INTERNATIONAL STANDARD

ISO 4998

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

Tôles en acier au carbone galvanisées en continu par immersion à chaud, de qualité destinée à la construction

Reference number
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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 4998 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 12, *Continuous mill flat rolled products*.

This fifth edition cancels and replaces the fourth edition (ISO 4998:2005), which has been technically revised.

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

1 Scope

This International Standard applies to continuous hot-dip zinc- and zinc-iron-alloy-coated carbon steel sheet 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 mass, ordering conditions and surface treatments.

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 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
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 This coating has a metallic lustre and is of the type normally furnished for a wide variety of applications. It may be furnished as S or N; however, it may 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 This product may 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 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.

3.6
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 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 Thickness

4.1 Zinc-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 sheet less than 600 mm wide may 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 may 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) 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, 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-coated sheet of structural quality are left to the discretion of the manufacturer. When requested, the purchaser shall be informed of the steel-making process being used.

Table 1 — Chemical composition (heat analysis)

Element	% max.
Carbon	0,25
Manganese	1,70
Phosphorus[a]	0,05
Sulfur	0,035
[a] Grades 250 and 280: phosphorus –0,10 % max. Grade 350: phosphorus –0,20 % max.	

Table 2 — Limits on additional chemical elements, %

Element	Cu[a] max.	Ni[a] max.	Cr[a,b] max.	Mo[a,b] 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
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 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 % may be supplied after agreement between the producer and purchaser.							

Table 3 — Product analysis tolerances, %

Element	Maximum of specified element	Tolerance over maximum specified
Carbon	0,25	0,04
Manganese	1,70	0,05
Phosphorus	0,05	0,01
Sulfur	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]	
			$L_o = 50$ 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 stress

R_m = tensile strength (for information only)

A = percentage elongation after fracture

L_o = gauge length on test piece

[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 MPa above the R_{eL} values for each grade.

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

[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.

5.3 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
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 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] Coating masses corresponding to the designations Z450, Z600 and Z700 are not available for steels with minimum yield stresses of 320 N/mm^2, 350 N/mm^2, 380 N/mm^2 and 550 N/mm^2. [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			$e \geqslant 3$ 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 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.

5.6 Surface treatment

5.6.1 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 alloyed coatings because it interferes with the adhesion of most paints.

5.6.2 Mill phosphating

The zinc-coated steel sheet may be processed chemically at the manufacturer's works to prepare all types of coatings for painting without further treatment, except normal cleaning.

5.6.3 Oiling

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

5.7 Dimensional and shape tolerances

5.7.1 Dimensional tolerances applicable to zinc-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 2, 3 and 4 of ISO 16163:2010 shall apply to the average product thickness 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 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 from the side edge. The minimum area of each specimen shall be 1 200 mm^2.

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 bend test shall be taken from each lot of sheet for shipment. The specimens for the coated 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.

6.4 Retest

If a test does not satisfy 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.

7 Test methods

7.1 Tensile test

The tests shall be conducted in accordance with the methods specified in ISO 6892-1. 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 — Calculation of 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 (ISO 2178) or by X-ray spectrometry (ISO 3497) using the relationship shown in the note below 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 conditions

The conditions of the coating are:

— N: normal coating (as produced)

— S: normal coating (skin passed)

— M: minimized spangle (as produced)

— 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 treatment

The types of surface treatment are:

— C: Mill passivation

— P: Mill phosphating

— O: Oiling

— 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 Resubmission

9.1 The manufacturer may 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 (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.

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

10 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.

11 Inspection and acceptance

11.1 While not usually required for products covered by this International Standard, the purchaser may 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.

11.2 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.

12 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) the number of this International Standard; i.e. ISO 4998:2011;

c) the grade designation;

d) the coating designation;

e) the order number;

f) the product dimensions;

g) the lot number;

h) the mass.

13 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) the number of this International Standard; i.e. ISO 4998:2011;

b) the name and designation of the material, for example, hot-dip 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.