Volume 22 Issue 2
July 2025

HOT DIP GALVANIZING TODAY 88

The Official Publication of the Hot Dip Galvanizers Association Southern Africa

ANNUAL MEMBERS DIRECTORY

CORROSION CONTROL OF STEEL

HOT DIP GALVANIZING... THE **BEST PROTECTION!**

CONSISTENTLY DELIVERING SUPERIOR QUALITY GALVANIZED PRODUCTS TO ALL OUR CUSTOMERS

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 Galvanizing and all Galvanizing done at our premises is in accordance to the SANS 121 / ISO 1461 specifications. Galvanizing certificates are supplied on request.

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

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

Isando | **Tel.** +27 11 974 8511

Randfontein | **Tel.** +27 11 693 5825

Web. www.armco.co.za

ARMCO SUPERLITE

OBO Bettermann Group

18

21

36

Contents

THE ASSOCIATION IS AN INFORMATION CENTRE ESTABLISHED FOR THE BENEFIT OF SPECIFIERS, CONSULTANTS, END USERS AND ITS MEMBERS.

ISSN 1023/781X

PUBLISHED BY:
Hot Dip Galvanizers Association Southern Africa
Bedfordview Office Park, Building 1, Ground Floor, 3 Riley Road, Bedfordview
P.O. Box 2212 Edenvale 1610 Tel: 011 746 8927 Email: hdgasa@icon.co.za Website: www.hdgasa.org.za

Executive Director: Robin Clarke Cell: 082 902 5119 Email: robin@hdgasa.org.za

Publication Liaison: Anthony Botha Cell: 082 326 6080 Email: anthony@hdgasa.org.za

Design and Layout: Sandra Addinall Tel: 083 601 7209 Email: cbtdesign@adcot.co.za

Reproduction and Printing: Camera Press Tel: 011 334 3815 Email: cpquotes@camerapress.co.za

EXECUTIVE DIRECTOR'S Comment

The Hot Dip Galvanizers Association celebrates its 60th year in 2025. It is an honour to be at the helm during this significant milestone.

The Association employees have been raising awareness of how zinc protects since the inception of the Association. In particular how the hot dip galvanizing process triggers a metallurgical reaction between molten zinc and cleaned steel to form a number of zinc and zinc alloy layers. These transcend protection by merely being a barrier to the environment but also provide secondary defence through the provision of cathodic protection.

Awareness of these benefits is created through information exchange with engineers, architects, corrosion control practitioners and steel fabricators. Such exchanges may simply be through telecons or e-mail exchanges of technical information to more formal meetings and presentations of courses. The HDGASA courses have been internationally adopted in both South America as well as parts of Asia. In S.A. our level 2 course dealing primarily with national standards carries accreditation for career development points.

Whilst the Association has built up an extensive data base and network of professionals in the consulting and engineering spaces, work is in progress to support university and technical college students as they garner knowledge and experience in the corrosion control field.

General points of media outreach have also been under development. Monthly media press releases aimed at stimulating industry awareness of steel beneficiation trends and challenges run in parallel with the promotion of hot dip galvanizing as a preferred corrosion control technology. Similarly, such articles are given broad "airtime" on our Association website and Facebook platforms.

International liaison is maintained through our links with international galvanizers associations worldwide. These links assist us in understanding both challenges and opportunities playing out on an international stage. The Associations gather bi-annually in Europe.

The HDGASA operations team continues to serve under the guidance of our executive committee. The committee comprises the galvanizers themselves as well as single representatives for our Affiliate and Associate member groups.

My sincere thanks to all our members for their ongoing participation, support and guidance.

Enjoy this edition of "Galvanizing Today"

LIUGONG

E SERIES

Creating a Better Future

NEW

Liugong 3.5T E Series Diesel Forklift

Winter Selling Price

From R306 000 ex vat

Lease from R6 900.00 per month

NEW

Liugong 2.5T E Series Diesel Forklift

Winter Selling Price

From R252 000 ex vat

Lease from R5 900.00 per month

RELIABLE & STABLE

> Fully upgraded power system.
> Structural component strength upgraded.
> Steering system reliability upgraded.

STRONG & DURABLE

> Optimize the overall layout and improve the stability of heavy-load operation.
> Stronger and powerful Mast.
> Heavy duty steering axle.

COMFORT

> Ergonomic layout.
> Small diameter steering wheel.
> LED high reliability lights.

NEW APPEARANCE

> Overall strong and more powerful.
> Counter weight with safety reflective label.

Parts & Service available on all Forklift Models

CES FORKLIFT MATERIAL HANDLING

LIFT SERV RENTALS | PARTS | SUPPORT

Office: +2710 110 0140 | **Sales:** +27 67 598 0245

WWW.LIFTSERV.CO.ZA

EDITORIAL COMMENT:
Going forward

This is the first ever hybrid issue of our magazine Hot Dip Galvanizing Today. The publication is a compilation of the editorial run as online only in the two previous issues and has the members directory for 2025 / 2026.

The postal services have been decimated over the years and returns from posting has become uneconomical and as such we have sourced a direct delivery contractor.

The readers who have supplied reachable physical addresses will receive a direct delivery of the publication in hardcopy format at the address furnished with their subscription. Should you wish to receive the annual issue which includes the members directory please advise the HDGASA of your physical address by email to *hdgasa@icon.co.za*. The online edition will be distributed via the email address of the recipient currently on our database and on *www.hdgtoday.com*

In this issue:

THE ASSOCIATION

HOT DIP GALVANIZERS ASSOCIATION SOUTHERN AFRICA

The importance of an association is that it plays a crucial role in our society, serving as a platform for like-minded individuals to unite, share ideas, and work towards common goals with a united purpose and powerful voice.

Whether it's a professional organisation, sports club, community group, union, federation, industry body, foundation, chamber or council, associations offer numerous benefits that contribute to personal and collective growth.

One of the critical reasons why associations are essential is the sense of community and belonging they provide. Being part of an association allows individuals to connect with others with similar interests and passions. Bridging the objectives of an association and the human beings that add life to it is critical.

Bringing this sense of belonging allows an association to foster camaraderie and support, creating a network of relationships that can be invaluable in both personal and professional spheres. The services and systems developed by the association offer opportunities for members to acquire new skills, knowledge, and experiences through workshops, seminars, and networking events.

Furthermore, an association advocates for their members, representing their collective interests and access to information and shared knowledge. Each point of access to a member provides a unified voice for issues affecting their members and works towards bringing about positive change in their respective industries. This collective advocacy can have a far-reaching impact, influencing policies, regulations, and public opinion.

In conclusion, an association is instrumental in fostering a sense of community, driving personal and professional development, advocating for collective interests, and positively impacting society. The importance of operational support and strategic co-creation cannot be overstated, for an association to flourish is insurmountable. Thoughtful appropriately directed collaboration offers a continued existence essential for the betterment of individuals and communities

The Hot Dip Galvanizers Association Southern Africa (HDGASA) is a not-for-profit trade association dedicated to serving the needs of end-users, specifiers, architects, engineers, contractors, fabricators and hot dip galvanizers throughout Southern Africa.

Founded in 1965, the Association's primary objective is to develop and expand the market for hot dip galvanizing and duplex systems as cost-effective corrosion control systems.

To further this aim, the Association provides training and information to end users, engineers, consultants, contractors, specifiers, designers and architects by way of courses, presentations, technical

research papers, plant tours and advisory involvement at the design stage of projects.

The HDGASA publishes promotional literature such as our Steel Protection Guide, Design Wall Chart and the "Hot Dip Galvanizing Today" magazine.

On behalf of our members, the Association liaises with regulatory and standards authorities governing corrosion control and associated industries.

Furthermore, the Association offers an independent inspection service, checking for compliance against the relevant standards.

Members of the Association shall at all times:

- Preserve the honour, integrity, dignity and good name of the Association.
- Promote and advance the objectives of the Association.
- Display professionalism, competence and ethics in terms of all actions and business dealings.
- Treat clients, associates and suppliers with fairness, respect and courtesy and foster good relations with them.
- Protect the interests of their clients and suppliers and not disclose any confidential or sensitive information regarding business affairs, trading secrets, technical methods or processes.
- Carry on business without causing harm other than by fair commercial competitive practices.
- Obey the laws of any country in which they are operating and observe accepted customs, codes and business practices.
- Timeously bring all cases of unethical conduct by other members to the attention of the Association.
- Act in the interests of the public by actively contributing to public health and safety and to the protection of the environment.
- Make a concerted effort to participate in Association affairs and programmes and where possible, contribute towards the development of the hot dip galvanizing.

The Association is a technical information centre established for the benefit of specifiers, consultants, end-users and members. Contact the Association should you require a comprehensive presentation on various aspects of hot dip galvanized coatings. The contents of any presentation can be tailored to suit the requirements of the audience i.e. Individualised Presentations to Companies, Engineers, Consulting Engineers and Projects.

The Association provides technical support in the field with the Visual Evaluation Guide for referencing conditions applicable to galvanizing outcomes, the reasons, responsible parties and remedial actions recommended.

Case studies, codes of practice and a broad range of information sheets simplify the technology and its intricacies and are available online. This is supported by answers to Frequently Asked Questions (FAQ) and other channels of information and feedback on the galvanizing industry and the technologies applicable thereto, these include technical papers, the Steel Protection Guide and the Design For Hot Dip Galvanizing Wall Chart.

Benefits of joining the Association

The Association offers training in all aspects related to hot dip galvanizing. Training courses are available to members at a substantial discount.

Assists members for quality aspects during fabrication, hot dip galvanizing and site inspections. The Association will investigate and objectively report on coating quality issues without compromising its credibility or professional reputation.

Offers technical advice relating to specifications, steels suitable for hot dip galvanizing and the appropriate corrosive control measures to suit various environments.

Actively develops increased awareness among current and future engineers, buying authorities and specifiers by way of presentations and plant tours and participation in relevant marketing events that promote the industry and its stakeholders.

We seek to identify capital projects and applications where hot dip galvanizing offers appropriate potential applications. Through direct involvement as early as possible in the conceptual, planning and design stages seek to successfully market the concept of corrosion control by hot dip galvanizing to relevant specifiers and key decision makers.

Provides free technical advice to galvanizing members relating to their galvanizing plant, equipment, processes, environmental compliance and specialized training of galvanizing personnel.

Becomes involved at the earliest design and development stages of all development projects, to positively promote the use of hot dip galvanizing in applications for which it is suited.

Will, where possible, attend international hot dip galvanizing conferences for networking with international bodies and if required, provide technical input at these functions to maintain the Association's established reputation. Furthermore, the Association will make the papers published at these conferences available to members.

Has an extensive technical library for the exclusive use of members.

Seeks to provide focused events including the HDGASA Awards event as well as the annual HDGASA Golf Day. The Association's in-house publication "Hot Dip Galvanizing Today" promotes all members through editorial and advertising with articles of interest to specifiers, end users and specialists in the corrosion control arena. Recipients of the publication number approximately 2000 individual recipients active within the corrosion protection industry and the various segments served. The list includes government representatives, NGOs, Environmental Bodies, end users, consultants, specifiers, fabricators and organisations that operate in the corrosion control industry.

The tertiary strategic marketing goals of the Association are to establish, where they do not exist, mutually beneficial relationships and networks with stakeholders and influential participants in the marketplace. These include local governments, NGOs, Environmental Bodies, The South African Bureau of Standards, SANRA, SAISC, International Zinc Association and EGGA. This core strategy is founded on researching, identifying and forging mutually strategic alliances.

HOT DIP GALVANIZERS ASSOCIATION SOUTHERN AFRICA
MEMBER CATEGORIES:

Affiliate Member (Company): Companies who sell products that are hot dip galvanized and who occasionally require the assistance of the Association.

Affiliate Member (Professional): Interested architects, consulting engineers or specifiers such as quantity surveyors, corrosion consultants, and designers from fabricating companies. This category is for individuals only.

Affiliate Member (Coating Inspector): Persons who have successfully completed and passed the Associations Level II Galvanizing Inspectors Course and wish to be registered as an approved HDGASA inspector. This category is for individuals only.

Associate Member (Galvanizer): Such galvanizers will be evaluated after a full years membership prior to attaining full Galvanizing Member status at the AGM.

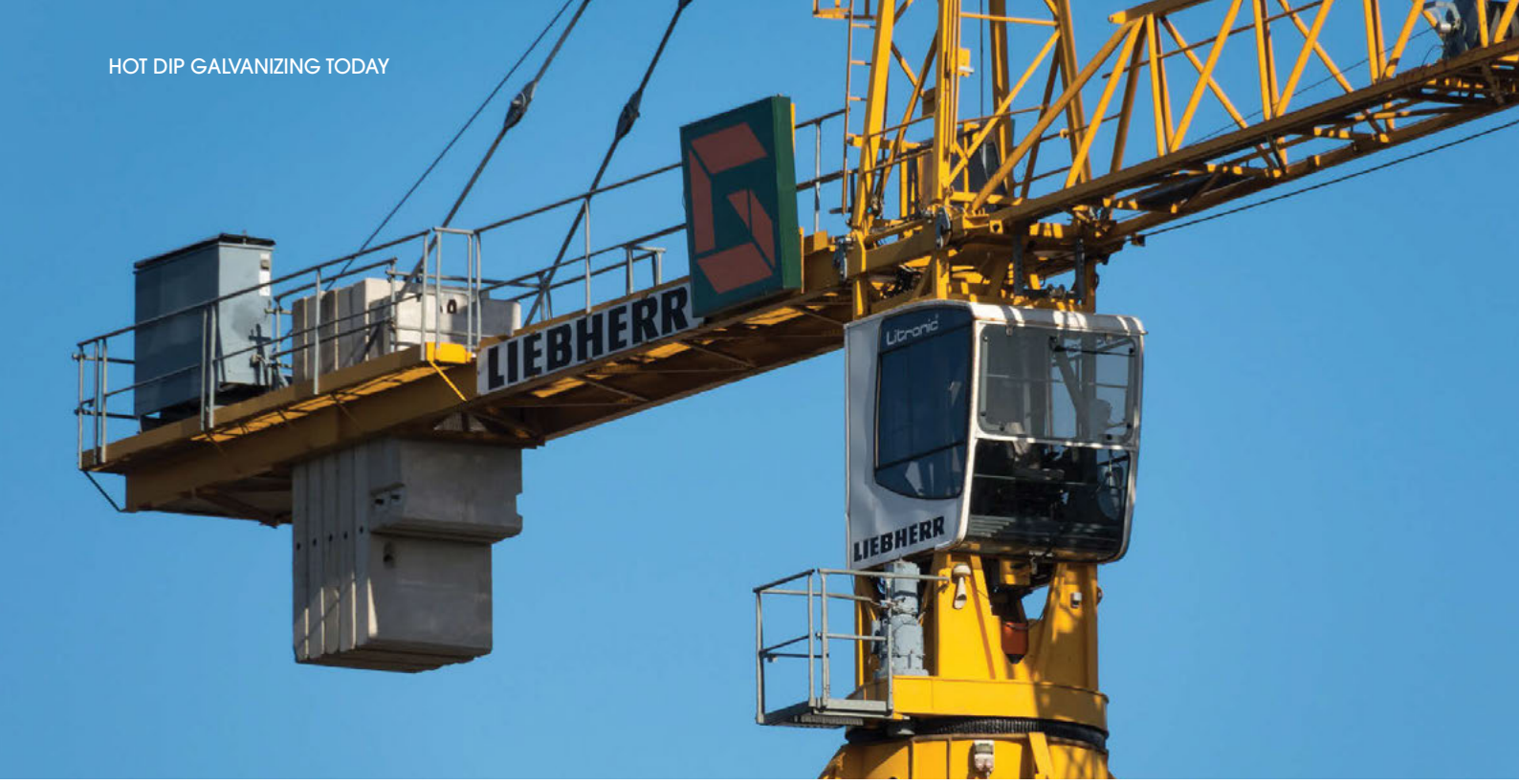
Associate Member (Support): Companies that purchase from and sell to the industry.

Corporate Members: Corporations who have interests in the Association; be it product or mining related etc.

Galvanizing Member: Existing hot dip galvanizing companies who have been in operation for a year.

International Member: Any international member (beyond the borders of South Africa) interested in joining the Association.

International Galvanizing Member: Any hot dip galvanizer beyond the borders of South Africa.



BENEFITS OF HOT DIP GALVANIZING
in the lifting industry

Corrosion resistance: HDG provides effective corrosion control, which is crucial for lifting equipment exposed to environments, including exterior atmospheric and marine conditions.

Durability: The zinc coating applied through HDG is a diffusion coating which is metallurgically bonded to the steel, offering proven ongoing protection that can extend the life of lifting equipment.

Maintenance reduction: Galvanized coatings require less frequent maintenance compared to steel coated with purely barrier-type coatings. HDG coatings reduce long-term maintenance costs and downtime through their ability to provide both barrier and cathodic protection to steel.

Cost-effectiveness: At times it may arise that the initial cost of galvanizing may require a higher initial investment, the extended service life and reduced maintenance make it the best lifetime-cost choice over the service life of the article.

Enhanced safety: Corrosion can compromise the structural integrity of lifting equipment. By controlling corrosion, HDG maintains the strength and reliability of the equipment, thereby contributing to safer operations.

Environmental resistance: HDG can withstand various environmental factors, including exposure to, atmospheric conditions as well as soil and water environments making it suitable for a wide range of lifting applications.

Applications of hot dip galvanizing in the lifting industry

Crane components: Galvanizing crane parts such as beams, columns, and other structural elements to ensure they withstand the elements and to maintain the design strength of the components over an extended service life.

Hoists and winches: Protecting hoist and winch components from corrosion, especially when used in outdoor or harsh environments lowers maintenance costs and allows for greater availability over the service life of the articles.

Lifting slings and hooks: Enhancing the durability of lifting slings, hooks, and other accessories that are frequently exposed to moisture and wear.

Support structures: Galvanizing support structures, such as towers and poles, that are integral to lifting systems.

Safety barriers and rails: Coating safety barriers and railings are used in conjunction with lifting equipment to ensure their longevity and effectiveness.

Considerations for using hot dip galvanizing

Preparation of articles: Proper surface preparation is essential for effective galvanizing. The metal must be clean and free of contaminants before coating. Comprehensive standards are available to guide the fabricator and manufacturer as well as the designer in components and materials to be hot dip galvanized such as ISO 14712 parts 1 and 2

Size and shape limitations: Potential limitations regarding the size and shape of components to be immersed in the galvanizing bath are best dealt with at the design phase in conjunction with the galvanizer.

Heat sensitivity: Hot dip galvanizing occurs at a temperature of around 450°C. Iron and steel will not be affected by this temperature range as the transformation of the metal and thus changes to its properties will only occur at temperatures above 700°C. However, careful consideration is required for materials that may be subject to stresses which may be relieved at the galvanizing temperature end may result in potential to distort or warp the material unless dealt with appropriately, affected by the galvanizing process.

Aesthetic considerations: The finish of hot dip galvanized steel may not always be as smooth or uniform as other coatings, which may be a consideration for applications where appearance is important. However, the limits of the aesthetics may be enhanced by a system known as Duplex coating for aesthetic and/or legal reasons, such as orange and white stripping of high tower equipment to conform to aviation regulations. Aesthetics for architectural, identifying coloured or camouflage appearances and extended service life may also employ Duplex systems.

Overall, hot dip galvanizing is historically and industrially widely used as the most effective method for protecting steel components, in the lifting industry, ensuring their durability, safety, and performance in challenging environments.

AVOIDING MICROBIOLOGICALLY induced corrosion (MIC)

IN RECENT YEARS, MOST SECTORS HAVE ACKNOWLEDGED MICROBIOLOGICALLY INDUCED CORROSION (MIC) AS A SEVERE CONCERN. ALMOST ALL METALS AND ALLOYS ARE IMPACTED BY THE PROCESS, WHICH OCCURS IN MOST AQUATIC SYSTEMS. THIS BEHAVIOUR IS ALSO OBSERVED IN POTABLE WATER SYSTEMS. MIC REFERS TO CORROSION INDUCED BY A RANGE OF MICROORGANISMS; HOWEVER, WE WILL FOCUS OUR ARTICLE ON BACTERIA.

