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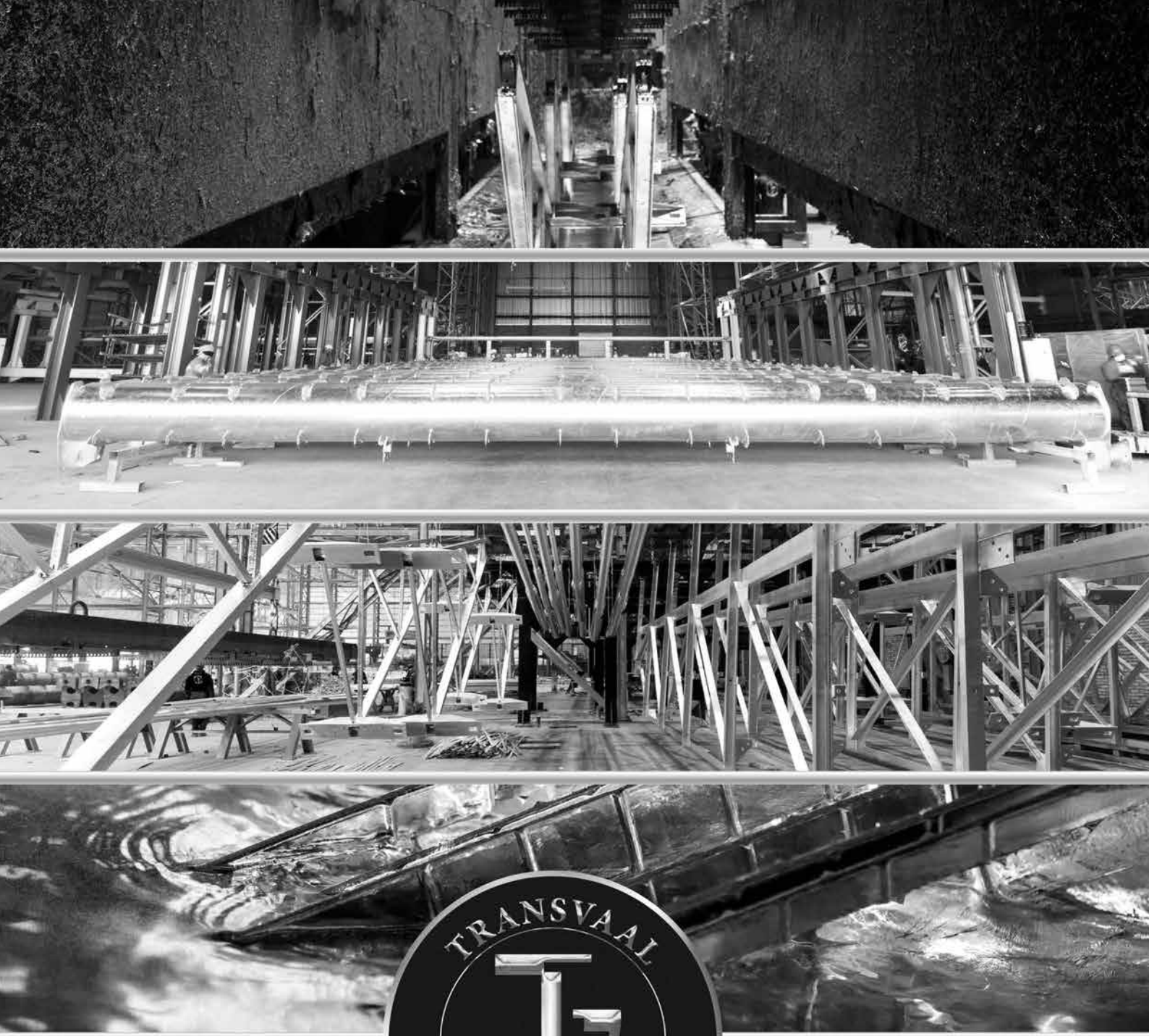
HOT DIP GALVANIZING TODAY 76

The Official Publication of the Hot Dip Galvanizers Association Southern Africa

CORROSION CONTROL OF STEEL



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EXECUTIVE DIRECTOR'S Comment

I will resist a written review of 2020. What a year, let us move on!!

Challenges remain for 2021 but reflecting on our ability to adapt and learn is certainly more useful than looking back.

The Covid virus threat has not disappeared and the second wave with claims of a new strain are biting hard. Numbers are becoming names of people close to us. Despite this, people have largely learnt to adapt with basic lifestyle changes to keep risks at manageable levels. Whilst exceptions are noted from time to time, most corporates and even medium to small enterprises have complied with legislation related to Covid virus containment requirements. Temperature testing and hygiene measures such as sanitizing of surfaces, availability of hand washes and appropriate signage related to distancing and wearing of masks abound. The potential cost of personnel illness, fines, or closures of plants for safety breaches appear to have been seriously considered. In the main, risks have in the formal sector been professionally managed. The development of what appear to be effective vaccines is also very encouraging. This is especially true for the vaccine developed at Oxford University and approved at year end 2020. There is no room for complacency however and this may possibly be the biggest threat that we face. Remaining economically active will be dependent on sustained responsible behaviour by all. Legislation are boundaries set for us by government, common sense and responsibility for our own well- being should determine our own actions, however.

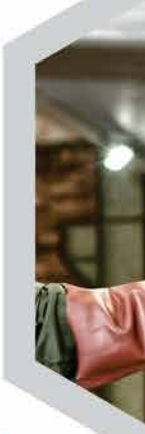
Assessing the potential for recovery of the iron and steel sector within the South African economy is a complex undertaking. Many factors are at play. Strategic decisions related to removing roadblocks in steel availability and pricing are urgently needed. Government funding to bring infrastructure projects into play will be important. Political stability and strong signals related to clean governance are also required to restore private investor confidence. Although simply expressed as single sentences, each of these are enormously complex challenges that will require courage and strong action to resolve.

In this context, the fact that priority infrastructure projects to the value of R350bn have been gazette on 24 July 2020 is most encouraging. Some investigations however reveal that most of the listed projects are nowhere near "shovel ready" and many remain in the tender compilation phase. Setting aside timing issues, these projects for supply of water and sanitation, energy, transport, housing, and agriculture are being touted to provide 250 000 jobs. Manufacturing and construction, key to the execution of the projects are significant job multipliers as well as opportunities for training and the transfer of skills. It is imperative that these projects proceed and are executed free from any suggestion of corruption and graft. Professional execution inclusive of on time delivery within budgets, commissioning as well as contracts for ongoing maintenance of these assets will be essential to the turnaround of our sector.

On a somber note, the Association mourns the passing of Bob Andrews in November 2020. On a personal level I had limited contact with Bob. Bobs decision to largely withdraw from an active role in corrosion consultancy and also from his passion of penmanship for our magazine preceded my arrival at the Association by a few months. Bob wrote many a thought-provoking piece for Hot Dip Galvanizing Today. Obituaries from those that worked closely with Bob and knew him on a personal level follow in the magazine. To family and friends however, sincere condolences from the Association staff and all our members.

By this time Christmas 2020 has passed and 2021 is upon us. I trust that all production plant shutdowns were successfully completed, staff rested and that start-ups proceeded smoothly.

I extend my sincere wishes for a healthy and prosperous 2021 to all.



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EDITORIAL COMMENT
in this issue

As we head into the year 2021 it has been determined that our days are shorter than the 24 hours we believe them to be. In 2020 the shortest time for a single rotation of the earth around the sun took place on July 19, 2020. That day was 1.4602 milliseconds shorter than 24 hours on that day. In light of this determination we are faced with the fact that 2020 was not as long as we felt it has been.

