2005 Volume 2 Issue 4

HOT DIP GALVANIZING TODAY

HOT DIP GALVANIZERS ASSOCIATION Southern Africa

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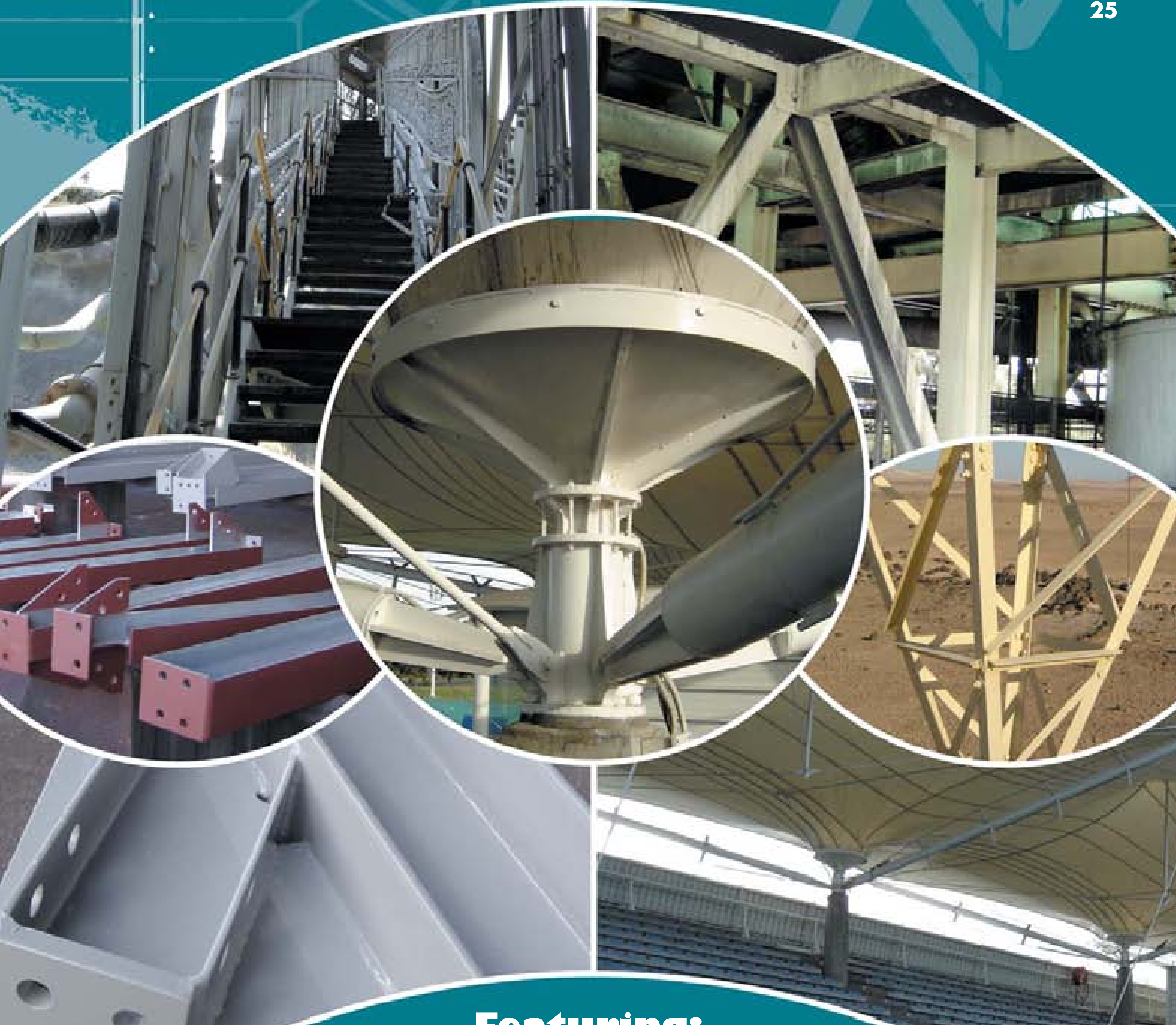

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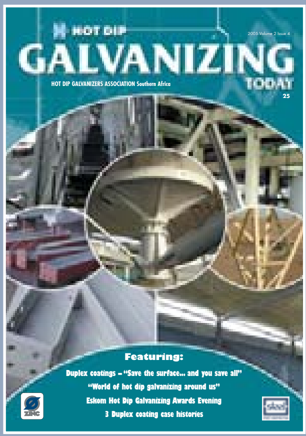

The Association is a technical information centre established for the benefit of specifiers, consultants, end users and its members

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Front Cover: *A kaleidoscope of various duplex coating photographs*

Hot Dip Galvanizing – Adding value to Steel

Executive Director's Comment

As we approach the end of 2005, I thought that a brief review of the past year would be beneficial. A review of the past would be incomplete without some thoughts on where we plan to go in the future.

2005 witnessed a small reduction in the amount of zinc consumed by our members. However, as we enter 2006 we are optimistic that the use of hot dip galvanizing and duplex coating systems are certainly positive and increased zinc consumption is already showing an upward trend.

During 2005, we at the Association, devoted considerable time, effort and facilities to activities, such as our inspector's courses, technical presentations to a wide range of authorities, audiences including universities and training institutions. We have worked on the improvement to our web site, continued development and expansion of our database primarily for the distribution of our technical magazine, publication of data sheets and case studies involving the application of appropriate use of hot dip galvanizing and duplex systems for corrosion protection for a wide range of environmental conditions.

Plans for 2006 include a continuation of these activities, but the subjects of environmental, health and plant safety, together with skills development will become a prominent feature of our coming years activities.

Compliance with statutory environmental requirements is forecast to play an ever-increasing role within our industry. Plans are in place to lead the way and to be pro-active in the implementation of waste management, air emissions and plant health and safety requirements.

Our skills development and plant training activities are being implemented. Through our participation within a MERSETA working group, we have developed and submitted training qualifications for our industry. This follows on a period of some three years during which time was devoted to the process. This particular programme is aimed at product quality and service improvements, health and safety within the plants and surrounding environments through the education and training of people involved in all facets of our industry.

As 2005 draws to a close, the Association staff extend their best wishes to our valued readers and participants to our magazine. May you all be blessed for the festive season and prosperity throughout 2006.

Bob Wilmot

Note from the Editor

Although in many instances throughout southern Africa, a single metallurgically bonded metallic coating such as hot dip galvanizing will suffice and provide many years of maintenance free life to the owners of the structure or component, there are instances where for an aesthetic appeal, a colour is required and other instances where hot dip galvanizing on its own is insufficient for long term service free life, due to the corrosive conditions at hand.

As a guideline rule, from an atmospheric corrosion perspective, generally within the first kilometre of the sea where due to wind driven chlorides off high wave action, high humidity, lack of rain wash off affect, etc. hot dip galvanizing on its own may not be able to provide the long term protective life that the coating is well known for.

There are a few exceptions to this rule, see Walter's Corner in the next issue.

Heavy industrial areas where airborne sulphurous fumes are present may also be corrosive to hot dip galvanizing on its own but with the stringent recently introduced environmental laws taking effect, airborne pollution, will in future be limited to designated areas and hence the use of hot dip galvanizing in the general areas may be expanded, as a result.

In aggressive marine and heavy pollution circumstances the added protection of a properly applied and appropriate paint system (Duplex Coating) to the correct dry film thickness, will synergistically extend the sum of the individual lives of the coatings, by upwards of 50%.

The main feature in the magazine includes the history of Duplex Coatings, including the originator Sir Jan van Eijnsbergen an eminent corrosion consultant and paint technologist who introduced the concept in the early fifties; we have a number of interesting articles compiled by authorities from the field of painting and powder coating.

Furthermore, several Duplex Coating case histories have been documented, proving their sustainability over at least 10 years of service free life.

The magazine also includes a pictorial feature on, "The World of Hot Dip Galvanizing Around Us". These interesting contributions have been sent with thanks from our sister organisations in Australia, Spain and the United States.

Our ***Guest Writer*** discusses "The reciprocal nature of language", whereas ***Miss Conception*** addresses "Adhesion of duplex coatings". In ***Walter's Corner***, Walter addresses the finer aspects of a duplex coating.

We are pleased to introduce to you our personality profile, Darelle Janse van Rensburg, who is a practising corrosion consultant known for her practical coating experience gleaned during her extensive tenure at Eskom.

In conjunction with the IZASA we are planning a conference in February 2006, in Johannesburg, incorporating international and local speakers on various aspects of hot dip galvanizing, see loose insert. Following this conference, we kick off with a road show to highlight the advantages of making use of hot dip galvanized reinforcement for concrete.

Finally, we at the Association wish to thank our supporters of "Hot Dip Galvanizing Today", without whom the magazine would not be where it is today and take this opportunity to wish all readers a joyful festive season and a Prosperous 2006. Take it easy on the roads.

Terry Smith

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"Save the surface... and you save all"

These are the words Sir Jan van Eijnsbergen, used in his first book on metal coatings published in 1939. Jan, an eminent corrosion consultant, discovered in the early fifties that the combination of a metallic and a paint coating provided a definite synergistic effect. Jan produced a book, "Duplex Systems" in 1994, which addressed most aspects of the concept. Since the early fifties, Duplex systems worldwide have developed considerably and are now an acceptable method of controlling the costly ravages of corrosion.

Duplex systems on a steel surface are generally defined as combinations of a metallic coating (zinc, zinc-aluminium or zinc-iron alloys), followed by one or more coats of paints or powder coatings. The metallic layer is applied by hot dipping, whereas the following coatings are applied by spraying, brushing, roller, or fluidized bed processes. Such combinations of metallic and inorganic coatings have proved to offer optimum corrosion resistant properties during exposure to the atmosphere.

The 5 basic functions of a duplex system are:

1. Increased durability: By covering the reactive zinc surface exposed to aggressive climates, such as industrial, marine or urban combinations, the speed of corrosion of the zinc surface is drastically reduced because oxidation, attack by moisture and contamination by sulphur compounds, nitrogen oxides or ammonia, are prevented by the organic coating or coating system. The combination of a zinc coating alloyed to the steel plus an organic coating possesses a synergistic effect, i.e. the protective value of the duplex system is higher than the sum of the protective values of the zinc and paint coatings separately.

2. Improvement of the aesthetic appearance: The original silvery zinc coating becomes greyish on weathering and differences in colour occur because of the differences in local oxidation and hydrolysis of the coating. Although differences in appearance are fairly unimportant on utility structures, there is a growing tendency to combine optimum corrosion resistance with a pleasing appearance

3. Contrasting colours: In many cases, objects are required to have contrasting colours in order to enhance visibility and distinction.

4. Camouflaging: It is often necessary to camouflage objects such as transmission towers, light poles and military installations to make them appear less obvious. In such cases, paint matching the surroundings of the object or special camouflage paints are applied.

5. Prolonged periods of protection: when objects require a very long duration of protection, because their surfaces are inaccessible or interruption of plant processes or contamination of goods and products are inadmissible, duplex coatings are used. If at the end of a long period of protection, reconditioning has to take place, absence of rust permits safe and cost-effective reconditioning.

Reliability

Reliability of a coating is generally defined as a function of the total sum of observed failures and is usually expressed as

R=100/*Sum of Failures*

Duplex systems have been shown to have a relatively high reliability factor when compared with paint systems applied on blasted or hand-brushed steel surfaces and with hot dip galvanizing. A comparison of the reliability factor for various systems is given in table 1.

Coating System	Reliability Factor
Hot dip galvanizing	1.0 – 1.2
Zinc-rich primer on Sa $2^1/_2$ blasted steel surface	0.4 – 0.6
Classical paint system (4 coats) on manually derusted steel	0.2 – 0.3
Duplex system (hot dip galvanized steel plus primer and topcoat)	2.2 – 2.4
***Reference:** Duplex Systems, JFH van Eijnsbergen, Elsevier – 1994.*	

Table 1.

Duplex systems – a view from the Hot Dip Galvanizers Association Southern Africa

by Bob Wilmot, HDGASA

Introduction

It has been estimated that corrosion of steel components and structures cost South Africa approximately R4.5 to R5 billion per year. This figure represents some 5.2% of our annual GDP. It is therefore clear that corrosion protection systems, no matter in what form they come, have the potential of saving the country substantial amounts of money. It also follows that the design and selection of suitable systems will likewise lead to cost savings. It is unwise to develop and base projects on initial costs without taking into account the long-term maintenance requirements and associated costs. It is likewise also necessary to match corrosion designs to service life, or in other words avoid both under and over designing in terms of the corrosion protection. There are many and varied corrosion protection systems available to the engineer or project developer. It requires experience and a basic understanding of corrosion science in order to ensure the selection of the most cost effective system to suit the project. This should include "value analysis" and life time costs involved in the protection of ones investment.

Duplex coatings

This paper sets out to consider a specific type of corrosion protection system, which is referred to as a Duplex system. The dictionary describes a duplex system as consisting of two elements or a "twofold" composition. The duplex system described in this paper is such a two-part corrosion protection coating, viz, hot dip galvanizing as the firm base or primer, followed by a selection of (1 to 3 or 4) top paint coatings to suit environmental conditions. In principle, the duplex system is designed as a cost effective and balanced, designed coating, considering environmental conditions and service life requirements.

Fundamentals of the duplex system

Briefly reviewing fundamentals that constitute the individual coatings, i.e. hot dip galvanizing and paint, of a duplex system, we will highlight the benefits that such component parts play within the corrosion protection coating.

Fundamentals of a paint coating

Preparation paramount to success

In order to achieve a quality corrosion protection system, the surface preparation of the steel to be protected, no matter which system is to be used, is of paramount importance to the success and long-term performance of the coating. A good protective paint system is as dependent on this requirement as that of any other system. Too often this aspect is overlooked resulting in less than adequate results. Generally the accepted cleaning method for a good paint system is the use of "abrasive blasting" to a specification of SA2½. The cleaning process is required to remove mill scale and products of corrosion such as ferrous oxide or

what is referred to as red rust. Failure to carry out this vital cleaning operation will result in an inadequate paint coating and hence less than specification requirements.

Mechanical bonding

Paint relies on "mechanical bonding" or a process of the paint being "keyed" to the surface roughness of the steel being coated. Abrasive blasting aids this aspect in that the steel surface is roughened by the mechanical cleaning action of the shot impacting the steel. In addition, an etching primer is likewise employed, again in order to key the paint coating to the steel. Should the cleaning operation be inadequate, loose particles and/or contaminants remain, affecting the mechanical bonding.

Barrier protection

Corrosion protection of a paint system relies on a "neutral barrier" being introduced between the steel that is to be protected, and the corrosive environment. Thick coatings, coupled with permeability, uniformity and continuity of the paint system, i.e. "barrier protection" achieve greater corrosion protection. Paint coatings are generally reliant on "barrier protection" as the first and only "Line of Defence" against a corrosive environment. Once this barrier protection is breached (through coating damage or porosity), corrosion of the underlying steel can commence resulting in corrosion creep, blistering and ultimately spoiling off of the paint.

Limited Cathodic Protection (CP)

Limited cathodic protection within a paint system is dependent on the mixing in of an "electro-negative to steel" metallic powder, such as aluminium or zinc, to form part of the paint matrix. Specifications call for up to 90% metallic particles in the dry film thickness (DFT) of a paint coating in order to claim any form of cathodic protection. CP in paint remains questionable, due in the main to the make-up of the final composition of the coating.

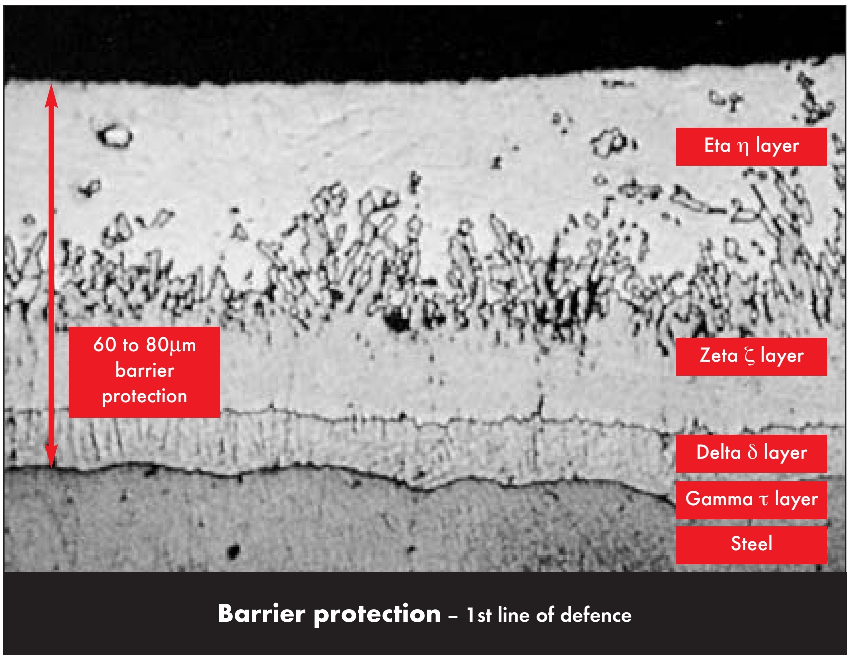


Figure 1: Micrograph (x 200 mag.) of a hot dip galvanized coating, illustrating the various zinc/iron layers and the metallurgical bonding that is formed between the coating and the steel.

No	Type of paint (vehicle basis)	a	b	c	d
1	Acrylic resin dispersions [1]	F-G	F-G	G	G
2	Acrylic/styrene resin dispersions [2]	G	G	G	VG
3	Acrylic/di-isocyanate (2-component) compositions	G	F	G	VG
4	Vinyl resin copolymer	F	F	G	G
5	Polyvinyl/acrylic resin combinations	G	G	G	VG
6	Polyvinyl resin dispersions [3]	F	F-G	G	F-G
7	Epoxy resin (2-component) [4]	G	G	G	VG
8	Epoxy ester [5]	P	F	G	G
9	Epoxy resin/coal tar combinations	P	F	F	G
10	Polyurethane resin (2-component) [6]	P	F	F-G	G

P = poor adhesion; F = fair (moderate) adhesion; G = good adhesion; VG = very good adhesion.

a = freshly hot-dip galvanized steel, within approximately 4 hours of galvanizing.

b = hot dip galvanized steel weathered for 1–3 months in a non-aggressive atmosphere.

c = hot dip galvanized steel, cold-etched or hot-phosphated.

d = hot dip galvanized steel sweep-blasted.

[1] Aqueous dispersion of acrylic resin.

[2] Aqueous dispersion of acrylic/styrene resin.

[3] Aqueous dispersion of polyvinyl resin.

[4] Epoxy resin with polyamide hardener.

[5] Epoxy resin, esterified with dehydrated castor oil.

[6] With an encapsulated di-isocyanate hardener.

***Reference:** Duplex Systems, JFH van Eijnsbergen, Elsevier – 1994.*

Table 2: Adhesion of air-drying paints to hot dip galvanized steel surfaces.

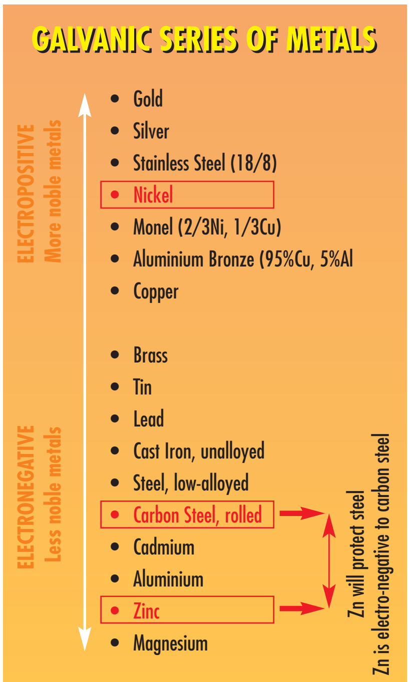


Table 3. Galvanic series of metals which shows zinc being electro-negative to steel and hence the zinc is the anode with steel being the cathode in a typical corrosion cell.

Typical paint systems

There is a large range and variety of paints, which start with single coat systems and move up in quality and cost to very effective and sophisticated systems. This paper reviews a "top paint system", comprising Inorganic Zinc + Epoxy + Polyurethane in comparison to the Duplex System.

Fundamentals of a hot dip galvanized coating

Preparation paramount to success

Again preparation is paramount to the success of the final corrosion protection coating. Preparation of steel, to be hot dip galvanized, is carried out in a factory controlled environment in which chemicals are the principal cleaning agents employed to ensure all surfaces are prepared for galvanizing. It is fundamental for the hot dip galvanizing, if the steel is not adequately cleaned it will not galvanize. We refer to hot dip galvanizing as an "honest coating" in that the cleaning operation, i.e. the pre-treatment preparation, if not carried out to a quality standard, the steel will not hot dip galvanize and uncoated areas will immediately be evident at the end of the process.

Chemical bonding (follows metallurgical laws)

Hot dip galvanized coatings are formed as a result of ***metallurgical laws***, i.e. the bond formed between the steel and the hot dip galvanized coating is described as a "chemical" bond, which is superior to that of mechanical bonds. A further benefit resulting from the metallurgical process is the formation of abrasion resistant iron zinc alloys. In addition, the zinc iron alloy layers provide an estimated 30% improvement in the atmospheric corrosion protection properties of the coating. (Reference Porter "Corrosion Resistance of Zinc and Zinc Alloys" page 62, ref No.2). Figure 1 is a micrograph illustrating the formation of the zinc/iron alloy layers that provide the bonding of the coating to the steel substrate.