Water quality can alter as a result of drinking water being distributed over a convoluted network of pipes, reservoirs, and consumer installations. Additionally, systems that provide drinkable water contain a variety of bacteria and other microbes. Despite disinfection, the proliferation of bacteria in potable water distribution networks has been extensively documented. Numerous bacteria contribute to the creation of biofilm, which can corrode building materials and have an impact on the distribution system's water quality. When flowing water comes into contact with a solid item, like the surface of a pipe, it will go through many chemical and biological changes that will eventually lead to the growth and formation of a biofilm.

The initial colonization of surfaces is predominantly carried out by bacteria that generate slime. Following the establishment of these slime-producing bacteria on the pipe surface, additional organisms may become ensnared within this substrate, resulting in the development of a complex biofilm composed of diverse bacterial species, inorganic surface films, and corrosion byproducts.

Once this biofilm is established, sulphate-reducing bacteria (SRB) inhabit the interface between the biofilm and the metal surface, as this area is anaerobic

and conducive to their preference for low-oxygen environments. SRBs are the microorganisms most frequently linked to microbiologically influenced corrosion (MIC) in industrial settings. They adhere to the steel surface, making it crucial to obtain scrapings directly from the metal when attempting to determine their presence. Relying solely on water sampling will typically yield few or no SRBs, despite their potential to cause significant corrosion issues.

SRB induces corrosion through the development of tubercles, which lead to pitting corrosion of the underlying steel substrate. These tubercles typically exhibit a brownish hue, and upon rupture, reveal a soft black core. Underneath this soft black layer, the metal surface presents a grey and shiny appearance, indicating

ongoing corrosion characterized by the presence of pits.

Numerous studies supported by the Water Research Commission have been conducted by the CSIR to investigate this specific type of corrosion in drinking water systems within Gauteng Province. The principal findings are summarized as follows:

- Despite the application of chlorination, biofilm formation was observed on all alloys across all locations.
- Tubercle development and colonization by sulfate-reducing bacteria (SRB) were primarily noted on carbon steel coupons at every site.
- Carbon steel coupons experienced SRB colonization within three months of exposure.
- Pitting corrosion beneath the tubercles was detected within three to six months following SRB colonization.
- The carbon steel coupons located at the Pretoria site were the first to be colonized by SRB.
- While chlorination can delay SRB colonization, it does not completely prevent it.
- The galvanized coupons maintained their protection due to the zinc coating, with no substrate penetration observed after 20 months at any location.

SRB can induce corrosion in metallic piping within potable water systems, even in the presence of chlorination. Their existence is frequently disregarded when assessing the aggressiveness of potable waters through various corrosion indices, which may occasionally result in misleading conclusions.

While SRB can corrode a wide range of metals and alloys, unlined carbon steel in potable water is particularly vulnerable to this form of corrosion. For instance, in sprinkler systems, corrosion of the unlined small-bore piping is typically not anticipated due to the minimal oxygen levels present. However, if SRB contamination occurs, the conditions become favourable for their proliferation, which is a primary factor contributing to corrosion and leaks in sprinkler systems. SRB can lead to corrosion issues in hot, cold, and low-temperature water systems.

It is crucial to prevent the introduction of SRBs into any new water system, as their establishment makes removal nearly impossible. The following guidelines should be observed:

- Utilize only potable water that has been adequately chlorinated for hydro-testing.
- Refrain from using stagnant water or water sourced from dams, ponds, etc.
- After repairing leaks, ensure that all water is flushed out of the system.
- If feasible, flush the system with an inert gas.

BOLTED CONNECTIONS and corrosion control

Bolted connections are one of the most widely used, versatile and reliable methods for joining structural steel members. Some of the advantages of bolting over methods such as welding and riveting are:

- Economy, speed and ease of erection;
- Reliability of service;
- Ease of inspection;
- Fewer, and less highly skilled operators are required;
- Reliable performance under fluctuating stresses;
- No pre-heating of high-strength steels;
- No weld cracking or induced internal stresses;
- No lamellar tearing of plates;
- No heat damage to the coating on hot dip galvanized or painted structures.

Type of structural bolts and fastening devices

Low-carbon steel bolts, generally known as grades 4.8, 5.8 and 8.8 have been in use for many years. High-strength structural bolts for use in high-strength bearing-type joints and high-strength friction type joints, which are referred to as grades 10.9 and 12.9. These 'high' strength bolting grades were introduced to increase the scope of structural bolting.

The strength of structural bolts is specified in terms of the tensile strength of the threaded fasteners. Two numbers separated by a full stop are stamped on the bolt head. The first number represents one-hundredth of the nominal tensile strength and the second number represents one-tenth of the ratio between nominal yield stress and nominal tensile strength expressed as a percentage. For example, a grade 4.8 bolt has:

- Tensile strength of 4 x 100 = 400MPa;
- Yield strength of 0.8 x 400 = 320MPa.

A large variety of fastening devices, other than bolts and nuts, are used throughout industry and these include components such as spring clips where permanent retention of clamping force is essential.

Corrosion control

While the mechanical properties of fastener assemblies are structurally dependable and cost-effective, the durability of such connections will be influenced by the degree of corrosion encountered in service. Deterioration brought about by rusting can lead to the seizure of fasteners and premature failure, in the form of corrosion fatigue.

Adequate corrosion protection of fasteners is, therefore of paramount importance if the overall integrity of a structure is to be retained throughout its life *(Figures 1, 2 & 3)*.

In bolted steel structures the bolts and nuts are critical items on which the integrity of the entire structure depends. Protection from corrosion is provided by using corrosion resistant materials or by providing a protective coating, either before or after installation.

Corrosion resistant metals

The use of fasteners, manufactured from corrosion resistant metal alloys, frequently provides the most cost effective method of avoiding degradation by corrosion in very aggressive environments.

Contact between dissimilar metals can result in galvanic corrosion, particularly where a large cathode is in electrolytic contact with a small anode. Austenitic stainless steel fasteners are used with success in many applications where there is contact with metals such as zinc and in mild to moderately corrosive environments, hot dip galvanized fasteners

Figure 1: An assortment of zinc coated bolts showing the importance of coating thickness in a particular environment.

Figure 2 (above) and Figure 3 (above right): Corrosion protection of holding down bolts should be equal to that provided for main structures.

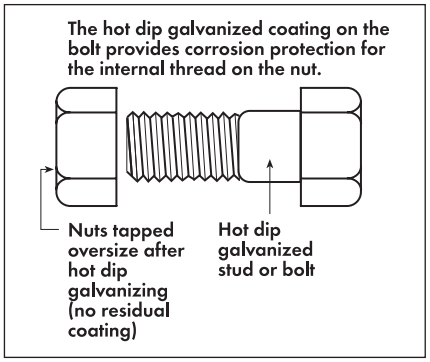


Figure 4.

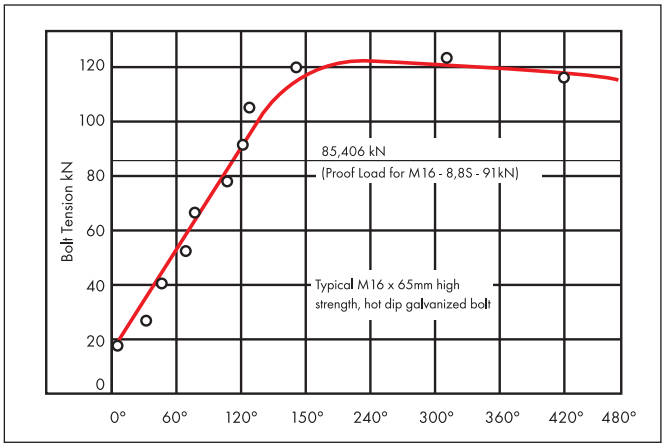


Figure 5: Demonstration of tensioning results obtained by the turn of the nut method.

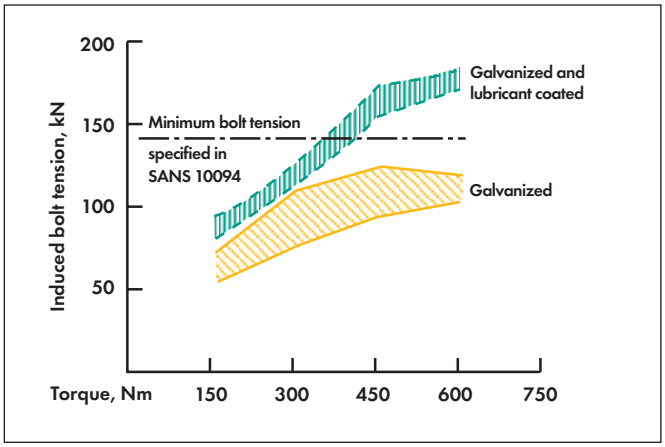


Figure 6: Torque/induced tension-relation for M20 high strength structural bolts, only galvanized and galvanized and lubricant coated.

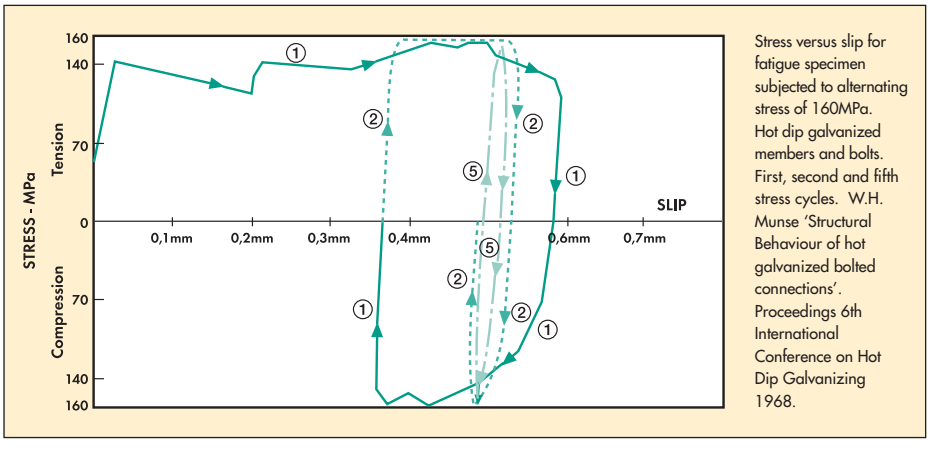


Figure 7.

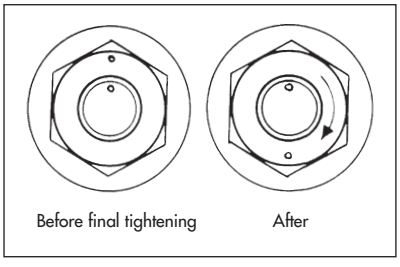


Figure 8: Where accurate tensioning is critical, permanent indication of the extent of part turn tightening can be identified by match marking.

have proved successful for connecting components manufactured from Corten steel.

The use of an organic coating over one or both metal coating interfaces of a joint prior to fastening, or the sealing of that joint after bolting, in an aggressive atmosphere will substantially increase the corrosion resistance of that joint.

Table 1 provides a guide to the compatibility of various metals and alloys in contact in building applications. For example, it will be observed from the table that a zinc coated fastener (anode) connected to 300 series stainless steel (cathode) is unacceptable in a corrosive environment whereas zinc coated steel connected with 300 series stainless steel is acceptable.

Protective coatings

A coating applied to fasteners must, of necessity, be tightly adhering and resistant to damage during and after assembly. For this reason, metal coating before assembly, is preferable. Additional protection, after assembly by means of an additional paint coating is beneficial in aggressive environments, particularly when these metal coatings have been applied.

	CONTACT MATERIAL (FASTENER/WASHER)											
	Aluminium and aluminium alloys		Copper and copper alloys		300 series stainless steels		Zinc coated steel and zinc		Aluminium/zinc coated steel		Lead	
Sheeting material	Industrial & marine	Rural	Industrial & marine	Rural	Industrial & marine	Rural	Industrial & marine	Rural	Industrial & marine	Rural	Industrial & marine	Rural
Aluminium and aluminium alloys	A	A	C	C	B	B	B	A	A	A	C	C
Copper and copper alloys	C	C	A	A	B	B	C	C	C	C	B	B
300 series Stainless Steels	C	B	B	B	A	A	C	C	C	B	B	B
Zinc coated steel and Zinc	A	A	C	C	B	B	A	A	A	A	B	A
Aluminium/Zinc coated steel	A	A	C	C	B	B	B	A	A	A	C	C
Lead	C	C	A	A	A	A	B	A	C	C	A	A

Legend:
A = Acceptable. Increase in the corrosion rate of the sheeting or contact material will be zero or slight.
B = Acceptable, but increase in the corrosion rate of the sheeting or contact material can occur.
C = Do not use. Accelerated corrosion will occur, or the difference in the lives of the two materials is too great, or both.

Table 1: Metals and alloys between which direct contact is acceptable.

OVERSIZE TAPPING ALLOWANCE FOR HOT DIP GALVANIZED NUTS	
Nominal Size of Thread	Allowance (mm)
M8 to M12	0.33
M16 to M24	0.38
>M24 = M27	0.43
>M27 = M30	0.47
>M30 = M36	0.57
>M36 = M48	0.76
>M48 = M64	1.0

Table 2: Recommended oversize tapping allowance.

	LENGTH OF BOLT, mm	
Nominal bolt diameter	Nut rotation 1/2 turn with 60° tolerance over no tolerance under	Nut rotation 3/4 turn with 60° tolerance over no tolerance under
M16	up to 120mm	120 up to 240mm
M20	up to 120mm	120 up to 240mm
M24	up to 160mm	160 up to 350mm
M30	up to 160mm	160 up to 350mm
M36	up to 160mm	160 up to 350mm

Table 3: Nut Rotation from the snug-tight condition.

Coating metals used include zinc and noble metals such as nickel and tin. In the case of the more reactive metals, such as zinc, coating thickness is of paramount importance as corrosion control service life is more or less proportional to the coating thickness.

Where metals, such as nickel and tin are used, thinner coatings will usually provide long-term protection provided that these coatings are free from imperfections and not subjected to mechanical damage which, in corrosive conditions, will lead to accelerated corrosion of exposed underlying steel. The cost of providing protection employing the more noble metals is high and as such has restricted the general use of these coatings for the corrosion protection of fasteners in the structural steel industry.

Hot dip galvanizing of fasteners

Hot dip galvanizing of fasteners is a specialised process and the products should, therefore, be purchased from an approved bolt manufacturer who will ensure that the correct manufacturing and galvanizing procedures, including oversize tolerances, etc., are adhered to.

Oversize tapping allowance for hot dip galvanized nuts

The zinc coating on external threads shall be free from lumps and shall not have been subjected to a cutting, rolling or finishing operation that could damage the zinc coating. The zinc coating of an external standard metric thread that has not been undercut shall be such as to enable the threaded part to fit an oversized tapped nut *(Figure 4)* per the allowances given in *Table 2*. On bolts greater than M24, undercutting of bolt threads is frequently preferred to only oversizing of nut threads.

Influence of galvanized coatings on thread stripping strength

In high-strength bolting, correct tightening is essential, and the oversized tapping of galvanized nuts does not necessitate a reduction in the level of minimum tension which applies to uncoated fasteners. To meet this requirement, galvanized high-strength nuts have a higher specified hardness than that demanded in the case of ungalvanized nuts.

Bolt relaxation

The possible effect of bolt relaxation, caused by the relatively soft outer zinc layer of the galvanized coating on the mating surfaces have been investigated. Tests carried out by the Hot Dip Galvanizers Association and the SABS revealed no substantial relaxation confirmed by international studies which shows that a maximum loss of bolt load of 6.5% for galvanized plates and bolts can arise, as opposed to 2.5% for uncoated bolts and members. This loss occurs within about five days and little further loss is recorded. This loss can be allowed for in design and is readily accommodated.

Slip factor of mating surfaces in friction-type joints

In the case of galvanized friction grip joints the galvanized coating behaves initially as a lubricant and a co-efficient of friction of normally less than 0.2. After the first few cycles, under alternating stress, the galvanized surfaces tend to lock up and further slip, under alternating stress, is negligible *(Figure 7)*. If the initial slip is undesirable, the application of a zinc silicate paint, to mating surfaces before assembly, will provide a slip factor above 0.4 and, this enables hot dip galvanized assemblies to be designed for performance which is similar to that of uncoated steel.

Zinc metal spraying or alternatively light abrasive blasting of mating surfaces will also provide an acceptable slip factor.

Lubrication of threads

For high-strength galvanized fasteners to be tensioned to the required level, thread lubrication, employing molybdenum disulphide-based lubricant or alternatively, a wax such as beeswax, is essential *(Figure 5)*.

Threaded Articles Class 10.9 Fastener Diameter	Local Coating Thickness (min.) µm or gms/m²	Mean Coating Thickness (min.) µm or gms/m²	Maximum Coating Thickness (min.) µm or gms/m²
ø > 6mm	40 (285)	50 (360)	65 (465)
Note: Excessively thick hot dip galvanized coatings (i.e. zinc immersion time of longer than 2 minutes), results in excessive growth of the hard Fe/Zn alloy layers and possible fatigue failure from crack propagation at stress raisers. Excessively thick coatings on threads will interfere with thread tolerances. Threads are to be clearly defined and free from excess solidified zinc, allowing for ease of nut fitting and tensioning.			

Table 4.

Bolt and nut assemblies

Hot dip galvanized bolts and nuts should ideally be supplied in the nutted- up condition. This ensures that bolts and nuts have been matched and supplied by the same manufacturer while the possibility of bolts being supplied with clogged threads is avoided.

Washers

High-strength washers are required to be through hardened before hot dip galvanizing.

High strength fasteners – Class 10.9 (Refer to SANS/ISO10684)

Class 10.9 fasteners may be hot dip galvanized, provided that a certificate of compliance is issued by the galvanizer, stating that the hot dip galvanizing has been carried out per SANS/ISO 10684 typically this is done by the following procedures

1. All pretreatment cleaning is achieved by lightly wheel-abrading for less than 5 minutes instead of acid pickling. This is preferred to eliminate the liberation of hydrogen ions (H+1) and remove the potential for hydrogen embrittlement.
2. Thick hot dip galvanized coatings are avoided by limiting the immersion times to less than 2 minutes, agitating in the molten zinc and ensure that all components are immersed for similar periods followed by efficient centrifuging *(Table 4).*
3. No stripping and re-galvanizing of rejected sub-quality coating is allowed.
4. No uncoated areas are acceptable.

Note: Users of fasteners must be aware of dangers during tightening procedures if they are not applied correctly.

Bolt tensioning procedures

Extensive tests have been carried out in order to arrive at the most effective method of tensioning hot dip galvanized fasteners while ensuring that this can be performed reliably by semi-skilled personnel. The torque required to tension hot dip galvanized fasteners, even after lubrication, can vary substantially from one fastener to another and, while this fact also applies to uncoated fasteners, the scatter is greater in the case of galvanized fasteners. It is recommended that reliable tensioning of high strength hot dip galvanized fasteners should not be based on torque/tension values, particularly in the case of friction grip connections. This recommendation is in line with results obtained in countries elsewhere and, for this reason, torque control tensioning is not encouraged either for coated or uncoated high-strength fasteners.

Recommended method of tensioning (turn of the nut method)

If hot dip galvanized fasteners are to be used, it is recommended that the turn of the nut method of tensioning should be adopted. This method has proved to be reliable and slight variations in the degree of final nut turning do not significantly influence the ultimate bolt tension *(Figure 6)*. The procedure is simple and does not entail the use of specialised equipment. Nuts are tightened to a snug tight position and variations in tightness at this stage do not significantly influence the final result. Snug tight is defined in many specifications as the full effort of a man on a standard podger spanner or the point at which there is a change in the note or speed of rotation when a pneumatic impact wrench begins impacting solidly.

