Data sheet: C 1.1

Availability, properties and tolerances

Galvanised Material

Hot-dip galvanised cold rolled and hot rolled steel substrate

GENERAL DESCRIPTION

Metallic coated sheet, specifically continuously hot-dip zinc-coated (galvanised) sheet, is a well-known product with a versatile range of applications in general industry, buildings, construction and appliances. As the name implies, continuous hot-dip coating involves the application of a molten coating onto the surface of steel sheet (cold- or hot rolled) in a non-stop process. In this process a material is produced with strength/formability properties provided by the steel substrate and the corrosion protection by the zinc coating. The zinc coating (layer) protects the steel by providing a barrier to elements in an exposed environment through the sacrificial nature of zinc (cathodic protection). Expected service life depends on coating thickness and the aggressiveness of the exposed environment.

SPECIFICATIONS

ArcelorMittal South Africa produces continuously galvanised sheet that conforms to the requirements of SANS 4998, SANS 3575, EN 10346, ASTM 653M and related specifications. In addition structural grades are available as per EN10346. ArcelorMittal South Africa's product range complies with the above standards. Where required, ISQ standards unique to ArcelorMittal South Africa with specific properties are developed to meet application criteria. Dimensional and shape tolerances are according to the EN 10143 standards.

PRODUCT RANGE

Mechanical properties

Galvanised (zinc coated steel) is available in various steel grades with guidelines on suitable steel substrate for moderate bending/forming, severe bending, moderate drawing and load-bearing applications.

Steel chemistry design and thermo-mechanical processing provide different mechanical properties for the substrates tabulated in Table 1.

For further information, contact:
ArcelorMittal South Africa Limited, PO Box 2, Vanderbijlpark 1900. No (016) 889 4081, Fax (016) 889-2022
e-mail address: chromadek@arcelormittal.com

Table 1: Mechanical properties specifications of the steel substrate

CLASS	DESCRIPTION	Thickness range (mm)		Mechanical Properties[1]			RELATED SPECIFICATIONS – STEEL SUBSTRATE[2]				
			AMSA	YS[3] MPa (min)	UTS[3] MPa (min)	%El[3] (min)	SANS	ASTM A653	EN 10346	JIS G3302	SAE /AISI[4]
Commercial	For applications requiring strength combined with workability needed for moderate bending and -forming i.e. Roofing, Cladding, Roll forming and General purposes.	0.3 - 3.0	ISQ230	230[5]			4998: Gr220	Gr230 CS type A	-	SGCC	1006
		0.25 - 2.0	ISQ300	275≤0.6 300>0.6	-	16	4998: Gr280	Gr275	-	-	1012
		0.25 - 0.4	ISQ550	550[5,7]	570[5,7]	-	4998: Gr550	Gr550[6]	-	SGCH	1012
		0.47 - 0.8	ISQ550 (3T)	550[5,7]	570[5,7]	-	-	-	-	-	-
Forming[8]	Suitable for severe bending, lock forming and moderate drawing operations i.e. Roof Tiles	0.4 - 1.6	LFQ/ RTQ	190-330	270-500	18≤0.5 20≤0.7 22>0.7	3575: 02/03	FS Type A	DX51D	-	-
Structural[9,10]	Suitable for load-bearing applications where specific mechanical properties are required for strength i.e. components for buildings. In general increasing yield strength levels have a corresponding decrease in ductility or formability.	0.4 - 2.0	-	220	300	20	4998: Gr220	Gr230	S220GD	-	-
		0.4 - 2.0	-	250	330	19	4998: Gr255	Gr255	S250GD	-	-
		0.5 - 3.0	-	280	360	18	4998: Gr280	Gr275	S280GD	-	-
		0.7 - 3.0	-	350	420	16	4998: Gr350	Gr340	S350GD	-	-
		0.3 - 1.2	-	550	560	-	4998: Gr550	Gr550[6]	S550GD[11]	-	-
		1.55 - 3.0	S450GD AMSA[12]	450	460	12	-	-	-	-	-