The year 2021 requires that we proceed with a new resolve to seek greater effectiveness in all spheres of life. From improving the way we deal with the Covid19 Pandemic to using the planet's limited resources most effectively. The need to use the knowledge acquired over eons to provide the foundation for innovation and efficiency is now more important than ever.

- Knowledge is the only instrument of production that is not subject to the law of diminishing returns. To know or not to know, that is a question that needs answering as we seek to improve outcomes to meet with the expectations of stakeholders utilizing hot dip galvanizing.

- We pay tribute to Bob Andrew, a true forward thinker, who was instrumental in hot dip galvanizing being adopted across the mining industry through the efforts shared with the late Walter Barnett.

- In spite of the pandemic, projects of significance were completed in 2020 and we highlight the Ngezi Stockpile Dome which was finalized in 2020.

- The Graskop Gorge Lift Co. (GGLC) adventure facility in Mpumalanga heads into its fifth year of operation. Established in 2017 the GGLC has proven the value of hot dip galvanizing as a corrosion control technology in challenging environments.

- The Moma Sands case study is revisited as the Mozambique Rovuma Gas Fields project seeks to be initiated. The correct selection of corrosion control technology for the environment is key to the long term operations expected once the project can be securely initiated. Moma Sands provides historical evidence of dealing with the challenges using hot dip galvanizing to control corrosion in this region.

- The history of nickel additions in galvanizing and where it's headed is considered. The use of additives to improve efficiency and effectiveness is an ongoing field of development and potentials for improvements in this field are always of interest.

- The HDGASA Executive Committee provides the core around which the association seeks to add value to all stakeholders. In this issue we introduce you to the members and welcome a new member.

- The new member of the HDGASA EXCO is a second generation leader from KZN. Amish Ramkisson, the MD of Phoenix Galvanizing, gives us a brief glimpse into the person at the helm of not only his organization but also the newest member of the association's leadership team.

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VIVA ENGINEERING:
Zimplats Ngezi Portal 3 Stockpile Dome

Multi-party collaboration at its best, Viva Engineering (Kempton Park, South Africa), Hogarths Engineering (Bulawayo, Zimbabwe) and Monoweld Galvanizing (Germiston, South Africa) delivered a world-class, hot dip galvanized, fabricated structure to Zimplats in late 2019.

The hot dip galvanized structural steel Ngezi Portal 3 Stockpile Dome, which covers the mine's main ROM 13 000 ton stockpile, was manufactured at Viva Engineering's workshop in Kempton Park.

The hot dip galvanized structure consisted of twelve main boxed gantries, 2.5m deep x 2m wide x 54m long. The boxed gantries were welded to base plates connected to concrete plinths at the base and bolted to a 7m diameter centre ring at the top.

Viva's CNC and preparation department used their newly acquired FICEP SP16T6 CNC Anglematic, for the project. The highly efficient machine and skilled operators ensured that all material preparation was completed three weeks ahead of schedule. Repetitive gantry sides were assembled in jigs which were inspected and signed off by Viva's Quality Department before assembly work started. The GMAW welding process and AMIGG 500PM pulse arch welding machines were used for this project. The results were evident with superior weld quality and 90% less spatter requiring minimal cleaning.

The hot dip galvanizing of all the articles was carried out against SANS121:2011 (ISO1461:2009), with particular care taken in ensuring that all articles met the acceptance criteria of the standard.

Appropriate measures to avoid distortion and warpage of the boxed gantries and other large sections was undertaken by a skilled and experienced galvanizing team.

Quality control throughout the process ensured a high degree of corrosion control for the structure.

Site installation was completed by Viva Engineering's Zimbabwe partner, Hogarths Engineering.

Three cranes were used during installation including a 250t, 90t and 55t unit. Initially, large base plates were bolted onto the cast-in plates, on top of the concrete plinths. The 12 main boxed gantries were pre-assembled on the ground in positions convenient for lifting by the 250t crane.

The 90t lattice boom crane was positioned at the top of the stockpile, where it lifted in and held the centre ring in position ready to receive the main gantries.

Overall installation of steelwork took just three and a half months. With no major site alterations or repairs required, the project was completed in early December 2019.

Roof sheeting of 0.8 mm IBR Chromadek, Traffic Green in colour was installed over an area of 5 500 square metres. Sheeting installation was started shortly after the first three bays of steelwork was completed and was finalized seven days after completion of the steelwork.

Viva Engineering's ISO 9001:2005 quality certification was obtained in August 2019, with Hogarths ISO certification obtained in February 2020. Certification was done while fabrication was being completed at Viva's workshop, proving that simultaneous production and continuous improvement initiatives are possible.

A testament to the high quality of workmanship and professionalism in project management, the Dome which is a similar size to the North Gate dome, was fabricated and hot dip galvanized in South Africa, exported to Zimbabwe and completed with the project critical path and a perfect safety record having been successfully achieved.

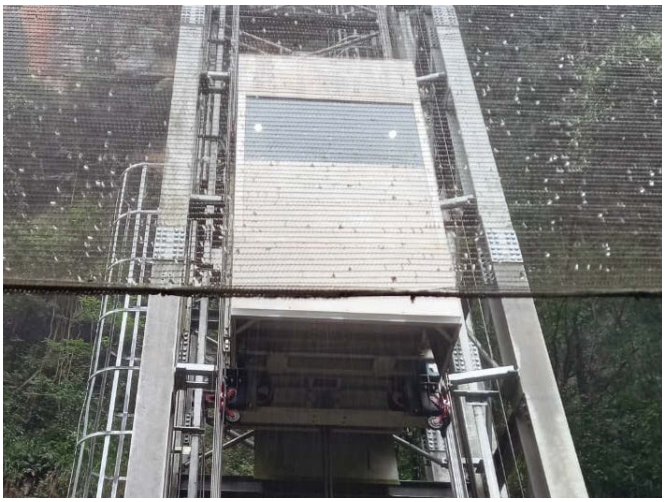
GRASKOP GORGE LIFT: 5 Years on (2017 to 2021)

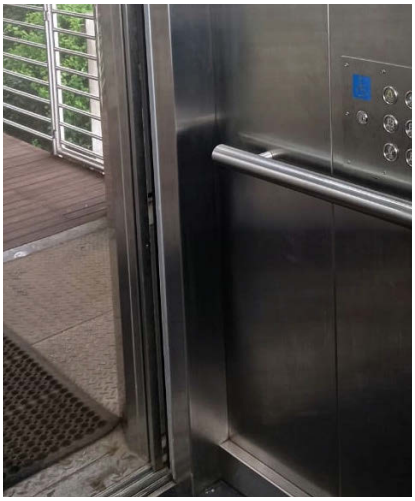
THE PURPOSE OF THIS PROJECT WAS TO CREATE AN EXCITING AND POPULAR TOURIST STOP OVER POINT ON THE PANORAMA ROUTE AT GRASKOP, MPUMALANGA.

The gorge has established itself as an adventure destination through the Big Swing, which is a well-known operation, so there had been some "human footprint" in the gorge for a while. The client wanted to expand on the adventure concept and added the lift and interactive walking trail in the rain forest below. The purpose of the structure is to accommodate the glass viewing panoramic lift taking visitors 51m down the face of the Graskop Gorge into the forest below, where wooden walkways and suspension bridges meander along a 600 metre trail through the indigenous forest with interactive exhibits.