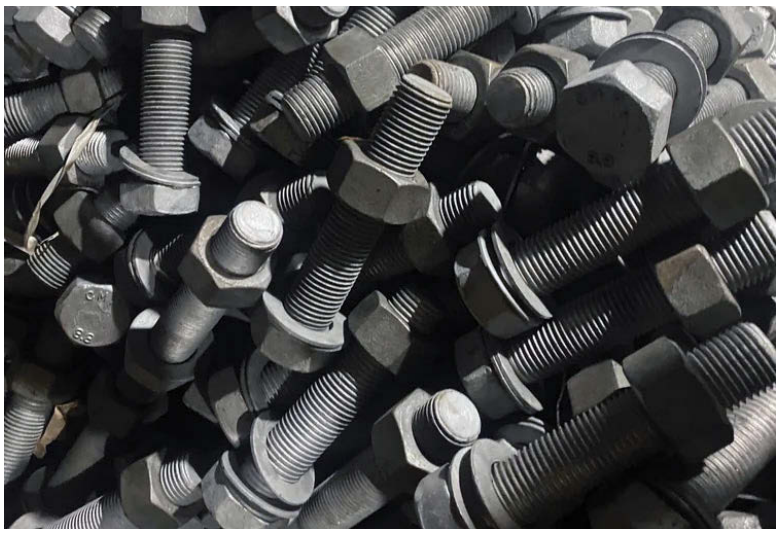
Podger spanners are graded in length, in relation to bolt size and strength and, for example, a spanner of some 450mm in length is regarded as appropriate for an M20 high strength structural bolt. It must be repeated that the clamping force supplied by snug tight is highly variable but this is not significant when bolts are subsequently fully tightened. The bolt tension/bolt elongation-curve is relatively flat once the proof load is exceeded and, hence, variations in the snug tight condition results in only small variations in the final bolt tension.

For the final tightening the standards in *Table 3* are recommended. The table provides for rotation up to 60° in excess of the recommended nut rotation or a total of 240° in the case of M16 and M20 fasteners up to a length of 120mm.

Where accurate tensioning is critical such as in the case of friction grip connections, a permanent indication of the extent of part-turn tightening can be identified by match marking the bolt end and nut, at the snug tightening stage, before the final tightening *(Figure 8)*.

Part torque – part turn method

This procedure entails the use of a torque wrench to induce a snug tight condition to all bolts before applying full tension by the turn of the nut procedures.



Alternative methods of tensioning hot dip galvanized fasteners

The use of load indicator washers provides effective tensioning but this entails the use of specially manufactured washers with protrusions which are flattened as tension increases and a reduction of the gap by a specified amount indicates that the minimum bolt tension has been reached.

Hydraulic tensioning equipment, which stresses the bolt to the required extent prior to nut tightening, is also available. These alternative methods entail the use of specialised equipment and for this reason the use of the uncomplicated and reliable turn-of-the-nut method is recommended.

The effect of hot dip galvanizing on strength properties of fasteners

The hot dip galvanizing process does not adversely affect the mechanical properties of high-strength fastener steel or even material such as spring steel. Hardened steels <1000MPa yield strength, are not considered to be prone to hydrogen embrittlement as a result of pickling, before galvanizing, and any absorbed hydrogen would be diffused during immersion in the molten zinc at 450°C.

In the case of a high strength grade 10.9 and above fasteners as well as products manufactured from spring steel, excessively thick galvanized coatings (>65µm) should be avoided since excessive growth of the hard Fe/Zn alloy layers can result in fatigue failure due to crack propagation from these layers into the substrate where a potential stress raiser may be present. In any case, excessively thick coatings on threads are undesirable as this will interfere with the thread tolerance and may also result in galling during tensioning. Ideally a maximum coating thickness of 65µm applies to all male threaded components.

The use of hot dip galvanized Class 10.9 bolts and nuts are permitted provided that a certificate of compliance is issued by the galvanizer that the fasteners have been processed in terms of SANS/ISO10684.

CASE STUDY

GALVANIZING FRIENDLY marker evaluation

by Chantell Aucamp

Background

Specially formulated markers are imported into South Africa by The Hot Dip Galvanizers Association of Southern Africa (HDGASA). This marker is specifically designed for use in the hot dip galvanizing process, as this marking pen stays on during fabrication but is removed completely in the galvanizing process.

Marker features

- Permanent marks during fabrication
- Ergonomic non-slip rubber grip
- Formulated for industrial use
- Marks on wet & oily surfaces
- Durable clip cap
- Fast drying
- Weather resistant marks
- Crisp lines or bold lines
- Suitable for all metal surfaces
- Design for Fabricators & Galvanizers
- Multi-lingual packaging
- Multiple colours (creamsicle, white & yellow)

Case study

Tests were conducted to verify the performance of the markers in different environments and galvanizing conditions.

Steel preparation

A 6m length angle iron was cut into 9 x 300mm lengths, in order to test all three colours supplied at three different galvanizers. A 6mm Ø hole was drilled into each piece in order to assist with the jigging process. The following references were written on the nine pieces of steel as per *(Figure 1)* and left outside in the sun to weather for approximately 3 to 4 weeks as per *(Figures 2, 3 & 4)*.

As per the above figures, it is noticeable that the writing has faded, and the steel corroded during the weathering process as anticipated.

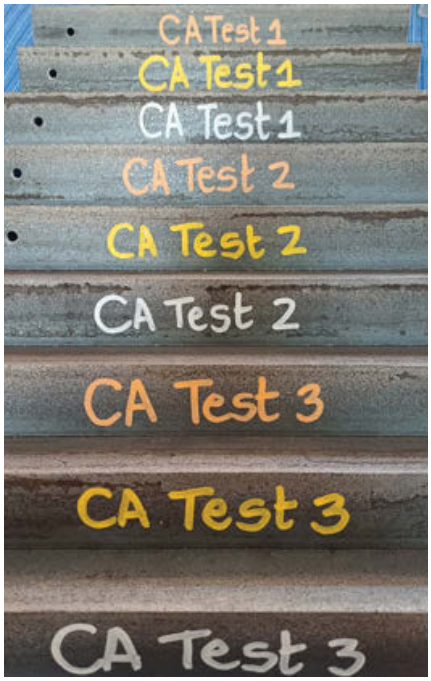
We conducted tests on the nine pieces of marked steel, by putting them through the hot dip galvanizing process at three different galvanizers, to verify if the marking pen will be completely removed during the galvanizing process.

Hot dip galvanizing process

Hot dip galvanizing is a process used to apply a protective coating of zinc to steel or iron surfaces. It involves immersing the cleaned and prepped steel or iron articles into a bath of molten zinc at a temperature of approximately 450°C to 460°C. The process of hot dip galvanizing consists of three key steps: surface preparation, galvanizing and inspection.

Step 1: Surface preparation

Degreasing – organic pollutants such as dirt, paint marks, grease, and oil are removed from the metal surface using a hot alkali solution.



1

Figure 1: References written on the 9 pieces of steel.

2

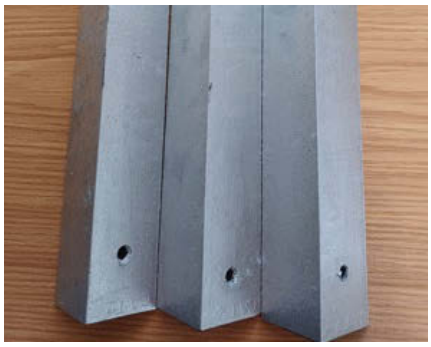
3

Figures 2, 3 and 4: The steel was left outside in the sun to weather for approximately 3 to 4 weeks.

4

5

Figures 5, 6, 7 and 8: The markings were completely removed during the galvanizing process *(see comparison between Figure 1 and Figure 8).*



6

7

8

Pickling – mill scale, and iron oxides are removed from the steel surface using a diluted solution of ambient hydrochloric acid.

Fluxing – the cleaned articles are dipped into a flux solution. The flux prevents the formation of oxides from the surface and provides a protective layer on the steel, promoting the formation of a uniform zinc coating.

Step 2: Galvanizing

The steel is entirely immersed in a bath (kettle) of molten zinc, the galvanizing step of the process happens. The bath chemistry must be at least 98% pure zinc and kept at a temperature of around 450°C, according to the specifications. The crane lowers the steel at an angle. This allows air to escape from tubular shapes or pockets in the design of a fabricated component, as well as molten zinc to displace the air. The zinc reacts with the iron in the steel in the kettle to generate a sequence of zinc-iron intermetallic alloy layers. The coating growth is complete after the fabrication item reaches batch temperature, and the products are slowly removed from the galvanizing bath. Draining, vibrating, and/or centrifuging are used to remove excess zinc. As long as the pieces remains around bath temperature after being removed from the bath, the metallurgical reaction will continue. Articles are cooled either by immersing them in a passivation solution or by leaving them out in the open air.

Step 3: Inspection and Finishing

The final stage of the procedure, inspection, is straightforward and rapid. Coating thickness and coating appearance are the two aspects of the hot dip galvanized coating that are thoroughly examined. Products are galvanized in accordance with the SANS121:2024 standard that have been long established, accepted, and approved.

Conclusion

As per the tests conducted at the three different galvanizers during their galvanizing process in accordance with SANS121:2024, it was concluded that the galvanizing friendly marker upheld the function it was designed for. The markings remained during the fabrication but was completely removed during the galvanizing process as per *(Figures 5, 6, 7 & 8)*.

CORROSION PROTECTION
of rebar for concrete structures

Introduction

There are numerous examples worldwide of "spalling concrete" found on structures within marine and inland urban and industrial environments. Clearly, there is a need to implement effective corrosion control methods in order to extend the long-term durability of steel-reinforced concrete.

Methods proposed for the corrosion protection of reinforcement do not, in any way, replace or usurp the importance of good quality concrete as the primary source of "barrier protection" against the corrosive attack of steel reinforcement. What is proposed in this paper is a "belt and braces", a cost-effective and site-practical method, of improving corrosion protection of embedded reinforcement, before actual placement within a structure, i.e. prior to, during delivery to site and final installation. In short, "prevention is better than cure".

The cost of adequate prevention carried out during the stages of design and execution are minimal compared to the savings they make possible during the service life and even more so, compared to the cost of rehabilitation, which might be required at later dates. The so -called De Sitter's "law of five" can be stated as follows: one dollar spent in getting the structure designed and built correctly is as effective as spending $5 when the structure has been constructed but corrosion has yet to start, $25 when corrosion has started at some points, $125 when corrosion has become widespread (Reference 3).

There are several methods of corrosion protection, such as, but not limited to the following:

- The use of membrane-type coatings applied to the surface of concrete structures.
- Painting the outer concrete surface to provide barrier protection.
- Addition of corrosion inhibitors to concrete.
- The use of stainless steel or 3CR12 as a substitute for normal carbon steel reinforcement.
- Cathodic protection of the reinforcement.
- Application of a coating to the reinforcement itself, i.e. epoxy coatings and specifically zinc in the form of hot dip galvanizing.

While these various methods provide varying degrees of success, this paper will examine the specific aspects of corrosion protection by the application of hot dip galvanizing for "barrier protection" (2nd line of defence) with the added benefit of cathodic protection (3rd line of defence) achieved by the fact that zinc is electro-negative to carbon steel. The main "barrier protection" (1st line of defence)

is of course the concrete cover of the embedded reinforcement. It is abundantly clear that many misconceptions persist with regard to the use of hot dip galvanizing as a corrosion protection system for reinforcement.

This paper addresses many of these issues in order to facilitate informed decision making, during the design stage for projects where reinforced concrete is to be used as a structural component.

It is known from practical experience and site investigations, around the world and specifically along the Southern African coastline, as well as at numerous inland locations that **"The life to the first maintenance of an uncoated steel bar reinforced concrete structure which has failed by concrete spalling after approximately 10 years, could have been extended too over 30 years if the re-bar had initially been hot dip galvanized".** This postulation assumes a quality concrete cover of 40mm minimum with >40 MPa strength concrete (ordinary Portland Cement) (*Reference 1).*

It is generally accepted that such concrete quality as well as correct site placement, presents practical difficulties that cannot always be avoided. A zinc coating, in the form of hot dip galvanizing, is suggested as a practical, and economical approach aimed at enhancing the durability of reinforced concrete.

Figure 1: While minimum cover may be specified the actual cover ultimately achieved is frequently dependant on practical site considerations.

1

Factors affecting the durability of reinforced concrete structures

Environment

Corrosion attack and hence, the ultimate service life of any material, is dependent on the environment in which such components are situated. The external environment is a major factor to be considered when designing all types of structures and reinforced concrete is no exception.

It is the environment that carries the corrosive-inducing elements and compounds such as oxygen, chlorides, sulphur dioxide and water to name but a few. Structures located along the coastline, which are exposed to prevailing winds from off the sea, are subjected to a greater degree of corrosion attack than at most inland sites. This applies particularly in the spray zone because of the presence of chloride-containing moisture in an oxygen-rich environment. Sulphur dioxide-containing atmospheres encountered in polluted industrial areas can be even more severe. It is essential to assess the degree of corrosion pertaining at each specific site whether inland or in a coastal region. Determine the microclimatic conditions, whether coastal or inland.

There are many examples of the effective use of hot dip galvanized reinforcement in corrosive marine and industrial environments both in Southern Africa and throughout the world. Many of these examples date back to the late 1950s and early 1960s.

Quality of concrete

The quality and permeability of concrete represent the most important or critical factors to be considered when reviewing corrosion control and/or protection of the embedded reinforcement. Concrete permeability (1st line of defence) is

influenced by the following factors, referred to as the four Cs.

- *Concrete Mix* – Low concrete permeability is a function of the bonding between the aggregate and the cement, the water/cement ratio and the size and grading of the aggregate.
- *Compaction* – Adequate and controlled compaction has an influence on both the quality of the concrete and its permeability.
- *Curing* – Site curing procedures influence permeability and ultimately concrete quality and strength.
- *Depth of Cover* – Depth of cover over the embedded reinforcement is of major significance when corrosion prevention of steel is being considered. Notwithstanding the depth of concrete cover required in terms of the specification, the final cover is often determined or limited by practical considerations at the time of the actual placing or pouring of the concrete. The reinforcement could shift within the shuttering or formwork and this could remain undetected due to practical restrictions during the pouring process. Practical aspects encountered during construction could compromise the final depth of covers.

Indications of the reduction of the initiation time of corrosion due to local reductions in the thickness of the concrete cover in some areas of the structure are halved with respect to its nominal value, in these areas the initiation is reduced to less than one-quarter of that predicted. This analogue is only valid when concrete is exposed to chlorides *(Reference 3).*

In other words, considering a chloride environment the following is possible:

- 24mm nominal concrete cover estimated 100 years to initiation of reinforcement corrosion.
- With the reduction of the nominal concrete cover to half, (12mm) estimates reduce to 15 years to initiation of reinforcement corrosion (*Refer to annex C).*

2a

2b

2c

2d

Figure 2a: Ingress of corrosive substances is first indicated by rust staining.

Figure 2b: Cracks appear.

Figure 2c: Spalling concrete.

Figure 2d: Potential structural failure – once spalling has occurred, it becomes very difficult and expensive to repair.

From the above, it is clear that the structural performance of reinforced concrete and the onset of corrosion of the reinforcement is largely determined by the quality of the concrete and the practical placement of the embedded steel reinforcement. It is therefore clear that the provision of corrosion protection to the reinforcement, by hot dip galvanizing, does not replace the requirement for good quality concrete. The purpose of corrosion protection of reinforcement is to extend the ultimate service life of the structure once the corrosive agents, present in an aggressive environment, have penetrated the concrete cover (*consider Figure 1).*

Structural failure due to corrosion

In order to place the need for hot dip galvanizing of reinforcement into context, we must first discuss a typical failure of a reinforced concrete structure, due to corrosion of the reinforcement.

Figures 2a - 2d illustrate the sequence of events leading to the ultimate failure of a reinforced concrete structure.

The service life of a structure can be defined as the period of time in which it is able to comply with the given requirements of safety, stability, serviceability, and function, without requiring extraordinary costs of maintenance and repair (*Reference 3).*

Hot dip galvanized steel reinforcing can be used to control corrosion in reinforced concrete exposed to the following conditions:

- Carbonation;
- Chloride and sulphate ion intrusion;
- Atmospheric pollution;
- A combination of chlorides and sulphates constituents;
- Freezing and thawing; and
- Expansive reactions e.g. alkali-aggregate reactions (*Reference 4).*

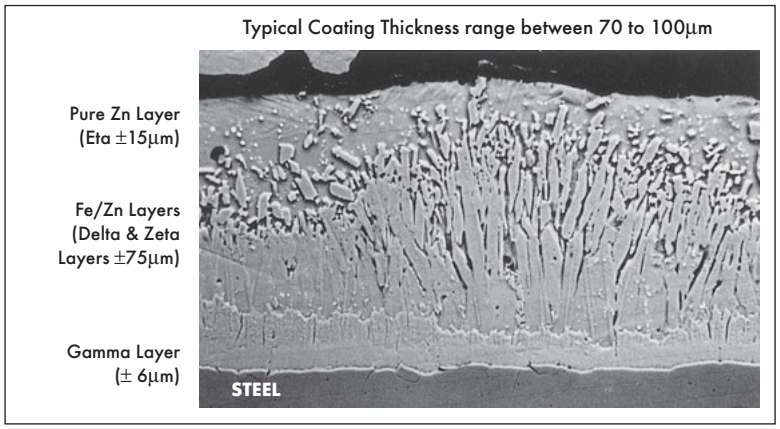


Figure 3: Typical hot dip galvanized coating showing the metallurgical bonded layers of iron/zinc with a pure (eta) top layer.

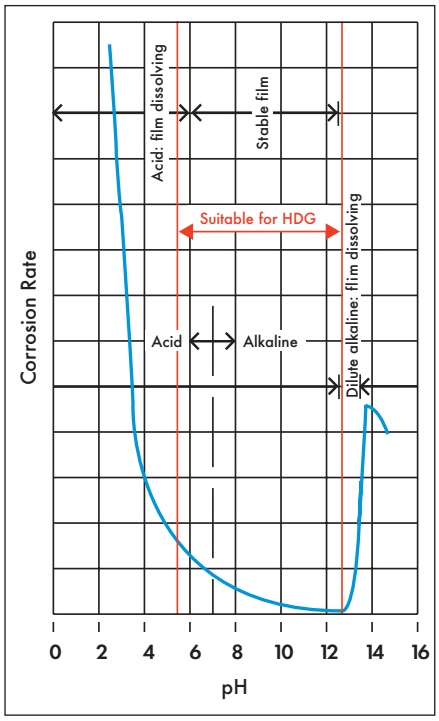


Figure 4: The relative corrosion rates (y axis) of zinc in terms of the pH scale (x axis).

Hot dip galvanized reinforcement offers significant advantages compared to uncoated carbon steel under equivalent circumstances. These include: an increase of initiation time of corrosion; greater tolerance for low cover, e.g. in slender (architectural) elements, and corrosion protection is offered to the reinforcement prior to it being embedded in concrete *(Reference 3).*

The structural integrity and longevity of bridges, tunnels, coastal buildings, industrial chimneys and cooling towers, as well as many inland industrial installations can be effectively and economically improved by the use of a zinc coating in the form of hot dip galvanizing to protect the embedded reinforcement.

Before continuing, let us briefly review the hot dip galvanizing process. What do we know of hot dip galvanizing, how does zinc protect and what constitutes the zinc coating?

Hot dip galvanizing process

Hot dip galvanizing is a metallurgical process whereby perfectly cleaned steel is totally immersed into molten zinc at a temperature of approximately 450°C. During this process the carbon steel metallurgically reacts with the molten zinc forming a series of zinc/iron alloys together with a top pure zinc layer, chemically bonded to the parent steel. The micrograph *(Figure 3)* is an illustration of a typical hot dip galvanized coating in which one can identify the various coating layers. Hot dip galvanized coatings provide "barrier protection" as well as "cathodic protection" of minor uncoated areas (handling damage), and micro-cracks that may be present, should cold bending be carried out after zinc coating.

Corrosion creep from an uncoated area is not possible as is the case with an epoxy coating, which is pure barrier protection. While zinc and/or iron/zinc alloys are present the zinc will "sacrifice" itself to protect the carbon steel. We therefore refer to zinc as a "wasting protector" due to the fact that it is electro-negative to carbon steel in terms of the galvanic series of metals. i.e. Zinc is anodic to cathodic carbon steel and will therefore provide "cathodic protection" of small-uncoated areas.

Hot dip galvanized coating thicknesses are dependent on factors such as immersion time, zinc temperature, speed of withdrawal and chemical analysis of the carbon steel reinforcement. It is possible that the chemical composition of the steel could result in coating thicknesses as much as 200µm. While such coatings improve corrosion protection, estimated at +30% better than pure zinc, it is

advisable to limit the coating thickness to <200µm and avoid excess brittle alloy layers and potential for coating flaking. While excessive zinc/iron alloys need to be controlled, they do provide additional benefits of increased corrosion protection and abrasion resistance. Coatings should be restricted to <200µm with due care and control during the hot dip galvanizing process.

