2011 Volume 8 Issue 1

HOT DIP GALVANIZING TODAY

HOT DIP GALVANIZERS ASSOCIATION Southern Africa

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Featuring:

- Fastener feature, including the Annual Availability Matrix
- Continuous hot dip galvanized sheeting • Galfan coated wire • Thermal metal spraying
- Stephens corner "It only works when you don't need it" (final article)
- Duplex coating systems – Comment on "The ultimate challenge for the paint industry"
- Regulars include Bob's Banter, On the Couch and Education and Training

ZINC

steel
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Zinc Metal Spraying?

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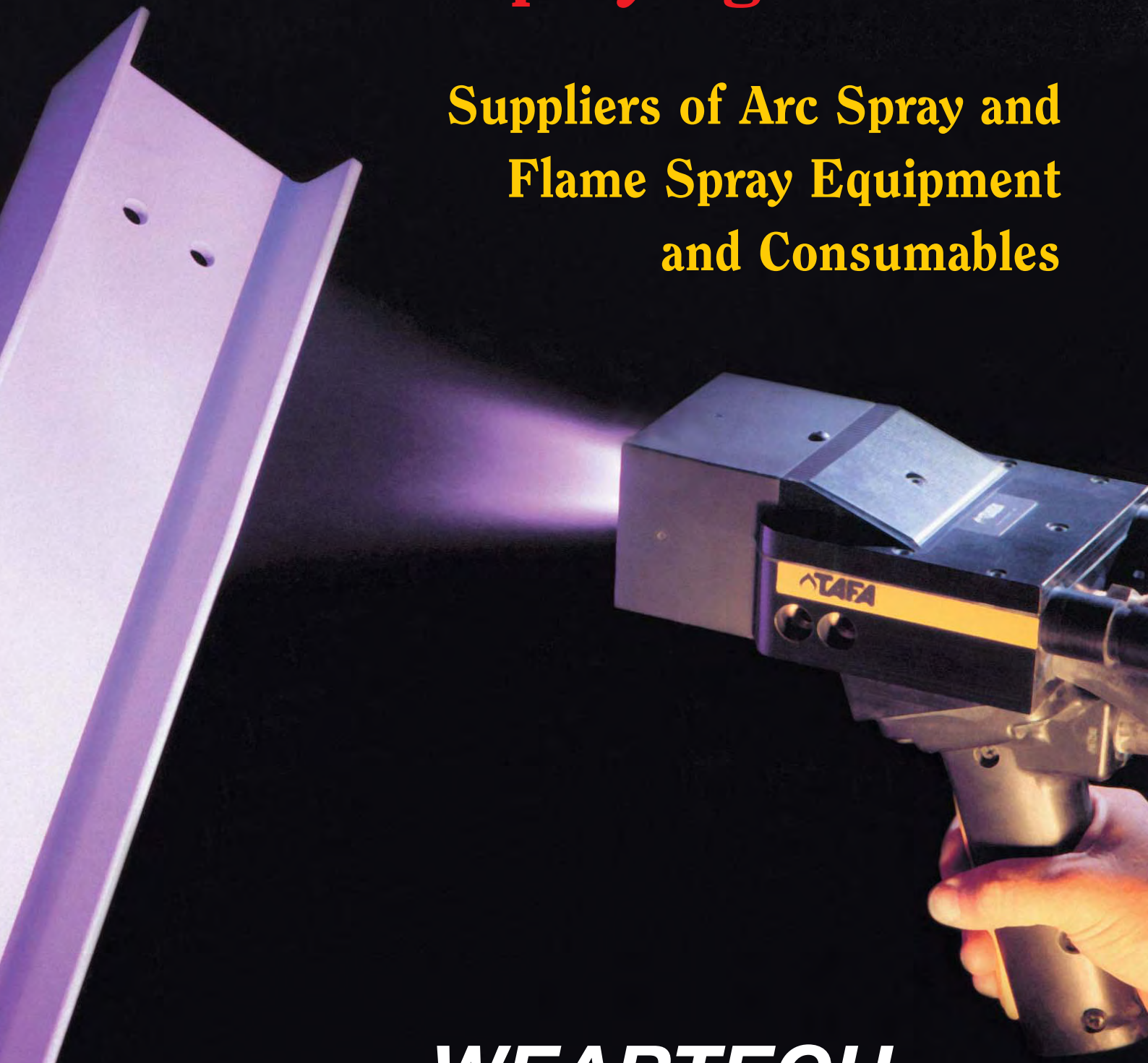

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The Association is an information centre established for the benefit of specifiers, consultants, end users and its members.

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CONTENTS

Front Cover: *A kaleidoscope of photos showing the final centrafugal action of some hot dip galvanized bolts; some general photos of bolts and nuts, including the residual coating thickness (90.6µm) of a holding down bolt and nut exposed for in excess of 30 years in a moderately corrosive environment; continuous hot dip galvanized sheeting, used horizontally on a building and for a light steel framed building and the "Maccaferri" Galfan coated gabion wall at Hospital Bend in Cape Town.*

Hot Dip Galvanizing – Adding value to Steel

Executive Director's Comment

As we move into 2011, it is normal to reflect on the state of our industry in general and more specifically on the roll of the Association in the corrosion control industry. Our primary goal, as an Association, is to provide an independent source of technical knowhow when employing hot dip galvanizing and duplex coating systems to combat the ravages of carbon steel corrosion.

We support the wider industry by site visits, formal inspection and independent reports on product quality and the appropriate application of galvanizing a duplex coating systems. We have a detailed range of technical publications, including our Steel Protection Guide, Practical Guidelines for the Inspector and our flagship quarterly journal Hot Dip Galvanizing Today. We have a web site (*www.hdgasa.org.za*) with case studies, codes of practice, information sheets, list of members and the latest updates on both formal and social activities.

Our educational activities include a new updated three day inspector's course that encompasses practical activities at both a galvanizing plant as well at a paint applicators yard for exposure to duplex coatings systems. From 2011 we have introduced a one day course entitled "*Introduction to the hot dip galvanizing process*". This course is aimed at the new comers to the industry as well as plant operators. We also view the one day course as a "bridging course" to the more advanced three day inspector's course.

A significant amount of data has been collected and distributed relating to environmental, health and safety of both plant operators as well as the wider public. Environmental and waste management controls, within the hot dip galvanizing industry, have and will continue to receive a great deal of attention. A number of our members are to be congratulated and encouraged to continue working at implementing their action plans aimed at improving their environmental and waste management controls.

The Association needs to be seen as a technical support service centre available to members as well as the wider corrosion control industry.

Bob Wilmot

Note from the Editor

I am pleased to inform you that the 2011 version and **update of SANS 121 (ISO 1461)**, has been released by the South African Bureau of Standards and while it is not necessarily hugely different to the earlier standard there are some noteworthy changes. In magazine No 40 we highlighted these changes. (Should you want a copy of the magazine, contact us). Besides the significance of referring to SANS 121 when specifying hot dip galvanizing, a further important reference specification that should be included each time is **SANS 14713**. In the next magazine we will discuss the usefulness of this specification.

One of our main features for this issue includes **hot dip galvanized fasteners**. We investigate the possibilities of hot dip galvanizing concrete self tapping screws which with the current coating often shows premature corrosion in coastal situations.

We furthermore, publish a report on dissimilar metals with the failure of posidrive screws used to fix a coated roof sheeted building in East London.

Although early days yet, Draft SA Standard may be adopting SANS 14399 for high-strength structural bolt and nut assemblies. This is likely to lead to the redundancy of SANS 10094 which will be replaced by SANS 10684 "Fasteners – Hot dip galvanized coatings".

An integral part of this feature is the publication of the annual hot dip galvanized fastener availability matrix which includes a section on the versatile "Lindapter" structural fixings.

Continuous hot dip galvanized sheeting is also featured where we have feedback from SASFA (South African Light Frame Building Association) discussing their success since inception of the Association.

Galfan coated wire – we look at the benefits of a locally produced Galfan wire with its associated corrosion benefits over pure zinc coated wire. Gabions, manufactured from Galfan wire are more suitable to aggressive coastal environments.

Corrosion protection by Zinc and Aluminium Thermal (Metal) spraying, where components are too large or cumbersome to hot dip galvanize. In the article **"Medupi Chimneys – Thermal Zinc Metal Spray of plate girders"** we discuss its successful use.

In addition to these, we feature the final article from Prof Stephen Yeomans in **"Stephen's Corner"** on hot dip galvanized reinforcement for concrete. **"It only works when you don't need it!"** Stephen's article includes a number of international projects.

Other regular articles include **Duplex Coatings** where where Bob Wilmot responds to Pieter Uys of Strutfast's article **"The Ultimate Challenge for the Paint Industry!"** We hope to continue this discussion in subsequent issues.

Education and Training includes our new 3-day Galvanizers Inspectors Course, which not only introduces greater practicality but more time in which to absorb the course information than the old 2-day course. A single day more practical course for those with limited formal education, has also been introduced.

Other regulars include **"On the couch"** where we interview Anna Loubser, General Manager of Galvatech in Cape Town and in **"Bob's BANTER"**, Bob discusses the concept of "Prisoner's dilemma".

Should a reader wish to express an opinion or provide us with an article, or comment on our articles, kindly contact us –

Enjoy the "magazinc".

Terry Smith

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Since1988 we have excelled as a high quality manufacturer of steel fasteners, specialising in hot dip galvanised bolts and nuts. Our fasteners come in mild steel and hi-tensile and range from M6 up to M30 in diameter. They are also available as zinc plated and cadmium plated.

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Evaluation of concrete screw-bolts

Screw-form anchor bolts are encountered in mounting applications which require rapid insertion of the fastener without the need to have a plug and that does not exert significant expansion pressure and may thus be used for near-edge installation within intact and/or cracked surfaces. These items are generally supplied in the electroplated condition, which has been found to offer inadequate environmental protection and have to be given a supplementary protective coating, particularly when used in outdoor applications.

The products of three suppliers of these fasteners were provided for comparative evaluation, namely:

- Avlock, who locally produce the Excalibur fastener under licence to Upat and Fischer,
- Heco Schrauben, who manufacture the Multi-Monti fastener, and
- APT, the manufacturer of the Thunderbolt fasteners.

	Thunderbolt	Excalibur	Multi-Monti
Electroplated			
Core	358-378	339-358	305-313
Surface	571-591	613-636	498-515
Hot Dip Galvanized (United Kingdom)			
Core	313-321		
Surface	498-515		
Hot Dip Galvanized (Galvspin)			
Core		297-305	269-276
Surface		390-413	330-348
Mechanically Plated			
Core	368-378	358-368	313-321
Surface	571-591	591-613	551-571
(all Vickers hardness measurements 1kg load)			

Table 1.

These products were subjected to a range of surface treatments intended to increase the survivability of the fasteners when exposed to aggressive environments. These treatments included hot dip galvanizing, undertaken both in the United Kingdom (exclusively on the Thunderbolt items – *Figure* 1) and locally, at Galvspin, on the Excalibur and Multi-Monti products (*Figure* 2). Mechanical plating (locally undertaken by Team Plating – *Figure* 3) was also attempted. Fasteners in the conventional electroplated condition (*Figure* 4) were evaluated as a comparative reference. Due to the nature of the hot dip galvanizing operation (immersion into molten zinc) the installation functionality of the fasteners should be compromised owing to the tempering influence exerted over their case hardened surface structures.

Figure 1. Foreign (United Kingdom) hot dip galvanized Thunderbolt fasteners as received.

Figure 2. Hot dip galvanized fasteners (ex Galvspin) as received.

Figure 3. The mechanically plated samples as received, with all the fastener manufacturers represented.

Figure 4. The electroplated samples as-received, with all the fastener manufacturers represented.

Samples from the nose of each of the fasteners were taken in the longitudinal direction and prepared for examination and hardness evaluation. The results are presented in *Table* 1.

The electroplated coating thicknesses were in the range 7-10mm (*Figure* 5). The hot dip galvanized coating thicknesses achieved for both the foreign and local applicators were similar and in the range 50-65mm (*Figure* 6). The mechanically applied

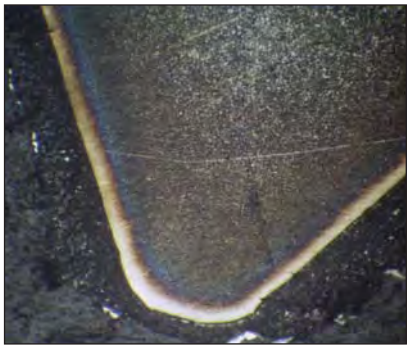
zinc coating thicknesses were in the range 40-45mm (*Figure* 7).

The hardness measurements supported the anticipated view that the thermal effect associated with the hot dip galvanizing has had a detrimental effect upon the surface hardness of the carburized fasteners and to a lesser degree upon their core hardnesses. The mechanical plating route did not affect these key parameters for the threaded anchor bolts.

Providing that the mechanically plated zinc offers satisfactory adhesion qualities under the abrasive conditions experienced during installation, the heavier mass of the applied zinc should offer the desired increase in longevity under corrosive service conditions without compromising their structural integrity and functionality.

RS *Thompson, Physmet.*

Figure 5. The electroplated coating in cross section (125x). Note the carburized surface skin of the substrate.



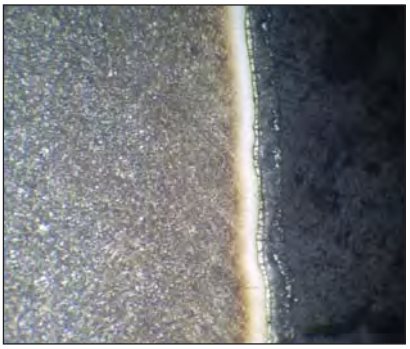


Figure 6. The hot dip galvanized coatings in cross section (125x). The overseas applied coating is on left, with the local application on right.

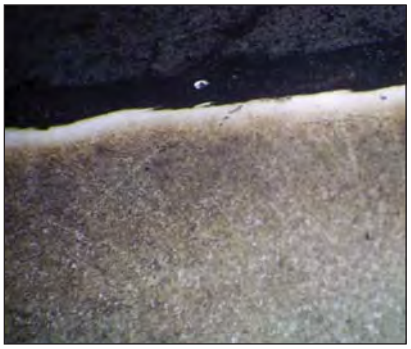


Figure 7. The mechanically plated coating in cross section (125x).

An update development in the fastener industry

Hot dip galvanizing of nuts and bolts have always been considered as a routine process without any real concerns relating to quality. It has been standard practice that when hot dip galvanizing grades 4.8 and 8.8 fasteners the applicable specification has been and should remain as SANS 121 (ISO 1461). Once we moved beyond a tensile level of 1 000MPa, as with a grade 10.9 friction grip fastener, the hot dip galvanizing will be undertaken in terms of SANS 121 (ISO 1461) in conjunction with Annex B of the SANS/ISO 10094 Standard.

This practice is now under review and the situation could well change once such detail reviews have been completed.

Draft SA Standard (DSS) are currently out at a public enquiry stage for International Standard adoption. The number and title of the draft standards are SANS 14399 parts 1 through 10 for high-strength structural bolt and nut assemblies. This 10 part family of specifications are extremely detailed and include greater controls and test procedures.

The effect that these specifications will bring to that of hot dip galvanizing of high tensile (>1 000MPa) fasteners is the redundancy of SANS 10094 to be replaced by SANS/ISO 10684 "Fasteners – Hot dip galvanized coatings".

We have received copies of all the above specifications and will comment accordingly. As far as SANS/ISO 10684 is concerned some changes are required, but some issues are of immediate interest.

1. Pickling in hydrochloric acid is allowed, which we believe should be eliminated to safe guard against the possibility of hydrogen embrittlement.
2. In annex F, reference is made to the following: "In some countries, where thread tolerance class in generally used, the national standards require the use of nuts two property classes higher." Does this mean that a nut for a grade 8.8 hot dip galvanized bolt should have a grade 12 nut? Surely this is a logistic nightmare and should be questioned bolt from a technical stand point as well as that of logistics?
3. High temperature (530°C to 560°C) is introduced and allowed, but limited to sizes <M27 in order to avoid micro-cracks.