1. *Coil mechanical properties will be specified on the associated test certificate.*
2. *For more detail consult the relevant specification.*
3. *YS=Yield strength, UTS= Tensile strength, %El= Elongation.*
4. *Chemical analysis only.*
5. *Expected values.*
6. *For thickness ≤0.71 mm, no tensile test is required if the hardness is 85 Rockwell B or higher.*
7. *The hardness will be 85 Rockwell B or higher.*
8. *Maximum coating mass of Z275.*
9. *Thicknesses larger than 2.00mm are available on enquiry only.*
10. *Restricted to certain width to thickness ratios.*
11. *Elongation >8 % for thickness ≥ 1.0 mm to conform to SANS 517 - Light Steel Frames.*
12. *AMSA = ArcelorMittal South Africa.*

For further information, contact:
ArcelorMittal South Africa Limited, PO Box 2, Vanderbijlpark 1900. No (016) 889 4081, Fax (016) 889-2022
e-mail address: chromadek@arcelormittal.com

Zinc coating mass

The continuous hot dip coating process ensures an even metallic coating to both the top and bottom sheet surfaces. The thin $Fe_2 Al_5$ alloy layer formed at the zinc/steel interface enables normal fabrication without incurring significant coating damage. Hot dip coatings are specified in a wide range of coating mass categories. The Z prefix in the coating designation indicates the zinc coating while the number denotes the total mass of the zinc coating deposited to both the top and bottom surfaces of the sheet in grams per square meter (g/m^2).

Table 2: Coating mass

Coating designation	Minimum Requirement Triple Spot Test (g/m^2) Total Both Sides	Minimum Requirement Single Spot Test (g/m^2) Total of both sides	Nominal thickness of zinc coating per side (µm)
Z100 [1]	100	85	7
Z150 [2]	150	128	10
Z200	200	170	14
Z275	275	235	19
Z450[3]	450	385	32
Z600[3]	600	510	42

Notes:
1. *Only available on 0.25, 0.27 and 0.30mm ISQ 550 material.*
2. *ISQ specification only.*
3. *Not recommended for forming grades.(Thicker coatings available on request for special applications)*

Please note for Z100 ISQ550 products only:
AMSA aims to supply on an average of 100 g/m^2 and not minimum 100g/ m^2 as stated for all other coatings. This implies that the average values of Triple Spots over the length of the coil will average Z100 with a minimum triple spot value of 95g/m^2 and Single Spot value of 81g/m^2

Coating surface finish

The zinc coating that forms has a bright metallic appearance and can be engineered to suit specific end-use requirements through the control of the coating bath chemistry and in-line treatment after coating as follows:

Normal or regular spangle

Regular / normal spangle is obtained during normal solidification of a hot-dip zinc coating on steel sheet, and results in the formation of a coating which exhibits zinc crystals of different sizes and brightness. The zinc coating is formed as a result of unrestricted growth of zinc crystals during normal solidification

With thick zinc coatings (Z450 or Z600), the coating has a tendency to develop very visible sag lines and ripples that results in a rough surface. However, the solidified zinc appearance has no effect on either the quality or corrosion resistance of the coating. These thick coatings are not suitable for organic coating prior to forming operations.

Flattened minimised spangle

This zinc coating finish is obtained by restricting the normal zinc crystal growth followed by a skin pass process. The zinc coating thus obtained has improved formability and the zinc surface serves as an excellent base for pre-painting, post-painting and powder coating applications.

This finish is recommended for applications where a high gloss paint finish is required. It is available for zinc coatings up to Z275, in a maximum material thickness of 1.20 mm, if passivation is required, or a maximum thickness of 1.60 mm if passivation is not required.

For further information, contact:
ArcelorMittal South Africa Limited, PO Box 2, Vanderbijlpark 1900. No (016) 889 4081, Fax (016) 889-2022
e-mail address: chromadek@arcelormittal.com

Zinc Surface Treatment

ArcelorMittal South Africa offers the following surface treatments to reduce the risk of wet storage staining during transport and storage:

Passivation

Passivation by chromic acid (ideally even coatings of 20 to 40 mg/m^2 total on both sides) is normally applied to all galvanised material. In cases where this treatment may interfere with subsequent processing such as phosphating, the galvanised steel may be ordered without passivation, in which case oiling is recommended.

