HOT DIP

2007 Volume 4 Issue 4

HOT DIP GALVANIZING TODAY

HOT DIP GALVANIZERS ASSOCIATION Southern Africa

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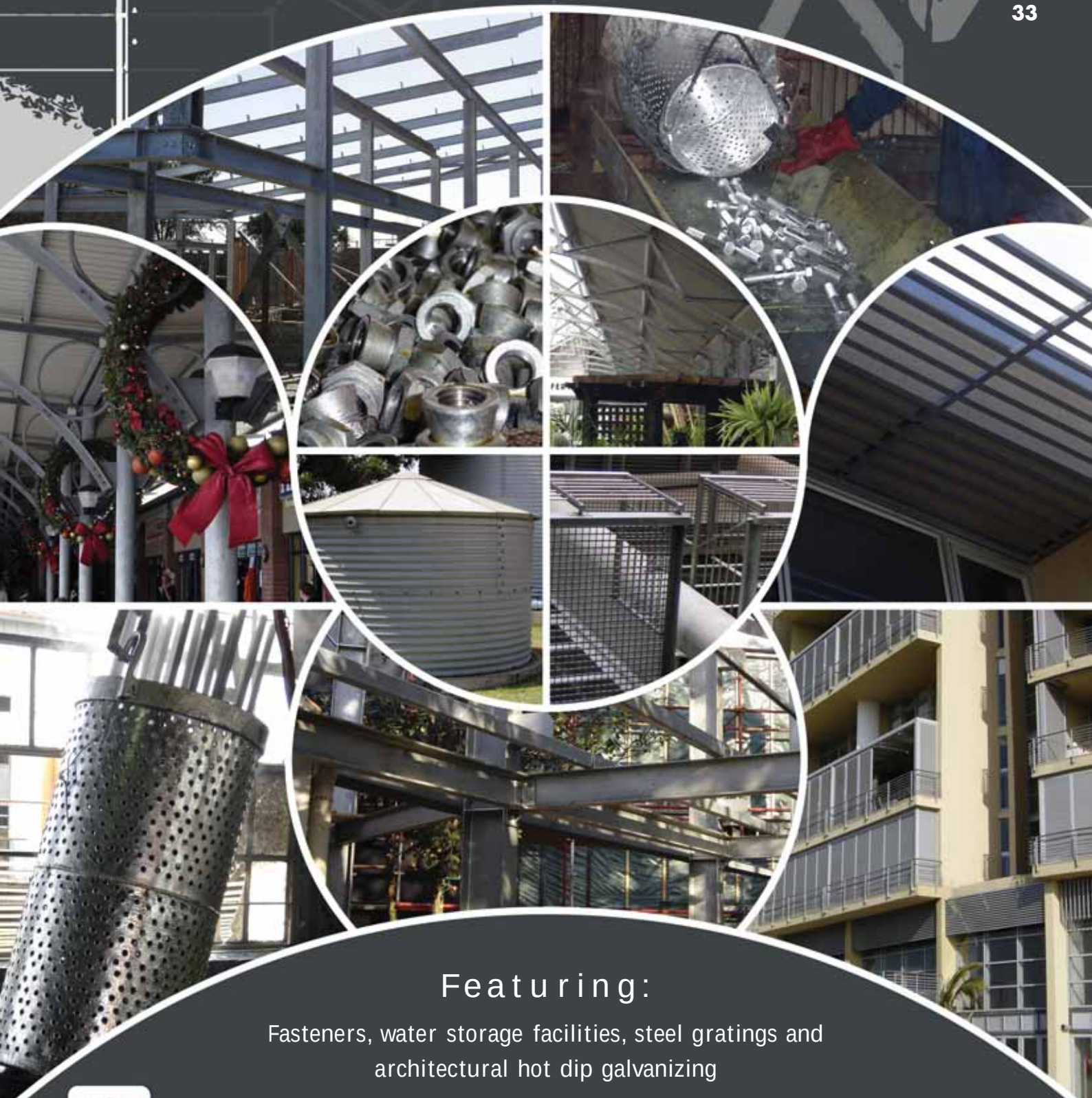

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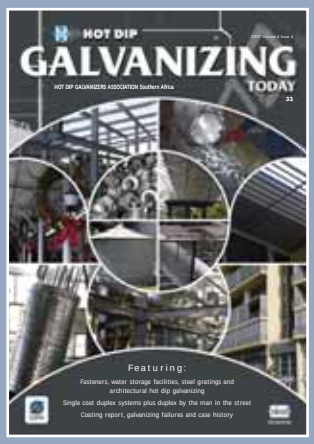

The Association is a technical information centre established for the benefit of specifiers, consultants, end users and its members

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Front Cover: *A kaleidoscope of photographs including fasteners, a water storage facility, steel gratings and a few architectural applications*

Hot Dip Galvanizing – Adding value to Steel

Executive Director's Comment

Hot dip galvanizing, being a metallurgical reaction between carbon steel and molten zinc, the final quality of the zinc coated steel component, is dependent on the chemical analysis of both the steel and molten zinc. The question of silicon (Si) and phosphorous (P) content in steel is dealt with on our "Information Sheet No. 4" to be found on our website, www.hdgasa.org.za.

Studies indicate that Si disturbs the equilibrium states available in the zinc iron (Zn-Fe) system and alter the growth mode of the resultant coating, and thus causing reactivity problems for the general galvanizer. This problem can be easily controlled by alloying the molten Zn bath with metals, such as nickel (Ni), provided the Si content of the steel does not exceed 0.25%.

In order to control the steel's reactivity when immersed into molten zinc, the Association has advocated that steel specifications "suitable for hot dip galvanizing" should include a clause to limit both the Si and P in order to achieve a quality hot dip galvanized product. The basic clause, to be included in the steel specification, should control Si in a range of 0.01 to 0.04% or alternatively 0.15 to 0.25% with P to be less than 0.02% maximum. It has been said that such a clause in the steel specification is difficult to achieve and maintain. This being the case, the proposed addition of Ni, as an alloying element in the molten zinc bath, aimed at controlling the reactivity of steel (Si & P) and resultant thickness of the Zn coating is questionable due to the above comment, "provided the Si content of the steel does not exceed 0.25%".

With the development of the newer higher grade steels, it is incumbent on the developers of such materials, to consider the client's requirements in terms of service life and hence corrosion protection systems needed to meet exposure conditions. Ni in the molten zinc bath is a great idea, but we still need to control both the Si and P.

Bob Wilmot

Note from the Editor

In my opinion, there are no wonder coatings that will perform equally well in all environments!

Paint types are generally manufactured to cater for specific conditions, i.e. epoxies are generally good for substrate adhesion and can provide high build, whereas polyurethanes are colour fast and generally better against UV. Acrylics on the other hand provide colour but on their own are not necessarily good corrosion protection coatings for steel.

Therefore using the incorrect paint type for the wrong application will result in a failure!

Hot dip galvanizing is no different, in spite of it being able to provide sound, durable and cost effective coating solutions in the majority of corrosive environments and a service free life of in excess of 30 years in 90% of South Africa, it is still not a wonder coating and when used inappropriately will provide a shorter service life and even fail prematurely alongside the best of all the others!

To date we have witnessed some premature failures of our coatings due to inappropriate use and incorrect exposure and in the case of duplex coatings, inadequate substrate preparation, inappropriate paint or insufficient paint film build.

We have also investigated complaints on coatings in far off places such as the Seychelles, Namibia and other areas and to this end we have decided to introduce a regular article called "Galvanizing Failures" starting with an application in Cape Town in this issue.

In addition to assist asset owners, we will evaluate and report on the durability of an exposed coating. To this end we extend an invitation to you the reader, inviting participation in a programme where Association staff will evaluate a weathered hot dip galvanized or duplex coating that is more than 10 years old. The contribution will be used as a case history and may then be published in the magazine. Should a reader wish to participate in this programme, kindly contact the Association.

The Association has now been operating out of premises in Cape Town since the beginning of August and over and above my cellular phone and email address, we now have a contact landline telephone and fax facility (*see contents page)*.

Features for this issue include: Fasteners, Water Storage Facilities, Steel Gratings and with a repeat of the essential check list for achieving Architectural Hot Dip Galvanizing.

Under Duplex Coatings, Mike Book of Duplex Coatings and Danie du Preez of Sigma Coatings discuss single coat duplex coatings.

Education and Training, expands on our certificated coating inspectors course, an essential requirement in any coating inspectors portfolio.

The Coating Report discusses how an incorrect metal coating choice, which is perceived to be similar, can have a major impact on the durability of a coating exposed to certain environments.

Our Case History highlights a hot dip galvanized coating on sub-station steelwork in Pietermaritzburg, which has been exposed for about 40 odd years and still going strong!

Other regular articles include Misconceptions, where she asks if all galvanized coatings are equal? Walter's Corner discusses, the durability of hot dip galvanizing and duplex protection. Our Guest Writer discusses Situational Awareness, a necessary skill for the modern world. Our Personality Profiles are the Creative Duo of Eerhard Huizinga & Jane Durand. In Members News we have some feedback from the recent APGGC and some zinc related news from Exxarro.

Should a reader wish to express an opinion or provide us with an article, kindly contact me – enjoy the magazinc.

Finally, have a safe and wonderfully restful Christmas break!

Terry Smith

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Armco Superlite – supplying water reservoirs to meet Africa's needs

Armco Superlite was established in South Africa in the 1930's as a subsidiary of one of America's largest steel producers, the American Rolling Mill Company. Today, Armco is a wholly South African owned company. Situated in Johannesburg, the company has its own hot dip galvanizing plant, which is part of the SABS mark scheme and ISO 1461 accredited.

Armco's name has become synonymous with their guardrail product, although the company also produces a range of other road safety products, as well as corrugated steel structures, including the Armtank water reservoirs.

These easy to erect water tanks are available in 50kl to 1 000kl capacities and are supplied in knockdown form, which allows for easy transportation and relocation. This hot dip galvanized, mild steel corrugated tank is suited to harsh African conditions and is a cost effective alternative to concrete or plastic reservoirs. Armtank reservoirs can be found in remote communities, on construction projects or in agricultural applications and are suited for either ground level or elevated situations.

No special skills are required to erect the Armtank water tanks and no concrete floor is required. The plates are sealed using only approved, durable and tested waterproofing compounds. The tanks come with a durable Driline geo-membrane as water proofing and an optional floating roof. Additional accessories include inlets, outlets, overflows and complete water purification systems.

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Hot dip galvanized window frames in Cape Town houses a popular necessity

The latest trend in upper end house style seems to be away from Tuscan towards 'floating' roofs with clerestory windows. This is especially so in Cape Town where this design takes maximum advantage of the views. Steel is the most suitable material for these roof structures and since cantilever sections are always included, for sun protection, the exposed steel need to be corrosion protected. Hot dip galvanizing is the obvious answer.

Normally the clerestory windows of these roofs consist of Aluminium frames fitted between the steel structure. The combination of steel and Aluminium tends to be costly and searching for savings is a main objective during design.

At House Miros in Hout Bay this was achieved by designing hot dip galvanized steel window frames which are also used to support the roof structure. The individual frames are sized to match the steel rafter spacing so that each rafter is supported where the frames meet and the roof load is then supported by the twin window mullions. The usual steel posts are saved and the closing of gaps between steel and Aluminium frames is avoided.

Despite the frames being made from 80 x 40 rectangular hollow sections we were concerned about possible warping during hot dipping. Another potential problem was that the glazing bead would have required continuous welding to prevent acid entrapment which would also cause warping due to the weld heat and have a high labour content. It was therefore decided to use a loose galvanized angle as the glazing bead and fix it to the frames with stainless steel self tapping screws. This allowed for exact alignment, an important factor, since the glass is fitted directly onto the glazing bead.

The result was a very light, durable and surprisingly attractive structure and no problems were encountered during fabrication and erection.

The Association wishes to thank Rod Holmes of Conspec Consulting Civil Engineers for this article.

Editorial comment:

Thanks very much for the article, Rod, however I just wish to state for the record that in your article you mention not sealing the welds would lead to acid entrapment. All acid that is likely to be trapped in crevices will volatilize when the article comes into contact with molten zinc at 450°C. What may remain behind in the crevice is a salt from either the acid or flux solution. When the article is dipped into the water quench following galvanizing, any salt is likely to leach out and discolour the surface of the galvanizing at the crevice. The discoloration can be cleaned off and if necessary the crevice sealed with a sealant.

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Hot dip galvanizing for general and architectural purposes

The achievement of a quality hot dip galvanized coating, for general and architectural use, is dependent on many issues, some controllable and some not. This checklist addresses the issues that can be controlled by the designer and those controllable by the galvanizer.

AG – Architectural Quality additional to SANS 121 GG – Normal Hot Dip Galvanizing to SANS 121
Y/N – Was this criteria achieved, yes/no? # – Contact the Association for a free copy

NOTE: THIS CHECKLIST IS TO BE USED AS A GUIDELINE AND ALTHOUGH FAIRLY COMPREHENSIVE, SUITABLE INFORMATION MAY STILL HAVE TO BE ADDED.

