
**Continuous hot-dip zinc-coated and
zinc-iron alloy-coated carbon steel
sheet of structural quality**

*Tôles en acier au carbone revêtues de zinc ou 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 on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 17, *Steel*, Subcommittee SC 12, *Continuous mill flat rolled products*.

This sixth edition cancels and replaces the fifth edition (ISO 4998:2011), which has been technically revised.

Continuous hot-dip zinc-coated and zinc-iron alloy-coated carbon steel sheet of structural quality

1 Scope

1.1 This International Standard specifies continuous hot-dip zinc-coated and zinc-iron alloy-coated carbon steel sheet of structural quality.

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

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

1.4 This International Standard does not cover steels designated as commercial quality, or drawing quality, which are covered in ISO 3575^[2].

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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 16163:2012, *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-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

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 of the type normally furnished for a wide variety of applications. It can be furnished as S or N; however, it can be variable in appearance and is not suitable for decorative painting.

3.3
minimized spangle coating

coating 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.

3.4
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

3.5
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 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.

3.6
differential coating

coating having a specified coating mass designation on one surface, and a different coating mass designation on the other surface

3.7
skin pass

light cold-rolling of the zinc-coated steel sheet

Note 1 to entry: 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.

3.8
lot

50 t or less of sheet of the same grade rolled to the same thickness and coating condition

4 Dimensions

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

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

4.2 The thickness of zinc- and zinc-iron alloy-coated sheet steel can be specified as a combination of the base metal and metallic coating, or 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 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 (product analysis) can 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. The sampling method and deviation limits shall be agreed upon between the interested parties at the time of ordering.

The product analysis tolerances shall be in accordance with [Tables 2](#) and [3](#).

The processes used in making the steel and in manufacturing zinc-coated sheet of structural quality 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)

Mass fractions as a percentage (%)

| Element | Maximum of specified element |
|--|------------------------------|
| C | 0,25 |
| Mn | 1,70 |
| Pa | 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 fractions as a percentage (%)

| Element | Cu ^a max. | Ni ^a max. | Cr ^{ab} max. | Mo ^{ab} max. | Nb max. | V ^c max. | Ti 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 can 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 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 Heat analysis greater than 0,008 % can be supplied after agreement between the producer and purchaser.

Table 3 — Product analysis tolerances

Mass fractions as a percentage (%)

| 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 specified requirement and not the heat analysis.

5.2 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} min. ^a MPa ^b | R_m MPa | A min. % ^c | |
|-------|--|--------------|-------------------------|---------------|
| | | | $L_0 = 50$ mm | $L_0 = 80$ 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_0 = gauge length on 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 $L_0 = 50$ mm or $L_0 = 80$ 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.

5.3 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 product. If a maximum coating mass is required, the manufacturer shall be notified at the time of ordering.

Table 5 — Mass of coating (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 ^b | No minimum ^b |
| Z100 | 100 | 85 |
| Z180 | 180 | 150 |
| Z200 | 200 | 170 |
| 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 |
| ZF100 | 100 | 85 |
| ZF180 | 180 | 150 |

NOTE 1 The amount of coating for each coating designation is not always evenly divided between the two surfaces of a zinc-coated sheet, nor 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 2 The coating thickness can be estimated from the coating mass by using the following relationship: 100 g/m² total both sides = 0,014 mm total both sides.

^a Coating masses corresponding to the designations Z450, Z600, and Z700 are not available for steels with minimum yield stresses of 320 N/mm², 350 N/mm², 380 N/mm², and 550 N/mm².

^b "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 for the coating designations included in Table 6. 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 coating.

Table 6 — Coating bend-test requirements

| Grade | 180° bend-mandrel diameter | | | | | |
|-------|----------------------------|--------------|------|---------------|------|------|
| | $e < 3$ mm | | | $e \geq 3$ mm | | |
| | Coating designation | | | | | |
| | 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 |

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

5.4 Weldability

This product is normally suitable for welding if appropriate welding conditions are selected with special attention to the heavier coatings. As 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.

5.5 Painting

Hot-dip zinc-coated and zinc-iron alloy-coated steel sheet is a suitable base for paint, but the first treatment can 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 or zinc-iron alloy-coated sheet. In designing a painting schedule, consideration shall be given to whether the hot-dip zinc-coated or zinc-iron alloy-coated sheet shall be ordered passivated or not passivated.