While every effort is undertaken to ensure that the passivation coatings are evenly applied, occasionally local colour variations are encountered. However, these colour differences will not impair the quality of the zinc coating and with time will gradually disappear.

Oiling

A corrosion preventive oil is used to coat galvanised sheet as an alternative providing additional protection against wet storage staining during handling and storage. Oil is only applied upon request.

Unoiled and un-passivated

If unoiled and/or un-passivated galvanised steel sheet is ordered, the danger of wet storage staining is increased and therefore no complaints to this effect will be entertained. Protective packing should be specified to reduce moisture ingress during transport and storage which will lower the risk but will not guarantee wet storage stain free material. Various packaging options are available (see 'Packaging Specification').

Dimensions

The standard width and thickness ranges offered with Regular-or Flattened Minimised Spangle are:

Table 3a: Regular Spangle: Available

Thickness[1] (mm)	Width (mm) [2, 4]
0.25[2] 0.27[2] 0.30[2]	762, 914, 925
0.40	925 ≤ w ≤ 1 219
0.47 0.50 0.53	925 ≤ w ≤ 1 320
0.58 0.80 1.00 1.20 1.40 1.60	925 ≤ w ≤ 1 524
1.90 2.40 3.00	925 ≤ w ≤ 1 225

Notes:

1. *Total coated thickness (TCT) i.e. sum of coating and substrate thicknesses.*
2. *Available as ISQ 550 with regular spangle coils only.*
3. *The following standard widths are available (Depending upon thickness): 925, 940, 1000, 1 175, 1 219, 1 225, 1 250 and 1 320mm.*
4. *Structural grades that require medium to high strength mechanical properties are subject to thickness and width limitations (Limitations available on enquiry).*
5. *Maximum width for ISQ 550 3T material is 1 225mm.*

For further information, contact:
ArcelorMittal South Africa Limited, PO Box 2, Vanderbijlpark 1900. No (016) 889 4081, Fax (016) 889-2022
e-mail address: chromadek@arcelormittal.com

Table 3b: Flattened Minimised Spangle:

Thickness (mm)[2]	Un-Passivated Width(mm)	Passivated Width(mm) Excluding LFQ material
0.40 – 0.41	925 ≤ w ≤ 1 219	925 ≤ w ≤ 1 050
0.42 – 0.44	925 ≤ w ≤ 1 225	925 ≤ w ≤ 1 075
0.45 – 0.49	925 ≤ w ≤ 1 265	925 ≤ w ≤ 1 115
0.50 – 0.59	925 ≤ w ≤ 1 320	925 ≤ w ≤ 1 175
0.60 – 1.20	N/A	925 ≤ w ≤ 1 225

Hot rolled substrate

Where hot rolled substrate (≥ 1.40mm to 3.00 mm) is used the zinc coating may highlight blemishes on the substrate surface such as scratches and coil breaks. Neither of these defects will affect the functionality of the material but could impair the aesthetic appearance. The end-user should take note of this, as no claims related to aesthetic reasons will be entertained.

Tolerances

Thickness

The permissible variation from nominal coated product thickness is as follows:

Table 4: Thickness tolerances

Coated thickness *t* (mm)	Permissible variation in thickness (mm)		
	Z100, Z150 & Z160[1]	Z200 & Z275	Z450 & Z600
0.25 - 0.35	-0.02 + 0.02		
0.40 – 0.50	-0.02 + 0.02	- 0.02 + 0.02	On enquiry
0.51 - 0.58	-0.03 + 0.03	- 0.03 + 0.03	- 0.08 + 0.08
0.59 - 0.80	-0.05 + 0.05	- 0.05 + 0.05	- 0.10 + 0.10
0.81 - 1.00	-0.05 + 0.05	- 0.05 + 0.05	- 0.11 + 0.11
1.01 - 1.20	-0.06 + 0.06	- 0.06 + 0.06	- 0.12 + 0.12
1.21 - 1.60	-0.08 + 0.08	- 0.08 + 0.08	- 0.14 + 0.14
1.61 - 2.00		-0.10 + 0.10	- 0.20 + 0.20
2.01 - 2.50		-0.12 + 0.12	- 0.22 + 0.22
2.51 - 3.00		-0.12 + 0.12	- 0.23 + 0.23

1) Only available for Colour Coated Material

Note: *Thickness tolerances not applicable to ±50 m on the front end of coils.*

For further information, contact:
ArcelorMittal South Africa Limited, PO Box 2, Vanderbijlpark 1900. No (016) 889 4081, Fax (016) 889-2022
e-mail address: chromadek@arcelormittal.com

Flatness

Table 5: Flatness tolerances

Coated thickness t, mm	Width w, mm	Tolerance I-units [2]	Previous equivalent Wave height (mm) [1]
<0.40	762 - 914	25	10
0.40 – 0.57	775 – 1 320	25	10
0.58 – 1.60	925 – 1 320	16	8
1.61 < 2.00	925 – 1 225	16	8
1.40 – 3.00[3]	925 – 1 225	56	15

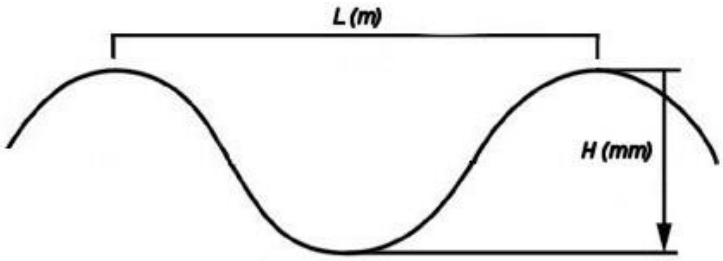
Notes:

1. *Flatness tolerance (wave height) is defined as the maximum possible deviation from a horizontal flat surface in any 1000 mm length (1 wave per metre)*
2. *I-Units are a better way of measuring flatness in that the effect of more than 1 wave per metre can be calculated.*
3. *Hot rolled substrate*

Calculation of I-Units

$$\text{I-unit} = 0.25 \times (H/L)^2$$

H = wave height in **mm**
L = wave length in **m**



Width

The permissible variation in width is as follows:

Table 6 : Width tolerances

Table 6a Trimmed for all Qualities in Table 1 except S450GD AMSA

Specified width *w* (mm)	Permissible variation (mm)
762 ≤ *w* < 1 225	-0+ 5
1 225 ≤ *w* < 1 524	-0+ 6

Table 6b Untrimmed/Mill Edge only applicable to S450GD AMSA

Specified width *w* (mm)	Permissible variation (mm)
1225	-0+ 20

For further information, contact:
ArcelorMittal South Africa Limited, PO Box 2, Vanderbijlpark 1900. No (016) 889 4081, Fax (016) 889-2022
e-mail address: chromadek@arcelormittal.com

Edge Camber

Edge camber is the maximum distance between a longitudinal edge and a straight edge supported on the latter. Edge camber shall be measured on the concave edge. The basis of measurement shall be a distance of 2m taken at any point on the edge. In the case of sheets and cut lengths with a length less than 2m, the basis measurement shall be equal to their length:

a. Edge camber $\leq$ 5mm over a length of 2m.
b. Lengths<2 m, $\leq$ 0.25% of the actual length.

PROPERTIES AND PERFORMANCE

Flexibility and coating adhesion

Bend tests to evaluate the adhesion of the zinc coating are carried out in accordance with the relevant material specifications. In addition to this, impact adherence cupping tests are performed on all products, irrespective of specification, to ensure good adhesion of the zinc coating.