Be aware of the proposals currently out for comment and should more detail be required, please revert to us at the Association.

Failure of roof fixing screws – Case study

The Hot Dip Galvanizers Association was requested to undertake an inspection of some roofing fasteners on a building in East London.

The roof cladding comprised aluminium colour coated roof sheeting fixed to hot dip galvanized and painted "C" type lip channel using 50mm stainless steel topspeed roof screws with aluminium rubber bonded sealing washers. Significant corrosive attack had taken place around the majority of fasteners as well as on the hot dip galvanized and painted lip channel.

In order to explain and understand the reasons for the corrosive attack found on this roof structure, we need to briefly review the question of differential metals within the contents of a corrosion cell. To do this we will refer to the galvanic series of metals, which is also known as the nobility of metals. A limited selection of metals from this series has been listed overleaf, starting with the electro-positive materials at the top, progressing down the list as each successive metal becomes more and more electro-negative to the one above.

From the galvanic series of metals, zinc is electro-negative to aluminium, carbon steel and stainless steel. Aluminium in turn is electro-negative to carbon steel with carbon steel being electro-negative to stainless steel. In other words, stainless steel is electro-positive to carbon steel, aluminium and zinc. This also means that in a corrosive environment, (corrosion cell) such as experienced on this site, zinc will sacrifice itself to protect aluminium, carbon steel and stainless steel. In addition, aluminium and carbon steel will corrode in preference to stainless steel. It is for this reason why the stainless steel has outlasted the other three metals involved in this instance.

With the above mixture of differential metals, all in electrical contact and exposed to a corrosive marine environment, zinc will corrode in order to protect aluminium, carbon steel and the stainless steel, i.e. all the metals that are more noble than zinc. In the case of the aluminium rubber bonded washers, the aluminium, being electro-negative to the

continued on page 8...

Typical corrosion evident around the majority of the stainless steel screws and aluminium rubber bonded carbon steel washers.

State of the corrosive attack on the hot dip galvanized painted lip channel with remains of the aluminium washers and the relatively "unaffected" stainless steel fasteners.

stainless steel topspeed roof screw, it will form the anode and corrode in preference to the stainless steel, being the cathode. In addition, the aluminium roof sheeting, in contact with the stainless steel screw will also corrode increasing the size of the hole and allowing the roof sheeting to pull past the fixing screw and corroded washer. It is for this reason that the stainless steel fasteners have remained, the washers have corroded away and the attachment of the aluminium sheeting has been compromised. Further evidence of this process is the resultant corrosion products, probably aluminium oxide, evident around all the attachment points.

Turning to the question of the corrosive attack on the hot dip galvanized and painted "C" type lip channels, we have a failure of the top paint coating. Once the "barrier protection" of the paint coating has been compromised the underlying zinc coating will start corroding forming a white patina, which has the tendency to spull off the surrounding paint. Further evidence of the white patina can be found on the hot dip galvanized perimeter fencing, where no top paint coating has been applied. This patina is the result of the zinc reaction with the chlorides contained in the sea spray, and consists of zinc chlorides, zinc hydroxides and zinc oxides. These products of corrosion are evidence of the slowly corroding barrier protection provided by the hot dip galvanized coating.

Examination of these purlin sections indicates a lack of adhesion of the paint coating to that of the hot dip galvanized surface. No primer has been employed and the paint coating was found to be far too thin, providing minimal additional corrosion protective properties. Where paint is to be used in conjunction with hot dip galvanizing, surface preparation is of paramount importance, followed by a paint system that is compatible with that of zinc. This is generally referred to as a Duplex coating system and quality is controlled by the use of laid down specifications. What is evident on this site does not conform or meet the requirements of a Duplex coating system.

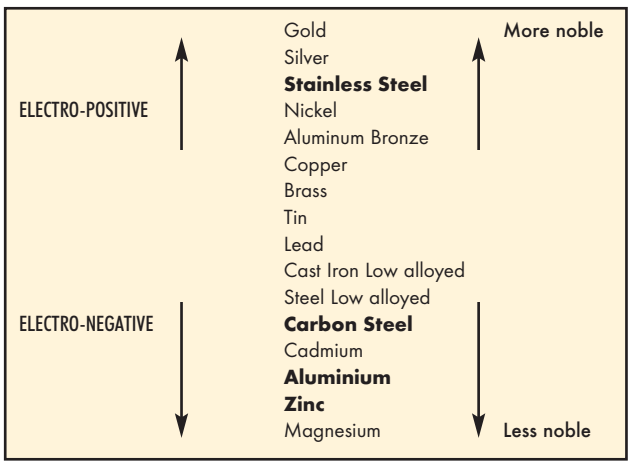
The hot dip galvanized purlin sections will provide corrosion protection to the carbon steel structural elements, but will remain aesthetically unacceptable.

Conclusion

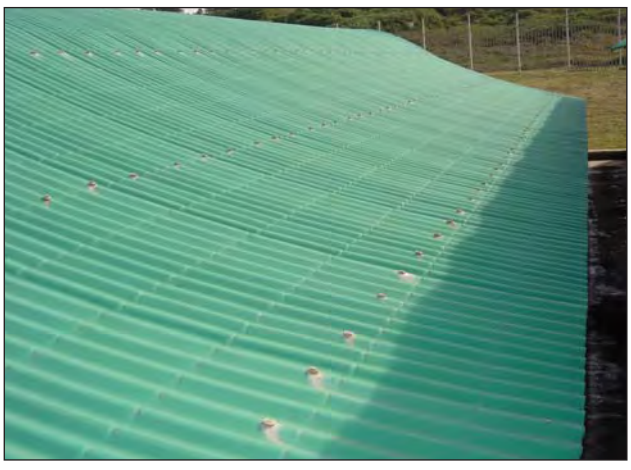
The corrosion evidence found on the roof and the supporting structure is the result of differential metals being used in the design. In addition, an inadequate paint specification and/or application of the hot dip galvanized lip channels have been employed.

Recommendations

Rectification will require two areas of attention.



Selected number of metals from the Galvanic Series (not all).



Corrosion products evident around every fastening location.

General view of the building.

Portion of the perimeter hot dip galvanized fencing.

1. Replace the stainless steel topspeed screws with hot dip galvanized equivalent components. These may be difficult to obtain commercially, in which case use the next (second) best alternative. Irrespective of the screw type used, one must completely seal each and every fastener with a bitumastic epoxy overcoat and ensure total isolation of the fixing point from the corrosive marine environment. Zinc and aluminium are relatively close to each other in the galvanic series, but in a marine environment it is recommended that one must use a good quality sealer.
2. Remove all corrosion products from the purlins and apply an epoxy based Duplex coating specification, comprising a zinc compatible primer, epoxy intermediate and a polyurethane finishing coat.
3. In the case where differential metals cannot be avoided, one must electrically insulate the two metals from each other. When this is not possible, it is essential to isolate the two metals from the corrosive environment.

Gautrain uses hot dip galvanized "Lindapter" structural fixings

Summary

Hot dip galvanized Lindapter steelwork fixings are currently being used to fix the Overhead Electrical Lines installed on the electrification project of the Gautrain high speed rail line

The 77km of track runs across 10.5km of viaducts as well as through 15km of tunnel and will link Johannesburg to Pretoria when the line is completed by March 2011.

Allan Macpherson from contractor Tractionel Enterprise describes the project:

"The philosophy adopted during the design of the electrical infrastructure for the Gautrain was that all components (within reason) had to be easy to handle, interchangeable, fool proof, robust and cost effective. An area of particular significance was selecting the most appropriate fasteners to be used to attach the equipment to the structures.

Traditional bolts, nuts and back straps were compared and evaluated against lindapter fixings, and in the end the choice was rather obvious. The ease of handling, application and the relatively low weight of the Lindapter versus the traditional bolts and back straps made the final decision a rather easy one.

Lindapter had the foresight to provide various off-the-shelf solutions to many of the challenges present when attaching components to different shapes and sizes of steel members. The Gautrain Overhead Track Design incorporates various steel profiles, varying in both shape and thickness.

Lindapter supplied a cost effective solution to each of these interfaces, off the shelf, supported by a very professional Technical Support team. The Gautrain design relies heavily upon the quality of the steel component interfaces to achieve the final system requirements – and this was achieved by utilising the ingenious Lindapter design."

Typical applications of Lindapter fixings on the Gautrain overhead track system include firmly securing cantilevers, tiebars and outriggers. A total of 16 000 Lindapter products are used in this project.

What is LINDAPTER?

Lindapter is a long established business (since 1934) specialising in technically advanced products for bolting steelwork together.

Simply bolt the sections together without drilling/welding/costly on site staff/electricity with the benefit of guaranteed loadings/on site adjustability/no damage to protective coatings/no hot work permits required and safe in hazardous environments.

Lindapters can be used to bolt virtually any 2 steel sections together without the need for drilling or welding on that steelwork.

All Lindapters are hot dip galvanized to SANS 121 (ISO 1461).

Fastener availability matrix and participating fastener suppliers

From experience it has been shown that on many occasions at building sites, alternatives to hot dip galvanized such as zinc electroplated fasteners are mistakingly used. In order to provide a similar service life to that of the hot dip galvanized structure, it is important to specify and use hot dip galvanized fasteners. To this end we provide the following "Fastener Availability Matrix", indicating the feasibility and availability of a range of hot dip galvanized fasteners, etc. Should a particular fastener that you require not be listed, kindly contact one of the participating fastener suppliers at the end of this matrix or the Association.

TYPE OF FASTENER	COMPANY	STEEL GRADE	SPECIFICATION	SPECIFICATION	AVAILABLE SIZES	HOT DIP GALVANIZED TO ORDER	HOT DIP GALVANIZED EX STOCK
LOCKING NUTS							
Hard Lock Nuts	Avlock International	Gr: 8/Gr: 5			M8 – M30	Yes	
	Bolt & Engineering Distributors	MS/Gr: 8				Yes	
	Bolt Fast	MS/Gr: 8			M8 – M30	Yes	
	Impala Bolt & Nut	MS/HT			M8 – M30	Yes	Yes
	Mr. Bolt & Nut	Gr: 4.8/Gr: 8			M8 – M48	Yes	
	National Socket Screws	Gr: 4.8/Gr: 8			M8 – M48		Yes
	SA Bolt Manufacturers	Gr: 4.8/Gr: 8			M8 – M64	Yes	
	Tel-Screw Products	MS/HT			M8 – M48	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS/HT			M8 – M36	Yes	Yes
Castle Nuts	Bolt & Engineering Distributors	Gr: 8	Various			Yes	
	Bolt Fast	MS/Gr: 8			M8 – M30	Yes	
	Mr. Bolt & Nut	Gr: 8			M8 – M30	Yes	
	Tel-Screw Products	MS/Gr: 8			M8 – M100	Yes	
Steel Hex Lock Nuts	Bolt & Engineering Distributors	MS			M8 – M48	Yes	
	Bolt Fast	MS			M8 – M100	Yes	
	Mr. Bolt & Nut	MS/Gr: 8			M8 – M100	Yes	
	National Socket Screws	MS			M8 – M48	Yes	
	SA Bolt Manufacturers	MS			M8 – M64	Yes	
	Tel-Screw Products	MS/HT			M8 – M100	Yes	
	WLS Fastener Manufacturing Co. cc	MS			M8 – M48	Yes	
Crimped Nuts	Bolt Fast	MS			M8 – M48	Yes	
	Impala Bolt & Nut	MS			M8 – M48	Yes	
	Mr. Bolt & Nut	MS			M8 – M48	Yes	
	Tel-Screw Products	MS			M8 – M48	Yes	
Locking Washers	Bolt & Engineering Distributors	MS	DIN 127		M8 – M52	Yes	
	Bolt Fast	MS			M8 – M52	Yes	
	Mr. Bolt & Nut	MS			M8 – M52	Yes	
	WLS Fastener Manufacturing Co. cc	MS			M8 – M52	Yes	
Nyloc Nuts Most smaller size nyloc nuts are only available in electroplated form	Bolt Fast	Gr: 8			M6 – M48		
	CBC Fasteners	Gr: 8			M6 – M48		
	Impala Bolt & Nut	Gr: 8			M6 – M48		
	Mr. Bolt & Nut	Gr: 8			M6 – M48		
	National Socket Screws	Gr: 8	Din 985		M6 – M48		
Cleeve Lock Nuts	Bolt Fast	Gr: 8			M8 – M30	Yes	
	Mr. Bolt & Nut	Gr: 8			M8 – M30	Yes	Yes
Prevailing Torque Hex Lock Nuts	Bolt Fast	Gr: 8			Selected sizes	Yes	
	Tel-Screw Products	Gr: 8 & 10	DIN 980V		Selected sizes	Yes	
NORMAL NUTS							
Hex OS Nuts	Bolt & Engineering Distributors	Gr: 8	DIN 934		M8 – M30	Yes	
	Bolt & Engineering Distributors	Gr:10	SABS 1282		M8 – M30	Yes	
	Bolt Fast	MS/Gr: 8 & 10			M8 – M64	Yes	Yes
	CBC Fasteners	Gr: 8	DIN 934	ISO 4032	M8 – M30	Yes	Yes
	Impala Bolt & Nut	Gr: 8	DIN 934		M8 – M30	Yes	Yes
	Mr. Bolt & Nut	MS Gr: 8 Gr:10			M8 – M30	Yes	
	National Socket Screws	MS/Gr: 8 & 10	DIN 934		M8 – M72		Yes
	SA Bolt Manufacturers	MS/Gr: 8 & 10	DIN 934	ISO 4032	M8 – M64	Yes	Yes
	Tel-Screw Products	Gr: 8; 10 & 12	DIN 934		M16 – M36	Yes	
	WLS Fastener Manufacturing Co. cc	MS/HT			M8 – M64	Yes	Yes
Hex Long OS Nuts	Bolt Fast	MS			M8 – M20	Yes	
	Mr. Bolt & Nut	MS/HT			M8 – M16	Yes	
	Rawlplug South Africa	MS			M8 – M16	Yes	
	Tel-Screw Products	MS/HT	TSP		M8 – M48	Yes	
	WLS Fastener Manufacturing Co. cc	MS			M8 – M36	Yes	Yes
Shear Nuts or Anti-vandal Nuts	Bolt & Engineering Distributors	MS	No Spec		M8 – M16	Yes	
	Bolt Fast	MS			M8 – M20	Yes	
	Impala Bolt & Nut	MS			M8 – M16		Yes
	Mr. Bolt & Nut	MS			M8 – M20	Yes	
	Rawlplug South Africa	MS			M8 – M16	Yes	Yes
	SA Bolt Manufacturers	MS/HT			M12 – M24	Yes	Yes
	Tel-Screw Products	MS/HT			M8 – M48	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS			M8 – M24	Yes	
Flanged Nuts	Bolt Fast	MS			M8 – M10	Yes	
	Mr. Bolt & Nut	MS			M8 – M10	Yes	Yes
	SA Bolt Manufacturers	MS HT			M8 – M36	Yes	Yes
	Tel-Screw Products	MS/HT			M8 – M36	Yes	
	WLS Fastener Manufacturing Co. cc	MS			M8 – M16		Yes

