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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

ICS: 77.140.50

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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 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 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 killed 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 referenced documents, in whole or in part, are normatively referenced in this document and 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 6892-1, *Metallic materials — Tensile testing at ambient 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 hardening 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
restrictive squareness
steel sheet processed to approach a true 90^0 angle at the shear cut.

Note This product is sometimes referred as “resquared”

3.5
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; to obtain the required surface finish.

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

3.6
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 leveling immediately prior to fabrication can achieve reasonable freedom from stretcher strain marks.

3.7
lot
50 t or less of steel sheet of the same grade rolled to the same thickness and condition.

3.8
Type 1
Cold-reduced steel sheet specified to mechanical properties only.

3.9

Type 2
Cold-reduced steel sheet specified to both mechanical properties and chemical composition.

4 Dimensions

Cold-reduced steel of high tensile strength and low yield point with improved formability is produced in thicknesses from 0,25mm to 3,2mm 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 party, 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 [1a)]	**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	0,14	1,40	2,50	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
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

a) SS = structural steel
DP = dual phase
BH = bake hardening

NOTE 1 Micro-alloying elements can be added.

Table 2— Limits on additional chemical elements

Mass fractions in percent

Element	Cu[a] max.	Ni [a] max.	Cr[ab] max.	Mo[ab] max.	Nb[c] max.	V[cd] 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] For interstitial free steels only, the value of 0,15 % titanium, and 0,10 % maximum for niobium and vanadium are acceptable to ensure that the carbon and nitrogen are fully stabilized.

[d] 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 Table 1 and Table 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
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
Si	> 0,30 to ≤ 0,60 > 0,60	0,05 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.

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 Clause 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 [1]	R_{eL} [2] N/mm², min.	O_{BH} [3] N/mm², min.	R_m [4] N/mm², min.	A min, %[5]	
				L_o=50mm	L_o=80mm
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 1 MPa = N/mm^2

Table 5— Mechanical properties for Type 2

Grade [1]	R_{eL} [2] MPa, min.	O_{BH} [3] MPa, min.	R_m [4] MPa, min.	A min, % [5] 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	—	1000	5
BH180	180		300	32
BH220	220	30	320	30
BH260	260	30	360	28
BH300	300	30	400	26

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
6) L_0 = original gauge length of test piece

NOTE 1 1 MPa =1N/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 Rel by 2%.
NOTE4 When yield phenomenon in not obvious, use Rp 0.2% in place of Rel.

5.5 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, this grade is not recommended for welding.

5.6 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.

5.7 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.