The coating bend test specimens are suitable for bending through 180º in any direction without showing any signs of flaking. An area of 6mm from each edge of the specimens is disregarded in order to exclude the effect of the cut edge. The inside diameter of the coating bend test is prescribed in Table 7

Table 7: Minimum inside bend diameter[1]

		180º Bend-mandrel diameter			
		Total thickness t $\leq$ 2mm		**Total Thickness > 2mm**	
		Zinc coating			
Class	**Grade**	**Up to Z275**	**>Z275, Z450, Z600**	**Up to Z275**	**>Z275, Z450, Z600**
Commercial	ISQ 230/GR220	1t	2t	2t	2t
	ISQ 300/GR280	2t	-	-	-
	ISQ 550 (3T)	3t	-	-	-
Forming and Drawing	LFQ/DQ/RTQ/ DX51D	0t	2t	-	-
Structural	GR220/S220GD	1t	2t	-	-
	GR255/S250GD	2t	3t	-	-
	GR280/S280GD	2t	3t	3t	-
	GR350/S350GD	3t	4t	3t	-
	S450GD	4t	-	4t	-
	S550GD	3t			

Notes: 1. Given as a multiple of t (t=total coated thickness i.e. sum of coating and substrate thicknesses.)

For further information, contact:
ArcelorMittal South Africa Limited, PO Box 2, Vanderbijlpark 1900. No (016) 889 4081, Fax (016) 889-2022
e-mail address: chromadek@arcelormittal.com

Strain ageing

Galvanised steel sheet tends to strain age and this may lead to the following:

1. Surface markings from stretcher strain (Lüder's lines) or fluting when the sheet is formed.
2. Deterioration in ductility.

It is recommended that the period between final processing at the mill and fabrication be kept as short as possible, preferably not exceeding six weeks.

Fretting

Fretting, also known as either friction marks or friction stain can occur superficially on hot dip galvanised coils. It is caused by the interaction of two surfaces in contact with one another, which are simultaneously subjected to either high or low frequency vibration. For this reason, fretting, if encountered, may be present when material is transported over relatively long distances by road or rail.

Fretting is observed as black patches which are a superficial phenomenon only, and are normally confined to only a few microns on the surface of the coating. The life expectancy of the material will thus not be compromised by the presence of fretting. However it may be of aesthetic concern to some end-users.

Performance of zinc coated steel

The zinc coating protects the steel substrate in two ways:

1. by providing a barrier between the steel and the environment and
2. through galvanic protection.

When zinc is exposed to the environment in a wet/dry cycle a relatively stable (insoluble in water) zinc oxide/carbonate protective layer is formed through the reaction of zinc with oxygen, water and carbon dioxide. This is the primary reason for the low corrosion rate of zinc in most environments. Zinc is more electro-negative than steel in the galvanic series and will sacrificially corrode when the base steel is exposed, at a cut edge or scratch. Material with a total coated thickness of less than 2.50 mm is adequately protected along cut edges by a Z275 coating.

However, the zinc oxide/carbonate layer tends to dissolve when the surface moisture film is sufficiently acidic or alkaline (oxide relatively stable in pH range 6-12.5). The specific environment i.e. agricultural, industrial, and coastal and others could influence actual performance. In general, with thicker the zinc coatings (see Table 8), greater protection will be provided in specific environments. It is recommended that galvanised sheeting be over-painted before the formation and first appearance of red corrosion products.

For further information, contact:
ArcelorMittal South Africa Limited, PO Box 2, Vanderbijlpark 1900. No (016) 889 4081, Fax (016) 889-2022
e-mail address: chromadek@arcelormittal.com

Table 8: Expected life (in years) for different zinc coatings and environments.