No.	THE DESIGNERS CRITERIA	AG	GG	Y/N
1	Discuss requirements with Hot Dip Galvanizers Association Southern Africa and/or the selected galvanizer/s before designing commences.	P1	P1	
2	Make use of an Association Galvanizing Member.	P1	P1	
3	Make the requirements known to the galvanizer, **in writing**, together with a sketch or sample, before placement of the order. Further discussion with the galvanizer may be required.	P1		
4	Make use of the Association wall chart – "Design for Hot Dip Galvanizing".#	P1	P1	
5	Choose correct steel type – see Association Specification. All parties to purchase the specified steel ideally from the same supplier. Insist on the steel chemical analysis certificates for record purposes and issue copies to the galvanizer before galvanizing commences.	P1	P1	
6	Ensure components can be dipped in a single immersion or alternatively discuss the impact of double end dipping with the selected galvanizer / Association.	P2	P2	
7	Optimise size of filling, draining and vent holes, see wall chart.#	P1	P1	
8	Optimise position of filling, draining and venting holes, see wall chart.#	P1	P1	
9	Should painting of the hot dip galvanizing be specified, ensure that instructions stating "No passivation is required – substrate is to be painted", is handed to the galvanizer, at order stage, unless specifically discussed and excluded.	P1	P1	
10	Select significant surfaces, highlight on drawing or sketch and discuss with galvanizer / Association.	P1	P1	
11	If necessary, hot dip galvanize a sample and establish acceptance / rejection criteria.	P1	P1	
12	Specify the correct temporary-marking pen for fabrication marking (a 50/50 PVA paint to water mix, works well for temporary marking).	P1	P1	
13	Ensure that if permanent marking, such as welded lettering is used it will be appropriately hidden from final view.	P1		
14	Specify all flame cut edges to be thoroughly ground, ideally 2mm into the parent material, to prevent thinner coatings.	P1	P1	
15	If deemed necessary, to minimise handling damage ensure correctly positioned lifting lugs are provided or soft lifting slings are used, by all parties, including the galvanizer, the transporter, the off loader and the erector, etc.	P1	P1	
16	Specify welding that is fit for purpose; do not allow over welding – this would minimise the incidence of distortion by limiting stresses in the weld and adjacent metal.	P2		

No.	THE DESIGNERS CRITERIA continued	AG	GG	Y/N
17	Should stick welding be used, ensure that all weld slag is comprehensively removed by abrasive blasting or grinding prior to delivery to the galvanizer. (Excessive weld porosity can have a marked effect on the quality of the hot dip galvanized coating).	P1	P1	
18	If the build-up of zinc at a weld is unacceptable for aesthetical reasons, request that the correct welding wire or rod be used. Some welding materials are reactive wrt hot dip galvanizing and can result in a thicker coating on the deposited weld. Discuss with the HDGASA.	P1		
19	Simplify componentry – Simple structures – Better coating quality Complex structures – Harder to manipulate in the galvanizing bath, more control, cleaning and fettling necessary.	P1	P1	
20	Simplify complex structures by making use of bolting where possible or alternatively design for after galvanizing welding, by using a suitable mask such as "Galvastop", which can be easily cleaned, successfully welded and correctly repaired.	P1	P1	
21	Discuss packaging / dunnage requirements with the galvanizer during transport and ensure that ample site stacking facilities are provided. A hot dip galvanized coating is applied in a factory and then transported to site where frequently the components are thrown off the truck. Inappropriate offloading may lead to unnecessary mechanical damage of the coating. Coating discolouration due to contaminants being deposited by wet trades, i.e. angle grinding of wet clay bricks in the presence of hot dip galvanized components, should be prevented.	P2	P2	
22	Discuss the appropriate repair method, if it is deemed to be necessary, with the galvanizer. Silver spray paint provides little or no protection, albeit more acceptable while the galvanized coating is shinny, will ultimately stand out and be aesthetically unacceptable, when the hot dip galvanized coating begins to weather to a matt dull grey appearance.	P1	P1	

No.	THE DESIGNERS CRITERIA continued	AG	GG	Y/N
23	Discuss coating inspection of the components prior to these leaving the galvanizer's premises.	P1	P1	
24	Discuss whether a certificate of conformance in accordance with the specification, is required.	P1	P1	
25	Ensure that selected galvanizers use their appropriate identification paint, (if acceptable to the client) before delivering the components to site. Furthermore, identification paint is to be applied only to areas identified on the drawings by the architect or consultant, particularly if the component is **not** to be over coated with a paint system.	P2	P2	
26	Allow sufficient time for the hot dip galvanizing process to take place, ideally 3 to 7 working days, unless other arrangements have been made.	P1	P1	
No.	**THE GALVANIZERS' CRITERIA**	**AG**	**GG**	**Y/N**
1	Should the order state the components are to be used for architectural purposes and no sketch is attached or appropriate sample accompanies the order, question whether the architecturally related components have been discussed with the Association, etc.	P1		
2	If not, notify the fabricator/customer, who in turn must discuss requirements with the specifier and reach consensus regarding the best achievable surface finish.	P1		
3	Insist on the appropriate steel chemical analysis certificates for galvanizing control and record purposes.	P1	P1	
4	Ensure that significant surfaces if necessary have been discussed and agreed on.	P1	P1	
5	Ensure components can be dipped in a single immersion, unless discussed with the fabricator / customer / specifier or the Association.	P1	P1	
6	Ensure when offloading black steel that any transport damage to components is recorded and the client appropriately notified.	P1	P1	
7	Ensure that reasonable fill, draining and vent holes have been provided.	P1	P1	
8	Ensure that filling, draining and vent holes have been positioned correctly.	P1	P1	
9	If necessary, ensure that lifting lugs have been provided. Alternatively use of soft lifting slings where necessary, when loading components for transportation.	P1	P1	
10	Ensure the use of optimum aluminium content in the zinc bath.	P1	P2	
11	Based on the chemical analysis of the steel, discuss immediate water quenching after galvanizing, if necessary to limit iron/zinc alloy build-up with reactive steel. The galvanizer should also be aware of the increased likelihood of distortion with certain components when quenching and discuss these with the customer/ Association.	P1	P1	
12	Ensure all agreed upon significant surfaces have been cleaned and free of imperfections after hot dip galvanizing, according to instructions.	P1	P1	
13	Ensure adequate fettling of the components using appropriate methods, particularly with reference to lumps, runs and excessive surface roughness, especially on significant surfaces, while taking care not to excessively clean the surface, leading to uncoated areas.	P1	P1	
14	Ensure that the specifier is informed of the method of renovation of uncoated areas that might occur due to air entrapment during galvanizing or as a result of mechanical damage at the galvanizer.	P1	P1	
15	Water quench if necessary to limit iron / zinc alloy build-up with reactive steel. Passivating chemical not to be present in quench water if subsequent painting is required.			
16	If correctly positioned lifting lugs are provided, ensure that they are used when jigging the component.	P1	P1	
17	Ensure that inspection of the components is carried out before and after galvanizing, to the customers requirements.	P1	P1	
18	Ensure that any identification paint used by the galvanizer, (unless specifically excluded by the client) is applied in an agreed upon location on the component.	P1	P2	

Hot dip galvanizing going POTTY...

It is surprising to note that ALIENS were the inspiration for beautiful Hot Dip Galvanized metal garden accents which have been sighted throughout South Africa. The “Aliens” of course are of the “plant kind” and the company in question aptly named Planet Wise.

During 1998 the Beyers family on Bloemenkraal Estate in the Overberg district became involved with the Working for Water Project, a Public Works Initiative. Its vision was to clear the invading vegetation through the process of economic empowerment. Planet Wise designs and manufactures décor products for garden and home and creates much needed employment for communities as far a field as Genadendal and Bereaville. Their manufacturing involves the use of biomass cleared from sites infested by invasive wattle by Working for Water teams. Fences and screens are made from black wattle saplings sticks, whilst decorative cones and balls are made of treated wattle bark. Planet wise also has its own invasive plant clearing teams and to-date the company, under the leadership of MD Beyers Beyers, has created employment for over 50 people. The company’s screens formed the focal point of the 2006 Kirstenbosch – South African exhibit sent to the prestigious London’s Chelsea Flower Show.

One has to ask how Hot Dip Galvanizing fits into all of this and product designer Mariki Beyers explains:” We saw a niche in the market, based on the popularity of our organic products for similar designs in metal. Frames are made of round bar and the big urns, pots and funnels are “woven”, basketlike with metal strapping. The “rust look” was quite big at the time, however, we realised that not everybody would want an ornament with a limited lifespan, particularly at the coast where the corrosion rate proved to be far more rapid than inland. The decision was made to Hot Dip Galvanize the goods and the response has been overwhelming! The galvanized urns also do very well in water features due to the added corrosion protection and the play of light and water over the shiny metal is simply breathtaking!”

Planet Wise products are available at Garden Centres and Nurseries nationwide and even exported as far a field as Spain, the United Kingdom & Thailand! You have to agree that good old metal strapping has never looked this good!

Hot dip galvanized fasteners, this and that...

Unlike other coatings, which are reliant on the coater's integrity, honesty and expertise to achieve coating thickness, hot dip galvanizing because it is based on a metallurgical principle, cannot be easily altered by the galvanizer. In fact what has to be carefully monitored is not the thinness of the coating but preventing excessive coating thickness.

This is important because the nuts of a hot dip galvanized bolt are usually hot dip galvanized as blanks. The coated nut blanks are then oversized with a suitable tap to ensure that they easily pass onto the bolt. For this to function successfully, the maximum coating on the bolt must not exceed 65µm. This is of particular importance when the fasteners are of high strength quality, i.e. Class 8.8 or 10.9 (thicker coatings on nuts are not as important, provided the spanner fits). *See photo right*.

Due to this occurrence and to avoid rejects because of excessive coating thickness, many fastener suppliers turn the nut onto the bolt prior to delivery. This "nutted on" principle does not only identify rejects but performs the task of ensuring

that when the fasteners are left exposed on a moist site, that no discolouration takes place on the inside of the nut.

When the bolt is finally fixed into position, the uncoated area at the nut thread is amply checked against possible corrosion failure by way of the sacrificial protection provided by the surrounding zinc coating on the bolt shaft.

Both Bob my colleague and I frequently visit sites to appease the complaints of specifiers and end users of hot dip galvanizing, often travelling long distances to get to these sites. There are many instances when we get to site, the complaint is about a trivial thing in terms of the coatings ability to achieve its objective of long term corrosion protection and quite often when this happens the fasteners that were supplied as "galvanized" have been misconstrued by the buyer and supplied as zinc electroplated.

We published a matrix in magazine No. 23, indicating the differences in the various metallic coatings, including zinc electroplating, mechanical plating, sherardizing and hot dip galvanizing and urge readers to familiarise themselves with these attributes especially if the role one plays is specification and selection. When reading the matrix and the varying coating thicknesses found based on the differing coating materials, one must also bare in mind that the life of a metallic zinc coating is more or less proportional to its thickness. A zinc-electroplated coating therefore should not be used in moderate to aggressive environments as the coating is invariably only one tenth of the thickness of a hot dip galvanized equivalent and will therefore provide one tenth of the service life. In order to make it easy to differentiate between zinc electroplated coatings to those that are hot dip galvanized, we also published an article in magazine No. 27.

Furthermore, when hot dip galvanized steel is connected to concrete by way of expansion or chemical anchor studs they are often manufactured from stainless steel and in spite of the

continued on page 39...

Impala Bolt & Nut

Impala Bolt & Nut provides a full range of fasteners to the industry, from mild steel to high tensile and even 10.9 friction grip bolts, set screws, nuts and threaded rod as well as flat and spring washers. The company also has a highly skilled, specialised fastener division that manufactures only special items which are unavailable off the shelf.

All items are available in plain finish, as well as zinc or cadmium plating, but it is in hot dip galvanized products that Impala Nut & Bolt has built up a reputation over the years as a sound, quality conscious supplier with a very good stock holding off the shelf.

They work very closely with their galvanizers, who offer good service, quality and turn-around time and they are continually striving to make purchasing of HDG products as simple as self-colour. They also attend to client's purchasing requirements as far as any specialised packaging of products is concerned.

"We have a loyal and dedicated team who can assist the customer in selecting the correct fastener for the application and assist with enquiries" says Impala Bolt & Nut's Managing Director, Anthony Diamond.

Proudly South African Tel-Screw products

Tel-Screw Products are one of the leading manufacturer's of quality standard and specialised fasteners and related products, backed by 38 years of experience.

The company has its head office in Boksburg with a branch in Jacobs, Kwa-Zulu Natal.

Tel-Screw Products stocks one of the largest ranges of specialised fasteners. Its hot dip galvanized fasteners to SANS 121 (ISO 1461) range from M8 – M76, with other finishes ranging from M2 – M100.

Tel-Screw Products have in excess of 350 tons of special and standard fasteners in stock, comprising over 18 000 products, which if required can be delivered over night anywhere in South Africa.

Tel-Screw Products deal with listed and reputable hot dip galvanizers to ensure that their clients get the best quality and service.

The company supplies hot dip galvanized threaded products with fitted oversized nuts to ensure that customers have no down time and loss of production due to nuts not fitting the bolts when used. Hot dip galvanizing certificates of conformance, as well as material certificates, are supplied with all products on request.

To ensure that the customer gets what he pays for, we at Tel-Screw Products have implemented an ISO 9001-2000 quality management system. Any hot dip galvanized coating quality is monitored by the quality control staff at Tel-Screw Products, ensuring conformance to SANS 121 (ISO 1461) specifications.

Special products, to customer specifications, can be manufactured and delivered at short notice.

Tel-Screw Products supports locally manufactured products and is a proud partner of the foundation for the development of Africa.