In the final operation, within the hot dip galvanizing process, steel is processed through a passivating solution (0.5% to 1% sodium di-chromate). While this process is aimed at the restriction and formation of zinc oxidise/hydroxide (white rust) during storage and in transit to the site, it has the added benefit, of passivating the hot dip galvanized zinc coating when exposed to high alkaline and reactive "wet" concrete. We will again refer to this issue later in this paper.

Zinc reaction with newly poured concrete

In order to place the question of hot dip galvanized reinforcing bars into context, we need to consider what transpires when reinforcing is cast into concrete. How does the zinc coating react with the newly poured and curing concrete? What reactions take place when corrosion-induced substances penetrate through to the reinforcement?

a. Zinc in a varying pH environment

From the diagram of the relative corrosion rates of zinc in terms of the pH scale, *Figure 4*, we see that zinc is attacked in an acid environment (pH <6) and again in highly alkaline conditions (pH >12.5). The fact that zinc corrodes at pH levels >12.5, gives rise to the misconception regarding the performance of hot dip galvanized reinforcement in contact with newly poured "wet" concrete.

Freshly poured "wet" concrete has a pH >12.5, which will cause it to react with zinc. In practice, the pH of the pour solution in concrete is usually below 13.3 during the first few hours after mixing, due to the presence of sulfate ions from the gypsum added to the Portland cement as a regulator.

This reaction progressively ceases whilst the concrete is curing, and is largely inhibited when the galvanized reinforcement is chromate passivated, as is normal practice, within the hot dip galvanizing process.

The passive film that forms on zinc not only reduces the rate of the anodic process (zinc dissolution), but also even hinders cathodic reactions of oxygen reduction and hydrogen evolution (*Reference 3*).

During initial contact between hot dip galvanized reinforcement and wet concrete, the outer zinc layer of the galvanized coating reacts to form zincates, (calcium hydroxyzincate). The zincates formed, consuming between 5 to 10µm of the outer zinc (eta) layer in the establishment of a passivated layer. This reaction ceases as the concrete hardens leaving a coating of stable zincates and the remaining (approximately 75 to 85µm) original zinc and zinc-iron alloys intact and able to provide corrosion protection, both barrier and cathodic.

It is noteworthy that within a short time, pH levels within concrete are reduced into a range of 8 to <12, due to the inevitable ingress of carbon dioxide (CO_2), referred to as carbonation. In this pH range, zinc performs exceptionally well, while the rate of corrosion of unprotected steel increases due to the loss of a protective

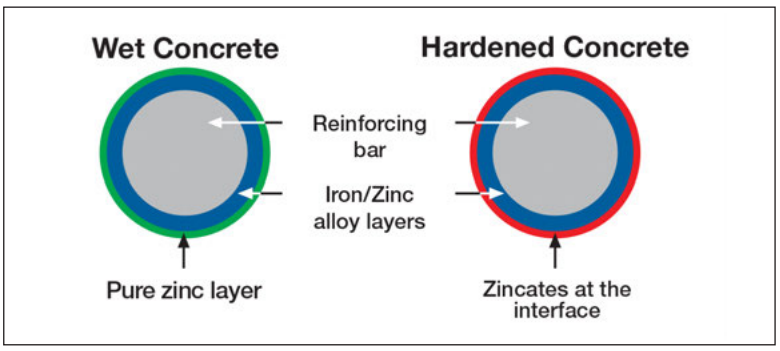


Figure 5: Evolution of the hot dip galvanized coating from the "wet" concrete pour to that of the "hardened" concrete at 7 to 10 days.

5

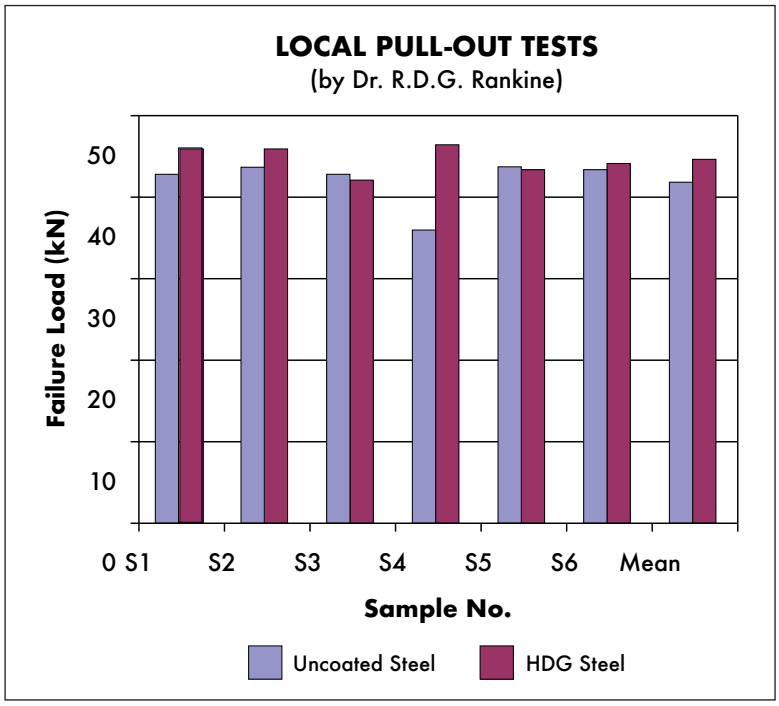


Figure 6: Bond strength tests conducted by The School of Concrete Technology, including six samples labelled S1 through to S6.

oxide passive film on steel. It could be argued that the formation of the zincates (calcium hydroxyzincate) is an additional corrosion protective barrier, which is perhaps debatable.

b. Evolution of hydrogen

It is known that when the wet concrete pour is exposed to zinc, a reaction takes place between the zinc and the cement paste or $Ca(OH)_2$ formed because of cement hydration. This corrosion reaction is controlled by diffusion processes and results in the evolution of hydrogen and the transformation of zinc into calcium hydroxyzincates, as shown by the following chemical formula *(Reference 4).*

$$2Zn + Ca(OH)_2 + 6H_2O \rightarrow Ca[Zn(OH)_3]_2 2H_2O + 2H_2$$

The resultant hydrogen, so formed, is believed to reduce the bond strength between the reinforcement and the concrete. However, this zinc corrosion reaction is only active during the initial curing period of between 6 to 10 days. During this period, as already stated, approximately 5 to 10µm of the pure zinc (eta) outer layer is consumed, leaving the remainder of the eta and all of the zinc/iron alloy layers unaffected. Subsequent loss of zinc (eta) and alloy (gamma, delta & zeta) layer, due to continued reaction, is no more than about 2µm per year although, in carbonated concrete, this may increase *(Reference 4).* Depending on the coating thickness a further 60 to 90 years or more can be expected before all the zinc is sacrificed in the protection of carbon steel.

Notwithstanding the above, the corrosion rate between zinc and fresh concrete can be controlled by the presence of chromates. Such chromates are provided by way of the sodium di-chromate applied during the hot dip galvanizing process or alternatively as potassium dichromate as an additive to the concrete mix. In addition, naturally occurring chromates, present in most Portland cements, can be relied upon to provide adequate passivation with no reduction in bond strength.

Bond strength of concrete to hot dip galvanized reinforcing bars

A further misconception that arises is that due to the formation of insoluble zinc salts and the evolution of hydrogen formed at the interface between the newly poured (wet) concrete and the hot dip galvanized reinforcement, is the reduced bond strength.

Extensive programmes of pullout tests conducted by a number of research organisations around the world including a series of local tests conducted by Dr. R.G.D. Rankine of the School of Concrete Technology. Results show conclusively that the bond strength is not reduced when compared with uncoated reinforcement. In fact, an actual increase in the bond strength has been observed. The graph, illustrated in *Figure 6*, reflects the results obtained during the tests conducted by Dr. R.D.G. Rankine (*Reference 2).*

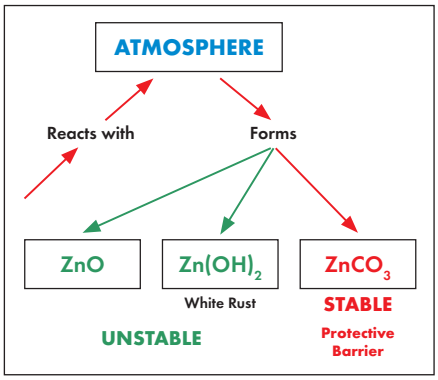


Figure 7: The reaction between zinc (Zn) and the atmosphere, including oxygen, water moisture, and carbon dioxide.

Generally, it is believed that during the early stages (6 to 10 days) of the concrete curing, the bond strength may be temporarily reduced due to the issues of hydrogen evolution and the formation of calcium hydroxyzincate etc. However, as the concrete hardens, the bond strength increases and there is no difference between uncoated reinforcement and that of the hot dip galvanized material. In fact, there is evidence to suggest that bond strength improves and is higher than that of uncoated reinforcement. The evolution of hydrogen is believed to be very short-lived and may well cease within approximately 1 hour *(Reference 4).*

A higher bond with respect to bare steel could be obtained, due to the formation of calcium hydroxyzincate crystals that fill the interfacial porosity of the cement paste and act as bridges between the zinc coating and the concrete (*Reference 3).*

Influence of temperature on steel tensile strength

A further misconception is that due to the hot dip galvanizing temperature of 450°C, the reinforcement will lose structural strength and its tensile integrity. This is not so, in that the transformation ranges of steel occurs between 700°C to 900°C, which is well above the hot dip galvanizing temperature. This fact is confirmed by laboratory tests as well as practical case studies with fasteners and structural steel components that have been hot dip galvanized.

7 Corrosion resistance

Two major factors cause the corrosion of steel reinforcement and hence long-term performance of reinforced concrete structures. Both are influenced by the permeability of the concrete cover.

a. **Carbonation**, i.e. the ingress of carbon dioxide (CO_2) from the atmosphere, and
b. **Chloride and sulphate ion intrusion**, again from the atmosphere or in other words the environment in which the structure is to function.

a. Carbonation

Carbon dioxide (CO_2) may well enhance the barrier protection of zinc by the formation of stable zinc carbonate ($ZnCO_3$), i.e. the reaction of zinc with carbon dioxide. At the same time, *Carbonation* is defined as a process whereby carbon dioxide in a moist environment reacts with hydrated cement paste to form an acid-aqueous solution that tends to reduce the concrete's alkalinity.

Zinc is amphoteric, i.e. able to react as a base and an acid, between a pH range >6 to <12.5, refer to ***Figure 4***. As the pH is reduced, due to carbonation, into a range of 8 or 9, it is ideal for the corrosion protective properties of zinc, but less favourable in the case of uncoated steel. Hot dip galvanized reinforcement therefore presents an ideal solution to combat carbonation.

The passive film of hot dip galvanized reinforcement is stable ($ZnCO_3$), *Figure 7*, even in mildly acidic environments, (pH of 6) so that the zinc coating remains passive even when the concrete is carbonated down to a pH of 8 or 9. In extreme cases, where all the calcium hydroxide is depleted, the value of pH may drop to as low as 8.3 *(Reference 4).* Zinc-coated reinforcement therefore remains passivated far longer than uncoated carbon steel where carbonation is encountered.

The corrosion rate of hot dip galvanized steel in carbonated concrete is approximately 0.5 to 0.8µm/yr, therefore a typical 80µm hot dip galvanized coating would be expected to last over 100 years. The corrosion rate of hot dip galvanized bars remains negligible in carbonated concrete even if a modest content of chloride is present.

b. Chloride attack

In chloride-contaminated concrete, which is the major reason for steel corrosion affecting the service life of reinforced concrete, the penetration of chloride ions can depassivate steel and promote active metal dissolution.

A combination of loss of alkalinity due to carbonation and the ingress or inclusions of chloride ions can act in combination and pose a serious destructive threat to the long-term stability of a concrete structure.

As chloride penetration of the concrete through to the embedded reinforcement is only possible through the concrete matrix, we can understand the significance of concrete quality and the need to ensure compliance to design and effective site management and supervision during construction.

Hot dip galvanized reinforcement can offer significant advantages over uncoated carbon steel in terms of substantial reduction or even total elimination of rust staining and greater tolerance to construction imperfections and greater resistance to chloride attack. Improved resistance to chloride attack is due, for a large part, to the lower value of free corrosion potential of hot dip galvanized steel.

It is worth pointing out that small-scale laboratory tests tend to indicate that hot dip galvanized steel is subject to corrosion in highly contaminated concrete. However, site experience and examination of several bridge decks exposed to chloride salts well in excess of the threshold value needed to induce corrosion of untreated steel, and of structures exposed to severe salt -water environments, have shown no evidence of corrosion or impaired performance of the concrete with no structural impairment due to lack of bond *(Reference 4)*.

Another interesting feature is that potassium chloride; also present in seawater, as opposed to sodium chloride, inhibits the corrosion of zinc. It is for this reason that totally immersed hot dip galvanized steel, as opposed to spray zone applications, will provide extended corrosion free life.

Even if pitting corrosion is initiated, the corrosion rate tends to be lower for hot dip galvanized steel, since the zinc coating that surrounds the pits

8

9

Figure 8: Corroded reinforcement resulting in the "spalling off" of the concrete. Note the lack of concrete cover.

Figure 9: Repairs to the concrete on this bridge structure proved to be unsuccessful in that the corroding reinforcing bars have again removed the concrete.

is a poor cathode and thus it reduces the effectiveness of the autocatalytic mechanism that takes place inside the pits on bare steel (*Reference 3).*

Up to date information, both from laboratory tests as well as site inspections and observations over the past 20years, is provided in a book, published during 2004, which clearly confirms the long-term benefits of hot dip galvanized reinforcing (*Reference 4).*

In this publication, Professor Yeomans has proposed a schematic representation to illustrate the benefits of hot hip galvanized reinforcement on the design and service life of reinforced concrete structures.

One of the major factors that contributes to the significant delay of the onset of corrosion of the base steel is the fact that the galvanizing provides a metallurgically alloyed coating of consistent quality that is highly resistant to damage during transportation, storage, site handling and concreting operations *(Reference 4, Page 59).*

Economic consideration of hot dip galvanizing reinforcement

The cost of hot dip galvanizing reinforcement is insignificant compared to the cost of repairing spalling concrete that results from the corrosion of uncoated reinforcement. *Refer to the so-called De Sitter's "law of five"* quoted earlier.

Costs vary from place to place and are subject to many factors such as the price of concrete, price of steel, site location, contractor's overheads and so on. However, notwithstanding this, it is believed that the increase in the overall cost of placed reinforced concrete is in the range of 5% to 10%. If one were to continue with this analysis and consider the use of hot dip galvanized reinforcement in strategic locations, such as the exterior walls of a structure and for high-risk corrosion areas, the overall cost increase for a project could be as little as 0.5 to 3%.

Whatever the final cost incurred to hot dip galvanize, it is more economical than many alternative methods of corrosion protection, and perhaps more importantly for the project owner, the savings that will result over the life of the project, by the reduction in maintenance and rectification costs.

Site visits and observations

The following photographs provide examples of sites where uncoated reinforcing bars were used in concrete that was undoubtedly required to conform to the specified standards for concrete quality and minimum depths of

10

11

Figure 10: The site of the 40-year-old pedestrian bridge (No. B776), which was demolished in 2008. It was established that hot dip galvanized reinforcement was used in the approach stairway, which was on the sea-facing side, indicated on the left of the photograph, with the sea some 50 meters further left.

Figure 11: Public seafront swimming pool in Cape Town, using seawater.

Figure 12: Sydney Opera House successfully employed hot dip galvanized reinforcements.

Figure 13: Johannesburg Civic Centre is an example of hot dip galvanized reinforcement being used as an architectural requirement to prevent rust staining on the slender (low concrete cover) fascia panels. Original construction period was from 1964 through to 1968. A recent inspection shown no sign of rust staining was evident.

cover. In the case of one particular site, both hot dip galvanized reinforcement as well as uncoated re-bar was used. Where hot dip galvanized reinforcement was used no spalling was found, while the uncoated bars were corroding and spalling of the concrete had commenced.

Some case studies

A recent case study resulting from a detailed investigation of a certain pedestrian bridge situated along the foreshore of Algoa Bay (Port Elizabeth South Africa) is briefly described.

The site of the 40-year-old pedestrian bridge (No B776), is due to be demolished (April 2005). It was established that hot dip galvanized reinforcement was used in the approach stairway, which was on the sea-facing side, indicated on the left of the photograph, with the sea some 50 meters further left.

Sample concrete cores were extracted from the sea-facing side, top slab and landside of the structure. These samples were sent to an independent concrete diagnostic & durability laboratory with instructions to establish the ingress of chlorides, carbonation and quality of the concrete. The depth of reinforcement cover was confirmed as being 45 to 60mm and a sample of hot dip galvanized bar was retrieved for examination.

Chloride concentrations (% as mass of cement) at a depth of 45 to 60mm ranged between 0.15 and 0.65 on the side facing inland, and 0.27 and 1.26 on the sea-facing side. At a depth of 30 to 45mm the chloride concentrations ranged between 0.19 and 2.6. Chloride levels at a depth of 15 to 30mm rise to between 0.49 to 8.8 as a % of cement mass. Accepting that the typical limit is 0.1% chloride for uncoated reinforcement, it should be totally unacceptable to use plain reinforcing without additional corrosion protection in this environment.

Carbonation was found to be more severe on the landside of the structure, with penetration depths of 18 to 22mm.

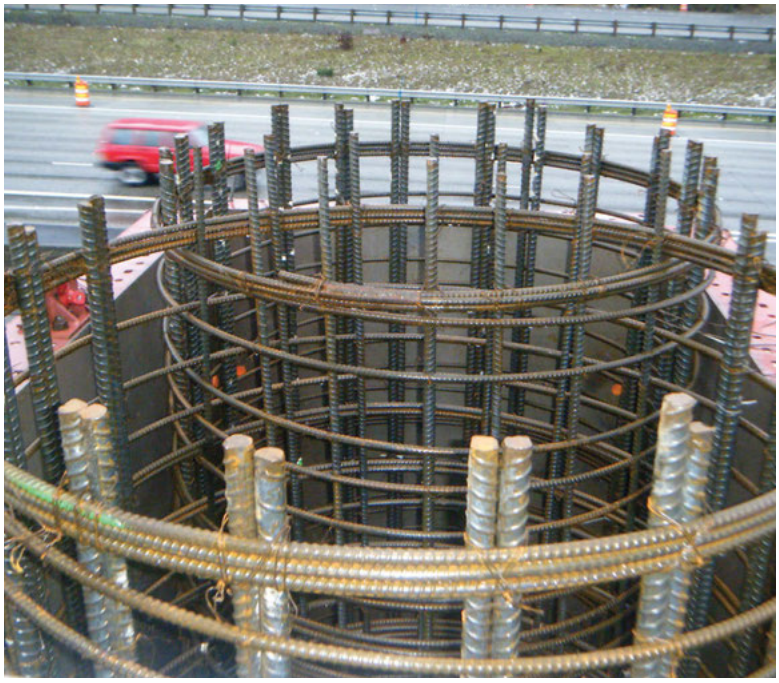
Concrete durability index testing results of oxygen permeability were as follows: 1 sample was "very good", 1 sample was "good", 4 were "poor" and 1 was "very poor". The sorptivity of 2 samples was excellent, 2 good and 2 were poor.

Examination of the hot dip galvanized reinforcing, after 40 years in service, revealed conclusive evidence that the zinc coating was providing excellent corrosion protection to the steel. *Further details of this case study may be found by visiting the HDGASA website, www.hdgasa.org.za.*

Perhaps the most published and long-standing examples of the performance of hot dip galvanized reinforcement are the

12

13



numerous reinforced concrete structures, on the island of Bermuda. For over 50 years hot dip galvanized reinforcement has been effectively employed with commendable results.

Reference to Chapter 7 of the reference *(Reference 4)* details the results of investigations of a number of installations dating back to construction in 1953 and 1968. These were:

- Dock wall in Hamilton Harbour.
- Jetty at the Royal Yacht Club.
- Dock wall at Pennon's Wharf, St. George's.
- An approach span of Longbird Bridge near the airport.

