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Continuous hot-dip zinc-coated twin-roll cast steel sheet of structural quality and high strength steel

Tôles coulées entre cylindres et galvanisées en continu par immersion à chaud, de qualité destinée à la construction et en acier à haute résistance

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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 15211 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 12, *Continuous mill flat rolled products*.

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Continuous hot-dip zinc-coated twin-roll cast steel sheet of structural quality and high strength steel

1 Scope

This International Standard specifies the characteristics of continuous hot-dip zinc-coated twin-roll cast steel sheet products of structural quality and high strength steel.

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.

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*

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

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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*

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ISO 7438, *Metallic materials — Bend test*

ISO 16160, *Hot-rolled steel sheet products — Dimensional and shape tolerances*

ISO 16162, *Cold-rolled steel sheet products — Dimensional and shape tolerances*

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.

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
layer formed as a result of unrestricted growth of zinc or zinc alloy crystals during normal solidification

NOTE Normal coating has a metallic lustre and is the type normally furnished for a wide variety of applications. It may be furnished as coating conditions S or N (see 11.4); however, it can be variable in appearance and is not suitable for decorative painting.

3.3
minimized spangle coating
finish obtained by restricting normal spangle formation during the solidification of the zinc or zinc alloy

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

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3.4
smooth finish
surface produced by skin-passing the coated material in order to achieve an improved smooth surface condition as compared with the normal as-coated product

3.5
differential coating
layer having a specified coating-mass designation on one surface and a different coating-mass designation on the other surface

3.6
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 can result from skin passing.

3.7
twin-roll cast steel sheet
steel sheet produced by casting to near final thickness directly from the liquid metal with minimal hot-rolling to achieve the final thickness

4 Thickness

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4.1 Zinc-coated structural quality and high strength twin-roll cast steel sheet is produced in thicknesses of up to 2,0 mm after zinc coating, and in widths of up to 2 000 mm in coils and cut lengths.

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4.2 Zinc-coated sheets less than 600 mm wide may be slit from wide sheets and may be considered sheets.

4.3 The thickness of zinc-coated twin-roll cast 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, 2 and 3. Upon request, a report of the heat analysis shall be made to the purchaser.

A verification analysis (product analysis) may be carried out by the purchaser to verify the specified analysis of the semi-finished or finished steel. The product analysis tolerances are shown in Table 4.

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

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Table 1 — Chemical composition — Heat analysis

Mass fractions in per cent maximum

Base-metal quality	C	Mn	P	S	Si[a]
Structural — All grades	0,25	1,35	0,035	0,040	–

[a] In this table, "–" indicates that there is no requirement, but the analysis shall be reported.

Table 2 — Chemical requirements[a] — Heat analysis— High strength steel

Mass fractions in per cent maximum

Designation	C	Mn	P	S	Si[a]	V min.	Ti min.	Nb min.	N[a]
Grade[c]									
HSS 310 Class 1[b]	0,22	1,35	0,04	0,04	–	0,008	0,008	0,008	–
HSS 310 Class 2	0,15	1,35	0,04	0,04	–	0,008	0,008	0,008	–
HSS 340 Class 1[b]	0,23	1,35	0,04	0,04	–	0,008	0,008	0,008	–
HSS 340 Class 2	0,15	1,35	0,04	0,04	–	0,008	0,008	0,008	–
HSS 380 Class 1[b]	0.25	1,35	0,04	0,04	–	0,008	0,008	0,008	–
HSS 380 Class 2	0,15	1,35	0,04	0,04	–	0,008	0,008	0,00	–
HSS 410 Class 1	0,26	1,50	0,04	0,04	–	0,008	0,008	0,008	–
HSS 410 Class 2	0,15	1,50	0,04	0,04	–	0,008	0,008	0,008	–
HSS 450 Class 1	0,26	1,50	0,04	0,04	–	0,008	0,008	0,008	–[c]
HSS 450 Class 2	0,15	1,50	0,04	0,04	–	0,008	0,008	0,008	–[c]
HSS 480 Class 1	0,26	1,65	0,04	0,04	–	0,008	0,008	0,008	–[c]
HSS 480 Class 2	0,15	1,65	0,04	0,04	–	0,008	0,008	0,008	–[c]
HSS 550 Class 1	0,26	1,65	0,04	0,04	–	0,008	0,008	0,008	–[c]
HSS 550 Class2	0,15	1,65	0,04	0,04	–	0,008	0,008	0,008	–[c]

[a] In this table, "–" indicates that there is no requirement for Si and N, but the analysis shall be reported.

[b] For each reduction of 0,01 % below the specified carbon maximum, an increase of 0,06 % manganese above the specified maximum shall be permitted up to a maximum of 1,50 %.

[c] The purchaser has the option of restricting the nitrogen content. It should be noted that, depending on the microalloying scheme (for example use of vanadium) of the producer, nitrogen is permitted as a deliberate addition. Consideration should be given to the use of nitrogen-binding elements (for example vanadium and titanium).

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Table 3 — Limits on additional chemical elements[a] for structural steel

Mass fractions in per cent

Element	Cu	Ni	Cr	Mo	Nb	V	Ti
	max						
Heat analysis	0,50	0,30	0,30	0,15	0,008	0,008	0,008
Product analysis	0,53	0,33	0,34	0,16	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. Where the amount of copper, nickel, chromium or molybdenum present is less than 0,02 %, the analysis shall be reported as < 0,02 %.

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Table 4 — Product analysis tolerances

Mass fractions in per cent

Element	Maximum of specified element	Tolerance over the maximum specified
Carbon	≤ 0,26	0,04
Manganese	≤ 01,65	0,05
Phosphorus	≤ 0,04	0,01
Sulfur	≤ 0,04	0,01
NOTE The maximum tolerance in this table is the allowable excess over the specified requirement and not the heat.		

5.2 Mechanical properties

Structural quality and high strength grades shall satisfy the mechanical properties shown in Tables 5 and 6. On request, a report of the mechanical properties shall be made to the purchaser.

Table 5 — Mechanical properties of structural quality twin-roll cast steel sheet

Grade	R_e min.[a] MPa	R_m min. MPa	A, min.[b] $e \leq 2$ mm	
			$L_o = 50$ mm	$L_o = 80$ mm
HR275	275	380	15	14
HR340	340	340	9	8
HR380	380	380	8	7
HR410	410	410	7	6
HR480	480	480	6	5
HR550	550	550	5	4

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R_e = lower yield strength

R_m = tensile strength

A = percentage elongation after fracture

L_o = gauge length on test piece

e = thickness of steel sheet, in millimetres

1 MPa = 1 N/mm^2

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

[b] 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.

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Table 6 — Mechanical properties for hot-rolled twin-roll cast high strength steel sheet

Grade	R_e min.[a] MPa	R_m min. MPa	A min.[b] $e \leq 2$	
			$L_o = 50$ mm	$L_o = 80$ mm
HSS 310 Class 1	310	410	18	17
HSS 310 Class 2	310	380	18	17
HSS 340 Class 1	340	450	15	14
HSS 340 Class 2	340	410	15	14
HSS 380 Class 1	380	480	13	12
HSS 380 Class 2	380	450	13	12
HSS 410 Class 1	410	520	11	10
HSS 410 Class 2	410	480	11	10
HSS 450 Class 1	450	550	10	9
HSS 450 Class 2	450	520	10	9
HSS 480 Class 1	480	585	8	7
HSS 480 Class 2	480	550	8	7
HSS 550 Class 1	550	620	7	6
HSS 550 Class 2	550	565	7	6

R_e = yield strength

R_m = tensile strength

A = percentage elongation after fracture

L_o = gauge length on test piece

e = thickness of steel sheet, in millimetres

1 MPa = 1 N/mm^2

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[a] The yield strength may be measured either by 0,5 % elongation proof stress, $R_{t0,5}$ (proof stress under load) or by 0,2 % offset, $R_{p0,2}$, where a definite yield strength phenomenon is not present.

[b] For thicknesses up to 2 mm, use either $L_o = 50$ mm or L_o 80 mm. In cases of dispute, however, only the results obtained on a 50 mm test piece shall be valid.

6 Coating

6.1 Coating mass

The coating mass shall conform to the limits for the coating designations shown in Table 7. The coating mass is the total amount of zinc on both surfaces of the sheet, expressed in grams per square metre (g/m^2) of sheet. The coating mass of differentially coated material shall be agreed upon between the interested parties. If a maximum coating mass is required, the manufacturer shall be notified at the time of ordering.

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Table 7 — Mass of coating — Total both sides[a]

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	585

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 a zinc-coated 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 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.

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6.2 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 Tables 8 and 9. Flaking of the coating within 7 mm from the edge of the test piece shall not be cause for rejection.

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Table 8 — Coating bend test requirements structural quality

Grade	180° Bend-mandrel diameter		
	$e \leq 2$ mm		
	Coating designation		
	Up to Z350	Z450 Z600	Z700
HR 275	1a	2a	3a
HR 340	1a	2a	3a
HR 380	2a	2a	3a

e = thickness of sheet, in millimetres

a = thickness of bend test piece, in millimetres

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Table 9 — Coating bend test requirements high strength steel

Grade	180° Bend-mandrel diameter		
	$e \leq 2$ mm		
	Coating designation		
	Up to Z350	Z450 Z600	Z700
275	1,5a	2a	3a
340	1,5a	2a	3a
380	2a	3a	3a

e = thickness of sheet, in millimetres

a = thickness of bend test piece, in millimetres

6.3 Weldability

This product is normally suitable for welding, if appropriate welding conditions are selected, with special attention to the heavier coatings. As carbon content increases above 0,15 %, spot welding becomes increasingly difficult. Because the heat of welding can have a significant effect on lowering the strength of grade 550, this grade is not recommended for welding.

6.4 Painting

Hot-dip zinc-coated twin-roll cast steel sheet is a suitable base for paint, but the first treatment may be different from those used on mild steel. Pre-treatment 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 passivated or not passivated.

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7 Surface treatment

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

7.2 Mill phosphating

Zinc-coated twin-roll cast 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.

7.3 Oiling

The zinc-coated twin-roll cast 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 stain. Where the zinc-coated sheet has received a passivating treatment, oiling further minimizes the hazard of wet storage stain.

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