
**Steel sheet, zinc-coated and zinc-iron
alloy-coated by the continuous hot-dip
process, of structural quality**

*Tôles en acier au carbone revêtues de zinc et d'un alliage zinc-fer en
continu par immersion à chaud, de qualité destinée à la construction*

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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.

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).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, 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 www.iso.org/iso/foreword.html.

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

This seventh edition cancels and replaces the sixth edition (ISO 4998:2014), which has been technically revised.

The main changes are as follows:

- update of terms and definitions;
- addition of coating mass designations.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Steel sheet, zinc-coated and zinc-iron alloy-coated by the continuous hot-dip process, of structural quality

1 Scope

This document specifies the requirements for steel sheet, zinc-coated and zinc-iron alloy-coated by the continuous hot-dip process, of structural quality.

The product is intended for applications where resistance to corrosion is of prime importance.

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

This document does not cover steel sheet designated as commercial quality, or drawing quality, which are covered in ISO 3575^[1].

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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, *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.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

zinc-coated steel sheet

product obtained by hot-dip coating of cold-reduced sheet coils or hot-rolled descaled sheet coils on a continuous zinc-coating line

3.2

zinc-iron alloy-coated steel sheet

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

Note 1 to entry: This product, designated ZF, is not spangled, is normally dull in appearance, and, for some applications, can be suitable for immediate painting without further treatment, except normal cleaning. Zinc-iron alloy coatings can powder during severe forming.

3.3

normal coating

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

Note 1 to entry: This coating has a metallic lustre and is the type normally furnished for a wide variety of applications. It can be furnished as S (normal coating, with skin pass) or N (normal coating, no skin pass); however, it can be variable in appearance and is not suitable for decorative painting.

3.4

minimized spangle

finish obtained by restricting normal spangle formation during the solidification of the zinc

Note 1 to entry: This product can have some lack of uniformity in surface appearance within a coil, or from coil to coil.

3.5

differential coating

coating deliberately produced to have a different coating mass on each surface

3.6

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 loss in ductility will result from skin passing.

3.7

lot

up to a specified quantity of steel sheet of the same designation rolled to the same thickness and coating condition

3.8

coating mass

total amount of coating on both sides of the sheet, expressed in grams per square metre (g/m^2) of sheet

4 Dimensions

4.1 Zinc-coated and zinc-iron alloy-coated structural quality steel 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 and zinc-iron alloy-coated steel sheet less than 600 mm wide, slit from wide sheet, is considered as sheet.

NOTE Thicknesses less than 0,4 mm will possibly not be available in grades 220, 250, 280, and 320.

4.2 The thickness of zinc-coated and zinc-iron alloy-coated steel sheet 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 as the base-metal alone.

5 Conditions of manufacture

5.1 Steelmaking

Unless otherwise agreed by the interested parties, the processes used in making the steel and in manufacturing zinc-coated and zinc-iron alloy-coated steel sheet of structural quality 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](#).

5.3 Chemical analysis

5.3.1 Heat analysis

An analysis of each heat shall be made by the manufacturer in order to determine conformity with the requirements given in [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 1 — Chemical composition (heat analysis)

Mass fraction in per cent

Element	Maximum of specified element
C	0,25
Mn	1,70
P ^a	0,05
S	0,035
^a Grades 250 and 280: P – 0,10 % max.; Grade 350: P – 0,20 % max.	

Table 2 — Limits on additional chemical elements

Mass fraction in per cent

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

^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.

Table 3 — Product analysis tolerances for Table 1

Mass fraction in per cent

Element	Maximum of specified element	Tolerance over maximum specified
C	0,25	0,04
Mn	1,70	0,05
P	0,05	0,01
S	0,035	0,01

NOTE The above maximum tolerance is the allowable excess over the requirement of heat analysis shown in Table 1.

5.4 Mechanical properties

Structural quality grades shall satisfy the mechanical properties shown in Table 4. On request, a report of the mechanical properties shall be made to the purchaser.

