

Hot Dip Galvanized Information Sheet No.13

Hot Dip Galvanizing - General / Batch Type versus Continuous Sheet

GENERAL OR BATCH TYPE HOT DIP GALVANIZING				CONTINUOUS SHEET HOT DIP GALVANIZING			
SPECIFICATIONS							
Specifications - local	SANS 121 #1			SANS 3575 #2 SANS 4998 #3			
Specifications - International	ISO 1461			ISO 3575 ISO 4998			
Coating grades	None #4			Several, must be specified #5/#6			
Coating thickness #6	Steel thickness (mm)	Local coating thickness (µm)	Mean coating thickness (µm)	Coating designation #7	Average mass of coating	Individual mass of coating	Min coating thickness on one face. (µm)
	$t \geq 6$	70	85	Z200	200	170	9,7
	$3 \leq t < 6$	55	70	Z275	275	235	13,4
	$1,5 \leq t < 3$	45	55	Z450	450	385	22
	$t < 1,5$	35	45	Z600	600	510	29
Steel thickness	Any steel thickness but preferentially greater than 2.0 thick particularly if not shaped or work-hardened.			From 0,28 to 2.9mm thick. Note: The final supplied steel thickness including the applied zinc coating will be marginally thicker.			
Smoothness and acceptance of the coating	Relatively smooth, depending on steel type, complexity of component and dipping exit angle. Free from roughness and sharp points, particularly at "pre-defined" significant surfaces.			Gas Knives (usually high pressure air) wipe off excess molten metal as the continuous sheet exits the zinc bath, leaving behind a closely controlled thickness of coating.			
Ordering, identification and receipt at site.	Steel that has been hot dip galvanized by the general process is relatively easy to identify that it is in fact hot dip galvanized. Silver paint that may have been incorrectly used for repair can easily be scrapped off.			The coating grade that has been specified may be difficult to assess in terms of coating grade (and therefore coating thickness) on receipt at site in terms of specification conformity. While taking random coating thickness readings using a calibrated coating thickness instrument are not acceptable in terms of the specification, they will however, provide a reasonable idea of what the coating thickness is and therefore the coating grade that has been delivered. A more accurate and acceptable method in terms of the specification is described in #8.			
PROCESS							
Process	Items that are completely fabricated are dipped in a bath of molten zinc at about 450°C and removed at a relatively steep angle and slow speed.			Continuous sheeting is rapidly (100 to 140m/min) passed through a bath of molten zinc at about 450°C and as it exits the bath the sheeting travels through gas air knives that wipe off the excess coating, resulting in the coating thickness designation that was specified.			
Composition of the coating	The coating comprises a series of iron/zinc (Fe/Zn) alloy layers, normally over coated by a relatively pure zinc layer.			The coating comprises mostly pure zinc with very little iron/zinc alloy layer (about 1 –2 µm), required for ductility.			

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Influences on coating thickness	Silicon and Phosphorus and combinations of these two elements in the steel have a major effect on coating thickness and appearance. Steel thickness and surface roughness also have an effect on coating thickness.	Effectiveness of the air or steam knives.
Zinc melt	98,5% Zn, 1,2%Pb and about 0,007% max. Al.	99,95% Zn, 0,008%Pb and about 0,02% max Al.
Smoothness	Relatively smooth, depending on steel type, surface profile, design shape and angle of exit.	Air or steam wiped and therefore generally smoother than general or batch type hot dip galvanizing.
Passivation	Components are water quenched where the water usually contains a small percentage of sodium dichromate. Although not quite yet fully used by the galvanizers, passivation treatments free of chrome 6 have been developed and are commercially available.	Mill passivation: <i>A chemical treatment is normally applied to zinc coatings to minimize the hazard of wet storage stain.</i> Mill phosphating: <i>This is applied so that subsequent painting after normal cleaning can be relatively easily achieved.</i> Oiling: This treatment method further prevents the formation of wet storage stain.
Testing adhesion	Testing of adhesion is not necessary in accordance with SANS 121.	In order to test the adhesion of a coating, a bend test and impact cupping test is conducted. See #9
DURABILITY		
Corrosion categories C1 to C5 (ISO 9223)	The corrosion of a zinc coating or a duplex coating system (hot dip galvanizing and an appropriate paint system) varies depending on the atmosphere the coating is subjected to, Information sheet No.13 , compiled from ISO 9223, for a performance comparison between general and continuously hot dip galvanized sheeting.	
Enhanced corrosion protection	Iron/zinc alloy layers which make up between 50 and 85% of the coating provide up to 30% better corrosion protection than pure zinc.	Limited iron/zinc alloy layers due to process speed and requirements for final product ductility.
Cathodic protection at edges	Zinc by its nature because of its position in the galvanic series of metals will sacrifice itself in preference to carbon steel. Cathodic protection is relative to moisture content, coating thickness and the amount of zinc present at the uncoated area.	
Effectiveness of cathodic protection	More effective due to greater coating thickness and an intact coating at all edges.	More effective on thin gauges and thick coatings. Less effective on thick gauge and thin coatings, particularly along cut exposed edges.
Wet storage stain	Wet storage stain is a white voluminous deposit (zinc hydroxide) that is formed on freshly hot dip galvanized surfaces which are in close contact in the presence of moisture. Freshly galvanized coatings react with the environment until such time as the cause is removed and a stable zinc carbonate film is formed on the coating surface. See Information sheet No.2	
Effect of wet storage stain	The presence of wet storage staining will rarely have a marked influence on a thick general hot dip galvanized coating.	The presence of wet storage stain, in between closely nestled sheeting, will if not addressed early enough, lead to premature corrosion of the zinc layer.
Abrasion resistance	Pure zinc is a soft metal, even though it is harder than most organic coating materials. The iron/zinc alloys produced in batch or general hot dip galvanizing are however, very hard. In fact they are harder than ordinary structural steel.	
Superior abrasion resistance	The iron/zinc alloys provide superior abrasion resistance.	Less abrasion resistant than general hot dip galvanizing but better than most organic or paint coatings.