Generally, the results are noteworthy and supportive of the motivation for this particular paper.

Conclusions

Hot dip galvanizing of reinforcement is not a substitute for good quality concrete standards. It will, however, add value and longevity to concrete structures while compensating for practical difficulties in fully complying with the requirements of relevant specifications. Hot dip galvanizing of reinforcement is an economical and cost-effective process that can be expected to substantially extend the useful service life of reinforced concrete structures in marine and other corrosive environments. The cost increase of the total cost of a project is money well spent and will, without doubt, provide a justifiable and economical return on an investment.

Finally, to quote from *Mr. Neil D. Allan (Chapter 7 of Reference 4):*

"Civil engineers are, by nature and training, analytical, logical and cautious. They usually need to have considerable confidence in any new product or technique before it is fully accepted. Galvanized reinforcement is slowly beginning to gain their confidence in the UK and USA. Galvanizing as a process has been around for over 100 years (175 years) and is well proven to delay significantly the onset of steel corrosion. Despite this, it is quite mystifying why designers who would happily specify galvanized handrails appear to baulk at the thought of using galvanized reinforcement".

References:

1. *A review of Hot Dip Galvanized Steel Reinforcing in Concrete Structures Exposed to South African Coastal Marine Environments* by Professor Dennis Twigg.
2. *Galvanized Steel Rebar in South Africa* by Dr. Rod Rankine.
3. *Corrosion of Steel in Concrete* by Luca Bertolini, Bernhard Elsener, Pietro Pedefferi and Rob Polder.
4. *Galvanized Steel Reinforcement in Concrete*, edited by Professor Stephen R. Yeomans and Elsevier Science Ltd. in the UK. First edition.
5. Hot Dip Galvanizers Association Southern Africa website – *www.hdgasa.org.za.*

SHIPSHAPE
duplex application

by Greg Combrink

A sophisticated ship-mounted weapon system assembly was designed and built by a local defence manufacturer services company. The system consisted of a warship deck-mounted weapon assembly able to be fitted with an assortment of guns, and a fire control system that can engage targets and control the gun to fire upon such threats.

Most warships operate in the marine environment where often waves break over the ships' bows wetting decks and moist sea winds laden with salt deposits onto the exposed surfaces on board the ship. It is in this highly aggressive and corrosive environment that the weapon system assembly does duty. Couple this with the shock wave conditions experienced when the weapon is fired and one has one of the worst operating conditions that one finds anywhere. And when an item of equipment is composed of an array of different materials and alloys it makes the situation even worse.

Historically on suitably calm days, one would often find sailors chipping and painting, greasing and cleaning decks, superstructure and of course this essential deck-mounted equipment on board navy ships. Often when deck equipment is not in use it is covered with waterproof tarpaulins and components such as gun barrels and void space access ports are masked up with temporary caps and doors in an attempt to prevent the highly aggressive environment from causing corrosion on these systems. Unfortunately, these methods are not always effective and one still often finds that equipment suffers corrosion despite these prevention attempts.

The weapon system assembly consists of several different materials and alloys and if they are left unprotected in the marine environment they will severely corrode. In the earlier prototypes, the focus was on getting the system functionally reliable and effective and very little attention was given to corrosion protection. Thus, after successfully fine-tuning the system's working ability, a specialist corrosion engineer was engaged to address the anti-corrosion design of the gun assembly for subsequent units.

Subsequently, units manufactured had the new anti-corrosion design implemented. The deck-mounted assembly and cover plates were of great concern as previously the steel and the aluminium components

had purely been sent out for coating without much specialist anti-corrosion thought having been put in. In those cases, the carbon steel parts were dropped off at the galvanizer for hot dip galvanizing and thereafter along with the aluminium cover plates sent off to be painted. At the time it was thought that such action would be satisfactory as experience showed that duplex coatings give sufficient service under extreme corrosive conditions.

But as too often happens in practice when a good specification is thoughtlessly applied things go wrong in practice. Needless to say, many of the initial units that had not undergone specially designed and controlled anti-corrosion procedures and that had been sent out as prototypes for sea trials suffered serious corrosion almost right from the start and began to look unsightly within a few days of exposure. Why was the system rusting, being the question that the manufacturer had asked and approached the corrosion engineer to figure this out. The corrosion protective systems were reviewed and a comprehensive design governing not just the materials to be used but also the processes involved was drawn up. This involved assessing the worst-case environment, the corrosion protection systems to be used, their compatibility with each other, the substrate materials being protected, the physical configuration of the component, and the requirements of the application processes, and also the delegation of responsibility to ensure compliance with the quality assurance policy and recording of quality control parameters that were to be monitored were specified.

In addition to doing the overall anti-corrosion design, applicators were also vetted by the corrosion engineer so that only contractors with the correct equipment and with the correct track records and understanding of the needs were used. These contractors were also consulted to consider the specifications and to comment on any snag points or possible improvements to the design so that the final product protection was optimized. This typically involved ensuring that best engineering practice was followed through the project thus eliminating instances of reworking and providing a sound base for subsequent operations. The main structural part of the weapon system was an intricate carbon steel component with several difficult-to-access spaces and surfaces that were to be duplex-coated. On the hot dip galvanizing side, the advice and recommendations from the galvaniser were considered and where appropriate incorporated into the design specification. This resulted in a very good galvanized surface layer of the required coating thickness, suitable for post-galvanizing painting. As the silicon content of the steel was slightly high much skill, experience and care were required to successfully achieve the appropriate hot dip galvanizing thickness and suitable finish to ensure that the weapon system's final finish could be achieved. The galvanizer advised specific HDG processes to the anti-corrosion specification and these modifications were incorporated into the specification such as safety aspects linked with tasks such as dipping angle into account and air vent holes specifically for galvanising so that the hot dip galvanizing process could be done in a single smooth action dip resulting in an excellent uniform HDG finish on all surfaces (including the difficult to access spaces and surfaces.) The zinc film thickness achieved was between 108µm and 134µm. The unit unfortunately went through the passivation process. Thus, the galvanized surface was passivated. Most galvanizing goes into service in the same zinc coating but passivated as it comes out of the bath and it is the norm to passivate the component. When the galvanised item is to be subsequently coated, it is better not to passivate the article. As passivation has a negative influence on the adhesion of the paint coating to the galvanised surface. Thus, it fell upon the paint applicator to remove the passivated layer and ensure a superior attachment of the paint coating to the article. The specification was subsequently modified to take this into account.

On the organic coating application side, an in-house internationally qualified coating specialist from the paint coating application contractor managed the application ensuring that the correct surface preparation procedure was closely complied with. This entailed the surface passivation layer removed and a sweep blasted surface developed that roughened

the surface but did not remove significant zinc coating from the surface. The paint coating operation took place under optimal conditions and followed the best practice procedures as required when using modern heavy-duty industrial organic coatings. The sweep blasting of the hot-dip galvanized surface was done at a delivery pressure, at the end of the blast hose, of <3 bar using Microblast© garnet blasting media. Only around 10µm of zinc was sacrificed resulting in a superb surface profile for keying of the paint coating.

Both of the contracted applicators (galvaniser and the organic coater) made valuable contributions ensuring that the subsequent final product had a well-finished appearance thereby ensuring that the weapon system had the best chance of lasting the designed lifespan with minimal maintenance. This aspect was also important to the manufacturer as they compete on the international stage against other weapon systems suppliers and a functional reliable unit that also looks good allows them to do so successfully. Working together the contractors and the corrosion engineer comprising the anti-corrosion team produced the result sought by the manufacturer.

Critical aspects that ensured success were the valuable inputs from the vetted contractors at the early design stage and the communication between the informal anti-corrosion team members and the manufacturer's project engineer. Also of utmost importance was the willingness of all parties to work together towards the common goal of ensuring that the best result possible sometimes under difficult working conditions was achieved.

Some specific and important factors

Galvanizing

- A contracting company with the correct galvanizing and handling equipment to ensure the correct and complete coating of the item being galvanized in a single dipping operation (if possible).
- A contractor that fully understands the preparation requirements (cleaning, and blasting) and how to correctly mask up areas that must not be galvanized during the dipping operation such as bearing surfaces.
- An experienced and knowledgeable galvanizer that can advise on critical requirements for galvanising such as an understanding of the dipping angle and component hanging point and the need for access and drainage ports.
- The silicon and phosphorous content of the steel that is to be galvanized as this influences dipping time and zinc film properties.
- The thickness and finish required for the zinc coating.
- The galvanizer must be told if the item galvanized is to be subsequently coated (i.e. duplex coatings) so that the passivation (conversion coating) process that is normally performed directly after dipping is avoided as this has an influence on subsequent organic coating adhesion to the galvanized surface (even if it will be sweep blasted before painting).
- The galvaniser should have the ability to do quality control tests to maintain a record thereof and to perform any repair that may be needed (preferably by zinc metal thermal spray).

Organic coating application

- A painting contractor who has much general paint application experience and knowledge.
- The contractor should have the required equipment to perform the coating application required as well as the surface preparation.
- The contractor should have specialist knowledge and a good track record of applying duplex coatings and especially fully understand and subsequently control the sweep blasting operation required. The type of coating to be used.
- The quality control measurements and records are to be kept updated during the painting application process and collated into a report.
- The contractor should have the knowledge and ability to repair any damaged areas with the same good finish and corrosion protection being achieved.

Generally: All the contractors involved in this project performed their tasks superbly even far exceeding expectations which reflected in a superior end product being achieved.

5 KEY FACTORS PRESENT in corrosive soils

UNDERSTANDING THE SOIL CORROSION OCCURRENCE AND THE FIVE KEY FACTORS THAT CONTRIBUTE TO THE PROCESS IS IMPORTANT FOR MINIMISING CORROSION IN MOST LAND-BASED CONSTRUCTION PROJECTS.

Most construction projects involve interaction with the earth in one form or another. Almost all types of infrastructure, from above ground structures such as buildings and roadways, to buried structures such as undergrounds pipes, vessels and utilities, rely on the soil as a means of stability and support. However, many soils, depending on their composition, may be potentially corrosive to metallic materials.

The severity of corrosion that can be caused by a particular soil type is dependent on a variety of factors, including the soil's chemical properties, environmental conditions and the properties of the metal in contact with the soil. In this article, we shall look at the causes of corrosion in soils and the factors that contribute to the varying degree of soil corrosiveness in detail.

What is soil corrosion?

Simply put, soil corrosion is an electrochemical process whereby complex chemical reactions between the soil and the contacting metal result in the formation of corrosion products and deterioration of the metal. Corrosion is a natural redox (reduction-oxidation) reaction that converts a refined metal to its more chemically stable state. Three components must be present for corrosion to occur: an anode (the buried metal in contact with the soil), a cathode (oxygen) and an electrolyte (the moisture found in the soil). The degree of corrosiveness and the rate of corrosion differ between different soil types and properties.

Factors that influence soil corrosion

The key factors that influence the severity and rate of corrosion of soils are:

Aeration

Aeration refers to the amount of air within the voids of the soil particles. A higher degree of aeration (higher porosity) lowers the tendency for the formation of corrosion. Well-aerated soils promote higher rates of evaporation and retain less water, thus reducing the amount of electrolyte available for the corrosive redox reaction to take place.

The amount of aeration in soils is directly related to the soil particle size and gradation. For example, sandy soils, due to their relatively large particle size, possess better aeration and allow for quicker drainage and evaporation of moisture than clayey soils.

Moisture content

As mentioned previously, one of the key elements necessary for corrosion to occur is an electrolyte, which is responsible for facilitating the transfer of electrons between the anode and the cathode. The drier the soil, the less electrolyte present to facilitate the corrosion process.

Soil resistivity is directly related to the soil's moisture content and the levels of soluble salts in the soil. Increasing the moisture content lowers the soil resistivity. Since corrosion is an electrochemical process that involves electric potentials and the transfer of electrons, high levels of soil resistivity obstruct the corrosion process while soils with low resistance levels are deemed more corrosive. Sandy soils drain easily and therefore are considered to be the least corrosive, while by contrast, clayey coils retain electrolytes (moisture) and are considered to be at the higher end of the corrosive spectrum.

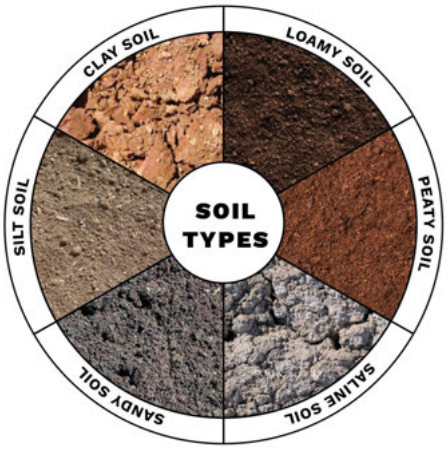
Dissolved salt content

Although the presence of water in soils enables oxidation and by extension corrosion, the process can be greatly accelerated by the presence of dissolved salts. Dissolved chloride salts in water increase the conductivity of the electrolyte (due to an increased number of dissociated ions) and enhance the number of electrolysis reactions. Generally, soils with chloride and sulfate levels below 100ppm and 200ppm respectively are considered mildly corrosive.

Soil acidity (pH level)

pH (potential of hydrogen) is a numerical scale used to measure the acidity or alkalinity of a solution. The scale ranges from 1 to 14, with 7 being the neutral (neither acidic nor alkaline) point. Values below 7 indicate acidity, with 1 being the most acidic and values above 7 indicate alkalinity, with 14 being the most alkaline.

The pH levels of soils vary widely, with values ranging anywhere from 2.5 to 10. A neutral pH of 7 in soils is considered



to be ideal to minimize the potential for corrosion. Soils with pH values below 5 are considered to be aggressive and can lead to increased corrosion rates and premature pitting of metals. The inherent pH of a given soil can fluctuate due to environmental factors such as rainfall.

Temperature

The soil's resistivity is affected by the atmospheric temperature. As the temperature decreases, the resistivity of the soil increases, and hence the corrosive potential of the soil decreases. As pore water freezes at 0°C (32°F), its resistivity increases abruptly. A subsequent decrease in the temperature results in an almost exponential increase in soil resistivity. Therefore, the formation of corrosion is highly unlikely in sub-zero temperature environments.

Methods to reduce soil corrosion

There are several methods available to mitigate the potential for soil corrosion, which include cathodic protection, sacrificial anodes and protective coatings. All of these are highly effective and can help avoid costly repairs and replacements in the long term.

Conclusion

It is almost impossible in most land-based construction projects to avoid interacting with the surrounding soil. It is therefore important to understand the soil corrosion phenomenon and the key factors that contribute to the process.

TRAINING UPDATE:
Continuing to develop competence and knowledge

The 2024/2025 year saw the Association's training efforts continue to grow, developing competence across the hot dip galvanizing industry and its related sectors. Training took place at the HDGASA offices, at galvanizer facilities, and on-site – including as far afield as De Aar – ensuring the widespread dissemination of practical knowledge that enhances both the technology and its users.

Thanks to the active participation of our members, their teams, and their customers, we continue to strengthen a shared commitment to advancing standards, professionalism, and the practical application of hot dip galvanizing.

Interest in our training programmes from within the SADC region, as well as from South America and the Asia-Pacific, highlights the global relevance of our work. This growing international engagement underscores the value of knowledge sharing and reinforces our focus on building strong networks throughout the global galvanizing community – delivering real benefits to our members and delegates alike.

Staying current with evolving standards, improved processes, and quality systems demands collective commitment. As our industry progresses toward more sustainable practices, the role of shared learning and collaboration becomes increasingly vital.

The Association remains focused on building a more resilient, knowledgeable, and future-ready galvanizing community. Training goes beyond skill development – it is about empowering the entire steel

value chain and creating lasting value, both economically and environmentally. Through continuous learning and mutual commitment, we are laying the foundation for a more innovative and sustainable future.

To all our partners, members, and collaborators – thank you.

Your continued support makes this journey possible. We look forward to growing together, delivering practical, relevant training that supports shared success across the hot dip galvanizing sector and its associated industries.

TRAINING Courses

LEVEL I INTRODUCTION TO HOT DIP GALVANIZING

This one-day course has been designed to provide an initial understanding of the concepts relating to the use of hot dip galvanized coatings as applied for corrosion control of carbon steel components. The course is presented as an introduction to the more advanced and detailed three-day qualification course needed for registration as a recognized hot dip galvanizing inspector.

Bookings are limited and will be treated on a first-come-first-serve basis. Please note that for the course to be viable we require at least six (6) candidates to attend. Arrangements can also be made for the course to be held at your premises for more than six (>6) candidates. The course is designed to provide a solid foundation for non-technical and support personnel and candidates who have a limited technical background and/or function.

The course comprises six lessons, each of approximately 45 minutes duration. The course may be run as a Workshop or be concluded with a one-hour examination designed to test course effectiveness. A standard grade pass of 50% is required to receive a certificate of achievement. Workshop participants will receive a certificate of attendance

Course Content

- Introduction to Corrosion
- Understanding Hot Dip Galvanizing & Zinc Coatings
- Inspection and Jigging before Hot Dip Galvanizing
- The Hot dip Galvanizing Process
- Inspection after Hot Dip Galvanizing
- Maintenance and Controls

Course Duration

This is a one-day course comprising six lectures and may include a one-hour examination to test the effectiveness of the course or it may be run as a workshop only.

Time

The course commences at 08h00 sharp and ends at 17h00. Lunch and refreshments will be provided.

Course Cost and Payment Terms

A quotation and availability of seats may be obtained by calling 010 746 8927 or e-mailing hdgasa@icon.co.za

Terms are on a strict payment before-attendance basis, unless by special prior arrangement. Upon receiving your Training Booking Form a reservation confirmation will be sent to the delegate as well as an invoice made out to the payee. Failure to attend the course without a two-week prior advice will levy a 50% charge to cover logistical expenses incurred. No refunds or credits will be entertained for any withdrawal. Only one postponement will be granted.

ADVANCED LEVEL II

(Prerequisite for certification as an HDGASA-endorsed galvanizing inspector)

The purpose of the Advanced Level II course is to provide delegates with the necessary skills to assess the quality and conformance of hot dip galvanized coatings and Duplex Systems in compliance with the applicable specifications and prescribed test methods. The delegate will be introduced to a range of zinc coating specifications and their appropriate applications. Interpretation of the specifications will be examined. Candidates will be instructed in all aspects of testing in line with the prescribed procedure for determining acceptance of batch hot dip galvanized fabricated steel articles. A firsthand practical visual inspection and coating thickness/mass evaluation to ensure that the articles meet the requirements of appearance and minimum mean coating thickness/mass will be undertaken following a plant visit to an operating hot dip galvanizing facility.

Course delegates will undertake a three-part exam as well as the presentation and submission of an inspection report. Part one will be a multiple choice closed book exam. Parts two and three are open-book exams. Part three is vital in attaining HDGASA endorsement as a certified inspector.

Following full attendance of the course, completion of all three exam papers, and the inspection report, a certificate will be issued to delegates that exceed the pass mark of 50% on the STANDARD GRADE. A HIGHER-GRADE pass will be acknowledged for an overall achievement of 75% in the exams. Part three must be passed with a score of 80% or greater to ensure registration as an HDGASA-endorsed GALVANIZING INSPECTOR and Membership of the HDGASA as an AFFILIATED MEMBER – GALVANIZING INSPECTOR.

Continuous Professional Development (CPD) Points are available on request to delegates who attend this course. Delegates wishing to receive CPD credits must inform the Association at the time of booking.

Bookings are limited and will be treated on a first-come-first-serve basis. Please note that for the course to be viable it is required that six or more (≥6) candidates attend. Arrangements can also be made

for the course to be held at a customer's venue for more than six (≥6) candidates – catering to be arranged by the customer.

Course Content

Day One (08h00 to 16h00)

- Introduction to the Environment, Steel Types & Corrosion
- Understanding Zinc Coatings; ISO 9223 & ISO 12944
- Design, Fabrication and Inspection before Hot Dip Galvanizing SANS (ISO) 14713
- The General Hot Dip Galvanizing Processes
- SANS 121 (ISO 1461) Batch Type Galvanizing

Day Two (08h00 to 16h00)

- Duplex Coatings and Hot Dip Galvanized Reinforcement in Concrete
- Inspection after Hot Dip Galvanizing including test procedures, application of specifications and reporting.
- Conducting an Acceptance Inspection i.r.o SANS 121:2024 / ISO 1461: 2022
- Hot Dip Galvanizing Plant Visit followed by syndicate inspection of finished materials awaiting final release. Quality Assurances in Coating Applications, Application of Specifications and Control Documentation of a QA System.