Manufactured in Africa for AFRICANS

Types of fasteners and availability matrix

TYPE OF FASTENER	COMPANY	STEEL GRADE	SPECIFICATION	SPECIFICATION	AVAILABLE SIZES	HOT DIP GALVANIZED TO ORDER	HOT DIP GALVANIZED EX STOCK
LOCKING NUTS							
Half Lock Nuts	Bolt & Eng Distributors	MS				Yes	
	Global Bolt & Tool	MS4.6/Gr: 8			M5 – M36	Yes	
	Tel-Screw Products	MS/HT			M8 – M48	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS/HT			M8 – M36	Yes	Yes
Hard Lock Nuts	Bolt & Eng Distributors	Gr: 8	No Spec			Yes	
Castle Nuts	Bolt & Eng Distributors	Gr: 8	Various			Yes	
	Global Bolt & Tool	Gr: 8	Various		M8 – M64	Yes	
	Tel-Screw Products	MS/Gr: 8			M6 – M100	Yes	
Steel Hex Lock Nuts	Bolt & Eng Distributors	MS				Yes	
	Global Bolt & Tool	MS4.6/Gr:8			M6 – M36	Yes	
	Tel-Screw Products	MS/HT			M6 – M100	Yes	
	WLS Fastener Manufacturing Co. cc	MS				Yes	
Crimped Nuts	Global Bolt & Tool	Gr: 8			M12 – M36	Yes	
	Impala Bolt & Nut	MS				Yes	
	Tel-Screw Products	MS			M8 – M48	Yes	
Flanged Crimped Nuts	Impala Bolt & Nut					Yes	
Locking Washers	Bolt & Eng Distributors		DIN 127			Yes	
	Global Bolt & Tool		DIN6797 – ext / DIN 6798 – int			Yes	
	WLS Fastener Manufacturing Co. cc					Yes	
Nyloc Nuts	Most suppliers	Most smaller size Nyloc nuts are imported and are only available as electroplated					
	Global Bolt & Tool		DIN 985			Yes	
	Impala Bolt & Nut		DIN 985				Yes
Cleeve Lock Nuts	Global Bolt & Tool		DIN 980			Yes	
Prevailing Torque Hex Lock Nuts	Tel-Screw Products	Gr: 8 & 10	DIN 980V			Yes	
NORMAL NUTS							
Hex OS Nuts	Bolt & Eng Distributors	Gr: 8	DIN 934				Yes
	Bolt & Eng Distributors	Gr: 10	SABS 1282			Yes	
	CBC Fasteners	Gr: 8	DIN 934	ISO 4032	M6 – M30	Yes	Yes
	Global Bolt & Tool	Gr: 4 & 8	DIN 934		M8 – M64	Yes	Yes
	Impala Bolt & Nut	Gr: 8	DIN 934		M8 – M30		Yes
	Tel-Screw Products	Gr: 8,10 & 12	DIN 934		M16 – M36	Yes	
	Tel-Screw Products – HS Friction Grip	Gr: 8 & 10	DIN 6915		M8 – M64	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS/HT			M8 – M64		Yes
Hex Long OS Nuts	Global Bolt & Tool	HT Gr: 8	TSP		M6 – M16	Yes	
	Rawlplug South Africa	MS			M6 – M16	Yes	
	Tel-Screw Products	MS / HT	TSP		M8 – M48	Yes	
	WLS Fastener Manufacturing Co. cc	MS			M8 – M36		Yes
Shear Nuts or Anti-vandal Nuts	Bolt & Eng Distributors	MS	No Spec			Yes	
	Global Bolt & Tool	HT Gr: 8				Yes	
	Impala Bolt & Nut	MS					Yes
	Rawlplug Sou th Africa	MS			M8 – M16	Yes	Yes
	Tel-Screw Products	MS/HT			M8 – M48	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS			M8 – M24	Yes	
Flanged Nuts	Global Bolt & Tool	HT Gr: 8			M8 – M36	Yes	
	Tel-Screw Products	HT/MS			M8 – M36		
	WLS Fastener Manufacturing Co. cc	MS			M8 – M16		Yes
WASHERS							
Thru Hardened Washers	Bolt & Eng Distributors		DIN 6916				Yes
	Global Bolt & Tool	HT Gr: 8	DIN 6916		M10 – M64	Yes	
	Tel-Screw Products		DIN 6916		M10 – M64	Yes	
	WLS Fastener Manufacturing Co. cc	MS			M8 – M36		Yes
Flat Washers	Bolt & Eng Distributors						Yes
	Global Bolt & Tool	MS	DIN 125		M4 – M64	Yes	
	Impala Bolt & Nut		DIN 120/125		M8 – M30		Yes
	Tel-Screw Products	MS	DIN 120/125		M8 – M76		Yes
	WLS Fastener Manufacturing Co. cc	MS			M8 – M76		Yes
Square Flat Washers	Global Bolt & Tool	MS			M12 – M24	Yes	
	Tel-Screw Products	Specially manufactured to order			M6 – M76	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS			M8 – M30		Yes
Square Curved Washers	Global Bolt & Tool	MS			M10 – M24	Yes	
	Tel-Screw Products	Specially manufactured to order			M6 – M76	Yes	Yes

Impala Bolt & Nut S.A. (Pty) Limited is a manufacturer of mild steel and hi-tensile bolts and nuts, ranging from M6 right up to M30 in diameter.

We have established ourselves over the years as a reliable and quality conscious manufacturer who strives for customer satisfaction with every order.
We specialise in hot dip galvanized bolts and nuts and have a very large stockholding of these items.

Impala Bolt also has a specialised fastener division which manufactures for the motor industry and any specials that you, the client, might have.
We are available at any time to be of assistance and offer sound advice as to what product best suits your application.

All items manufactured are also available in zinc plated / hot dipped / CAD and trivalent coating as per the motor industry standards.

Our dedicated sales team will gladly assist you with all your requirements.

IMPALA BOLT & NUT S.A. (PTY) LIMITED

Manufacturers of Industrial Fasteners

48 Nagington Road, Wadeville, Germiston
P.O. Box 14766 Wadeville 1422
Tel.: (011) 824-3925 • Fax: (011) 824-3803

TYPE OF FASTENER	COMPANY	STEEL GRADE	SPECIFICATION	SPECIFICATION	AVAILABLE SIZES	HOT DIP GALVANIZED TO ORDER	HOT DIP GALVANIZED EX STOCK
WASHERS continued							
Spring Washers	Bolt & Eng Distributors		DIN 127				Yes
	Global Bolt & Tool	MS	DIN 127		M4 – M64	Yes	
	Impala Bolt & Nut		DIN 127		M8 – M30		Yes
	Tel-Screw Products		DIN 127		M8 – M64		Yes
	WLS Fastener Manufacturing Co. cc				M8 – M36		Yes
BOLTS AND SCREWS							
Hex Head Screws	CBC Fasteners	MS	DIN 933	ISO 4017	M18 – M30	Yes	Yes
	CBC Fasteners	Gr: 8.8	DIN 933	ISO 4017	M8 – M30	Yes	Yes
	Global Bolt & Tool	MS4.6/HT Gr: 8	DIN 558 / DIN 933		M8 – M36	Yes	
	Impala Bolt & Nut	MS	DIN 658		M8 – M24		Yes
	Impala Bolt & Nut	Gr: 8.8	DIN 933		M8 – M30		Yes
	Rawlplug South Africa	MS	DIN 933		M6 – M12	Yes	
	Tel-Screw Products	Gr: 8.8/MS	DIN 933		M5 – M39	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS/HT			M8 – M36		Yes
Hex Head Bolts and OS Nuts	Bolt & Eng Distributors	MS	DIN 601		M8 – M30	Yes	
	CBC Fasteners	MS	DIN 601	SABS 135	M8 – M30	Yes	Yes
	Global Bolt & Tool	MS4.6		Lengths up to 300mm	M8 – M36	Yes	
	Impala Bolt & Nut	MS			M8 – M30	Yes	
	Tel-Screw Products	MS/HT	DIN 601	Lay – 520	M8 – M39	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS			M8 – M36		Yes
Hex Head Bolts and OS Nuts (High tensile)	Bolt & Eng Distributors	Gr: 8.8	DIN 933		M27 – M56	Yes	
	CBC Fasteners	Gr: 8.8	DIN 931	ISO 4014	M8 – M30	Yes	Yes
	Global Bolt & Tool	HT Gr: 8.8	DIN 931		M8 – M36	Yes	
	Impala Bolt & Nut	Gr: 8.8	DIN 931		M8 – M30		Yes
	Tel-Screw Products	Gr: 8.8/MS	DIN 931		M8 – M56	Yes	Yes
	WLS Fastener Manufacturing Co. cc	HT			M8 – M36		Yes
Large Dia Bolts & OS Nuts	Bolt & Eng Distributors		DIN 601/934			Yes	
	Global Bolt & Tool	MS/HT	DIN 601555 / DIN 931/934		M36 – M64	Yes	
	Tel-Screw Products	Gr: MS/8.8			M36 – M76	Yes	
	WLS Fastener Manufacturing Co. cc	MS/HT			M39 – M76	Yes	
Cup Head Square Neck Bolts & OS Nuts	Bolt & Eng Distributors	MS	SABS 1143		M8 – M20	Yes	
	CBC Fasteners	MS	SABS 1143		M8 – M20	Yes	Selected
	Global Bolt & Tool	MS	DIN 603555		M8 – M16	Yes	
	Impala Bolt & Nut	MS	DIN 603		M8 – M16	Yes	
	Rawlplug South Africa	MS	DIN 603		M8 – M12	Yes	
	Tel-Screw Products	MS	SABS 1143 / DIN 603		M8 – M30	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS			M8 – M20	Yes	
C/Sunk Square Neck Bolts & OS Nuts	Bolt & Eng Distributors	MS	SABS 1143		M12 – M24	Yes	
	CBC Fasteners	MS	SABS 1143		M10 – M20	Yes	No
	Global Bolt & Tool	MS	DIN 608555		M10 – M20	Yes	
	Impala Bolt & Nut	MS	DIN 605		M10 – M16	Yes	
	Tel-Screw Products	MS/HT	SABS 1143		M8 – M30	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS			M10 – M20	Yes	
C/Sunk Nib Bolts & OS Nuts	CBC Fasteners	MS	SABS 1143		M12 – M24	Yes	No
	Global Bolt & Tool	MS Gr: 4.6	DIN 604555		M12 – M20	Yes	
	Impala Bolt & Nut	MS	DIN 604		M10 – M20	Yes	
	Tel-Screw Products	MS	SABS 1143		M8 – M24	Yes	
	WLS Fastener Manufacturing Co. cc	MS			M12 – M24	Yes	
Friction Grip Bolts & Nuts	Bolt & Eng Distributors	Gr: 10.9S	SABS 1282		M12 – M30	Yes	
	CBC Fasteners	Gr: 8.8S/10.9S	SABS 1282	ISO 7411	M12 – M30	Yes	No
	Global Bolt & Tool	HT Gr: 8.8 – 10.9	DIN 6914		M10 – M20	Yes	
	S.A. Bolt Manufacturers	Gr: 8.8/10.9S			M12 – M30	Yes	
	Tel-Screw Products	MS/HT					
	WLS Fastener Manufacturing Co. cc	HT			M12 – M30	Yes	
Hex Socket C/Sunk Head Screws	Bolt & Eng Distributors	Gr: 10.9	DIN 7991		M8 – M24	Yes	
	Global Bolt & Tool	HT	DIN 7991		M8 – M24	Yes	
	S.A. Bolt Manufacturers	Gr: 10.9/12.9			M6 – M48	Yes	
	Tel-Screw Products	HT					
	WLS Fastener Manufacturing Co. cc	HT			M8 – M24	Yes	
Lockbolts	S.A. Bolt Manufacturers Pins & Collars	Gr: 6.8/8.8			M12 – M24	Yes	
Pigtails – 1 &1½ Turn	Bascol (Pty) Ltd	MS			M8 – M12	Yes	Yes
	Bolt & Eng Distributors	MS			M8 – M12	Yes	
	Global Bolt & Tool	MS			M16 – M36	Yes	
	Tel-Screw Products	MS/SS/HT			M6 – M76	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS			M8 – M24	Yes	
3m – Threaded Rod	Bascol (Pty) Ltd	MS/EN8			M10 – M64	Yes	Yes
	Bolt & Eng Distributors	MS			M8 – M36	Yes	
	Global Bolt & Tool	MS/HT	DIN 975		M6 – M36	Yes, from M8	