Table 4 — Mechanical properties

Grade	R_{eL}^a min. MPa ^b	R_m max. MPa	A^c min. %	
			$L_o = 50$ 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	550	570	—	—

R_{eL} : lower yield strength

R_m : tensile strength (for information only)

A : percentage elongation after fracture

L_o : gauge length of original test piece

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

^b 1 MPa = 1 N/mm².

^c Use either $L_o = 50$ mm or $L_o = 80$ mm to measure elongation. For material up to and including 0,6 mm in thickness, the elongation values in this table shall be reduced by 2.

5.5 Coating

5.5.1 Coating mass

The coating mass limits shall conform to the limits for the designations shown in Table 5. The interested parties shall agree upon the coating mass of differentially coated product. 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 mass designation	Minimum check limit	
	Triple-spot test g/m ² (of sheet)	Single-spot test g/m ² (of sheet)
Z001	No minimum ^b	No minimum ^b
Z080	80	68
Z100	100	85
Z120	120	102
Z140	140	119
Z180	180	150
Z200	200	170
Z220	220	187
Z275	275	235
Z350	350	300
Z450 ^a	450	385
Z600 ^a	600	510
Z700 ^a	700	585
ZF001	No minimum ^b	No minimum ^b
ZF080	80	68
ZF100	100	85
ZF120	120	102
ZF180	180	150

Z: zinc
ZF: zinc-iron alloy

NOTE 1 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 zinc-coated steel sheet and the two surfaces of zinc-iron alloy-coated steel sheet; neither is the 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 2 The coating thickness can be estimated from the coating mass by using the following relationship: 100 g/m² total coating mass both sides = 0,014 mm total coating thickness both sides.

^a Coating masses corresponding to the designations Z450, Z600, and Z700 are not available for steels with minimum yield stresses of 340 N/mm², 370 N/mm², 400 N/mm², and 570 N/mm².

^b "No minimum" means that there are no established minimum check limits for triple-spot and single-spot tests.

5.5.2 Coating adherence

The zinc-coated (Z) steel 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 cause for rejection. The bend test requirements of [Table 6](#) do not apply to zinc-iron alloy-coated (ZF) steel sheet.

Table 6 — Coating adherence — Bend test mandrel diameter

Grade	180° bend-mandrel diameter					
	mm					
	Coating mass designation					
	$e < 3$			$e \geq 3$		
	Up to Z350	Z450 Z600	Z700	Up to Z450	Z600	Z700
220	1a	2a	3a	2a	3a	4a
250	1a	2a	3a	2a	3a	4a
280	2a	2a	3a	3a	3a	4a
320	3a	3a	3a	3a	3a	4a
350	3a	3a	3a	3a	3a	4a
380	3a	3a	3a	3a	3a	4a
a: thickness of bend test piece, in millimetres						
e: thickness of sheet, in millimetres						

5.6 Weldability

This product is normally suitable for welding when appropriate welding methods and procedures are used with special attention to the heavier coatings. When the carbon content increases above 0,15 %, spot welding becomes increasingly difficult. Because the heat of welding might have a significant effect on lowering the strength of grade 550, this grade is not recommended for welding.

5.7 Painting

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

NOTE Surfaces with certain passivation treatments (e.g. chromated) are not suitable for phosphating or the application of a pre-treatment (etch) primer.

5.8 Surface treatment

5.8.1 Mill passivation

A chemical treatment is normally applied to zinc coatings to minimize the hazard of wet-storage staining (white rust) during shipment and storage. However, the inhibiting characteristics of the treatment are limited and if a shipment is received wet, the material shall be used immediately or dried. This treatment is not usually applied to zinc-iron alloy coatings because it interferes with the adhesion of most paints. If specified by the purchaser, zinc-iron alloy coatings shall have a chemical treatment applied.

NOTE Chromate-free treatment is available for use.

5.8.2 Mill phosphating

When specified, the manufacturer shall apply phosphate treatments to zinc-coated or zinc-iron alloy-coated steel sheet to prepare the surface for painting without further treatment except normal cleaning.