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PRODUCTS		
Appearance	Depending on steel type, coating appearance can vary from a spangle finish to a silvery or matt or even dark matt grey finish.	Different appearances ranging from a spangle coating, minimized spangle coating, iron/zinc alloy coating to a differential coating are offered.
Can appearance be altered?	Yes, the addition of a Zn/Ni/Al alloy can improve coating appearance.	See above.
Ductility	Not ductile, items must be completely fabricated before coating, generally excessive bending will cause cracking of the Fe/Zn alloy layer.	Ductile for subsequent profiling, as Fe/Zn alloy layer almost non-existent.
Component size limitations	Most fabricated steel items can be hot dip galvanized, provided they can fit into the respective galvanizing bath sizes. #10	Coils of sheeting, up to 1,5m wide, between 0,3 to 3.0mm thick and specified lengths.
Coating repairs	Site alterations and coating damage should be appropriately repaired. See #11 . If not repaired, the uncoated area will suffer discoloration and eventually localised corrosion but corrosion creep is impossible while zinc is present.	
Are coating repairs allowable in terms of the standard?	Yes, at the galvanizer or at site, provided that an individual repair is no greater than 10cm ² and the combined repair area on one component is not be greater than 0,5% of the surface area.	No mention regarding coating repair is made in either specification but if that is required, the same method of coating repair would be applicable.
For enhanced corrosion protection or individual specification requirements including a colour, hot dip galvanizing can be duplex coated by painting with an appropriate paint system.	Combining a hot dip galvanized coating with an appropriate paint coating system, results in a synergistic effect, whereby the sum of the individual coatings, can be increased by between 1,3 to 2,7 times the individual coating lives (depending on the specific environment at hand).	
	<ul style="list-style-type: none"> Specify the use of the Association's Code of Practice for Preparation, HDGASA 01-1990. Specification for the Performance Requirements of Coating Systems. HDGASA 02-1990. Engineering Specification, HDGASA 03-2006. Discuss with the Association and/or paint supplier. Preferably use galvanizer within house industrial painting facilities. 	<ul style="list-style-type: none"> Specify "Chromaprep" – Factory primed coated hot dip galvanized sheeting, ready for top coating. Specify "Chromadek" or "Chromadek Plus" – Factory painted top coats.

NOTES:

- # 1** The local standard (SANS 121) is linked to the international standard (ISO), it is recommended that both standard numbers be referenced, i.e. SANS 121 (ISO 1461) Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods.
- # 2** SANS 3575 – Continuous hot dip zinc coated carbon steel sheet of commercial, lock forming and drawing qualities.
- # 3** SANS 4998 – Continuous hot dip zinc coated carbon steel sheet of structural quality.

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4 When specifying general hot dip galvanizing no reference to coating thickness is required other than reference to the Standard, i.e. SANS 121. However, should a heavy-duty coating be required, i.e. 25% greater than that required in table 2 of the standard, this must be stipulated. This is allowable in terms of the Specific Permit Conditions issued to all Mark Scheme Holders of the SABS, without compromising the standard. Note: Where steel composition does not induce moderate to high reactivity, (such as in aluminium killed or non reactive steels), thicker coatings are not always easily achieved. Furthermore, all items that are centrifuged in accordance with SANS 121, table 3, cannot be hot dip galvanized to heavy-duty applications.