TYPE OF FASTENER	COMPANY	STEEL GRADE	SPECIFICATION	SPECIFICATION	AVAILABLE SIZES	HOT DIP GALVANIZED TO ORDER	HOT DIP GALVANIZED EX STOCK
BOLTS AND SCREWS continued							
3m – Threaded Rod continued	Impala Bolt & Nut	MS/HT	DIN 975		M8 – M24	Yes	
	Tel-Screw Products	MS/HT			M8 – M76	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS			M8 – M36		Yes
1m – Threaded Rod	Bascol (Pty) Ltd	MS/EN8			M10 – M64	Yes	Yes
	Bolt & Eng Distributors	DIN 975			M12 – M30	Yes	Yes
	Global Bolt & Tool	MS/HT			M5 – M36	Yes, from M8	
	Impala Bolt & Nut	MS/HT	DIN 975		M8 – M24	Yes	
	Rawlplug South Africa	HT			M5 –M30	Yes	
	Tel-Screw Products	MS/HT			M8 – M76	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS			M8 – M36		Yes
HD Bolts (Foundation Bolts) & OS Nuts	Bascol (Pty) Ltd	MS/EN8			M10 – M64	Yes	Yes
	Bolt & Eng Distributors	MS	NO SPEC			Yes	
	Global Bolt & Tool	MS			M2 – M36	Yes	
	Rawlplug South Africa	MS/HT			M8 – M36	Yes	
	Tel-Screw Products	MS/HT			M8 – M72	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS			M8 – M72	Yes	
CONCRETE ANCHOR BOLTS							
Rawlbolts	Rawlplug South Africa	5.8	BBA	All International	M5 – M24	Yes	
SPT Construction Anchors	Rawlplug South Africa		EU	All International	M6 – M24	Yes	
R-KEM Chemical Bolts	Rawlplug South Africa	5.8/HT	BBA		M8 – M30	Yes	Yes
R-KEX Chemical Bolts	Rawlplug South Africa	5.8/HT	BBA		M8 – M30	Yes	Yes
R-CAS Chemical Bolts	Rawlplug South Africa	5.8/HT	BBA		M8 – M30	Yes	Yes
R-HAC Chemical Bolts	Rawlplug South Africa	5.8/HT	BBA		M8 – M30	Yes	Yes
Express Anchor Bolts	Fischer Upat Fixings				M10 – M24	Yes	
	Global Bolt & Tool	MS			M10 – M20	Yes	
	Rawlplug South Africa				M6 – M24	Yes	Yes
Chemical Anchors & Threaded Studs	Bascol (Pty) Ltd	MS/EN8			M10 – M64	Yes	
	Bolt & Eng Distributors	EN8	NO SPEC			Yes	
	Fischer Upat Fixings					Yes	

TYPE OF FASTENER	COMPANY	STEEL GRADE	SPECIFICATION	SPECIFICATION	AVAILABLE SIZES	HOT DIP GALVANIZED TO ORDER	HOT DIP GALVANIZED EX STOCK
CONCRETE ANCHOR BOLTS continued							
Chemical Anchors & Threaded Studs continued	Global Bolt & Tool	MS			M12 – M20	Yes	
	Rawlplug South Africa	MS/HT			M8 – M30	Yes	Yes
	Tel-Screw Products	MS/HT			M8 – M36	Yes	Yes
	Tel-Screw Products	MS/HT			M16 – M76	Yes	
	WLS Fastener Manufacturing Co. cc	EN8			M8 – M30	Yes	Yes
Kalm Chemical Anchor Bolt	WLS Fastener Manufacturing Co. cc	EN8			M8 – M30	Yes	
Trugrip Anchor Bolt	Global Bolt & Tool	EN8			M10 – M20		Yes
	WLS Fastener Manufacturing Co. cc	EN8			M10 - M30		Yes
Rawl Kemfix Chemical Anchor Studs - for use with all chemical anchoring (capsule and/or cartridge systems)	Rawlplug South Africa	Gr: 5.8	Imported	Imported	M8 – M30 Various lengths		Yes
Through Bolts / Stud Anchors / Wedge Anchors	Global Bolt & Tool	HT			M8 – M20	Yes	
	Rawlplug South Africa	Gr: 5.8	Imported	Imported	M8 – M24 Various lengths		Yes
MISCELLANEOUS							
Self Drilling Screws	Fischer Upat					Yes	
	Global Bolt & Tool		DIN 7504		5mm – 6.3mm	Yes	
	Rawlplug South Africa				Various	Yes	
	WLS Fastener Manufacturing Co. cc					Yes	
Cast-In Lifting Sockets	Tel-Screw Products	EN8			M8 – M36		
	WLS Fastener Manufacturing Co. cc	EN8			M8 – M36	Yes	
SPECIAL FASTENERS							
Countersunk Machine Screws	Bolt & Eng Distributors	MS/HT	DIN 963			Yes	
	Global Bolt & Tool	MS	DIN 963 & 965		M3 – M12	Yes	
	Tel-Screw Products	MS/HT	DIN 963 & 965		M6 – M36	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS/HT			M8 – M36	Yes	
Round U-Bolts	Bascol (Pty) Ltd	MS			M8 – M36	Yes	Yes
	Bolt & Eng Distributors	MS			M8 – M76	Yes	
	Global Bolt & Tool	MS			M6 – M30	Yes, from M10	
	Tel-Screw Products	MS/HT			M8 – M76	Yes	Yes
	Tel-Screw Products	HT			M8 – M76	Yes	
Square U-Bolts	Bascol (Pty) Ltd	MS			M8 – M48	Yes	
	Bolt & Eng Distributors	MS	NO SPEC		M8 – M24	Yes	
	Global Bolt & Tool	MS			M6 – M30	Yes, from M10	
	Tel-Screw Products	MS/HT			M8 – M76	Yes	
	WLS Fastener Manufacturing Co. cc	MS/HT			M8 – M36	Yes	
TV U- Bolts	Bascol (Pty) Ltd	MS			M8 – M16	Yes	Yes
	Global Bolt & Tool	MS			M6 – M30	Yes	
	Tel-Screw Products	MS/HT			M8 – M76	Yes	Yes
Hook Bolts	Bascol (Pty) Ltd	MS			M8 – M20	Yes	
	Bolt & Eng Distributors	MS	NO SPEC		M8 – M76	Yes	
	Global Bolt & Tool	MS			M6 x 50 – M6 x 300	Yes	
	Rawlplug South Africa	MS			M5 – M12	Yes	
	Tel-Screw Products	MS/HT			M8 – M76	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS/HT			M8 – M76	Yes	
Channel Bolts	Bascol (Pty) Ltd	MS			M8 – M10	Yes	
	Bolt & Eng Distributors	MS			M8 – M10	Yes	
	Global Bolt & Tool	MS			M6 – M8	Yes	
	Tel-Screw Products	MS/HT			M8 – M76	Yes	
	WLS Fastener Manufacturing Co. cc	MS/HT			M8 – M76	Yes	
J-Bolts	Bascol (Pty) Ltd	MS			M8 – M36	Yes	
	Bolt & Eng Distributors	MS	NO SPEC		M8 – M24	Yes	
	Global Bolt & Tool	MS			M6 – M8	Yes	
	Rawlplug South Africa	MS			M5 – M12	Yes	
	Tel-Screw Products	MS/HT			M8 – M76	Yes	
	WLS Fastener Manufacturing Co. cc	MS/HT			M8 – M76	Yes	
Eye-Bolts	Bascol (Pty) Ltd	MS			M8 – M16	Yes	
	Bolt & Eng Distributors	MS	NO SPEC		M8 – M76	Yes	
	Global Bolt & Tool	MS/HT			M8 – M36	Yes	
	Rawlplug South Africa	MS			M5 – M12	Yes	
	Tel-Screw Products	MS/HT			M8 – M76	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS			M6 – M76	Yes	
Straining Eye-Bolts	Bascol (Pty) Ltd	MS			M8 – M16	Yes	
	Global Bolt & Tool	MS			M10 x 200 – M16 x 300	Yes	
	Tel-Screw Products	MS/HT			M6 – M76	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS			M8 – M24	Yes	
Linked Eye Nuts	Rawlplug South Africa				M6 – M16	Yes	

TYPE OF FASTENER	COMPANY	STEEL GRADE	SPECIFICATION	SPECIFICATION	AVAILABLE SIZES	HOT DIP GALVANIZED TO ORDER	HOT DIP GALVANIZED EX STOCK
SPECIAL FASTENERS continued							
Linked Eye Rods	Tel-Screw Products	MS/HT			M8 – M76	Yes	
Forged Eyebolts	Global Bolt & Tool	Lifting: HT / Scaffolding: MS			M16 – M20	Yes	
	Rawlplug South Africa				M6 – M16	Yes	
	Tel-Screw Products	MS/HT			M8 – M30	Yes	
Welded Eyebolts	Rawlplug South Africa	MS			M8 – M16	Yes	
Scaffold Rings	Rawlplug South Africa	MS			M8 – M16	Yes	
Threaded Studs	Bascol (Pty) Ltd	MS/EN8			M8 – M64	Yes	
	Bolt & Eng Distributors	MS	NO SPEC		M8 – M76	Yes	
	Global Bolt & Tool	MS/HT			M6 – M36	Yes	
	Rawlplug South Africa	MS/HT			M5 – M30	Yes	
	Tel-Screw Products	MS/HT			M8 – M76	Yes	
	WLS Fastener Manufacturing Co. cc	MS/HT			M8 – M76	Yes	Yes
Tie Rods	Bascol (Pty) Ltd	MS/EN8			M8 – M64	Yes	
	Bolt & Eng Distributors	MS	NO SPEC		M8 – M76	Yes	
	Global Bolt & Tool	MS			M8 – M30	Yes	
	Tel-Screw Products	MS/HT			M8 – M76	Yes	
	WLS Fastener Manufacturing Co. cc	MS/HT			M8 – M76	Yes	
Other specials	Bascol (Pty) Ltd	MS/EN8	Threading & bending to customers specification				
	Bolt & Eng Distributors	Specials manufactured to order					
	Rawlplug South Africa	Special application chemical and/or mechanical anchor bolts as required					
	Tel-Screw Products	Specials manufactured to order			M8 – M76	Yes	
	WLS Fastener Manufacturing Co. cc	MS/HT			M8 - M76	Yes	
Domed Head or Cap Nuts	Global Bolt & Tool	MS	DIN 1587		M6 – M20	Yes	
	Tel-Screw Products	MS/HT	DIN 1587		M6 – M76	Yes	
	WLS Fastener Manufacturing Co. cc	MS/HT			M8 - M36	Yes	
Hex Coach Screws	Global Bolt & Tool	MS	DIN 571		M6 – M12	Yes	
	Rawlplug South Africa		DIN 7976		M5 – M12	Yes	
	Tel-Screw Products	MS	DIN 7976		M6 – M12	Yes	Yes

OS – Over Sized / MS – Mild Steel / HT – High Tensile

THE ABOVE MATRIX IS NOT NECESSARILY COMPREHENSIVE AND TOTALLY REPRESENTATIVE OF THE INDUSTRY BUT INCLUDES PARTICIPATING FASTENER MANUFACTURERS AND STOCKISTS.

MISCONCEPTIONS

Miss Conception puts it "straight"

"Miss Conception" rectifies incorrect impressions concerning hot dip galvanizing.

For long term corrosion protection, all that is required is to specify "galvanizing" and satisfactory results will be achieved in most environments and applications.

True or false?

The word "galvanizing" is frequently used to describe a variety of coatings with different properties. There are numerous different forms of zinc coatings, all of which have their specific values. Meanwhile, the term "galvanizing" is frequently used to describe coatings with vastly different characteristics. For example, zinc rich paints are often referred to as "cold galvanizing" while a thin steel strip which is continuously coated with a thin molten zinc coating is invariably regarded as the same as the substantially thicker genuine hot dip galvanized coating as applied by what can be described as the general hot dip galvanizing process. Another misleading term is "electrogalvanizing" which, in truth, is zinc electroplating with an inordinately thin zinc coating of as little as 1.7 to 2.5 micrometres.

Zinc coatings and, in particular, those applied by the hot dip galvanizing process can provide outstanding long term corrosion control provided that certain essential requirements are met.

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The most important fact to appreciate is that the life of a zinc coating is more or less proportional to its thickness when exposed in a given environment. To illustrate, if a zinc coating that is 20µm thick will last to 5% surface red rust for 8 years, an 80µm thick hot dip galvanized zinc coating should yield 32 years of life in the same environment. This illustration emphasises the significant differences between the general hot dip galvanized coating, continuously galvanized sheet and zinc electroplating.

Apart from thickness, another important factor is the structure of the applied zinc coating. In the case of hot dip galvanizing, a series of iron/zinc alloy layers is formed beneath the outer relatively pure surface zinc layer. These alloys provide not only abrasion resistance but their corrosion resistant properties are, if anything, superior to those of relatively pure zinc. Fe/Zn alloys are virtually absent in all other zinc coatings, including that applied onto pre-galvanized sheet.

Another extremely important attribute of a thick zinc coating as applied by the general hot dip galvanizing process is the cathodic protection provided by the entire coating. This is of particular importance if the underlying steel is exposed to the elements as a result of localised coating damage. This cathodic or sacrificial protection provided by zinc is distinctly limited or even entirely ineffective with paint and very thin metallic coatings.

How then does one ensure that the correct protective coating is provided for a given application where long-term protection is essential?

As already stated, the term "galvanizing" is used to describe a host of different coating methods. In order to avoid confusion and to ensure that the correct coating is provided, it is important to specify "hot dip galvanizing in accordance with the requirements of SANS 121 (ISO 1461) hot dip galvanizing specification". This document provides the quality standards for structural steel and other products including hot dip galvanized bolts, nuts and washers.

If this requirement is adhered to, the supply of inadequate zinc coatings will be prevented in most cases while if an incorrect coating is supplied, the supplier can be justifiably instructed to effect replacement at no extra cost.

Hot dip galvanized Mentis Rectagrid floor grating

Mentis Rectagrid RS40 offers structural integrity and ensures a safe working environment.

The structural integrity of floor grating and its load bearing capacity plays an important role in ensuring a safe working environment for personnel. To ensure optimum reliability in corrosive environments, floor grating can be hot dip galvanized or manufactured in stainless steel or 3CR12.

The single largest producer of floor grating in southern Africa is Andrew Mentis whose Rectagrid products have become the benchmark in floor grating in South Africa. The company has been manufacturing Mentis Rectagrid RS40 and RS80 floor grating for 40 years, and these highly engineered floor grating products are produced at Andrew Mentis' world class facility at Elandsfontein, Johannesburg.