5.8.3 Oiling

When specified, zinc-coated and zinc-iron alloy-coated steel sheet as produced shall be oiled to prevent marring and scratching of the soft surface during handling or shipping and to minimize wet storage stain.

NOTE When zinc-coated and zinc-iron alloy-coated steel sheet has received a passivating treatment, oiling will further minimize the hazard of wet storage stain.

5.9 Dimensional and shape tolerances

5.9.1 Dimensional and shape tolerances applicable to zinc-coated and zinc-iron alloy-coated steel sheet shall be as specified in ISO 16163. The tolerances for thickness apply to products whose thickness is a combination of base-metal and coating thickness.

5.9.2 When the base-metal thickness is specified, the thickness tolerances of ISO 16163 shall apply to the product thickness calculated in accordance with [Annex A](#).

6 Sampling

6.1 Chemical composition

The manufacturer shall test each heat to determine conformance with the requirements of [Tables 1](#) and [2](#).

6.2 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 conformity with the requirements of [Table 4](#).

6.3 Coating tests

6.3.1 Coating mass

6.3.1.1 The manufacturer shall develop a testing plan with a frequency sufficient to adequately characterize the lot of material and ensure conformity with specification requirements.

6.3.1.2 The purchaser may conduct verification tests by securing a sample piece approximately 300 mm in length by the as-coated width and cutting three test specimens, one from the mid-width position and one from each side, not closer than 25 mm to the side edge. The minimum area of each specimen shall be 1 200 mm².

6.3.2 Triple-spot test

The triple-spot test result shall be the average coating mass found on the three specimens taken in accordance with [6.3.1](#).

6.3.3 Single-spot test

The single-spot test result shall be the minimum coating mass found on any one of the three specimens used for the triple-spot test. Material, which has been slit from wide coil, shall be subject to a single-spot test only.

6.3.4 Coating adherence

One representative sample for the coating adherence bend test shall be taken from each lot of sheet for shipment. The specimens for the coating adherence bend test shall not be taken closer than 25 mm to a side edge. The minimum width of the test specimen shall be 50 mm.

7 Test methods

7.1 Tensile test

The tests shall be conducted in accordance with the methods specified in ISO 6892-1. Either transverse test pieces or longitudinal test pieces shall be taken mid-way between the centre and the edge of the sheet. The base-metal thickness shall be used to calculate the cross-sectional area needed for the tensile test; however, for orders specifying thickness “as base-metal only”, there are two permissible methods for determining the base-metal thickness.

- a) Option A — Determination of the actual base-metal thickness through direct measurement of the substrate of a specimen whose coating has been removed.
- b) Option B — Calculation of the base-metal thickness through subtraction of the equivalent coating thickness for the appropriate coating designation included in [Annex A](#) from the actual coated thickness of the test specimen.

7.2 Coating properties

7.2.1 Coating mass

The manufacturer shall conduct tests using methods deemed necessary to ensure that the material conforms with the requirements shown in [Table 5](#). Commonly used methods include those specified in ISO 1460, ISO 2178, and ISO 3497. The coating mass is determined by converting coating thickness measurements made with magnetic gauges (see ISO 2178) or by X-ray spectrometry (see ISO 3497) using the relationship given in [Table 5](#). Either the test method in ISO 2178 or ISO 3497 shall be used as a basis for acceptance, but not for rejection. In cases of dispute, ISO 1460 shall be used as the referee method.

7.2.2 Coating adherence

Bend tests shall be conducted in accordance with the methods specified in ISO 7438. The bend tests may also be conducted with the other suitable methods.

8 Designation system

8.1 General

The designation system includes the coating type, coating mass, coating finish condition, surface treatment and steel grade.

8.2 Coating type

The letter Z indicates a zinc coating and the letters ZF indicate a zinc-iron alloy coating.

8.3 Coating mass

8.3.1 The coating mass designations for zinc coating are Z001, Z080, Z100, Z120, Z140, Z180, Z200, Z220, Z275, Z350, Z450, Z600, and Z700. The coating designations for zinc-iron alloy coating are ZF001, ZF080, ZF100, ZF120, and ZF180.