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TYPE OF FASTENER	COMPANY	STEEL GRADE	SPECIFICATION	SPECIFICATION	AVAILABLE SIZES	HOT DIP GALVANIZED TO ORDER	HOT DIP GALVANIZED EX STOCK
WASHERS							
Thru Hardened Washers	Bolt & Engineering Distributors	MS	DIN 6916		M6 – M42	Yes	
	Bolt Fast	Gr: 8			M6 – M48	Yes	
	Impala Bolt & Nut	MS	DIN 6916		M10 – M30	Yes	
	Mr. Bolt & Nut	G:10			M6 – M48	Yes	Yes
	National Socket Screws	Gr:10			M6 – M48	Yes	Yes
	SA Bolt Manufacturers	Gr: 8			M8 – M64	Yes	
	Tel-Screw Products	MS	DIN 6916		M10 – M64	Yes	
	WLS Fastener Manufacturing Co. cc	MS			M8 – M36		Yes
Flat Washers	Bolt & Engineering Distributors	MS			M8 – M30		Yes
	Bolt Fast	MS			M6 – M64		Yes
	Impala Bolt & Nut	MS	DIN 120/125		M8 – M30		Yes
	Mr. Bolt & Nut	MS			M6 – M64	Yes	Yes
	National Socket Screws	MS	DIN 120/125		M6 – M64	Yes	Yes
	SA Bolt Manufacturers	MS	DIN 120/125		M8 – M64	Yes	
	Tel-Screw Products	MS	DIN 120/125		M8 – M76	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS			M8 – M76		Yes
Square Flat Washers	Bolt Fast	MS			M12	Yes	
	Mr. Bolt & Nut	MS Taper			M10 – M24	Yes	Yes
	National Socket Screws	MS Taper	435		M10 – M24	Yes	Yes
	SA Bolt Manufacturers	MS			M8 – M30	Yes	
	Tel-Screw Products	Specially manufactured to order			M6 – M76	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS			M8 – M30		Yes
Square Curved Washers	Bolt Fast				M16 – M30	Yes	
	Mr. Bolt & Nut				M8 – M76	Yes	Yes
	SA Bolt Manufacturers	Specially manufactured to order			M16 – M30	Yes	
	Tel-Screw Products	Specially manufactured to order			M6 – M76	Yes	Yes
Spring Washers	Bolt & Engineering Distributors		DIN 127		M8 – M36		Yes
	Bolt Fast	MS			M6 – M52		Yes
	Impala Bolt & Nut		DIN 127		M8 – M30		Yes
	Mr. Bolt & Nut				M8 – M36	Yes	Yes
	National Socket Screws				M8 – M36	Yes	Yes
	SA Bolt Manufacturers		DIN 127		M8 – M48	Yes	
	Tel-Screw Products		DIN 127		M8 – M64		Yes
	WLS Fastener Manufacturing Co. cc				M8 – M36		Yes
BOLTS AND SCREWS							
Hex Head Screws	Bolt Fast	MS/Gr: 8 & 10			M8 – M42		Yes
	CBC Fasteners	MS	DIN 558	ISO 4018	M18 – M30	Yes	Yes
	CBC Fasteners	Gr: 8.8 & 10.9	DIN 933	ISO 4017	M8 – M30	Yes	Yes
	Impala Bolt & Nut	MS	DIN 658		M8 – M24		Yes
	Impala Bolt & Nut	Gr: 8.8	DIN 933		M8 – M30		Yes
	Mr. Bolt & Nut	MS/Gr: 8 & 10			M8 – M64	Yes	
	National Socket Screws	MS/Gr: 8 & 10	Din558/Din933		M8 – M48	Yes	Yes
	Rawlplug South Africa	MS	DIN 933		M8 – M12	Yes	
	SA Bolt Manufacturers	MS/Gr 8.8; 10.9; 12.9	DIN 933		M48 – M72	Yes	Yes
	Tel-Screw Products	MS/Gr: 8.8			M8 – M39	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS/HT			M8 – M36	Yes	Yes
Hex Head Bolts and OS Nuts	Bolt & Engineering Distributors	MS	DIN 601		M8 – M30	Yes	
	Bolt Fast	MS			M8 – M36		Yes
	CBC Fasteners	MS	DIN 601	SABS 135	M8 – M30	Yes	Yes
	Impala Bolt & Nut	MS	DIN 931		M8 – M30	Yes	Yes
	Mr. Bolt & Nut	MS			M8 – M36	Yes	
	National Socket Screws	MS	DIN 601		M8 – M36	Yes	Yes
	SA Bolt Manufacturers	MS	DIN 601		M10 – M64	Yes	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 & Engineering Distributors	Gr: 8.8	DIN 933		M27 – M56	Yes	
	Bolt Fast	MS/Gr: 8 & 10			M8 – M52		Yes
	CBC Fasteners	Gr: 8.8 & 10.9	DIN 931	ISO 4014	M8 – M30	Yes	Yes
	Impala Bolt & Nut	Gr: 8.8 & 10.9	DIN 931		M8 – M30	Yes	Yes
	Mr. Bolt & Nut	Gr 8.8 & 10.9			M8 – M52	Yes	
	National Socket Screws	Gr: 8.8 & 10.9	DIN 931		M8 – M52	Yes	Yes
	SA Bolt Manufacturers	Gr 8.8; 10.9; 12.9	DIN 931		M10 – M64	Yes	Yes
	WLS Fastener Manufacturing Co. cc	HT			M8 – M36		Yes
Large Dia Bolts and OS Nuts	Bolt & Engineering Distributors	MS/Gr: 8.8	DIN 601/934		M27 – M64	Yes	
	Bolt Fast	Gr: 8			M30 – M76	Yes	
	Mr. Bolt & Nut	MS/Gr 8.8			M27 – M64	Yes	
	National Socket Screws	MS/Gr 8.8	DIN931/601		M27 – M64	Yes	Yes
	SA Bolt Manufacturers	Gr: 8.8 & 10.9			M27 – M64	Yes	
	Tel-Screw Products	MS/Gr: 8.8			M36 – M76	Yes	
	WLS Fastener Manufacturing Co. cc	MS HT			M39 – M76	Yes	
Cup Head Square Neck Bolts and OS Nuts	Avlock	MS	DIN603		M8 – M16	Yes	Certain sizes
	Bolt & Engineering Distributors	MS	SABS 1143		M8 – M20	Yes	
	Bolt Fast	MS			M8 – M30	Yes	
	CBC Fasteners	MS	SABS 1143		M8 – M20	Yes	Selected
	Impala Bolt & Nut	MS	DIN 603		M8 – M16	Yes	Certain sizes
	Mr. Bolt & Nut	MS			M8 – M30	Yes	
	Rawlplug South Africa	MS	DIN 603		M8 – M12	Yes	

TYPE OF FASTENER	COMPANY	STEEL GRADE	SPECIFICATION	SPECIFICATION	AVAILABLE SIZES	HOT DIP GALVANIZED TO ORDER	HOT DIP GALVANIZED EX STOCK
BOLTS AND SCREWS (continued)							
Cup Head Square Neck Bolts and OS Nuts (continued)	SA Bolt Manufacturers	MS	DIN 603		M8 – M24	Yes	
	Tel-Screw Products	MS	SABS1143/DIN 603		M8 – M30	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS			M8 – M20	Yes	
C/Sunk Square Neck Bolts and OS Nuts	Avlock	MS/HT	SABS 1143		M8 – M30	Yes	Yes
	Bolt & Engineering Distributors	MS	SABS 1143		M12 – M24	Yes	
	Bolt Fast	MS			M10 – M24	Yes	
	CBC Fasteners	MS	SABS 1143		M10 – M20	Yes	
	Impala Bolt & Nut	MS	DIN 605		M10 – M16	Yes	
	Mr. Bolt & Nut	MS			M8 – M24	Yes	
	SA Bolt Manufacturers	MS	DIN 605		M8 – M33	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 and OS Nuts	Bolt Fast	MS			M10 – M24	Yes	
	CBC Fasteners	MS	SABS 1143		M12 – M24	Yes	
	Impala Bolt & Nut	MS	DIN 604		M10 – M20	Yes	
	Mr. Bolt & Nut	MS			M12 – M30	Yes	
	SA Bolt Manufacturers	MS	DIN 604		M12 – M36	Yes	
	Tel-Screw Products	MS	SABS 1143		M8 – M24	Yes	
	WLS Fastener Manufacturing Co. cc	MS			M12 – M24	Yes	
Friction Grip Bolts and Nuts	Bolt & Engineering Distributors	Gr: 10.9S	SABS 1282		M12 – M30	Yes	
	CBC Fasteners	Gr: 8.8S & 10.9		EN 14399	M16 – M30	Yes	
	CBC Fasteners	Gr: 8.8S & 10.9S	SABS 1282	ISO 7411	M12 – M30	Yes	
	Impala Bolt & Nut	Gr: 8.8S & 10.9S			M12 – M30		Yes
	Mr. Bolt & Nut	Gr: 10.9			M12 – M30	Yes	
	National Socket Screws	Gr: 10.9	DIN 6914		Certain sizes	Yes	
	SA Bolt Manufacturers	Gr: 8.8 & 10.9S			M12 – M30	Yes	
Hex Socket C/Sunk Head Screws	Bolt & Engineering Distributors	Gr: 10.9	DIN 7991		M8 – M24	Yes	
	Bolt Fast	MS			M8 – M39	Yes	
	Mr. Bolt & Nut	Gr: 10.9 & 12.9			M12 – M24	Yes	
	National Socket Screws	Gr: 10.9 & 12.9			M12 – M24	Yes	
	SA Bolt Manufacturers	Gr: 10.9 & 12.9			M8 – M48	Yes	
	Tel-Screw Products	HT			M8 – M24		
	WLS Fastener Manufacturing Co. cc	HT			M8 – M24	Yes	

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TYPE OF FASTENER	COMPANY	STEEL GRADE	SPECIFICATION	SPECIFICATION	AVAILABLE SIZES	HOT DIP GALVANIZED TO ORDER	HOT DIP GALVANIZED EX STOCK
BOLTS AND SCREWS (continued)							
Lockbolts	Avlock	8.8 Pins/6.8 collars			1/2" – 7/8" (imperial)	Yes	
	Impala Bolt & Nut Pins & Collars 1/2" - 7/8"	8.8 Pins/6.8 collars			1/2" – 7/8" (imperial)	Yes	
	Mr. Bolt & Nut	8.8 Pins/6.8 collars			1/2" – 7/8" (imperial)	Yes	
	SA Bolt Manufacturers	8.8 Pins/6.8 collars			1/2" – 7/8" (imperial)		
Pigtails – 1 & 1 1/2 Turn	Bolt & Engineering Distributors	MS			M8 – M12	Yes	
	Bolt Fast					Yes	
	Mr. Bolt & Nut	MS			M8 – M12	Yes	
	Tel-Screw Products				M8 – M76	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS			M8 – M24	Yes	
3m – Threaded Rod	Bolt & Engineering Distributors	MS			M8 – M36	Yes	
	Bolt Fast	MS/Gr: 8			M8 – M30		Yes
	CBC Fasteners	MS	DIN 975				
	Impala Bolt & Nut	MS/HT	DIN 975		M8 – M24	Yes	
	Mr. Bolt & Nut	MS/Gr: 8.8			M10 – M30	Yes	
	National Socket Screws	MS/Gr: 8	DIN 975		M10 – M30		Yes
	SA Bolt Manufacturers	MS/HT	DIN 975		M8 – M36	Yes	
	Tel-Screw Products	MS/HT			M8 – M76	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS			M8 – M36		Yes
1m – Threaded Rod	Bolt & Engineering Distributors		DIN975		M12 – M30	Yes	Yes
	Bolt Fast	MS/Gr: 8 & 10			M8 – M52		Yes
	CBC Fasteners	MS	DIN 975				
	Impala Bolt & Nut	MS/HT	DIN 975		M8 – M24	Yes	Selected
	Mr. Bolt & Nut	MS/HT			M8 – M52	Yes	
	National Socket Screws	MS/Gr: 8.8	DIN975		M8 – M48	Yes	Selected
	Rawlplug South Africa	HT			M8 – M30	Yes	
	SA Bolt Manufacturers	MS/HT	DIN 975		M8 – M36	Yes	
	Tel-Screw Products	MS/HT			M8 – M36	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS			M8 – M36		Yes
HD Bolts (Foundation Bolts) and OS Nuts	Bolt & Engineering Distributors	MS	No spec		M8 – M36	Yes	
	Bolt Fast	MS EN8			M8 – M72		Yes
	Impala Bolt & Nut	MS/350WA			M8 – M72	Yes	
	Mr. Bolt & Nut	MS/EN8			M8 – M72	Yes	
	Rawlplug South Africa	MS/HT			M8 – M36	Yes	
	SA Bolt Manufacturers	MS/HT			M12 – M72	Yes	Selected sizes
	Tel-Screw Products	MS/HT			M8 – M72	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS			M8 – M72	Yes	
CONCRETE ANCHOR BOLTS							
Anchors	National Socket Screws	5.8		International	M8 – M20	Yes	
Rawlbolts	Rawlplug South Africa	5.8	www.rawl.co.za	International	M8 – M24	Yes	
	Mr. Bolt & Nut				M8 – M24	Yes	
SPT Throughbolts	Rawlplug South Africa		www.rawl.co.za	EU	M8 – M20	Yes	Yes
Through Bolts	Rawlplug South Africa		www.rawl.co.za		M8 – M24	Yes	Yes
	Mr. Bolt & Nut				M8 – M24	Yes	
R-Cas Chemical Spin-in Anchors	Rawlplug South Africa	5.8 HT	www.rawl.co.za	BBA	M8 – M30	Yes	Yes
R-Hac Chemical Hammer-in Anchors	Rawlplug South Africa	5.8/HT	www.rawl.co.za	BBA	M8 – M30	Yes	Yes
R-Kem Chemical Cartridge System	Rawlplug South Africa	5.8 HT	www.rawl.co.za	BBA	M8 – M30	Yes	Yes
R-Ker Chemical Cartridge System	Rawlplug South Africa	5.8/HT	www.rawl.co.za	EU	M8 – M30	Yes	Yes
R-KeX Chemical Slow Cure Cartridge System	Rawlplug South Africa	5.8/HT	www.rawl.co.za	BBA	M8 – M30	Yes	Yes
Express Anchors	Rawlplug South Africa	5.8/HT	www.rawl.co.za	EU	M8 – M20	Yes	Yes
Rawl Kemfix Chemical Anchor Studs – for use with all chemical anchoring (capsule and/or cartridge systems)	Rawlplug South Africa	5.8/HT	www.rawl.co.za	BBA	M8 – M30	Yes	Yes
Chemical Anchors with Studs	Bolt Fast	MS/EN8			Various		
	Mr. Bolt & Nut	MS/EN8			M8 – M64	Yes	
	Rawlplug South Africa	5.8/HT	www.rawl.co.za	BBA	M8 – M30	Yes	Yes
	SA Bolt Manufacturers	EN8			M8 – M30	Yes	
	Tel-Screw Products	MS/HT			M8 – M36	Yes	Yes
	WLS Fastener Manufacturing Co. cc	EN8			M8 – M30	Yes	Yes
Concrete Anchor Bolts	Bolt Fast	MS			M8 – M24	Yes	
	Mr. Bolt & Nut	MS		BBA	M8 - M24	Yes	
Concrete Expansion Bolts	Bolt Fast	MS			M8 – M24	Yes	
	Bolt Fast - single collar wedge type anchor				M8 – M30	Yes	
	Bolt Fast - nail plug hammer in anchors				M8		Yes
	Bolt Fast - mortar cartridge system				300, 345 & 380mm		Yes
	Bolt Fast - double collar anchors				M8 – M30		Yes
MISCELLANEOUS							
Type 17 Self Drilling Screws	Avlock	1022			#8 – #14	Yes	
	Mr. Bolt & Nut				#8 – # 14	Yes	
Gutter or Veranda Bolts	Avlock	1006			M8 x 12 x 75mm	Yes	
	Mr. Bolt & Nut	MS			M8 x 22 – 75mm		Yes

TYPE OF FASTENER	COMPANY	STEEL GRADE	SPECIFICATION	SPECIFICATION	AVAILABLE SIZES	HOT DIP GALVANIZED TO ORDER	HOT DIP GALVANIZED EX STOCK
MISCELLANEOUS (continued)							
Self Drilling Screws SDS can be successfully hot dip galvanized but due to a slight thread softening, a smaller diameter pilot hole must first be drilled	Avlock	MS			Various	Yes	
	Mr.Bolt & Nut	MS			Various	Yes	
	Bolt Fast	MS			Various	Yes	
	Rawlplug South Africa		www.rawl.co.za		Various	Yes	
	WLS Fastener Manufacturing Co. cc					Yes	
Cast-In Lifting Sockets	Rawlplug South Africa	5.8/HT	www.rawl.co.za	BBA	M10 – M24	Yes	
Insulation Fixings	Rawlplug South Africa		www.rawl.co.za	BBA	Various	Yes	
Lindapter	Structural Fixing Systems		www.lindapter.com	M10 – M36	Yes	Yes	
SPECIAL FASTENERS							
Countersunk Machine Screws	Bolt & Engineering Distributors	MS/HT	DIN 963			Yes	
	Bolt Fast	MS			M8 – M24	Yes	
	Mr. Bolt & Nut	MS/HT				Yes	
	National Socket Screws	MS	DIN 963 & 965		M8 – M24	Yes	
	Tel-Screw Products	MS/HT	DIN 963 & 965		M8 – M36	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS/HT			M8 – M36	Yes	
Round U-Bolts	Bolt & Engineering Distributors	MS			M8 – M76	Yes	
	Bolt Fast	MS			M8 – M72	Yes	
	Mr. Bolt & Nut	MS			M8 – M76	Yes	
	Rawlplug South Africa	MS/HT	DIN 963 & 965		M8 – M36	Yes	
	SA Bolt Manufacturers	MS/HT			M8 – M72	Yes	
	Tel-Screw Products	MS/HT			M8 – M76	Yes	Yes
	Tel-Screw Products	HT			M8 – M76	Yes	
Square U-Bolts	Bolt & Engineering Distributors	MS	No spec		M8 – M24	Yes	
	Bolt Fast	MS			M8 – M76	Yes	
	Mr. Bolt & Nut	MS			M8 – M76	Yes	
	Rawlplug South Africa	MS/HT	DIN 963 & 965		M8 – M36	Yes	
	SA Bolt Manufacturers	MS/HT			M8 – M76	Yes	
	Tel-Screw Products	MS/HT			M8 – M76	Yes	
	WLS Fastener Manufacturing Co. cc	MS/HT			M8 – M36	Yes	
TV U- Bolts	Bolt Fast	MS			M8 – M76	Yes	
	Mr. Bolt & Nut	MS			M8 – M76	Yes	
	Tel-Screw Products	MS/HT			M8 – M76	Yes	Yes

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TYPE OF FASTENER	COMPANY	STEEL GRADE	SPECIFICATION	SPECIFICATION	AVAILABLE SIZES	HOT DIP GALVANIZED TO ORDER	HOT DIP GALVANIZED EX STOCK
SPECIAL FASTENERS (continued)							
Hook Bolts	Avlock	MS			M8 – M10	Yes	
	Bolt & Engineering Distributors	MS	No spec		M8 – M76	Yes	
	Bolt Fast	MS			M8 – M76	Yes	
	Mr. Bolt & Nut	MS			M8 – M76	Yes	
	Rawlplug South Africa	MS			M8 – M12	Yes	
	SA Bolt Manufacturers	MS/HT			M8 – M76	Yes	
	Tel-Screw Products	MS/HT			M8 – M76	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS/HT			M8 – M76	Yes	
Channel Bolts	Bolt & Engineering Distributors	MS			M8 – M10	Yes	
	Bolt Fast	MS			M8 – M76	Yes	
	Mr. Bolt & Nut	MS			M8 – M76	Yes	
	Tel-Screw Products	MS/HT			M8 – M76	Yes	
	WLS Fastener Manufacturing Co. cc	MS/HT			M8 – M76	Yes	
J-Bolts	Bolt & Engineering Distributors	MS	No spec		M8 - M24	Yes	
	Bolt Fast	MS			M8 – M76	Yes	
	Mr. Bolt & Nut	MS			M8 - M76	Yes	
	Rawlplug South Africa	MS	www.rawl.co.za		M8 – M12	Yes	
	Rawlplug South Africa	MS			M8 – M36	Yes	
	SA Bolt Manufacturers	MS/HT			M8 – M76	Yes	
	Tel-Screw Products	MS/HT			M8 – M76	Yes	
	WLS Fastener Manufacturing Co. cc	MS/HT			M8 – M76	Yes	
Eye-Bolts	Bolt & Engineering Distributors	MS	No Spec		M8 – M76	Yes	
	Bolt Fast	MS			M8 – M42	Yes	
	Mr. Bolt & Nut	MS			M8 – M76	Yes	
	Rawlplug South Africa	MS	www.rawl.co.za		M8 – M36	Yes	
	SA Bolt Manufacturers	MS			M8 – M76	Yes	
	Tel-Screw Products	MS/HT			M8 – M76	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS			M8 – M76	Yes	
Straining Eye-Bolts	Bolt Fast	MS			M8 – M76	Yes	
	Mr. Bolt & Nut	MS			M8 – M76	Yes	
	Tel-Screw Products	MS/HT			M8 – M76	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS			M8 – M24	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-Bolts	Bolt Fast	MS/HT			M8 – M76	Yes	
	Mr. Bolt & Nut	MS/HT			M8 – M76	Yes	
Linked Eye Nuts	Bolt Fast	MS/HT			M8 – M76	Yes	
	Mr. Bolt & Nut	MS/HT			M8 – M76	Yes	
	Rawlplug South Africa		www.rawl.co.za		M8 – M16	Yes	
Linked Eye Rods	Bolt Fast	MS/HT			M8 – M76	Yes	
	Mr. Bolt & Nut	MS/HT			M8 – M76	Yes	
	Tel-Screw Products	MS/HT			M8 – M76	Yes	
Forged Eye-Bolts	Bolt Fast	MS/HT			M8 – M30	Yes	
	Mr. Bolt & Nut	MS/HT			M8 – M30	Yes	
	Rawlplug South Africa		www.rawl.co.za		M8 – M16	Yes	
	SA Bolt Manufacturers	MS/HT			M8 – M30	Yes	
	Tel-Screw Products	MS/HT			M8 – M30	Yes	
Welded Eye-Bolts	Bolt Fast	MS			M8 – M16	Yes	
	Mr. Bolt & Nut	MS			M8 – M16	Yes	
	Rawlplug South Africa	MS	www.rawl.co.za		M8 – M16	Yes	
Scaffold Rings	Bolt Fast	MS			M8 – M16	Yes	
	Mr. Bolt & Nut	MS			M8 – M16	Yes	
	Rawlplug South Africa	MS	www.rawl.co.za		M8 – M16	Yes	
Threaded Studs	Bolt & Engineering Distributors	MS	No spec		M8 – M76	Yes	
	Bolt Fast	MS/EN8			M8 – M76	Yes	
	Mr. Bolt & Nut	MS EN8 B7			M8 – M76	Yes	
	National Socket Screws	MS/Gr:8.8	975		M8 – M30	Yes	
	Rawlplug South Africa	MS/HT	www.rawl.co.za		M8 – M30	Yes	
	SA Bolt Manufacturers	MS/HT			M8 – M76	Yes	
	Tel-Screw Products	MS/HT			M8 – M76	Yes	
	WLS Fastener Manufacturing Co. cc	MS/HT			M8 – M76	Yes	Yes
Tie Rods	Bolt & Engineering Distributors	MS	No spec		M8 – M76	Yes	
	Bolt Fast	MS/EN8			M8 – M76	Yes	
	Mr. Bolt & Nut	MS			M8 – M76	Yes	
	Tel-Screw Products	MS/HT			M8 – M76	Yes	
	WLS Fastener Manufacturing Co. cc	MS/HT			M8 – M76	Yes	
Other specials	Avlock	Any special manufacturing				Yes	
	Bolt & Engineering Distributors	Specials manufactured to order					
	Bolt Fast	Any special manufacturing					
	Impala Bolt & Nut	All specials relating to fasteners			M8 – M72	Yes	
	Mr. Bolt & Nut	Any special manufactured to specification				Yes	
	National Socket Screws	Specials manufactured to order from blanks in stock			M12 - M56	Yes	
	Rawlplug South Africa	Special application chemical and/or mechanical anchor bolts as required					
	SA Bolt Manufacturers	Any special manufactured fasteners				Yes	
	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	Mr. Bolt & Nut	MS			M8 – M20	Yes	
	Tel-Screw Products	MS/HT	DIN 1587		M8 – M76	Yes	
	WLS Fastener Manufacturing Co. cc	MS/HT			M8 – M36	Yes	
Hex Coach Screws	Bolt Fast	MS			M8 – M20	Yes	
	Mr. Bolt & Nut	MS/HT			M8 – M20	Yes	
	National Socket Screws	MS/HT			M8 – M20	Yes	
	Rawlplug South Africa		DIN 7976	www.rawl.co.za	M8 – M12	Yes	
	SA Bolt Manufacturers	MS			M8 – M20	Yes	
	Tel-Screw Products	MS	DIN 7976		M8 – M12	Yes	Yes

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

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

THE ASSOCIATION ASSUMES THAT ALL PARTICIPATING COMPANIES IN THE MATRIX, DO IN FACT STOCK OR ORDER HOT DIP GALVANIZED FASTENERS WHEN REQUESTED TO DO SO. THE ASSOCIATION THEREFORE, EXCLUDES ITSELF FROM THE RESPONSIBILITY OF ENSURING THAT ALL FASTENERS OFFERED WILL IN FACT BE HOT DIP GALVANIZED, BY THESE COMPANIES.

SHOULD ANYONE USING THIS MATRIX FIND INACCURACIES OR ERRORS OR HAVE ADDITIONAL SUGGESTIONS, KINDLY CONTACT THE EDITOR.

PARTICIPATING FASTENER SUPPLIERS CONTACT DETAILS

COMPANY	TELEPHONE	EMAIL	WEBSITE
Avlock International	011 917 2110	query@avlock.co.za	www.avlock.co.za
Bolt & Engineering Distributors	011 824 7500	mike@bolteng.co.za	www.bolteng.co.za
Bolt Fast	021 505 1000	ShaunD@boltfast.co.za	www.boltfast.co.za
CBC Fasteners	011 767 0000	tech@cbc.co.za	www.cbc.co.za
Impala Bolt & Nut	011 824 3925	adiamond@impalasa.co.za	www.impalabolt.co.za
Mr. Bolt & Nut	021 511 9805	mark@mrboltandnut.co.za	–
National Socket Screws	011 397 0150	nss@screws.co.za	www.screws.co.za
Rawlplug	011 894 7147	rmuller@infodoor.co.za	www.rawlplug.co.za
SA Bolt Manufacturers	011 814 2240	info@sabolt.co.za	www.sabolt.co.za
Structural Fixing Systems	011 433 2052	stevets@global.co.za	www.lindapter.com
Tel-Screw Products (Pty) Ltd	011 898 3200	info@telscrew.co.za	www.telscrew.co.za
WLS Fasteners	011 882 1150	wlsandrew@telkomsa.net	www.kalm.de

Development of the LSFB industry in Southern Africa

Introduction

The Southern African Institute of Steel Construction had identified the potential of the development of light steel frame building in Southern Africa already in 2003. After a few overseas fact finding missions and meetings with a number of interested parties, a development plan was drawn up, and SASFA was established in November 2006 to coordinate the development of the industry. The Founder Members included ArcelorMittal SA, Everite and Saint Gobain Construction Products (Gyproc and Isover).

What is LSFB?

Light steel frame building is a frame building method, similar to timber frame construction. It has been described as 'off-site' building, as a lot of the manufacturing takes place in factories, and the components are assembled on site.

It consists of structural wall panels and trusses, assembled using cold formed steel sections made from thin gauge high strength galvanized steel sheet. Sections are joined together - normally in a factory - using rivets or self tapping screws, to form structural wall panels and roof trusses which are transported to site for erection on foundations and floor slabs.

The wall frames are clad externally and internally on site with a range of alternative cladding and lining materials, with services (electrical and plumbing) and insulation material installed in the wall cavity. Any type of roofing material can be used.

Light steel frame building offers environmentally friendly, structurally sound buildings; speed of construction; excellent thermal insulation; accuracy and quality finishes.

Milestones

From the outset, the quest for quality was used as the guideline for SASFA's activities.

As a first step, the SASFA Building Code was drafted – while based on the Australian Standard, the scope was expanded beyond the steel frame to include cladding, lining, insulation and services. This Code served as a guideline during the initial development of this industry, and was submitted to the SABS to use as input to the SANS Standard. SANS 517 was finally approved and published in November 2009.

SASFA also developed an Accreditation Scheme to facilitate identification of suitable light steel frame (LSF) building systems, manufacturers and builders. The first step of the scheme has been rolled out by assessing locally used building systems – the Scottsdale, FrameMaster, Mitek and Hayes systems have been accredited with assistance from the University of Stellenbosch. Manufacturers of LSF systems will next be assessed to ascertain that their quality management systems will ensure consistent product of approved quality.

SASFA compiled a Quality Checklist, to assist contractors and inspectors alike to ensure that completed buildings comply fully with set standards. This was necessary, as there was no knowledge base of this building method in Southern Africa. SASFA also fulfils a quality monitor role, by visiting projects and carrying out inspections on request.

Training was obviously also on our agenda, and as a first step an Australian trainer experienced in LSF building was brought to South Africa to 'train the trainers'. We have subsequently developed separate training programmes for building contractors, designers and inspectors, and present these courses country wide.

Awareness raising seminars were held in the major centres, involving prominent overseas speakers. SASFA has made many presentations at local and overseas seminars and conferences, and have been involved in several exhibitions. Lectures are given to senior building science and architecture students on invitation by the universities and technikons. A special LSFB category has been established in the annual Steel Awards of the Institute of Steel Construction since 2008, and in excess of 10 entries are judged annually. In order to keep interested parties informed about developments, biannual industry meetings are being held, also providing a forum for networking.

A website (www.sasfa.co.za) was established to promote the industry.

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Member Category	January 2011
Major material supplier	1
Other material, component and equipment suppliers	6
Manufacturers of Light Steel Frame Building Systems Large (>1 000t/yr)	13
Other (<1 000t/yr)	4
Merchants, service centres and distributors	9
Building industry member	17
Design Consultants	7
Associate member	11
Total	**71**

Table 1: SASFA company membership.

Amongst other, it contains the SASFA membership list with contact detail, which serves as the 'yellow pages' of the industry.

Status of industry

After the initial rapid expansion of light steel frame manufacturing capacity, the industry entered a consolidation phase during the recent downturn in the building industry. However, as demand for new buildings is increasing, it is encouraging to see the number of new entrants into this industry. *Table* 1 summarises SASFA's membership, per category of member.

Authorities and the banks

As required by the building regulations, LSFB projects have to be submitted for approval by the local authorities with a rational design carried out by a competent person / engineer. Since the publication of SANS 517:2009 Light Steel Frame Building, the NHBRC accepts the standard as the rational design provided all the requirements are met.

ABSA, FNB and Standard Bank have all accepted LSFB for bonding purposes, subject to their normal criteria. Especially ABSA has been very supportive of the development programmes.

Market activity

As was expected, light steel roof trusses gained rapid acceptance into the market. The ease of handling, consistent structural properties and resistance against creep, ageing, warping and rot, convinced designers and developers / builders that LSF trusses offer an attractive alternative to gang nailed timber trusses. LSF trusses have made inroads in the conventional timber truss market, from residential to commercial and even industrial projects, with roof spans up to 35m!

Penetration into the walling market took off at a slower pace – according to industry reports, LSF roof trusses were used to cover a total floor area of 1.6 million square metres during 2009, while LSF buildings with floor area of 250 000m^2 were built in the same year.

A wide range of building types are built using LSFB – from emergency low cost housing, through to large luxury houses, from sound rooms and movie theatres to warehouses and multi-storey commercial buildings. A recent development is the use of LSF walling in conjunction with reinforced concrete or heavy structural steel columns.

The low activity in the local building market during the past two years naturally also impacted on the demand for LSFB. According to official building statistics the floor area of buildings completed during 2010 was more than 40% lower than during 2007. However, a recent survey amongst LSFB manufacturers showed them to be very positive about prospects during the coming year. A few reported such demand that they could not even close down over the recent builders' holiday!

The development program in South Africa has stimulated similar development in neighbouring countries. Some local manufacturers have become involved in projects in sub Saharan African countries – especially Mozambique and Angola.

8th International Conference on Zinc and Zinc Alloy Coated Steel Sheet

GALVATECH 2011

Genova (Italy), June 21 – 25, 2011

Scope

Galvatech 2011 is the premier "international conference of the year" for anyone interested in galv sheet.

Papers will cover technology relating to zinc and zinc alloy coated sheet production and applications.