Mentis Rectagrid is manufactured using a pressure locking system pioneered by Andrew Mentis, and quality control during the manufacturing process ensures that close tolerances are maintained in accordance with those laid down in the Metal Bar Grating Manual published by the National Association of Architectural Metal Manufacturers in the U.S.A. It is significant that these are the same tolerances and standards adopted for use by most leading grating manufacturers worldwide.

The production process ensures that the round transverse bar fits tightly through the pierced bearer bar. This not only guarantees the superior structural integrity of the product, but also eliminates it vulnerability to corrosion. This in turn ensures the superior locking characteristics of the Mentis Rectagrid as well as accurate bearer bar pitching.

Use of the Rectagrid Open Ended System or O.E.S. eliminates the banding of panels which simplifies design and erection thereby reducing costs. It also improves the appearances of the floor grating and its accurate pitching gives an aesthetically pleasing pattern match and unjointed appearance when joining the open ended panels.

All transverse bars are 7.6mm in diameter, and all panels finish on half pitches in both directions with allowance for 4 mm clearance between panels. Saddle clamps automatically hold panels at full pitching space when installed.

Floor grating is used in a wide variety of applications including access walkways on process plants and in factories and manufacturing facilities. Mentis Rectagrid is also available in uncoated mild steel or bitumen dipped mild steel. It can also be manufactured in aluminium if required.

More about Andrew Mentis (Pty) Ltd

Andrew Mentis (Pty) Ltd is a leading manufacturer of grating, expanded metal, Mentrail (guard-rails for roads), DieLine Walkways, industrial handrail systems (tubular as well as solid), steel floor tiles and Mendrill (automatic drilling and boring machines). Established in 1950, the company's products are used in industries as diverse as power generation, mining, petrochemical, motor, construction, food, paper and steel.

The Vitagrid® fully serrated grating gains galvanizing popularity

Vitagrid fully serrated gratings©, stair treads, and expanded metals patented and trade marked systems have gained wide acceptance in the local and international markets to the point where many alternative copies are now available. Vitagrid view this as a compliment to their ingenuity and their constant efforts to improve and lead the market into manufacturing safe, acceptable gratings and product systems that conform to the ever changing need of their markets demands.

With this in mind Vitagrid have recently improved their product range once again and stepped up the ante to manufacturing gratings and accessory products that are now very much more hot dip galvanizing friendly for the contracting community.

With the release of the latest version of their interactive product, design, detailing and guide "Vitagrid CD"©, this makes specifying, using and managing our product range very easy with specific emphasis on ensuring that the special coating integrity is maintained during manufacture and after the construction phase has been completed.

Easy to understand design, interactive visual suggestions, erection recommendations and training areas on the CD ensure that on site rectifications or changes are kept to the absolute minimum.

The high standard of welding employed to AWS D1.1 ensures that porosity is kept to the minimum on fully banded products, and a high standard of welding is employed on the stanchions for these safety critical items.

A huge plus in using Vitagrid products is that all the material used is mill dressed giving a rounded edge on the bearer bars to which a hot dip galvanized coating will adhere to with out chipping. Slit material that is not properly de-burred or dressed will result in chipping at the sharp edges and have less coating adherence in these areas resulting in transportation and erection damage in addition to earlier corrosion and wear.

Vitagrid uses 350WA mill drawn material in the production of their products ensuring a sound, economical and definable design base for all our clients loading requirements and which ensures a high galvanizing quality with a lower maintenance cycle than commercial quality mild steels.

Vitagrid's unique Maclock® handrail tubular system design allows full hot dip galvanizing both inside and outside of the stanchions and their accessories, giving the client peace of mind that no uncoated areas will be open to corrosion.

Alternative to the tubular handrails is the Maclock solid forged stanchions© started in 1940 in South Africa and used extensively in many large projects in the country. These unique and high quality ball type stanchion units are a single forged unit and are not welded together at the ball joints.

Many of these units are still in existence today in older buildings.

The copyrighted slotted base plate makes fitment and replacement of any existing type of stanchion holing easy and simple where clients wish to change existing non-conforming products in both the tubular and solid forged systems. This includes angle stanchions.

All Vitagrid and Maclock products are hot dip galvanizing friendly and the resilient and corrosion preventative features make this an ideal finish for these hard working products.

As the only ISO9001 – 2000 design registered grating, expanded metal and handrail system manufacturer in South Africa we are able to ensure that all our products conform to recognised standards and have been properly designed to meet the requirements of our clients.

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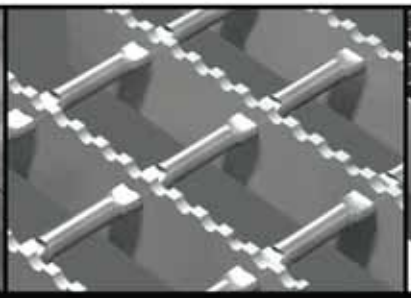

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Single coat duplex system

With durable life expectancy of 70 years to R.I 3 in an ISO 12944 C3 medium corrosive environment

Basics of duplex systems

A duplex system is a combination of hot dip galvanizing and the application of a suitable paint coating. The hot dip galvanizing is used as the primer coat or base on which we apply a top coat. This enables us to achieve a longer life expectancy. The overall corrosion free life of a structure can be increased substantially by the synergistic effect provided by a duplex system. It can also be used to improve the aesthetic appearance of the hot dip galvanized steel. This is particularly useful for balconies, staircases, railings, fences, lamps, poles, structures and stadia, etc.

Surface preparation

As when doing any form of coating, surface preparation plays an extremely important roll in ensuring the success of an application. It is critical that the surface preparation is done correctly.

The following preparation steps need to be followed by a duplex coating specialist in order to have a successful duplex coating system.

All hot dip galvanized steel is to be degreased by washing with a water emulsifiable solvent degreaser and rinsed with potable water, ensuring that a water break free surface is achieved.

This is followed up with -

Sweep blasting of the hot dip galvanized steel using a maximum air pressure of 1.5 - 2.5 bar and a 6mm nozzle. A micro grit such as garnet, with a nozzle distance of 500 - 700 mm from the hot dip galvanized surface, providing the ideal key for the adhesion of the coating, is also essential. Correct sweep blasting will ensure that only the minimum amount of zinc oxide is removed and that the zinc surface is left in a slightly roughened condition.

In order to test whether the sweep blasting has been successful, one can measure the coating thickness before and after sweep blasting. The reading after sweep blasting will generally have grown in thickness. When one measures the profile, the probe will only pick up the peaks of the profile, indicating a growth in the hot dip galvanized coating.

Benefits of a one coat duplex system

Production through put is key with the tendency to have shorter lead times for projects in the current market conditions. Paint shops have historically been seen as major causes of bottle necks in the manufacturing environment.

For environments that are exposed to UV, one coat applications were unheard of a few years ago. These systems were typically made up of a primer, and a polyurethane top coat.

Sigma Coatings has engineered a two component direct to metal high build zinc phosphate polyurethane coating (Sigmafast 210) that eliminates the need to have a primer followed by a top coat.

To further eliminate bottle necking, Sigmafast 210 cures in one third of the time as that of a conventional epoxy coating. Sigmafast 210 has a touch drying time of only 1 hour and a dry to handle time of 3 hours at 20°C. This enables fast turn around time in paint shops which allows contractors to paint and load / turn steel within the same day.

Being a polyurethane it has good resistance to atmospheric exposure. It is non-chalking, non-yellowing and is tough and abrasion resistant. This coating can be recoated for touch ups and repairs even after unlimited atmospheric exposure.

Sigmafast 210 can be easily applied with both airless and conventional

spray to a recommended Dry Film Thickness of 80 - 120µm. The theoretical spreading rate of the product at 80µm is 6.9m²/ltr.

Sigmafast 210 has a semi gloss finish and can be tinted to a wide colour range including a "galvanized colour" finish.

Sigmafast 210 can cure in temperatures as low as minus 5 degrees compared to the industry "norm" of 10 to 15 degrees.

Life Expectancy

With reference to the ISO 12944 – 2:1998, in a C3 medium environment the zinc loss is >0.7 to 2.1µm per year. Hot dip galvanizing structural steel would usually result in a coating thickness of in excess of 85µm, providing a minimum durable life expectancy of about 40 odd years (85µm/2.1µm loss of zinc per year). *See also Modified from Table 5 – ISO 9223, last page of Case History*.

The high build zinc phosphate polyurethane has a design life expectancy of between 8 - 12 years. Should preparation and application of the top coat have been done correctly, the combined sum of the coating lives plus the synergistic effect (at least 1.5 times the sum of the combined individual coating lives) can result in a minimum of a 70 year durable life expectancy in a C3 medium environment.

The durable life expectancy cost of the coating is now calculated at R0-86 per m² per year (R60/m² / 70 years) excluding the cost of the galvanized.

For paint specification details used for duplex coating technology in other corrosion categories including C5M

environments, contact Sigma Coating and for any pricing requirements, contact Duplex Coatings.

Article courtesy of Mike Book (Duplex Coatings) and Danie Du Preez (Sigma Coatings).

Application requirements of a duplex system for the "man in the street"

After ensuring that the hot dip galvanized surface is completely clean and a water break free surface has been achieved immediately prior to over coating, it becomes equally important to apply the correct paint system.

This will be determined by the micro-climatic conditions, which can vary substantially from one corrosive site to another. Prevailing wind direction, rainfall, land contours and proximity to the spray zone in a coastal environment, are all significant factors.

As a rule of thumb, all sites within a distance of 500m of the tidal zone should be regarded as aggressively corrosive. The selected paint coating must be capable of withstanding aggressive attack by chlorides frequently deposited onto coating surfaces for extended periods. Long periods of wetness with chloride contaminated moisture will exacerbate the corrosion problem while in low rainfall areas; the absence of the washing effect of rain water increases the propensity for coating failure.

The selected paint system must possess the following attributes: minimal porosity, UV resistance, high solids content to reduce permeability by corrosive moisture and an adequate dry film thickness of at least 100 up to 250 microns DFT, depending on proximity to the spray zone.

How does this impact on the man in the street? He goes to his local hardware shop to buy paint. There he finds acrylic water based primers and enamel oil based topcoats to apply onto hot dip galvanized steel. This seems to be an obvious choice as they are single pack, non-toxic products, which provide good adhesion. The problem with these coatings is that they provide very thin coverage varying from 20 to 40 microns. The hot dip galvanized articles are then painted with a two-coat decorative paint system, which would be ideal for use only in moderately corrosive applications.

The paint coating is soon breached due to permeation by moisture and salt spray and the underlying zinc surface is converted into soluble zinc hydroxide. As the paint coating becomes more permeable, it is further breached and the item becomes coated with white zinc corrosion products. These coatings, which can fail very quickly are frequently observed. They lead to a great deal of confusion and dissatisfaction on the part of the client who looks to blame the painter, the galvanizer or the paint supplier, while the real cause is incorrect paint selection and inadequate paint coverage. Inland areas subjected to the South East wind with no protection would also be subjected to attack by chlorides and wind borne particles would provide an ongoing blasting effect.

It is imperative, especially within 500m from the sea, that a heavy-duty paint system is applied to prevent the hot dip galvanized coating coming into contact with salt spray and moisture. An ideal system is an epoxy primer, a high build epoxy intermediate coat

A "very novel duplex coating" system

In 2005, Phoenix Galvanizing entered the only hot dip galvanized "Horn" in the Architecture Category of the Annual Eskom Awards event. The wire frame "Horn", a sculpture by Langa Magwa has now been woven with animal hide taken from feasts and traditional ceremonies from the area has now been fitted in the piazza of the Africa Centre. Also shown is the only hot dip galvanized "Horn".

The paint system used is inadequate for this environment but because it is on the leeward side of the prevailing wind, seems to be unaffected.

with micaceous iron oxide (MIO) and a polyurethane topcoat to a total paint DFT (dry film thickness) of about 150 - 200 microns. This duplex system has provided outstanding results in corrosive marine applications where the synergistic effect produced by combining the protective properties of an organic paint system with hot dip galvanizing is invariably most effective in providing long-term corrosion control.

As the above systems are normally only applied in a factory, the best solution would be to ensure a paint applicator applies this heavy-duty coating. Failing this Mr. Citizen must ensure that he builds up his own paint coating to an acceptable dry film thickness.

The ideal solution would be for the paint companies to develop a user and environmentally friendly heavy duty paint coating that could be applied by the man in the street and capable of withstanding the harsh environment encountered in the Cape Peninsula and other similar coastal areas.

I.B. Dodds
Cape Galvanising (Pty) Ltd

A recently removed sign on the prevailing wind side showed the intact paint coating on the palings of the fence under the sign in comparison to the failed paint below the sign, due to the chloride containing winds, inappropriate paint and insufficient paint coating thickness.

Photo left shows the overall coating thickness and right the hot dip galvanized coating thickness, suggesting that the paint coating was a DFT of about 40 odd micrometres.

Walter's Corner

Durability of hot dip galvanizing and duplex protection

As with all other corrosion control systems, the durability of hot dip galvanizing varies considerably depending on a variety of factors. In the case of atmospheric corrosion rates; humidity levels, temperature and air pollution levels all play a significant role, while in immersed conditions both pH levels and the degree of water hardness are important, not to mention chloride levels both in the atmosphere and in water.