Day Three (08h00 – 15h30)

- Practical Inspection Report Presentation by delegates and feedback from group.
- Three-part examination
  - 1-hour closed book multiple-choice Fundamental Theory Examination
  - 2-hour open book written Advanced Theory Examination
  - 2-hour open book written Inspector Examination

Course Duration

This three-day course comprises lectures on the first and second day concluding with a plant tour and a practical hot dip galvanized lot acceptance inspection and report. The third day comprises a report back on the practical undertaken on the afternoon of day 2, and the three qualifying examinations. Lunch and refreshments will be provided. Comprehensive course notes may be collected from our offices two weeks before the course by the delegate or requested to be sent via courier at an additional fee.

Course Cost and Payment Terms

A quotation and availability of seats may be obtained by calling 010 746 8927 or e-mailing ***hdgasa@icon.co.za***

Terms are on a strict payment-before-attendance basis, unless by special prior arrangement. Upon receiving your Training Booking Form, a reservation confirmation will be sent to the delegate as well as an invoice made out to the payee. Failure to attend the course without a two-week prior advice will levy a 50% charge to cover logistical expenses incurred. No refunds or credits will be entertained for any withdrawal. Only one postponement will be granted.

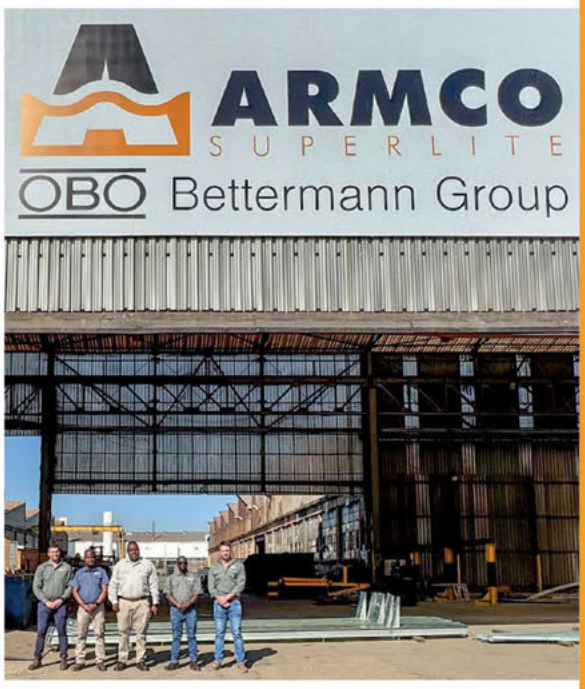
Armco Superlite

Armco Superlite is a wholly owned subsidiary of OBO Bettermann Holdings Africa.

Armco practices a cradle to grave policy with regards to our chemicals which emphasizes who we buy from and what happens to the products after use. Our **Isando** and **Randfontein** plants have been licensed under the "National Enviroment: Air Quality Act, (Act.No. 39 of 2004), standards and regulations.

SERVICES OFFERED:
Fabrication / Jobbing
Degreasing System - Alkali / Acid Pickle: HCl
Drying Oven
Sandblasting
Collection / Delivery
ISO 9001:2015 Certified

GALVANIZING BATH SIZES:
Isando: 13m x 1.45m x 2m
Randfontein: 6m 1.45m x 1.8m



Consistently delivering superior quality galvanized products to all our customers

OUR TEAM:

Eric Checha
Plant Manager Isando

Hein Terblanche
General Manager

Jonathan Moraba
Quality Manager

Duncan Ackerman
Sales Executive

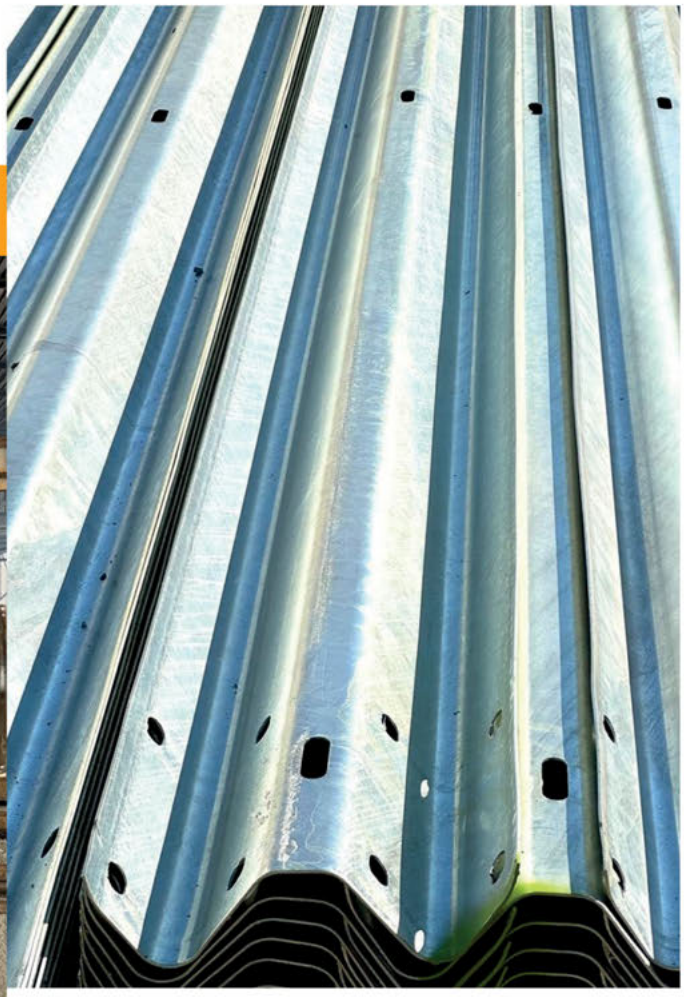
Abel Sibanda
Plant Manager Randfontein

Armco Galvanizers

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 Galvanizing and all Galvanizing done at our premises is in accordance to the SANS 121 / ISO 1461 specifications. Galvanizing certificates are supplied on request.

ISANDO

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



RANDFONTEIN

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

ARMCO SUPERLITE

ISANDO
Tel: +27 11 974 8511
131 Anvil Road, Isando

RANDFONTEIN
Tel: +27 11 693 5825
23 Fiat Road, Aureus, Randfontein

Email: mail@armco.co.za | **Web:** www.armco.co.za

KROME

THE ELEMENT OF PERFECTION

QUALITY

At Krome Metal Chemicals, quality is our top priority. We adhere to stringent quality control measures and follow industry best practices to ensure that our specialty corrosion chemicals deliver outstanding results. Our dedicated team of experts works tirelessly to develop and improve our formulations, providing you with products that meet the highest standards of performance and reliability.

PARTNERSHIPS

Krome Metal Chemicals (Pty) Ltd is proud to collaborate with global partners who share our commitment to excellence. These partnerships enable us to stay at the forefront of the metal finishing industry, keeping us updated on the latest products and services. By working closely with our partners, we can bring you the best possible chemical solutions that drive efficiency, productivity, and success.

www.krome.co.za

RELIABLE, INNOVATIVE AND QUALITY DRIVEN

YOUR LEADING METAL TREATMENT SOLUTION PROVIDER

PRODUCTS

Our products have successfully competed directly with leading European suppliers, demonstrating superior performance and efficiency. This has proven successful within our South African, African, Australian and South American customer base.

- **Krome Ferro-Kill** quickly and efficiently removes iron from flux solutions, without affecting the zinc or ammonia concentration.
- **Krome Iron Fix** is formulated for the removal of iron and other metals from acid solutions.
- **K-Soak Enviro 121** is a granular alkaline cleaner with the benefit of cleaning as effectively as a standard hot soak cleaner at a low temperature 20°C.
- **Kromeclean PA** is an acidulated degreaser with light descaling properties used for cleaning heavily soiled articles.
- **K-Soak HDG300** is a high-efficiency degreaser for use on iron and steel. A highly effective, long-lasting degreaser including a Demitting agent.
- **K-Flux HD** is a molecular mix of crystals completely stable when exposed to the atmosphere, providing better dissolution and storage than the deliquescent nature of zinc chloride solidifying.
- **K-Flux De-Dross** is a powdered additive that aids in the reduction of zinc losses during de-dressing. It resolubilizes the zinc trapped in top dross, returning it to the kettle, resulting in less loss of zinc and easier removal of iron within the kettle.
- **K-Flux DS Double Salts** is a specialized powdered flux for uniform fluxing of mild steel completely stable when exposed to the atmosphere. This allows better dissolution and storage versus to the deliquescent nature of zinc chloride, which solidifies under the same conditions.
- **Krome Nickel Tablets** are specially formulated as an effective means of introducing nickel metal into a hot dip galvanizing, zinc kettle.
- **Kromemist 75** is a liquid inhibitor formulated for use in conventional Hydrochloric Acid pickling operations on mild or unreactive steels. Kromemist 75 improves risibility and cleaning, reducing carryover of chlorides. Low foam reduces drag-out.
- **Acitrol 82** is an effective inhibitor for Hydrochloric acid in pickling operations. Acitrol 82 significantly reduces the hydrogen embrittlement of the steel that can be caused by pickling.
- **K-Flux Buffer** is a specially formulated buffer solution to maintain the pH of a Flux. K-Flux Buffer reduces oxidation of the article and keeps the iron level in the flux at the correct levels.
- **Galvastop K** is a rapidly air-drying blend of silicate-free synthetic resins specifically formulated for the hot dip galvanizing industry as a stable and convenient stop-off material. It can go through the pre-treatment cycle and withstand 500°C in the hot dip cycle.
- **Chemcoater 652** is a chromate-based liquid for a sludge-less solution for treating after hot dip galvanizing. A light chromate coating is deposited, which is pale yellow in color.

GAUTENG 011 450 2680

KWAZULU-NATAL 031 701 1126

CAPE TOWN 021 551 0230

PORT ELIZABETH 061 838 4510

GAUTENG



LIANRU GALVANISERS (PTY) LTD

Exceeding our customers' expectations


Ockert Engelbrecht


Nelis Pienaar


Leroux Pienaar

ABOUT

Lianru Galvanisers was establish in 1996 and currently has approximately 160 employees.

Specialising in hot dip galvanizing, we operate 24 hours per day, six days a week, servicing the requirements of the Gauteng area. We are registered members of the Hot Dip Galvanizers Association of Southern Africa and S.A.B.S ISO 1461 approved.

We have 5 x 8 ton trucks, 6 x 13 meter trailers, 2 x 1 ton L.D.V.'s and 3 x MAN horses.

SERVICES OFFERED

- Fabrication/General
- Degreasing System: – Alkali / Acid Pickle: – HCl
- Collection / Delivery Transport
- Abrasive Blasting

BATH SIZES (l x w x d):

Bath 1: 7.2m x 1.3m x 1.6m

Bath 2: 4.5m x 1.3m x 1.6m

CONTACT DETAILS

Telephone:
+27 (0)11 814 3080

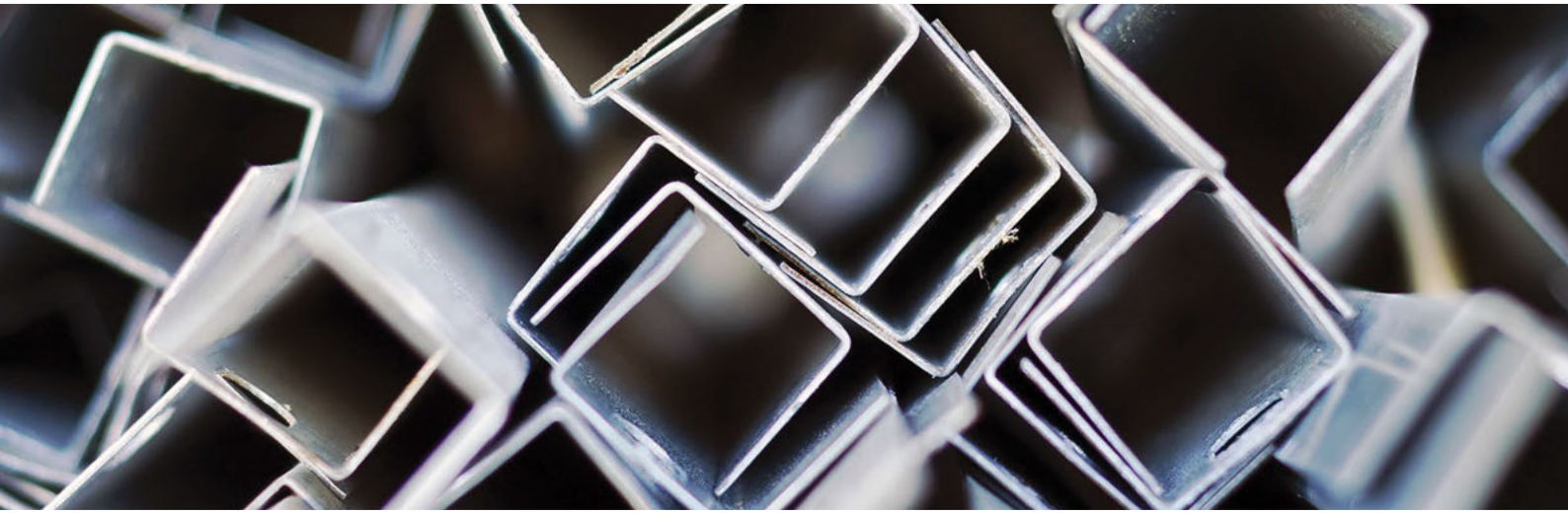
Email:
calis@lantic.net

Website:
www.lianru.co.za

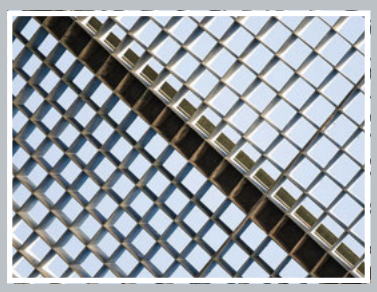
Physical Address:
14 Fifth Street, Vorsterskroon, Nigel

LIANRU
GALVANISERS

HOT DIP GALVANIZING SPECIALISTS



CONTINUOUSLY MANUFACTURING THE HIGHEST QUALITY PRODUCTS



Registered members of Hot Dip Galvanising Association of S.A. and S.A.B.S ISO 1461 approved.

LIANRU GALVANISERS (PTY) LTD

Tel.: +27 (0)11 814 3080 Email: calis@lantic.net Website: www.lianru.co.za

14 Fifth Street, Vorsterskroon, Nigel

GAUTENG

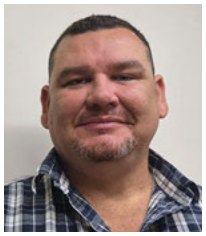
Metsep
The waste-acid regeneration specialists

METSEP SOUTH AFRICA (PTY) LTD

The sensible waste-acid management solution

Rob Watchorn,
MD

Charlotte McFadyen,
Financial Manager



Jonathan VD Merwe,
Logistics Manager

Gift Kandoto,
Plant Manager

ABOUT

A complete and cost-effective waste-acid regeneration service for the steel manufacturing and processing industries.

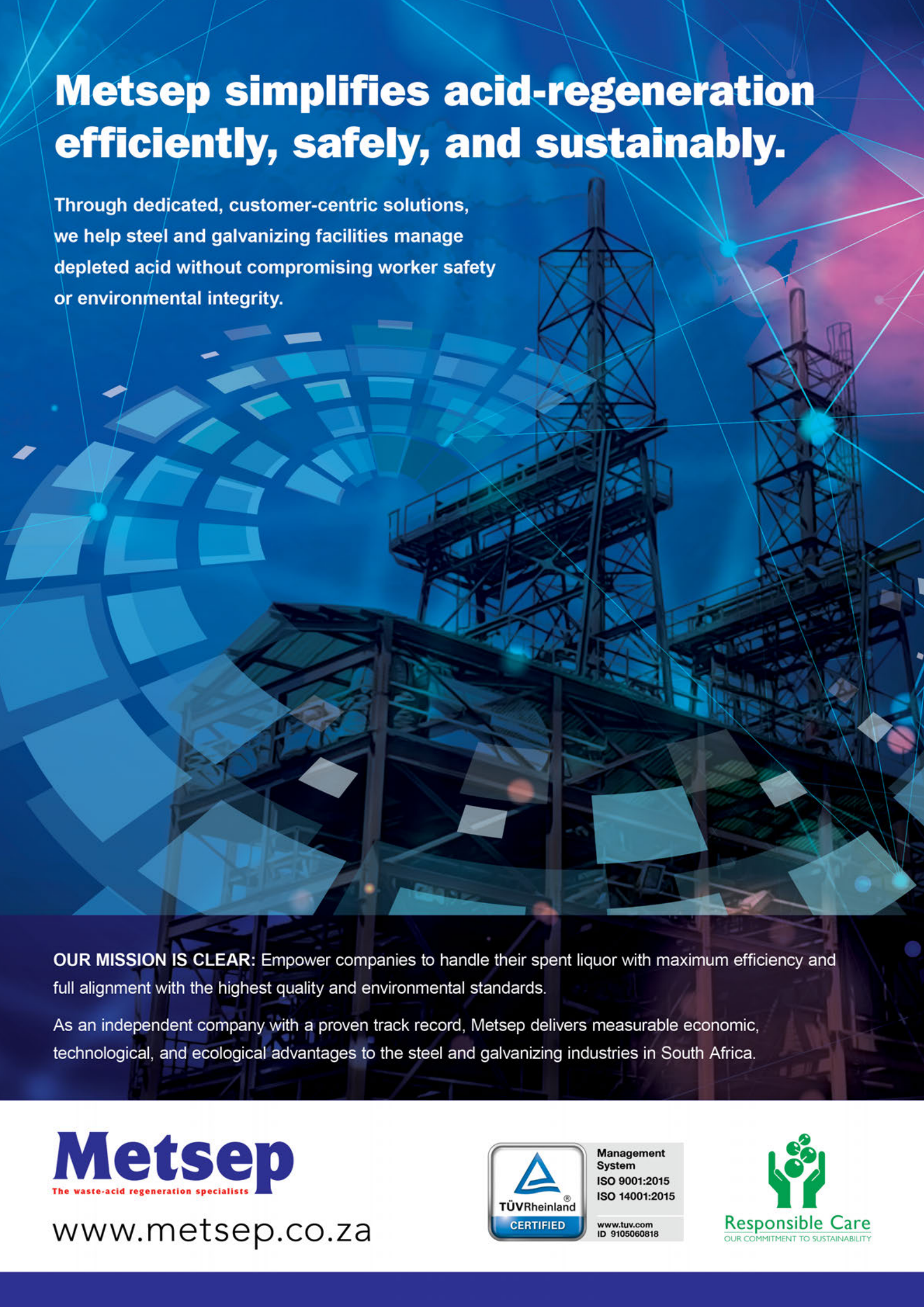
Through a combination of world-class technology and proven, customer-focused services, Metsep saves you money, time, inconvenience and the risks associated with hazardous waste.

CONTACT DETAILS

Telephone:
+27 (0)11 626 2425

Email:
metsep@metsep.co.za

Physical Address:
Lower Jupiter Road
Heriotdale, Johannesburg



Metsep simplifies acid-regeneration efficiently, safely, and sustainably.

Through dedicated, customer-centric solutions, we help steel and galvanizing facilities manage depleted acid without compromising worker safety or environmental integrity.

OUR MISSION IS CLEAR: Empower companies to handle their spent liquor with maximum efficiency and full alignment with the highest quality and environmental standards.

As an independent company with a proven track record, Metsep delivers measurable economic, technological, and ecological advantages to the steel and galvanizing industries in South Africa.

Metsep
The waste-acid regeneration specialists

www.metsep.co.za

TÜVRheinland® CERTIFIED
Management System
ISO 9001:2015
ISO 14001:2015
www.tuv.com
ID 9105060818

Responsible Care
OUR COMMITMENT TO SUSTAINABILITY

GAUTENG



MONOWELD GALVANIZERS

Superior capability

ABOUT

Monoweld Galvanizers is well equipped to handle any large project where speed of throughput is a critical requirement. This world class German-manufactured kettle from Pillings is complemented by a state-of-the-art, gas fired furnace system which should see the company reduce its dependence on electricity and working greener to reduce its carbon footprint. There is an abundance of space for loading, post galvanizing inspection and warehousing, with eight loading bays and in excess of 12 000m² of warehouse area. The facility is served by 30 overhead cranes and 5 forklifts.

BENEFITS

Total flexibility

- Throughput processing capability, especially on large contracts and projects, which results in faster delivery to site.
- Design and fabrication constraints on large and bulky products are significantly reduced.
- Enables the hot dip galvanizing of certain products which previously had to be painted.
- The Line 1 kettle eliminates the need for double-dipping on fabricated items between 2.3m and 3.4m in height, resulting in better quality finishes at a lower cost.
- Consistent good quality.

CONTACT DETAILS

Telephone:
+27 (11) 876 2900

Email:
monoweld@monoweld.co.za

Website:
www.monoweld.co.za

Physical Address:
Cnr Power & Sigma Roads,
Germiston, Industries West
Johannesburg

THINKING FORWARD

Creating a better galvanizing future for our clients by advancing how a galvanizing plant should function and operate, to effectively increase production, decrease turnaround time and eradicate environmental waste to 0%.

CORROSION PROTECTION SPECIALISTS

ADDITIONAL SERVICES

- Technical assistance on corrosion protection and correct fabrication for hot dip galvanizing.
- Post galvanizing backup services.
- Transport service for collection and delivery.
- Lay-down areas for inspection and collation.
- Dispatching direct to site.
- Shot blasting facility on site.
- Mobile thermal zinc metal spraying units.
- Subcontractor office space with data conversion capability.
- Full data pack on completion of the project.
- Containerization of projects.

CONSISTENT, REPEATABLE QUALITY IN ACCORDANCE WITH LOCAL AND INTERNATIONAL STANDARDS

Monoweld Galvanizers is ISO 1461 2022 and ISO 9001 Certified

Kettle Size: Length - 15m : Width – 1.9m : Depth – 3.25m

MONOWELD™
CORROSION PROTECTION

+27 (0)11 876 2900 monoweld@monoweld.co.za Cnr Power & Sigma Roads, Germiston, Industries West, Johannesburg

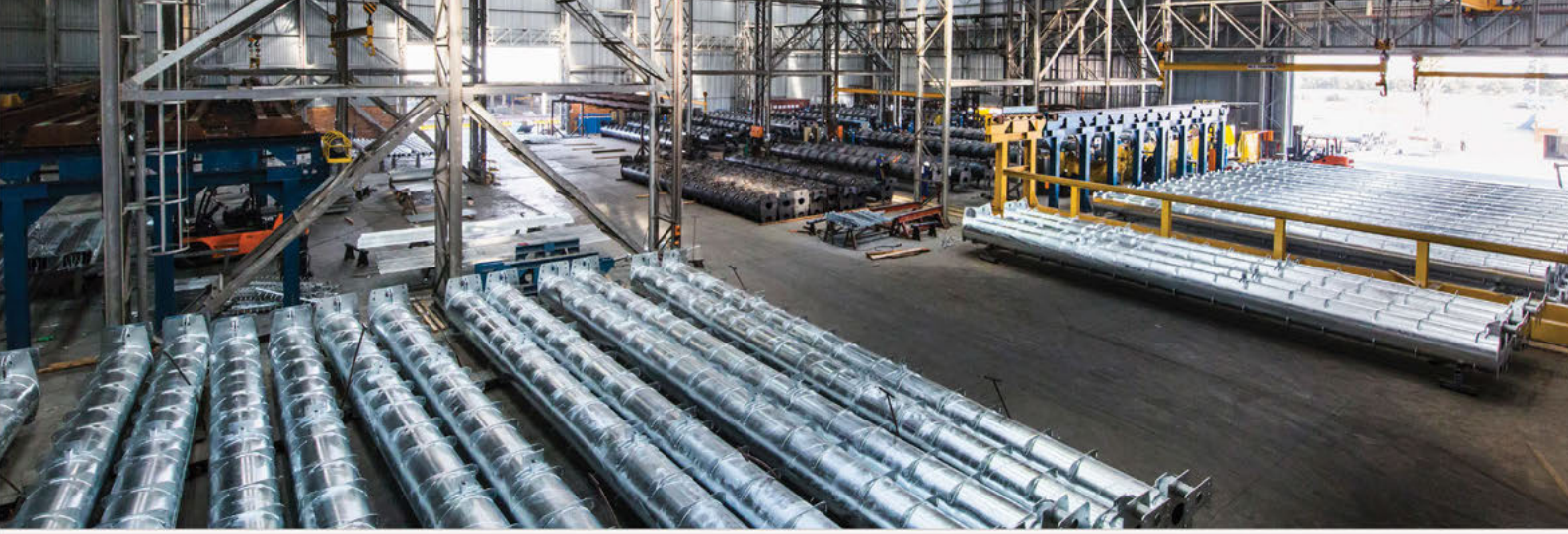
Transvaal Galvanizers are the ***GALVANISING INDUSTRY LEADERS*** in Southern Africa.

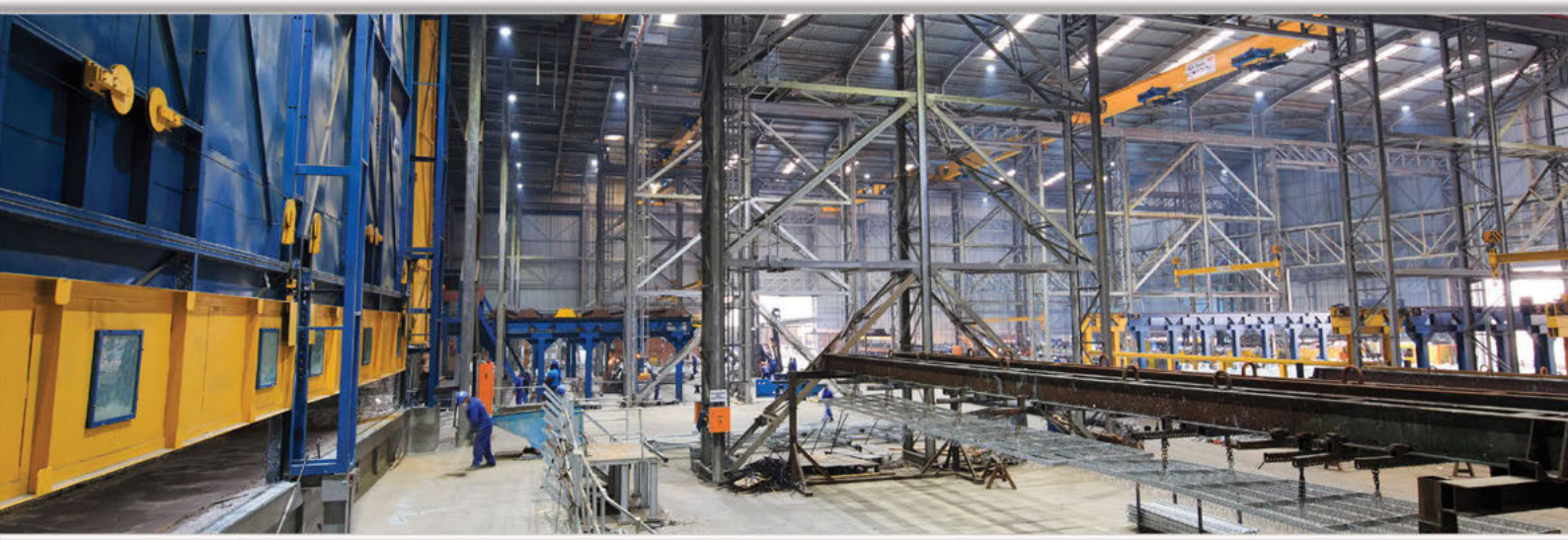
Transvaal Galvanisers was founded in 1984 by the directors of Imab engineering with the vision of revolutionizing the Galvanising industry.

In the decades that followed, the company has enjoyed sustainable growth, continually ensuring that it is at the forefront of galvansing innovation. As such, it has become a driving force within the greater galvanising industry and is a name synonymous with quality.

Over the years, what started out as a relatively small operation has expanded and evolved into a **highly skilled and knowledgeable staff** complement, led by a dynamic and forward-thinking management team, running the largest galvanising plant in the southern hemisphere. Our commitment to the company's vision of providing the best hot dip galvanising service, while causing no harm, and using the business to inspire and implement solutions to the environmental crisis through leadership and direction, allows Transvaal Galvanisers to provide exceptional service and the highest quality outputs at unparalleled turnaround times.

Being part of a large group of companies mostly within the metal sector, has given us the ability to expand into large construction and renewable energy projects where we provide **full turnkey solutions**. Having successfully completed and supplied several intricate renewable energy and construction projects we can confidently state that we are your **one stop shop** when it comes to renewable energy and construction projects.





QUALITY SPECIALISTS IN SPIN, DIP & DRAGLINE GALVANISING

Our **large-capacity zinc kettle** allows us to process heavy and oversized steel in a single dip - **reducing handling, improving turnaround, and lowering costs for our clients.**

www.**transgalv**.co.za 011 - 814 - 1113/4 transgalv@**transgalv**.co.za

DURBAN GALVANIZING

35 Years

Durban Galvanizing Pty (Ltd) Trusted Since 1990.

About:

Celebrating 35 years of excellence, Durban Galvanizing is a trusted provider of hot dip galvanizing services based in KwaZulu-Natal. Since 1990, we've been protecting steel for industries across construction, engineering, agriculture, and infrastructure. Our reputation is built on durability, fast turnaround times, and a commitment to quality and corrosion protection. As proud members of HDGASA, we continue to uphold the highest standards in galvanizing and environmental responsibility—delivering proven performance, year after year.

Services Offered:

- Large structural steel hot dip galvanizing
- Small part spin/centrifuge hot dip galvanizing
- Transport and logistics

Facilities

Briardene
Zinc kettle size: 9.5m x 1.3m x 3.0m
Lifting Height: 3,5m
Maximum Capacity: 1250 t/m

Phoenix
Zinc kettle size: 14m x 1.4m x 2.5m
Lifting Height: 5m
Maximum Capacity: 1850 t/m

Phoenix Centrifuge
Maximum size article
that can be spun: 600mm high
Maximum Capacity: 200 t/m

durbangalvanizing.co.za
031 563 7032

Briardene
64 Marseilles Crescent, Briardene

Phoenix
274 Aberdare Drive, Phoenix Industrial Park

Marburg Depot
1463 Lind Road, Marburg, Port Shepstone

Pietermaritzburg Depot
36 Yarborough Rd, Mkondeni

35 Years

TRUSTED SINCE 1990

- Committed to Quality
- Environmentally Compliant
- High Capacity
- Convenient Transport Solutions

DURBAN GALVANIZING

KWAZULU NATAL

PINETOWN GALVANIZING

General and spin galvanizing

SERVICES OFFERED

- Any fabrication / general steelwork
- Hot dip galvanizing of steel

BATH SIZES (l x w x d):

Bath 1: 9.0m x 1.2m x 3.0m

CONTACT DETAILS

Telephone:
+27 (0)31 700 5599

Email:
admin@pinetowngalvanizing.com

Physical Address:
38 Hillclimb Road, Mahogany Ridge, Pinetown

GENERAL GALVANIZING, SPIN & STRUCTURAL

SABS APPROVED

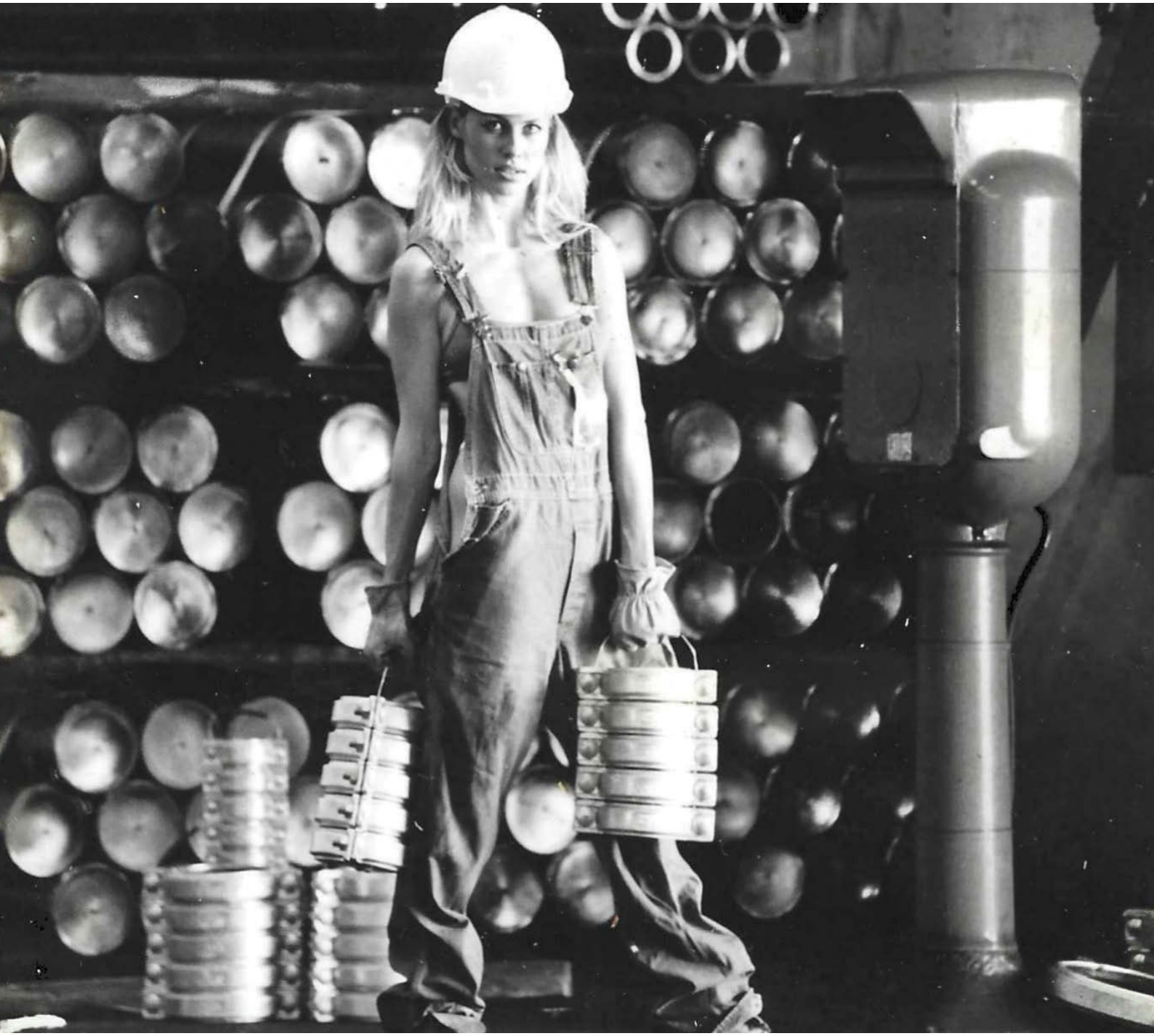
SANS121
ISO1461

HOT DIP GALVANIZERS ASSOCIATION SOUTHERN AFRICA

Pinetown GALVANIZING

+27 (0)31 700 5599 l admin@pinetowngalvanizing.com l 38 Hillclimb Road, Mahogany Ridge, Pinetown

RAND YORK



South Africa's Leading Exporter of Galvanised Fabrications

Rand York is a leading steel fabricator and component manufacturer with a 40-year legacy of excellence. Renowned for supplying high-quality product to 65 countries across every continent, this family-run operation combines expertise, innovation, and global reach. Efficiently managed by the Corbett brothers, Rand York's reputation is built on trust and precision. As a significant supply partner to global OEMs, the company is ISO 9001:2015 certified and adheres to stringent ISO, ASTM, and EU standards, including CE validations.

A Range of bespoke products

RYC is a volume-based manufacturer, offering our customers the benefits of scaled production.

OUR SERVICES

- High tensile post tensioning steel
- Fish / connector plates
- Bespoke welded sections
- Specialised steel pressings
- Steel pipe couplings
- Steel forgings
- Ferrous and non-ferrous castings
- Drill steel
- Rockbolts for ground support
- Fully threaded bar
- Specialist steel accessories for civil & mining
- Corrosion experts







info@randyork.com
www.randyork.com

WESTERN CAPE

General Manager
Sim Swart
sim@advancedgalv.co.za

Operations Manager
Hendrik Gerber
hendrik@advancedgalv.co.za

Production Manager
Gys Vermeulen
gys@advancedgalv.co.za

Transport Manager
Aubrey Absalom
transport@advancedgalv.co.za

ADVANCED GALVANISING

Proven, honest, sustainable corrosion protection

After 17 years of dedicated leadership, Johan Louw has made the decision to step down as Chief Executive Officer of Advanced Galvanising. Johan's tenure has been marked by exceptional growth and the transformation of the company into a respected leader within the galvanizing industry.

We extend our sincere gratitude to Johan for his unwavering commitment, strategic leadership, and invaluable contributions. We wish him all the best in his future endeavours.

As we look to the future, we are excited to announce a new chapter for Advanced Galvanising. Hendrik Gerber and Sim Swart will jointly assume the role of CEO, bringing with them a wealth of experience and a shared vision for sustained excellence and innovation.

- Hendrik Gerber will be responsible for production, factory operations, and personnel management. With deep operational expertise and proven leadership, Hendrik will ensure that our production continues to meet the highest standards of quality and efficiency.
- Sim Swart will lead marketing and client relations, drawing on his strategic insight and strong track record of building lasting client partnerships. His focus will be on further strengthening our market presence and customer engagement.

In addition to their new leadership roles, Hendrik and Sim have acquired a stake in Advanced Galvanising, highlighting their long-term commitment to the company. This milestone represents a significant step forward in ensuring a strong, stable, and growth-focused future for our organisation.

We are also pleased to welcome two key additions to our leadership team:

- Gys Vermeulen joins us as Production Manager, bringing over 22 years of experience in the galvanising industry. His industry knowledge and leadership will be instrumental in driving operational excellence.
- Aubrey Absalom joins as our new Transport Manager. With 11 years of experience in transport and logistics, Aubrey's skills and dedication will be vital in enhancing our supply chain efficiency.

Please join us in welcoming Gys and Aubrey to their new roles, and in supporting Hendrik and Sim as they lead Advanced Galvanising into an exciting new era.

CONTACT DETAILS

Telephone:
+27 (21) 951 6242

Website:
www.advancedgalv.co.za

Physical Address:
6 Dorbyl Street, Sacks Circle,
Bellville South, Cape Town

PROVEN, HONEST, SUSTAINABLE CORROSION PROTECTION

If it is coated – it is protected

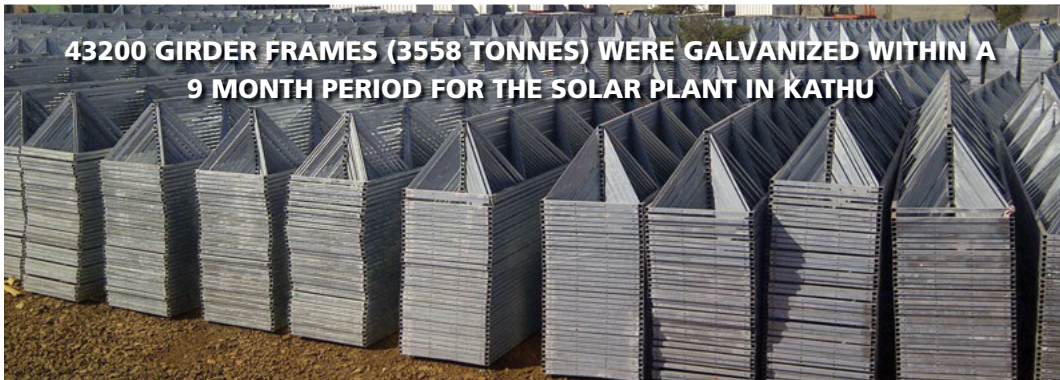
Advanced Galvanising holds the SATAS mark for hot dip galvanizing and all galvanizing done at our premises is in accordance to SANS 121 / ISO 1461 standard.

Established at the site of the *"Old Dorbyl Building"* in Sacks Circle, Bellville-South during 1994 with a kettle size of **14m long x 1.4m wide x 3m deep.**

ADVANCED GALVANISING

Telephone: +27 (21) 951 6242
6 Dorbyl Street, Sacks Circle, Bellville South

www.advancedgalv.co.za



PTL PRODUCTS
COATINGS & CHEMICALS

SOLUTIONS FOR HOT DIP GALVANIZING THROUGH PARTNERSHIPS

PROVIDERS OF ALL CHEMICAL REQUIREMENTS

- Highly efficient, low temperature and cost saving alkaline and acidic degreasers
- Acid fume suppressants and inhibitors
- Full range of fluxes
- Passivation, chrome and chrome 3
- White rust removers
- Paint strippers
- Nickel tablets – proven to reduce zinc pick up and improve overall finish
- Stopgalv – excellent masking product where no galvanizing is required
- Raw materials eg. ammonium chloride, zinc chloride, caustic soda lye
- Powder coating powder for duplex coatings

- **Comprehensive solutions nationwide**
- **Technical support and testing**
- **Product available from your nearest branch**

www.ptl-sa.com

Gauteng: Head Office
Unit 5 Green Africa Industrial Park,
88 Main Reef Road, Wychwood, Germiston
Tel: 011 616 0150/1
Email office@ptl-sa.com

KwaZulu-Natal: Tel: 066 380 5460

CapeTown: Tel: 021 551 9079

Port Elizabeth & East London: Tel: 071 638 6524



GALVANISING CO. LTD
Member of Lampotang Group of Companies

GALVANISING CO. LTD

Results you want

ABOUT

Galvanising Co. Ltd is the market leader in hot dip galvanizing in Mauritius with nearly 40 years of experience in the industry.

GUARANTEE AND CERTIFICATION:

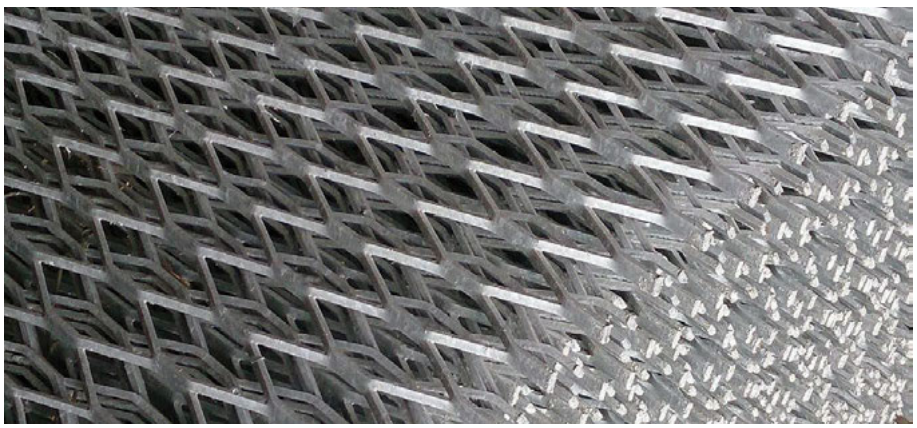
- We are MS ISO 1461:2009 certified
- We issue certification of quality based on MS ISO 1461:2009 upon request

SERVICES OFFERED

- Hot dip galvanizing of bars, tubes and metal structures of different sizes and dimensions.
- Sales of galvanized tubes, bars and expanded metals (retail and wholesale)
- Expert advice and training on pre/post galvanizing care and precautions.

BATH SIZES:

Bath 1: 7m long x 2m deep x 760mm wide



CONTACT DETAILS

Telephone:
+230 234 5118 / 234 5317

Email:
customercare@galvanisingcoltd.com

Physical Address:
DBM Industrial Zone, La Tour Koenig, Pointe aux Sables, Mauritius

INTERNATIONAL



GIMECO IMPIANTI S.R.L.

A galvanizer's single partner and reference for any galvanizing solution

ABOUT

Gimeco has been designing, building, installing and renovating hot dip galvanizing plants since 1976 and, having a past as galvanizers, we are well aware of the needs, specific features and criticality of galvanizing and, more generally, of the metallurgic processes.

Our technicians will be able to determine, together with the client, the most appropriate of all solutions. Whether the construction is configured from scratch starting from free land or inside an already designed warehouse (even in the case of revamping an existing industrial body).

We offer design and technical assistance dedicated to specific products, such as different types of pipes, pylons, lighting poles, motorway barriers and others that involve an entire galvanizing plant and, if necessary, also all the processing phases of the raw product

A Gimeco industrial galvanizing plant has a configuration without "bottlenecks", so that the entire production flow takes place with maximum efficiency, with the lowest possible costs and maximum economic return.

Solutions include the standard configurations with thermal (oven-dryer) and chemical (degreasing-picklingflushing) sections, as well as more complex configurations including transport and lifting automation, for all kinds of production and products of different sizes.

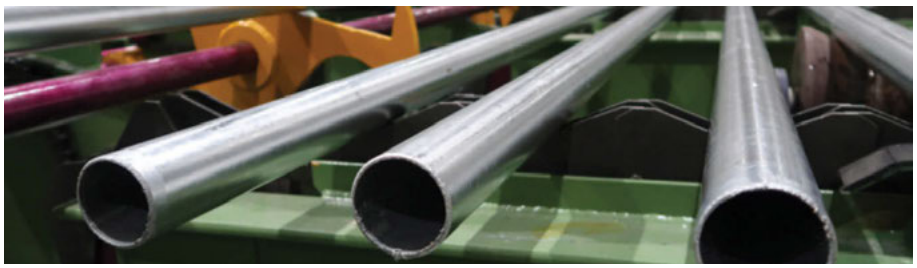
CONTACT DETAILS

Telephone:
+ 39 02 909 60751

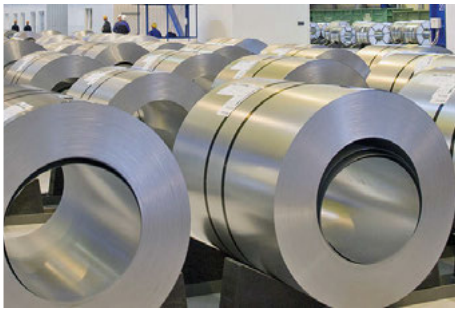
Email:
info@gimeco.it

Website:
https://gimeco.com

Physical Address:
Via Primo Maggio, 31, 20060,
Trezzano Rosa, Milan, Italy







SHREETECH INTERNATIONAL

Metal solutions with a “green heart”

ABOUT

Shreetech International is a leading manufacturer of high quality speciality chemicals used in various metal treatment industries, from galvanizing to phosphating, colour coating, wire drawing, water treatment, ship building, radiator manufacturing and other specialized industries.

All our products are manufactured with green chemistry at heart, not only ensuring they are environment-friendly, but also reducing the consumption of energy in plants and providing excellent zinc saving for the clients.

With over 40 years of experience, our products are exported to over 35 countries around the world. All our products are REACH compliant and are packed and labelled as per the CLP regulations. This has enabled us to export our products to various countries in the European Union.

Our products are broadly classified into 5 categories based on their use:

Pipe galvanizing chemicals: Products designed by us ensure galvanized articles meet the required amount of coating on both outer and inner surfaces and provide a smooth and uniform coating along the periphery thus protecting the pipe/tube over the entire surface.

Hot dip galvanizing: Shreetech International caters to the entire line of hot dip galvanizing through quality chemicals tailor-made for each stage of the pre- and post-galvanizing process. Our R&D department strives to provide the best products and ensure constant enhancement and innovation in a quest to achieve optimum results.

Wire drawing: Specially formulated products for the delicate process of wire galvanizing.

Continuous galvanizing line: The comprehensive field of continuous galvanizing is one that requires constant innovation and development. Keeping in mind the distinctive needs of both the flux and non-oxidation lines, we have carefully formulated a wide range of products.

Metal treatment: We have diversified our product offering into various metal treatment industries. With utility in mind, we offer some unique products for the following industry segments: pipe manufacturing / ship building; the radiator industry; and Galvalume lines.

CONTACT DETAILS

Telephone:
+91 22 42144545

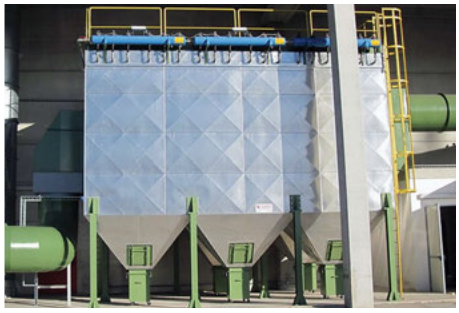
Email:
pnmenon@bom5.vsnl.net.in

Website:
https://shreetechinternational.com

Physical Address:
521/522, 2nd Floor Solitaire, Corporate Park, Bldg No:5, Andheri Ghatkopar Link Road, Chakala, Andheri East, Mumbai 400093, India

INTERNATIONAL





SIRIO

SIRIO GALVANIZING PLANTS - ITALY

The best solution for general, centrifuge and pipes hot dip galvanizing plants

ABOUT

SIRIO was founded in 1987 as an independent, complete and flexible company, based in Senago (MI). With its know-how, SIRIO supplies the best solution to realize turnkey projects for general hot dip galvanizing plants, centrifuge hot dip galvanizing plants and pipes galvanizing plants. Together with our sister company SIRIO WIRE, SIRIO also supplies turnkey projects for pickling and phosphating plants for wire rod, pipes, bars and profiles and small parts.

SIRIO plants include all the most restrictive environment protection systems and operator safety systems imposed by the European Community. The operational structure of SIRIO is composed of a qualified and professional team of technicians who are part of a modern engineering office. This team operates inside the factory where there is an equipped modern mechanical workshop for the construction of all the parts that compose our plants. The technical structure uses the most advanced design systems with the possibility of a remote control of the realized plants by means of management and remote assistance systems.

SIRIO technicians and skilled workers guarantee the installation of the equipment and a prompt assistance in case of need.

CONTACT DETAILS

Telephone:
+39 02 99 82 277

Email:
liuba@sirioimpanti.com

Website:
https://www.sirioimpianti.com

Physical Address:
Sirio S.r.l, Via Piemonte, 39/41,
20030 Senago (Milan), Italy



W. PILLING

Galvanizing solutions and precision weldments since 1873

For over 150 years, W Pilling has been a trusted name in the metalworking industry, beginning with the manufacture of waterwheels and annealing pots for the wire industry in Altena. Founded by Ludwig Lüling and Wilhelm Pilling, the company has evolved into a global leader in high-performance furnace inserts and custom weldments.

Operating from modern facilities in Altena and Riepe, W Pilling produces an extensive range of products, including:

- Galvanizing kettles
- Custom components for hot dip galvanizing, die-casting, wire and strip steel processing, metal fusion, and heat treatment applications
- Cauldrons and crucibles
- Tubs and muffles
- Annealing hoods

Our solutions are trusted in over 100 countries, with a focus on tailor-made, German-engineered products.

Galvanizing kettles – manufactured exclusively in Riepe

Our Riepe plant specializes in the production of galvanizing kettles, manufacturing over 300 units annually with wall thicknesses up to 80mm. We support a wide range of sizes, shapes, and weights, serving both jobbing galvanizing operations and sheet galvanizing lines.

Special features include:

- Custom cladding for aluminium-containing zinc alloys, providing superior corrosion resistance
- Warm-forming processes to reduce mechanical stress during manufacturing
- Electroslag welding in a single layer for consistent heat input and structural integrity

To complement our kettles, we also provide zinc bottom dross shovels, precision-designed for optimal fit and functionality based on the kettle's specifications.

W Pilling continues to uphold a tradition of engineering excellence, offering individualized solutions that meet the highest standards of quality, safety, and performance.

CONTACT DETAILS

W. Pilling Riepe GmbH & Co. KG

Telephone:
+49 (0) 23 52 / 20 15 - 0

Email:
post@pilling.de

Website:
www.pilling.de

Physical Address:

Gutenbergstraße 2
26632 Ihlow-Riepe

CLASSIFIED listings

GALVANIZING MEMBERS

Bay Galvanisers
110 Alumnia Allee Street, Alton, Richards Bay
Tel.: +27 (0)35 751 1942
don@problast.co.za

Galferro Galvanisers
Cnr Neon & Radon Road, Fulcrum, Springs
Tel.: +27 (0)11 817 3667
leana@galferro.co.za

Galvanising Techniques (Pty) Ltd
52 Burman Road, Deal Party, Gqeberha
Tel.: +27 (0)41 486 1432
ian@metalman.co.za

Galvatech (Pty) Ltd
52 Sacks Circle, Bellville South, Cape Town
Tel: +27 (0)21 951 1211
info@galvatech.co.za

Morhot Galvanisers
Site 4, Indwe Road, Fort Jackson,
East London, Eastern Cape
Tel.: +27 (0)43 763 1143
morhotgalv@gmail.com

THE ASSOCIATION WOULD LIKE TO ACKNOWLEDGE THE ADVERTISERS AND THANK THEM FOR THEIR SUPPORT

Pro-Tech Galvanizers (Pty) Ltd
12 Fabriek Cres, Vosterkroon, Nigel
Tel.: +27 (0)11 814 4292
jonathan@protechgalvanizers.co.za

South Cape Galvanizing (Pty) Ltd
11 Ring Road, George Industria, George
Tel.: +27 (0)44 884 0882
johan@scgalv.co.za

AFFILIATE MEMBERS

Abeco Tanks (Pty) Ltd
6A Bradford Road, Bedfordview
Tel.: +27 (0)11 616-7999
manniejnr@abeco.co.za

BAMR (Pty) Ltd
4 Palm Street, Newlands, Cape Town
Tel.: +27 (0)21 683 2100
sales@bamr.co.za

Central Support Systems (Pty) Ltd
34 Mount Ida Road, Robertsham,
Johannesburg South
Tel.: +27 (0)11 492 2314
sherritk@css.za.com

CIS Engineering (Pty) Ltd
8 Firestone Street, N.W. 7, Vanderbijlpark
Tel.: +27 (0)16 986 1135
christo@cisengineering.co.za

Columbus Steel (Pty) Ltd
Tel.: +27 (0)13 247 2848
dutoit.sean@columbus.co.za

Corrosion Institute of Southern Africa
38 Allan Road, Glen Austin, Midrand
Tel.: +27 (0)10 224 0761
director@corrisa.org.za / admin@corrisa.org.za

Duplex Coatings (Pty) Ltd
Unifront Industrial Park, 7 Dekema Road,
Wadeville, Germiston
Tel.: +27 (0)87 701 5743
shanons@duplexcoatings.co.za

Furipoint (Pty) Ltd
72 Connaught Road, Parow Valley
Tel.: +27 (0)74 143 8409
mo@furipoint.co.za / accounts@furipoint.co.za

Hennwill Engineering (Pty) Ltd
13 Bunsen Street, Industria, Johannesburg
Tel.: +27 (0)11 473 1800
derrick@hennwill.co.za

Macsteel Group
7 Brook Street, Lillianton, Boksburg
Tel.: +27 (0)11 871 4875
franco.mordini@macsteel.co.za

Mast Projects cc
10 Milne Road, Vulcania, Brakpan
Tel.: +27 (0)11 306 7000
jaco@mastprojects.co.za

Mentis Africa
147 North Reef Road, Activia Park, Elandsfontein
Tel.: +27 (0)11 255 3231
neels.buitendag@mentis.com

O-Line (Pty) Ltd
14/16 Prop St, Selby Ext 11, Johannesburg
Tel.: +27 (0)11 378 3701
smart.graeme@o-line.com /
grobler.natasha@o-line.com

PCW Tank (Pty) Ltd
290 Kwanbi Cress, Sunderland Ridge, Centurion
Tel.: +27 (0)82 907 7661
riaan@pipecoza.com

Southern African Institute of Steel Construction
Unit F7, The Block, 1 Tamchele Avenue, Beverly,
Fourways
Tel.: +27 (0)11 726 6111
waydene@saisc.co.za / elrika@saisc.co.za

Weartech (Pty) Ltd
187 Galjoen Street, Wadeville
Tel.: +27 (0)11 824 6010
adam@weartech.co.za

ASSOCIATE MEMBERS

CBC Fasteners (Pty) Ltd
6 Coppinger Street, Factoria, Krugersdorp
Tel.: +27 (0)11 767 0000
rob@cbc.co.za

Chemplus
2877 Albertina Sisulu Road, Technikon, Roodepoort
Tel.: +27 (0)11 760 6000
tomc@chemplus.co.za

PTL Products
Unit 5-6, Green Africa Industrial Park,
88 Main Reef Road, Wychwood, Germiston
Tel.: +27 (0)11 616 0150
office@ptl-sa.com

Three Sixty Commodity Solutions (Pty) Ltd
First Floor, Kildare Centre, Cnr Kildare Road and
Main Street, Newlands, Cape Town
Tel.: +27 (0)21 013 3530
craig@three-sixty.co.za

CORPORATE MEMBERS

Arcelormittal South Africa
3 Delfos Boulevard, Vanderbijlpark
Tel.: +27 (0)16 889 9111
colin.thomas@mittalsteel.com

INTERNATIONAL MEMBERS

Anglobal – Galvostahl
Luanda, Angola
Tel.: +244 222 022 394
custodia.gunga@anglobal.co.ao

Asia Pacific General Galvanizing Association
Melbourne, Australia
Tel.: +61 3 9654 1266
secretariat@galvanizingasia.com

Atun Kimya SAN. TIC. A.Ş.
Istanbul, Turkye
Tel.: +90 0216 491 29 87
huden@atunkimya.com

Galvanising Co Ltd – Mauritius
Pointe aux Sables, Mauritius
Tel.: +230 234 5118
factory@galvanisingcoltd.com

Gerald Haynes CEng MIMMM
Devon, United Kingdom
Tel.: +44 7930 841866
Gerald@CTCConsultants.net

Namzinc (Pty) Ltd
C13 Road Rosh Pinah, Namibia
Tel.: +264811555442
wchigumira@vedantaresources.co.na

AVAILABLE FROM THE ASSOCIATION

METAL-PRO GALV-FRIENDLY MARKERS

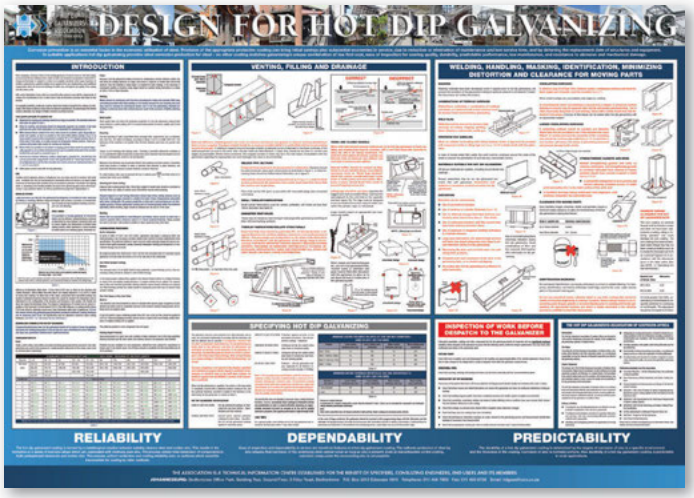
Designed for use in the hot dip galvanizing process, this **marking pen** stays on during fabrication but is removed completely in the galvanizing process.

PRO FEATURES

- Permanent marks during fabrication
- Ergonomic non-slip rubber PRO GRIP®
- Marks on wet and oily surfaces
- 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

CALL NOW FOR PRICES

CONTACT CHANTÉLL AUCAMP +27 (0)10 746 8927 OR EMAIL hdgasa@icon.co.za

TRANSVAAL GALVANISERS

QUALITY SPECIALISTS IN DIP & DRAGLINE GALVANISING

Transvaal Galvanisers is the largest capacity galvaniser in Africa, operating 4 hot dip galvanising lines on a single premises.

Our biggest zinc kettle allows for the galvanising of 14 tonnes of material in a single dip.

As galvanising experts we pride ourselves on offering you the highest quality finished products, customer service and advice.

011 - 814 - 1113/4 | www.transgalv.co.za | transgalv@transgalv.co.za