The Conference will bring together steel producers, plant designers and researchers and it will provide a forum for an exchange on best practices and state-of-the-art technology. It will also take an outlook on developments in the foreseeable future.

Additional sessions will be aimed at:

- sharing experiences on technical enhancement and eco-sustainability among zinc coated sheets processes and other (e.g. general hot dip galvanizing);
- disseminating knowledge of zinc coated products characteristics through participation of end-users (e.g. designers, architects and other specifiers).

Technical Focus

The Conference will cover topics concerning:

- New Coating Lines and Technology
- Technologies to Preserve the Global Environments
- Construction Applications
- Electrogalvanized, Hot dip Galvanized and Galvannealed Steels and Advanced Steel
- Conversion Coating and Pre-painted Steel Prediction
- Surface and Structural Analysis
- Process Technologies
- Automotive Applications
- Joining and Forming
- Zinc coated Products for Designers, Architects and other Specifiers
- Corrosion Mechanisms, Monitoring and Life
- General Hot Dip Galvanizing

Background

The Galvatech Conferences are held every three years *(1989 Tokyo, 1992 Amsterdam, 1995 Chicago, 1998 Tokyo, 2001 Brussels, 2004 Chicago, 2007 Osaka).* Since 1989, the venue has been rotating between Europe, North America and Japan. We are delighted to convene Galvatech'11 as the eighth conference of this series.

Language

The official language of the Conference will be English.

Papers received

The organizers have to date received more than 170 technical papers and posters.

Conference web site www.aimnet.it/galvatech2011.htm

Fasteners and lightweight steel structures

The introduction of lightweight roof structures and steel frame buildings into the South African market has gained notable momentum over the last few years, and has caused much excitement in the construction industry.

As a result of the versatility of lightweight steel construction, this construction method is now being used in markets ranging from industrial and commercial roof structures to upmarket houses, low rise buildings and low cost housing projects.

A wide variety of fasteners and fixings are used in lightweight steel construction and as most of the conventional fasteners used on thicker gauge steel are not suitable for use with thin gauge steel, a whole new range of fasteners has been developed for this market.

The Southern African Light Steel Frame Building Association (SASFA) has drawn up a code for low rise light steel frame buildings which includes the corrosion protection requirements for fasteners used in these buildings (see table below). The coating classes in this table are based on environmental categories as described in ISO 9223 and coatings are specified according to the Australian Standard AS3566.2-2002.

The SASFA code has since been incorporated as part of SANS 517:2009 (Light steel frame building) and the Australian Standard AS3566.2 – 2002 has been adopted as the basis for SANS 1273 (Fasteners for roof and wall coverings in the form of sheeting) which is also used in the SANS 517 standard.

Once the coating class of the fastener has been determined from *Table* 1, the

coating type and coating thickness is selected from *Table* 2.

The coatings of the fasteners must comply with the stipulations of SANS 1273 (AS3566.2 – 2002) which includes salt spray tests; sulphur dioxide tests; porosity tests; UV tests and Real World testing.

The fasteners that are typically used to assemble tracks and studs that make up the wall frames as well as

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the joining of the wall frames, are wafer head or modified truss head self drilling screws (*see photo on page* 21) A fastener with a low head is usually required to fit in the dimples that are formed by the roll forming machine on the joints. This ensures that the internal and external cladding will fit flush onto the steel frame.

The wall frames are fixed to the concrete slab using anchors. Here expansion -, thread cutting- or chemical anchors are normally used.

There are a variety of outer cladding material options available that include fibre cement planks, single skin brick and fibre cement boards. A variety of fasteners are available to fix the cladding to the steel frame. A countersunk self drilling screw with reaming wings can be used to fix fibre cement planks and boards to steel ranging from 1.0 – 4.5mm in thickness. For steel thinner than 1.0mm a Class 3 FibreZip screws is recommended as they are specifically designed for this application.

The fixing of roof sheeting to thin gauge steel battens also requires special fasteners. The standard self drilling screws with a no. 3 drill point remove too much material when drilling through the steel, leaving very little steel for the screws to tap into. This results in pull-out values that are too low and unacceptable. For this application RoofZip screws were designed.

With a smaller drill point, broad buttress thread design resulting in improved pull-out values and C4 mechanical tin-zinc coating the RoofZip is ideally suited for fixing I.B.R and corrugated profiles to thin gauge purlins in C2 to C4 environments.

The use of the correct type of fastener with the correct corrosion resistant coating will ensure that the life span of the steel frame building will not be compromised by premature failure of fasteners caused by corrosion.

Application	Location in building	Ease of access[1]	Atmosphere[2]	Coating class (min)[3,4]
1. Steel wall frames	Inside building envelope	Difficult	Inland	C2
		Difficult	Aggressive	C2
	Outside building envelope	Easy	Inland	C2
		Easy	Aggressive	C3
2. Trusses	Ventilated roof cavity	Difficult	Inland	C2
		Difficult	Aggressive	C3
	Unventilated roof cavity	Difficult	Inland	C2
		Difficult	Aggressive	C2
3. Wall frame anchors	Inside building envelope	Difficult	Inland	C2
		Difficult	Aggressive	C2
4. External cladding	Outside building envelope	Easy	Inland	C2
		Easy	Aggressive	C3
5. Internal lining, ceilings	'wet rooms'	Easy	Internal - regular condensation	C2
	all other rooms	Easy	Internal - dry	C1
6. Roofing	Outside building envelope	Easy	Inland	C2
		Easy	Aggressive	C3

[1] For Inspection and maintenance
[2] "Aggressive" Marine environment (500m to 10km from the sea) or industrially polluted atmospheres. "Inland" all other environments
[3] Coating class defines corrosion resistance requirements
[4] Subject to requirements of SANS 1273

Table 1.

Coating Class	Coating type	Minimum coating thickness µm
C 1	Electroplated zinc	4
C 2	Electroplated zinc	12
	Mechanically plated zinc	17
	Mechanically plated tin-zinc (≥20% Sn, 80% Zn)	12
C 3	Electroplated zinc	30
	Mechanically plated zinc	40
	Mechanically plated tin-zinc (≥20% Sn, 80% Zn)	25
	Hot dip galvanized	30

Table 2.

PROPOSED FEATURES FOR 2011

May / June (No 47):
• Tubes, pipes, scaffolding • Masts and poles • Water storage
• Heat exchangers and cooling fans

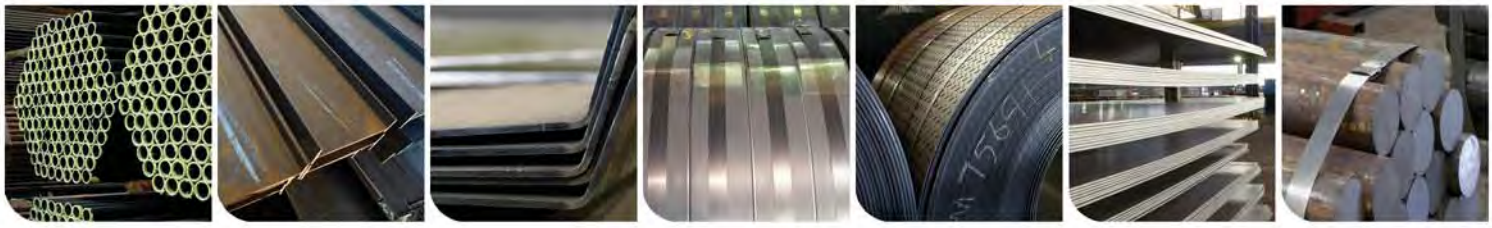
August / September (No 48):
• Annual Hot Dip Galvanizing Awards • Cable ladders and trays
• Hot dip galvanizing used for artistic purposes

November / December (No 49):
• The world of hot dip galvanizing around us • Greening of the hot dip galvanizing industry

NOTE: FEATURES MAY BE SUBJECT TO CHANGE

TRIDENT STEEL

THE AVENG GROUP



Trident Steel is an AVENG Group company with our main operation centrally situated in Roodekop, Germiston with other facilities in Alrode, Durban, Port Elizabeth, Rosslyn and Cape Town.

We supply a wide product range to the steel industry in South Africa as well as internationally from our extensive steel yards, modern and comprehensive steel processing and steel service centres, speciality steel division and tube manufacturing plant.

We offer our customers a quality product, delivered on time at a competitive price.

Our growth is guaranteed by the contribution we make to the success of our customers.

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■ Tel: (011) 861 7111 ■ Fax: (011) 865 3035 ■ Website: www.trident.co.za / www.aveng.co.za ■ Email: trident@trident.co.za / export@trident.co.za

What is a spangle?

Introduction

For years, galvanized articles made by hot dip coating techniques were identified by the characteristic *spangled* appearance. In many cases, this is still true today. However, because of some changes in the manufacturing processes associated with zinc production and the galvanizing process, not all hot dip galvanized steel sheet made today has a visible spangle. This explanation for this is given later in this GalvInfoNote.

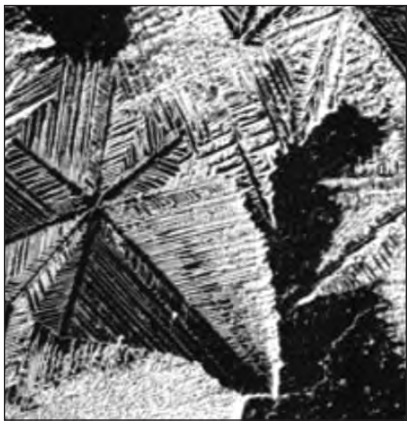


Figure 1.

What is a spangle?

The dictionary defines "spangle" as a glittering object. When spangle is used to define the surface appearance of galvanized steel sheet, it includes the typical snowflake-like or six-fold star pattern that is visible to the unaided eye. The following photograph shows the details of this pattern. This photograph shows the typical spangle pattern of a galvanized coating. The surface is magnified about 10x.

The features shown here encompass a number of quite complex metallurgical phenomena. In this GalvInfo Note, we will attempt to explain why these features are present.

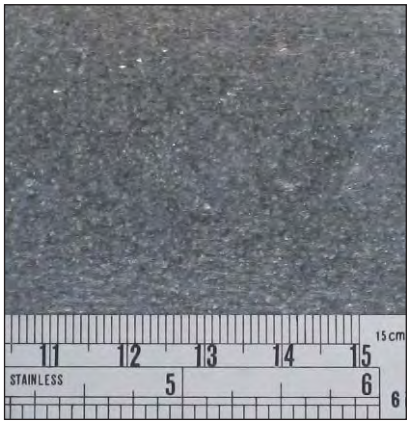


Figure 2.

Figure 3.

Figure 4.

Figure 5.

The Solidification process

First, one needs to understand that the development of spangles occurs when the molten zinc adhering to the steel sheet is cooled below the melting point of zinc. The freezing point is approximately 419°C (787°F). At this temperature, the randomly-arranged atoms in the liquid zinc begin to position themselves into a very orderly arrangement. This occurs at many random locations within the molten zinc layer. This transformation from a disordered arrangement of the atoms into an orderly arrangement defines the "solidification" or "crystallisation" process. The small solidifying areas within the molten zinc are defined as "grains"[1]. As the individual atoms of molten zinc attach themselves to a solidifying grain (causing grain growth), they form into a distinct array, or crystal. In the case of zinc, the crystals form with hexagonal (six-fold) symmetry. It is this fundamental way in which the individual atoms of zinc arrange themselves as the solid zinc grains grow larger that leads to the often-visible hexagonal symmetry of the final spangle. When the coating is finally completely solidified, the individual spangles define specific individual grains of zinc.

"Nucleation" is the term used to define the process of transformation of randomly arranged atoms of molten metal into a small, organised array of atoms in the "seed" crystals at the initial stage of solidification. A high rate of nucleation during the freezing process would tend to cause the formation of numerous small grains in the final solidified structure, while a low rate of nucleation would tend to favour the growth of large grains.

Dendritic growth

There is another aspect of the solidification process that leads to the snowflake pattern in galvanized coatings, viz., "dendritic" (meaning tree-shaped) growth. Dendritic growth causes the individual growing (solidifying) grains to grow into the melt (the molten zinc coating) with a distinct leading rounded

edge. A "primary" dendrite arm is identified in the photograph above. There are secondary dendrite arms that grow laterally away from the "primary" dendrite arms.

Dendritic growth of grains during the solidifying of metals is very common. The reason that the dendrites are readily visible in a galvanized coating is that we are basically seeing a two-dimensional version of an as-cast, dendritic, solidified grain structure. Remember, the coating is less than 0.001 inches (25mm) thick, considerably less than the diameter of a spangle. In other metals (for instance in the steel substrate), the original as-cast, three dimensional, dendritic structure of the grains is subsequently broken up into many smaller, more equiaxed grains. This is related to the effects of hot rolling (for example, rolling a 9-inch thick slab of steel into a 0.050-inch thick steel sheet), cold rolling and recrystallisation during the sheet-annealing process.

The rate of growth of the dendrite arms during the solidification of a galvanized coating competes with the rate of nucleation of new grains within the molten zinc. This process determines the final size of the completely solidified structure. In the case of the above photograph, which is a galvanized coating with a well-defined large spangle pattern, the rate of dendrite growth dominated the solidification process leading to a small number of large spangles. One characteristic of such spangles is that they are thickest at their centres and thinnest at their edges, or grain boundaries. The grain boundaries can be said to be "depressed" and are difficult to smooth by subsequent temper passing.

Dendritic growth is not the only way in which grains can grow during the solidification process. It requires one or more special conditions to be present. One of these conditions is the presence of other elements in the molten metal.

These can be either intentionally added alloying elements or impurities. In the case of galvanized coatings on steel sheet, the most common reason for the well-defined dendritic growth pattern is the presence of lead in the coating. It has long been thought that the reason lead results in large spangles is that it has the effect of reducing the number of nucleation sites. In recent work1, it is proposed that that the presence of lead decreases the solid/liquid interfacial energy in the solidifying coating. This leads to an increase in dendrite growth velocity, resulting in large spangles. Lead precipitates at the coating surface and the varying distribution of lead particles across the surface define the optical appearance (dull vs. shiny spangles).

Lead is a common impurity in zinc. In years gone by, the most common form of zinc metal production involved smelting, distillation and condensation. Lead is a common metal found in zinc-containing ores, and this refining

continued on page 26...

process carried it through as an impurity in the zinc. Therefore, in the early days of galvanizing, lead was almost always present in the zinc, and it was common to see the spangle pattern. Galvanized coatings on steel became identified by the characteristic spangle. Essentially, all hot dip galvanized coatings had a spangled appearance. If the spangle wasn't visible, the users "knew" that the steel had not been galvanized.

The first galvanized coatings contained as much as 1% lead. During the past 25 years, the presence of such high lead levels has not been common in the galvanized coatings on steel sheet, at least not in North America, Europe, and Japan. Typical concentrations of lead in most galvanized sheet made during the past 25 years are less than 0.15%, often as low as 0.03 to 0.05%. However, this amount of lead is still sufficient to develop dendritic growth behaviour during the solidification process. Today, a typical level of lead in the coating bath on lines where the primary product has a well-developed spangle pattern is in the range of 0.05 to 0.15% lead.

Non-spangled coatings

In recent times, the production of zinc from zinc-containing ores has been changed to an electrolytic recovery method. In this method of zinc production, the refined zinc is very pure, with the lead being excluded. This change occurred at a time when many users of galvanized sheet, especially those desiring a high quality finish after painting, such as the automotive and appliance industries, needed a non-spangled coating. Removing the lead gave them the product they desired. The amount of lead in the coating for lead-free coatings is less than 0.01%.

Lead-free coatings still have a grain pattern that is visible to the unaided eye. Typically, the spangles are about 0.5mm in diameter and are clearly visible when seen at 5 to 10x. However, the grains no longer grow by a dendritic mode but by a cellular mode of growth. Essentially, the grains of zinc nucleate on the steel surface, and grow outward toward the free surface. The absence of lead takes away the strong driving force for growth in the plane of the sheet, preventing the formation of large spangles. Rapid spangle growth cannot occur and the absence of lead results in the coating appearing uniformly shiny.

This non-spangled coating, when combined with temper rolling by the galvanized-sheet producer, can be made very smooth. The large grain boundary depressions and surface relief of a spangled coating are not present.

The coating can be painted to give a very smooth, reflective finish.

An added advantage of producing a lead-free galvanized coating is that is not susceptible to a problem known as intergranular corrosion. This is a coating failure mechanism in damp environments caused by the lead concentrating at the spangle boundaries.

Why is lead still used on many galvanizing lines?

The manufacture of non-spangled coatings, or lead-free coatings, is not easily done. The reason relates to the influence of even a small amount of impurities, such as lead, on the

viscosity of the molten zinc. It is difficult to avoid small sags and ripples in the coating when the lead is totally removed. The thicker the coating, the greater the tendency to form sags and ripples. Fortunately, the automotive and appliance industries need only relatively thin coatings (typically 60 to 80g/m^2/side) of zinc to obtain the level of corrosion resistance their customers demand. Also, the products used by these industries are made on relatively new high-speed lines, or older lines that have been refurbished to allow production at high speeds. The combination of high processing speeds and low coating weights allows the producer to use lead-free coating baths, avoid the development of spangles, and still attain a smooth coating.

If the end user requires a heavier coating mass (100g/m^2/side and higher), there is a distinct tendency for the coating, when applied from a lead-free bath, to develop very visible sags and ripples. The result is that the surface is not smooth and the coating locally is composed of thick and thin regions. This tendency for sags is exacerbated a low line speeds (<75 meters/minute). Thus, older, low speed coating lines, lines designed to process heavy-gauge sheet, and those that are used to make heavy coating weight products (275g/m^2 meter or G90 and heavier) typically still have some amount of lead in the coating bath to improve the final coating uniformity. Often, the concentration of lead in the coating bath is between 0.05 and 0.15%.

The net result is that the final product from many lines still has a visible spangle pattern. This meets with the marketplace needs in that a number of industries, especially those that use bare (unpainted) galvanized sheet, still want the large, bright, reflective spangle pattern.

Some galvanized-sheet manufacturers have established practices on their older or low-speed lines where they use essentially lead-free zinc, but add a small amount of antimony to the zinc coating bath. The antimony addition accomplishes the same influence on viscosity and spangle formation as lead. The final result is a smooth, visible spangle coating. Typically, the amount of antimony in the coating bath is about 0.03 to 0.10%.

Reference

1) J. Strutzenberger, J. Federl: Metall. Trans. A, 1998, *vol.* 29A' *pp.* 631-646

1 Metals, like many solids in nature, have a "grain" structure. For example, the steel sheet beneath the galvanized coating consists of many small grains of iron-carbon alloy (steel). The individual grains of steel are very small compared with the grains of zinc in the zinc coating, and these small steel grains are essentially "glued" to one another by atomic bonding forces. One can think of this as "grains of sand in a sandstone rock". In the case of the sandstone rock, the size of the individual grains of sand are often larger than the grains in the steel sheet, but one can visualise the concept of grains using this analogy.

The Association wishes to thank Gary Dallin of GalvInfo Center for this article.

Improving the effect of a galvanized coating on wire to protect steel products

Corrosion protection using zinc

In the past, the most common form of corrosion protection for metallic surfaces has been through the hot dip galvanizing process whereby a zinc layer is firmly alloyed with the steel surface, protecting the steel in two ways:

- Forming a barrier which isolates the steel from external corrosive agents, and
- Through the process of sacrificial corrosion.

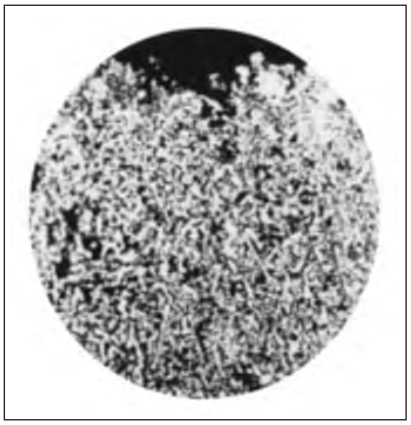
This system has been used successfully for coating steel sheeting, pipework and wire material products in civil engineering and building construction. One standard use for the steel wire products is in the form of a double twist mesh system used in gabions, mattresses, soil reinforcement, erosion protection and rockfall netting. These products form part of the range of standard components supplied by Maccaferri SA in their role as service provider for civil and environmental engineering solutions.

Combining zinc and aluminium

The method based on galvanization only has been improved on by the inclusion of aluminium as an alloy with the zinc in a redesigned coating process. The International Lead Zinc Research Organisation (ILZRO) obtained worldwide patents on this new form of coating in 1981 and gave it the name of Galfan from "Galvanization Fantastique".

Galfan, in the form of a 95% zinc and 5% aluminium coating is superior to pure zinc coatings in that the rate of corrosion with time has a parabolic rather than linear form. This is due to the fact that zinc corrodes at a faster rate than the aluminium. Hence, as the zinc element corrodes, an aluminium rich surface is developed with a greater resistance to corrosion, resulting in an extended life of the protection.

Zinc coating.



Galfan coating.

This eutectic Zn-Al mischmetal also contains small additions of cerium-lanthanum rare earths to improve the reliability of the coating process. This combination results in a physical structure which has a more crystalline form and improved mechanical characteristics.

A further advantage of the zinc aluminium coating is that it has a finer microstructure and provides better cathodic protection. Consequently, in the event that the surface becomes scratched the coating has the ability to restore itself more effectively than when zinc on its own is present, and continue the corrosion protection.

The improved aluminium passive barrier

Aluminium is more electropositive than zinc, and corrodes at a lower rate. A "passive barrier" is created when the coating produces an oxidising film blocking the wire from oxidation and corrosion. The aluminium oxide

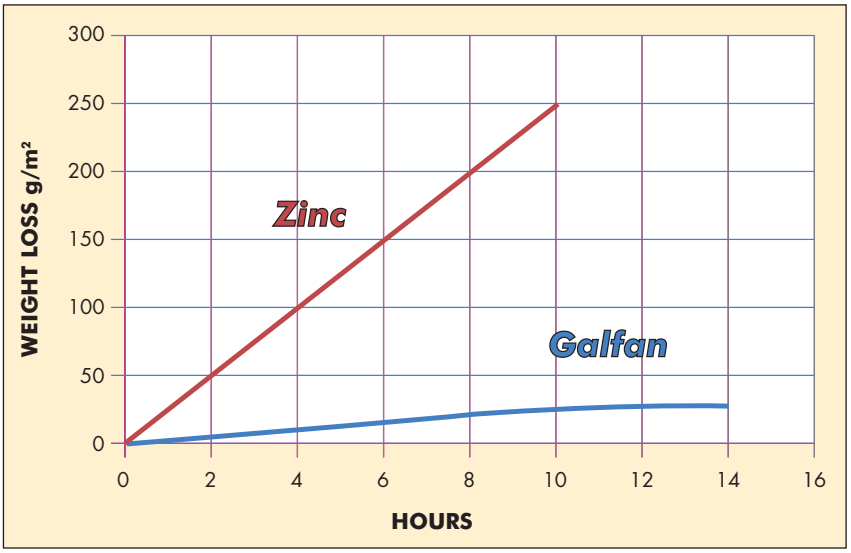


Figure 1.

crystals are more uniform and less porous therefore the passivating performance is more effective.

The images below produced using the scanning electron microscope photomicrograph show by comparison the zinc coating laminar (laminated) microstructure as opposed to the Galfan fine eutectic microstructure which is clearly more compact.

Other reasons for using a zinc-aluminium alloy

Zinc has a cathodic feature which promotes its sacrificial protection. When zinc is scratched, damaged or abraded away, zinc oxides cover the exposed steel surface. The steel-zinc alloy is therefore important for the internal protection and adhesion of the coating to the steel.

The aluminium oxides on the other hand are externally more stable and hence provide the initial barrier required at the surface to withstand the effects of the environment and the potential for damage. The aluminium is more ductile than the zinc thus improving the formability of the surface by withstanding flaking and cracking when the wire is bent or twisted.

Research on the properties of Galfan

Exposure tests in different environments

In a study in the USA which was started in 1992, three test sites were chosen as follows: Montreal (Canada), Weirton and Newark. The conditions ranged from the most corrosive at Montreal with numerous freeze/thaw cycles and acid rain, to a moderately corrosive industrial environment at Weirton and a mild suburban/rural environment at Newark respectively. At each site, a number of small mild steel strips and plates all precoated using either a galvanizing process or with Galfan were installed in the soil to depths of 450mm and also at the soil/atmosphere interface on the surface. At short intervals up to two years and eventually after a full 8 years, specimens were removed and tested to determine the loss in their coating content.

The results showed that in general, the Galfan-coated specimens were less corroded than those that were galvanized. Loss in Galfan coating after the 8 years was approximately 15% whilst the Zinc-coated specimens lost up to 65% of their coating. (*Corrosion Testing Laboratories: February* 2001).

Standard tests on durability

(a) Salt Spray Test: The Salt Spray Test is carried out according to ASTM B117 in which a 5% NaCl

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solution is used at 35°C. This process simulates exposure of the specimens for up to 1000 hours, to an aggressive marine environment. Test results have substantiated the assumptions that Galfan's corrosion resistance progressively improves over time.

(b) **Kesternich Test:** The Kesternich test is also based on exposure until a state of 5% Red Rust is reached. In this case a sulphur dioxide compound is used in accordance with ASTM G1/88. Specimens are exposed in an atmosphere at 93 – 94% relative humidity which contains 10% SO_2 at 35°C. The graph below illustrates the performance of Galfan coating against Zinc.

Ageing tests

Ageing tests have demonstrated that the percentage of aluminium on the external surface of Galfan products increases with time. This development at the corrosion front, the decreasing of zinc and the increasing of the aluminium, connected to the increasing of oxygen at the same locations, becomes more pronounced with time.

Following tests on exposure over time in different environments the concept of the Galfan Performance Ratio (GPR) has been developed.

GPR = Zinc loss for a heavy Galvanizing Coating / Zinc Loss for a Galfan Coating

Results have shown that GPR ≈ 2.0 for 8.5 years and 3.0 for 25 years. A projection of this relationship indicates that the GPR or 50 years could be ≈ 4.0.

Standard coating thicknesses

In South Africa, the Zinc and Galfan (or Zinc-alloy) coating thicknesses set by SABS conform with international standards under EN 10244-2. In this specification a coating thickness of 245g/m² is required for the Galfan coating on a 2.7mm diameter steel wire (or 0.035mm thick). SANS 1580 covers the minimum coating thickness using zinc only. For the same 2.7mm wire this is at present 275g/m² (or 38µm thick).

Conclusions

In conditions of extreme exposure it is necessary to ensure that the coating type is appropriate. In the past zinc only coated wire would have had to be carefully maintained and at times replaced when conditions were extremely severe. Now with the availability of Galfan, new opportunities have been opened and the service life of hydraulic structures especially, using gabions and mattresses has been improved considerably. Users of Galfan in certain parts of the world have stated that Galfan is capable of providing 4 to 5 times greater protection than zinc coating of the same thickness.

In addition to this it has been found that Galfan wire is easy to weave and its finish allows the cut ends of the selvedge to "heal over" thus providing further resistance to corrosion. Furthermore, Galfan maintains a "like-new" appearance until the end of its life span.

Finally, Galfan allows the end user to achieve two important goals at the same time: First, the provision of a longer corrosion life and second, considerably lower cost per year of service life.

References

1. *Bergische Universitat Gesamthoschschule Wuppera*; 2000
2. *Centre de Recherches Métallurgiques – Abbaye du Val-Benoit Liege: Belgium*: 1987
3. *Nisshin Steel Company Ltd*: 2000
4. J.L. *Pagniez: French Coated Steel Information Center*: 1981
5. *Mike Caroll: Davis Wire Corporation*: 2008
6. *Alasdair Morrison; Cape Gate*: 2011

Prepared by Des Lange Pr Tech Eng
Technical Manager: Maccaferri SA
10 *February* 2011

3 CPD POINTS

Revised 3-day Galvanizers Inspectors Course for 2011

Hot dip galvanizing is one of the most widely used methods of protecting steel from corrosion. During fabrication and after hot dip galvanizing the coating is inspected for compliance with the relevant specifications.

Following up on comments received from the many participants attending our regular two day inspector courses over the last nine years, we have expanded and updated our two day course. Starting in early 2011, see below for details, we will be introducing a three day course.

Included are revisions of the course material and the introduction of more practical activities in the form of a full morning at a hot dip galvanizing plant followed by an afternoon of Duplex coatings. The galvanizing plant visit examines materials prior to galvanizing and hands on inspections of finished product. The afternoon is a visit to a paint applicators yard and Duplex coatings systems. Included are demonstrations on chemical cleaning and/or sweep blasting, examination of resulting profiles and followed by the application of paint onto galvanizing. The course will provide delegates with sufficient knowledge to advise on fabrication for successful hot dip galvanizing and also test, inspect and interpret test results after hot dip galvanizing.

COURSE DURATION AND CONTENTS

Day 1	**(08h00 to 16h00)**
Lecture 1	Introduction to the Environment, Steel & Corrosion
Lecture 2	Understanding Zinc Coatings (How does Zn protect)
	ISO 9223 & 12944
Lecture 3	Designs, Fabrication and Inspection before hot dip galvanizing SANS (ISO) 14713:1999
Lecture 4	General Hot Dip Galvanizing Processes
	SANS 121 (ISO 1461:2009) Batch type galvanizing
	SANS 32 (EN 10240: 1997) Automatic T & P
	SANS 10094:2007 HDG of Friction Grip Fasteners
Day 2	**(07h00 to 16h00)**
	Hot Dip Galvanizing Plant Visit and Inspection
Lecture 5	Duplex Coatings and HDG Reinforcement in Concrete
	Duplex Coatings Plant Visit and Applications
Day 3	**(08h00 to Completion of Exam)**
Lecture 6	Inspections after Hot Dip Galvanizing
Lecture 7	Quality Assurances in Coating Applications
	Application of specifications
	Control documentation for a QA System
	Examination on Course Effectiveness

Course schedule may be altered and interesting activities added for the benefit of delegates.

Following the course and successful result in a three part exam, the delegate will be issued with a certificate and if required, registered as an approved HDGSA Galvanizing Inspector. Registration will be confirmed on an annual basis. Successful galvanizing inspectors will become Affiliate Galvanizing Inspector Members of the HDGASA for the year.

VENUE AND NUMBER OF DELEGATES

The courses are usually run in Johannesburg from the Hot Dip Galvanizers Association in St Andrews, Bedfordview and also from a suitable venue in Cape Town. Bookings are limited to 10 people per course on a first come first serve basis.

DATE AND TIME

Courses commence at 08h00 sharp and end at 16h30 (or as otherwise instructed). Lunch and refreshments will be provided. Comprehensive course notes can be collected from our offices two weeks before the course (this is highly recommended).

Johannesburg:
15 to 17 February; 15 to 17 March; 19 to 21 April; 17 to 19 May; 21 to 23 June; 16 to 18 August; 4 to 6 October; 22 to 24 November.

Cape Town:
8 to 10 March; 7 to 9 June; 6 to 8 September.

Special courses can be arranged for a minimum of 6 delegates at appropriate venues in South Africa.

COURSE COST AND PAYMENT TERMS

R4 200.00 per person exclusive of VAT. Should you have two or more delegates from the same company, course costs will be R4 000.00 per person exclusive of VAT. Please note that payment is due on the first day of training. Cheques are to be made out to "Hot Dip Galvanizers Association SA". Members qualify for a discount.

CONTINUOUS PROFESSIONAL DEVELOPMENT (CPD)

By attending the Association's 3 day course Galvanizing Inspectors Course, you will obtain 3 points (accredited by ECSA).

SHOULD YOU BE INTERESTED, KINDLY CONTACT SASKIA SALVATORI OR MARJORIE MONTGOMERIE AT THE ASSOCIATION

Medupi Chimneys – thermal zinc metal spray of plate girders – Platform 205m

Background

The Medupi Power Station has two 213m high chimneys with three flues. The flues are manufactured from both mild and stainless steel. The majority of the mild steel in this project is hot dip galvanized, except for three of the girders.

The three girders with dimensions of 17m x 3.1m are required for the support of the Medupi North and South chimney platforms at 205m. In this instance however the dimensions of the girders ruled out the use of hot dip galvanizing due to the combination of the length and width, making it either too long or too wide to fit in a kettle for a double dip. Another factor which also ruled out hot dip galvanizing was the possibility of distortion.

Although Robor Galvanizers are renowned for their ability to handle very complicated and large double dips a joint decision with Grinaker-Lta was reached that the best alternative to hot dip galvanizing would be to thermal zinc metal spray the girders.

Thermal Zinc Metal Spray is the best alternative to hot dip galvanizing due to the fact that the zinc applied during thermal zinc metal spraying is of the same chemical composition as the zinc used in the hot dip galvanizing process. The only difference is that adhesion to the steel surface is mechanical, whereas during hot dip galvanizing a metallurgical bond is formed.

Thermal metal spraying in the workshop.

Logistics and other requirements

Robor Galvanizers drafted a method statement detailing the safety, environmental and quality requirements which was accepted by Grinaker-Lta. Robor transported the equipment, consumables and personnel to the Grinaker-Lta fabrication site at Vanderbijlpark. The compressed air needed was supplied by a mobile compressor courtesy of Grinaker-Lta fabrication workshops.

The metal spray process required the shot blasting of the girders and was carried out in the facility run by Bulldog Projects situated in close proximity. The size of the products necessitated shot blasting of one side of the girders at a

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Typical coating thickness achieved.

Frequent quality and coating thickness testing was required.

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  6 000m²
- 5 000m² concrete lay down area added to enhance our offering
- Line 2 kettle with a totally matched processing facility
- 4m deep • 2m wide • 10m long
- On-site water treatment facility

Benefits to you:

- Increased flexibility
- Shorter lead times
- Increased kettle depth with fewer vertical dips
- More comprehensive service offering

Logistics capabilities include:

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- Crane capacity
- Transport fleet
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The appearance of the finished zinc metal sprayed coating.

time which resulted in the frequent use of heavy transport vehicles between the blasting and spray areas. This was necessary to avoid flash rusting of the freshly blasted areas. The spray process was carried out under cover but in a well ventilated area.

Once the one side was completed, the girder would be turned over and transported back to blasting area where the whole process would be repeated.

In-process quality checks

It quickly became evident that frequent quality checks were needed to identify areas which required additional layers of metal spray. The operators from Robor were issued with calibrated thickness gauges which they used for their own inspections. In addition, frequent checks were also carried out by a member of the Robor management team who also checked on the safety compliance issues.

Final inspection

The final inspection was carried out using the requirements as set out in the SANS/ISO 1461 standard. A total of four reference areas, as opposed to the required three, were selected along the length of each girder. Five coating thickness readings were taken in each reference area. The results were used to calculate the local and mean coating thicknesses. The results are shown in *table* 1.

In Summary

The project was successfully completed taking into account the dimension of the products and the logistical issues . The finished products were accepted by all parties and it was generally accepted that this project, being a first of its kind, was handled professionally by all involved.

The Association wishes to thank Nico Schoeman *of Robor Galvanizers for this article.*

Part no. 101 530 02					
Individual readings	Area 1	Area 2	Area 3	Area 4	Mean coating thickness
1	339	238	137	129	
2	260	279	140	177	
3	273	222	153	201	
4	275	269	131	154	
5	378	230	137	178	
Local mean coating	305	247.6	139.6	167.8	215
Part no. 101 530 02 CCC					
Individual readings	Area 1	Area 2	Area 3	Area 4	Mean coating thickness
1	256	191	298	187	
2	257	193	236	225	
3	236	251	184	257	
4	242	250	180	229	
5	234	270	134	243	
Local mean coating	245	231	206.4	228.2	227.65
Part no. 101 530 01					
Individual readings	Area 1	Area 2	Area 3	Area 4	Mean coating thickness
1	205	318	343	240	
2	252	265	260	290	
3	227	317	231	353	
4	242	339	264	315	
5	265	287	365	266	
Local mean coating	238.2	305.2	292.6	292.8	282.2

Table 1.

MRH new painting facility

MRH (Affliate member of HDGASA) operates two fully-fledged blasting and painting facilities in Philippi, Cape Town. The new facility boasts one of the largest blast booths in South Africa.

These two facilities provide a combined area of 10 000m^2 with 4 000m^2 of under-cover area and the rest being "lay-down" space.

The MRH facilities also cater for the off-loading and collection of steel by large horse-and-trailer trucks.

The marine office is located alongside Sturrock Dry Dock in Alkmaar Road in the Port of Cape Town.

MRH is a Level 1 BBEEE company.

On the Couch.....

Anna Loubser

By Desere Strydom

I am privileged to share the couch with a genuine galvanizing "chic" this edition. Something that doesn't happen often, as the industry is predominantly male dominated and the few ladies working in the industry hardly ever venture outside of office blocks. Anna however is a breath of fresh air; hands on in her approach and not scared to get down and dirty, whilst maintaining her femininity! I present General Manager of **Galvatech, Anna Loubser aka Mamma.**

You entered the Industry in quite a unique way, please tell us more. I am actually a qualified nurse and midwife. I had been working as the Nursing Service Manager at Kingsbury Hospital for ten years when a family member with problems in his galvanizing plant, tongue in cheek asked me to manage his galvanizing concern. I thought that if I could manage nursing services, surely I could manage a galvanizing concern.

How long have you been in the Industry? I started at the first galvanizing plant in December 1999 and have been with Galvatech since 2006.

How do you as a female maintain your femininity in your daily functions? When I first started at the plant I looked at this dirty place and started washing down walls, cleaning the ablution and tearoom facilities; then I proceeded with work at every single station. I do my daily tasks in jeans, Galvatech T-Shirt and safety boots and most of my admin tasks afterhours.

How has the response been to you as a lady from clients and colleagues alike? My workers call me "**Mamma**"(Mommy), so yes they do see me as a woman, but accept my position as their manager. It wasn't easy at first, but after a few months I managed to earn their respect by being consistent with discipline. It took some time for them to accept reporting to a woman, but eventually they knew that Mamma *"knows what she's talking about and cannot be fooled"*. Fortunately due to my exposure at the other galvanizing plant, clients knew me and trusted me.

Galvatech has done very well in the annual HDGASA Awards – Winners in Duplex Coating Category in both 2008 and 2009. Is there a secret or just luck? In consultation with our Sales Representative, we entered the Dust Mitigation Project in Saldanha on which we were the main supplier – which scooped the first award. After tasting success of winning, we entered successfully. Fortunately the quality of work we produce ensures that we get the tenders for prominent projects, making entering easier.

Which projects are you most proudly associated with and for what reason? I am proud of all the work we do, because we produce excellent quality. Our zinc bath size is

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7.5m long which together with an efficient work flow originally implemented by our three directors, all of whom are certified engineers, ensures an excellent service delivery. Obviously I am very proud of the two Award winning projects!

The industry is taking time to recover from the recent recession, where do you see it going? I am not convinced that the wheel has turned yet, especially in Cape Town, where things seem to happen slower than elsewhere. But I do see a slight upturn. The fact remains that hot dip galvanizing remains the most cost effective way of preserving steel and more people have realised it doesn't pay to take a short cut when it comes to corrosion protection. There will always be a demand for hot dip galvanizing, if one can ensure good management and service delivery – both attributes I believe Galvatech has.

Is there much demand for architectural galvanizing finish and in Western Cape and how does Galvatech cope with the demand? There is always the issue of design, because most structures requiring architectural galvanizing are simply not designed taking the process into account. We are finding that to effectively deal with the demand, we need to be involved from planning stages with the architects and project managers.

Please tell us about your private life? I am married to a General Practitioner. We have three sons. Hannes is an accountant, Gideon died tragically in an accident in April 2010 and the youngest Andrew is currently busy studying electronic engineering.

Please tell us about your hobbies, passions and interests. Music and reading. My husband has promised me that one day he will build me a library where I can kick back and read and listen to music to my heart's content. I am sorry to say that I am a complete workaholic and I enjoy every minute of it. Work remains my biggest passion!

Desere Strydom
http://commentfromthecouch.blogspot.com

Also see www.galvatech.co.za

"It only works when you don't need it!"

In this final article in this series, we cover some field studies of the use of galvanized reinforcement and report on the economics and typical applications of galvanized reinforcement across the world.

Field studies of galvanized reinforcement

In addition to extensive laboratory data, evidence from field applications has clearly demonstrated that galvanizing extends the life of reinforcement in concrete and provides a safe-guard against premature cracking and rust staining of the concrete. As previously noted, the corrosion protection afforded by galvanizing is due to a combination of beneficial effects. Of primary importance is the substantially higher chloride threshold for zinc coated steel in concrete compared to conventional (black) steel. In addition, galvanized reinforcement is resistant to the effects of carbonation of the concrete mass.

The net effect of the presence of the zinc coating is that it not only delays the initiation of the corrosion process, but it continues to provide barrier protection during that period when the coating is reacting (i.e. dissolving) but remains intact. Even when the coating is breached, the zinc sacrificially protects the steel thereby further extending the life of the reinforcement.

Considerable research has been done in the USA in particular to investigate the use of galvanized reinforcement for concrete bridge and highway construction exposed to high levels of accumulated chlorides due to the application of deicing salts or in marine exposure. In bridge decks for example, where both top and bottom bar mats were galvanized, very low corrosion current densities resulted compared to black steel, and the extent of corrosion on the galvanized bars was significantly less. It has also been shown that when galvanized bars were used in the top mat only, though some corrosion of the zinc occurred there was very much less corrosion compared to black bars in equivalent conditions.

Other data from both bridge decks and marine exposure has also verified the enhanced field performance of galvanized reinforcement. Surveys of many structures at different ages and with varying concrete quality and chloride levels have consistently revealed that galvanized steel outperforms black steel where meaningful corrosion comparisons were able to be made.

For example, bridge deck surveys in 1991 and again in 2002 found that after periods of up to 24 years exposure, galvanized bars had suffered only superficial corrosion in sound, uncracked concrete even when the chloride levels were several times higher than ACI levels for corrosion of black steel. Further, the thickness of the zinc remaining on the surface was still well in excess of that required by ASTM A767 for new material.

The overall results from these bridge surveys confirmed the satisfactory performance of galvanized reinforcement after long-term exposure to both calcium chloride used as an admixture at the time of casting and roadway de-icing salts. The report concluded that the galvanized reinforcing bars generally showed satisfactory resistance to

The Royal Bermuda Yacht Club (1968) with galvanized rebar, and still in excellent condition.

The new Watford Bridge (1979) reinforced with galvanized rebar.

Figure 1: The Bermuda case study.

corrosion and visual inspection revealed no significant signs of corrosion on any of the reinforcement. Further, cracking, delamination and spalling or evidence of active corrosion was not generally observed.

Similar data from Bermuda has also verified the long-term durability of galvanized reinforced concrete in marine environments. Commencing shortly after WW2, a number of docks, jetties and other infrastructure were constructed using a mix of galvanized and bare steel bars (*see Figure* 1). A survey undertaken in 1991 showed that the galvanizing was providing continuing corrosion protection to reinforcement at chloride levels well in excess of threshold levels for bare steel corrosion.

Follow-up examination confirmed these findings and revealed that the galvanized bars maintained a residual zinc coating thickness at a structure age of 42+ years well in excess of the minimum requirement. Examination of concrete cores from these structures confirmed the previously mentioned observations that the zinc corrosion products had

continued on page 38...

migrated a considerable distance (300-500 microns) beyond the surface of the coating and into the adjacent concrete matrix with no visible effect on the concrete mass.

Studies such as these clearly indicate that galvanized bar, when properly used as the exclusive reinforcing material, can provide enhanced corrosion protection compared to black steel in equivalent concrete and exposure conditions. What is clear is that in good quality concrete that is well compacted, cured and of adequate cover, galvanized bar survives for extended periods of time and offers a cost-effective method of corrosion protection. In poor quality concrete however, particularly those with high w/c ratio and low cover to the reinforcement, galvanizing will delay the onset of chloride induced corrosion of the reinforcement, but this may be of limited benefit.

Deepwater ocean outfalls, Australia.

Coal storage bunker, Australia.

Outfall pipes, Singapore.

Waste treatment facility, Bermuda.

Figure 2: Galvanized reinforcement concrete in general construction.

Economics of galvanized reinforcement

When the costs and consequences of corrosion damage to a reinforced concrete building are analysed, the extra cost of galvanizing is seen as a small investment in corrosion protection. While the initial cost of galvanizing may add up to 50% to the cost of the reinforcement, depending on the country of origin and the availability and access to galvanizing plants within the country, the cost of using galvanized reinforcement as a percentage of total building cost is always significantly less than this. The overall cost depends, of course, on the nature and location of construction and the extent to which galvanized bar is used throughout the structure. For example, it is rarely necessary for the structural core or internal elements of large reinforced concrete structures such as high rise building, or the deeply embedded components of large abutments and foundations, to be galvanized.

General cost analysis for building construction reveals that the galvanizing of reinforcement increases the overall cost of reinforced concrete as-placed by about 6-10%. The actual value will vary depending on many factors including the type of bar and the galvanizing price, the amount of steel used per cubic meter of concrete poured, and the unit cost of the concrete mass. The concrete price is made up of several main components including the supply of the concrete, the formwork and steel supply and fixing costs. On average, the cost of the steel would not be more than about 25% of the total cost of the concrete as placed. Considering also that it is rarely necessary to galvanize all steel in the structure, and that the cost of the structural frame and skin of a building normally represents only about

25-30% of total building costs, the additional cost of galvanizing reduces to between 1.5-3.0% of total building cost. However, by galvanizing only certain vulnerable or critical elements, e.g. surface panels, the additional cost of galvanizing reduces further still, perhaps to as little as 0.5-1.0%.

These percentages, of course, relate only to total construction costs and when taken against total project costs or final selling prices the added cost of galvanizing becomes very small indeed, often less that 0.2%. This represents a very small fraction of the cost of repairs should unprotected reinforcement corrode. Similar costing analysis has been reported on a number of occasions.

Applications of galvanized reinforcement

Galvanized steel bar and other fittings including bolts, ties, anchors, dowel bars and piping, have been widely used in a variety of reinforced concrete structures and elements. The rationale for this is based on the philosophy that the coating provides a safeguard against early or unexpected corrosion of the reinforcement. Should such damage occur costly repair and remediation of the structure may be necessitated in order to realise the full design life of the structure. This represents an ever-increasing economic burden and the redirection of scarce resources.

Particular circumstances where the galvanizing of reinforcement is likely to be a cost-effective and sound engineering decision include:

- light-weight precast cladding elements and architectural building features;
- surface exposed beams and columns and exposed slabs;
- prefabricated building units such as kitchen and bathroom modules and tilt-up construction;
- immersed or buried elements subject to ground water effects and tidal fluctuations;
- coastal and marine structures;
- transport infrastructure including bridge decks, roads and crash barriers; and
- high risk structures in aggressive environments.

Many examples exist around the world where galvanized reinforcement has been successfully used in a variety of types of reinforced concrete buildings, structures and general construction. Some prominent, world-wide examples are shown in *Figures* 2-5.

Finally, it is noteworthy that in the State of the Art Report on Coating Protection for Reinforcement (Comite Euro-International du Beton, 1992) the

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Sydney Opera House sails.

National Theatre, London.

New Zealand Parliament, Wellington.

Empire City, Albany, NY.

Figure 3: Galvanized reinforcement concrete in buildings.

benefits from the practical use of galvanized reinforcement were listed as follows:

- proper galvanizing procedures have no significant effect on the mechanical properties of the steel reinforcement;
- zinc coating furnishes local cathodic protection to the steel, as long as the coating has not been consumed;
- galvanized reinforcement provides protection to the steel during storage and construction prior to placing the concrete;
- corrosion of galvanized steel in concrete is less intense and less extensive for a substantial period of time than that of black steel;
- galvanized steel in concrete tolerates higher chloride concentration than black steel before corrosion starts;
- galvanized reinforcement delays the onset of cracking, and spalling of concrete is less likely to occur or is delayed;
- the concrete can be used in more aggressive environments, and so a standard design of concrete components can be retained for various exposure conditions by the use of galvanized steel in the most aggressive cases;
- lightweight and porous concretes can be used with the same cover as for normal concretes;
- poor workmanship resulting in variable concrete quality (poor compaction, high water/cement ratio), can easily be tolerated;
- accidentally reduced cover is less dangerous than with black steel;
- unexpected continuous contact between concrete and trapped water can be tolerated;
- repair of damaged structures can be delayed longer than with black steel;
- galvanized hardware is acceptable at the surface of the concrete, as it is for the joints between precast panels;
- the use of galvanized reinforcement ensures a clean appearance of the finished concrete with no trouble arising at cracks either from spalling or rust staining; and
- galvanized reinforcement is cleaner and easier to work with, and makes it possible to consider the use of thinner wires as welded fabrics.

Safety barrier, Europe.

Figure 4: Galvanized reinforcement concrete in bridges and highways.

The report goes on to say that "it is important to remember that even if these benefits are achieved, the use of galvanized reinforcement should not be considered as an alternative to the provisions of adequate cover of dense, impermeable concrete, unless special design criteria have to be met. Galvanizing of reinforcement is a complementary measure of corrosion protection – a kind of insurance against the inability of the concrete to isolate and protect the steel."

Concluding comments

Over a very long period of time (in fact about 60 years), the galvanizing of steel reinforcement has been shown to provide a cost-effective and reliable means of corrosion protection to concrete in a variety of exposure conditions. Clearly, galvanizing is only one of a number of protection systems that can be used in reinforced concrete. However, the convenience of manufacture and supply of the product, the ease of handling, transportation and installation, and the fact that no special design requirements are needed, has meant that it has been accepted in many countries for a wide range of concrete construction.

As with all corrosion protection systems, there is a cost associated with galvanizing. However, when that cost is balanced against total construction costs, and the enormous potential costs associated with untimely repair of damaged concrete, the premium that is paid to galvanize reinforcement is very small indeed. Even if one cycle of local patch repairs over a large concrete structure can be avoided, the cost of the galvanizing would have been more than met. Primarily though, the reason for using any corrosion protection system is to extend the service life of the structure. Experience with galvanizing has shown this can be readily achieved in many types of reinforced concrete structures and elements in mild, moderate and severe exposure conditions.

Above all however, it is important to remember that when using galvanized reinforcement (as with any protection system for concrete), that the concrete is properly designed and placed and is appropriate for the type of element and the exposure conditions. Unless specific design requirements apply, such as reduced cover or ultra light-weight construction, the concrete should be designed and placed as though conventional steel reinforcement was to be used. In essence, the use of galvanizing should not be at the expense of this basic quality and integrity of the concrete. In this way, the galvanizing can be considered to provide protection against those circumstances that may lead to premature corrosion of conventional reinforcement and deterioration of the concrete mass.

Further reading

- American Galvanizers Association, Field Handling Guide: Hot-Dip Galvanizing versus Fusion Bonded Epoxy, 2000.
- American Galvanizing Association, A guide to specifying and inspecting hot-dip galvanized reinforcing steel, 2004.
- Bentur N, Diamond S and Berke NS, *Steel Corrosion in Concrete*, E & FN Spon, Chapman and Hall, London, 1997.
- Broomfield JP, *Corrosion of Steel in Concrete*, E & FN Spon, Chapman and Hall, London, 1997.
- Concrete Institute of Australia, The Use of Galvanized Reinforcement in Concrete, Current Practice Note 17, 2008.
- Committee Euro-International du Beton, Coating Protection for Reinforcement: State of the Art Report, Thomas Telford Services Ltd, 1995.
- Galvanizers Association of Australia, After-fabrication hot dip galvanizing, Guide to AS/NZS 4680.
- Yeomans SR (Editor), *Galvanized Reinforcing Steel in Concrete*, Elsevier UK, December 2004, ISBN 008044511X, 320pp.

Professor Stephen R Yeomans, Senior Visiting Fellow, University of New South Wales, Canberra, Australia.

The Association wishes to thank Stephen for his support in providing us with this interesting series of articles.

Retrofitting Cantilever Balconies

Cape Town based Conspec Consulting Engineers, Rod Holmes says that despite the economic downturn they have still done some challenging and interesting jobs using hot dip galvanized steel. "Since most of our work is near the sea we use hot dip galvanized steel for all external steel structures". One of these projects is described below.

The client wanted to add cantilever balconies to an existing house near the sea. The stepped footprint provided the opportunity to have double cantilevers at the corners thus allowing a column free design. A bolt on steel frame supporting a cast in-situ deck was used.

Some of the design considerations for using hot dip galvanized steel were as follows:

1. To design mutually perpendicular bolted cantilever connections would have been ugly and expensive. A shop welded connection was used but the fabricated piece had to be transportable and man handleable. Fortunately the dimensions of the house allowed this.

   The steel members were all open sections and the sizes were large enough to ensure no warping occurred during dipping.

   The existing structure was a reinforced concrete beam following the stepped façade which was suitable for bolting into.
2. The steel frame is secured with epoxy fixed anchors which are in shear. The bolt holes were close tolerance as a small slippage could lead to an exaggerated deflection. If rebar was struck during drilling it would not have been possible to move the bolts. We therefore specified that all the bolt holes must be cored with a diamond core bit.
3. There is a purpose bent steel channel to support a glass balustrade fixed onto the main steel frame. Initially this was specified as welded but due to the risk of possible warping during dipping this was changed to bolt-on using countersunk bolts.

No cutting or modifications to the steel was required and the hot dip galvanized finish would have been suitable for a long service life (the site is approximately 2kms from the sea) however the client chose to paint the steel mainly for aesthetic reasons.

Co-operation with conflict may be better than competition

The *Prisoners Dilemma* is a game that economists and social scientists play to measure the benefits of co-operation. When played by two people, the idea is that each will benefit if both of them co-operate. If one co-operates and the other doesn't, the one co-operating will lose and the one who doesn't will gain. If neither co-operates, each will lose.

The game got its name from the following hypothetical situation: imagine two criminals arrested under the suspicion of having committed a crime together. The police, however, do not have enough evidence to convict them outright. The two prisoners are questioned separately and offered the same deal: if each confesses and implicates the other (neither co-operates with each other), both will go to prison for 10 years. If neither confesses (both co-operate), each will serve 1 year for carrying a concealed weapon. If one confesses and the other doesn't, the one who confesses (doesn't co-operate) will go free while the other (co-operates) will go to prison for the maximum 20 year sentence.

Several points are raised: co-operation produces synergy; there is always a temptation not to co-operate and an incentive is required for co-operation.

For co-operation, people must believe that their goals are linked. As one person moves toward attainment of his or her goal, the others must also move toward reaching their goals. They must understand that others' goal attainment helps them: they must all be successful together. Striving to reach an individual goal is competition. In simple terms, competition is the opposite of co-operation.

In competition, people's goals are not linked. One person's successful goal

attainment often makes others less likely to reach their goals. In a work group, members often feel competitive when they want to appear to the manager as the most effective and innovative member of the team. These people conclude that they are better off when others act ineffectively. The believe that they are less likely to succeed when others are more productive. They are often frustrated when someone else proposes a creative solution since they believe they will be less likely to reach their goal. The competitive environment does not produce synergy and can undermine relationships and effective work.

Competition is a zero-sum situation: what one person gains the other loses – the sum is zero.

Although we live in a competitive world, managers are slowly realising that co-operation produces the maximum benefit. But how does one achieve co-operation in a competitive world?

The critical factor is having the same goal or vision. Does this mean that everybody has to be the same? Certainly not. Co-operation thrives on diversity, provided there is interdependence. Open-minded, controversial discussion – constructive controversy – so that people can combine and integrate their ideas is needed. Opposing views are required to produce a co-operative situation and to enhance relationships.

Will conflict damage co-operation? No, it does not have to. Conflict is not the opposite of co-operation: it can assist in realising the benefits of working co-operatively.

Individuals must be able to develop and express their own ideas. As they present their perspectives on an issue or problem to others, they can deepen their understanding and widen their experience. As they question and understand the viewpoints of others, they see how their ideas can be built on. This is the foundation for innovation. Co-operative and not competitive goals, will induce the willingness to incorporate opposing views and reach agreement.

Co-operation has to be nurtured. Encouraging co-operative language, listening and thinking can do this. The "Six Hat Thinking" of de Bono is co-operative thinking: individual ideas are catered for in a climate of different co-operative settings. Aggressive disregard of ideas of others is competitive not co-operative.

Our country, our businesses and our people need to be more co-operative and less competitive. We need to have more co-operative goals and work at them in a co-operative manner. We must not get bogged down in conflicts but use them to enhance co-operation.

The Association wishes to thank Bob Andrew who is a consulting value engineer and honourary member of the Association for his article. He can be contacted on anneve@iafrica.com or boband@mweb.co.za.

The case for duplex coating 'systems' must continue

The ultimate challenge for the corrosion control industry!

I read with great interest Pieter Uys' letter "***The case for duplex coating on a hot dip galvanized substrate in an aggressive* (C5) *environment***", published in our *Hot Dip Galvanizing Today* 2010 *Volume* 7 *Issue* 4.

I believe it is abundantly clear from Pieter's letter, that it is based on a depth of practical knowledge and years of experience. His position is completely understandable when he indicates that he *"will definitely not promote the undeniable potential benefits of Duplex Systems to unsuspecting customers"*.

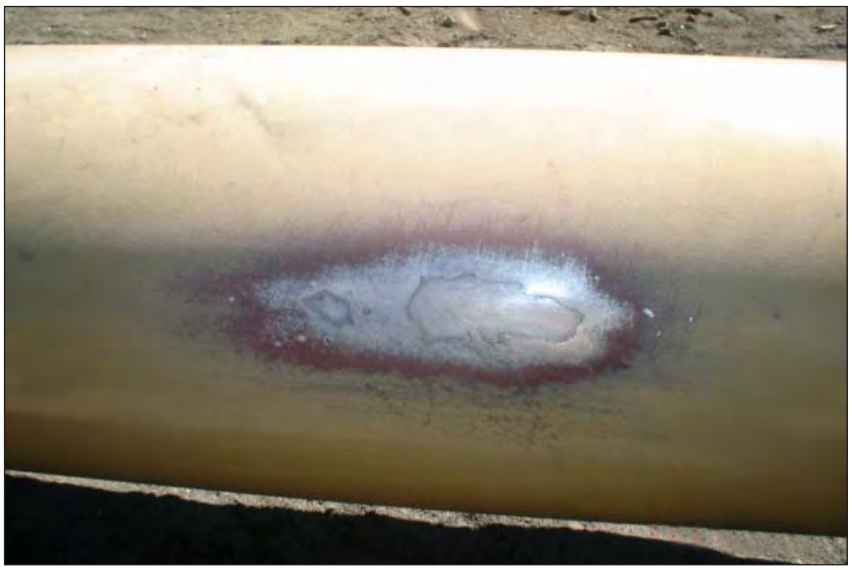
From extensive research and publications, (*refer Sir* J.F.H *van Eijnsbergen "Duplex Systems"*), and including numerous site applications, duplex systems are most effective and do perform in severe corrosive environments. Numerous case studies support these findings, but alas Pieter's reference to failures is all too factual and to the point that engineers shy away from the process.

If duplex systems are so effective, what is the problem?

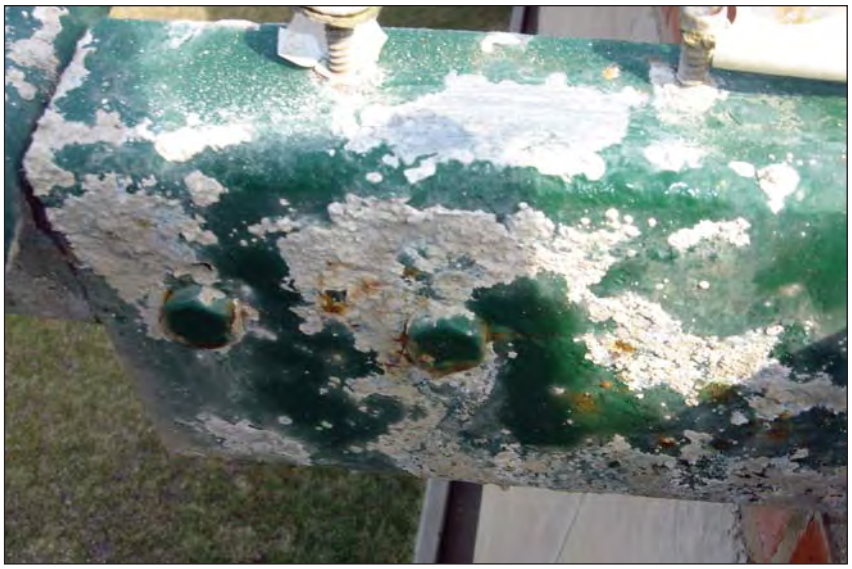
The apparent concept that the paint and hot dip galvanizing industries are engaged in some kind of cold war should be abolished once and for all. Adopt and entrench our slogan of "we fight the common corrosion enemy". It is a fact that efforts continue to be made for our two industries to unite in ***our*** war on corrosion.

In an attempt to address the above question (what is the problem?), we turn to a review of our own field

continued on page 44...



Delamination of the galvanizing due to shot blasting, usually results in complaints that the galvanizing was inadequate.



The above two photos show premature coating failures due to incorrect paint used and/or inadequate dry film thickness.

experiences and arrive at the following summary.

1. Duplex (hot dip galvanizing plus paint) should not be seen or referred to as a coating, but rather as a system. This concept should hopefully indicate that we are not just dealing with any type of paint on top of galvanizing. Hot dip galvanizing plus any type of top paint coating will fail and give duplex systems bad press. The concept of a Duplex system should indicate that there is a specification including quality controls, appropriate preparation of the zinc surface to accept mechanically bonded paint, and normally two, three or even four specific types of paint coatings. The total system is designed and specified to meet specific environmental conditions with a service life performance being the objective.

2. As with any coating system, surface preparation is of paramount importance. In hot dip galvanizing, if the steel is not clean it will not galvanize. We can extend this slogan to duplex systems as, "if the galvanized (zinc) surface is not prepared correctly, the paint will not bond".

   Duplex failure investigations have shown that galvanized surface preparations represent a major source of premature failures. No distinction or understanding is made or appreciated between the processes of "shot blasting" at a blast pressure of 700kPa, for paint onto raw steel, versus "sweep blasting" at a maximum blast pressure of 250 to 300kPa, for paint onto hot dip galvanizing.

3. Paint dry film thickness (DFT) is usually totally inadequate as a barrier protection. The type and number of top paint coatings are specified in terms of design with the same quality control checks as if the paint is to be applied to shot blasted steel. NB. Galvanized surfaces are sweep blasted, not shot blasted.

4. There are many excellent paint

Paint coating delaminating due to little or no zinc surface preparation necessary to accept the mechanically bonded paint coating

manufacturers with great research facilities, all capable of supplying top grade paints, designed to meet the specific applications. In many instances, failures are unrelated to the paint, but can be placed at the door of the applicator, including specified and appropriate zinc surface preparation and the controlled application of the specified paint coatings.

Going back to 1990, representatives of both the paint and hot dip galvanizing practitioners recognised the need to address the problems relating to duplex coating failures. In the interests of overcoming the negative publicity relating to corrosion control systems, a work group was formed and tasked with developing a Code of Practice to govern and provide a standard for the application of a duplex coating system. This **Code of Practice for Surface Preparation and Application of Organic Coatings** is published on our Associations web site as **HDGASA 01: 1990.**

I can certainly understand Pieter Uys' position, but as they say in the classics (I think), there are no free rides. If you do not comply with the specification "rules" do not complain when failures result.

Bob Wilmot.

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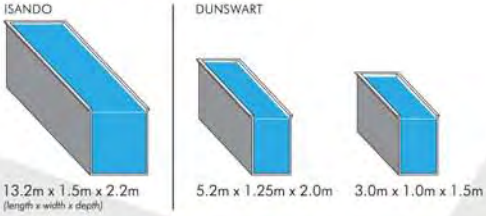

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