INTERNATIONAL STANDARD

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Continuous hot-dip zinc-coated carbon steel sheet of commercial and drawing qualities

Tôles en acier au carbone galvanisées en continu par immersion à chaud, de qualité commerciale et pour emboutissage

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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.

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 3575 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 3575:2005), which has been technically revised.

Continuous hot-dip zinc-coated carbon steel sheet of commercial and drawing qualities

1 Scope

This International Standard applies to carbon steel sheet of commercial and drawing qualities coated by the continuous hot-dip zinc-coating process.

Zinc-coated sheet is suitable for applications where resistance to corrosion is of prime importance.

The steel sheet is produced in a number of qualities, coating mass, surface treatments and ordering conditions.

Zinc- and zinc-iron-alloy-coated steel sheet can be ordered in one of two ordering conditions.

a) Condition A): steel ordered to satisfy mechanical property requirements.

b) Condition B): steel ordered to make an identified part.

This International Standard does not cover steels designated as structural quality, which are covered in ISO 4998[1].

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 1460, *Metallic coatings — Hot dip galvanized coatings on ferrous materials — Gravimetric determination of the mass per unit area*

ISO 2178, *Non-magnetic coatings on magnetic substrates — Measurement of coating thickness — Magnetic method*

ISO 3497, *Metallic coatings — Measurement of coating thickness — X-ray spectrometric methods*

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

ISO 7438, *Metallic materials — Bend test*

ISO 16163:2010, *Continuously hot-dipped coated 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 Quality applications

3.1.1
commercial
intended for general fabricating purposes where sheet is used in the flat condition, or for bending or moderate forming

3.1.2
drawing
intended for parts where drawing or severe forming may be involved

3.1.3
deep drawing
intended for parts where severe forming or severe drawing may be involved

3.1.4
deep drawing-aluminum killed (non-aging)
intended for fabricating parts where particularly severe drawing or forming may be involved or essential freedom from aging is required

3.1.5
extra-deep drawing (stabilized)
intended for applications requiring interstitial free steel (IF) which is non-aging and has maximum formability

3.2
aluminum killed
steel which has been deoxidized with aluminum that is sufficient to prevent the evolution of gas during solidification

3.3
stabilized interstitial free steel
extra-low-carbon steel in which all interstitial elements are combined with titanium and/or equivalent elements

NOTE Stabilized steel is sometimes referred to as interstitial free steel.

3.4
continuous hot-dip zinc-coated steel sheet
product obtained by hot-dip zinc coating cold-reduced sheet coils or hot-rolled descaled sheet coils on a continuous zinc-coating line to produce either zinc-coated coils or zinc-coated cut lengths

3.5
breakage allowance
agreed upon level of acceptable die breakage not subject to claim

3.6
normal spangle
coating formed as a result of unrestricted growth of zinc crystals during normal solidification

NOTE This coating has a metallic lustre and is the type normally furnished for a wide variety of applications. It may be furnished S (normal coating, with skin pass) or N (normal coating, as coated); however, it may be variable in appearance and not suitable for decorative painting.

3.7
minimized spangle
coating obtained by restricting normal spangle formation during the solidification of the zinc

NOTE This product may have some lack of uniformity in surface appearance within a coil or from coil to coil.

3.8
smooth finish
smoothness produced by skin-passing the coated material in order to achieve an improved surface condition as compared with the normal as-coated product

3.9
zinc-iron alloy coating
coating produced by processing the zinc-coated steel sheet so that the coating formed on the base metal is composed of zinc-iron alloys

NOTE This product, designated ZF is not spangled, is normally dull in appearance and, for some applications, may be suitable for immediate painting without further treatment, except normal cleaning. Zinc-iron alloy coatings may powder during severe forming.

3.10
skin pass
light cold-rolling of the zinc-coated steel sheet

NOTE The purpose of the skin pass is to produce a higher degree of surface smoothness and thereby improve the surface appearance. The skin pass also temporarily minimizes the occurrence of a surface condition known as stretcher strain (Luder's Lines) or fluting during the fabrication of finished parts. The skin pass also controls and improves flatness. Some increase in hardness and loss of ductility will result from skin passing.

3.11
differential coating
coating having a coating mass on one surface significantly different from the coating mass on the other surface

3.12
lot
50 t or less of steel sheet of the same grade rolled to the same thickness

4 Thickness

4.1 Zinc-coated sheet is produced in thicknesses from 0,25 mm to 5 mm inclusive after coating, and in widths of 600 mm and over in coils and cut lengths. Zinc-coated sheet less than 600 mm wide, slit from wide sheet, will be considered as sheet.