5.6 Surface treatments

5.6.1 Mill passivation

A chemical treatment is normally applied to zinc coatings to minimize the hazard of wet-storage stain (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, as it can interfere with phosphate deposition or paint adhesion. If specified by the purchaser, zinc-iron coatings shall have a chemical treatment applied.

5.6.2 Mill phosphating

When specified, the manufacturer can 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.

5.6.3 Oiling

The zinc-coated or zinc-iron alloy-coated steel sheet as produced can be oiled to prevent marring and scratching of the soft surface during handling or shipping and to minimize wet storage stain. When the zinc-coated or zinc-iron alloy-coated steel sheet has received a passivating treatment, oiling will further minimize the hazard of wet storage stain.

5.7 Dimensional and shape tolerances

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

5.7.2 When the base metal thickness is specified, the thickness tolerances of Tables 1, 3, and 4 of ISO 16163:2012 shall apply to the average product thickness as calculated in accordance with [Annex A](#).

6 Sampling

6.1 Chemical composition

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

6.2 Tensile test

One representative transverse sample shall be taken from each lot to verify conformance to the requirements of [Table 4](#). Transverse test pieces shall be taken midway between the centre and the edge of the sheet as-rolled.

6.3 Coating tests

6.3.1 Coating mass

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

6.3.1.2 The purchaser can 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 from 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 be taken not closer than 25 mm from the 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. Transverse test pieces shall be taken midway between centre and 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 — Determine the actual base metal thickness by direct measurement of the substrate of a specimen whose coating has been removed.
- b) Option B — Calculate the base metal thickness by subtraction of the average 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 complies 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 shown in the note to [Table 5](#).

7.2.2 Coating adherence

Bend tests shall be conducted in accordance with the methods specified in ISO 7438.

8 Designation system

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

8.1 Coating type

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

8.2 Coating mass

The coating mass designations for zinc coating are 001, 100, 180, 200, 275, 350, 450, 600, and 700. The coating designations for zinc-iron alloy coating are 001, 100, and 180.

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.

8.3 Coating finish conditions

The conditions of the coating are

- N: normal coating (as produced),
- S: normal coating (skin passed),
- M: minimized spangle (as produced), and
- E: minimized spangle (skin passed).

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

8.4 Surface treatments

The types of surface treatment are

- C: mill passivation,
- P: mill phosphating,

- O: oiling, and
- CO: mill passivation and oiling.

8.5 Example

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

- Z: zinc coating;
- 275: coating mass;
- M: minimized spangle;
- C: mill passivation;
- 250: steel grade.

9 Retests

9.1 Machining and flaws

If any test piece shows defective areas, it shall be discarded and another piece substituted.

9.2 Elongation

If the percentage elongation of any test piece is less than that specified in [Table 4](#), and 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 shall be carried out.

9.3 Additional tests

If a test does not give the specified results, two more test pieces shall be taken at random from the same lot. Both retests shall conform to the requirements of this International Standard; otherwise the lot shall be rejected.

10 Resubmission

10.1 The manufacturer can resubmit for acceptance the products that have been rejected during earlier inspection because of unsatisfactory properties, after they have been subjected to a suitable treatment (for example selection, heat treatment) which, on request, will be indicated to the purchaser. In this case, the tests should be carried out as if they applied to a new lot.

10.2 The manufacturer has the right to present the rejected products to a new examination for compliance with the requirements for another quality or grade.

11 Workmanship

The zinc-coated steel sheet in cut lengths shall be free from amounts of laminations, surface flaws, and other imperfections that are detrimental to subsequent appropriate processing. Processing for shipment in coils does not afford the manufacturer the opportunity to observe readily or to remove defective portions as can be carried out for cut-length products.

12 Inspection and acceptance

12.1 While not usually required for products covered by this International Standard, the purchaser can specify that inspection and tests for acceptance be observed prior to shipment from the manufacturer's works. In these cases, 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.

12.2 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.

13 Coil size

When zinc-coated steel or zinc-iron alloy-coated steel sheet 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 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 International Standard, i.e. ISO 4998:2014;
- 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 to be supplied by the purchaser

To specify requirements adequately in accordance with this International Standard, inquiries and orders shall include the following information:

- a) a reference to this International Standard, i.e. ISO 4998:2014;
- b) the name and designation of the material, for example, hot-dip zinc-coated steel sheet, Z275NC 220 (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;