Some years ago, at the close of a technical presentation by Sir Jan van Eijnsbergen, an eminent Dutch corrosion scientist, whose subject concerned the durability of hot dip galvanizing and other protective methods in various environments, a local technical expert drew attention to the fact that in Walvis Bay, the chances of hot dip galvanizing lasting longer than three years was remote. This led to an interesting subsequent debate from which the following conclusions were reached:

1) The life of a hot dip galvanized coating of 85µm in thickness in Walvis Bay is reported in one exposure test to be less than 3 years. Our experience gleaned at various sites shows that although Walvis Bay is aggressive, a hot dip galvanized coating, on its own, has been shown to last more than 5 years and in some instances more than 10 years, where specific site conditions had an influence. A sustainable life of in excess of 20 years can be achieved if hot dip galvanizing is comprehensively over coated with an appropriate paint coating system, referred to as a "duplex system". Corrosive elements, which are said to emanate from the seabed, which together with the chlorides and early morning sea mist, result in an extremely aggressive and corrosive atmosphere. Plainly the life of a thinner 20µm thick zinc coating, as applied by way of the continuously galvanizing process, will be considerably less than 3 years.

2) To infer that because a hot dip galvanized coating has a distinctly limited life in Walvis Bay it is of little if any value as a protective system elsewhere, is utter nonsense. By the same token, there are recorded examples elsewhere where galvanizing has provided protection for up to 100 years and to use such examples for determining general durability would also be meaningless.

3) When specifying hot dip galvanizing, it is most important to clearly state what is required. To illustrate; for so called galvanized gutters for building purposes, the national galvanizing specification SANS 121 (ISO 1461) should always be specified for corrosive environments. If this is not done, thinly pre-galvanized sheet at lower cost will invariably be used for the fabrication of gutters.

4) Hot dip galvanizing can be used successfully in Walvis Bay provided that the attributes of a zinc metal coating are used in combination with a heavy duty organic coating in order to provide "duplex" protection.

Duplex coating for extended corrosion control

The synergistic effect of a correctly applied paint system onto a hot dip galvanized surface will yield a corrosion free life equal to the sum of the lives of the paint system and that of the galvanizing when used separately, plus at least 50%, for example:

Life of hot dip galvanized coating
= 10 years

Life of paint system
= 5 years

Total
= 15 years

Plus 50%
= 7.5 years

Total theoretical maintenance free life of duplex coating
= 22.5 years

Contrary to the general view, painting of hot dip galvanized surfaces is a straight forward process which is invariably very successful provided that fairly obvious measures are adopted. Paint must be applied to a thoroughly cleaned zinc surface. This is normally achieved with the aid of a specially formulated "galvanized iron cleaner". It is important to remove all traces of the cleaner chemical with clean water, allow the surface to dry, before applying paint.

A process described as sweep blasting is successfully used for surface preparation but this process should never be used if the correct equipment is not available. Sweep blasting or shallow blasting as it is sometimes described, necessitates the use of a non metallic fine garnet blast medium at a very low (<3 bar) nozzle velocity. If correctly performed, not more than 6µm of the zinc coating is removed and the underlying hard alloy layers will not be shattered or damaged in any way.

Frequently a paint coating is successfully applied to a hot dip galvanized surface after several months of weathering and after the stable zinc carbonate film has been naturally formed on the galvanized surface. Following such weathering of the zinc surface, it remains of

paramount importance, that adequate surface preparation is carried out in order to accept the top paint system, which relies on mechanical bonding of the paint to the zinc.

The selection of a compatible paint coating is important. There are some paint chemicals which will react chemically with zinc if applied directly onto a galvanized surface without the use of a primer coat. The most frequent example is the application of an alkyd enamel paint directly onto a galvanized surface. The result is that the alkyd reacts with the zinc surface to form zinc soaps. This process of saponification causes de-adhesion and flaking of the paint which is the reason why so many people wish to know how to paint the galvanized roof gutters on their house.

Calcium plumbate is an effective primer coat for all galvanized surfaces while paint coatings are also successfully applied without a primer provided that a zinc compatible paint coating is used. Paints based on vinyl and most epoxy systems can be applied directly onto a galvanized surface but the use of a primer is no doubt preferred as with paint coatings in general.

There is nothing better than personal experience to convince one that a protective coating system can successfully provide the required long term performance. My residential property in Bedfordview is surrounded by a hot dip galvanized palisade fence which was erected about ten years ago. Solely for aesthetic purposes, a vinyl paint coating was applied over the galvanizing 6 years later after the galvanized coating had weathered naturally. The equipment and materials used for painting consisted of a degreasing chemical, clean water, a scrubbing brush, a tin of paint and a paint brush, while the painter was the gentleman who weeds my garden and mows the lawn on a regular basis! After a total of ten years, there is no indication of any deterioration in this protective system while after four years, the most attractive rich green coloured paint coating continues to adhere extremely well directly onto the underlying galvanized surface.

This concept of duplex protection was promoted many years ago by the well known scientist and friend, Sir Jan van Eijnsbergen, who visited South Africa on several occasions. As a paint chemist, he was able to grasp the benefits derived from combining a good paint system with a hot dip galvanized coating even in aggressive environments such as that encountered in Walvis Bay. In fact, it was Sir Jan van Eijnsbergen who coined the term "duplex system" which is now used universally to describe the combined use of hot dip galvanizing and a paint system.

Guest Writer

Bob Andrew, our guest writer, is a consulting value engineer and Honourary Life Member of this Association.

Situational awareness: A necessary skill for the modern world

We all know how difficult it is today to get things done or to get things done properly. Lack of time is often an excuse. Not knowing what to do or how to do it, or not even knowing what the problem is and what must be achieved, are often the real reasons.

Our 'situational awareness', i.e. our level of understanding of things happening around us, can affect our performance in completing tasks, especially if the task is complex and dynamic. Situational awareness is about knowing what's going on so that we can figure out what to do. Situational awareness is a key human performance factor in high risk situations that require critical decision making, such as aviation, air traffic control, surgery, emergency response, strategic business affairs and military combat. In these areas, finely tuned and reliable situational awareness is essential.

Situational awareness is also just as critical in many of our day-to-day work activities. If we do not have the right knowledge to do a task, or we don't know how to use the knowledge we do have to integrate it into a coherent picture to allow us to get on with the task, we will not complete the task properly. In essence, it is our knowledge of the environment surrounding both us and the problem that dictates how well we do something.

Poor situational awareness of a team can cause a great deal of confusion that will undoubtedly limit performance-nobody knows what's the right thing to do. In these situations, there will be ambiguity and argument, improper procedures will be used, things will be left 'up in the air' and targets will not be met. What is often most damaging in these situations is that the confusion leads people to become fixated or preoccupied on one specific thing, thinking that at least there's one or two things they can do, and thereby are unable to appreciate the bigger picture, which is required to complete the task successfully.

Situational awareness can be enhanced by using a systems thinking approach in which the task is viewed as a system with objectives the first thing to be determined and then the relationships and dependencies between the elements (sub-tasks) of the system are defined. For example, airline pilots need to focus first on where they are going to land before they can decide how they are going to arrive. Even when in the air, pilots need to continually visualise their landing while at the same time be aware of their current position and how the aircraft is working. They commonly call this 'flying ahead of the plane'.

In the same as way as pilots fly their aircrafts, managers need to understand that effective control mechanisms can be only be confidently implemented if the all the interrelationships between their people and the various tasks are clear and to be able to visualise and communicate the end result. People need to see that their individual achievements and those of the group are controlled by their actions. If their actions do not take into account the dynamics and interrelatedness of the system the results will be different to their expectations.

Determining the knowledge we need is often an obstacle since the knowledge we think we need might not be as critical as the knowledge we don't know we need. Only by realistically understanding the problem and understanding the complexity of the environment will we be able to determine our requirements.

Situational awareness is keeping track on what's going on around you. Situational awareness and sensemaking are closely related. Situational awareness helps us make sense of ambiguous and complex problems. There must be a motivated and continuous effort to understand connections, among people, places and events so that we can anticipate and know how to act effectively. Of prime importance is knowing how your job and those of others around you contribute to the accomplishment of the objectives.

Electro-galvanized (electro plated) expanded metal used in the manufacture of sound baffles at a plant near Atlantis, Western Cape

As part of the Association's effort to educate and improve the frequent ineffective communication between end clients and the galvanizer, often via a number of contracting parties, the specifiers finish expectations and the manufacturer and galvanizer's commitment to the quality of the final product, etc. we include for your reading, this coating report by the Association.

The Hot Dip Galvanizers Association was asked to inspect and evaluate the performance of the electroplated

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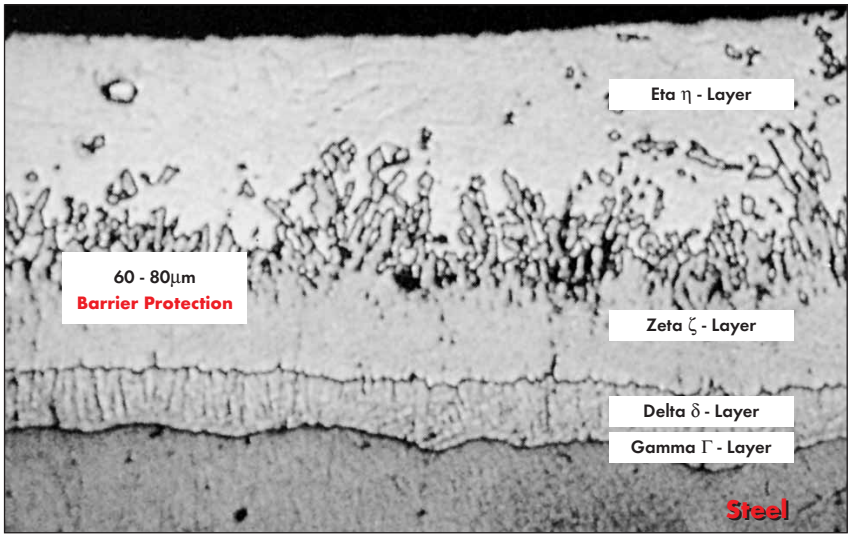
Photo above left shows the sound baffle behind a louvre screen. The photo right shows a number of sound baffles alongside one another before the outer louvre screen has been fixed.

expanded metal plates used in the manufacture of sound baffles at a plant in Atlantis, Western Cape. I report as follows:

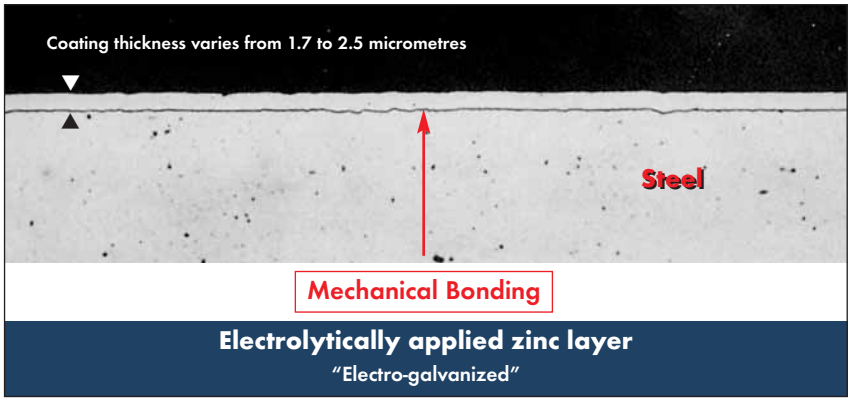
Hot dip galvanizing

General hot dip galvanizing

Structural components in this plant have been hot dip galvanized to SANS 121 (ISO 1461), which requires that for steel thickness equal and greater than 3mm but less than 6mm, the local coating shall be 55µm with a mean of 70µm. For steel equal and greater than 6mm the local coating thickness shall be 70µm with a mean of 85µm. Due to the reactivity of most structural steels the resultant coating thickness achieved is generally up to 50% more than the specification requires.



Micrograph showing the structure and coating thickness of a general hot dip galvanized coating.



Micrograph showing the structure and coating thickness of an electroplated coating.

Coating designation	Description	Nominal coating thickness per side	Nominal coating mass per unit area per side (g/m²)	Minimum coating mass per unit area per side (g/m²)
ZE 25 / 25	Normal coating	2.5 / 2.5	18 / 18	12 / 12
ZE 50 / 50	Heavy coating	5.0 / 5.0	36 / 36	28 / 28
ZE 75 / 75		7.5 / 7.5	54 / 54	47 / 47
ZE 50 / 0	One-sided coating	5.0 /0.0	36 / 0	28 / 0
ZE 75 / 0		7.5 / 0.0	54 / 0	47 / 0
ZE 100 / 0		10.0 / 0.0	72 / 0	65 / 0

Electroplated sheet coating mass and thickness.

Furthermore, due to the chemical reaction that takes place between molten zinc at 450ºC and the steel, the coating is metallurgically bonded to the steel. The coating therefore, comprises a series of iron zinc alloy layers, which offer at least a further 30% better corrosion resistance than pure zinc *(see micrographs)*.