The architectural brief was to design a lift shaft structure to accommodate the panoramic glass viewing lift for the Graskop Gorge Lift Company, as well as the buildings around the panoramic lift at the Graskop Gorge Adventure Centre. The site was chosen adjacent to a structure for informal curio traders and a protruding rock outcrop which had been a viewing point with a small pub. This was the ideal position for the lift shaft. The brief was to incorporate the traders into the adventure tourism complex and upgrade the existing structure. The centre should accommodate the ticketing office, shops of various sizes, a restaurant and general viewing areas for the public. Support services for the centre also had to be included. The servicing of the lift required easy access to the lift motor room. A viewing platform was subsequently added around the lift motor room as an extension to the public deck.

Structural steel was the choice of material for the lift shaft structure from the beginning. Reasons include compatibility





with the lift installation, and the open truss-like nature of the shaft structure to simulate the waterfall on the opposite side of the gorge.

The distance from the base to the top of the shaft is 60m, with the total vertical lift travel distance of 51m. The shaft structure was designed as a vertical structure with two top fixing points apart from the fixing at the concrete base. UC 305x305x97 H-profiles were used for the 6 main shaft columns, because adequate l/r ratios were required for 10m segment lengths. Each segment was fully braced using 63.5×3 and 88.9×2.5 Circular hollow sections cross bracing between 203x133x25 UB lateral stiffness beams. 305x165x46 UB profiles were used for the access platform beams at the top of the shaft with 80x80x6 angles for bracing. UC 152x152x23 profiles were used as knee brace elements to support and fix the top viewing platform to the main shaft structure.

Cladding formed a minimal part of the shaft structure itself, only the top machine room side walls and roof received IBR cladding after the access platform to the machine room was completed.

The project faced some challenges including a national shortage of 305x305x97 H profiles, required the design to be altered to use 254x254x73 in the top part of the shaft. For the erection of the shaft a 70 tonne crane was planned, but it would require the crane to be too close to the edge of the cliff, and the crane cables were too short to reach the 51m deep bottom. Instead a 9 tonne Spierings Mobile Tower Crane was hired that could lift 2.5t per lift at a 27m reach, having adequate cable length to reach down to the bottom.

The exquisite setting of the lift shaft structure opposite the Panorama Waterfall forms a truly aesthetic pleasing view from a distance, with the natural waterfall on one side of the gorge and the grey coloured, open truss-like lift shaft structure simulating the waterfall on the opposite side of the gorge, forming a beautiful parallel with each other.

Tons of structural steel used
110 t

Structural profiles used
Hot rolled H-profiles, hot rolled I-profiles, angle profiles, circular hollow sections

Cladding profile/type used
IBR

Cladding area/coverage and tonnage
1100m^2, 2.8 tons

Project Team

Consulting Engineers
Fourie Consulting Engineers

Client/Developer
Graskop Gorge Lift Company in partnership with the NEF (National Empowerment Fund)

Architect
Förtsch and Associates Architects

Structural Engineer
LEW Consulting Engineers (Pty) Ltd

Quantity Surveyor
Siyakha Quantity Surveyors (Pty) Ltd

Project Manager
Purlin Consulting

Main Contractor
ENZA Construction (Pty) Ltd

Steelwork Contractor
Quality Steel Construction (Pty) Ltd

Steel Erector
Quality Steel Construction (Pty) Ltd

Cladding Manufacturer
Safintra (part of the Safal Group)

Cladding Supplier
Safintra Roofing Nelspruit (part of the Safal Group)

Cladding Contractor
Roofing Solutions cc

Corrosion Protection (Hot Dip Galvanizing)
Babcock Nthuthuko Powerlines (Pty) Ltd

THE HISTORY OF NICKEL ADDITIONS IN GALVANIZING
and where it's headed

A hot dip galvanized coating has two main components, the inner alloy layers and the outer unalloyed zinc (Zn) layer. The inner alloy layers are more brittle than the outer Zn layer and, if they grow uncontrollably, there is a tendency for thick brittle coatings to occur. This phenomenon of steel reactivity to galvanizing is a major gripe of galvanizers throughout the world. Thick coatings are not only visually unattractive but can be detrimental to long term performance of the coating as delamination and cracking of the coating compromises coating protection life. This steel reactivity is primarily the result of the well-known Sandelin Effect caused by silicon (Si) and phosphorus (P) contents within the steel.

The reasons for using these elements in steel making are beyond the scope of this description but it is important to be aware that they are not just impurities but may be added to provide for certain steel properties such as formability, machinability, etc. The table below shows the key elemental ranges for these elements in steels where acceptable galvanized coatings can be produced.

Element	%
Si	< 0.04
Si + 2.5P	≤ 0.09
Si	0.15 – 0.20

Galvanized coatings with steels meeting these compositions will generally be aesthetically pleasing, have acceptable adhesion and, be free of (dull) alloy outbursts. A more detailed analysis can be found in the 1998 International Lead Zinc Research Organisation (ILZRO – now part of the International Zinc Association) publication Galvanizing reactive steels – *a guide for galvanizers and specifiers.*

In galvanizing two competing forces are at play, namely, the dissolution of iron (Fe) within the liquid Zn and the consequent suite of resultant intermetallic reactions. This results in the well-known alloy layers being formed within the coating and a typical "normal" coating consists of a successive layer of alloys from gamma (Γ) to delta (δ) to zeta (ζ) overlaid with pure Zn (the eta layer – η), the shiny surface on withdrawal from the Zn bath.

The kinetic complexity of alloy formation is critical in understanding steel reactivity but in essence, the excessive growth of ζ is the chief reason for thick dull coatings.

To limit excessive coating growth it is necessary to contain iron diffusion through compact alloy formation and avoid excessive zeta-phase development. In the mid-1960s ILZRO sponsored a study *Solid State Kinetics of the Galvanizing Process* at what is now CANMET in Canada. Reducing steel reactivity was formally discussed in seminars in 1975. Incidentally, this was also the first mention of the use of nickel (Ni) in fluxes. Alloying the Zn bath melt to try and reduce steel reactivity was tried in North America and Europe where the complex alloy Polygalva was developed. However, real success came with ILZRO's work on what became known as Technigalva, carried out at Cominco (now Teck Resources) during the period 1972 to 1977. The Technigalva process was

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Nickel prevents high coating thicknesses and dark grey coatings, increases coating ductility and the fluidity of the Zn bath.

