350	350	—	600	16
DP280	280	—	600	20
DP400	400	—	800	8
DP600	600	—	1000	5
BH180	180		300	32
BH220	220	30	340	30
BH260	260	30	380	28
BH300	300	30	420	26

Grade [1]	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
DP300	0,12	0,70	2,00	0,080	0,030
DP350	0,14	1,40	2,50	0,100	0,030
DP280	0,14	1,40	2,50	0,030	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

1) SS = structural steel
DP = dual phase
BH = bake hardening
2) R_{eL} = lower yield strength
3) O_{BH} = see A.2.3
4) R_m = tensile strength
5) A = percentage elongation after fracture

NOTE 1 1 N/mm² = 1 MPa
NOTE 2 Micro-alloying elements can be added.

Table 3 — Limits on additional chemical elements

Element	Heat analysis %, max.	Product analysis %, max.
Cu	0,20	0,23
NI	0,20	0,23
NOTE This table applies to Type 2, Grades SS, DP and BH.		

Table 4 — Product analysis tolerances

Element	Maximum of specified element %	Tolerance %
Carbon	⩽ 0,15	0,03
	> 0,15 to ⩽ 0,40	0,04
Manganese	> 0,60 to ⩽ 1,15	0,04
	> 1,15 to ⩽ 1,70	0,05
	> 1,70	Subject to negotiation
Phosphorus	⩽ 0,04	0,01
	> 0,04	Not applicable
Sulfur	⩽ 0,06	0,01
Silicon	> 0,30 to ⩽ 0,60	0,05
	> 0,60	0,06

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.

Annex A
(normative)

Bake hardening test method

A.1 Scope

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

A.2 Definitions

For the purposes of this International Standard, the principle definitions used in this annex are as follows.

A.2.1
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; preliminary strain elongation herein shall be 2 % (refer to Figure A.2)

A.2.2
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 (refer to Figure A.1)

A.2.3
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

A.3 Test piece

The class of test piece shall be the same as that used to determine compliance to the mechanical properties of Table 1 or 2.

A.4 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.5 Test

A.5.1 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} (kgf or 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.5.2 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.5.3 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.5.4 BH amount

The BH amount, O_{BH}, shall be obtained from the following formula:

$$O_{BH} = \frac{F_{SA} - F_{WH}}{A_0}$$

where

F_{SA} is the strain ageing yield load, in kilograms force (newtons);

F_{WH} is the preliminary strain load, in kilograms force (newtons);

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

A.5.5 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).