Barrier protection (1st line of defence)

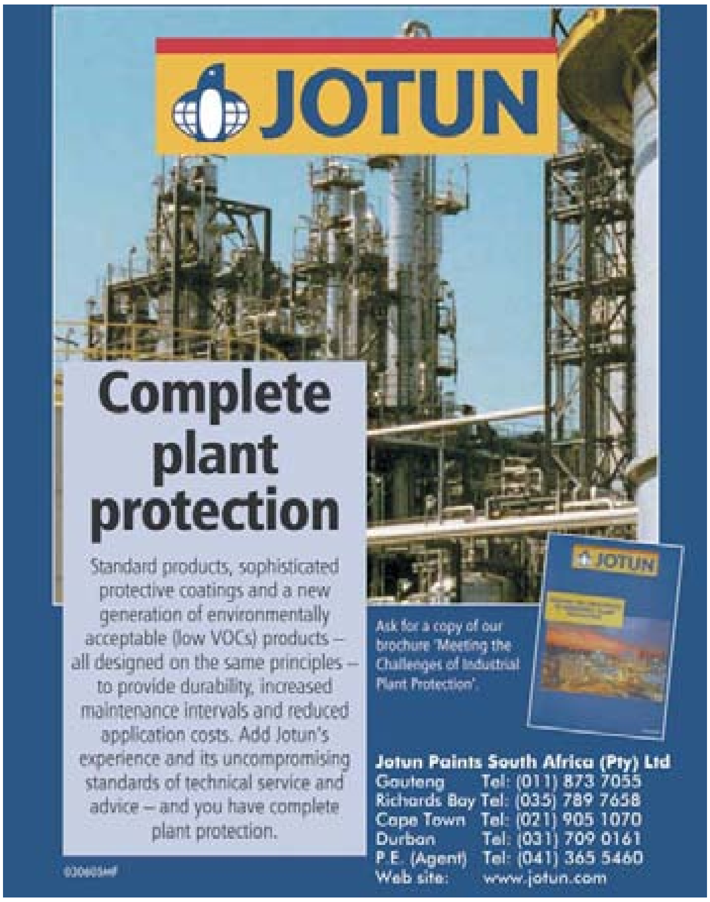
Similar to a paint system, hot dip galvanizing utilizes "barrier protection" as its first line of defence, i.e. it forms a barrier between the steel and the corrosive environment.

However, unlike a typical paint system, barrier protection is the 1st line of defence, followed by a 2nd line of defence, viz, Cathodic Protection (CP). It is important to understand and appreciate that the thicker the barrier protection the greater the corrosion protection that is provided.

Cathodic protection (2nd line of defence)

Two dissimilar metals in electrical contact with each other, within an electrolyte, an electrical current flows between them, referred to as a Bi-metallic couple. Current passes from the anode (zinc), which "sacrifices itself" to protect the cathode (steel) (see figure 2). This is known as cathodic protection of the cathode by the anode. In other words, we use physics of the corrosion cell (bimetallic couple), as a weapon to combat the onset of corrosion of the material that we use in our steel structures.

The corroding anode is electro-negative (zinc) to the cathode (steel). This phenomenon of physical laws allows



for the confident prediction as to which metals will be cathodic or anodic when placed in a corrosion cell or a "bi-metallic cell". Table 3 lists a selected number of these metals and is used to explain why zinc will "sacrifice" itself in order to protect carbon steel.

Self healing characteristics of zinc

Zinc corrodes forming three products of corrosion, viz, zinc oxide, zinc hydroxide, these being unstable and the third stable "barrier protection" of zinc carbonate. Should the hot dip galvanized coating be damaged so as to expose the underlying steel, cathodic protection of the zinc will sacrifice itself so protecting the exposed steel. In addition, the zinc products of corrosion tend to seal the exposed surface and so re-establish the barrier protection. This characteristic is used very effectively when we consider a duplex system, using paint in combination with hot dip galvanizing.

What is a duplex coating?

Having individually considered the fundamentals and characteristics of paint and hot dip galvanizing as corrosion protection systems, we can now evaluate the two systems acting in combination. We refer to such a system as a **Duplex** coating, i.e. hot dip galvanizing as the primer or firm base on which a suitable top paint coating or coatings can be added. The result, in terms of corrosion protection, is a **"synergistic"** effect. **Synergistic** is defined as the interaction or cooperation of two or more products, acting in unison to produce a new or enhanced effect compared to their separate effects.

How does a duplex system work?

When hot dip galvanizing (zinc and zinc/iron alloys) is used as the primer or "firm base" on which to apply the top paint coating/s, we use the adhesion characteristics of hot dip galvanizing and its metallurgical bonding to steel. In addition, should the top paint coating/s be damaged or, with time, become porous, the zinc

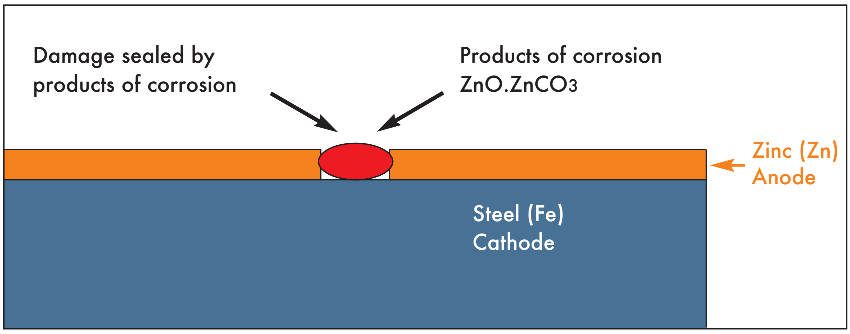


Figure 2: Protection of steel by zinc in the case of hot dip galvanizing – cathodic protection 2nd line of defence.

1	2	3	4	5	6	7
				MAINTENANCE FREE LIFE OF THE COATING		
Corrosion category	Description of environment	Corrosion rate (av. loss of steel in µm/yr.)	Corrosion rate (ave. loss of zinc in µm/yr.)	Continuously hot dip galvanized sheeting Coating class – Z275 (±20µm)	Hot dip galvanized coating (85µm) Steel thickness ≥ 6mm	DUPLEX COATING SYSTEM Hot dip galvanizing + an appropriate paint system
C1	Interior: dry	≤ 1.3	≤ 0.1	>50	>50 #1	Not required for corrosion protection #2
C2	Interior: occasional condensation Exterior: exposed rural inland	> 1.3 to 25	0.1 to 0.7	>40	>50 #1	Not required for corrosion protection #2
C3	Interior: high humidity, some air pollution Exterior: urban inland or mild coastal	> 25 to 50	0.7 to 2.1	10 to 40	>40	Not required for corrosion protection #2
C4	Interior: swimming pools, chemical plant, etc. Exterior: industrial inland or urban coastal	>50 to 80	21 to 4.2	5 to 10	20 to 40	Coating life in columns 5 & 6, plus the paint life multiplied by a factor of at least 50%
C5-I or C5-M	Exterior: industrial with high humidity or high salinity coastal	>80 to 200	4,2 to 8,4	2 to 5	10 to 20	Coating life in columns 5 & 6, plus the paint life multiplied by a factor of at least 50%

#1 Although mathematically incorrect (coating thickness divided by the corrosion rate), the maintenance free life indicated in column 6 has for practical purposes been curtailed to a maximum of 50 years.

General hot dip galvanizing specifications state the local (minimum) and the mean coating thicknesses. The coating thickness actually achieved, varies with the steel composition and this can range from the minimum to at least 50% greater.

As life expectancy predictions are normally based on the minimum coating thickness, they are usually conservative.

#2 A duplex system may also be specified in order to provide a colour for aesthetic reasons.

Note 1: The specification does not stipulate a maximum upper coating thickness limitation, however, excessively thick coatings on threaded articles are undesirable. In order to ensure effective tensioning, the coating thickness on the bolt should not exceed a maximum of 65µm, this applies particularly to high strength bolts. See note 2.

Note 2: The coating thickness referred to in the Association's booklet, "Steel Protection by Hot Dip Galvanizing and Duplex Systems" in chapter 10 page 33 states this maximum to be 90µm. This is incorrect and should be amended to read 65µm.

Where the service life of the coating is based on the coating thickness on the structure, all hot dip galvanized fasteners should be over coated with an appropriate paint system (duplex coating) in order to derive a similar life to that of the structure.

Note 3: The loss values used for the corrosivity categories are identical to those of ISO 12944 part 2 and SANS 14713 (ISO 14713).

Note 4: In coastal areas in hot humid zones, the coating thickness loss can exceed the limits of category C5-M. Special precautions must therefore be taken when selecting a protective coating system for steel structures in such areas.

Table 4: Atmospheric corrosivity categories and examples of typical environments taken from ISO 9223.

products of corrosion will tend to seal such porosity in the top paint coating and thereby re-establish the barrier protection. In effect this provides the corrosion protection system with a 3rd line of defence against the corrosive environment.

Where paint is applied direct onto the steel and the barrier protection (1st

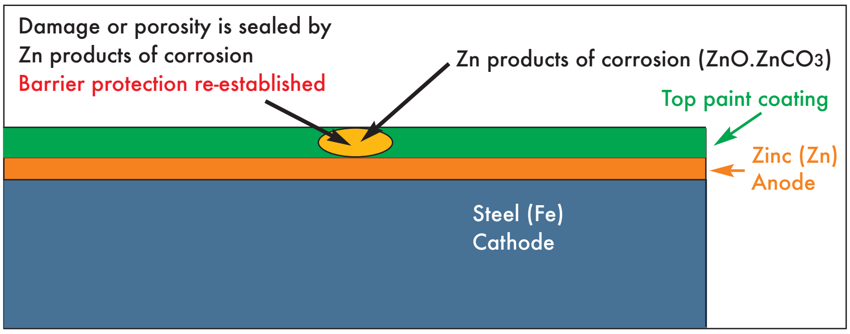


Figure 3: Protection of steel by a duplex system – hot dip galvanizing plus an appropriate paint system.

line of defence) is breached allowing corrosion of the underlying steel, the steel products of corrosion, being far more voluminous than the steel from which they are formed, the paint coating is subjected to stresses leading to blistering and spalling off of the paint (corrosion protection barrier). This process does not take place when hot dip galvanizing is used as the protective coating due to the fact the zinc products of corrosion are far less voluminous and hence does not result in blistering or spalling off of the galvanized coating. In addition, cathodic protection, characteristic of zinc, prevents corrosion creep.

When we use these characteristics of hot dip galvanizing and an appropriate paint system employed in combination, we achieve the synergistic effect, which is illustrated in figure 3.

In order to further establish a measure of the service life of a duplex system, we can use the following simple formula to calculate the net effect:

Duplex Service Life
= Factor x (HDG Life + Paint Life)
= 1.5 x (9years + 5 years)
= 21 years to 5% red rust

Factors used for different Environments are listed below:

- Industrial + marine 1.8 to 2.0
- Sea water (immersion) 1.5 to 1.6
- Non-aggressive climate 2.0 to 2.7

Paint is not there to protect the hot dip galvanizing (zinc), but rather the hot dip galvanizing is there to support the paint when it starts to fail!

Again preparation is paramount to success

As is the case of all types of coatings, the surface preparation is paramount to the success of the coating. Preparation of the steel, for galvanizing, is carried out in a plant environment and this together with the fact that hot dip galvanizing is "an honest coating", ie. if the steel is not clean, it will not galvanize, we are assured of the zinc coating to the steel. Preparation for the duplex system concerns the preparation of the hot dip galvanized surface suitable to accept the top paint coating/s.

Two forms of the zinc surface preparation are recommended, being:

1. SWEEP blasting and NOT normal abrasive blasting
2. Chemical cleaning.

In the case of both methods the cleaning objective is the removal of all surface contaminants, ie. passivating solution, products of corrosion and oil or grease, etc. The principal of; "if it is not clean, it will not coat". Unlike the hot dip galvanized coating, paint requires a surface into which it can be keyed, ie. to be mechanical bonded to the surface, in this instance, zinc.

Once the zinc surface has been prepared, by one of the two methods indicated, the paint primer, being

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compatible with zinc, must follow shortly in order to avoid the renewal of contaminants. This requirement is too often overlooked resulting in premature coating failure and the consequent impression that a duplex system is flawed. As with any paint system, preparation and correct application is critical to the long-term performance of the system. This requirement applies in equal proportion to the application of the paint coating/s in the duplex system.

One might illustrate a duplex system in terms of a military battle, with corrosion being the enemy and our forces being constituted in terms of defence in depth, as well as an all-round defence.

Duplex Coating Service Life

As is the case with all types of corrosion protection coating systems, the service life of the product is dependent on two basic considerations, viz, the type of coating and, as important, the environment in which the coating is designed to operate.

The question of the service life of a duplex coating system is illustrated in terms of ISO 9223, which is similar to the ISO 12944 specification. These specifications set out to broadly define the environment in terms of C1 (a benign environment) through to a C5I or C5M (being severe corrosive conditions). Using this specification, table 4 has been developed.

In all of the foregoing discussion, we have simply considered PAINT, without specific reference to the number or type of paint coating/s. This approach has been adopted due to the fact that there are many types and combinations of paint coating/s. We briefly referred to Inorganic zinc + epoxy + polyurethane as a very good paint system. A suggested duplex system, that is an equivalent to such a paint system, would be to replace the paint primer with that of hot dip galvanizing, followed by a compatible epoxy primer and a final top coating of polyurethane to achieve an aesthetical appeal and to protect against UV attack. In this system we would have the adhesion of hot dip galvanizing to the steel followed by the possibility of a number of different

Paint (film) Characteristics	Types of paint mentioned in Fig. VI-1									
	1	2	3	4	5	6	7	8	9	10
Application (a)	B/S	B/S	S	S	S	S/B	S	S	S	S
Drying (b_1)	Av	Av	Av	Sh	Sh	Av	Av	Av	Av	Av
Hardening (b_2)	Lo	Lo	Av	Av	Av	Lo	Av	Av	Lo	Av
Hardness	F	F/G	G/VG	G	G	F	G	F/G	F	G/VG
Flexibility	G	G	G	G	G	G	F/G	F/G	G	G
Impact resistance	G	G/VG	VG	G	VG	G	G	G	G	VG
Gloss (retention) (c)	F	F	VG	P	F	F	P	F	P	VG
Colour fastness (d)	VG	VG	VG	P	F	F	F	F	–	VG
Pot stability (e)	G	G	P	VG	VG	G	P	G	P	P
Thermal resistance (f)	F	F	G	P	F	F	F	F	P	G
Weather resistance (g)										
Rural climate	VG	VG	VG	VG	VG	VG	VG	VG	P	VG
Marine climate	F	VG	VG	VG	VG	G	VG	G	G	VG
Industrial climate	F	F	G	G	VG	G	VG	F	VG	G
Chemical resistance (h)										
Acid solutions	P	F	G	G	G	F	VG	F	VG	G
Alkaline solutions	P	P	F	G	G	P	G	P	VG	VG
Adhesion	see comparative values in table 2									

(a) B = mainly by brush; S = mainly by spraying or by continuous rolling.

(b_1) Sh = short (less than I hour); Av = average (between 1 – 4 hours); Lo = long (4 – 12 hours); (drying depends on film thickness, temperature and humidity of surrounding air).

(b_2) Sh = short (through-hardening within 3 hours); Av average (through-hardening within 1 – 7 days); Lo = long (through-hardening in 7 days or more).

(c) Indications F and P mainly refer to chalking.

(d) Indications F and P mainly refer to yellowing.

(e) VG = 6 months and more at room temperature; G = 6 – 9 weeks at room temperature; F = approximately 4 weeks at room temperature; P = less than 36 hours (after addition of hardener).

(f) VG = permanent at 50 – 150°C; G = permanent at 50 – 75°C; F = for short periods at 50 – 75°C only; P = up to 50°C only.

(g) Loss of gloss and/or colour not counted.

(h) Dependent on duration of immersion, concentration and temperature of aqueous solution.

Reference: *Duplex Systems, JFH van Eijnsbergen, Elsevier - 1994.*

Table 5: Adhesion of air-drying paints to hot dip galvanized steel surfaces.

paint coatings selected to suit specific environmental conditions.

Conclusion

A Duplex system uses the strengths of both hot dip galvanizing and selected paint coatings to compile an enhanced "synergistic new performance" coating, which is cost effective where "value analysis", long term maintenance costs are taken into consideration, and a system that will perform in severe corrosive environments.

Surface preparation is a critical factor to the success of the coating's performance and as such, must not be overlooked in terms of the specification, as well as at the time of the application.

Although the paint coating systems that have been referred to and tested in this feature are excellent, it is always wise when selecting a paint system, to discuss the relevant system with the applicable paint manufacturer.

PLASCON

Duplex Coatings...

Barloworld Plascon together with International Protective Coatings is committed to participating in the diverse protective coatings market where we aim to be a "total solutions" provider.

Our range of products and services used and supported globally, put International Protective Coatings in the unique position to satisfy industry and customer requirements, wherever they arise.

WHY DUPLEX?

- Extended corrosion resistance
- Superior aesthetics
- Synergistic effects
- Unmatched economic benefits
- And ease of re-painting

TYPICAL AREAS WHERE DUPLEX COATINGS ARE USED:

- Mining Industry
- Bridges
- Conveyor systems
- Hand rails & walkways
- Transmission towers
- Overhead sign supports
- Piping and dock levelers

For further information, please contact: jjohnson@plascon.co.za

Barloworld Plascon

International Protective Coatings

Summary of testing the benefits of a duplex system (hot dip galvanizing plus paint) vs an all paint system

A number of different coating systems were compared during a recent 4 000 hour accelerated weathering test, the article addresses only the conclusion and recommendations.

For purposes of discussion and comparison we have selected four specific coatings as indicated below. In these comparisons we wish to highlight the benefit of using hot dip galvanizing, with it's metallurgical bonding to steel, as a superior form of primer for the subsequent paint coatings.

The discussion that follows will examine coatings 2 and 11 and 3 and 8. These specific coatings have been chosen on the basis that they will be used in corrosive conditions, classified in terms of ISO 9223, for class C4 and C5 type environments.

Evaluating the "top range" of coatings that would be employed in a C5 environment.

Comparison No.1 (*Sample* Nos. 2 *and* 11)

2. Hot dip galvanized + epoxy primer + epoxy MIO + polyurethane acrylic enamel

   compared to

11. Abrasive blast + inorganic zinc primer + modified aluminum epoxy mastic + cross-linked epoxy + aliphatic acrylic polyurethane

Where the two samples have been cross scribed and exposed for 4 000 hours in a salt environment, one can see the effect of corrosion. In the case of the hot dip galvanized primer (sample 2, on the left), the exposed steel is being protected by the cathodic protective properties of zinc, ie. zinc is electro-negative to steel, and where the zinc products of corrosion have the tendency to seal the cross scribing with no red rust in evidence. With sample 11, on the right, where an inorganic zinc rich primer has been used as the base coat, little or no cathodic protection is in evidence and the exposed steel has developed red rust.

Comparison No.2 (*Sample* Nos. 3 *and* 8)

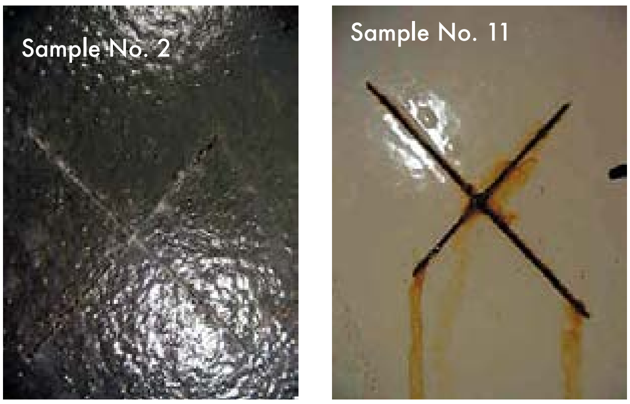
3. Hot dip galvanized + epoxy primer + polyurethane

   compared to

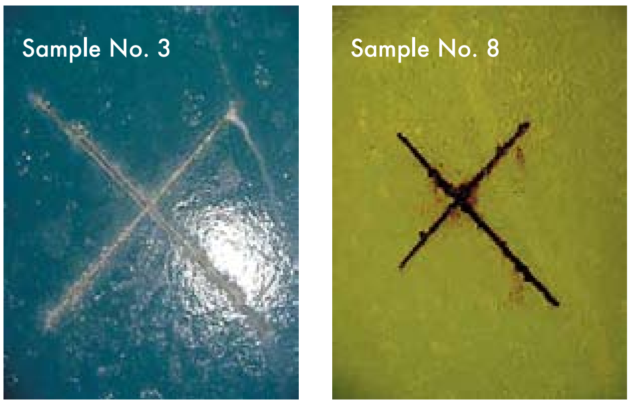
8. Abrasive blast + inorganic zinc + epoxy primer + polyurethane

Again where the two samples have been cross scribed and exposed for 4 000 hours in a salt environment, one can see the effect of corrosion.