Continuously hot dip galvanized sheeting

Hot dip galvanizing also encompasses the continuous galvanizing of sheet manufactured by Arcellor Mittal Steel or Dufurco. Sheet steel coils are welded together end on end to form a continuous strip, which is passed through a reducing atmosphere where it is heated to about 850ºC and then through a bath of molten zinc running at about 100m to 140m per minute. Following the zinc bath the steel passes through a series of air knives where it is mechanically wiped producing the various classes of coating available in terms of the specification – SANS 3575 or SANS 4998. The latter applies to structural grades of sheeting. Coating classes range from Z100 to Z600. The numerical part of this coating class stands for the mass of the coating, measured in grams/square metre. The higher coating mass equates to a thicker coating, which when exposed, results in longer life. The ends of the sound baffles and outer louvre screens have been manufactured from a Z275 class of coating. The Z275 class of coating is presently and has been in the past the most available of the coating classes. To equate the Z275 to coating thickness, the number is divided by 7 – the specific gravity of zinc and 2, which includes both sides, resulting in a nominal coating thickness of about 20 microns. The specification, however, allows a reduction in coating thickness of no less than 40% of the individual value, which is 235gms/m². The thinnest part of the coating is therefore 235 x 40% ÷ 7 = 13.5 microns. The coating thickness for

new sheeting in the Z275 class would therefore range between 13.5 and 20 and occasionally up to 30µm. The coating is bonded to the steel substrate with a very thin iron/zinc alloy layer of about 1µm. Micrograph above right shows an electroplated coating, which is similar in appearance to a micrograph of the coating on continuously galvanized sheeting.

Electro-galvanized steel sheeting

Electro-galvanized steel sheet consists of a cold rolled steel substrate over coated with zinc by electrolytic deposition on a continuous line. Electro-galvanizing allows greater control in coating thickness while also permitting two different coating thicknesses on either face of the sheet. A range of coating thicknesses is offered with the maximum coating thickness being equivalent to a Z100 continuous hot dip galvanized sheet.

Bonding of the coating is purely mechanical and therefore there are no iron / zinc alloy layers.

The table of zinc coatings below is taken from the data sheet. The expanded metal was manufactured from a ZE 25 / 25, which according to the table, has a nominal coating thickness of 2.5µm per face, with a minimum of 1.7µm on one side.

Conclusion and recommendation

As the life of a zinc coating is more or less proportional to its thickness on the environment it is exposed to, it stands to reason that the expanded metal with a 1.7µm coating will last a fraction of that of a Z275 continuously hot dip galvanized sheeting (13.5µm), which in turn will last a fraction of that of a general hot dip galvanized coating (55 to 85µm).

The conditions at hand, which are most probably a C3 to C4 corrosion category in accordance with ISO 9223, has a nominal zinc corrosion rate of about 1 to 4µm per year. This would explain the corrosion seen on the expanded metal plates after 2 to 3 months of exposure. *See also table extracted from the ISO 9223 specification in the Case History on page 45.*

The outer louvres have also been manufactured from continuously galvanized sheeting using a Z275 class of coating. Furthermore, due to the fact that the louvres have been manufactured after the sheeting was galvanized, all welding must be adequately repaired after manufacture. Coating repair should

continued on page 34...

be done according to the Association's Coating Repair Procedure.

Alternatively and preferably the louvres should have been manufactured from plain mild steel and then hot dip galvanized to SANS 121.

To increase the sustainable life of the sound baffles both the end frames and expanded metal should have been manufactured from at least a Z600 continuously hot dip galvanized sheeting. This would provide a nominal coating thickness of 43µm (with a minimum local coating thickness of 34µm).

The word "Galvanizing" is often loosely use and wrongly interpreted by others down the supply chain to mean after fabrication hot dip galvanizing whereas innocently a completely different coating may be supplied, with the consequent results of reduced service life and premature failure.

Accurate specifications relating to the correct metallic zinc coatings relative to their expected lives are extremely important in achieving the set requirements of the end use client!

Terry Smith

General view of the steel masts at the plant. It is generally accepted that all steel that is used to manufacture components for power plants and power conveyance pylons are at least hot dip galvanized to SANS 121 for corrosion protection.

Photo above left shows the sound baffle with rusted expanded metal after 2 - 3 months exposure. Photo above right shows the necessary repair required after manufacture of the outer louvres.

Zinc speeds recovery from pneumonia

Zinc appears to significantly reduce the duration of fever and severity of illness in boys with pneumonia and other serious lower respiratory infections, according to a new study published in the March issue of the American Journal of Clinical Nutrition. Researchers studied 153 children aged between two months and two-years-old, who were hospitalised with severe acute lower respiratory infections. They found that recovery from very ill status and from fever in boys who received zinc treatments was 2.6 times and three times those in non-zinc-treated children. In contrast, the treatment did not seem to benefit girls. Supplements of vitamin A, also known to reduce childhood mortality, had no effect on recovery from pneumonia either. The children were randomly assigned to receive 10mg zinc as acetate (twice daily for five days), 10 000µg retinol equivalents vitamin A (twice daily for four days), both nutrients combined, or a placebo. The team from the Society for Applied Sciences in Kolkata, India, and colleagues could not explain why boys, but not girls, benefited from zinc. They add that analysis of previous zinc trials for gender-based differences could help understand the findings.

Source: American Journal of Clinical Nutrition (vol 79, no 3, 430-436).

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SABS ISO 9001:2000
Galvanising Mark-SABS 1461

The 7th Asian Pacific General Galvanizing Conference

"The 7th APGGA (Asian Pacific General Galvanizing Conference) was held in Beijing, China from 14th - 20th September 2007. The conference included a number of options in terms of plant visits.

There were over 400 conference delegates from 24 countries, with 27 papers presented to the delegates. The papers covered world trends in hot dip galvanizing as well as indications of the global demands for galvanized steel, as well as process controls, issues pertaining to the kettle and a heavy emphasis on environmental issues. Of significance to us in South Africa is the continuing growth worldwide of infrastructural development, which gives rise to increased demand for hot dip galvanized steel.

The conference included plant tours to galvanizing plants in Hangzhou and Shanghai. All 3 plants visited were relatively modern. What impressed most was the growing environmental awareness in the plants. In one of the plants, the water treatment was of such a standard that the treated water was purified and disposed of into a pond containing Koi fish before being re-used.

From left to right: Johan du Plessis of SA Galvanizing Services; Riaan Louw of Robor Galvanizers; Dave Whelan of Metsep; Rob White of IZASA, Robert Watchorn of Metsep and Geoff Colloty of Robor Galvanizers.

There were 8 South African representatives at the conference, and the photograph above was taken in the conference venue.

The conference itself was preceded by a "Meeting of the Countries", where the member countries of the APGGA met to provide an update on the activities of their respective Associations, and the state of the Hot Dip Galvanizing industry in each country.

The South African Industry and the HDGASA were represented by Geoff Colloty and Riaan Louw, who updated the meeting on the prevailing state of the local hot dip galvanizing industry

At the 6th APGGA Meeting, held in Cairns, Australia, in 2005, South Africa put in a bid to host the 7th Conference. However, due to lack of support from the Members, we withdrew our entry. The 2010 Conference has now been awarded to Taiwan, unopposed.

There were a substantial number of delegates who then expressed their concern about SA withdrawing from the bid process – as it seemed SA was the preferred venue. Between 400 and 500 delegates could have been secured!! Such a pity!!! A huge opportunity to showcase the industry and the country has been lost!!! To those members who lacked the 'guts' to come forward and support a bid from SA, shame on you!!!

News from Zincor

"Zincor completed a planned roaster rebuild during the middle of the year and all work was completed within the planned project timing. Although there was reduced zinc production during this period, Zincor had sufficient zinc stocks and there were no supply constraints in the zinc market in any way. The last of the roaster rebuilds will be carried out in mid 2008 and on completion of this project Zincor will have rebuilt all the roasters. This will result in sustained zinc production for the South African market as well as having capacity to support any new demand in the South African market.

The USD zinc price has come off the highs that were experienced earlier this year and besides some price spikes, the longer trend is for a lower USD zinc price. As zinc is priced in Rands in the South African market, the final Rand zinc price will be determined by the strength of the Rand against the USD.

Zincor would like to thank all their customers and final consumers of hot dip galvanized products for their support during 2007 and we would like to wish everyone well over the coming holiday period."

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AKZO NOBEL

Personality Profile

Creative duo – Eerhard Huizinga & Jane Durand

The winding tree covered path leading up to the studio of Durban Architect firm Durand Huizinga Architect, reveals nothing about its creative occupants until seemingly out of nowhere mammoth colourful mosaic concrete columns appear that assaults the senses in every facet of the phrase. Bounding dogs and a wraparound verandah, complete with a kiddies swing illustrate that working and living, harmoniously coexist in this partnership.

Jane Durand and Eerhard Huizinga were both born and bred in Durban. Jane grew up in Kloof and Eerhard in Durban North. Jane muses that she was always creative as a child and decided to study fine art at Michaelis in Cape Town after school. She admits that the move to Cape Town was a bit of a shock to the system; coming from a very sheltered upbringing and after a year she decided to do something "more sensible". She moved back home and enrolled for a degree in Architecture at UKZN. Eerhard on the other hand, wanted to study Automotive or Industrial Design (in which he is still extremely interested). This proved to be impossible at the time as there were no educational institutions offering courses. Architecture was his next choice and the decision sealed their fate when Jane entered first year and noticed the "4th year guy on the other side of the screen in the studio". Jane was honoured as Best Student throughout her course and graduated Cum Laude. The couple moved abroad for a year, after Jane graduated, and a "prac" year was spent working for architecture firms in Vienna, where the couple was strongly influenced by the Secession and Modern Movement.

The couple returned to South Africa in 1994, full of hope for the birth of the New South Africa. They tied the knot in 1995 and the union saw the beginning of Durand Huizinga Architects. They explain that their work at the time comprised of a plethora of RDP and Low Cost Housing projects – these included Mt Moira, Cato Manor and KwaMashu. These projects challenged the team to come up with innovative ways of constructing dwellings within an extremely tight budget. It stimulated thinking out of the box and they came up with revolutionary systems such as developing a technique to build on steep slopes of 1:3, which hadn't really successfully been done before. The couple collaborated on a Training Centre in Besters Camp, near KwaMashu, using a portal steel frame, designed specifically to allow unskilled labour to complete the project afterwards. The design

allowed for space restrictions in terms of labour & equipment. The slow bureaucratic grind of Government Projects however proved to be too much for Jane and she pursued her interests outside of architecture, establishing herself as one of the leading Mosaic artists in South Africa. Her high profile commissions have included the Constitutional Court in Gauteng, murals in Sibaya Casino, the Bat Centre and many more.

Eerhard persevered with the "architecture" side of things and the couple is fortunate to collaborate on projects at times, such as a recent private commission for a residence in Durban, where Eerhard designed a state of the art HDG conservatory for a client that had fallen in love with the "aged HDG look". Jane designed the Mosaic path which is visible through the HDG grating. He chuckles about the Ads&Alts route his career seems to have taken, which eventually led him to serve on the AMAFA (formerly the National Monuments Council) Council for 4 years. This council reviews all building proposals for buildings older than 60 years. "I had never thought that I would do architecture using classical orders, but I steadily built up a respect for older styles, through AMAFA, which lead to quite a design philosophy re-think!" This motorcycle fanatic was also responsible for countless School Upgrades – "all over the KZN countryside – great motorbike stuff." He was also a part-time Architecture lecturer at UKZN and DUT respectively for approximately 7 years. Career highlights include a recently completed shopping centre in King Williams Town, a Youth Centre in Durban CBD, which featured extensive use of HDG, as well as a signature development in Zimbali. Eerhard is extremely excited about an upcoming residential development in Everton,

which has a portion of this Contemporary residence clad in copper!

The company's design philosophy is to focus on direct volumetric responses that are in control of the sense of space – displaying materials and honesty with little over embellishment or detail. Industry role models include Jørn Utzon, Geoffrey Bauer and Carlo Scarpa for Eerhard and the illustrious Antonio Gaudi and Gustav Klimt for Jane. They giggle when being questioned about their hobbies. This area it seems has been clearly defined in two eras – pre-children and post. Since the addition of Emily and Bernhard to the Huizinga family, they enjoy spending time sailing and going to the beach, where Eerhard surf skis. Both are passionate DIY fanatics and their previous home has been featured in countless décor magazines. The renovation of their new home is a masterpiece in the making!

For more information on Jane Durand's work, visit www.durandmosaic.co.za

The Association wishes to thank Desere Strydom for this contribution.

...continued from page 12

favourable anode/cathode ratio in a dry environments may prove to be a problem in more moist conditions. Hot dip galvanized expansion bolts or chemical anchor studs are available.

When considering holding down bolts, often these are only coated at the exposed end of the bolt. The thinking presumably is that it is a cheaper option or that hot dip galvanizing interferes with the concrete bonding of the holding down bolt. Both assumptions are incorrect, as the cost to individually coat only the exposed end has to be treated with special care and therefore the cost is more or less the same. There is no bond loss when using hot dip galvanizing in concrete, in fact the opposite is correct, the bond is improved *(see photo top left page 37 magazine No. 23).*

Speaking about holding down bolts, consideration should be given to using threaded rod that is already hot dip galvanized and then attached to anchor plates by double oversized nuts both top and bottom of the plate. If the rod is cut there will be an uncoated rod end that may be exposed to the atmosphere. This can be suitably repaired but if left unrepaired in parts of the country falling into C1 to C3 environments, other than discolouration, very little corrosion will take place in the medium to long term *(see photo middle top page 37 magazine No. 23).*

The electrical fraternity frequently make use of threaded rod to suspend service ducting inside ceiling voids of offices or from the underside of commercial buildings. The environment in these circumstances are relatively mild and making use of zinc electroplated threaded rods is quite acceptable. However, service ducting is often required in more aggressive conditions where hot dip galvanized threaded rods and nuts should be preferred. Hot dip galvanized threaded rod is available in one metre lengths and often longer.