5 A number of coating designations are available in terms of SANS 3575 or 4998 from Z100 to Z700. Common coating designations are Z160 (only locally available), Z275, and Z600.

6 Generally, local specifications call for the use of continuously galvanized sheeting according to SANS 3575 or 4998 coating grade Z275. The former standard includes commercial grade material, whereas the latter standard includes structural grades of material. Both standards have identical coating mass requirements.

As an example, a coating grade of Z275, in both specifications require a coating mass of 275g/m² as a triple spot test but 235g/m² on a single spot test. The specifications also state that not less than 40% of the single spot test will be found on either surface. This equates to a nominal zinc coating thickness of about 20µm with a minimum thickness of 13.4µm.

Similarly, a Z600 would have a coating mass of 600g/m² as a triple spot test but 510g/m² on a single spot test. Not less than 29µm as a single spot test should be found on either surface.

The equivalent thickness is calculated from the following formula:

$$\text{Thickness in microns } (\mu\text{m}) = \frac{\text{Mass per unit area, g/m}^2}{2 \times 7}$$

(2 includes both sides and 7 is the approximate specific gravity of zinc)

While the coating thickness readings taken on site by means of a calibrated electro-magnetic thickness gauge can provide a good indication of coating thickness, it is worthwhile to bear in mind that readings done in this manner may only be used as an approximation. Both SANS 3575 and 4998 and the previous standard SANS 934, do not include testing of coating thickness by electro-magnetic coating thickness gauges.

Should accuracy proving coating thickness for any reason be required, samples of at least 2000mm² (according to SANS 3575/4998) will be necessary for stripping purposes, using the gravimetric method to ISO 1460. This method only proves the overall mass of the coating and not the distribution.

7 Listed coating designations are representative of the range but the list is not comprehensive. For the full range of coating designations, refer to SANS 3575/4998 as appropriate.

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8 In order to prove mass of a coating, test specimens shall be taken from a sample piece approximately 300mm in length on the as-coated width. The purchaser may verify the mass of the coating using the following sampling method.

Three specimens shall be cut, one from the mid-width position and one from each side not closer than 25mm to the side edge. Minimum specimen areas shall be 2000mm². The samples shall be subjected to chemical stripping (gravimetric) testing to ISO 1460.

9 Bend test pieces taken after delivery, shall withstand being bent through 180° in either direction without flaking of the coating on the outside of the bend. The radius (D/2) of the bend is determined by the number of pieces of the same thickness (or mandrel equivalent) shown as follows:

D = 0, for coating Z001 to Z275.

D = 1 x a, (a = product thickness) for coating Z350.

D = 2 x a. for coatings Z450 to Z700.

When pressing together the two legs of the specimen, care should be taken to ensure that the coating is not damaged. The test is invalidated if breakage occurs in the base metal. Flaking of coating within 7mm from the edge of the test piece shall not be cause for rejection.

The impact cupping test is not required by SANS 3575/4998, but has been developed as a proprietary adhesion test conducted by Arcelor Mittal.

10 **Different appearances include:**

- 1) *Spangle coating*: A coating formed as a result of unrestricted growth of zinc crystals during normal solidification. This coating has a metallic lustre and is the type normally furnished for a wide variety of applications.
- 2) *Minimized spangle coating*: A coating obtained by restricting normal spangle formation during solidification of the zinc. This product may have some lack of uniformity in surface appearance within a coil. It is normally furnished in coating designation 350, 275 and 200 and in the range of thicknesses 0,5 to 3,0 mm inclusive. This finish is normally specified for cosmetic considerations.
- 3) *Iron/zinc alloy coating*: A coating produced by processing the zinc-coated steel sheet so that the coating formed on the base metal is composed of iron/zinc alloys. This product is not spangled, is normally dull in appearance, and for some applications may be suitable for immediate painting without further treatment, except normal cleaning. Iron/zinc alloy coatings may powder during severe forming.
- 4) *Differential coating*: A coating having a specified coating mass on one surface, and a significant lighter coating mass on the other surface. The two surfaces may have different surface appearances.

11 Bath sizes vary from the smallest of 0.7m dia x 1.2m deep of an in-line galvanizer to general galvanizers with 10 x 2 x 4m deep and three 14m long baths, one each in Johannesburg, Cape Town and Durban. The average bath size is 7.5m long.

Besides double end dipping, which can be quite successful, depending on the galvanizer, innovative methods have and can be devised in order to dip oversized components. Kindly discuss these with the galvanizer at hand or the HDGASA.