In the case of the hot dip galvanized primer (sample 3, on the left), the exposed steel is being protected by the



Comparison No. 1: Cross scribing after 4 000 hours salt spray exposure



Comparison No. 2: Cross scribing after 4 000 hours salt spray exposure cathodic protective properties of zinc. The zinc products of corrosion have the tendency to seal the cross scribing and hence no red rust is in evidence.

With sample 8, on the right, where inorganic zinc has been used as the primer, little or no cathodic protection is in evidence and the exposed steel has developed red rust. In addition there is significant indications of the top paint coating becoming porous and developing cracking.

The conclusions reached as a result of this study are not intended to detract from the undoubted durable performance of the paint system incorporating an inorganic zinc rich primer. The results obtained do however highlight the significant benefits that can be derived by applying a hot dip galvanized coating beneath a similar heavy-duty organic paint system. Use is made of the metallurgical bonding of galvanizing to the steel, the barrier and cathodic protection of zinc and the barrier protection of paint. In terms of a C4 and C5 environment, hot dip galvanizing has a limited service life potential, as does a paint system when used separately. The two systems used together as a Duplex system interact resulting in a Synergistic Effect.

What we learnt from these tests!

- Zinc rich paints do not provide long-term cathodic protection on exposed edges.
- Zinc and Aluminium metal spraying and hot dip galvanizing do provide long- term cathodic protection on exposed edges.
- Hot dip galvanizing on its own is insufficient for long-term protection, in extremely aggressive environments.
- The paint coating of a duplex coating for aggressive environments should be at least 150µm DFT.
- Make use of the HDGASA Codes of Practice when preparing for and evaluating duplex coatings.
- **Make use of HDGASA for advice on duplex coatings.**

It again goes to prove the saying that was first enunciated by a certain knowledgeable expert from the paint industry: ***Hot Dip Galvanizing represents the best form of primer for a paint system!***

Estimated Cost Comparison
(Based on 8mm steel at 31.85m²/ton)

2. Hot dip galvanized + epoxy primer + epoxy MIO + polyurethane acrylic enamel

Hot dip galvanized	Epoxy primer	Epoxy MIO	Polyurethane acrylic enamel	Totals
R1 900/ton	R640/ton	R800/ton	R960/ton	R4 300/ton
R59.65/m²	R20.09/m²	R25.12/m²	R30.14/m²	R135.00/m²

11. Abrasive blast + inorganic zinc primer + modified aluminum epoxy mastic + cross-linked epoxy + aliphatic acrylic polyurethane

Abrasive blast	Inorganic zinc	Modified aluminum epoxy mastic	Cross-linked epoxy	Aliphatic acrylic polyurethane	Totals
R960/ton	R960/ton	R960/ton	R640/ton	R960/ton	R4 480/ton
R30.14/m²	R30.14/m²	R30.14/m²	R20.09/m²	R30.14/m²	R140.66/m²

Estimated Cost Comparison
(Based on 8mm steel at 31.85m²/ton)

3. Hot dip galvanized + epoxy primer + polyurethane

Hot dip galvanized	Epoxy primer	Polyurethane	Totals
R1900/ton	R640/ton	R960/ton	R3500/ton
R59.65/m²	R20.09/m²	R30.14/m²	R109.88/m²

8. Abrasive blast + inorganic zinc + epoxy primer + polyurethane

Abrasive blast	Inorganic zinc	Epoxy primer	Polyurethane	Totals
R960/ton	R960/ton	R640/ton	R960/ton	R3 520/ton
R30.14/m²	R30.14/m²	R20.09/m²	R30.14/m²	R110.51/m²

Total coating thickness readings before and after 4 000 hour test

		Total coating thickness readings (µm)		
		Min	Mean	Max
Sample 2	Before test	190	212	224
	After test	205	246	292
Sample 11	Before test	376	399	435
	After test	292	347	423
Sample 3	Before test	156	163	170
	After test	128	145	155
Sample 8	Before test	180	195	213
	After test	254	267	278

Planning the duplex system for Goedehoop Colliery

Some ten years ago, the authorities at Grooteluk Colliery requested Braam Bosman, a corrosion consultant, to undertake a survey in order to identify the level of general corrosion that could be expected throughout the mine as well as specific sites where severe corrosion could be anticipated. This assignment included the need to provide a detailed specification for corrosion control.

The study included chemical analysis of process waters as well as an assessment of the calorific values of the grades of coal to be processed.

Based on the results of this survey, a cost effective specification was proposed which was somewhat unique in that a single heavy duty organic paint coating (no primer) was recommended for application onto sweep blasted hot dip galvanized surfaces using an ultra fine garnet "microblast" cleaning abrasive for surface preparation.

The contract for applying this duplex protective system was awarded to Barloworld Galvanizers and Reef Industrial Painters who were responsible for applying the paint coating immediately after hot dip galvanizing at the galvanizers premises.

Braam Bosman and his inspectors were appointed to undertake routine inspections and surveillance in order to ensure that the required quality standards were adhered to with special attention given to loading, offloading and stacking procedures. These control measures were also implemented during site erection. As a result of these comprehensive control procedures, a total coating damage factor of less than 2% was realised up to completion of the project.

A key to the success of this project was the positive teamwork between Barloworld Galvanizers, Reef Industrial Painters and Braam Bosman's inspectorate. The concept of applying the paint coat immediately after hot dip galvanizing on the galvanizers premises proved to be singularly successful.

Technical support was provided by Walter Barnett of the Hot Dip Galvanizers Association from inception through to completion of this successful project.

PAINTED STEEL VS HOT DIP GALVANIZED STEEL

PAINTED STEEL	HOT DIP GALVANIZED STEEL
After some time, rust is formed underneath the paint film, which only become visible after a longer period of diffusion of oxygen and water through the paint film.	Formation of insoluble zinc salts (zinc patina) at the interface by reactions with oxygen and water. No rust is formed. Pores in the zinc film are blocked by solid volume zinc corrosion products.
Under-rusting proceeds, followed by loss of adhesion of the paint film because of the increased volume of rust products (approximately twice to three times the volume of the steel from which they have been formed)	No loss of adhesion of zinc coating. Further blockade of pores by solid volume zinc corrosion products. Partial corrosion of the of the eta layer. Alloy layers still remain intact.
Spread of rust and further loss of adhesion of the paint film; rapid destruction of the coating system.	Corrosion proceeds very slowly. No rust at the interface. Partial corrosion of the zinc layer proceeds. Alloy layers still remain intact.
Protection by paint coating is almost completely gone. Complete derusting becomes necessary before applying a new paint coating.	Zinc coating system is weathered on a part of the steel surface. Still no rust; slow weathering of the alloy layers. Very few pinpoints of rust. Reconditioning is possible and easy.
When loss of adhesion is partial, the overall protective value of the new paint coating is very limited.	Upon further weathering of the alloy layers, more pinpoints of rust appear, slowly extending into rusty areas. Reconditioning is necessary at this point of weathering

***Reference:** Duplex Systems, JFH van Eijnsbergen, Elsevier, p. 22 Table 1.*

Table 6.

Editors note

The duplex coating applied at Goedehoop Colliery is about ten years old and is featured as one of the case histories.

A paint applicator's view on duplex coating systems

by Mike Book proprietor of Duplex Coatings cc

Surface preparation for duplex systems

In order to apply duplex systems correctly, it is necessary to know the general characteristics of the hot dip galvanizing process, so that one can determine the best method of surface preparation. Effective protection by a duplex system is only possible if long-term inter-coat adhesion is obtained by means of a paint coating that will not react chemically with the zinc substrate.

Inadequate preparation of the zinc surface, prior to the application of a compatible paint system or powder coating is the main cause of premature failure.

Failure to inform the galvanizer that the items will be duplex coated will usually result in the galvanized items being passivated in a sodium dichromate solution and may influence paint adhesion (see photo overleaf – Adhesion failure – paint applied to insufficiently treated hot dip galvanizing) see also #1. Likewise zinc protuberances and lumps which may be acceptable on hot dip galvanized only surfaces, will not necessarily be removed if the galvanizer is unaware of the requirements to paint.

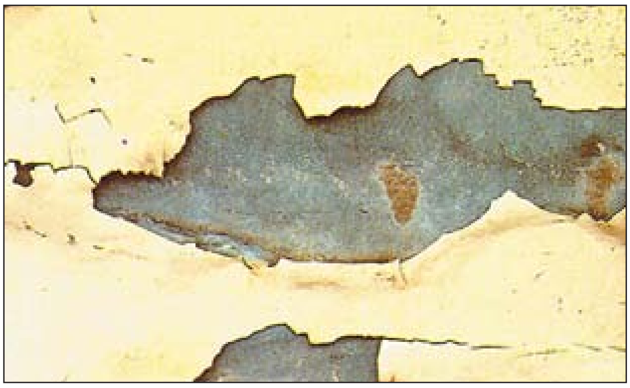
We have two general types of cleaning:

- ◆ Mechanical:
  Sweep blasting; scouring with abrasive paper.
- ◆ Chemical Cleaning:
  Cold etching and phosphating; hot phosphating; chromating; galvannealing and outdoor weathering.

The preferred method of preparation for large contracts consisting of items of various configurations is the Sweep Blast method.

Cold etching (phosphating) or the use of "Galvanized Iron Cleaners" is unreliable for the following reasons:

- Labour intensive
- Time consuming
- Areas not etched properly
- Areas not rinsed properly resulting in painting over contaminated surfaces
- Certain GIC cleaners are not user friendly ie. are not easy to remove if left on too long and allowed to dry.



Adhesion failure – paint applied to insufficiently treated hot dip galvanizing.

Sweep Blasting

It is essential that only highly skilled operatives trained in the aspects of sweep blasting of galvanized items be used to ensure that the galvanized coating is only decreased to by 8 - 13μm (see figure 5). This reduction in the galvanized coating thickness hardly influences the corrosion resistance.

N.B *Do not sweep blast continuously galvanized sheeting as the galvanizing thickness is too thin and sweep blasting will damage the galvanized protection. Chemical clean sheeting to a water break free surface.*

(To sweep blast structural steel the air pressure should be set at 1.5 - 2.5 bar using a 6mm nozzle and a fine inert abrasive eg. garnet. Sweep blasting at between 30 - 45m^2 per hour (blasting mild steel to S.A 2$^1/_2$ is 8 - 12m^2 per hour at 7 bar pressure) from a nozzle distance of 500 - 700mm from the galvanized surface will provide an ideal key for coating).

A detailed code of practice for surface preparation and application of duplex systems has been published by the South African Hot Dip Galvanizers Association and is freely available.

Paints and specifications for duplex systems

The selection of a coating or coating systems on hot dip galvanized steel surfaces which have been chemically or mechanical pre-treated or (in some cases) only degreased, depends on four main parameters:

a) Increased weather resistance ie. maximum duration of protection of an object in the atmosphere versus the aesthetic effect (colour) or vice versa.
b) Paint application method to be used on the project.
c) Environmental laws and rules regarding composition and application of paint products.
d) Consideration regarding the transport/erection damage repairs on site.

A wide variety of paint products are available nowadays, including powder coatings, water-dispersed paint (aqueous paint products) epoxys, polyurethanes, vinyls etc., and when selecting a coating system the asset owner would take into consideration the following:

- The type of plant to be constructed.
- The geographic location of the plant.
- The natural local atmospheric environment (macro environment).
- The plant operating or process environment (micro environment).
- Subsequent maintenance requirements. Certain plants would be too costly to shut down to carry out general maintenance, and therefore these inaccessible areas must be designed to accommodate the harsh environment that they are exposed to.
- Construction program.
- Economics.

All the Project owners' requirements should be considered, and discussed in the light of these factors, before any serious attempt is made to make decisions relating to the specification.

Coating specifications in most instances ignore or disregard specific problems associated with application in the working area and tend to assume that laboratory conditions can be achieved " in situ" and it is therefore important to involve all the "players" ie. the asset owner, the consultant, the paint manufacturer, the galvanizer and the applicator in the beginning, so that all parties have a clear understanding of the specification requirements.

It is also advisable that at the beginning of the contract program a sample batch be processed to identify problems and clarify the standard of the specification.

Once all parties have agreed to the standard of the workmanship, a sample be kept as a reference panel, and used as a bench mark for the contract.

Accurate costing is a large contributing factor to the success of a coating system so that the contractor can fulfill all the necessary obligations without the need to economise or cut corners.

Without a reasonable financial commitment to the coating specification all efforts to achieve its inherent high goals will be worthless.

A system that is designed to fail, will fail.

Duplex coating systems offer numerous advantages over con-ventional coating systems in most applications see table 1.

The durable life expectancy of a typical paint system for a C5 M-I environment (Zinc Epoxy Polyurethane system with a DFT of 250µm) is approximately 8 years to RI 3 degree of rusting.

The durable life expectancy of a duplex system can be calculated using the following formulae and the incremental factors set out below:

= HDG Life (15 years + paint 8 years) x 1.8

= 41 years year's to a 5% surface red rust.

Factor used for different environments:

- Industrial and Marine = 1.8 - 2.0
- Sea Water Immersion = 1.5 - 1.6
- Non aggressive climates = 2.0 - 2.7

Editors note

See also table 4 for durable life expectancies of a duplex system.

The durability range is not a "guarantee time", but a technical consideration that can help the asset owner set up a maintenance program.

Maintenance is often required at more frequent intervals because of fading, chalking, contamination, wear and tear, and aesthetic reasons.

Cost comparisons of a standard duplex system vs a typical zinc/epoxy/polyurethane system for a C5M or C5I environment.

The choice of a corrosion protection system is often based on the initial cost per m²/tonne with little regard to long term considerations. Unlike paint, hot dip galvanizing is priced per tonne of structural steel and painting is priced at m² and then converted to a rate per tonne (m² rate x m² per tonne).

COST COMPARISON DUPLEX SYSTEM vs HEAVY DUTY PAINT SYSTEM								
	Duplex System				Heavy Duty Paint System			
Steel thickness	3mm	6mm	8-10mm	15mm	3mm	6mm	8-10mm	15mm
Area per tonne	84m²	42m²	28m²	17m²	84m²	42m²	28 m²	17 m²
H.Dip Galv. Cost	R1700/t See #2	R1700/t See #2	R1700/t See #2	R1700/t See #2				
Blast & Inorganic Zinc					R55m²	R55m²	R55m²	R55m²
Prep Epoxy P/U	R64m²	R64m²	R64m²	R64m²	R56m²	R56m²	R56m²	R56m²
Price per tonne for complete system	R7064/t	R4388/t	R3492/t	R2788/t	R8484/T	R4242/t	R2828/t	R1717/t
Durable life expect.	41 yrs	41 yrs	41 yrs	41 yrs	15 yrs	15 yrs	15 yrs	15 yrs
DLE per tonne cost per year	R172/t	R107/t	R85/t	R68/t	R565/t	R283/t	R188/t	R114/t
Add maint. Cost + 50% inflation factor	0	0	0	0	R847/t	R424/t	R282/t	R171/t
Total cost per ton/yr	R172/t	R107/t	R85/t	R68/t	R1412/t	R711/t	R470/t	R285/t
% Variance	0	0	0	0	820%	664%	553%	419%

Table 7.

LIFE CYCLE COST SUMMARY FOR 41 YEARS				
		Durable Life Expectancy Cost per Year per Ton		
Steel Thickness	Total m² per ton	Duplex System	Heavy Duty Paint System	% Cost Diff
3mm	84m²	R 1 72.00/T	R 1 412.00/T	820%
6 mm	42m²	R 1 07.00/T	R 711.00/T	664%
8-10 mm	28m²	R 85.00/T	R 470.00/T	553%
15 mm	17m²	R 68.00/T	R 285.00/T	419%

Table 8.

TECHNICAL ADVANTAGES OF DUPLEX SYSTEMS		
	Duplex Coatings VS	Heavy Duty Coating System
1) Preparation	Pickle in acid – part of the process	Abrasive blast to SA 2½
2) Curing	Painting of the HDG can start immediately the item is galvanized – the sooner the better	Inorganic zinc's require 2 - 3 day curing in a relative humidity of 70%
3) Tie Coat	No tie coat required	Due to the open matrix of inorganic zincs a tie coat is required to "seal" the surface
4) Uniformity	No stripe coating of edges. Hot dip galvanizing produces a similar or greater coating thickness to that on all surfaces, at edges	Paint coatings are thinner over corners and sharp edges. These edges are prone to corrosion attack when exposed to the exterior environments where condensation is evident
5) Adhesion	The hot dip galvanized coating is metallurgically bonded to the steel	Inorganic zinc primers are susceptible to much cracking if applied too thick, especially in corners
6) Inaccessible Areas	Because the items are dipped in molten zinc inaccessible areas are coated i.e. behind the lip on cold rolled lip channels	Coating behind the lip on cold rolled lip channels are difficult to paint and requires 100% inspection
7) Transport/ erection damage	Hot dip galvanizing is resilient to transport/erection damage	The thicker the coating the more susceptible it is to transport/erection damage. Uncured zinc primers split above the blast profile

Table 9.

For a true cost analysis the following must also be taken into account:

- Ongoing maintenance cost during the life of the corrosion protection system
- Life cycle costing per m^2 for the durable life of the coating system.

We have based our costing on the following types of structural steel:

- 3mm thick cold rolled purlins @ $84m^2$ per tonne
- 6mm thick structural steel (light) @ $42m^2$ per tonne
- 8 - 10mm thick structural steel (medium) @ $28m^2$ per tonne
- 15mm thick structural steel (heavy) @ $17m^2$ per tonne

For this costing exercise, we have compared a duplex system (HDG + epoxy + polyurethane) to a paint system (inorganic zinc / epoxy / polyurethane) carried out in a "shop" environment where the rates shown in table 10 were used.

It is quite clear that heavy duty paint coating systems are initially cheaper than a Duplex System at the beginning of the project for medium to heavy steel (>32 m^2 per tonne), however, in the long term can work out between 400 - 800% more expensive without taking into account the losses the asset owner may suffer due to downtime and the high cost of access scaffolding, etc.

With Duplex Coatings the cost savings start from the beginning of the project.

Duplex System	Heavy Duty Paint System
HDG R1 700/tonne	Blast & Inorganic Zinc R55m^2
Prep/Epoxy and Polyurethane R64m^2	Stripe coat epoxy and Polyurethane R56m^2
Durable life expectancy in a C5M or C5I environment	
41 years	15 years
Maintenance cost for corrosion purposes	
0	x 1.5 original coating cost every 15 years

Table 10.

Case Histories of duplex coatings applied 10 - 12 years ago

Case History "A"

Location	:	Alusaf, Richards Bay
Contractor	:	ABB Feralin
Contract	:	Alumina Conveyor system from the Richards Bay Harbour to the Alumina Silos at Alusaf (± 4 500 tonnes)
Specification	:	Chemically clean; epoxy zinc phosphate primer; polyurethane enamel
Paint Supplier	:	Sigma
Environment	:	C5 Marine/Industrial (harsh)

This painted only bracing (no hot dip galvanizing) is showing signs of premature failure amongst the other duplex coated members.

condition, however, minor maintenance will be required on the galvanized grating which has been exposed to fumes from a nearby stack. (see photo below).

Case History "B"

Location	:	Goodehoop Colliery – Witbank
Contractor	:	PH Projects
Galvanizer	:	Barloworld Galvanizers
Specification	:	Sweep blast and 1 coat high build epoxy DFT –125µm
Paint Supplier	:	Sigma
Environment	:	C5 Industrial Coal washing Plant ±1 500 tonnes

This Duplex System was specified and inspected by Braam Bosman during 1995/1996 and a recent inspection shows no deterioration whatsoever, whereas a conveyor structure erected at the same time and coated with a conventional paint system, has deteriorated and will require major maintenance within the next 3 years.

It appears that a bracing between two columns was manufactured, painted and installed on site (no galvanizing) and under the same harsh wet environment of a coal washing plant, the coating is beginning to fail (see photo above).

Future maintenance will be required on the hot dip galvanized gratings due to micro climatic conditions.

Refer also to Case History on Goedehoop Colliery.

Cautionary notes

Alkyd enamels should not be used directly onto hot dip galvanized surfaces as the alkyd saponifies ie. reacts with the zinc surfaces to form soap which causes loss of adhesion of the paint layer.

If a Duplex System is to be applied, Hot Dip Galvanize without passivation (see #1).

On the Hghveld, the exclusion of the sodium dichromate passivation after hot dip galvanizing is of paramount importance. However, when painting is likely to be delayed for several days or weeks, particularly in moist, marine atmospheres, passivation of the steel should be encouraged.

Conclusion

Conventional paint systems can be as much as 400 - 800% more expensive than a Duplex System over a period of 41 years. Growing demand will increase competition and lower selling prices for Duplex Systems making it even more attractive to asset owners. The Hot Dip Galvanizing Industry together with the cooperation of owners and specifiers must not permit erosion of work standards.

Everyone has to guard against the "low bid" trap at the beginning of a project which can bring with it poor workmanship, delays and costly re-work. Every contract must provide QA/QC procedures that can verify proper application.

It is the responsibility of all the participants to strive to deliver high quality Duplex Systems which result in a **LOW LIFE CYCLE COST.**

Editors note

Case History "A" – The gratings referred to in the above case history are taking strain with detrimental attack of the coating taking place. As stated, steel exposed to harsh industrial/marine environments (C5I or C5M) should be appropriately coated. Hot dip galvanizing on its own will not necessarily provide an acceptable service free life. Alternative action includes the application of a duplex system, replacement of the gratings for stripping and re-galvanizing every ten years of life (when at least 5% of the galvanized surface has failed) or alternatively using a more durable material such as a higher grade stainless steel or glass reinforced polyester, in this environment.

#1 – *The exclusion of the passivation by the galvanizer is not always mandatory. Should painting follow shortly after hot dip galvanizing then exclusion of the passivation is necessary, however, should painting be delayed for more than 4 hours in a moist aggressive marine atmosphere, then passivation by the galvanizer should be encouraged.*

#2 – *For simplicity the author has used R1 700.00 / ton for the cost of light, medium and heavy steel. The actual cost however, varies depending on location, from R2.50/kg for 3mm steel (light); R1.75 to R2.00/kg for 4 - 8mm steel (medium) and R1.60 to R1.75/kg for 10mm steel and above (heavy). Hot dip galvanizing prices are amongst other plant related things affected mainly by the zinc price and the Rand/Dollar exchange rate.*

Surface preparation for duplex coating systems – chemical pretreatment

Chemical cleaning

For optimum functioning of duplex systems, it is imperative to remove all contaminants and other compounds from the zinc surface. For chemical cleaning, generally an aqueous alkaline solution with a pH of 11 to 12, is used. Solutions of 2 to 5% by weight of one or more of the following chemicals are used: sodium hydroxide, sodium metasilicate, sodium orthosilicate, trisodium phosphate, sodium nitrate and / or sodium carbonate.

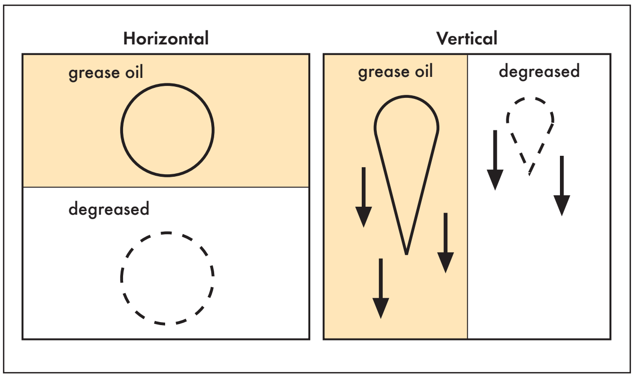


Figure 4: Practical test for judging of galvanized steel surfaces. One droplet of a 1% solution of Fettrot BB (Bayer) in ethyl alcohol on metal surface. Wait 30 - 60 seconds. Form and extension of red ring indicate presence of oil or grease, as well as effective degreasing (dotted lines).

Mixtures of these products are accompanied by small percentages of emulsifying and chelating agents, breaking down during the degreasing procedure on the zinc surface. Often, air is pumped through the degreasing tank to accelerate degreasing reactions on the zinc surface, as well as to promote (by mechanical action) the removal of fatty substances.

For mass production, degreasing solutions are sprayed onto the zinc surface during the passage of the hot dip galvanized parts through a tunnel unit. Care should be taken to adjust both position (angle) of the spraying nozzles and the pressure of the degreasing solution. The temperature of the degreasing solution should be maintained at 60 to 85°C.

In order to assess the cleanliness of the zinc surface prior to painting, the following simple method may be used. Place one droplet of a 1% solution of Fettrot BB or Ceresrot (Bayer) in ethyl alcohol onto the surface. After 30 - 60 seconds, a circular doted line forms, indicating cleanliness of that surface. When degreasing is insufficient, a continuous red circular line is formed. On vertical, sufficiently degreased surfaces, the droplet sags less and the red line is intermittent whereas this line is continuous and more inclined to sag on poorly degreased surfaces (see figure 4).

A more sophisticated way of detecting impurities on zinc surfaces is the photon electron emission PEE method, which is nowadays also applicable without a vacuum.

When weathered hot dip galvanized surfaces are degreased, weak acid solutions of phosphoric acid or inhibited sulfamine acid compounds are used, taking care that the pH value of such acid degreasing solutions remains above 4.

Sweep Blasting

Refer to "Surface preparation for duplex coating systems - mechanical pretreatment". The diagram below shows a typical surface profile of a correctly sweep blasted hot dip galvanized coating which, when measured before and after sweep blasting will tend to grow in coating thickness. The reason for this growth is the fluffing up of the soft zinc layer and the electro magnetic coating thickness guage probe, measuring the peaks of the profile (see photos right).

Coating thickness readings before sweep blasting:
Left: Mean 111 Min 94 Max 141 No. of readings 15
Right: Mean 85 Min 73 Max 98 No. of readings 16

Coating thickness readings after sweep blasting:
Left: Mean 121 Min 99 Max 148 No. of readings 15
Right: Mean 100 Min 84 Max 125 No. of readings 16

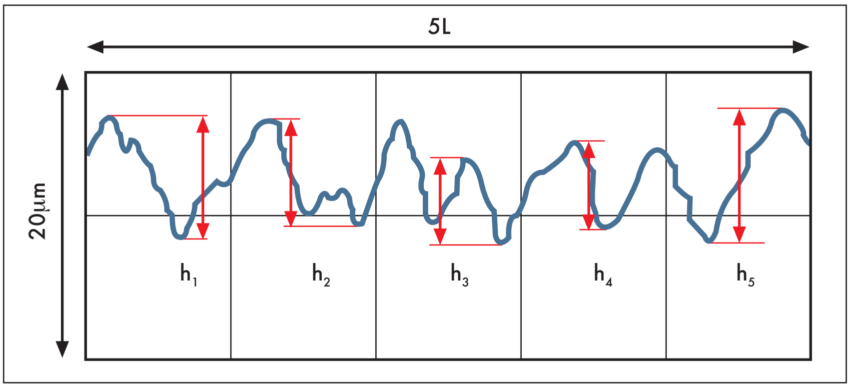


Figure 5: Surface profile of a swept galvanized steel surface over a length 5L. Top to bottom: R_z

$$R_z = \frac{H_1 + h_2 + h_3 + h_4 + h_5}{5}$$

Reduction of zinc coating thickness 8 - 13µ

Surface preparation for duplex coating systems – mechanical pretreatment

By Bradley Storer – Blastrite

With the demand for duplex coating systems growing, it is necessary to have the correct surface preparation specification in place to ensure coating adherence to the hot dip galvanized surface.

Pre-treatment of hot dip galvanized surfaces is best carried out immediately after hot dip galvanizing, before the surface becomes contaminated by oil, grease and dirt.

Surface preparation methods for the duplex systems have varied over the years from using chemical pretreatments, light abrasive blasting and mechanical methods for surface preparation. The method that has proved most successful is light abrasive blasting – termed "sweep blasting". However sweep blasting has had it's problems, with the incorrect abrasive, wrong particle size and the wrong blast pressure being used (blast pressure – air pressure at the blast nozzle).

The abrasive choice plays a crucial role. When choosing the abrasive one must ensure the following:

- Product is inert
- Appropriate particle size is used to achieve the specified profile – a particle size that is too large can result in a surface profile of 50 micron plus. While correct profile is about 10 - 15 micron (see figure 5).
- No recycled or contaminated abrasive is to be used.

It is imperative that the surface preparation method be done in accordance with the correct specification – numerous tests and following world best practice methods has resulted in the following specification:

1. *Abrasive*

   Garnet – Microblast abrasive, grading being 150 - 300 micron.

2. *Blast Pressure*

   Blast pressure – pressure at the nozzle to be regulated not to exceed 2.5 bar (40 - 50psi). A blast pressure of more than 2.5 bar will result in the abrasive having more kinetic energy and therefore a larger surface profile being created and possible damage to the hot dip galvanized coating.

3. *Stand-off distance*

   Distance between the blast nozzle and the substrate, the "rule of thumb" is that a distance of 500mm must

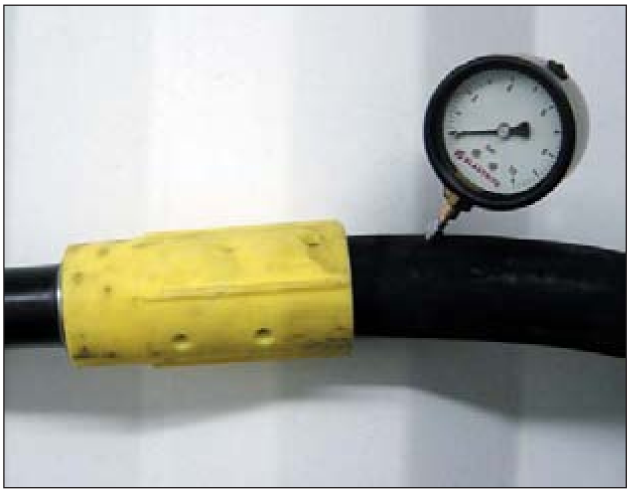


Figure 6: Photo shows the needle valve (not operational) for monitoring correct blast pressure by the operator.

be maintained between the end of the blast nozzle and the substrate.

4. *Oil & moisture trap*

   Compressor and Blast Pots to be equipped with oil and moisture filters.

The above to be done in a "sweep blast" action, moving the nozzle across the surface area in a quick motion

Light abrasive blasting in accordance to the above mentioned method will result in the correct surface cleanliness and profile being achieved:

- All zinc oxides / chalking is removed
- Blast profile of about 10 - 15 micron obtained

Achieving the correct profile will result in:

1. Good adhesion of the subsequent coating.
2. Correct coating spreading rates.

Achieving the incorrect profile will result in:

1. Damage to the hot dip galvanized coating with peaks sticking through coating.
2. Increasing the consumption of paint.

Editorial note:

The majority of the above guidelines are addressed in the Association's CODE OF PRACTICE FOR SURFACE PREPARATION AND APPLICATION OF ORGANIC COATINGS.

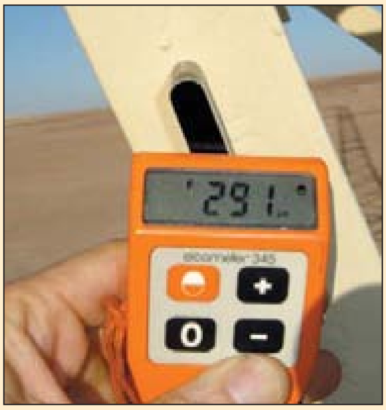
In order to ensure the all important correct blast pressure is maintained and controlled by the operator, a needle valve can be inserted through the blast hose at the operators hand instrument. This instrument allows him to monitor the crucial air pressure and hence maintain absolute control over the sweep blasting operation (see figure 6).

Duplex protection for a transmission line erected in an aggressive environment

Hot dip galvanizing is the protective coating generally specified for the protection of electrical transmission towers in southern Africa and elsewhere throughout the world. Thousands of these structures can be seen wherever one travels in South Africa where electrical power is required to be transmitted over long distances.

Many years ago, engineers at Eskom based their initial cost calculations on a maintenance free coating life of 50 years for steel transmission towers, which were hot dip galvanized. This projection has proved to be correct and if anything conservative in most inland regions. Meanwhile, the savings in maintenance painting costs have been immense when one considers the need to gain access to these structures, which are spread eagled over long distances, not to mention disruptions in power transmissions in order to enable maintenance crews to gain access to these structures.

Understandably, the maintenance free protective life of hot dip galvanizing is diminished in aggressive coastal regions where, in some cases, duplex protection is advisable.



Some years ago, we were requested to recommend a cost effective protective system for a transmission line to be erected along the aggressively corrosive Namibian coastline. This line extends relatively near the coast for 20km, from Swakopmund to a substation "Kuiseb" some 20 to 25km from Walvis Bay and then inland to Windhoek.

The protective duplex system recommended entailed hot dip galvanizing followed by the application of an epoxy primer overcoated with a highbuild epoxy containing MIO and a top coat of polyurethane.

Erection of this transmission line was completed about two and a half years ago. The coastal section to the substation and the inland line up to a distance of about 45km from the coast have been provided with duplex protection. A recent survey of the protective systems applied in this instance indicates clearly that there is no evidence of premature failure.

The performance of this duplex system in these aggressively corrosive conditions will be monitored regularly in the future.

How to avoid premature failure of paint coatings applied to hot dip galvanized steel in corrosive coastal environments

By Iain Dodds of Cape Galvanising

The numerous failures of paint coatings on hot dip galvanized surfaces compound the myth that successful painting of hot dip galvanizing is both complex and difficult to achieve. Our aim is to identify the reasons for these failures and how they can be avoided.

The most frequently encountered problem is inadequate adhesion between the hot dip galvanized surface and the paint film. This will invariably be overcome if the following simple procedure is adhered to.

1. If subsequent immediate painting is required (ie. within 4 hours of hot dip galvanizing – this can be longer depending on the environment at hand, normally acceptable in the Highveld areas), the galvanizer must be instructed not to passivate the zinc coating surface in a sodium dichromate solution.
2. If subsequent painting is required and this is likely to be carried out at a later stage, particularly in moist or humid atmospheres, passivation should not be excluded, as wet storage stain (white rust) may develop prior to painting. It is considered that the removal of the passive layer is less difficult than removal of white rust, prior to painting.
3. Prior to painting, the hot dip galvanized surface must be scrubbed with the aid of a reputable galvanized iron cleaner (GIC) until a water break free surface is achieved. All traces of

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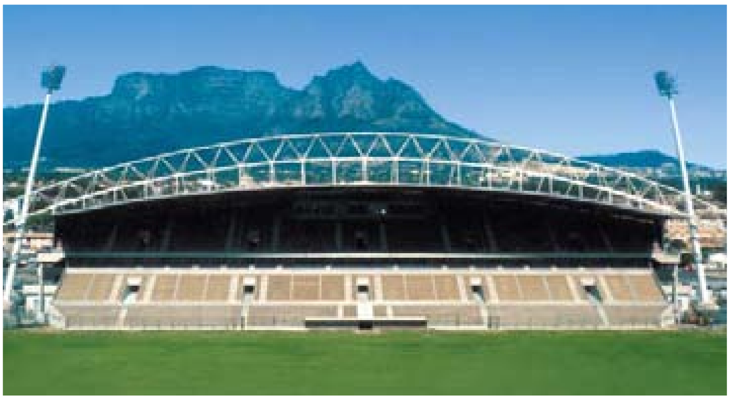
- Hot Dip Galvanizing
- Duplex Systems
- SABS ISO 1461
- SABS ISO 2063



- Grit Blasting to SA3
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the cleaner must then be thoroughly rinsed off, with painting commencing as soon as possible (see note1 overleaf). Once the cleaned surfaces have been dried (in moist atmospheres) or had sufficient time to dry completely on their own (in dry atmospheres). This is a universally approved procedure and a fundamental prerequisite for successful painting.

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

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

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

How does this impact on the man in the street? He goes to his local hardware shop to buy paint. There he finds acrylic water based primers and enamel oil based topcoats to apply onto hot dip galvanized steel. This seems to be an obvious choice as they are single pack, non-toxic products, which provide good adhesion.

Above and below: An example of a failed duplex coating as a result of insufficient DFT of the paint coating being subjected to the corrosive conditions of Muizenberg. Note the voluminous white zinc corrosion products.

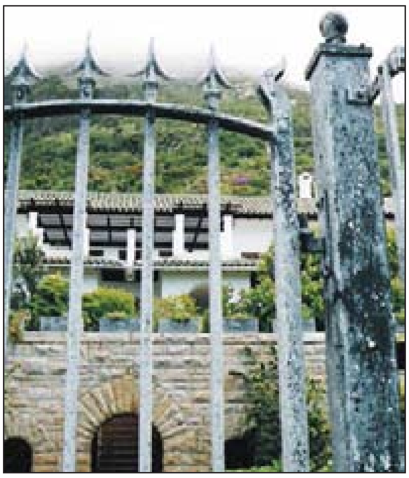
The problem with these coatings is that they provide very thin coverage varying from 20 to 40 microns. The hot dip galvanized articles are then painted with a two coat decorative paint system, which would be ideal for use only in moderately corrosive applications.

The paint coating is soon breached due to permeation by moisture and salt spray and the underlying zinc surface is converted into soluble zinc hydroxide. As the paint coating becomes more permeable, it is further breached and the item becomes coated with white zinc corrosion products. These coatings which can fail very quickly are frequently observed. They lead to a great deal of confusion and dissatisfaction on the part of the client who looks to blame the painter, the galvanizer or the paint supplier, while the real cause is incorrect paint selection and inadequate paint coverage.

It is imperative, especially within 500m from the sea, that a heavy duty paint system is applied to prevent the hot dip galvanizing coming into contact with salt spray and moisture. An ideal system is an epoxy primer, an epoxy MIO intermediate coat and a polyurethane topcoat to a total paint DFT of about 150 - 200 microns. This duplex system has provided outstanding results in corrosive marine applications where the synergistic effect produced by combining the protective properties of an organic paint system with hot dip galvanizing is invariably most effective in providing long term corrosion control.

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

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

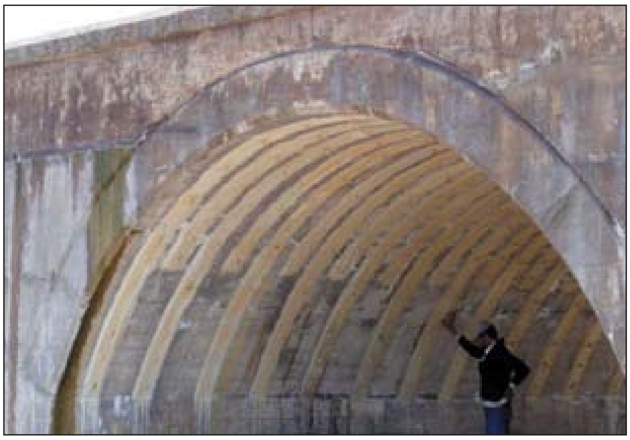


Some miscellaneous duplex coating applications

The following duplex coating applications took place at Galvatech in Bellville, Cape Town.


Duplex coated water treatment plant pipes were sweep blasted both externally and internally after hot dip galvanizing and then coated with an epoxy primer followed by 3 coats of coal tar epoxy.


Duplex coated syncro lift mechanisms at Kalk Bay Harbour were sweep blasted after hot dip galvanizing followed by an epoxy primer, two coats of high solids abrasion resistant epoxy paint. A final polyurethane coating was applied on site.

Duplex coated steel reinforcement strips on the underside of the Kalk Bay concrete railway bridge. The hot dip galvanized strips were sweep blasted after hot dip galvanizing and then coated with a special epoxy type of paint before being fixed to the underside of the bridge by way of mechanical pins and epoxy adhesive.

Zinc primers – an overview

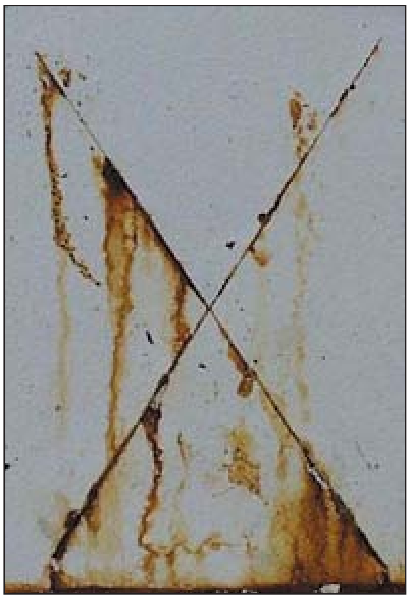
by Dr Colin Alvey, Corrosion Advisory Technical Services (Randburg) cc

Metallic zinc as a protective primer

It is generally accepted that particles of metallic zinc applied to a steel surface in a paint matrix in the form of a zinc primer provide protection to the steel by the process of cathodic protection. In the presence of moisture as the electrolyte, the steel forms the cathode and the zinc the anode in the resultant corrosion cell. The steel, being the cathode, does not corrode whilst the zinc, being the anode, corrodes preferentially and protects the steel. This protection continues until the zinc in the paint matrix is consumed or depleted.

Hot dip galvanizing vs zinc rich paint

It must be remembered that it is metallic zinc that affords cathodic protection to steel and the extent of protection offered is directly proportional to the coating thickness in terms of hot dip galvanizing and in terms of a zinc rich paint, the mass of zinc present in the dry film as well as the coating thickness. A further factor is the environment at hand.



Powder coated mild steel – 2 000 hours salt spray.

Care should therefore be taken when selecting zinc based coating systems for chemical environments. Zinc, being an amphoteric metal, is attacked by both acids and alkalis. Zinc should only be used in the pH range 6 to 12.5.

Zinc phosphate and zinc chromate containing paints do not provide cathodic protection as they are inhibitive rather than sacrificial pigments and provide protection by a totally different mechanism.

When considering zinc rich paints, only those that contain sufficient quantities of metallic zinc dust will provide cathodic protection. There must obviously be sufficient zinc particles present to ensure that they are in electrical contact with each other in order to provide a common anode. Individual isolated zinc particles dispersed in the paint binder will not provide protection as they would essentially be insulated from the substrate and each other. On the other hand, if too much zinc dust is added to the paint there may not be sufficient binder available to glue these particles together, giving an unbound coating with poor adhesion and cohesion. In accordance with ISO 12944, all zinc rich paints should contain a minimum of 80% zinc in the dry film in order to function as sacrificial primers.