Many users have when tightening fasteners found that the coating may be scratched by the spanner action. The appearance of these scratches is deemed to be through the entire coating, whereas in reality scratching through the entire coating is almost impossible due to the hard iron/zinc alloy layers, being harder than mild steel *(see article page 17, magazine No. 23).*

In order to assist specifiers and end users we have managed to get a number of fastener suppliers to assist us in compiling the fastener matrix. This matrix suggests what fasteners can be hot dip galvanized and whether the various players maintain a stock amount.

Kindly advise if you have any ideas to improve the value of the fastener matrix and should you not have a copy of magazine No. 23 or No. 27, kindly contact us.

Finally, to ensure timeous delivery of the fasteners required for the successful roll out of a project, consider ordering the fasteners as early as possible, in fact possibly when the steel is ordered for fabrication.

All galvanized coatings are not necessarily the same

A recent comment from a consulting engineer suggested that in our magazine we always highlight the successful use and long term service free life of the coating when used appropriately, such as in our regular case history file, however, we do not highlight the failures.

So we have decided to introduce a regular column "Galvanizing Failures" starting with this issue. The failures we intend to highlight are generally the misuse of the coating used inappropriately, such as the one first one below compiled by Iain Dodds of Cape Galvanizing.

All hot dip galvanized coatings do not necessarily provide the same corrosion protection

A site visit was made to the Stark Ayres nursery in Rosebank, Cape Town, at the request of consulting engineer, Basil Beams to inspect hot dip galvanized gutters that had failed after 6 years.

The most noticeable feature about Stark Ayres in Rosebank is that it is a walking advertisement for hot dip galvanizing. All the open plan buildings have a galvanized steel roof with hot dip galvanized columns, rafters, trusses, purlins and the one major weak link are gutters made from continuously hot dip galvanized sheeting known as pre-galvanized sheet.

Elcometer readings made on the structural steel showed a coating thickness of 125 to 185 microns on the columns. Readings on the inside sections of the central gutter measured 14 to 20 microns. There was no visible corrosion on the underside of the gutter but severe corrosion and total failure on parts of the gutter visible from the top side. The gutter was in parts saturated with leaves from an overhanging tree which in turn was blocking rainwater from running down the gutter and subsequently not allowing it to dry off. In fact the wetting time with the leaves in the gutter would run into several days in summer and would never dry off in winter. Small rust spots were visible on the half of the gutter that was dry without leaves and was probably due to rainwater run off over the galvanized roof sheets which have slightly corroded edges and erosion due to the velocity of the water.

As half the length of the gutter was completely corroded due to a combination of moisture, leaves and dampness we recommended the gutter be replaced by a newly manufactured one, which, should be hot dip galvanized by a general galvanizer. A minimum of 85 microns of zinc is ideally required in this environment. To ensure an even longer service life, a suitable paint system should be over coated on the galvanized surface on the inside of the gutter. This duplex coating should be an epoxy primer over coated with a polyurethane top coat with a minimum DFT of a 100 microns.

Corrosion of the pre-galv material has taken place due also to the frequent blocking of the gutter downpipes.

Coating thickness in the gutter, 16.5 micrometres.

The inside of the gutter in certain areas was in an advanced state of corrosion.

Leaves and debris in a gutter can have a marked effect on the service life.

All the structures and utility steelwork at Starck Ayers is hot dip galvanized, a fitting compliment to the hot dip galvainzing industry.

The gutter should also be cleaned out regularly to remove the leaves and ideally pitched at a run off angle to prevent the permanent dampness on the zinc painted coating. It is regrettable that a corrosion free designed building that has been entirely hot dip galvanized, should have been "spoilt" by the inappropriate use of pre-galvanized sheeting at potentially the most corrosive area of the building.

Besides the extensive use of hot dip galvanizing in the buildings other items of interest included hot dip galvanized racks and stands, trolleys, the roof sheets and the palisade boundary fence.

An interesting feature of the duplex coated boundary palisade fence was that the paint coating had completely failed on the side facing the South East wind. The paint coating varied in DFT from about 30 to 40 microns on the side that was still intact. The galvanized coating was in an excellent condition and in no danger except where welding took place in joining the panels, where inadequate coating repair was undertaken. The failure of the paint coating facing the South East wind was entirely due to inadequate paint coating thickness, which was easily permeated by a wind that carries chlorides and wind borne particles that provide an ongoing blasting effect. The wind velocity

reaches some 40/50km in strength on a regular basis in summer in this area. *(See photos on page 27).*

Conclusion

In order to ensure the correct coating is supplied one must select between Continuous hot dip galvanized sheeting to SANS 4998 (Structural grades of material) or SANS 3575 (Commercial and deep draw materials) and General or Batch hot dip galvanizing SANS 121 (ISO 1461). In aggressive environments such as the one in question, the latter specification, in this instance should have been used.

The latter specification is often the intended specification but due to price differentials, clients are often persuaded by contractors to choose the former even though the coating thickness is only 20% to 25% of the general hot dip galvanized coating thickness. This in turn in a corrosive environment impacts as the life of the coating as is the case with Stark Ayres.

Continuous hot dip galvanizing of sheeting has been successfully used for roof sheeting materials but the differences are that roof sheeting are exposed full sun, correct angle of run off and (2) The angle allows for complete run off of moisture and rain. (3) A heavier zinc coating.

Whilst continuous sheet galvanizing has its uses especially in inland areas it is not recommended in coastal or damp environments.

As it is replacing general galvanizing more and more due to its price differential clients must be aware of the consequences or specifiers must request a certain coating thickness which must be certified. The danger exists in the term “hot dip galvanizing” as it refers to either coating thereby requiring a coating specification that identifies the galvanized coating thickness.

I.B. Dodds,
Cape Galvanising (Pty) Ltd

Case History
No. 14/2007

Evaluation of the hot dip galvanized coating at Pentrich Sub-Station, Mkondeni, Pietermaritzburg

The application

Eskom has for many years relied on hot dip galvanizing to protect their assets amongst other things such as the steelwork required for power stations, pylon structures and sub-station steelwork that are exposed to the many environmental conditions throughout South Africa.

This substation is clearly one of these assets. The sub-station was built around 1967 and exposed to the atmosphere of Mkondeni, Pietermaritzburg. Believing that the steelwork had to be painted as it was showing signs of discolouration in certain areas, Eskom requested a paint contractor to quote on refurbishing the coating. The cost of R1.2 million to paint over the residual hot dip galvanized coating made staff at Eskom take a indepth view of the situation. The Association was requested to evaluate the condition of the existing coating and found some very interesting results.

The 132/88kV terminal tower on the Georgedale / Pentrich line.

A typical 132/88kV isolator support.

Environmental conditions

According to ISO 9223 – Corrosion of Metals and Alloys – Corrosivity of Atmospheres – Classification and the slow rate of corrosion achieved, *(see table at end of case history)*, suggests this part of Pietermaritzburg is likely to be a C2 or at worse a C3 environment. A modified table of corrosion rates taken from ISO 9223 has been included at the tail end of this report.

Hot dip galvanizing is normally specified primarily for corrosion protection. For this reason, the two most important inspection criteria of the coating taken at any time during the life of the coating are coating thickness and coating continuity.

The hot dip galvanized coating thickness on several components within the sub-station was scrapped clean of atmospheric contaminants, measured using a calibrated electromagnetic coating thickness gauge and results tabulated below.

Although SABS 763 was the hot dip galvanizing specification at the time of installation, coating thickness

General photo of Pentrich Sub-Station.

COATING THICKNESS (µm)				
Georgedale / Pentrich 3 – 132/88kV Terminal Tower				
	Mean	Max	Min	No. of readings
90 x 90 x 8mm L	95	114	83	9
30 x 30 x 3mm L	134	161	114	11
M12 Hex Nut	78	141	55	10
M12 hex Bolt	97	132	65	12
132/88kV Isolator Support				
50 x 50 x 6mm L	88	109	61	22
150 x 75 Channel	123	179	89	18
70 x 70 x 12 L	155	162	145	14
M16 Hex Nut	73	88	59	4

Hot dip galvanized coating thickness readings taken on various exposed components at Pentrich Sub-Station.

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Photos above starting top left in each row show residual coating thickness readings of 90; 138; 142; 102; 48; 84; 85; 113 and 75µm, taken on the 132/88kV terminal tower and one of isolator supports.

requirements are similar to SANS 121 (ISO 1461), the current specification. SANS 121 requires that for steel thickness equal to and greater than 6mm the local coating thickness shall be a minimum of 70µm with a mean of at least 85µm. Steel equal to and greater than 3mm but less than 6mm shall have a local coating thickness of 55µm with a mean of 70µm. *See also table 2 and 3 from SANS 121 (ISO 1461).*

As life of a zinc coating, no matter how applied is more or less proportional to its thickness in a given environment, the thicker coating will provide a substantially longer life than a thinner coating.

In spite of the atmospheric conditions the hot dip galvanized coating has corroded very little in the 40 years of exposure.

Photo right shows Mr Rob Maitland-Stuart of Eskom Distribution looking very satisfied at the thought of not having to refurbish the coating due to its substantial residual coating, see photo above left (162µm).

The paint support barrier over the HD nuts was easily removed and the residual zinc electroplated coating measured between 7.1 and 16.4µm.

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The holding down nuts and bolts of all the structures from the coating thickness readings taken, seemed to have been originally zinc electroplated and are breaking down. The holding down bolts have subsequently been over coated using some zinc rich paint, which was scrapped off to measure the residual metallic zinc coating thickness. Although because of their size and the local atmospheric corrosion conditions, corrosion of these bolts in the medium term would never really compromise the life of the structure, they however should be repaired using an appropriate zinc rich epoxy.

"Zincfix" due to its convenient size, easy achievement of the required coating thickness in a single application and durable performance, is recommended as the preferred coating repair material. See the Association's Coating Repair Procedure.

Conclusion and recommendation:

One of the major benefits of using a metallic zinc coating no matter how it is applied is its predictable life performance. This is calculated by measuring the mean hot dip galvanized coating thickness and comparing that with the corrosion rate figures given in the ISO 9223 specification.

Bear in mind that coating life is proportional to its thickness and for this reason the thinner zinc electroplated coatings on the holding down nuts in spite of the interim support provided by the paint, is far less durable when compared to the superior, thicker hot dip galvanized coating on the structural steel components, covered in the case history.

The uncoated holding down bolts and zinc electroplated nuts, should be suitably cleaned and comprehensively over coated with an approved paint coating. One such approved coating system is "Zincfix". Zincfix was introduced into the market about 8 years ago and because of convenience, easy application, predictable coating thickness applied in a single coat and known performance, is extremely popular in the market.

The residual hot dip galvanized coating on the structural steel after 40 years of exposure to the atmosphere of Mkondeni, Pietermaritzburg, is in a sound condition and will not require any refurbishment for another 40 years.

TABLE 2: MINIMUM COATING THICKNESS ON ARTICLES THAT ARE NOT CENTRIFUGED – SANS 121 (ISO 1461)		
Profiles	**Local coating thickness, min. µm***	**Mean coating thickness, min. µm***
Steel ≥ 6mm	70	85
Steel ≥ 3mm to < 6mm	55	70
Steel ≥1.5mm to <3mm	45	55
Steel < 1.5mm	35	45
TABLE 3. MINIMUM COATING THICKNESS ON ARTICLES THAT ARE CENTRIFUGED TO SANS 121 (ISO 1461)		
Diameter of the article	**Local coating thickness, min. um***	**Mean coating thickness, min. um***
20mm diameter	45	55
6mm to < 20mm diameter	35	45
< 6mm diameter	20	25

NOTE 1: Hot dip galvanizing specifications state the minimum acceptable coating thickness and not average coating thicknesses. The thickness actually achieved, varies with steel composition and this can range from the minimum up to at least 50% greater. As life expectancy predictions are normally based on the minimum coating thickness, they are usually conservative.

1	2	3	4	5	6	7
				MAINTENANCE FREE LIFE OF THE COATING		
Corrosion category	**Description of environment**	**Corrosion rate (av. loss of steel in µm / yr.)**	**Corrosion rate (ave. loss of zinc in µm / yr.)**	**Continuously hot dip galvanized sheeting Coating class – Z275 (±20µm)**	**Hot dip galvanized coating (85µm) Steel thickness ≥ 6mm**	**DUPLEX COATING SYSTEM Hot dip galvanizing + an appropriate paint system**
C1	Interior: dry	≤1.3	≤0.1	>50	>50 #1	Not required for corrosion protection #2
C2	Interior: occasional condensation Exterior: exposed rural inland	>1.3 to 25	0.1 to 0.7	>40	>50 #1	Not required for corrosion protection #2
C3	Interior: high humidity, some air pollution Exterior: urban inland or mild coastal	>25 to 50	0.7 to 2.1	10 to 40	>40	Not required for corrosion protection #2
C4	Interior: swimming pools, chemical plant, etc. Exterior: industrial inland or urban coastal	>50 to 80	2.1 to 4.2	5 to 10	20 to 40	Coating life in columns 5 & 6, plus the paint life multiplied by a factor of at least 50%
C5-I or C5-M	Exterior: industrial with high humidity or high salinity coastal	>80 to 200	4.2 to 8.4	2 to 5	10 to 20	Coating life in columns 5 & 6, plus the paint life multiplied by a factor of at least 50%

Modified from Table 5 – ISO 9223.

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