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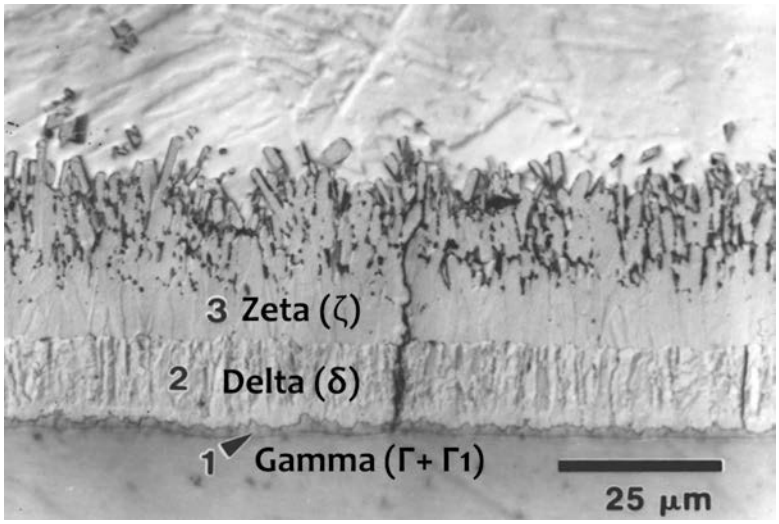
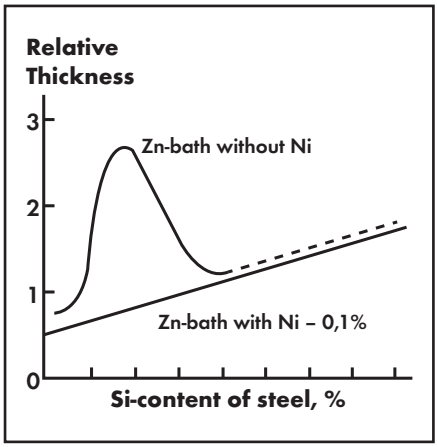
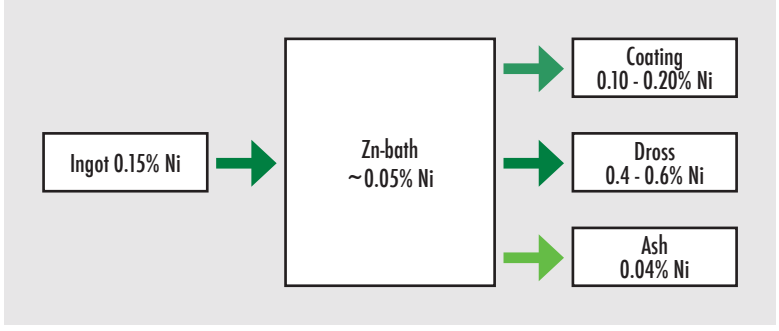




rapidly adopted by the industry and, to put this into perspective a survey carried out at the 2003 Intergalva Conference indicated that 53% of survey respondents were using Ni in their galvanizing baths. The simplified effect of Ni in suppressing the Sandelin peak is shown below.

Until 2012 few galvanizers in South Africa alloyed their galvanizing bath with only one galvanizer (Cape Galvanizing) in the country consistently doing so. This changed dramatically as new zinc suppliers entered the South African Zn supply business and Zn Ni alloys were offered to the market-place. Whilst these alloys can work under close control, the most optimum Ni concentration in the bath of 0.05% is also close to the upper limit where dross formation becomes excessive through the production of gamma 2 (Γ_2) alloy resulting in floating dross. As Ni reduces the solubility of Fe in Zn, bottom dross formation may also increase if the optimum Ni concentration is exceeded. In Europe alloys are supplied very close to the required bath composition where suppliers are closer to their customers and so transport costs are low. Typically, 0.15% Ni alloys are provided. These have been termed "tailor made alloys". Supply to South Africa required a different approach as even Zn Ni alloys at 0.5% Ni are prone to excessive dross production if any bath management control deviation occurs. Factors such as pre-treatment issues (resulting in variable surface cleanliness), bath temperature variations, irregularly timed alloy additions, alloy variability, disturbance of the dross layer and poor management of floating dross are just some of the factors to be taken into account. If bath management is ideal, the distribution of nickel should be as shown below (Pankert, Intergalva 2009).



Direct addition of Ni seems the correct approach but the requirement of controlling the locally raised Ni concentration in the bath at the point of addition (and subsequent possibilities of dross formation) remains a challenge. Over 15 years ago studies showed that a solution was the use of Ni powder encapsulated within a matrix containing fluxes and an inflammable substrate having no impact upon the Zn as it wets out the Ni with minimal fuming. This resulted in a coated tablet form designed to spread the Ni addition loading factor, maximise the incorporation of Ni within

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COATINGS & CHEMICALS

the active Zn melt, prevent hygroscopic activity and minimise dross production. Key to performance is not only the size distribution of the Ni powder but its surface area and wettability. Close quality control is required to achieve this and it is not simply a matter of adding a fixed quantity of Ni powder into a binding substrate.

As a final comment, alloy additions only work when control of the galvanizing process is optimised. In the HDGASA Training Course the overriding requirement for good galvanizing is product cleanliness prior to immersion into the galvanizing bath. The mantra *if the steel is not clean it will not galvanize* is stressed repeatedly. It is imperative that flux cleaning of some sort is incorporated in the galvanizing production process and the Fe level in the flux be kept as low as possible (preferably ≤ 0.5 g/l Fe^{2+}) so that a clean steel surface is presented to the Zn bath. Without doing this, it is impossible to ensure the effectiveness of Ni because, as stated earlier, the solubility of Fe in Zn is reduced considerably when Ni is present. Ideally drying of the jigged articles prior to galvanizing should also be employed, especially in coastal regions.

CASE STUDIES REVIEW:
Moma Sands Mozambique

1 and 2 General views of the Moma Sands project located on the remote northern coast of Mozambique.

The Rovuma Basin LNG development is certain to need huge amounts of infrastructure and the right corrosion control application. Lessons can be learnt from previous projects in similar conditions which have been undertaken in Mozambique. Already several primary utility structures for the region have been fabricated and hot dip galvanized.

The Moma Sands Project is a case study which provides a real life view of how hot dip galvanizing has been successfully specified as an effective and applicable corrosion control of steel under these atmospheric conditions.

The extensive use of hot dip galvanizing for structural steel components on an extremely remote site where logistics, materials handling, transport and co-ordinated planning had a profound influence on the project timing and completion date.

1

Photo courtesy Kenmare Resources plc.

2

Photo courtesy Kenmare Resources plc.

Photo courtesy Kenmare Resources plc.

Photo courtesy Kenmare Resources plc.

3 The sea pier and conveyor termination from where refined product will load onto sea-barges for trans-shipment to ships anchored off shore.

4 One of three such structures, where refined products will be stored prior to conveyance, via an overland conveyor, to a specially constructed loading pier, for loading onto sea-barges for tran-shipment to ships anchored off shore.

5 A view from off shore.

Environmental conditions

The corrosive conditions encountered at this remote location can be classified as a C4 or a C5 environment in terms of ISO 9223:2012. In terms of this classification and considering the hot humid environment, in a marine location, a C4 atmospheric condition is to be encountered. A C4 corrosivity category is described as;

Subtropical to topical, periods of time of wetness, very high industrial pollution (SO2 90 to ≤ 250µg/m³) or significant chloride effect/deposits, e.g. industrial polluted areas, jetties and offshore structures, within a few hundred metres of the ocean and certain exposed areas along the coastline.

Photo courtesy Kenmare Resources plc.

Zinc corrosion rates for this environmental classification are estimated in the range of 2 to 4 micron (µm) per year. Considering the actual site conditions, the expected corrosion rate of zinc would be approximately 2 to 3µm per year. Assuming these environmental conditions the estimated "service life" of the hot dip galvanized structural steel would be in excess of 30 years before 1st maintenance.

The site

The site is located on the Mozambique coast approximately 30 minutes flying time north of Beira. The project involved the design, off site fabrication of steel and hot dip galvanizing, followed by the logistics of loading, ocean transportation of the entire project facilities, trans-shipping, via a sea barge to the beach, haulage inland over a distance of 3 to 4km to the various sites comprising the project.

The project required integrated logistics planning and co-ordination of all supply arrangements. No infrastructure or formal facilities existed prior to the commencement of the project.

Outcomes

The use of hot dip galvanized steel, in the given corrosive environment, has provided corrosion control in line with the expected maintenance free service life in excess of

30 years. This estimate is conservatively based on the mean zinc coating thickness of 85µm and a corrosion rate of between 2 and 3µm per year. When the actual coating thickness was measured during the original site visit it was found to be well in excess of 100µm even, more often than not in excess of 120µm.

Alternative corrosion control coatings cannot match the performance of hot dip galvanizing when one considers the rough handling involved in loading, transportation and offloading at such an isolated site.

Design requirements of durability and longevity were achieved by way of the metallurgically bonded hot dip galvanized zinc coating, both from the standpoint of a "barrier protection" as well as "cathodic protection". Handling damage, repairs were achieved by the application of a suitable zinc rich epoxy, which does not compromise corrosion control characteristics of the coating, due to cathodic protection of hot dip galvanized steel.

In conclusion

The primary features and benefits achieved on this project were:

1. Cost and economic effectiveness of hot dip galvanizing, given the site location and lack or availability of local materials and equipment.
2. The effective use of hot dip galvanizing in a C4 atmosphere, i.e. marine conditions and designing the corrosion control system to suit the given environment and service life requirements.
3. Versatility of steel and the proven and effective methods used to combat corrosive elements within the given environment.

The benefits and economics of hot dip galvanizing on large projects, situated in remote locations that involve special logistical arrangements, extreme and changeable weather conditions are again reaffirmed by this case study.

BOB ANDREW

14/04/1944 – 10/10/2020

The Association's long relationship with Bob Andrew followed Walter Barnet's involvement at Kinross Mine on the far Eastrand. Walter's relationship with Bob and Louis Pretorius was instrumental in the mining industry specifying hot dip galvanizing as a primary corrosion control technology for the Rasimone Platinum Mine in Rustenburg.

This project also marked the beginning of Bob Wilmot's relationship with Bob Andrew. Bob Wilmot, former Executive Director and honorary life member of the HDGASA had the following to say, "Bob Andrew was an honorary life member of the HDGASA. It was through the association that I was privileged to have known Bob Andrew. Our industry valued and his respected contributions to corrosion control. As a whole his position was that hot dip galvanizing was an appropriate form of corrosion control that benefited the mining sector. The association regarded him as a very wise counsellor who was always willing to provide valuable input regarding matters of corrosive environments specific to the mining sector. Bob's knowledge of the mining sector was extensive and as such he was in a position to make available valuable advice related to the appropriate application of hot dip galvanizing as a valuable, cost effective and sustainable form of corrosion control."

Bob was a keen author who contributed over the years to the association's publication in his column "Bob's Banter". A man of philosophy, philanthropy and learning he was always obliging in sharing his wealth of knowledge and experience.

In the latter years Bob succumbed to illness and the fatigue that accompanies the debilitation of sickness. Bob will always be remembered for the strong role he played to ensure the acceptance and application of hot dip galvanizing in the mining sector.

As a result of these efforts mining has over the years benefitted from superior corrosion control of the myriad of articles whose service life was maintained by hot dip galvanizing's corrosion control. The following guide has been drafted to provide the mining sector with supported and proven application of corrosion control in the mining arena.

A man of philosophy, philanthropy and learning he was always obliging in sharing his wealth of knowledge and experience.

Bob Andrew was a BSc Chemical Engineer from the University of Witwatersrand and obtained an MSc (Corrosion Science) from the University of Manchester.

He was a highly intelligent individual, an avid reader, deep thinker and maintained high standards of delivery excellence throughout his career. Beyond that, he was a good listener, and a trusted and loyal friend to many.

He had over 30 years' experience in corrosion protection, having worked for the CSIR, AECI, JCI Ltd and Anglo Platinum, as well as a Corrosion Consultant. In this period, I had the pleasure of managing him for several years until his retirement. At his retirement, his speech became a legend as he noted in closing to the numerous attendees that "I have fought the good fight against Anorexia and profess openly that I have failed miserably".

He was a retired Fellow of the SA Institute of Mining and Metallurgy, a retired Professional Engineer, a retired member of NACE and an Honory Life Member of the Corrosion Institute of Southern Africa and the Hot-dip Galvanizers Association of Southern Africa.

He is the author of "Guidelines for Corrosion Protection in Mining and Metallurgical Industries", published by NACE in 1997.

Daily commuting and driving, and the quest for a more rested lifestyle caused him and his wife Ann to retire to Parys, south of Johannesburg in 2001. From here he ventured forth as a Corrosion Consultant and Trainer par-excellence. He found much joy in all the activities surrounding the delivery of Training Courses. His wife Ann passed away a few years later and he remarried 2 years thereafter. Iris and Bob were involved in various local community activities, namely the Parys Museum and the Lewis Balink Charity Foundation.

On retiring from Anglo Platinum in 2000, Bob had been involved with training in the fields of project management, project risk & cost management, value management and corrosion risk management. In 2007, Bob and I formed a joint venture called Ithuta, aimed at offering practical short courses and coaching on a range of topics, including project management, project contract, risk and cost management, corrosion protection and value management. He was also deeply involved with the Knowledge Management field during this period. He also wrote profusely and authored the much-valued "Bob's Banter" in the HDGA's "Hot Dip Galvanizing Today" periodical for several years. My first read in this periodical was always his latest contribution.

His personal life deteriorated as various adverse medical conditions caused him to have to curtail his activities and led to a split with Iris. He sold his home and moved to a local Retirement Home where he passed away on the 10th October 2020 from medical complications.

Bob will be remembered as a practical, highly competent and respected Professional Corrosion Engineer, leaving a legacy of corrosion prevention successes behind and having had a direct influence in the implementation of Hot Dipped Galvanising Steel in the mining shafts and underground structural steel environment in the South African Platinum Industry.

Bob will be sorely missed by his colleagues, family and friends.

HOT DIP GALVANIZING'S proven mining applications

Hot dip galvanizing has been successfully used to protect small components as well as large structures in the Mining Industry in South Africa over several decades and accommodating extension of the life of mines beyond the original planned service life.

Hot dip galvanizing is a diffusion process and occurs when a suitably cleaned iron or steel article is immersed in molten zinc at ≈ 450°C. This is preceded by a cleaning phase which includes degreasing, pickling in acid and then applying suitable fluxing. Abrasive cleaning is generally not necessary, other than to remove weld slag or tenacious mill scale etc.

Through immersion, all surfaces are brought into contact with the molten zinc and resulting in the formation of a comparatively uniform, metallurgically bonded zinc and zinc-iron coating including internal surfaces, edges and corners. The general galvanizing process or batch type hot dip galvanizing, of products other than sheet and wire, provides a dense coat which is capable of providing both abrasion resistance and corrosion control to iron or steel. The hot dip galvanized coating structure differs somewhat to the 'thinner' or wiped coatings applied to sheet and wire technologies. Zinc can be applied to steel and other metals by a variety of processes. These methods include electro-deposition, thermal spraying, mechanical plating, zinc rich pastes & paints and hot dip galvanizing.

The formation of zinc-iron alloys i.e. metallurgical bonds between zinc and steel, are entirely absent in all other pure zinc coating technologies, used for corrosion control. The durability of a zinc coating is, in broad terms, roughly proportional to its thickness, regardless of the method of application. Hot dip

galvanizing employs zinc's strengths as both a barrier and a sacrificial material.

Applications of hot dip galvanizing for corrosion control include:

Structural steel applications

All structural steel is suitable for hot dip galvanizing. However the steel chemistry of a given batch will be the predominant determining factor of the thickness of the hot dip galvanized coating developed with the silicon and phosphorus content playing the major roles.

The preferred silicon equivalent* level is between 0.15% and 0.25%, and in this range, coatings are developed without such coatings becoming undesirably brittle. Not only do these thicker coatings provide longer corrosion free life but the abrasion resistant properties of the zinc-iron alloys, which make up the greater proportion of these coating, are of considerable benefit in the case of buntons and shaft guides.

While steel suppliers are well informed in this regard, orders for shaft guide and bunton steel should state "material to be suitable for hot dip galvanizing, Si content 0.1% – 0.25%". This is not necessary in the case of normal structural steel such as angles etc.

* Silicon Equivalent SiE = Si % + (2.5 x P %) where Si = Silicon & P = Phosphorus

Buntons

Streamlined buntons can be hot dip galvanized without distortion. An advantage is that internal surfaces are also hot dip galvanized. If buntons are not open-ended, drainage and ventilation holes must be provided on end plates to ensure satisfactory coating of internal surfaces and to prevent explosions during hot dip galvanizing. The hard zinc-iron alloys that constitute about 80% of the final hot dip galvanized coating are far more resistant to abrasion, which is experienced on the upper bunton surfaces, than that of uncoated steel or painted surfaces.

Shaft guides

Both top hat and square tube guides are suitable for hot dip galvanizing. The galvanizers who specialise in coating guides have installed equipment for checking tolerances and straightening should this be necessary. The main corrosion problem with guides is in crevices at bolted mating surfaces and the provision of a hot dip galvanized coating on mating surfaces reduces corrosion substantially.

Corrosion on riding surfaces is normally not severe, due to the wiping effect, but, the abrasion resistant zinc-iron alloys in the coating usually remain present, even on riding surfaces, for several years after installation. Guides are usually hot dip galvanized prior to cropping, drilling and matching but straps are hot dip galvanized after drilling. The drilling, cropping and matching may be performed by a specialist galvanizer, in-house, alternatively, the galvanizer is a sub-contractor to the fabricator in which case the galvanizer is only responsible, to the fabricator, for galvanizing and supply to the specified degree of straightness. Orders must specify that all cropped ends and uncoated bolt holes shall be coated by zinc thermal spraying in accordance with SANS 121: 2011 (ISO 1461: 2009).

Station steel structures

Screens, grid flooring and structural steel components, used in stations, are hot dip galvanized without difficulty. These structures are often test erected either at the galvanizer's or fabricator's works or even at the mine site to ensure correct fabrication has been carried out and to avoid the need for costly and time consuming modifications during installation underground.

Hydro-power piping

Organic coatings are generally unsuitable for protecting this equipment and either hot dip galvanizing or a material such as 3CR12 should be considered. When hot dip galvanizing is selected, the galvanizer must be instructed to remove excess zinc and protuberances from gasket grooves either by re-matching or melting out excess zinc. Another method is to mask grooves with a silicon based material which will prevent the formation of a coating in the grooves during galvanizing. The masking material is then removed after galvanizing.

Air columns

Galvanizing can be an effective method of protection for both internal and external surfaces of air-columns. Added external protection at deeper, more corrosive mine shaft levels, can be provided by duplex coating with an appropriate paint system.

Pump columns

The degree of corrosion control of a hot dip galvanized coating, applied to internal surfaces of high pressure pump columns, will depend on the level of corrosivity of the water being pumped, the amount of abrasive suspended solids present and the flow rate which, if higher than 0.5m/s, will reduce the service life of the coating.

External surfaces can be provided with additional protection by duplex painting at levels in a shaft where corrosion is severe but internal duplex coating is not recommended since it is difficult to determine whether paint coatings applied onto internal pipe surfaces possesses the required adhesion properties and dislodged paint films can result in damage to mechanical equipment in the pipeline system.

Flanged piping

When flanged piping systems are used under high pressure conditions, the galvanizer shall be required to ensure that the 'gramophone grooves on the flange faces, are clearly visible after the galvanized coating has been applied. Certain high pressure gaskets, however, do not require grooves to be present on flange faces. Hot dip galvanized high

strength fasteners, with suitably lubricated threads, should be used to connect flanges.

Flangeless piping

Hot dip galvanizing has an advantage over organic coatings, in the case of flangeless piping, in that, provided the weld metal is deposited in a continuous, flowing and uninterrupted run, damage to the zinc coating, on internal surfaces, will be insignificant. If a second pass is required after the route run, the deposited metal must first be allowed to cool down in order to avoid excessive temperature build-up which could result in localised melting of zinc on internal surfaces. Both shielded wire and stick welding is suitable.

Ventilation ducting

This product was conventionally fabricated from 'thinly' coated pre-galvanized sheet to which ungalvanized flanges and attachments were welded. Ducting, which is fully galvanized with a heavy duty coating after fabrication, is now available and this should be specified. Ducting up to 1.5m diameter can be galvanized after fabrication.

Buried pipelines

The durability of external surfaces of buried pipes will depend on the corrosivity level of the soil. If soil conditions are corrosive and foreign non-corrosive back-fill is not available, the application of a low cost bitumen or tar coating, to galvanized external pipe surfaces not only prevents rapid thinning of the zinc coating but also reduces the propensity for localised bacterial corrosion. However, a comprehensive evaluation of soil analysis etc, should always be carried out before using buried pipes.

Chute bodies

Hot dip galvanized structures are frequently used in conjunction with removable liners, in severely abrasive applications, and the ability of this coating to withstand fairly rough handling in service and when maintenance takes place, is an advantage. Contact between hot dip galvanized surfaces and uncoated steel may have the tendency to diminish the coating life at contact surfaces in moist conditions due to cathodic protection by the coating of the uncoated steel. This may be avoided, in some applications, by providing an insulating paint film prior to attaching the lining.

Headgears

Hot dip galvanizing of structural steel for sub-vertical headgears is a practical solution to the corrosion of these structures. Even for surface headgears there is a case for employing hot dip galvanizing. Hot dip galvanizing will provide indefinite maintenance free corrosion life for such surface structures at more or less the same initial cost of painting with a dependable paint system.

The plate girders on which these structures are mounted can distort during galvanizing unless they are designed

with subsequent galvanizing in view (ISO 14713 parts 1 and 2). An alternative to galvanizing, for plate girders, is zinc thermal spraying or the application of an inorganic zinc-rich paint primer after abrasive blast cleaning and followed by a compatible paint top coat.

Gold plants

Structural steel, for the construction of gold plants, is effectively protected by hot dip galvanizing but, as zinc forms an amalgam with gold zinc coated steel should not be permitted where recoverable gold dust is present.

Refrigeration plants

Refrigeration and ice plants are effectively protected by hot dip galvanizing and no additional paint protection is necessary. The coating is not affected by sub-zero temperatures and it can be expected to provide maintenance free life when used in this application.

Cooling towers and storage tanks

Under most conditions hot dip galvanizing after fabrication provides adequate protection. Where corrosive water is used, added protection by means of a duplex system is recommended by using a product such as epoxy tar. In the case of storage tanks which will contain portable water specially formulated bituminous paints, which are "taint" free are available for internal lining.

Concrete rebar

Hot dip galvanizing of steel embedded in concrete does not adversely affect bond strength in any way and hot dip galvanized coating is being increasingly used to prevent concrete spalling caused by corroding reinforcing steel. Anchor bolts and other connecting devices, which are case into concrete, should be fully galvanized, not just the protruding portion.

Conveyor steel

Hot dip galvanizing of conveyor steel structure, including idler bases, is recommended and usually more cost effective than painting. This applies to both surface and underground conditions. It is, however, not practical to galvanize idlers.

Brackets, clamps and sundry fittings

Small components, including castings, forgings and hot and cold pressings are suitable for hot dip galvanizing. These products are galvanized by specialists who utilise a centrifuging process which removes excess zinc deposits. Provided that accepted engineering standards are applied in the manufacture of cold worked components, such as pipe brackets and cold headed bolts etc. the possibility of subsequent fatigue failure, during service, can be discounted. Maximum coating thickness standards for components falling into this category are provided in SANS 121: 2011 (ISO 1461: 2009) and this should always be specified in order to avoid receiving thinly zinc electroplated components by misconception.

Heat exchangers

These are often partially hot dip galvanized with a coating applied on the outside only. This is achieved by attaching a snorkel tube to the heat exchange header and then (because it will float) forcing it under the surface of the molten zinc.

Hot dip galvanizing is an effective method of protecting heat exchangers which would be difficult to coat uniformly by spraying or brushing with a paint system. Units are frequently removed after several years in service and regalvanized before being returned to service.

In all the aforementioned applications the corrosion control of iron and steel is achieved by firstly enveloping the articles in a tough imperviable barrier of the Zinc-Carbonate film, or zinc patina, and in parallel cathodically protected by the sacrificial anodic layer of the zinc and zinc-iron alloys. As we grow and re-establish the strength of the sector let us ensure the best practices in corrosion control to deliver the lowest Total Cost Of Ownership (TCO) of mines for the initial planned lifespan and potential extensions beyond.

PERSONALITY PROFILE

AMISH RAMKISSON

How did you get involved in the hot dip galvanizing industry?

My father, Anni, and uncle, Roy, started Phoenix Galvanising in 1996. I was 14 at the time and every school holiday was spent in the plant doing, what I thought at the time, was basic jobs like quality control, crane movement, receiving, dispatch, etc. But now, looking back on those years I understand that it was long term training in our very niche industry. Training that you cannot get anywhere else. I also used to accompany Anni on all his sales visits, whether it be to local customers here in KZN or to our customers in Gauteng. Our industry has its own charisma, language and pace and I am very privileged to have been exposed to those elements from a young age.

Tell us a little about yourself, your home life, your hobbies and passions.

I have been married to my wife Trishana for 6 years. We have one child, Amithi, who is 4 years old. She is the light of my life and my greatest joy. My passions are travelling, photography and motorsport and I'm lucky that you can merge all 3 of them into singular trips. I have started a photography business as a passion project and it has allowed me to learn about my creative side and although it is a huge departure from galvanizing, it

is very rewarding. I also take part in club level amateur motorsport, which takes us to all the race-tracks in South Africa and I have also raced at the Nurburgring in Germany and Spa Francorchamps in Belgium.

What professional achievement are you most proud of?

I have a Bachelors in Business Administration (Finance & Economics) from UNISA and a Post-graduate Diploma in Management (Economics) from Wits Business School. My parents were highly influential in my academic career and I am proud that I achieved those goals. I would like to further study and achieve a Masters in Business Administration. I am also proud of the fact that I can use my studies in our day-to-day operations of Phoenix Galvanising as economic and management knowledge aids us in achieving our long term financial and production objectives.

Who has had the biggest influence in your life?

Easily my parents and their group of friends. My parents gave my brother and I a stellar education and life experiences and the freedom to let us experience life on our own. They taught me sincerity and compassion for family and community but also showed me how to do it by setting the example themselves. My father is very calculating and pragmatic and my late mother was highly professional in all her personal, professional and civic endeavors. She had her Masters in Education and taught high school Afrikaans for 21 years and then took a dare devil decision to join my father in Phoenix Galvanising. She then taught herself business acumen and corporate affairs and never stopped learning. Their group of friends are highly successful yet simple and humble and always have an ear to listen or a moment to dispense some wisdom.

What is your philosophy of life?

I am quite an adrenaline junkie and my philosophy on life used to be, "If you're not on the edge, you're taking up too much space!". But since I have a 4 year old child and a wife and home to take care of, my philosophy has changed. I'd say its now, "Leave space for the pram, but if you're not on the edge, you're taking up too much space!"
What is your favourite reading?
Anything on economics and the practically of the study material and how it affects every little decision in life. One book that stands out is Freakonomics by Levitt & Dubner.

Do you have any dislikes?

No. I am very open minded and would like to think that I'm non-judgmental. I'd also like to think that I'd try anything once.

Complete the sentence: "At five o'clock on a Friday... it's a few hours away from F1 qualifying on Saturday!"

AVAILABLE FROM THE ASSOCIATION

METAL-PRO GALV-FRIENDLY MARKERS

Designed for use in the hot dip galvanizing process, this **marking pen** stays on during fabrication but is removed completely in the galvanizing process.

PRO FEATURES

- Permanent marks during fabrication
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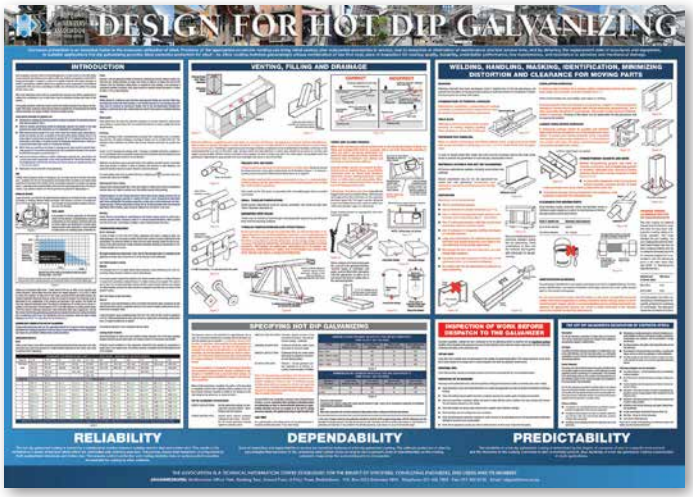
- Durable clip cap
- Fast drying
- Weather resistant marks
- Crisp lines or bold lines
- Suitable for all metal surfaces

DESIGN FOR HOT DIP GALVANIZING WALL CHART

The **wallchart** is an invaluable reference chart for fabricators and specifiers. Key information is readily available to allow for best engineering practice for galvanizing.



TECHNICAL GUIDES

The HDGASA **Steel Protection Guide** and **Facts about Hot Dip Galvanizing** are available in high-gloss printed material for reference and guidance.

HOT DIP GALVANIZERS ASSOCIATION SOUTHERN AFRICA

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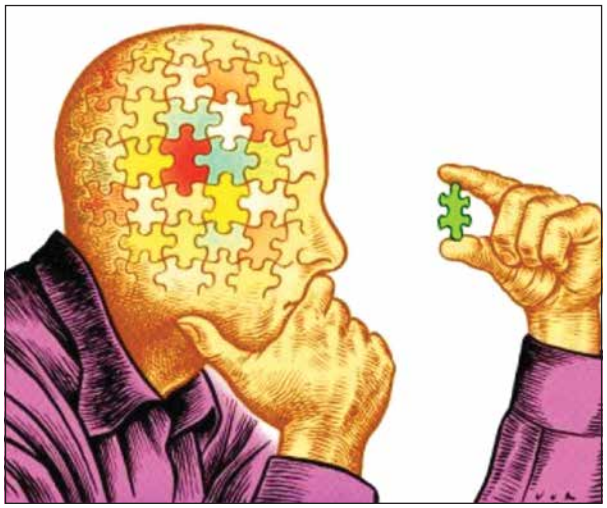


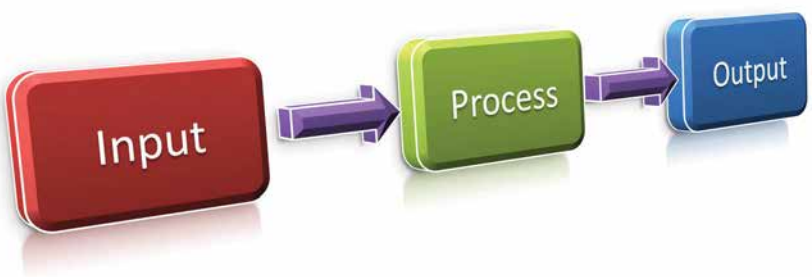
TO KNOW
or not to know?

APPLIED KNOWLEDGE, GAINED THROUGH TRAINING, STRENGTHENS THE FOUNDATION FOR EFFECTIVENESS AND ENSURES BEST ENGINEERING PRACTICES GROW RATHER THAN DIMINISH AN ORGANIZATIONS VALUE.

All things are prone to the ravages of time, including knowledge. The corrosion of knowledge is evident in three ways:

1. The absence of knowledge of facts,
2. The lack of acquaintance with a process or processes,
3. The absence of knowledge of how to conduct a necessary activity or activities.

The world in the 21st century is a dynamic environment where shifting job functions affect the workplace with little or no management of change being considered. However this dynamic environment demands that we act proactively and use innovation to create significance in areas of value that previously never existed. In choosing to move rapidly and innovatively we must never forego our foundation of knowledge. For when we ignore the vast amount of existing knowledge we undermine our own future efforts and again fall into an abyss, of having to be reactive, thus losing any gains we seek to deliver.



I recently watched a YouTube video posted by an innovative individual whose idea it was to introduce viewers, with no knowledge of motor vehicles, to the fundamentals of the components of a modern motor vehicle. The individual was enthusiastic and spoke confidently with concise explanations of each of the vehicle's components under the hood of a modern motor car. There was only one problem, he was completely ignorant as to what he was pointing out under the hood of the vehicle while providing confident yet nonsensical explanations as to what each component was and how it functioned. All that effort wasted, a lack of knowledge so obvious it was almost ridiculous.

In today's world, people are forever moving from one income stream to the next. Most of these movements are due to necessity rather than specialization in any one discipline. However very little effort is made to ensure an understanding of foundational knowledge exists when these changes occur.

We have been spoon fed by a society on quick fixes. From food which lacks nutrition, to schooling that lacks education. We have become indoctrinated that we only need to know the outcome itself and nothing that goes into achieving the outcome. As such we are aware that these outcomes rarely meet our expectation. To compensate for the disparity between the outcome expected and the ultimate outcome received we attempt to insulate ourselves with warranties and guarantees. We forego understanding the foundational facts of what we are 'buying-in-to' by having a provider give us a guarantee or warrantee, as a written promise, to meet our perceived expectation. Even then, when we do seek recourse the guarantee or warranty seldom satisfies our needs however it shields the supplier with legalise and innuendo.

When the product is complicated with several organizations participating in the value chain, an unhappy situation can become apocalyptic both from a commercial and personal view. The chain reaction when the delivery does not meet the expectation is to blame another entity lower down the totem for this failure. Escalation in order to secure an outcome closer to expectation is debilitating and commercial consequences can be disastrous. Project critical paths are shattered and costs soar.

It has been said that madness is primarily identified when someone continues doing the same thing over and over again and expects to get a different result. It is for this reason we agree that we all work in a mad, mad world.

Hot dip galvanizing is a proven reliable and for the most part predictable technology. For those who need to use this technology it is simple, relatively inexpensive and long lasting in its

ability to control corrosion. Hot dip galvanizing's foundational knowledge is exceptionally well documented over more than a century and a half. As such solutions to any perceived challenges faced when dealing with this technology are readily available through a plethora of informational outlets and internationally accepted training courses provided by the association.

Training is the only factor of production that does not suffer from the law of diminishing returns. Applied knowledge, gained through training, strengthens the foundation for effectiveness and ensures best engineering practices grow rather than diminish an organizations value.

As we head into 2021 it is more important than ever to ensure that the necessary knowledge is vested in personnel who link the efforts of the organization to the results being sought. Well trained personnel ensure effectiveness throughout the value chain. For galvanizing the correct specification, from the outset, and applied hot dip galvanizing standards are invaluable. The standards for fabrication and inspection of hot dip galvanized articles is therefore critical to avoid unnecessary delays and the associated cost creep that destroys viability of projects.

Courses on all aspects of hot dip galvanizing are available at reasonable rates from the Hot Dip Galvanizers Association. From a basic lecture outlining hot dip galvanizing's role in corrosion control to a high level comprehensive three day course as a specialist and inspector. The association is available to discuss each organizations needs and provide a suitable training solution for each to ensure:

1. Knowledge of the facts regarding hot dip galvanizing and corrosion control.
2. Personnel are clearly acquainted with the hot dip galvanizing process and the applicable standards.
3. Are able to conduct a necessary activity or activities for the best possible outcome, when specifying and using hot dip galvanizing technology.

Full details of existing courses are available on our website. Should you wish to discuss a tailored training opportunity please contact Anthony Botha at +27 11 456 7960 for further discussions.

COURSES OFFERED

"Knowledge is the only instrument of production that is not subject to diminishing returns" John Maurice Clark

Level I: Introduction to Hot Dip Galvanizing

The HDGASA one day INTRODUCTION TO HOT DIP GALVANIZING course is designed to provide an initial understanding of the concepts relating to hot dip galvanized coatings applied for corrosion control of steel components. The course comprises six modules. In order for the course to be viable we require six or more candidates to attend. Arrangements can also be made for this course to be held at a venue of your choosing for more than six candidates. In addition to the course, a special visit to a hot dip galvanizing plant may be arranged on a separate date, should six or more candidates be interested and able to attend.

Level II: Certified Galvanizing Inspectors

The HDGASA advanced Level II course provides the necessary skills to assess the quality and conformance of Hot Dip Galvanized coatings and Duplex Systems to the applicable specification. Delegates are introduced to other metallic type coating specifications and their application for corrosion control design.

The course provides an in-depth interpretation of the specifications and accepted best practice procedures for determining coating thickness, visual inspection of surface finishes as well as the evaluation of these coatings for corrosion control of steel components. The course includes a visit to a hot dip galvanizing plant where delegates will have an opportunity to assess finished product against the relevant quality standards on a real time first hand basis.

Three Continuous Professional Development (CPD) points are awarded to delegates attending the entire course. Bookings are limited to a maximum of 10 people, with applications treated on a first-come-first-serve basis. In order for the course to be viable we require 6 or more candidates to attend. Arrangements can also be made for the course to be held at a venue of your choice for more than 6 candidates.

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HOT DIP GALVANIZERS ASSOCIATION SOUTHERN AFRICA

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Armco Galvanizers Isando has been operating since 1989. Geared up to accommodate heavy structural steel up and till 13m in length. Isando has an average output of plus minus 2000 tons per month.

Armco Galvanizers Randfontein is our second facility based in the Randfontein area. Randfontein has an average output of plus minus 800 tons per month and is geared up to handle light to medium structural steel up and till 6m in length.

Armco Superlite is listed in accordance with the BSI ISO 9001:2015 quality scheme which ensures the quality of all products and services produced by **Armco Superlite**. Specific customer quality plans are drawn up where required for any of our operations.

Armco holds the SATAS mark for Hot Dipped Galvanized steel and all products galvanized at our premises are according to the SANS 121 / ISO 1461 specification. Galvanizing certificates are supplied on request.

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