From the point of view of zinc content, **hot dip galvanizing is the ultimate zinc rich primer.**

A "Duplex Coating" is a term first introduced by Jan van Eijnsbergen of the Dutch Hot Dip Galvanizing Institute in the early fifties. It describes the protection of steel by over coating hot dip galvanizing with an organic coating system. The purpose is to provide additional corrosion resistance, easy visibility, camouflage, or when a pleasing aesthetic appearance is necessary.

Duplex coating systems provide synergy by virtue of the fact that the durability of the combined hot dip galvanized / organic coating system is greater than the sum of the separate durabilities of the hot dip galvanizing and a organic coating layer applied directly to the steel substrate.

The reasons for this synergistic effect are as follows.

When moisture, oxygen and pollutants diffuse through a paint coating onto steel, rust soon forms at the interface. Since rust (a mixture of various hydrated iron oxides with varying compositions) has a volume which is approximately twice to three times the volume of the steel from which it has been formed, the paint coating will lose contact with the substrate and, depending upon its adhesion and cohesion, will start to crack and/or flake off.

Powder coated continuous hot dip galvanized sheeting – Z275 – 2 000 hours salt spray.

When hot dip galvanized steel is the base of a paint system, the occurrence of moisture, oxygen and pollutants at the zinc / paint interface causes the pure zinc (or eta layer) to corrode slowly. However, these zinc corrosion products (mainly zinc oxide and zinc hydroxide) have a volume which is only 15 - 20% more than the volume of zinc from which they have been formed. These zinc corrosion products will block off small pores, craters or cracks in the paint coating, thus conserving its protective properties over an extended period, provided that adequate adhesion of the paint coating was initially achieved.

The benefit of a metallic zinc primer such as hot dip galvanizing under an organic coating system is illustrated by the comparative photographs on the opposite page. The photograph on the left shows a powder coated mild steel panel that has been exposed in a salt spray cabinet for 2 000 hours. The rust staining weeping from the scribe cuts shows that the underlying steel is corroding where the salt spray has gained access to the substrate. The coating adjacent to the scribes is being lifted by the voluminous iron corrosion products. The photograph on the right shows a powder coated panel made from continuous hot dip galvanized sheeting – coating class Z275 (equates to about a 20µm coating thickness). In this instance the metallic zinc primer has provided cathodic protection to the underlying steel at the scribe cuts. The surrounding zinc is sacrificing itself to protect the steel, forming white zinc corrosion products. The solid volume of the zinc corrosion products is small and therefore the coating adjacent to the scribes has suffered little damage. After the same 2 000 hours period there is still sufficient zinc to prevent corrosion of the underlying steel. The sacrificial nature of zinc at the scribe points will in time deplete the surrounding zinc coating and as it recedes, leaving uncoated steel at the scribe point, localised corrosion will commence. Maintenance painting repairs would then be required before the steel substrate is damaged.

In extenuating circumstances such as, possible design restrictions, size of component, geographical location of the fabricator in comparison to the galvanizer, or where hot dip galvanizing is impractical or impossible etc., hot dip galvanizing may have to be substituted by either inorganic zinc or organic (epoxy) zinc.

It is beyond the scope of this article to cover the detailed pros and cons of hot dip galvanizing versus zinc rich paints but one of the main factors for consideration remains costs. A number of articles comparing the relative costs of hot dip galvanizing versus painting have been published.

The essential difference that must be appreciated is that hot dip galvanizing costs are calculated by mass, of steel hot dip galvanized whilst painting costs are based on area painted. Tables are available for most steel sections giving surface area by mass.

As a rule of thumb the following can be used:

Extra light steel	more than $40 m^2$/ton
Light steel	30 to 40 m^2/ton
Medium steel	20 to 30 m2/ton
Heavy steel	less than 20 m^2/ton

In hot dip galvanizing, steel is subjected to a routine cleaning process, including, degreasing, acid pickling and fluxing, with intermediate water rinsing, thereby creating a thoroughly clean surface, essential for hot dip galvanizing to take place. The resultant coating thickness is dependent on several factors including, chemical composition of the steel, steel thickness and surface roughness, as well as a number of other less important factors. In steel of thickness equal and greater than 3mm but less than 6mm, the mean coating thickness is required to be at

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least 70µm and on steel thickness greater than 6mm, 85µm.

The painter will abrasive blast clean the steel and then spray apply a suitable 75 micron thick (inorganic or organic) zinc rich primer coat for a protective coating system at a cost based on the total area of steel he has painted.

Case histories have shown that for steel sections up to some 35m^2/ton it is more cost effective to blast clean and paint whereas for steel sections with greater than 35m^2/ton, it is more cost effective to hot dip galvanize. Obviously this cut off point varies with raw material and labour costs at any point in time. It will also be argued that the hot dip galvanized coating contains more zinc and will therefore last longer than the 75 micron of paint (with 80% zinc in the dry film). On the other hand the hot dip galvanizing will require thorough cleaning before the primer or intermediate coat can be applied.

The point is, however, that both methods of providing the required metallic zinc primer can be cost effective, depending upon circumstances. It is for this reason that in recent years both options have been given in protective coating specifications, leaving the final decision whether to hot dip galvanize or paint, up to market forces.

Unfortunately galvanizing has not faired well in these instances as consideration has to be given to the logistics of galvanizing rather than painting.

Most fabricators have a painting facility in their shops such that the fabricated steel moves through the wheelabrator and into the paint shop where it receives the primer, intermediate and sometimes the finishing coat before it is transported to site. If the steel is to be hot dip galvanized the fabricator has to fabricate, transport the steel to the galvanizer and return it before applying the subsequent paint coatings. In order to make hot dip galvanizing cost effective in this instance the galvanizer needs a painting facility in order to apply the top coats without incurring further transport costs. The concept of applying paint at the galvanizers premises has already been successfully implemented at a number of galvanizers throughout the country.

Clearly hot dip galvanized coatings and paint coatings complement each other in the protective coatings industry. However, there is still a perception in the market place that the galvanizers and paint manufacturers are in competition with each other.

Editorial comment to the article on zinc primers

- *Although zinc is amphoteric, i.e. will corrode at pH less than 6 and above 12.5, if sufficiently over coated with a comprehensive organic coating system, it will provide better protection than the same paint coating system applied over plain carbon steel.*
- *Due to the nature of paint having zinc dust in the coating matrix, on application the zinc will tend to immediately start sacrificing itself, leading to a relatively shortened period of sacrificial protection, and consequently corrosion protection.*
- *All paint coatings in time become porous and this allows moisture to penetrate the coating.*
- *In comparison to a coating thickness of about 20µm, produced by class Z275, continuous hot dip galvanizing of sheeting (SANS 3575), general hot dip galvanizing (SANS 121) produces a thicker coating. 45µm - mean coating thickness, for steel less than 1.5mm thick to 85µm, mean coating thickness, for steel equal to or greater than 6mm. The thicker the available coating, the longer the period of sacrificial protection at damaged areas such as the scribe points detailed in the article, before the onset of localised corrosion.*
- *Recent price comparisons indicate that hot dip galvanizing on its own is competitive when compared to an abrasive blast and a paint coating of about 75µm DFT of inorganic zinc rich paint, in steels from ultra light (70 to 120m^2/ton) to heavy steel (25m^2/ton). This comparison excludes the cost of independent substrate and coating inspection for the painted steelwork and additional transportation of the hot dip galvanized steel.*
- *A hot dip galvanized coating comprises a series of Fe/Zn alloy layers making up between 50 and 85% of the coating. In most instances the Fe/Zn alloys will provide at least 30% greater corrosion resistance than a pure zinc coating. (Frank Porter).*
- *In our opinion, the logistics of additional transport concerns not only the galvanizers but many steel fabricators, faced with stringent environmental regulations for applying paint, lack of skilled painting staff and general downsizing of expertise, forces many fabricators to outsource the painting stage. Furthermore, there are many hot dip galvanizers who have gained the necessary expertise to prepare and apply at least the primer coat, if not the entire coating system. Additionally, where this expertise is not available, some galvanizers can provide industrial painters with floor space, in which preparation and subsequent painting may take place. One galvanizer on the reef is currently considering an in-house powder coating line.*
- *While there is merit in using a duplex coating where it is required, such as in the instances referred to in the article at the start of this feature, there will in most instances be co-operation between the paint and hot dip galvanizing industries. However, when a single coating is specified that must be appropriate and cost effective, there will always be competition between the players of both industries.*
- *In Colin's article he discusses the performance of hot dip galvanizing in comparison to a zinc rich primer and says that the details are too cumbersome for the article at hand. We would like to challenge the zinc primer manufacturers using the services of Colin Alvey to a performance duel. Any takers?*

Duplex Coatings using powder paints

By Graeme Stead of Coating Consultants

My first experimentation with duplex coatings was in the early 1980s. We had used a powder primer (which had been developed for Volkswagen) over hot dip galvanizing for coating turnstiles for railway stations. These were over coated with liquid polyurethane enamel. These items were reported to give outstanding resistance to wear. An offshoot of this technology was a farm sign which has been hanging on a pole on a dusty dirt road for more than 20 years and is still in great shape despite being the target of school kids' stones for two decades!

In fact I gave a picture of this sign to Sir Jan van Eijnsbergen who requested examples of early duplex powder coatings in South Africa. Sir Jan, who coined the name 'duplex coatings', produced his famous book on duplex coatings in 1994 [1.] He wrote "*Powder coatings are increasingly used in Duplex Systems for two important reasons. First, they do not contain any volatile matter (solvents, thinners), thus avoiding costly installations to remove them and are more acceptable to worldwide environmental laws. Second, they possess superior surface hardness and wear resistance in comparison with organic duplex coatings*". He tabled the advantages and disadvantages as follows:

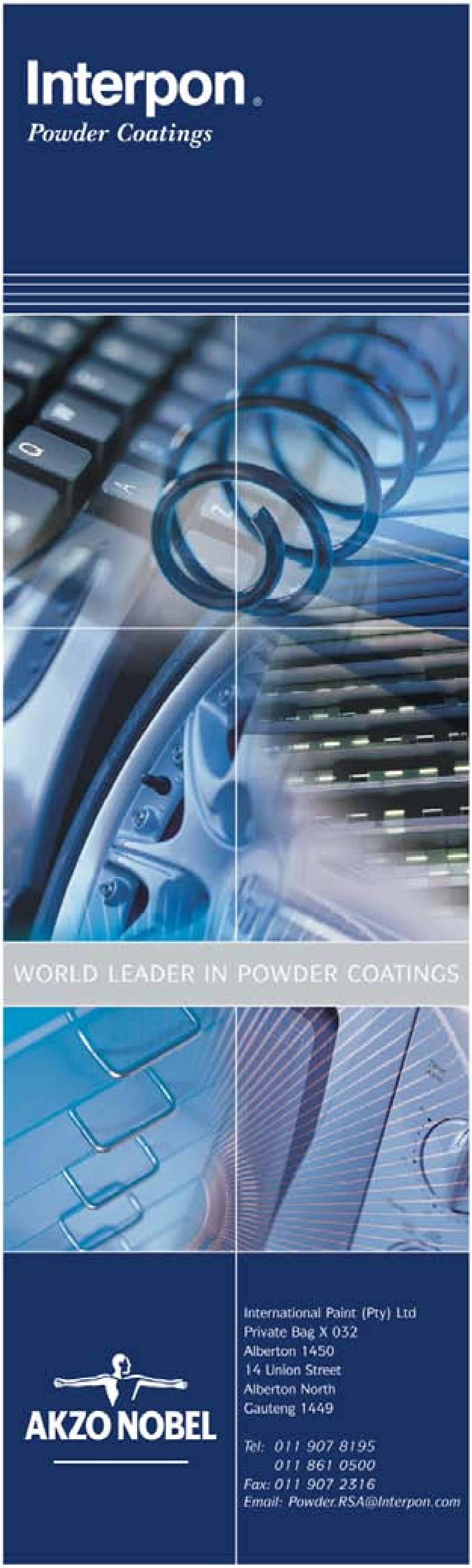
Advantages

- No volatile matter present
- No environmental problems with volatile compounds
- High impact and scratch resistance
- High surface hardness
- Small chance of coating damage during transportation and assembly
- Low powder losses during application
- High to very high resistance against moisture
- Excellent adhesion
- Even coating thickness
- Less fire hazard
- Less floor occupancy in comparison to liquid paint application (no flash-off and inter-coat drying zones)

Disadvantages

- Application only by electrostatic spraying or fluidized bed coating
- Limitations as to form and volume
- Stoving is necessary
- High investment costs for (semi automatic coating lines

Powder coatings and hot dip galvanizing in combination provide excellent corrosion resistant coatings. Such a duplex system provides a high grade architectural finish. The powder coating comprises an epoxy / epoxy polyester or pure polyester thermosetting resin that is applied to a clean hot dip galvanized surface and cured at temperatures near 180°C.



Surface preparation

The surface preparation required to promote good adhesion between the powder coating and the hot dip galvanized surface is similar to that of paints. A profiled galvanized surface will provide an excellent surface for applying powder coatings.

- The components should not be quenched after hot dip galvanizing.
- The surface of the steel should remain clean.
- When transporting the steel be sure to cover loads and keep dry.
- If surface contamination has occurred, clean the steel with a proprietary solvent/detergent that is designed for cleaning prior to powder coating.
- Maximum adhesion is achieved by using a zinc phosphate treatment before powder coating the steel. The surface must be entirely clean as this treatment has no cleansing action.
- It is an advantage to preheat the steel prior to powder coating.
- Use a 'degassing' grade of polyester powder only. Anti-blistering agents such as polyethylene oxide, can be added to the powder to prevent pinholing and promote good adhesion[2].

Hot dip galvanizing substitutes very adequately for a primer and has many advantages over a liquid primer e.g. high edge cover, formation of corrosion resistant layers, very strong adhesion to the substrate – to mention just a few. As Sir Jan says: "Save the surface…..and you save all." After the considerable work involved in hot dip galvanizing, followed by the highly technical process of powder coating and baking, one would think that sufficient corrosion protection had been achieved! But alas, as many have found out to their cost, more is required to provide resistance to exterior, wet conditions!

One must remember that the underlying zinc is a potentially reactive metal surface. Successful exterior corrosion protection is a matter of building sufficient insulation over the hot dip galvanizing to prevent ingress of moisture. In other words, an additional coat (or two) is / are required. van Eijnsbergen says: *"The superior combination of an epoxy powder primer followed by an polyester powder topcoat, yielding a much improved water resistance over (compared with) a single polyester powder coat after twelve weeks of* GM *Scab Corrosion Test, is shown …etc."*

The specifier must design for the worst case i.e. the thinnest possible thickness which will be achieved by the particular application. Testing and/or thorough consultation is necessary to determine whether the coating will be resistant to the environment for which it is planned. Excellent primers such as zinc rich epoxy powder primers, and liquid paint stoving primers are available to enhance the corrosion protection of the polyester powder topcoat. One of the problems of powder coatings is also its most attractive feature – its good looks. The unwary can be quite taken with the outstanding appearance of architectural finishes, not realising that the coating thickness may be well under par.

As with all industrial processes, quality control is of vital importance. Powder coatings only develop their true properties when they have completed their required 'heat history' viz. stoving schedule. Under-cured powder coatings can be as brittle as glass! When properly cured they become tough, highly adherent and abrasion resistant. Thickness, especially in recesses and corners requires to be carefully checked to maintain overall coating integrity.

The market for duplex powder coatings

This consists of any item that can be hot dip galvanized and fit into a powder coating facility (spray booth, conveyor and oven) The following applications were picked up on the South African Web Sites:

- Various cable ladder and tray systems. All steel to be hot dip galvanized and epoxy powder coated on exposed surfaces only.
- Catering equipment.
- Lighting equipment.
- Water tank walls constructed from Zincalume® steel panels. Powder coated panels are available as an option and come in a wide range of colours.
- Lighting products.
- Security fence poles.
- Satellite dishes.
- Air conditioning plant.
- Conservatory structures.
- Panel and Switchboard components.

May this list continue! Powder coating duplex systems are here to stay!

References

1. Eijnsbergen JFH van , Duplex Systems, Elsevier 1994
2. American Galvanizers Association – Powder coating hot dip galvanized steel www.galvanizeit.org

Editors note:

It has been found that when powder coating takes place over the sometimes rough surface achieved by hot dip galvanizing, a structured powder coating helps hide the small blemishes of the metallic coating. However, as a precaution it is important to note that when the component is to be subjected to aggressive marine or polluted industrial environments, the use of a structured powder coating should be avoided particularly as the recorded final DFT *will be practically less than the specified coating thickness due to the peaks and valleys achieved by this type of powder. For aggressive climates a single epoxy / epoxy polyester powder coating layer of at least* 120µm *or the combination of an epoxy plus a polyester exterior powder coating of a similar coating thickness should be specified. Consult the powder coating manufacturer.*

Powder coating over hot dip galvanizing generally calls for "degassing". This involves heating the hot dip galvanized components to about 180°C *to drive off any moisture from the chemical process liquids and eliminates the possibility of blisters appearing through the powder layer when stoving takes place. The term "degassing" is therefore a misnomer as no gas is trapped in the hot dip galvanized coating.*

Re-establishment of the Duplex Committee

During the mid 1980s the South African Hot Dip Galvanizers Association realised that, whilst there was an increasing requirement for duplex coatings in South Africa, there was little co-ordinated information available as to which particular coating systems in the market place were suitable for duplex systems. They were very sensitive to the fact that the use of the wrong coating systems would lead to failures which would discredit the concept of duplex systems. In order to ensure that this did not happen they called together the major paint manufacturers in the country at that time and formed a specialised "Duplex Committee". This committee, which met regularly, sponsored the independent testing of a number of proprietary organic coatings for use in duplex systems. The test work, carried out by Eric Duligal & Associates, covered the following:

(i) Investigation of current practice and recommendations of paint manufacturers on application of paints to hot dip galvanized surfaces.

(ii) Testing of manufacturer's products and systems.

(iii) Adhesion of coatings to sweep blasted surfaces.

(iv) Evaluation of adhesion testing methods.

(v) Evaluation of different surface preparation methods.

Whilst the results achieved from these tests were interesting and indicated that there was a definite future for duplex systems in South Africa, the control of system selection was going to be difficult, if not impossible, considering the vast number of proprietary products available and the lack of documented performance results and case histories.

It soon became apparent that formal codes and specifications for duplex coatings were required. The Duplex Committee then channelled its efforts into producing a specification and code of practice for duplex systems and these were published in 1990.

Specification for the performance requirements of coating systems: No SAHDGA 1-1990

This document covers coating systems applied to new unweathered hot dip galvanized steel (sheet and section) excluding in-line coil coating. It is a very useful document in that it specifies all of the tests to which a candidate coating system must be subjected before it qualifies to be used in a duplex system. In addition to specifying the test methods, it also specifies the minimum test criteria or results that the coating must achieve. This specification covers the selection of duplex systems for use in the following environments:

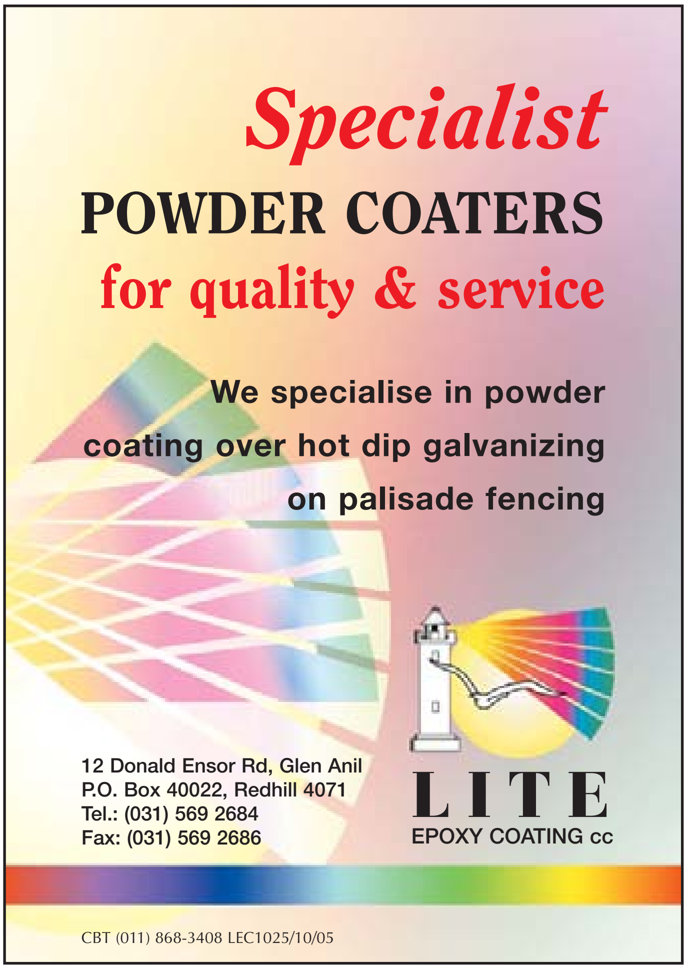
Mild - (rural) conditions.

Industrial - conditions (mildly polluted environments, not in immediate proximity to chemical plant).

Marine - (coastal) environments.

Mining - applications underground.

Immersion - For the lining and coating of pipes carrying raw potable or re-circulated water, gas or oil, but excluding very aggressive chemicals such as acids, bleach solutions, ferric chloride solutions and brine.



The onus was on the paint manufacturer to test his materials for conformance to this specification before recommending or specifying their use in duplex systems. If the Association was advised by the manufacturer of his compliant systems, the Association could in turn recommend the use of the particular systems to end-users and specifiers. Correctly implemented, this specification is of obvious benefit to all parties.

Code of practice for surface preparation and application of organic coatings: No SAHDGA 01-1990

This code of practice, as is the case for the specification, refers to duplex systems applied to new unweathered hot dip galvanized steel (sheet and section) excluding in-line coil coating. The code has been prepared for specifiers, end users, inspection authorities and painting contractors to make them aware of the procedures necessary to ensure acceptable adhesion of paint to hot dip galvanized surfaces. It was obviously intended to cover the application of only those materials that comply with the requirements of the "Specification for the Performance Requirements of Coating Systems" described above.

The implementation of the code of practice and its sister specification virtually guarantees a successful duplex coating system.

The protective coatings industry has changed considerably since the early 1990s with a number of new overseas based manufacturers entering the market place. It is time for the Duplex Committee to re-convene to update the Specification and Code of Practice for Duplex Systems and to address new duplex systems and galvanized iron cleaners.

In a number of European countries duplex coatings are becoming the rule rather than the exception, particularly on architectural structural steelwork. With closer cooperation between the hot dip galvanizing and painting industries, there is no reason why this should not become the trend in South Africa to the benefit of the steel construction industry.

The above article was compiled by Dr Colin Alvey in the interests of Duplex Coatings, the Association wishes to thank Colin for his interest.

Should you be interested in being part of the re-established duplex coating committee for both solution and powder coatings, kindly fill in the details below and fax or email them for the attention of Terry Smith at (011) 456 6304 or hdgasa@icon.co.za or terry@hdgasa.org.za.

READER'S COMMENTS

Sandie Thomas of Richard Egan & Associates, writes – In magazine number 23, Case History N°3/2005, the name Mitchels Plain was spelt incorrectly. It should be "Mitchels Plain" and not Mitchelsplein, as we spelt it.

Editor – Thanks for your correction and interest in our magazine, Sandie.

Johannes Potgieter of the Department of Water Affairs, writes – that he would like to see a register of all the interesting articles that have been published in past magazines, compiled for easy reference.

Editor – Thanks for the response Johannes, we are presently compiling such a register and will advise in the next magazine, when it is available. We will most probably place it on our Web Site!

Ray Wilsenbach, MD of Nemtech felt that the photo entitled, "A typical hot dip galvanized support of an electrified fence", in magazine number 24, used to enhance the article provided by Nemtech was inappropriate.

Editor – Thanks for pointing this out, Ray we apologise for the inconvenience but innocently added the photo to enhance the effect of the article.

First name: ______________________________

Surname: ______________________________

Contact tel: ______________________________

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Organisation represented: ______________________________

Interest: ______________________________

Interests would include: *Paint and powder manufacturers; paint applicators and powder coaters; abrasive blast media suppliers; abrasive blasting companies; Corrosion Consultants; general interest, etc.*

Another yard stone, another day – O-line duplex is definitely the way

Graeme Smart, Sales & Marketing Director

The recent award of the Mufulira project to O-line by Marpels Joint Venture for the supply of cable ladders, has once again proved that together the combined input and expertise of all major industry roll players, can create a synergistic operation which would provide clients nationally and internationally with sound solutions at cost effective prices.

After many hours of discussions and the help of experts in all areas of discipline it was decided that a Duplex coating was to be specified. The coating of which consists of hot dip galvanizing over coated with an epoxy powder under coat for added corrosion protection and a pure polyester powder finish for the UV rays produced by the Zambian sun, has been accepted by the client.

The resultant effects of this decision has given O-line the opportunity to once again prove the value and effectiveness of the DUPLEX Coating system which in the past, due to some misconceptions by certain parties, did not receive the recognition it deserved.

The Duplex coating system has withstood the test of time. Classical examples being that of Phalaborwa (Cable Ladders); Mossgas (Cable Trays); Hong Kong (Sun Shields) and many others of which I quote Walter Barnett " are still fighting the common enemy" "corrosion".

O-line prides itself in that its powder coating plant has an impeccable track record when it comes to success in terms of adhesion and bonding of the powder coating to the hot dip galvanizing. This is obtained through careful preparation of the product, which undergoes a seven-stage process before entering the spray lines. O-line runs a Chemetall line, which is monitored three times a week to ensure the cycle remains stable and consistent.

Seven Stage cycle

The stages begin with a degreasing process, which is a soap blend commonly

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Kevin Murphy

known as formula 30 then into a water rinse. From the rinse, in the event of white rust, it enters the de-rusting bath which is a combination of phosphoric and sulfuric acids followed by a second water rinse. From the second rinse into the pre-treatment bath or etching process back into a third water rinse and finally into the passivation bath and into the dryers.

Once the product has left the Chemetall line the product` enters the "degassing" stage whereby the item is heated to appropriate temperatures.

Spray line

With regards to the Mufulira Project the product undergoes a double coat application via electrostatic adhesion spraying, the under coat is an "Interpon 100" epoxy based powder and the second coat is an "Interpon 600" polyester based powder. The curing process is achieved by utilising infrared in the first cure, and the addition of gas for the second cure.

O-line is certain that the duplex coating will exceed expectations and create further opportunities, specifically where expertise and product solutions are sought within South Africa.

It is imperative that more projects are handled in this manner, whereby expertise and organisations are able to join together in providing a service, which meets global standards, resulting in competitiveness against foreign intervention in the African market. Projects of this nature are the lifeblood of our sustainability.

To conclude O-line would like to extend our appreciation for the opportunities afforded us and the contributions made by the following organisations and individuals.

- SNC-LAVALIN /Marples Joint Venture - Donald Coupland;
- CATS - Dr Colin E. Alvey;
- Hot Dip Galvanizers Association - Walter Barnett and Terry Smith;
- AKZO NOBEL - Technical staff.

Federation Square – Australia

Vision

Federation Square is one of the most ambitious and complex projects ever undertaken in Victoria, Australia.
It is a complete new city block, the first ever to physically connect the central business district with the Yarra River. Situated at the heart of central Melbourne, Federation Square will be a fusion of arts and events, leisure, hospitality and promenading.

Design

Federation Square's design is the product of an international architectural competition won in July 1997 by Lab Architecture Studio of London in association with Bates Smart Architecture of Melbourne. Atelier One were appointed Project Structural Engineers. The judging panel said of the winning design: "It draws its inspiration from the unique characteristics of Melbourne's arcades and laneways and transforms these elements into a new form of organisation, celebrating the city. The design will invite pedestrians to explore a complex and urban linkage of open and closed spaces, a set of different amenities brought together in the architectural equivalent of Federation".

Federation Square has been described as an area with extensive flow, integrating activities across the site and forming links within it as well as with the Yarra River, Arts Centre, Southgate and the Central Business District.

Federation Square's architectural intent is to generate visual harmony for the site while maintaining differences between its civic, cultural and commercial buildings. The approach creates distinctions through a high degree of surface and material variation. The creative use of the "pinwheel" triangular grid, in which every panel is exactly the same size with only the orientation changing, as the molular basis for this system allows both façade cladding and frame shapes to be treated in a continually changing visually dynamic way. On the main buildings three cladding materials have been used, sandstone, zinc and glass.

Interest in the appearance of hot dip galvanizing is its appeal as a naturally occurring cast coating with a distinctive metal character. Greater uniformity within certain parameters can be achieved by concerted attention to steel detailing and fabrication.

A number of buildings form the complex with significant steel involvement in the principle buildings. These are clad in stone, zinc and glass panels of "pinwheel" shapes fixed to hot dip galvanized steel frames usually exposed to view from within the buildings but also occasionally visible from outside through exposed unclad holes.

South and north atrium buildings

These public interactive buildings are framed in an exposed web of raw hot dip galvanized steel, clad internally and externally in "pinwheel" shaped glass. The south atrium provides an amphitheatre, while the north atrium provides public access to the National Gallery. Arguably this will become one of the most unique buildings in the world.

The primary frames and members are fabricated from 200mm square hollow sections with the inner and outer walls a "web" like structure, non parallel and approximately 1 200mm to 1 500mm apart. The pinwheel shaped glass is fixed to light secondary hot dip galvanized frames of the same shape. The primary steel is similarly shaped with more than 1 000 straight pieces different and individually numbered.

Pre-production and prototyping

Consultations were held with all parties to discuss every aspect of the hot dip galvanizing process and its impact on the visual and structural criteria of the project. The hot dip galvanized colour and sheen variance between hollow, plate and strip sections were considered. Detailing, such as drain hole frequency, size and location, weld growth and dimensional stability within product design tolerance, were addressed. Steel composition was critical to the appearance outcome and was closely monitored. A disciplined quality assurance program was a common interest and responsibility. As all frames were double dipped due to their size, the galvanizer instituted special procedures at their plant to ensure that all offered standards were maintained under a strict production quality system.

Fabricator delivery

After hot dip galvanizing, members were returned to the fabricator's factory for checking and stock piling ready for despatch to site in the required erection sequence. As of October 2001 approximately 90% of the primary steel was erected into the unique web without the need for any remedial work to a member. In excess of 1 000 tonnes of hot dip galvanized steel have been used.

The Association wishes to thank Galvanizers Association – Australia for this contribution.

Editorial Comment

It is worthwhile noting that in spite of some 1 000 tons of very difficult steel section configurations (see photo) that were hot dip galvanized, only 10% of the steel needed some form of remedial work, over the project period.

This could only be achieved by firstly, initial and subsequent regular communication between all parties, including the galvanizer and secondly a mix of other important aspects, including:

- *Size of members vs available bath sizes, weld growth and dimensional stability.*
- *The position and optimum size of fill and drain holes.*
- *Steel composition.*
- *The colour variance between hollow, plate and structural sections.*
- *Disciplined QA program, including sample approval by all parties.*

We are of the opinion that instituting sound and regular communication opportunities between all parties and by implementing the requirements of the "Architectural Check List", see magazine no 24, a far higher degree of hot dip galvanizing coating success can be achieved to the satisfaction of all parties.

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Grand Arbour – Australia

Redevelopment of World Expo 88 Site

The South Bank Corporation is a body corporate established by the Queensland Parliament as gazetted on May 8th 1989, with more recent amendments reflecting the growing role of the Corporation in the further management of this city area. The mission of the Corporation is to facilitate the development and operation of a successful world-class leisure, business and residential precinct, for the enjoyment of visitors and the general benefit of the Brisbane community.

Master Plan

Denton Corker Marshall

The master plan of the expo site and some adjoining neighbourhood, comprises approximately 43 hectares along the Brisbane River, directly opposite the central business district.

In addition to the Brisbane Convention and Exhibition Centre, South Bank features an international hotel, high quality corporate office development, selected academic facilities, residential apartments and a range of restaurants, retail outlets, a swimming lagoon with its own beach and a tropical arbour linking the entire development.

Parkland

The 17 hectare South Bank Parklands stretches along one kilometre of the river bank, where further development includes placement of tropical rainforest trees, surrounding open green spaces of ground vegetation; a soothing contrast to city activity.

Vision

The success of the development has arisen from the adage that enthusiasm is infectious. In this case, it has also been innovative and inspired.

A cooperative team of experts have created a city development equal to any in the region, with an admirably balance of community consideration, appropriate function, environmental concern and aesthetic appeal.

Even yet, the project is not considered closed, where clearly opportunity is being provided for further development for the future growth of the area.

The Arbour Denton Corker Marshall's project report comments: "The Grand Arbour is a 1km long architectural and sculptural installation, providing a physical and visual link between the many facilities of the South Bank precinct. A central aspect of the masterplan development, the Arbour mediates with the new open parkland to the west, while providing a sheltered north-south route through the entire site. Sinuous steel posts, up to 10m high, support a band of purple bougainvillea, either above, to the side or entirely enveloping the curving path. The juxtaposition of the various post configurations creates a diversity of spaces from tight and enclosed to wide and expansive. Overlapping steel panels form a plated yellow ribbon canopy along half of the Arbour's length. A total of 406 hot dip galvanized steel posts are spaced at 4m nominal centres. A unique architectural and urban gesture, the Grand Arbour is designed to offer Brisbane a new, distinctive and memorable landmark.

Modular Components

The height of the posts (10m) meant that they would have to be in parts for ease of transportation and assembly. A kit of parts, made up of a small range of components was the solution. The posts were divided into three unequal lengths – base, neck and head. Three variants were devised for each part (A,B,C) resulting in a total of only nine different components. Any base component could be connected to any neck and any neck with any head. They could also be rotated 180°. This allowed for a possible 108 different permutations for the post profiles, varying from 10m high gently undulating to head height expressively curving.

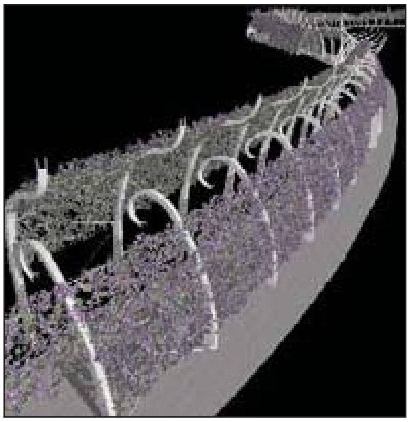
Computer Model

The complexity and non-linear nature of the project meant that traditional documentation techniques would be insufficient. Advanced Computer Aided Design for all stages including design, documentation and construction was utilised. The entire Arbour was simulated as a full scale 3D computer model, from which all plans, elevations and sections were extracted.

Specially written computer programmes analysed the CAD model and automatically generated schedules for the Arbour setout and post components.

Finishes

Hot dip galvanizing was selected as the finish for the posts. Corten steel (a pre-rusted finish) had been considered in the early stages, but concerns over run-off staining of the path (and pedestrians) negated its use. Furthermore its rusty brown colour would give the impression that the posts were imitating trees.



The Arbour, while being organic, was clearly to be a man-made insertion into the landscape, not an imitation of nature. "The grey metallic finish of the hot dip galvanizing provided the desired artificiality and industrial ruggedness, in addition to a low level of maintenance."

The Association wishes to thank Galvanizers Association – Australia for this contribution.

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Isabel II Park, Palencia – Spain

Integration of the living present and historical tradition

The concept of the public garden or park should be a place of tranquillity and aesthetic beauty, where people can go to find peace and to re-charge their "batteries" in the midst of a busy city life. A good park will blend living gardens with complementary architectural structures that are both pleasing to the eye and have a certain practical use. The architecture of the Isabel II Park in Palencia, Spain has sought to do this in a novel way, suitable for a progressively improved city.

The structures occupy an area of approximately 38 000m^2, including the area of the Paseo del Salón, an old avenue open to pedestrian traffic which is integrated within the general space of the park. Inside the old park two highly differentiated areas may be clearly identified. One, to the southeast, is made up of what is known as the Historical Garden of Isabel II, and features the ornamental gardens and the oldest and leafiest wooded area. The other, to the northeast, has more open spaces.

The new scheme attempts to unify the two old areas of the park, with the idea of creating a common sky-roof, with vegetation in the old area and the symbolic canopy of the pergola of hot dip galvanized steel of variable height in the modern area. Furthermore, the new layout of the park joins these two aforementioned old areas through three longitudinal routes, brought together in three broad avenues running east-west.

The Main Avenue runs through the entire park, parallel to the pedestrianised Paseo del Salón. Situated in the Paseo is a long, low pergola with a structure of hot dip galvanized sections and a roof of expanded hot dip galvanized steel sheet, that will serve as a venue for future exhibitions, and beneath which there has also been installed a series of permanent kiosks.

The Central Avenue runs along the longitudinal axis of the historical ornamental gardens and the Rose Garden. The large pergola, a spacious hot dip galvanized steel structure, is located on this avenue, in the area of greatest remodelling of the park. With its height it constitutes a metallic canopy equivalent to the existing tree canopy in the area of the Historical Garden. This pergola is similarly covered with expanded hot dip galvanized steel sheeting, with different perforations that throw a shadow that changes throughout the day, and below which is located the garden of aromatic and medicinal plants. At the far end of the pergola there is a lake, over which the Central Avenue extends by means of a footbridge, which is also hot dip galvanized.

The Open-Air Auditorium

Hot dip galvanized steel is the selected material for the construction of the open air auditorium, and equal importance has been given to it in the architecture of all the elements in the park, as described above. Due to its aerial lightness, its iridescent colour, its great corrosion resistance and its low maintenance cost, it proves to be the ideal material, on one hand for generating a very beautiful contrast between nature and artifice and on the other, for ensuring its practical use in the open air.

The structure of the auditorium has utilised steel sections, which have been hot dip galvanized. The slender vertical pillars are made of two clipped profiles. They support a box built with a framework of steel trusses, wrapped in a translucent skin of expanded hot dip galvanized steel sheet and a light covering of two layers, one of cellular polycarbonate and the other of expanded hot dip galvanized steel sheet as in the façade. This raised aerial box conceals the structure that will be the support for the stage infrastructure, the scenery and the lighting equipment.

The structure of the enclosed stage area is organised into three sections. Four principal trusses parallel to the front of the stage, 5.5m high and 15m wide, support the distance of 12m between pillars and have a projection of 1.5m on both sides, through which pass the two longitudinal maintenance walkways. Perpendicular to the front of the stage and as a tie-in to the aforementioned structure there are two second-order trusses with chord and web members. Finally, a third section of trusses is located on the main trusses in the form of "hairpins" and acts as a support for the four transverse walkways, as well as a support substructure for the lattice of the façade. The enclosed stage area therefore contains four transverse and two longitudinal walkways, made up by grid panels and hot dip galvanized steel flats.

The foundation consists of a reinforced concrete slab, under which is a space that houses some small dressing rooms and toilets, taking up a third of the area.

The metallic structure of the auditorium was modulated in pieces of the greatest possible size, within the constraints imposed by transport and the galvanizing process, with the aim of producing a work with the fewest possible joints, all of which are bolted.

The Auditorium of the Isabel II Park was awarded First Prize in the Spanish Galvanizers Association Awards, 2004.

The Association wishes to thank the Spanish Galvanizers Association for this contribution.

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A snapshot of what is going on in North America

The Association wishes to thank the AGA for this contribution.

Caltrans District 7 Headquarters

Caltrans is responsible for design, construction, operation and maintenance of California's state highway system. Due to previous experience, hot dip galvanizing has been the exclusive choice of Caltrans for corrosion protection.

Caltrans demonstrated the partnership with hot dip galvanizing in an aesthetic fashion by integrating a hot dip galvanized fascia into the design of its new headquarters, located in the historic civic centre area of Los Angeles. Included in this visual image of what Caltrans does on a daily basis – ie., design with hot dip galvanizing – is the structural steel and handrail for the unique face of the building.

Architect – Morphosis

Contractor – Clark Construction Group

Liberty Pedestrian Bridge over the Reedy River

The Liberty Bridge is both a curved and cantilevered structure, the only one of its kind in the USA, creating an aerial amphitheatre for pedestrians to enjoy the spectacular views of the Reedy River Falls in Greenville, South Carolina. With a 90 foot (27.5m) high suspension towers that lean 15° away from the walking deck, the bridge's 330 foot (100m) long by 200 foot (61m) clear span appears to float above the landscape.

Both the reinforcing steel and bridge cables were hot dip galvanized, as the architect stated, "I want this bridge to stand for as long as possible without maintenance to the concrete deck."

Architect – Miguel Rosales of Rosales, Gottemoeller & Associates

Engineer – Schliach Bergermann

Harrisburg Airport Multimodal Transportation Facility

The Harrisburg Airport Director, who had a previously very positive experience using hot dip galvanizing, together with the designers selected the coating again to protect most of the structural elements of the building. "The designers liked the strong contextual relationship between the hot dip galvanized multimodal facility and the airport's new terminal."

Architect & Engineer – HNTB *Architecture*

Underground Mining Personnel Carriers & Transport Vehicles

For harsh underground coal-mining operations, other than the hood, fenders, bed and rails, hot dip galvanizing was selected to protect the entire vehicle. The ability of the coating to withstand abrasion, rough treatment and regular wash-downs, necessary to remove dust build-up, was the major consideration for the selection.

The durability of the hot dip galvanized coating on these vehicles has saved the mining industry thousands of dollars and continues to attract end-users in a variety of other underground applications.

Architect & Engineer – Terra Pro

We recently received the following letter from a reader:

duplex coatings c.c

CK No 2005/009611/23

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Southdale
2135

Tel.: 827-4221
Fax: 827-4561
Email: bulldogproj@murrob.com

Specialists in the preparation and painting of hot dip galvanized steel: sweep blasting, abrasive blasting, tank linings and industrial painting

Re: Product "X"

I recently received a brochure from a paint manufacturer in KZN which contains extravagant claims concerning the protective properties of a zinc rich paint that has been developed. The brochure also contains statements of a somewhat questionable technical nature in comparing hot dip galvanizing with this organic zinc rich product.

I would value your comments.

Yours sincerely
Mike Book
Duplex Coatings cc

***Editors comment*:**

Walter had already pre-empted the concerns expressed by Mike Book in correspondence addressed to the author of this brochure. Readers may find these comments interesting. To avoid embarrassment, the name of the paint manufacturer and that of his product have been withheld.

I have read with interest your notice concerning the merits of "X" zinc rich paint. With respect, it is necessary to comment on some of the statements contained in this notice.

- *You refer to the propensity for distortion in the case of hot dip galvanizing. Meanwhile, some 350 000 tonnes of steel other than sheet and wire is successfully hot dip galvanized annually in SA. The fact is that provided the correct design fabrication and galvanizing procedures are implemented, the incidence of distortion is minimal. To say therefore that "there will be a distortion that could be costly in the manufacturing of the items" is misleading since the truth is that in the vast majority of cases, the absence of any distortion of components which have been hot dip galvanized can be guaranteed.*
- *You make the claim that "X has been formulated as a paint to offer the same protection as galvanising". This ignores the fact that hot dip galvanizing is metallurgically bonded to the steel substrate by a series of corrosion and abrasion resistant Fe/Zn alloys whereas any paint system relies entirely on adequate surface preparation to ensure a mechanical bond.*
- *You state that "As can be seen in the photograph, the steel would have to be grit blasted and the correct quality procedures will need to be followed in order to make this product a successful one". You do not make it clear which process you are referring to but presumably you mean "X" since the hot dip galvanizing process does not require grit blasting for surface*

continued on page 49...

MISCONCEPTIONS

Miss Conception puts it "straight"

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

Hot dip galvanizing combined with a good paint system provides limited added corrosion protection while the adhesion properties of a paint system applied onto a hot dip galvanized surface will always be suspect.

True or false?

The simple response to this statement is that it is based on misinformation and ignorance of technically substantiated facts.

While this subject has been discussed previously in this column it warrants revisiting.

The demand for duplex protection (hot dip galvanizing plus a heavy-duty protective paint system) continues to increase for applications where aggressive corrosive conditions pertain. This trend is due to the numerous successful results obtained by monitoring the performance of duplex coatings exposed to aggressive conditions throughout the country and elsewhere. To illustrate, a slipway for fishing boats at Saldanha Bay was originally protected by a good epoxy paint system. A similar structure at St Helena was subsequently protected by a duplex system where an epoxy paint system was applied over the hot dip galvanized coating. After several years in service, the Saldanha Bay structure was condemned as unsafe, due to corrosion. Meanwhile, the consulting engineers involved with both these projects were monitoring the performance of the duplex protected structure at St Helena.

The performance of the duplex coating at St Helena has been entirely satisfactory with the result that the consultants decided to recommend duplex protection for all replacement slipway steel at Saldanha Bay. This is an interesting project in that the contractor was able to salvage some 25% of the original steel components, which were subsequently hot dip galvanized and painted with the same duplex system as applied onto all replacement steel. This is only one of many examples of success that can be sited.

Contrary to the common misconception, hot dip galvanizing is indeed an ideal surface on which to apply a paint coating. The best results are achieved if paint is applied onto freshly hot dip galvanized surfaces after appropriate surface preparation and as soon as possible after hot dip galvanizing. Delayed painting to enable the zinc surface to weather is unnecessary and can be undesirable particularly in corrosive environments where the coating may be subjected to surface contamination. The selection of a compatible paint is important. Most paints are compatible with zinc but alkyd enamels should not be applied directly onto a hot dip galvanized surface. This is because the alkyd products react with zinc at the interface to form zinc soaps, which over a period of time will result in de-adhesion. This chemical reaction is technically described as saponification.

As with any other material to be painted, adequate surface preparation and surface cleanliness are important prerequisites for acceptable paint adhesion. Some of the reputable galvanized iron cleaning (GIC) chemicals, supplied by paint manufacturers are quite effective for substrate preparation, provided that they are applied in accordance with the manufacturer's instructions.

Light sweep blasting of the hot dip galvanized surface with the correct abrasive which is readily available, will provide outstanding adhesion. Unfortunately this surface preparation method is abused by applicators who through ignorance and an absence of technical expertise combined with a degree of sheer stupidity, see the term sweep blasting as a method of shattering the hot dip galvanized coating with an unsuitable abrasive at inordinately high blasting velocities. The motivation for such irresponsible behaviour, which is frequently encountered, is beyond comprehension.

If correctly done, sweep blasting will remove a negligible quantity of the zinc coating (at the most about 6 - 10 microns) while at the same time it will provide a surface profile of about 50 microns.

The concept of duplex protection is gaining in popularity with the result that many galvanizers in Europe are adopting the concept of a "one stop corrosion protection shop" where both hot dip galvanizing and subsequent painting is undertaken at the galvanizers' premises. South African galvanizers are currently implementing this concept to the extent that some have already reached the mature stage where they can be acknowledged as both galvanizers and competent paint applicators.

Personality Profile

Darelle Tania Janse van Rensburg

I am an independent corrosion and coating consultant and currently head the Corrosion and Coating Section of Orytech (Pty) Ltd. This company also specialises in industrial plant, project management services.

I originally started out as a high school Science teacher, but later joined Eskom's Corrosion Group, in 1990. Here, I developed and obtained the necessary skills as a corrosion protection specialist with respect to power generation, distribution and transmission plants. I later headed the Corrosion Group at Eskom and apart from having had a resource managerial function, also provided technical advice and support in the fields of industrial coatings, material protection and general corrosion problems. During my period with Eskom, I have completed numerous research, inspections and failure investigations projects related to the corrosion and corrosion protection of power generation, transmission and distribution plants.

Up to now, and even in my new capacity as an independent consultant, I have been involved in the writing of many of Eskom's corrosion protection specifications and have specified hot dip galvanizing on more occasions than I can remember. My appreciation for hot dip galvanizing as an excellent long-term corrosion protection system have come about, having first hand witnessed it's high-quality performance in terms of corrosion protection of structural steelwork throughout South Africa, that is with respect to Eskom's overhead power line structures and sub-stations. Also, having personally tested numerous duplex-systems over the years, I have come to recognise that hot dip galvanizing can be effectively used in high corrosive environments, especially when suitably overcoated with durable organic coating systems.

My present goal is to expand and continue with the development of an independent corrosion and corrosion protection testing laboratories for heavy-duty industrial systems. I envisage that in the years to come, many new systems will be developed, tested and used in combination with hot dip galvanizing. In addition, it is certain that in many of the future material exposure programmes that I may be involved with, hot dip galvanizing will continue to be used as a bench-mark corrosion protection system, in terms of the performance testing of many other materials.

I presently hold the position of Second Vice President of the Corrosion Institute of Southern Africa, and through this function have come to greatly appreciate the technical support and dedication provided to the industry, by the Hot Dip Galvanizers Association of Southern Africa. Since only a few companies continue to invest in research and development programmes, it is good to see that an industry, ie. hot dip galvanizing industry, can still stand together and jointly, support, investigate, share and research their own technology.

Guest Writer

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

The reciprocal nature of language

I used to be intrigued and mystified by the origin of languages. Modern linguistics did not help me much as most theories seemed to be solely in terms of one language with little attempt being made to give them a wider application. Our common linguistic ancestry seems to have a truly inaccessible past. I was alarmed that according to some evolutionists, the distant common ancestor and the 'material cause' of all modern language might not even have been a language, but a form of vertebrate evolution: of body, brain and behaviour, or whatever this means.

My understanding of language took a giant step forward when I realised that all I needed to know is that there is a relationship between what is going on 'in my head' and a bodily activity that produces sounds and gestures which are perceivable by others and interpretable by them. Language seems to be my capacity to try to alter the mental organisation of someone else. Sometimes, I succeed in this, but more often I do not, especially, or so it seems, in relation to my teenage children. In this regard, I found it easier to change my own mental state by talking to myself.

Wild African parrots provided me with an important key to the understanding of language. I read that they coordinate their mating ritual by producing a common song. While each bird appears to be singing a full melody, it is actually a duet in which the two birds progressively expand upon each other's phrases. What is intriguing is that the level of the ritual is determined not so much by the 'meaning' of the sounds but by the intensity and dynamics of the melodic coupling. It seems that the mating ritual has 'reciprocal altruism' (you scratch my back, I'll scratch yours) bound up with it. The mutual coordination of the mating behaviour develops from a 'back and forth' kind of relationship where each parrot benefits from the response of the other. Surely, this must be true about language.

The last ten years of our new democracy in South Africa has taught me a lot about language. We have eleven official languages- ten indigenous ones and English. Previously, the different languages were viewed as the cornerstones of the cultures they supposedly represented and for a variety of reasons generally kept the people apart from one another. Now, within a framework of democracy, they are bringing people together. South Africans are going out of their way to learn and speak as many of the other languages as they can and even with just a smattering they are communicating. Personally, I have found that it does not even matter if you can't speak the language properly but if you just stop and greet a person, using gestures and a smile, one can communicate. I had a conversation the other day with a complete stranger: we smiled, we laughed, we used one or two common words, we slapped hands, we touched and although we did not know what the other was saying, both of us came away knowing that we had bridged a divide and it was a very valuable experience. Languages are also in the process of blending. This may horrify the purists but it is a trend that nobody can stop as it has powerful tentacles driving into all aspects of our unique society, including music, writing and the media.

My firm view of language now is that it is a powerful instrument and constitutes one of the principal forces controlling and forming human behaviour. Language needs to be supported by face-to-face contacts where gestures, facial expressions and tone complement syntax and understanding. Unlike the African parrots, human beings need to see one another to maximise the co-ordination of behaviour through language. As is happening in South Africa, language can also help people truly 'see' one another.

Walter's Corner

Corrosion control by hot dip galvanizing plus paint

Zinc rates among the most intriguing metals provided by the creator for the benefit of mankind. Apart from its nutritional value and numerous other important metallurgic properties, millions of tons of zinc produced annually throughout the world are used to provide protection from corrosion. This in itself is an enigma since zinc is an unstable metal in its pure form, which is a polite way of saying that it is prone to corrode. Why then is it successfully used to reduce corrosion?

The answer to this is fairly simple. When a zinc coating applied by the hot dip galvanizing process is exposed to the atmosphere, the zinc surface of the coating reacts with the oxygen and carbon oxide in the air to provide a stable corrosion resistant surface film of zinc carbonate which protects the underlying reactive zinc.

The prime objective of a hot dip galvanized coating and some of the other zinc coating processes is to provide an impermeable metal film, which precludes the contact of moisture and corrosion inducing substances with the steel substrate. The durability of this protective barrier is determined mostly by the corrosion resistant properties of zinc carbonate. This explains why added protection by way of an organic paint coating enhances the durability of a hot dip galvanized coating in aggressively corrosive applications, since the protective zinc carbonate layer on the surface of the galvanized coating is enhanced by the added protection gained from the paint coating. When moisture permeates through the paint coating, any zinc corrosion products formed at the paint / zinc interface constitute a solid volume of about 20% greater than the zinc from which they have been produced. Were a similar protective paint to be applied directly onto a steel surface, the corrosion products produced at the interface would be some 2 to 3 times greater than the original steel. Clearly, the propensity for de-adhesion of the paint film and subsequent coating failure is also far greater.

The second line of defence provided by zinc is cathodic protection whereby zinc, which is electronegative in relation to steel, constitutes the anode with steel as the cathode in a corrosion cell. This results in the zinc being preferentially sacrificed to protect the steel.

With a hot dip galvanized coating, cathodic protection will only come into effect and for that matter is only required once the coating has been breached and underlying steel is exposed for whatever reason. The benefit of this protective mechanism is significant in that corrosion cannot creep under a galvanized coating, while small uncoated surfaces are provided with cathodic protection from the surrounding zinc film.

In the case of paints, which contain zinc, the situation is different in that zinc is added to the paint in order to augment barrier protection by the paint throughout its service life. When moisture permeates through the paint film to the steel substrate, cathodic protection at the interface is provided by the zinc particles present within the paint. Plainly, the presence of sufficient zinc particles is essential (80% of the dry film is generally recommended) in order to provide electrical contact between the particles within the binder as well as with the steel. Nevertheless, it follows that once zinc particles have been consumed in providing sacrificial protection to the steel, the mechanism of cathodic protection ceases and the barrier protection provided by the paint is reduced.

This is not to say that zinc rich products are not what they are "painted to be". Products such as inorganic zinc silicate have a proven successful track record as prime coats over which to apply a heavy-duty organic paint system. But I venture to suggest that cost effective easy to apply duplex systems (hot dip galvanizing plus paint) provide at least equal if not enhanced long term corrosion protection to that available from zinc containing paint systems.

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Barloworld Galvanizers installs four metre deep kettle

For some time, the management of Barloworld Galvanizers had given serious consideration to installing a deeper kettle.

This largely arose from a noticeable trend towards more 'long' products in excess of 2.3m requiring hot dip galvanizing. Most products with a 'height' in excess of this figure, particularly fabricated structures and box frames, as well as fencing panels and gates, required vertical double dipping.

Barloworld Galvanizers have for a while now, had the ability to galvanize plate girders up to 18.5m in length without distortion. This has resulted in extending the market for hot dip galvanizing, where previously such products had to be painted.

The old Line 2 kettle needed replacing, and rather than replace with the same size kettle, the decision was taken to extend the size, so as to again be able to offer more to the market in terms of hot dip galvanizing as a corrosion protection method.

With the growing demand for hot dip galvanizing for the architectural sector, the need to overcome double dipping, with the associated aesthetic imperfections was also taken into consideration.

It was then decided to install a 10m long kettle, which is 2m wide and 4m deep, thereby providing a totally new offering to the market.

A new heating system was configured, so as to conserve energy usage, making this kettle exceptionally thermally efficient, a key environmental factor in this day and age.

The new kettle was commissioned in early September, and considerable benefits are already being realised not least the speedier processing rate, which is impacting positively on turnaround times.

The management and staff at Barloworld Galvanizers are extremely proud to be able to bring this offering to the corrosion protection market in southern Africa, as well as once again, being at the forefront of introducing innovation to the hot dip galvanizing industry.

Editors Note:

We at the HDGASA congratulate Barloworld Galvanizers on this initiative, which will no doubt enhance our marketing efforts on hot dip galvanizing.

Obituary

It is with sadness that we announce the death of Tony Franco on Saturday 5 November.

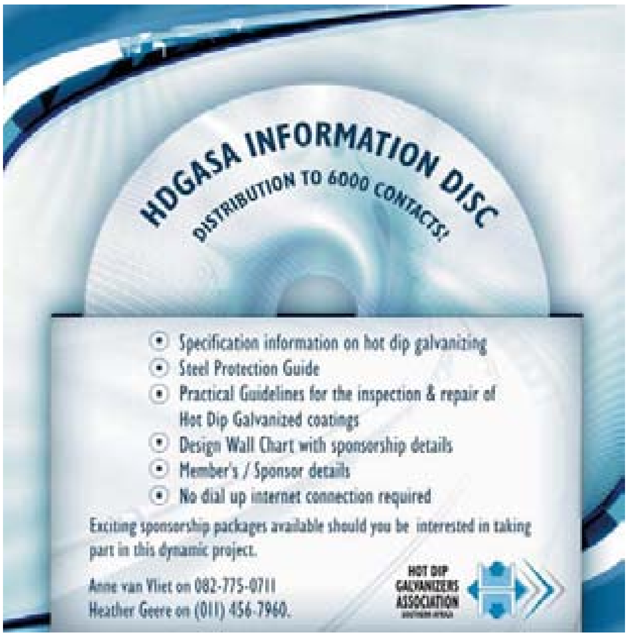
Tony started his career in the early sixties at Rietfontein General Galvanizers and in the latter years established several galvanizing plants, the first being South Cape Galvanizers with his son Marc. Bay Galvanizers in Richards Bay and Pietermaritzburg were eventually sold to other parties, when Tony moved to the South Coast.

We express our sincere condolences to his wife Ronelle, son Marc and daughters Mia and Kaylene and his family.

Arrival of the 4 metre deep kettle.

One of the first box frames to be hot dip galvanized in a single dip.

HDGASA Information Disc



We are extremely happy to report that the distribution of this magazine has grown from 3 000 contacts in April 2005 to 5 093 contacts as at end September 2005. We are very confident that this number will be increased to at least 6 000 by the end of February 2006. These contacts are made up primarily of specifiers, consulting engineers, QS's architects, fabricators, end users and members.

In keeping with modern technologically, the HDGASA will be compiling an Information Disk, which will be distributed early in 2006.

Our commitment to this CD will be to ensure that it is powerful, professional, user friendly, informative and so exciting that everybody will want to browse and keep the CD handy. Obviously a project of this magnitude will incur costs and we are therefore looking for sponsorship to assist with funding this marketing project.

Should you wish to take part in this project by way of sponsorship, kindly contact the HDGASA as soon as possible.

2006 FEATURES

January/February: Lighting, Lighting Masts, Electrical Pylons, Communication Masts.

April/May: Conveyance Piping, Water & Grain Storage, Training & Education.

July/August: Annual Awards Event, Agriculture.

October/November: Gold, Platinum, Coal & Diamond Mining

...continued from page 43

preparation. But then you go on to say that "X can be painted onto rusted surfaces". This would seem to be a contradiction of the original statement. In any case, during some 45 years experience in the corrosion control industry, I have yet to come across a surface tolerant organic coating that can be reliably applied onto a steel surface that has not been adequately prepared.

- *You refer to the formation of white rust as beneficial. This is far from the truth. Zinc hydroxide (white rust) is an unstable and undesirable zinc corrosion product. When a hot dip galvanized zinc surface is exposed to the atmosphere, carbon dioxide and oxygen react with the surface zinc to form stable corrosion resistant zinc carbonate which protects the underlying zinc. White rust is formed when carbon dioxide is depleted and moisture is present e.g. in the case of closely packed pregalvanized sheets.*
- *You do not indicate the actual zinc content of your zinc rich product which should contain 80% in the dry film to be effective. The durability of a zinc rich paint coating is to a large extent determined by the zinc content.*

Finally, there are many excellent zinc rich paints available which provide good corrosion control and no doubt your product could be one of these, but to compare zinc rich paint with hot dip galvanizing is not comparing apples with apples.

I respectfully suggest that to make claims that "X" is a superior product based on suspect technical information is not conducive to the promotion of your product.

Please accept these comments as constructive from someone who has been involved in the corrosion control industry for almost half a century.

The Association would like to acknowledge the advertisers and thank them for their support

IZASA supports southern Africa architects' competition

The International Zinc Association of Southern Africa (IZASA), as part of its mandate to support new initiatives with zinc has recently co-sponsored the South African Institute of Architects Award - Steel in the Fabric of the South African house. The competition was sponsored to increase the awareness of the use of steel, primarily lightweight and galvanized, in residential construction. Steel is used widely for residential construction in North America and Australia where framing systems have been used for many years. Steel is perceived to have strong advantages over other materials, principally durability, adaptability and speed of construction.

The International Zinc Association (IZA) has been an active supporter internationally of such bodies such as the Light Gauge Steel Framing Alliance and the Metal Roofing Association in the USA, the Japanese Iron and Steel light framing initiative, and now the International Iron and Steel Institute (IISI) initiative Sustainable Steel Construction. This focuses largely upon the creating greater usage of steel in residential use. In terms of this, a number of interesting pointers for market development have been obtained through an initial market survey. For instance, although regional variances occur,

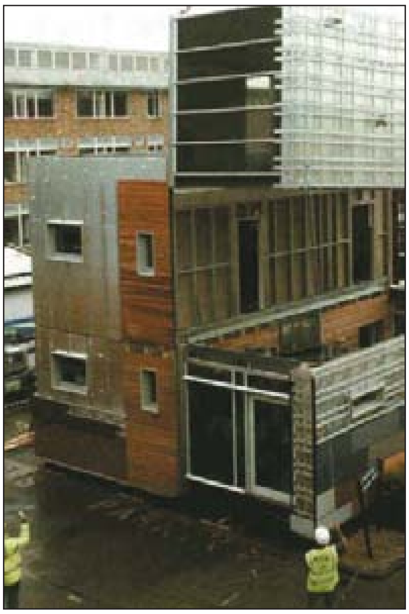


Figure 9. Pre-fabricated room systems being installed in the UK (Materials World, Vol. 13, No. 7, July 2005)

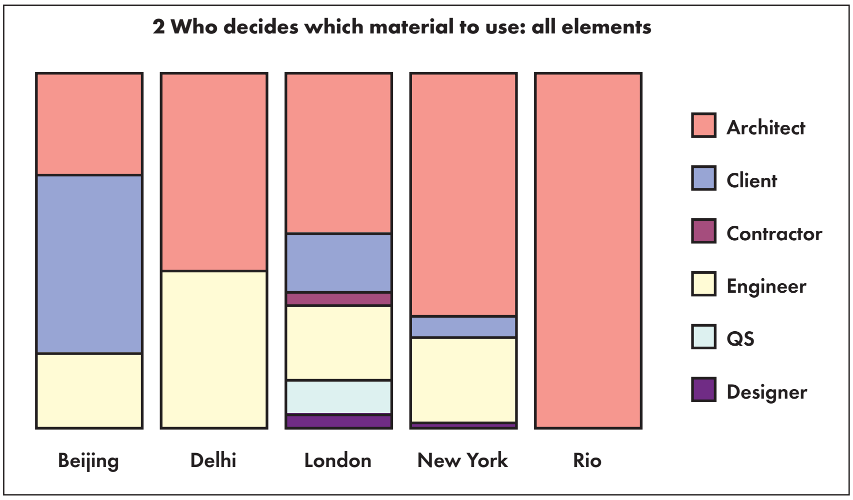


Figure 7. Who decides the material in residential construction? (IISI).

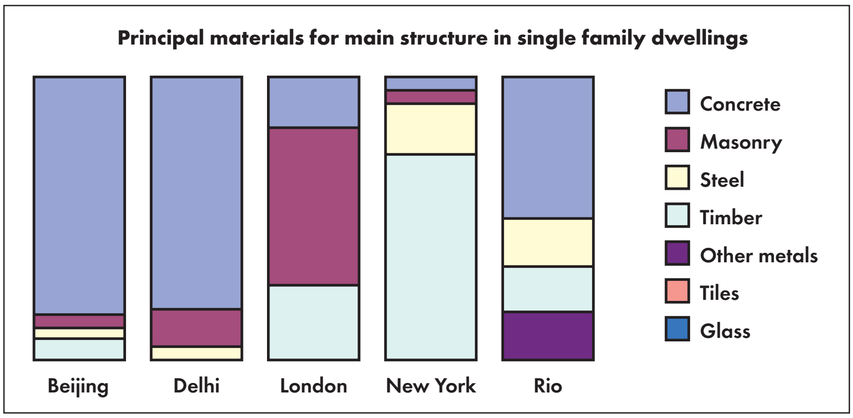
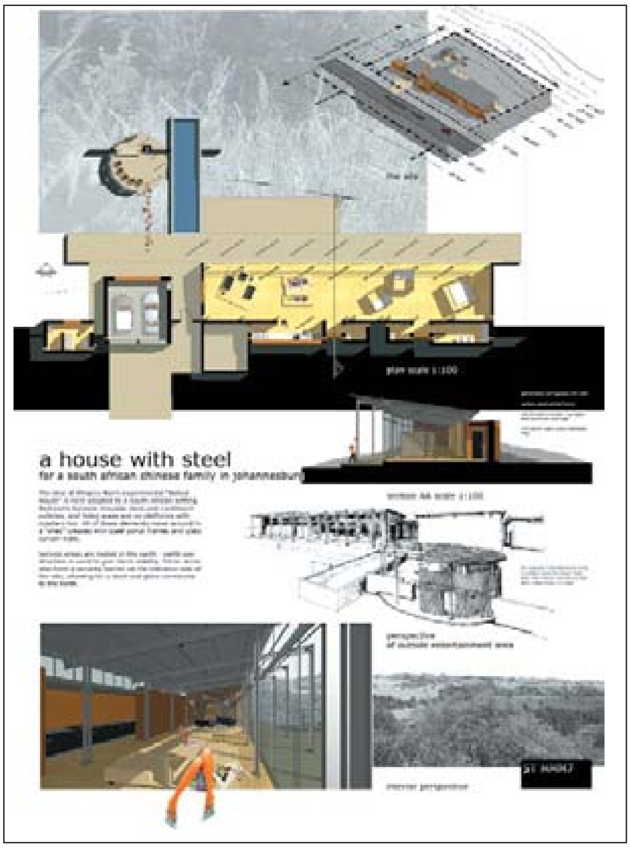
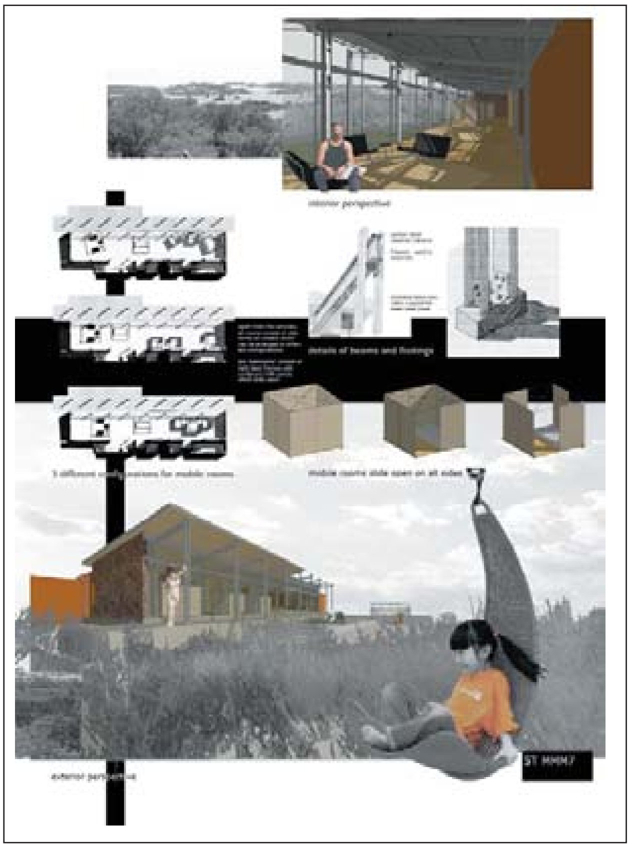


Figure 8. Principal materials for main structure in single family housing (IISI).

the importance of the architect in the initial materials selection process for building has been highlighted (figure 7). Over 50% of decisions relating to materials are determined by the architect and end client combined. When looking at the statistics for materials use, it is clear that steel is nowhere near being a dominant material (figure 8). Considering the ability of steel to provide for longer spans and more open space, a clear message of more awareness required requires action rather than words.

Although continuously hot dip galvanized roof sheeting has been used for many years in South Africa it has not enjoyed great appeal across the whole residential market-place. In Europe, the need to develop more residential space is driving a review of material choices and construction techniques (figure 9). In the South East of England for instance, there is a plan to create over 250 000 homes over the next few years, with the urgency being





such that it is being overseen through the office of the Deputy Prime Minister. Similar urgencies are required in South Africa.

Off this base, the IZA internationally, and specifically IZASA locally, is committed to partnering the development of the steel based residential market. Some constraints to development do exist such as the need to review standards and drive better skills development but these constraints are in fact drivers for opportunities and have created whole new industries overseas. However, the architect still needs to be at the forefront of specifying.

To further the development of the use of hot dip galvanized steel in residential construction, the IZASA sponsored the Student's prize in the Architects competition to create an awareness and encourage wider use of light gauge steel framed structures. Working in conjunction with the Southern African Institute of Steel Construction, this industry

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initiative reached every tertiary Architecture Department in southern Africa. Overall, some 28 submissions were received and these will form the basis of a travelling exhibition destined for every major building and construction event in the region over the next couple of years. Using the internationally regarded architect Glen Murcutt (who has practices in the US, Europe and Australia) as the draw card, the Architects competition was judged at the Annual Regional Architects Congress. The prize for the winning practicing architect (provided by a local steel producer) was an all expenses trip to attend a Glenn Murcutt Master-Class. The Students' Prize was a cash prize to the winning student and a cash prize to the student's Architecture Department. IZASA believes that only through ongoing exposure to the Architectural community will light steel framing be accepted in a traditional brick and tile community.

As part of a Steel Initiative, IZASA sponsored the students' prize at the recently held Annual Architects meeting in Bloemfontein. Submissions were received from all the Architecture Departments in South Africa. The judges commended the student submissions and applauded their use of steel in creating space and challenging conventional thinking on residential dwellings.

The winning entry came from Marita Meyer, a 3rd year student from the Architecture Department at the University of the Free State. This entry focused upon the creation of open space and entry of natural light – easily obtained with judicial use of steel. Her submission entitled, "A house with steel for a South African Chinese family in Johannesburg", was based upon the idea of Shigeru Ban's experimental "Naked House" adapted to a South African setting. Bedrooms become movable steel-and-cardboard cubicles, and living areas are on platforms with coasters too. All of these elements move around in a "shed" created with steel portal frames and glass curtain walls.Marita was thrilled to have won the prize and said it has certainly made her think more about the use of open space created so easily using hot dip galvanized steel.

Working with various partners, IZASA is committed to an ongoing programme of education and development in the area. It is hoped to hold Industry workshops in the near future to plot the road ahead and have stakeholder (including government) commitment to increase the role of hot dip galvanized steel in residential development.

For further information on the use of hot dip galvanized steel in residential construction kindly contact Rob White at IZASA at izasa@icon.co.za or the HDGASA.

"Road Shows" on the benefits of using hot dip galvanized rebar planned for 2006

The International Zinc Association Southern Africa is to partner the HDGASA in a series of countrywide seminars during early February 2006.

Many instances of poor reinforced concrete structure performance can be attributed to the corrosion of rebar. This leads to early unsightly rust staining and eventual spalling of the concrete due to the expansion forces created by corroding rebar. Despite the often termed benign environment of the Highveld, local examples of such problems are giving increasing cause for concern. In addition, the range of climatic conditions experienced around the large coastal expanse of the country has resulted in expensive repair and reconstruction.

The seminars will highlight the major causes of deterioration in concrete structures and the use of hot dip galvanizing of rebar as a long term solution. The presentations will include local experience together with that of international work, some of which has been sponsored by the United Nations. Case history examples will be used to illustrate where the use of hot dip galvanized rebar has been successful. The seminars will provide time to provide for a transparent open discussion amongst delegates and speakers. Many concrete structures are built by government and these seminars are targeted at this market as well as the building and construction industry in general. The seminars will last for two hours and refreshments will be provided.

The seminar dates are:

- Cape Town - Thursday 9th Feb 2006
- Port Elizabeth – Friday 10th Feb 2006
- Johannesburg – Monday 13th Feb 2006
- Durban – Tuesday 14th Feb 2006

For further information, please contact, Heather at the HDGASA *on* 011 456 7960 *or email heather@hdgasa.org.za.*

ADDING VALUE TO STEEL FOR 40 YEARS

The Association held its annual prestigious awards evening in August where amongst other things we celebrated the 40th anniversary of the Hot Dip Galvanizers Association.

To commemorate this momentous occasion, of "adding value to steel for 40 years", we decided to produce a historical DVD based on what we experienced on the screen that night.

For those that never attended the evening, the DVD takes one back with an insight into the history of zinc, the players who for various reasons found themselves at the forefront of the discovery and later development, the early smelters, etc. It also addresses its early uses and in particular its more recent health benefit discoveries, including its aphrodisiac qualities.

The history of hot dip galvanizing is also detailed from where it started in France and the UK and later on in South Africa, where it started with hot dip galvanizing of sheet imported from the UK and finally to when general hot dip galvanizing started and who the pioneers were.

In order to defray costs the* DVD *is selling for the nominal cost of* R80-00 *per copy including* VAT *but excluding packaging and postage, should anyone be interested in purchasing a copy, kindly contact* Saskia Salvatori *at the* Associations *offices.

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The "honest coating" stands up to its name

Hot dip galvanizing is known as the "Honest Coating".

How did it get this name?

A hot dip galvanized coating is formed by interaction between iron and molten zinc and if the steel surface is not clean it will not react with the molten zinc. Conversely, if the steel is clean it will react and produce a continuous coating, so if coatings appear sound and continuous, they are sound and continuous.

Marking of steel is essential for identifying rolled sections and plate at the stockists yard. This is frequently done with adhesive labels which often are very difficult to remove, prior to the process. These items are then purchased for fabrication and must again be identified prior to and after fabrication.

Temporary marking as in the use of oil based paint and other non-water based products, play havoc in the daily stress of the galvanizer who when it is detected tries with difficulty to remove these contaminants, so that uncoated areas do not appear after hot dip galvanizing.

All water based paints, particularly if mixed with 50% water work extremely well as does the "Pental White 100WS" or "Pental White 100W" marking pen, available from your local stationer.

The photos indicate marking labels and oil based paint on black steel, mechanical removal of marking paint and finally the result after hot dip galvanizing when inappropriate marking paint has been used and not removed before hot dip galvanizing.

Twistdraai Colliery

The application

A perception exists that suggests that one cannot apply hot dip galvanizing within a colliery. Hot dip galvanizing has over the years been extensively used for conveyors, both overland and even underground. In the most severe corrosive conditions such as a coal washing plant, hot dip galvanizing plus a suitable top paint system has been applied with excellent results.

Environmental conditions

Corrosive conditions within the Twistdraai coal washing plant would be classified as a C5 environment in terms of ISO 9223. In other words, one of the more extreme corrosive conditions listed in the ISO specification.

The photographs below can best illustrate the corrosive conditions encountered at the washing plant.

The site

This case study reviews the performance of a duplex system at Sasol's Secunda Twistdraai coal washing plant. Coal is delivered from the mine to the coal washing plant, where after processing it is dispatched to end users.

Our findings

During the site inspection, some 53 different overall coating thickness readings were taken with the following results:

Maximum 888μm, Mean coating thickness 388μm, Minimum 277μm.

Two examples of the extent and severity of the corrosion conditions on painted steel.

Further examples of the integrity of the duplex system.

This 378μm coating reading was typical of that found on the structural steel.

In general terms the structural steel together with the duplex system was found to be in excellent condition. It was reported that the coating system has been in operation for approximately 4 years. In addition an annual inspection is conducted aimed at monitoring the coating performance. A series of photographs were also taken and these have been used to illustrate our findings as well as any specific comments.

Conclusion

A Duplex system uses the strengths of both hot dip galvanizing and selected paint coatings to compile and enhance "synergistic new performance" coating, which is cost effective where "value analysis" and long-term maintenance costs are taken into consideration. The system is designed to provide extended service life in severe corrosive environments.

Surface preparation is a critical factor to the success of the coating's performance and as such, must not be overlooked in terms of the specification, as well as at the time of the application.

Hot dip galvanizing is simply the best form of primer for a good paint system!

Goedehoop Colliery

The application

Goedehoop Colliery has been in existence since the early eighties. In about 1995 the mine embarked on several extensions, one of them being to the coal washout facility and conveyor material supply system. It was then suggested to mine management personnel that because of previous paint coating failures that a duplex coating system be used to protect the steel.

The suggested system comprised a single coat high build epoxy coating applied onto a sweep blasted hot dip galvanized surface in accordance with the Association's Code of Practice for surface preparation and application of organic coatings.

The environmental conditions

Coal washing facilities are relatively aggressive environments, due to the combination of coal dust and water. See "Planning the Duplex System for Goedehoop Colliery"

Our findings

Although in existence for a number of years the old wash out plant was found to have several coating failures. Coatings in these conditions are extremely difficult to maintain unless the entire operation is shut down.

The duplex coating system on the steelwork in the new area is in exceptional condition, so much so that the organic coating had to be purposely damaged in order to assess the adhesion of the organic coating and overall condition of the hot dip galvanized coating underneath.

Conclusion

After 10 years of service the duplex coating system is in exceptional condition and had to be purposely damaged, in order to assess and measure the hot dip galvanized coating thickness.

In comparison the paint coating on the carbon steel hand rails of the coal washout facility had failed.

General photo of the structure.

Cross cutting proved that adhesion of the coating was sound.

Hot dip galvanized coating thickness (paint removed).

Total duplex coating thickness.

In comparison the paint coating on the carbon steel handrails has failed.

General corrosion conditions of the coal washout facility.

Phalaborwa Copper Mine

The application

Like most established organisations, Phalaborwa mining operation has its own in-house corrosion prevention specifications. In the mid eighties the mine called for tenders for the supply of certain cable ladders for use on the mine. Not being able to offer the specified multi-coat, solution paint system, due to several technical reasons, O-line Support Systems offered to supply the cable ladders coated according to their own in-house developed duplex powder coating system. The mine was at first sceptical but entertained the bid as long as the new system was placed alongside their tried and tested system for future performance evaluation. The performance of the new system in time proved to be superior, which resulted in the mine altering its specification to include the duplex coated cable ladders.

The environmental conditions

Phalaborwa Copper Mine is situated in Phalaborwa, midway on the western border of the Kruger National Game Park. General atmospheric conditions at hand are dry and dusty and appeared to be a typical C1 to C2 environment. However it was confirmed that aggressive conditions exist in the acid and zinconia plant which produce a number of corrosive chemicals, including sulphuric acid and can be categorised as a C5I environment. Mr Koos Horn, a recently retired superintendent from the mine, originally responsible for specifying the duplex protective system, had this to say: "This method of corrosion control, since first specifying the duplex system, has outlasted all other coatings and materials used previously in all conditions of the mine including the acid and zirconia plant" (See Corrosion Categories in terms of ISO 9223, table 4, page 10).

Our findings

Due to the age of the original installation and subsequent staff retirements and changes, etc., the original parallel installation could not be located. However, we did find a cable ladder system that was installed in the mid eighties, using the proprietary powder coated duplex system. The cable ladders were reported to be the original O-line system, which was hot dip galvanized and then overcoated with an epoxy polyester powder. The cable ladders are no longer in use due to the building being declared redundant.

In spite of the relatively non-corrosive environment in this instance, the powder paint is still adhering to the hot dip galvanized substrate and on cross-cutting the coating to ascertain paint adhesion, the coating remained intact despite trying to lift it at the cross-cut. There were however, several other coatings on components located at the site that were in the process of breaking down.

Conclusion

After 20 odd years of service at Phalaborwa Copper Mine, the duplex coated cable ladders are still performing well in that the powder paint is still adhering well to the hot dip galvanized substrate.

Editors comment

Subsequent to our visit and discussions with Mr Horn, we understand that there are many kilometres of cable racking that are duplex coated, still performing adequately after 18 to 20 years in many other operational parts of the mine.

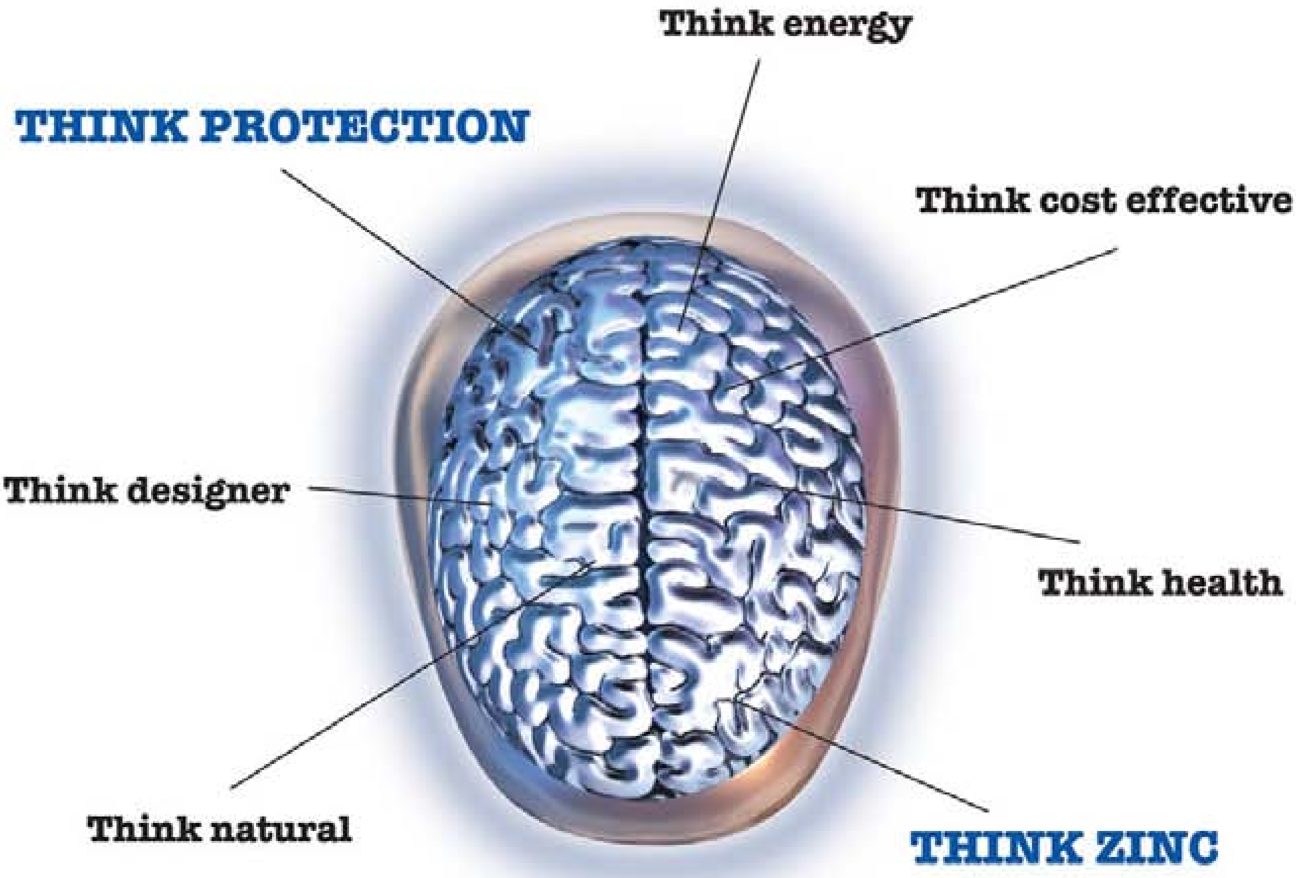
The investment made in powder coating technology by O-line Support Systems some twenty years ago, has proved to be well spent in terms of the success the company has had in applying duplex coating technology.

Insitu cable ladders in the redundant Transfer Station No. 1.

Total coating thickness reading on the cleaned up side rail of the cable ladder.

Cable ladder cross rung.

Exposed powder coating subjected to a cross cut adhesion test.



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