8.3.2 The coating is expressed as the total mass on both surfaces, in grams per square metre. The coating mass specified should be compatible with the desired service life, the thickness of the base-metal, and with the forming requirements involved.

NOTE For differential coatings, the coating mass of each surface, which is based on the agreement of the interested parties, is shown in the order of top surface and bottom surface. An example of a differential coating designation is Z120S60C02.

8.4 Coating finish condition

The coating finish conditions are:

- N: normal coating, no skin pass;
- S: normal coating, with skin pass;
- M: minimized spangle, no skin pass;
- E: minimized spangle, with skin pass.

The “M” and “E” coating finish conditions are normally furnished in designations Z350, Z275, Z200, and Z180 in thicknesses of 0,40 mm to 3 mm, inclusive.

8.5 Surface treatment

The surface treatment designations are:

- C: mill passivation;
- P: mill phosphating;
- O: oiling;
- CO: mill passivation and oiling.

8.6 Example

An example of a complete designation is Z275MC250. This designation example includes the following components:

- Z: zinc coating;
- 275: coating mass;
- M: minimized spangle, no skin pass;
- C: mill passivation;
- 250: steel grade.

9 Retests

9.1 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.

9.2 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 carried out.

9.3 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 document; otherwise the lot shall be rejected.

10 Resubmission

10.1 The manufacturer may 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), which on request, will be indicated to the purchaser. In this case, tests shall be carried out as if they applied to a new lot.

10.2 The manufacturer may present the rejected products to a new examination for conformity with the requirements for another quality.

11 Workmanship

11.1 The surface condition shall be that normally obtained for a zinc-coated and zinc-iron alloy-coated steel sheet product.

11.2 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.

11.3 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, it is the responsibility of the manufacturer to provide a product that meets the requirement for surface condition that is normally obtained on zinc-coated and zinc-iron alloy-coated steel sheet products.

12 Inspection and acceptance

12.1 Although not usually required for products covered by this document, 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 document.

12.2 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.

13 Coil size

When zinc-coated steel sheet or zinc-iron alloy-coated steel sheet in accordance with this document 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.

14 Marking

Unless otherwise stated, the following minimum requirements for identifying the steel sheet shall be legibly stenciled 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 document, i.e. ISO 4998:2023;
- c) the grade designation;
- d) the coating designation;
- e) the order number;
- f) the product dimensions;
- g) the lot number;
- h) the mass.

15 Information supplied by the purchaser

To specify adequately the requirements of this document, inquiries and orders shall include the following information:

- a) a reference to this document, i.e. ISO 4998:2023;
- b) the name and designation of the material, i.e. zinc-coated steel sheet, Z275NC220 (see [Clause 8](#));
- c) dimensions: for cut lengths, thickness (combination of base-metal and coating or base-metal alone), width, length, and bundle mass and the total quantity required; for coils, thickness (combination of base-metal and coating or base-metal alone), width, minimum or range of inside diameter, outside diameter, and the maximum acceptable coil mass and the quantity required;

NOTE 1 When the base-metal alone is specified, see [Annex A](#) for details.

NOTE 2 When the method of specifying thickness is not indicated, the combination of base-metal and coating will be provided.

- d) the application (name of part) when available;

NOTE 3 Identification of the application provides the opportunity to assess the compatibility of the end use with the ordered grade and coating designation. Proper identification of the part can include a description of the part or a visual examination of a submitted part and/or prints, or any combination thereof.

- e) the report of the heat analysis (see [5.3.1](#)) and mechanical properties (see [5.4](#)), if required;
- f) whether mill passivated or not (see [5.8.1](#));
- g) whether mill phosphated or not (see [5.8.2](#));
- h) whether oiled or not (see [5.8.3](#));
- i) coating finish condition (see [8.4](#));
- j) inspection and tests for acceptance prior to shipment from the manufacturer's works, if required (see [Clause 12](#));
- k) the coil size requirements (see [Clause 13](#)).

EXAMPLE A typical ordering description is as follows: