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Hot-dip zinc-coated steel sheet and strip

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Foreword

This Japanese Industrial Standard has been revised by the Minister of Economy, Trade and Industry based on the provision of Article 14, paragraph (1) of the Industrial Standardization Act applied mutatis mutandis pursuant to the provision of Article 16 of the said Act in response to a proposal for revision of Japanese Industrial Standard with a draft being attached, submitted by The Japan Iron and Steel Federation (JISF), an accredited standards development organization. This edition replaces the previous edition (**JIS G 3302** : 2019), which has been technically revised.

However, **JIS G 3302** : 2019 may be applied in the **JIS** mark certification based on the relevant provisions of Article 30, paragraph (1), etc. of the Industrial Standardization Act until 19 December 2023.

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Hot-dip zinc-coated steel sheet and strip

Introduction

This Japanese Industrial Standard has been prepared based on **ISO 3575** : 2016, Edition 5 and **ISO 4998** : 2014, Edition 6, with some modifications of the technical contents.

Annex JA to Annex JE are unique to **JIS** and not given in the corresponding International Standards. The vertical lines on both sides and dotted underlines indicate changes from the corresponding International Standards. A list of modifications with the explanations is given in Annex JF.

1 Scope

This Standard specifies requirements for hot-dip zinc-coated steel sheets (hereafter referred to as sheets), steel strips (hereafter referred to as coils), and corrugated steel sheets manufactured by processing sheets into the shapes and dimensions specified in **JIS G 3316** (hereafter referred to as corrugated sheets).

NOTE 1 The International Standards corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 3575 : 2016 *Continuous hot-dip zinc-coated and zinc-iron alloy-coated carbon steel sheet of commercial and drawing qualities*

ISO 4998 : 2014 *Continuous hot-dip zinc-coated and zinc-iron alloy-coated carbon steel sheet of structural quality* (Overall evaluation: MOD)

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standards and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

NOTE 2 A new standard specifying the requirements common to **JIS G 3302**, **JIS G 3314**, **JIS G 3317**, **JIS G 3321** and **JIS G 3323** is planned to be established at the next revision of this Standard (hereafter referred to as the new standard specifying common requirements).

2 Normative references

Part or all of the provisions of the following standards, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS G 0201 *Glossary of terms used in iron and steel (Heat treatment)*

JIS G 0202 *Glossary of terms used in iron and steel (Testing)*

JIS G 0203 *Glossary of terms used in iron and steel (Products and quality)*

JIS G 0320 *Standard test method for heat analysis of steel products*

JIS G 0404 *Steel and steel products — General technical delivery requirements*

JIS G 0415 *Steel and steel products — Inspection documents*

JIS G 3316 *Shapes and dimensions of corrugated steel sheets*

JIS K 0119 *General rules for X-ray fluorescence analysis*

JIS K 8847 *Hexamethylenetetramine (Reagent)*

JIS Z 2241 *Metallic materials — Tensile testing — Method of test at room temperature*

JIS Z 8401 *Rounding of numbers*

3 Terms and definitions

For the purpose of this Standard, the following terms and definitions, and those given in **JIS G 0201**, **JIS G 0202** and **JIS G 0203** apply.

3.1

continuous hot-dip zinc-iron alloy coated steel sheet

coating obtained by heating after hot-dip zinc coating so that the entire coating layer becomes an alloy layer of zinc and iron

3.2

continuous hot-dip zinc-coated steel sheet

coating obtained when alloying by heating is not performed after hot-dip zinc coating

3.3

normal spangle

surface finish formed as a result of unrestricted growth of zinc crystals (spangles) during solidification process

3.4

minimized spangle

surface finish obtained by restricting spangle formation

3.5

chromate-free conversion

coating not containing hexavalent chromium, which is formed by chemical conversion

4 Symbols of grades and applicable nominal thicknesses

The symbols of grades and applicable nominal thicknesses ¹⁾ shall be as follows.

Note ¹⁾ See **10.1.1 a)** for the nominal thicknesses.

a) The sheets and coils are classified into 6 grades of hot-rolled steel sheet and strip

(hereafter referred to as hot-rolled base metal) and into 11 grades of cold-reduced steel sheet and strip (hereafter referred to as cold-reduced base metal). The symbols of grades and applicable nominal thicknesses shall be as given in Table 1 and Table 2.

- b) The corrugated sheets are classified into 7 grades of commercial quality, commercial hard quality and high strength commercial quality as given in Table 2. The symbols of grades and applicable nominal thicknesses shall be as given in Table JA.1. The types of shapes and their symbols for corrugated sheets shall be as given in Table 1 of JIS G 3316.
- c) When the symbols of grades in Table 2 are applied for roofing and architectural siding applications, the symbols of grades and applicable nominal thicknesses shall be as given in Table JB.1. The symbols for roofing and architectural siding applications shall be as given in Table 3.

Table 1 Symbols of grades and applicable nominal thicknesses (hot-rolled base metal)

Symbol of grade	Applicable nominal thickness mm	Application (informative)
SGHC	1.6 or over up to and incl. 6.0	Commercial
SGH340		High strength commercial
SGH400		
SGH440		
SGH490		
SGH540		
For those with a nominal thickness of 1.6 mm or over up to and including 3.2 mm, unless the use of hot-rolled base metal is specifically required, the cold-reduced base metal which satisfies the specifications for hot-rolled base metal may be used.		

Table 2 Symbols of grades and applicable nominal thicknesses (cold-reduced base metal)

Symbol of grade	Applicable nominal thickness mm	Application (informa- tive)
SGCC	0.19 or over up to and incl. 3.2	Commercial
SGCH	0.11 or over up to and incl. 1.0	Commercial hard
SGCD1	0.30 or over up to and incl. 2.3	Drawing, Class 1
SGCD2	0.40 or over up to and incl. 2.3	Drawing, Class 2
SGCD3	0.60 or over up to and incl. 2.3	Drawing, Class 3
SGCD4		Drawing, Class 4, non-ageing property ^{a)}
SGC340	0.25 or over up to and incl. 3.2	High strength com- mercial
SGC400		
SGC440		
SGC490		
SGC570	0.25 or over up to and incl. 2.0	
Note ^{a)} See JIS G 0203 for its definition.		

Table 3 Symbols for roofing and architectural siding applications

Application	Symbol for roofing/architectural siding
Roofing	R
Architectural siding	A

5 Chemical composition

The base metal of sheets, coils and corrugated sheets shall be tested for chemical composition in accordance with 14.1, and the heat analysis values shall be as given in Table 4.

Table 4 Chemical composition

Unit: %

Symbol of grade	C	Mn	P	S
SGHC	0.15 max.	0.80 max.	0.05 max.	0.05 max.
SGH340	0.25 max.	1.70 max.	0.20 max.	0.05 max.
SGH400	0.25 max.	1.70 max.	0.20 max.	0.05 max.
SGH440	0.25 max.	2.00 max.	0.20 max.	0.05 max.
SGH490	0.30 max.	2.00 max.	0.20 max.	0.05 max.
SGH540	0.30 max.	2.50 max.	0.20 max.	0.05 max.
SGCC	0.15 max.	0.80 max.	0.05 max.	0.05 max.
SGCH	0.18 max.	1.20 max.	0.08 max.	0.05 max.
SGCD1	0.12 max.	0.60 max.	0.04 max.	0.04 max.
SGCD2	0.10 max.	0.45 max.	0.03 max.	0.03 max.
SGCD3	0.08 max.	0.45 max.	0.03 max.	0.03 max.
SGCD4	0.06 max.	0.45 max.	0.03 max.	0.03 max.
SGC340	0.25 max.	1.70 max.	0.20 max.	0.05 max.
SGC400	0.25 max.	1.70 max.	0.20 max.	0.05 max.
SGC440	0.25 max.	2.00 max.	0.20 max.	0.05 max.
SGC490	0.30 max.	2.00 max.	0.20 max.	0.05 max.
SGC570	0.30 max.	2.50 max.	0.20 max.	0.05 max.
Alloy elements other than those given in this table may be added as required.				

6 Coating

6.1 Plating bath composition

The plating bath composition shall be analysed in accordance with 14.2, and shall be as given in Table 5.

NOTE 1 In the hot-dip coating process, a base metal is immersed in a molten metal bath (plating bath) at a high temperature, and then cooled to form a coating on the base metal surface.

NOTE 2 See 14.2 for the analysis of plating bath composition.

Table 5 Plating bath composition

Unit: %	
Elements other than Zn	Zn
1.0 max. ^{a)}	Remainder ^{b)}
Note ^{a)}	The figure indicates the total amount of elements which are added intentionally.
Note ^{b)}	The remainder may include elements which are mixed unavoidably.

6.2 Types of coating

The coating is classified into two types : continuous hot-dip zinc-coating and continuous hot-dip zinc-iron alloy coating.

6.3 Coating mass

6.3.1 Symbols for coating masses

The symbols for coating masses shall be as follows.

- The coating applied shall be of equivalent thickness on both surfaces. The symbols for coating masses shall be as given in Table 6.
- The applicable symbols for coating masses of corrugated sheets shall be as given in Table JA.2.
- The applicable symbols for coating masses used for roofing and architectural siding applications shall be as given in Table JB.2.

Table 6 Coating masses (total mass on both surfaces)

Unit: g/m²

Type of coating	Symbol for coating mass	Minimum triple-spot average coating mass	Minimum single-spot coating mass
Continuous hot-dip zinc-coating	Z06 ^{a)}	60	51
	Z08	80	68
	Z10	100	85
	Z12	120	102
	Z14	140	119
	Z18	180	153
	Z20	200	170
	Z22	220	187
	Z25	250	213
	Z27	275	234
	Z35 ^{b)}	350	298
	Z37 ^{b)}	370	315
	Z45 ^{b)}	450	383
	Z60 ^{b)}	600	510
Continuous hot-dip zinc-iron alloy coating	F04 ^{a)}	40	34
	F06	60	51
	F08	80	68
	F10 ^{b)}	100	85
	F12 ^{b)}	120	102
	F18 ^{a), b)}	180	153
Note ^{a)} Applicable by agreement between the purchaser and the manufacturer.			
Note ^{b)} Not applicable to SGCD1, SGCD2, SGCD3 and SGCD4.			

6.3.2 Coating mass

The sheets, coils and ~~corrugated sheets~~ shall be tested for coating masses in accordance with **14.3** and shall satisfy the following requirements.

- a) The coating mass of sheets, coils and ~~corrugated sheets~~ shall be expressed by the total mass on both surfaces, and shall meet the minimum triple-spot average coating mass value and the minimum single-spot coating mass value given in Table 6. The minimum triple-spot average coating mass shall apply to the average of the measured values of three test pieces taken from the specimen, and the minimum single-spot coating mass shall apply to the smallest value among the measured values of the three test pieces of which the average value is obtained. ~~When the coating mass is measured in accordance with Annex JD, the minimum triple-spot average coating mass value and the minimum single-spot coating mass value shall apply to the average coating mass value and the minimum coating mass value, respectively, which are obtained in accordance with JD.6.5.~~

It is desirable that the coating mass on one side be not less than 40 % of the required value for the minimum single-spot coating mass (total mass on both surfaces).

- b) The coating mass of corrugated sheets shall apply to pre-corrugated sheets.
- c) The upper limit value of the coating mass (total mass on both surfaces) of sheets, coils and corrugated sheets may be as agreed between the purchaser and the manufacturer.

6.4 Coating surface finishes

6.4.1 Classification and symbols for surface finish for continuous hot-dip zinc-coating

The classification and symbols for the surface finish for continuous hot-dip zinc-coating shall be as given in Table 7.

Table 7 Classification and symbols for surface finish for continuous hot-dip zinc-coating

Classification of coating surface finish	Symbol for coating surface finish
Normal spangle	R
Minimized spangle	Z

6.4.2 Skin-pass treatment

When requested by the purchaser, skin-pass treatment, designated as S, shall be performed.

NOTE Skin-pass treatment is usually performed to produce smooth surfaces.

6.5 Coating adherence

The coating adherence shall be as follows.

- a) Continuous hot-dip zinc-coated sheets and coils, when tested for coating adherence in accordance with 14.3 under the bend test conditions given in Table 8 and Table 9, shall be free from flaking of the coating on the external surface of the test piece (not less than 7 mm from both side edges of test piece).
- b) The requirements for coating adherence shall not apply to SGCH and SGC570.
- c) In the case of the continuous hot-dip zinc-coated corrugated sheets, requirements in a) and b) shall apply to pre-corrugated sheets.
- d) The coating adherence may be evaluated by other evaluation test methods than that specified in 14.3, instead of fulfilling the requirement in a), at the discretion of the manufacturer. In this case, the evaluated coating adherence shall be at least equivalent to that obtained by the test method specified in 14.3.

Table 8 Coating adherence and bendability (hot-rolled base metal)

Symbol of grade	Bend angle	Internal spacing ^{a)} Number of sheets					
		Nominal thickness 1.6 mm or over to and excl. 3.0 mm			Nominal thickness 3.0 mm or over to and incl. 6.0 mm		
		Symbol for coating mass			Symbol for coating mass		
		Z06 to Z27	Z35, Z37	Z45, Z60	Z06 to Z27	Z35, Z37	Z45, Z60
SGHC	180°	1	2	2	2	2	2
SGH340		1	1	2	2	2	3
SGH400		2	2	2	3	3	3
SGH440		3	3	3	3	3	3
SGH490							
SGH540							
Note ^{a)} The figures indicate the number of sheets of nominal thickness. The test piece shall be bent with the internal spacing not more than the total layer thickness of indicated number of sheets.							

Table 9 Coating adherence and bendability (cold-reduced base metal)

Sym- bol of grade	Bend angle	Internal spacing ^{a)} Number of sheets								
		Nominal thickness 0.19 mm or over to and excl. 1.6 mm			Nominal thickness 1.6 mm or over to and excl. 3.0 mm			Nominal thickness 3.0 mm or over up to and incl. 3.2 mm		
		Symbol for coating mass			Symbol for coating mass			Symbol for coating mass		
		Z06 to Z27	Z35, Z37	Z45, Z60	Z06 to Z27	Z35, Z37	Z45, Z60	Z06 to Z27	Z35, Z37	Z45, Z60
SGCC	180°	1	1	2	1	2	2	2	2	2
SGCD1		1	—	—	1	—	—	—	—	—
SGCD2		0 (flat on itself)	—	—	0 (flat on itself)	—	—	—	—	—
SGCD3										
SGCD4										
SGC340		1	1	2	1	1	2	2	2	3
SGC400		2	2	2	2	2	2	3	3	3
SGC440	3	3	3	3	3	3	3	3	3	
SGC490										
Note ^{a)} The figures indicate the number of sheets of nominal thickness. The test piece shall be bent with the internal spacing not more than the total layer thickness of indicated number of sheets.										

7 Chemical conversion

The classification and symbols for chemical conversion for sheets, coils and corrugated sheets shall be as given in Table 10.

Table 10 Classification and symbols for chemical conversion

Classification of chemical conversion	Symbol for chemical conversion
Chromate-free conversion	^{a)}
No conversion	M
Note ^{a)} The symbol for chromate-free conversion shall be as agreed between the purchaser and the manufacturer.	

8 Oiling

The classification and symbols for oiling for sheets, coils and corrugated sheets shall be as given in Table 11. Unless otherwise specified, continuous hot-dip zinc-coating shall be unoled and continuous hot-dip zinc-iron alloy coating shall be oiled.

Table 11 Classification and symbols for oiling

Classification of oiling	Symbol for oiling
Oiled	O
Unoled	X

9 Mechanical properties

9.1 Applicable mechanical properties

The mechanical properties applicable to sheets and coils shall be as given in Table 12. The mechanical properties of the corrugated sheets shall apply to pre-corrugated sheets and shall be as given in Table 12.

Table 12 Applicable mechanical properties

Symbol of grade	Bendability ^{a)}	Yield point or proof stress, tensile strength and elongation
SGHC	○	—
SGH340	○	○
SGH400	○	○
SGH440	○	○
SGH490	○	○
SGH540	○	○
SGCC	○ ^{b)}	—
SGCH	—	—
SGCD1	○	○
SGCD2	○	○
SGCD3	○	○
SGCD4	○	○
SGC340	○	○
SGC400	○	○
SGC440	○	○
SGC490	○	○
SGC570	—	○
Note ^{a)} Bendability applies to the continuous hot-dip zinc-coated steel sheets and not to the continuous hot-dip zinc-iron alloy coated steel sheets.		
Note ^{b)} If used for corrugated sheets, the bendability shall not apply.		

9.2 Bendability

When continuous hot-dip zinc-coated sheets, coils and pre-corrugated sheets are tested for bendability in accordance with 14.4, the external surface of the test piece

(not less than 7 mm from both side edges of test piece) shall be free from visible cracks and breakage of base metal.

NOTE For the details of bend test, see 14.4.2.

9.3 Yield point or proof stress, tensile strength and elongation

The sheets, coils and pre-corrugated sheets shall be tested for yield point or proof stress, tensile strength and elongation in accordance with 14.4, and shall satisfy the requirements given in Table 13 or Table 14. The values given in Table 13 or Table 14 shall apply to those which undergo delivery inspection ²⁾.

Note ²⁾ Age-hardening of sheets, coils and pre-corrugated sheets may cause an increase in yield point or proof stress and a decrease in elongation.

Table 13 Yield point or proof stress, tensile strength and elongation (hot-rolled base metal)

Symbol of grade	Yield point or proof stress	Tensile strength	Elongation %					Test piece and direction
			Nominal thickness					
			mm					
			1.6 or over to and excl. 2.0	2.0 or over to and excl. 2.5	2.5 or over to and excl. 3.2	3.2 or over to and excl. 4.0	4.0 or over up to and incl. 6.0	
SGHC	—							
SGH340	245 min.	340 min.	20 min.	20 min.	20 min.	20 min.	20 min.	No. 5 in rolling direction or perpendicular to rolling di- rection
SGH400	295 min.	400 min.	18 min.	18 min.	18 min.	18 min.	18 min.	
SGH440	335 min.	440 min.						
SGH490	365 min.	490 min.	16 min.	16 min.	16 min.	16 min.	16 min.	
SGH540	400 min.	540 min.						
NOTE 1	For SGHC, a yield point or proof stress of 205 N/mm ² or over and a tensile strength of 270 N/mm ² or over may be as agreed between the purchaser and the manufacturer.							
NOTE 2	1 N/mm ² = 1 MPa							

Table 14 Yield point or proof stress, tensile strength and elongation (cold-reduced base metal)

Symbol of grade	Yield point or proof stress	Tensile strength	Elongation						Test piece and direction		
			%								
			Nominal thickness								
mm						0.25 or over to and excl. 0.40	0.40 or over to and excl. 0.60	0.60 or over to and excl. 1.0	1.0 or over to and excl. 1.6	1.6 or over to and excl. 2.5	2.5 or over up to and incl. 3.2
SGCC	—										
SGCH	—										
SGCD1	—	270 min.	32 min.	34 min.	36 min.	37 min.	38 min.	—	No. 5 in rolling direction		
SGCD2	—	270 min.	—	36 min.	38 min.	39 min.	40 min.	—			
SGCD3	—	270 min.	—	—	40 min.	41 min.	42 min.	—			
SGCD4 ^{a)}	—	270 min.	—	—	42 min.	43 min.	44 min.	—			
SGC340	245 min.	340 min.	20 min.	20 min.	20 min.	20 min.	20 min.	20 min.	No. 5 in rolling direction or perpendicular to rolling direction		
SGC400	295 min.	400 min.	18 min.	18 min.	18 min.	18 min.	18 min.	18 min.			
SGC440	335 min.	440 min.	18 min.	18 min.	18 min.	18 min.	18 min.	18 min.			
SGC490	365 min.	490 min.	16 min.	16 min.	16 min.	16 min.	16 min.	16 min.			
SGC570	560 min.	570 min.	—								
NOTE 1 For SGCC, a yield point or proof stress of 205 N/mm ² or over and a tensile strength of 270 N/mm ² or over may be as agreed between the purchaser and the manufacturer.											
NOTE 2 SGCH, as it is not subjected to annealing, usually has a Rockwell hardness of 85 HRBW or over, or a Vickers hardness of 170 HV or over.											
NOTE 3 1 N/mm ² = 1 MPa											
Note ^{a)} The sheets and coils of SGCD4 shall be free from stretcher strain marks when being formed, for a period of six months after manufacture.											

10 Dimensions

10.1 Expression of dimensions

10.1.1 Denominations for thickness

The denominations for thickness of sheets, coils and corrugated sheets shall be as follows. For corrugated sheets, the following denominations for thickness shall apply to pre-corrugated sheets.

- The thickness of base metal before coating shall be taken as the nominal thickness.
- The thickness of base metal after coating shall be taken as the product thickness. The product thickness, which is the basis of tolerances, shall be the nominal thickness plus the equivalent coating thickness and shall be obtained by adding the equivalent coating thickness given in Table 15 to the nominal thickness expressed to the third decimal place. The resultant value shall be rounded to the second decimal place according to Rule A of JIS Z 8401.