Corrosion Zone[3]:		C0	C1/C2		C3	C4	C5
Environment:		Dry	Dry conditions		Urban Inland/40-100km from HWM[4]	1-5 km from HWM[4]	Urban Coastal (400m – 1km/Industrial
Application:		Interior	Exterior : Desert	Exterior: Rural occasional condensation	Interior: High humidity with some air pollution/ Exterior: Urban inland/mild coastal	Exterior: Industrial inland/Urban coastal	Exterior: Industrial high humidity/ Coastal high salinity
Corrosion rate (µm/y)		**~0**	**<0.1**	**<0.7**	**0.7-2.1**	**2.1-4.2**	**4.2.-8.4**
*Coating	+/-µm per surface	Average expected life (in years)					
Z100	7	20	>15	15	5	N/R	N/R
Z150	10	25	>20	20	7	N/R	N/R
Z200	14	30	>25	25	10	N/R	N/R
Z275	19	50	>25	25	15	Note 5	N/R
Z350	24	50	>25	25	17	Note 5	N/R
Z450	31	50	>25	25	22	Note 5	Note 5
Z600	42	50	>25	25	25	Note 5	Note 5

*Galvanised not recommended for Fertiliser plant applications

Note:
1. N/R-not recommended.
2. Terms and conditions apply (Factors like design, erection and micro-climate could impact expected life)
3. Corrosion zones as per ISO 9223
4. HWM – High water mark
5. Atmospheric pollutants could impact on expected life and the supplier should therefore be contacted for a recommendation.

GENERAL INFORMATION

Wet storage stain (White rust)

Zinc reacts with the environment to form a continuous passive layer of a protective oxide/carbonate in a wet/dry cycle. It is important that a zinc coated surface when wet is exposed to adequate ventilation and dries in free flowing air to develop this layer. Wet storage staining (also known as white rust) is formed when the reactive zinc, on two surfaces in close proximity, in contact with moisture and without exposure to CO_2 (drying cycle), form the chemical compound- zinc hydroxide (ZnOH).

The extent of the formation of wet storage stain is dependent on:

1. Exposure time to moisture,
2. Temperature experienced during exposure and
3. Contaminants (i.e. Chlorine salts) that could accelerate the reaction.

The key is that galvanised surfaces, in close proximity, must be kept dry at all times during transport and storage, all necessary precautions must be taken to prevent the formation of condensation or ingress of moisture between surfaces.

Packs of galvanised material must not be stacked directly on floors. Rainwater or water vapour can easily be drawn in between tightly stacked profiled or flat sheets, or between laps of coils by capillary action. Due to the absence of freely circulating air, this moisture cannot evaporate, causing unfavourable conditions that may result in wet storage staining of the galvanised material.

For further information, contact:
ArcelorMittal South Africa Limited, PO Box 2, Vanderbijlpark 1900. No (016) 889 4081, Fax (016) 889-2022
e-mail address: chromadek@arcelormittal.com

Unless galvanised material is stored in a warehouse under a controlled atmosphere, no claims for wet storage stains will be entertained.

Welding

Zinc coated steels may be welded satisfactorily by the most commonly practised welding techniques. Weld spatter should be avoided, to ensure no damage to the zinc coated surface. Spatter will act as preferential sites for corrosion. Closer control of welding parameters and welding in adequately ventilated areas is necessary to reduce the effect of toxic fumes when welding galvanised steel.

Painting

Chemical conversion coatings and primers have been developed to provide good adhesion of subsequent paint films applied to zinc-coated surfaces. To obtain optimum results it is essential to adhere to the instructions of the paint manufacturers.

Warranty

ArcelorMittal South Africa warrants the prime quality of their galvanised products, but cannot accept liability for damage to the material sustained during and after profiling, transport to or storage at the building site, and during erection

Quality assurance

A quality assurance system complying to SANS 9001 governs the galvanising manufacturing process, and ArcelorMittal South Africa's products conform to the requirements of both: SANS ISO 3575 and SANS ISO 4998.

Supply conditions

Hot-dip galvanised coil and sheet are supplied in terms of Price List 140 and ArcelorMittal South Africa's General Conditions of Sale.

For further information, contact:
ArcelorMittal South Africa Limited, PO Box 2, Vanderbijlpark 1900. No (016) 889 4081, Fax (016) 889-2022
e-mail address: chromadek@arcelormittal.com