INTERNATIONAL STANDARD

ISO 14788

Second edition
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Continuous hot-dip zinc-5 % aluminium alloy coated steel sheet

Tôles en acier revêtues à chaud en continu d'alliage zinc-aluminium 5 %

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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

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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 14788 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 14788:1998), which has been technically revised.

Continuous hot-dip zinc-5 % aluminium alloy coated steel sheet

1 Scope

1.1 This International Standard specifies the minimum requirements for steel sheet, in coils and cut lengths, metallic-coated by the continuous hot-dip process, with zinc-5 % aluminium alloy coating.

1.2 The product is intended for applications requiring corrosion resistance, formability and paintability.

1.3 The steel sheet is produced in a number of qualities and grades, coating mass, surface treatments and coating conditions designed to be compatible with differing application requirements.

1.4 The product is produced in two types:

— T1: zinc-5 % aluminium-mischmetal alloy coating,

— T2: zinc-5 % aluminium-0,1 % magnesium alloy coating.

NOTE There may be differences in product characteristics between Type 1 and Type 2 coated steel sheet, depending on the intended application.

1.5 Zinc-5 % aluminium alloy coated steel sheet is produced in thicknesses up to 5 mm after coating, and in widths of 600 mm and over in coils and cut lengths. Zinc-5 % aluminium alloy coated steel sheet less than 600 mm wide may be slit from wide sheet and will be considered as sheet.

1.6 The thickness of zinc-5 % aluminium alloy coated 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.

1.7 Zinc-5 % aluminium alloy coated steel sheet may be ordered in one of two conditions as described in 4.2.1:

a) Condition A) Steel ordered to satisfy mechanical property requirements,

b) Condition B) Steel when ordered to make an identified part.

1.8 Zinc-5 % aluminium alloy coated steel sheet is available in several fabrication qualities.

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

— Drawing: intended for fabricating parts where 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 from 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.

— Structural: zinc-5 % aluminium alloy coated steel sheet is produced in six grades as defined by a minimum yield stress.

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 1460:1992, *Metallic coatings — Hot dip galvanized coatings on ferrous materials — Gravimetric determination of the mass per unit area*

ISO 2178:1982, *Non-magnetic coatings on magnetic substrates — Measurement of coating thickness — Magnetic method*

ISO 3497:2000, *Metallic coatings — Measurement of coating thickness — X-ray spectrometric methods*

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

ISO 7438:2005, *Metallic materials — Bend test*

ISO 16160:2000, *Continuously hot-rolled steel sheet products — Dimensional and shape tolerances*

ISO 16162:2000, *Continuously cold-rolled steel sheet products — Dimensional and shape tolerances*

ISO 16163:2000, *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
continuous hot-dip zinc-5 % aluminium-coated steel sheet
product obtained by hot-dip coating of steel sheet coils on a continuous coating line to produce either coated coils or cut lengths

3.2
normal spangle
coating formed as a result of the unrestricted growth of zinc-5 % aluminium alloy crystals during normal solidification

3.3
smooth finish
smooth coating produced by skin-passing the coated material in order to achieve an improved-surface condition as compared with the normal as-coated product

3.4
skin pass
light cold rolling of the 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 fabrication of finished parts. The skin pass also controls and improves flatness.

3.5
ageing
susceptibility of zinc-5 % aluminium alloy coated steel sheet to changes in properties with the passage of time

NOTE Aging may result in a change in yield strength and corresponding decrease in ductility during storage. Aging always has a negative effect on formability. The redevelopment of an upper yield point as a result of aging can result in renewed susceptibility to surface imperfections, such as stretcher strain marks (Luder'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.

3.6
differential coating
coating having a coating mass on one surface significantly different from the coating mass on the other surface

4 Requirements

4.1 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 semi-finished or finished steel and shall take into consideration any normal heterogeneity. Non-killed steels, such as rimmed or capped steels, are not technologically suited for verification analysis. The product analysis tolerances are shown in Table 3.

The processes used in making the steel and in manufacturing zinc-5 % aluminium alloy coated sheet are left to the discretion of the manufacturer. When requested, the purchaser shall be informed of the steelmaking process being used.

Table 1 — Chemical composition (heat analysis), %

Base-metal quality	C max.	Mn max.	P max.	S max.	Ti max.
Commercial	0,15	0,60	0,05	0,05	—
Drawing [a]	0,12	0,50	0,04	0,04	—
Drawing quality aluminum killed [a]	0,08	0,45	0,03	0,03	—
Extra-deep drawing quality [a]	0,02	0,25	0,02	0,02	0,15
Structural	0,40	0,20	0,04	0,05	—

[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 [a, b] max.	Mo [a, b] max.	Nb [c] max.	V [c, d] max.	Ti [d] 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 the 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 will 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 will 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 consumer.

Table 3 — Product analysis tolerances, %

Element	Maximum of specified element	Tolerance over maximum specified
C	0,25	0,04
Mn	1,70	0,14
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.

4.2 Mechanical properties

4.2.1 Commercial and drawing qualities

Zinc-5 % aluminium alloy coated steel sheet of designations 01, 02, 03,and 04 is 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 to satisfactory manufacturing performance within a properly established breakage allowance, which shall be previously agreed upon between 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.

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 or 04 should be specified.

4.2.2 Structural quality

The mechanical properties, at the time the steel is made available for shipment, shall satisfy the requirements listed in Table 5.

Table 4 — Mechanical properties

Base-metal quality [a]		R_e [b] max	R_m [c] max	A min. [d] %		
Designation	Name	N/mm [b, e]	N/mm [b, e]	L_o = 50 mm	L_o = 80 mm	$L_o = 5{,}65\sqrt{S_o}$ [f]
01	Commercial	—	—	—	—	—
02	Drawing	300 [g]	430	24	23	22
03	Deep drawing aluminum killed	220	410	29	28	27
04	Extra-deep drawing (stabilized interstitial free)	200	350	37	36	35

R_e yield stress
R_m tensile strength
A percentage elongation after fracture
L_o gauge length of test piece
S_o original cross-sectional area of gauge length
e thickness of steel sheet, in millimetres

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

Designation	Time period
0	—
02	8 days
03	6 months
04	6 months

NOTE 2 For products produced according to performance criteria, 4.2.1, the typical mechanical properties presented here are non-mandatory. For products ordered according to specific mechanical properties (ordering condition A), 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 can be specified.

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

[a] All qualities are available with a normal spangle or smooth finish zinc-5 % aluminium alloy 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 and 04, would normally be expected to be 270 N/mm^2. All tensile strength values are determined to the nearest 10 N/mm^2.

[d] For material up to and including 0,6 mm in thickness, the elongation values in the table shall be reduced by 2.

[e] 1 N/mm^2 = 1 MPa.

[f] May be used for material over 3 mm in thickness.

[g] This value applies to skin-passed products only.

4.3 Coating

4.3.1 Coating mass

The coating mass limits shall conform to the limits for the designations shown in Table 6. The coating mass is the total amount of coating on both sides of the sheet, expressed in grams per square metre.

4.3.2 Coating adherence

The coated sheet shall be capable of being bent in any direction, in accordance with the mandrel diameter requirements of Table 7, 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.

Table 5 — Mechanical properties of structural-quality steels

Grade	R_e [a] min N/mm2	R_m min N/mm2	A min [b] %	
			L_o = 50 mm	L_o = 80 mm
220	220	310	20	18
250	250	360	18	16
280	280	380	16	14
320	320	430	14	12
350	350	450	12	10
380	380	540	12	10
550 [c]	550	570	—	—

NOTE In determining the base-metal mechanical properties, base-metal thickness should be measured after stripping the coating from the end of the specimen contacting the grips of the tension-testing machine before testing.

[a] The yield stress specified in this table shall be the lower yield stress (R_{el}). The values can also be measured by 0,5 % total elongation proof stress (proof stress under load) or by 0,2 % offset when a definite yield phenomenon is not present. When the upper yield stress (R_{eh}) is specified, the values shall be 20 N/mm^2 above the R_{el} values for each grade.

[b] The elongation values in the table shall be reduced by 2 for material up to and including 0,6 mm in thickness,

[c] Grade 550 is in the unannealed condition and therefore has limited ductility. If the hardness is HRB 85 or higher, no tension test is required. Bend testing for coating adherence is not applicable to Grade 550.

Table 6 — Coating mass test limits for zinc-5 % aluminium alloy coated steel sheet

Coating designation	Triple-spot test total both sides min. g/m^2	Single-spot test total both sides min. g/m^2
ZA001	no minimum	no minimum
ZA080	80	70
ZA090	90	75
ZA095	95	80
ZA100	100	85
ZA120	120	100
ZA130	130	110
ZA135	135	115
ZA140	140	120
ZA150	150	130
ZA160	160	135
ZA180	180	155

Table 6 — (*continued*)

Coating designation	Triple-spot test total both sides min. g/m^2	Single-spot test total both sides min. g/m^2
ZA185	185	155
ZA200	200	170
ZA225	225	190
ZA250	250	210
ZA255	255	215
ZA275	275	235
ZA300	300	255
ZA350	350	300
ZA450	450	385
ZA600	600	510
ZA700	700	595

NOTE 1 Not all coating designations may be available from all producers.

NOTE 2 The coating mass, in grams per square metre, refers to the total coating on both surfaces. Because of the many variables and changing conditions that are characteristics of continuous hot-dip coating, the coating mass is not always evenly divided between the two surfaces of a sheet, nor is the coating evenly distributed from edge to edge. However, it can normally be expected that no less than 40 % of the single-spot test limit will be found on either surface.

NOTE 3 The coating thickness may be estimated from the coating mass by using the following relationship:

100 g/m^2 total both sides ≅ 0,015 mm total both sides.

Table 7 — Coating adherence — Bend test mandrel diameter

Base-metal quality		Coated metal-180° bend mandrel diameter, mm								
		Coating designation								
		e < 3 mm				e ⩾ 3 mm				
		up to ZA275	ZA300 ZA350	ZA450 ZA600	ZA700	up to ZA275	ZA300 ZA350	ZA450	ZA600	ZA700
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
Extra deep drawing		0	1a	2a	2a	0	1a	2a	2a	2a
Structural grade										
	220	1a	1a	2a	3a	2a	2a	2a	3a	4a
	250	1a	1a	2a	3a	2a	2a	2a	3a	4a
	280	2a	2a	2a	3a	3a	3a	3a	3a	4a
	320	3a	3a	3a	3a	3a	3a	3a	3a	4a
	350	3a	3a	3a	3a	3a	3a	3a	3a	4a
	380	3a	3a	3a	3a	3a	3a	3a	3a	4a

a = bend mandrel diameter = e

e = thickness of steel sheet, in millimetres