4.2 The thickness of hot-dip zinc-coated and zinc-iron alloy sheet steel may be specified as a combination of the base metal and metallic coating, or as the base metal alone. The purchaser shall indicate on the order which method of specifying thickness is required. In the event that the purchaser does not indicate any preference, the thickness as a combination of the base metal and coating will be provided. Annex A describes the requirements for specifying the thickness of the base metal alone.

5 Conditions of manufacture

5.1 Chemical composition

The chemical composition (heat analysis) shall not exceed the values given in Tables 1 and 2. On request, a report of the heat analysis shall be made to the purchaser.

A verification analysis may be made by the purchaser to verify the specified analysis of the product and shall take into consideration any normal heterogeneity. Non-killed steels (such as rimmed or capped steels) are not technologically suited to product analysis. For killed steels, the sampling method and deviation limits shall be agreed upon between the interested parties at the time of ordering. The product analysis tolerances are shown in Table 3.

The processes used in making the steel and in manufacturing zinc-coated sheet are left to the discretion of the manufacturer. When requested, the purchaser shall be informed of the steel-making process used.

Table 1 — Chemical composition (heat analysis), %

Base-metal quality		C	Mn	P	S	Ti
Designation	**Name**	max.	max.	max.	max.	max.
01	Commercial	0,15	0,60	0,05	0,035	
02	Drawing	0,10	0,50	0,04	0,035	
03[a]	Deep drawing	0,08	0,45	0,03	0,03	
04[a]	Deep drawing aluminum killed	0,06	0,45	0,03	0,03	
05[a]	Extra deep drawing stabilized	0,02	0,25	0,02	0,02	0,15

[a] For interstitial free steels only, the values of 0,15 % titanium, and 0,10 % maximum for niobium and vanadium are acceptable to ensure that the carbon and nitrogen are fully stabilized.

Table 2 — Limits on additional chemical elements, %

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.

Table 3 — Product analysis tolerances, %

Element	Maximum of specified element	Tolerance over maximum specified
C	0,15	0,03
Mn	0,60	0,03
P	0,05	0,01
S	0,035	0,01

NOTE The above maximum tolerance is the allowable excess over the specified requirement and not the heat analysis.

5.2 Mechanical properties

Zinc-coated sheet of designations 02, 03, 04 and 05 are supplied under the following two ordering conditions:

a) Ordering condition A). Steel when ordered to mechanical properties shall, at the time the steel is made available for shipment, satisfy the applicable requirements of Table 4.

b) Ordering condition B). Steel when ordered to make an identified part shall be supplied with a commitment for satisfactory manufacturing performance within a proper breakage allowance, which shall be previously agreed upon by the interested parties. In these cases, the part name, the details of fabrication, and special requirements (such as freedom from stretcher strain or fluting) shall be specified.

NOTE Prolonged storage of the sheet can cause a change in mechanical properties (increase in hardness and decrease in elongation), leading to a decrease in drawability. To minimize this effect, quality 03, 04 and 05 should be specified.

Table 4 — Mechanical properties

Base-metal quality [a]		R_e max.[b] MPa[h]	R_m max.[c] MPa	A min.[d]			$\bar{r}$ [e,f,g] min.	$\bar{n}$ [e,f,g] min.
Designation	**Name**			$L_o = 80$ mm	$L_o = 50$ mm	$L_o = 5{,}65\sqrt{S_o}$ [i]		
01	Commercial	—	—	—	—	—	—	—
02	Drawing	300 [j]	430	24	23	22	—	—
03	Deep drawing	260	410	26	25	24	—	—
04	Deep drawing aluminum killed	220	410	29	28	27	—	—
05	Extra deep drawing stabilized	200	350	37	36	35	1,4	0,17

R_e = yield stress
R_m = tensile strength
A = percent elongation after fracture
L_o = gauge length on test piece
S_o = original cross-sectional area of gauge length

NOTE 1 Time period from date of shipment for values stated in this table to be applicable.

Designation	Time period
01	—
02	8 days
03	1 month
04	6 months
05	6 months

NOTE 2 For products produced according to performance criteria 4.2, the typical mechanical properties presented here are non-mandatory. For products specified according to mechanical properties, the purchaser may negotiate with the supplier if a specific range, or a more restrictive range, is required for the application, therefore, by agreement, these values may be specified.

NOTE 3 These typical mechanical properties apply to the full range of steel sheet thicknesses. The yield stress tends to increase and some of the formability aspects tend to decrease as the sheet thickness decreases.

a All qualities are available with a minimized spangle zinc coating.
b The yield values apply to 0,2 % proof stress if the yield point is not pronounced, otherwise to the lower yield point (R_{eL}).
c Minimum tensile strength for qualities 02, 03, 04 and 05 would normally be expected to be 270 MPa. All tensile strength values are determined to the nearest 10 MPa.
d For material up to and including 0,6 mm in thickness, the elongation values in the table shall be reduced by 2.
e $\bar{r}$ and $\bar{n}$ values are only applicable to thickness 0,5 mm. For thickness > 2,0 mm, the $\bar{r}$ value is reduced by 0,2.
f $\bar{r}$ can also be written as r-bar and $\bar{n}$ can also be written as n-bar.
g $\bar{r}$ and $\bar{n}$ values may be modified or excluded from this specification, by agreement between the producer and the purchaser.
h 1 MPa = 1 N/mm^2.
i May be used for material over 3 mm in thickness.
j This value applies to skin-passed products only.

5.3 Coating

5.3.1 Coating mass

The coating mass limits shall conform to the limits for the designations shown in Table 5. The coating mass is the total amount of coating on both sides of the sheet, expressed in grams per square metre. The interested parties shall agree upon the coating mass of differentially coated products. If a maximum coating mass is required, the manufacturer shall be notified at the time of ordering.

Table 5 — Coating mass (total both sides)

Coating designation	Minimum check limit	
	Triple-spot test g/m^2 (of sheet)	Single-spot test g/m^2 (of sheet)
Z001	No minimum [a]	No minimum [a]
Z100	100	85
Z180	180	150
Z200	200	170
Z275	275	235
Z350	350	300
Z450	450	385
Z600	600	510
Z700	700	595
ZF001	No minimum	No minimum
ZF100	100	85
ZF180	180	150
Because of the many variables and changing conditions that are characteristic of continuous zinc coating, the coating mass is not always evenly divided between the two surfaces of a zinc-coated sheet; neither is the zinc coating evenly distributed from edge to edge. However, it can normally be expected that not less than 40 % of the single-spot check limit will be found on either surface.		
NOTE The coating thickness may be estimated from the coating mass by using the following relationship: 100 g/m^2 total both sides = 0,014 mm total both sides.		
[a] "No minimum" means that there are no established minimum check limits for triple- and single-spot tests.		

5.3.2 Coating adherence

The zinc-coated sheet shall be capable of being bent in any direction, in accordance with the mandrel diameter requirements of Table 6, without flaking of the coating on the outside of the bend. Flaking of the coating within 7 mm from the edge of the test piece shall not be a cause for rejection. The bend test requirements of Table 6 do not apply to zinc-iron alloy coating.

Table 6 — Coating adherence — Bend test mandrel diameter

Base-metal quality	Coated metal –180° bend mandrel diameter mm								
	Coating designation								
	$e < 3$ mm				$e \geqslant 3$ mm				
	up to Z275	Z350	Z450 Z600	Z700	up to Z275	Z350	Z450	Z600	Z700
Commercial	1a	1a	2a	3a	2a	2a	2a	3a	4a
Drawing	0	1a	2a	2a	0	1a	2a	2a	2a
Deep drawing	0	1a	2a	2a	0	1a	2a	2a	2a
Deep drawing aluminum killed	0	1a	2a	2a	0	1a	2a	2a	2a
Extra deep drawing stabilized	0	1a	2a	2a	0	1a	2a	2a	2a

a = thickness of bend test piece, in millimetres
e = thickness of steel sheet, in millimetres

5.4 Fabrication qualities

Zinc-coated steel sheet is available in several fabrication qualities.

— Commercial: intended for general fabrication purposes where sheet is used flat, or for bending or moderate forming.

— Drawing: intended for fabricating parts where drawing or severe forming may be involved.

— Deep drawing: intended for fabricating parts where severe drawing or severe forming may be involved.

— Deep drawing aluminium killed (non-aging): intended for fabricating parts where particularly severe drawing or forming may be involved or essential freedom form aging is required.

— Extra-deep drawing (stabilized interstitial-free): intended for applications requiring interstitial-free steel (IF) which is non-aging and has maximum formability.

5.5 Weldability

The product is suitable for welding if appropriate welding methods and procedures are used with special attention to the heavier coatings. Zinc-iron alloyed coatings (ZF) are usually more suitable than other coatings (Z) for resistance welding.

5.6 Painting

Hot-dip zinc-coated steel sheet is a suitable base for paint, but the first treatment may be different from those used on mild steel. Pretreatment primers, chemical conversion coatings (chromate, phosphate or oxide type), and some paints specially formulated for direct application to zinc surfaces, are all appropriate first treatments for hot-dip zinc-coated sheet. In drawing up a painting schedule, consideration shall be given to whether the hot-dip zinc-coated sheet shall be ordered in the passivated or not passivated state.